

SEVEN
EDITORA
2026

Horizons of Insight:

Exploring the Frontiers of Multidisciplinary Science

1ST EDITION

Seven Publicações
(Organização)

EDITOR-IN-CHIEF

Prof^o Me. Isabele de Souza Carvalho

EXECUTIVE EDITOR

Nathan Albano Valente

BOOK ORGANIZERS

Seven Publications LTDA

EDITORIAL PRODUCTION

Seven Publicações Ltda

EDITORIAL DESIGNER

Stephanie Caroline Meyer de Quadros

TEXT EDITING

Isabele de Souza Carvalho

TRANSLATION

Isabele de Souza Carvalho

ART EDIT

Evellyn Thais de Souza

LIBRARIAN

Bruna Heller

COVER IMAGES

AdobeStok

2026 by Seven Editora

Copyright © Seven Editora

Text Copyright © 2026 The Authors

Copyright of the 2026 Edition © Seven Editora

The content of the text and its data in its form, correctness, and reliability are the sole responsibility of the authors and do not necessarily represent the official position of Seven Publicações Ltda. The download of the work and sharing it is allowed as long as credits are attributed to the authors but without the possibility of altering it or using it for commercial purposes.

All manuscripts were previously submitted to blind peer review, members of the Editorial Board of this Publisher, and were approved for publication based on criteria of neutrality and academic impartiality.

Seven Publicações Ltda is committed to ensuring editorial integrity at all stages of the publication process, avoiding plagiarism and fraudulent data or results, and preventing financial interests from compromising the publication's ethical standards.

Suspected situations of scientific misconduct will be investigated under the highest standard of academic and ethical rigor.



The contents of this book have been submitted by the authors for open-access publication, under the terms and conditions of the Creative Commons 4.0 International Attribution License

EDITORIAL BOARD

EDITOR-IN-CHIEF

Prof. Me. Isabele de Souza Carvalho

EDITORIAL BOARD

Adriana Barni Truccolo - State University of Rio Grande do Sul
Adriana Barretta Almeida - Federal University of Paraná
Alessandre Gomes de Lima - Faculty of Medicine of the University of Porto
Anderson Nunes Da Silva - Federal University of Northern Tocantins
Antonio da Costa Cardoso Neto - University of Flores Buenos Aires
Antônio Alves de Fontes-Júnior - Cruzeiro do Sul University
Ariane Fernandes da Conceição - Federal University of Triângulo Mineiro
Arnaldo Oliveira Souza Júnior - Federal University of Piauí, CEAD
Caio Vinicius Efigenio Formiga - Pontifical Catholic University of Goiás
Charles Henrique Andrade de Oliveira - University of Pernambuco
Egas José Armando - Eduardo Mondlane University of Mozambique
Inaldo Kley do Nascimento Moraes - State University of Southwest Bahia
Irlane Maia de Oliveira - Federal University of Mato Grosso
Janyel Trevisol - Federal University of Santa Maria
Jorge Fernando Silva de Menezes - University of Aveiro
Jorge Luís Pereira Cavalcante - Iberoamerican University Foundation
Kleber Farinazo Borges - University of Brasília
Luiz Gonzaga Lapa Junior - University of Brasília
Mara Lucia da Silva Ribeiro - Federal University of São Paulo
Marcelo Silva de Carvalho - Federal University of Alfenas
Marcos Garcia Costa Moraes - State University of Paraíba
Maria Gorete Valus - University of Campinas
Mônica Maria de Almeida Brainer - Federal Institute of Goiás Ceres Campus
Moacir Silva de Castro - Pontifical Catholic University of São Paulo
Paulo Roberto Duailibe Monteiro - Fluminense Federal University
Pedro Henrique Ferreira Marçal - Vale do Rio Doce University
Rafael Braga Esteves - University of São Paulo
Telma Regina Stroparo - State University of Ponta Grossa
Valéria Raquel Alcantara Barbosa - Oswaldo Cruz Foundation
Wanderson Santos de Farias - University of Sustainable Development
Yuni Saputri M.A - Nalanda University, India

International Cataloguing in Publication Data (CIP)
(Brazilian Book Chamber, SP, Brazil)

S498h Seven Editora.

Horizons of Insight [recurso eletrônico] : Exploring the
Frontiers of Multidisciplinary Science / Seven Editora. –
São José dos Pinhais, PR: Editora Seven, 2026.

Dados eletrônicos (1 PDF).

ISBN 978-65-6109-267-8

1. Pesquisa. 2. Inovação. 3. Conhecimento.
I. Título.

CDU 001.8

Bruna Heller - Librarian - CRB10/2348

Indexes for systematic catalog:

1 Pesquisa científica 001.8

DOI: 10.56238/sevened2026.008-

Seven Publicações Ltda
CNPJ: 43.789.355/0001-14
editora@sevenevents.com.br
São José dos Pinhais/PR

AUTHOR'S STATEMENT

The author of this work DECLARES, for the following purposes, that:

Do not have any commercial interest that generates a conflict of interest about the published content;

Declares to have actively participated in the construction of the respective manuscripts, preferably under the following conditions: "a) Study design, and/or data acquisition, and/or data analysis and interpretation; b) Preparation of the article or revision to make the material intellectually relevant; c) Final approval of the manuscript for submission";

Certifies that the published text is completely free of data and/or fraudulent results and authorship defects;

Confirms the correct citation and reference of all data and interpretations of data from other surveys;

Acknowledges having informed all the sources of funding received to carry out the research;

Authorizes the editing of the work, including catalog records, ISBN, DOI, and other indexers, visual design and creation of the cover, and internal layout, as well as its release and dissemination according to the criteria of Seven Eventos Acadêmicos and Editora.

EDITOR'S STATEMENT

Seven Publications DECLARES, for rights, duties, and any methodological or legal meanings, that:

This publication constitutes only a temporary transfer of copyright, constituting a right to publication and reproduction of the materials. The Publisher is not co-responsible for the creation of the published manuscripts, under the terms established in the Copyright Law (Law 9610/98), in article 184 of the Penal Code and in article 927 of the Civil Code; The author(s) is solely responsible for verifying such copyright and other issues, holding the Publisher harmless from any civil, administrative, and criminal damages that may arise.

Authorizes the DISCLOSURE OF THE WORK by the author(s) in lectures, courses, events, shows, media, and television, provided that there is due recognition of the authorship and edition and without any commercial purpose, with the presentation of the due CREDITS to SEVEN PUBLICATIONS, being the author(s) and publisher(s) responsible for the omission/exclusion of this information;

All eBooks are open access, so don't sell them on your website, partner sites, e-commerce platforms, or any other virtual or physical medium. Therefore, it is exempt from copyright transfers to authors, since the format does not generate rights other than the didactic and advertising purposes of the work, which can be consulted at any time.

All members of the editorial board are PhDs and linked to public institutions of higher education, as recommended by CAPES to obtain the Qualis book;

Seven Eventos Acadêmicos does not attribute, sell, or authorize the use of the authors' names and e-mails, as well as any other data of them, for any purpose other than the dissemination of this work, following the Civil Rights Framework for the Internet, the General Data Protection Law and the Constitution of the Federative Republic.

AUTHORS

Acácia Sayuri Wakasugi
Ádila Marta da Silva e Silva
Adilson Oliveira Cruz
Adjalma Campos de França Neto
Adria Amanda Carvalho Jacinto
Adria Stephanie Xavier Barroso
Adrian Willy da Silva Borges
Adriana Almeida dos Santos
Adriana Gusmão Trajano de Araújo
Adriana Santos Araujo
Adriana Silva dos Santos
Adrielle Samara de Castro Bezerra
Aguida Marques Pereira dos Santos
Ailton Ferreira Cavalcante
Aírton Ribeiro dos Santos
Alaan Ubaíara Brito
Alahna de Oliveira Lopes
Alberto Carlos de Melo Lima
Alberto Consolaro
Alcibíades Medina M.
Alcides Feitosa Neto
Aldeize Santos Tribuzy
Aldina da Silva Melo
Alejandra Filippo Gonzalez Neves dos Santos
Alejandro Pérez-Duarte Fernández
Alessandra Aniszewski Kucner
Alessandra Gusmão Trajano de Araújo
Alessandra Helen Alves Claudino
Alessandra Mendes Monteiro
Alessandra Souza Garcia
Alessandro Morais Cunha
Alexandra Aparecida Borges de Souza
Alexandra Pantoja Monteiro
Alexandre Holanda Damasceno
Alexandre Nascimento de Almeida
Allan Andrade de Souza
Allana Eduarda Braga Iquegami
Allynson Takehiro Fujita
Allyson Yann Batista Santos
Alvaro Antônio da Silva
Álvaro Luiz Jesus dos Santos
Amanda Cavalcanti Pinheiro Barbas
Amanda da Rosa Lena
Amanda Diniz Medeiros
Amanda dos Santos Gonçalves
Amanda Emanuele dos Santos Correa
Amanda Martins Araújo

Amanda Myrianne Dobzinski
Amanda Queirolo Ribeiro da Cruz
Ana Caroline Justo Bellafronte Rique
Ana Clara Alves Nunes
Ana Claudia da Silva Barroso
Ana Cláudia Ferreira da Silva
Ana Cristina Figueira de Almeida de Souza Ramos
Ana Edvirens Vasconcelos de Souza
Ana Flávia Faria Paiva
Ana Júlia Bezerra Martins
Ana Katherine Silveira Pereira Caracas
Ana Kellen Parente do Nascimento
Ana Laura de Souza Gonçalves
Ana Luiza Normanha Ribeiro de Almeida
Ana Luiza Silva Teixeira
Ana Luzia Ferreira Farias
Ana Maria Rita Pedroso Vilela Torres de Carvalho
Engel
Ana Paula Fernandes Teixeira
Ana Paula Moraes Camacho Estrela
Ana Paula Schonarth
Ana Sheila dos Santos Gomes
Ana Thais Bagatini
Andre Augusto Nobrega Dantas
Andre de Oliveira Melo
André Gomes dos Santos
André Luis Rocha de Souza
André Rausch Carellos Silva
Andréa Huhn
Andréia de Carvalho Knipp
Andréa King de Abreu Yamaguchi
Andressa Carvalho de Oliveira
Andressa Érica Ávila Pinheiro
Andressa Karina Stefani
Andressa Marjory
Ángel Gutiérrez Rodríguez
Angela Issa Haonat
Angela Maria Corrêa Mouzinho Santos
Angela Paula da Silva Pessoa
Angela Zamora Cilento de Rezende
Anna Monise Rigon Von Heimburg
Anna Paula Lemos Santos Peres
Anna Virgínia Muniz Machado
Antônio Artur de Souza
Antonio Carlos Cortez Pinheiro
Antonio Cássio Vaz
Antonio Coêlho Soares Junior

Antonio Cordeiro de Souza Junior
Antonio Escandiel de Souza
Antonio Henrique Figueira Louro
Antonio Marcos Nogueira Sodré
Antonio Marinho do Nascimento
Antonio Werbiton Marinho Almeida
Áquila Jerard Moulin Ditzz
Ariana Oliveira Gusmao
Arthur Galvão de Mendonça
Arthur Rodrigues Lourenço
Arthur Sandro Golombieski Ferreira
Ary dos Santos Pinto
Athyla Caetano
Átila Bonfim Ferreira Cavalcante
Aurélia Regina de Souza Honorato
Bárbara Corrêa Garcia Simões
Beatriz Andreia Melo Silva Cossaros
Beatriz Barros Silva
Beatriz Silva Freitas
Benedito Gomes Bezerra
Betania Jacob Stange Lopes
Bianca Bispo dos Santos
Bianca Lemos Cobra
Bianca Souza Alves França
Bibiana de Paula Friderichs
Biratan dos Santos Palmeira
Bruna Maria Silva Frauches
Bruna Sthefani Santos Guimarães
Bruno de Omena Celestino
Bruno Lucas Ferreira
Cainã Guimarães Soares
Caio Nordi Jorge Armani Cirino
Camila Aline Lázaro
Camila Bruschi Tonon
Camila Gonçalves Ribeiro
Camila Lima dos Santos
Camila Silva Campos
Camila Soares Ramos
Carla Boin
Carla Maria Caldas Figueiredo
Carla Sabrina dos Santos Souza
Carlos Adrian Gomes de Oliveira
Carlos Alberto Pereira da Silva Junior
Carlos Augusto Tenório Cândido
Carlos Eduardo do Nascimento
Carolina Aparecida dos Santos
Carolina Aparecida dos Santos
Caroline de Medeiros
Caroline Fofano de Almeida
Caroline Gisele Santos Silva

Caroline Scalabrin de Oliveira Alves
Cecília Leite Oliveira
Celestina Lima de Rezende Farias
Cezar Augusto Romano
Cezar Ricardo Lima Neves
Christian Guilherme Capobianco dos Santos
Cícero Henrique Macêdo Soares
Cileide Tavares Borges do Couto
Cinthia Marie Ota Fraletti
Cintia Canato Martins
Clarissa Melo Lima
Claudia Christina Ribeiro Guimarães Neri de Magalhães
Claudia Regina Biancato Bastos
Cláudio Gonçalves da Silva
Claudio Noel de Toni Junior
Cleber Rebelo Israel Reis
Cleidjane Gomes Faustino
Cleiton Mendes Honorato Sousa
Clicia Ferreira Gardenal
Conceição Mikaelly de Vasconcelos Linhares
Cristiana Maria do Valle Freitas
Cristiane Almeida Lisboa
Cristiano Veloso
Cristina Berger Fadel
Cristina Carla Xavier da Silva
Cristina Gomes de Souza
Cristina Picanço de Sousa Corrêa
Cristine Barbosa Malafaia
Dafinhê Thor Castro de Martins Barros
Daniel Amin Ferraz
Daniel Dias Machado
Daniel Fernandes Argolo
Daniel Galvão de França Blaskiewicz
Daniel Sypriano de Sales
Daniela Braga de Sousa
Daniela Faria de Souza
Daniela Pauletto
Danielle Uessler
Daniely Verônica Cardoso Carvalho
Dante Gallian
Dante Matheus de Almeida dos Reis
Danubio Freire Gomes de Matos Neto
Danusa Mayara de Souza
Dario Deivid Silva da Silva
Daurenice Lopes de Araújo Vaz
Davi Nunes da Silva
Davi Victal Pacheco
Dayla Corrêa Campos
Dayse Andrade Romão

Dayvison Santos de Oliveira
Décio Luiz Meireles Tavares
Delson Fernando Barcellos Xavier
Denilson Albano Portácio
Dênio Ramam Carvalho de Oliveira
Denis Forte
Denise Bolzan Berlese
Denise Soares de Alcantara
Diego Augusto Carneiro Junho
Diego Mariozi Ferreira
Diego Saraiva de Mello
Dilce Pio Nascimento
Dimas Melo Gonçalves
Dimas Melo Gonçalves
Dimas Melo Gonçalves
Divaldo Martins de Souza
Djuli Margô Naissinger Sidekum
Ed Ernest Taves
Éder do Vale Palheta
Ederaldo José Pereira Lima
Edgard Siza Tribuzy
Edilaine Cristina Pamplona Menezes
Edilaine Cristina Pamplona Menezes
Edla dos Anjos Cardoso
Edmilson dos Santos Moraes
Edrei Santos de Lima
Edson da Silva Barros
Edson Igreja Bentes
Eduarda de Matos Lopes
Eduardo Castedo Abrunhosa
Eduardo Dionathas Firmino
Eduardo Silva Rodrigues
Eduardo Winter
Edwaldo Costa
Eglalciane de Lyrio Tongo Castro
Elauton Guerra Mota de Farias
Elda Lenilma Palheta Alves
Elenara Barbosa Machado Neves
Eliane do Socorro Ferreira da Silva
Elicardo Heber de Almeida Batista
Eliecer Cedeño
Eliney Alessandro Vieira Cardoso
Elizabeth de Fátima Correia
Elizabeth Ferreira da Silva
Ellen Regina da Costa Paes
Elsimar Souza Santos
Elton Silva de Moura
Emanuele Ferreira Gomes
Emanuella Maria Elen Moraes Sousa
Emanuelle Vieira Nogueira

Emanuelly Garcia de Sousa Moraes
Emerson Roberto dos Santos
Emile Danielly Amorim Pereira
Emily Pereira Lima
Erica Nunes dos Santos
Estela Pazeto Nolêto
Eudes Quintino de Oliveira Júnior
Eva Dayna Felix Carneiro
Evanildo Vieira dos Santos
Evelton Cezar Bitencourt
Evelyn de Oliveira Vieira da Silva
Everaldo dos Santos Mendes
Everton Moura Arruda
Eviny Torres De Jesus
Fábia Jaqueline Miranda Nobre
Fabiano de Paiva Sales
Fabiano Prudêncio da Silva
Fábio Henrique Marinho Cabral
Fabio Robson Casara Cavalcante
Fabíola Thomaz Maia
Fabrício Moraes de Almeida
Fabricio Ziviani
Fâni Ribeiro Silva
Fani Tamires de Souza Batista
Febrina Dafit
Felipe Azevedo Rios Silva
Felipe da Silva Leite
Felipe Fontana
Felipe Renato de Castro Rodrigues
Felipe Teles Tourounoglou
Felipe Vieira Barbosa
Fernán Enrique Vergara Figueroa
Fernanda Caroline Conrado
Fernanda de Medeiros Costa
Fernanda Scharf
Fernanda Souza de Sales
Fernando André de Oliveira Duarte
Fernando Antônio de Medeiros
Fernando Carrilho da Silva
Fernando Melo da Silva
Filipe Barbosa Martins
Filomena Maria G. da Silva Cordeiro Moita
Flávia Alves do Amaral
Flávia Cristina Custódio
Flávia da Silva Fernandes
Flávia Maria Silva Brito
Flávio Carvalho Cavalcante
Flávio de São Pedro Filho
Flavio Evangelista Silva
Flávio Furtado de Farias

Flavio Maracajá	Gisele dos Santos Mendonça
Flávio Marcelo Cavalcante Mota	Gisele Giandoni Wolkoff
Flávio Ribeiro da Costa	Gisele Giandoni Wolkoff
Francisca Elsa Silva Franklin	Giselle Medeiros do Nascimento
Francisca Marli Rodrigues de Andrade	Giselle Pestana Godoi
Francisca Moraes da Silveira	Giuliana Valderano de Lima
Francisca Vanessa de Carvalho Lima	Giuliano Citrini Stipkovic
Francisco de Almeida Lobo	Givanildo Ximenes Santana
Francisco de Sousa Vieira Filho	Giza Guimarães P. Sales
Francisco Denis Pereira Chaves	Glenda Almeida Matos Moreira
Francisco Ernani Alves Magalhães	Gleyce Adrielle da Silva Rodrigues
Francisco Fabio Braga Florêncio	Gloria de Lourdes Silva de Oliveira Melo
Francisco José de Oliveira Neto	Graciene Rabelo Mota e Silva
Francisco José Lopes Cajad	Graciete Nascimento Barbosa
Francisco Lúcio de Lira Mendonça	Gracyeli Santos Souza Guarienti
Francisco Roberto Rojas Caldelas	Grasiele Mattei Ise dos Santos
Francisco Xavier Gomes Pantoja Junior	Graziela Fernanda Bonato
Franscristhiany Silva Souza	Graziele Martins Fraga Nascimento
Frederico Cordeiro Martins	Graziele Queiroz Mazete Maran
Gabriel Adolfo Gomes Potin	Guajarina do Socorro Carmo de Sousa Camarão
Gabriel da Silva Nepomuceno Flores	Guilherme de Azevedo Mendes Corrêa Guimarães
Gabriel Ferreira dos Santos	Guilherme Pereira Amorim
Gabriel Jorge Pradera	Guiomar Rocha Pereira Magalhães Bittencourt
Gabriel Lima Oliveira Martins	Gustavo Augusto Teixeira de Fatima
Gabriel Paz de Lima	Gustavo Davanco Nardi
Gabriela Caroline Alves Claudino	Gustavo Viana de Lima
Gabriela Cristina Duarte	Hanna Cristina Ferreira Assunção Neves
Gabriela Fernanda Schiochet	Héctor Fabian Gutiérrez Rangel
Gabriela Rocha Vidal Silva	Heden Robson Monteiro Souza
Gabriela Trentin Zandoná	Helaine de Oliveira Menezes
Gabrielle Castilho Alves Silva	Hélio Nascimento da Paixão Júnior
Gabrielly Hneda Fadel	Hêmilly Suélen Sousa Guilherme
George Bedinelli Rossi	Henrique Barcelos Brandão
Georgete Lopes Freitas	Henrique de Sousa Mangueira
Geovane dos Reis Dantas	Henrique Leite França Comes
Geovani Broering	Henrique Ribeiro da Glória Antunes
Geovani Broering	Henry Armas Murrieta
Geovani Broering	Heraldo Márcio de Aguiar
Geovani Rafael Lima Cavaleiro	Hévilley Yorrana Alcântara Aguiar
Geraldine Alves dos Santos	Hildeberto Pedro Paixão
Geraldo Nunes Corrêa	Hubert André Nunes Dos Santos
Gerusa Ribeiro	Humberto Henrique Ramos Brotto
Gil Eduardo Guimarães	Ianka Lustosa Resplande
Gilberto Rodríguez Montufar	Idalisio Soares Aranha Neto
Gilmar Santos Batista	Igor Alexandre Klaic
Gilson Aires de Menezes Júnior	Ilcimar Gomes Vieira Costa
Giovana dos Santos Couto	Ingrid Winkler
Giovanna Couto de Sá	Ingrid Winkler
Giovanna de Souza Frasson	Iolene Mara Cardoso de Matos
Girleene Figueiredo Maciel	Irene Mendes Fontes

Isabela Braga Zanetti
Isabela de Andrade Lima Barreto Lins
Isabela Lima Quadros
Isabela Morette
Isabela Nunes Tavares
Isabele Luzia Rodrigues Alves de Freitas
Isabella Holanda da Silva
Isabella Ravazoli
Isadora Soares Pissanelli
Isis Souza Rabelo
Iva Zaiza Valente Sobral
Izabel Cristina Dell'Antônio Piva
Izamara de Sousa Oliveira
Jacqueline Parente de Sousa
Jadson Justi
Jadson Miranda Oliveira
Jair Moisés de Sousa
Jamile da Silva Teixeira Goes de Jesus
Janaína Aparecida de Sales Floriano
Janaina Corrêa dos Santos
Jander Marcus Cirino Lopes
Jane Carla Marinho de Souza Maia
Janiele da Silva Melo Rabelo
Jaqueline Alexsandra Azevedo Ferreira
Jardelson de Medeiros Silva
Jayna Dannice Borges do Nascimento
Jean Rafael Ribeiro
Jean-Claude Martins de Andrade
Jeanisson Cesar Mariano Silva
Jefferson Carvalho Galvão
Jennifer Kelly Abreu Melo
Jéssica Carneiro de Camargo
Jessica Saldanha Martins
Jessyca Caroline Rocha Ribas
Jesus Enrique Reyes Acevedo
Jhennifer Stefany Teles Gonçalves
João Arthur Alves de Souza
João Batista Melo Lima
João Carlos da Silva
João Carlos Lisboa de Lima
João Daniel de Souza Menezes
João Gabriel Gonçalves França Vasconcelos
João Gabriel Wibelinger Holtermann
João Guilherme de Oliveira Duarte
João Lopes Rodrigues
João Paulo do Carmo
João Pedro Almeida Antunes dos Santos
João Pedro Da Silva
João Pedro de Souza Coelho
João Pinheiro de Barros Neto

João Ricardo Costa Silva
João Ricardo Nobre Ramos
João Santana Alves
João Victor Abreu Rodrigues
João Victor de Vasconcellos Ferreira
João Vitor dos Santos Sobrinho
João Vitor Lima Sousa
Joaquim Carlos González
Joaquim Ribeiro de Souza Junior
Jobson Costa Sousa
Jocelma Almeida Rios
Jocimar de Souza
Joel Carlos Zukowski Junior
Joel de Abreu Nobre
Joelson Miller Bezerra de Sousa
Jonas Eligio Garcia de Azevedo
Jonathan Joaquim de Moraes
Jonathan Silva Ribeiro
Jordana Lima Braga
José Benedito Guimarães Junior
José Caetano Serafim Neto
José Carlos Cogo
José Célio Silveira Andrade
José Domingos Alves dos Santos
José Eduardo Vieira da Silva
José Leandro Santos Pessoa
José Luís de Barros Guimarães
José Manuel Salum Tomé
José Maria Viana dos Santos
José Neto de Oliveira Felipe
José Reginaldo Hughes Carvalho
José Reudson de Souza
José Ricarte de Lima
José Roberto Alves Moreira
Jose Santos Xavier
José Seixas de Aquino Filho
José Valentim Martins Melo
Joshua Pinto Farias de Almeida
Josieli Moris Gomes Calderano
Josiette de Nazaré Silva da Costa
Josineide Pantoja da Costa
Josué Vicente de Carvalho
Júlia Mayumi Imamura
Júlia Wagner Pedrazzi
Juliana Alves Coelho
Juliana Do Amor Divino Tavares
Juliana Penha Messias
Juliana Zenóbia Costa Dias
Julianne Alvim Milward-de-Azevedo
Juliano Schimiguel

Júlio Cesar André
Julio Vieira Neto
Júnio Fábio Silva do Vale
Jusceliany Rodrigues Leonel Correa
Juscelino Silva
Juscelio Clemente de Abreu
Kaio Henrique Rodrigues Nazário
Kalebe Galvani da Silva
Karen Renatta Barros Rodrigues
Karine Silva Camargo
Kárita Roberta da Silva Melo
Karl Stoeckl
Karla Laíssa Silva de Oliveira
Kátia Lamara de Araújo Santos
Kayole Alves Landim Borges
Keiko Verônica Ono Fonseca
Kelen Cristina Crivelaro Silvestre
Keren Sayuri Okochi
Kevin Gonçalves Calbusch
Keyciane Cardoso Lima Mascarenhas
Khairil Ansari, Yusnadi
Khamphe Phoungthong
Kleberon de Oliveira
Kleriston Luis Rocha Neris
Klismeryane Costa de Melo
Krícia Lavareda Mendes Gregório
Kuaanan Techato
Laiane Pereira Cardoso
Laíres Sale Reis
Laís Samira Correia Nunes
Laise de Jesus dos Santos
Laleska Moraes Ferreira
Lara Andrade Fachin
Lara Maia Silva Gabrich
Larissa de Macedo Câmara
Larissa Gonçalves Fratari Moreira
Larissa Mourão Pantoja
Larissa Rocha Camargo da Silva
Larissa Silveira de Mendonça Fragoso
Latif
Laura Gonçalves Maciel
Laura Manuci de Andrade
Laurentino de Sousa Santos
Lauriene Karina Ramos da Costa Ferreira
Lázaro César de Sousa Silva
Leandra da Silva Florentino
Leandro Batista Duarte
Leandro Giroux Gomes
Leidiane Braz de Sousa
Leidson Frank Santana Cardoso

Léo Fernando Castelhana Bruno
Leomir Rafael Brito Silva
Leonardo Bezerra
Leonardo da Silva Rodrigues Calderon
Leonardo Gaist
Leonardo Lopes Bezerra
Leonardo Pastorin Vieira Costa
Leonardo Socolott Alvarenga
Leonor Venson de Souza
Letícia Gomes de Oliveira
Lia Mara Wibelinger
Lidia Martins da Silva
Liliane Coelho Ferreira Nascimento
Lisbetty del Pilar Morales Mora
Lívia Cavalcante de Araújo
Lívia Maria Della Porta Cosac
Lizandra Cristina Oriel de Sousa
Lizandra Lima Santos
Loiane Letícia dos Santos
Lorena Lourenço Rosa da Silva
Loso Judijanto
Luan Costa Ferreira
Luan da Silva Freitas
Luana Amélia de Abreu Teixeira
Luana da Silva Souza
Lucas Albanaz Vargas
Lucas de Oliveira Rodrigues
Lucas de Souza Victor
Lucas Dornas Xavier
Lucas Emanuel Mateus Pereira Lopes
Lucas Galvão Pinho
Lucas Mateus Ferreira Oliveira
Lucas Mendes Tavares da Silveira
Lucas Miranda Pantoja
Lucas Vilas Boas Pacheco
Luciana Alves da Silva
Luciana Cristina Porfírio
Luciana Moro de Souza
Luciana Teixeira Randi
Luciana Turatti
Luciane de Fatima Rodrigues de Souza
Luciano Antonio Rodrigues
Luciano Henrique Pereira da Silva
Luciano Jesus Hage Martins
Luciene dos Santos Sobczak
Lucileni Maria Mendonça Sales
Lúcio Paulo Alves Pires
Luiguy Xavier de Lima
Luis da Silva Simoes
Luis Felipe Coelho Carvalho dos Santos

Luis Felipe Trindade Natário
Luís Otávio Garcia de Oliveira
Luiz Antonio de Oliveira Dantas
Luiz Carlos Bevilacqua dos Santos Reis
Luiz Carlos da Silva
Luiz Carlos de Almeida
Luiz Cláudio Machado dos Santos
Luiz Gonzaga Gandini Junior
Luiz Gustavo Bieberbach Engroff
Luiz Honorato da Silva Junior
Luiz Ricardo Baptista de Godoy
Luiza Vaucher Mendes Pereira
Luzia Débora Saldanha Marques
Luzivone Lopes Gomes
Mabel Montecinos-Bustos
Machidovel Trigueiro Filho
Maicom Aparecido Mortol
Maira Uchôa Moura
Mairla Meneses Lopes Teles
Manuel Enrique Gamero Guandique
Manuela Ithamar Lima
Manuella Pimenta Loureiro
Marcel Leite Rios
Marcela de la Paz Inostroza Figueroa
Marcela de Souza Sotto Mayor
Marcela Oliveira Santos
Marcella Camilly Dias Ribeiro
Marcelo da Silva Martins
Marcelo de Souza Picanço
Marcelo Jasmim Meiriño
Marcelo Luiz Soares Pereira
Marcelo Martins Bueno
Marcelo Martins Farias
Márcia de Araujo da Costa
Marciele Misiak
Márcio Carneiro Barbosa
Márcio Cledes
Marcio Rodrigo Nunes de Souza
Márcio Silva da Conceição
Marco Antônio Barbieri
Marco Antônio Barros dos Santos
Marco Antonio Marín Álvarez
Marco Valério de Albuquerque Vinagre
Marcos Cesar Pitta
Marcos Rogério de Mendonça
Margareth Araújo e Silva
Maria Adélia Icó M. dos Santos
Maria Antônia do Socorro Rabelo Araujo
Maria Aparecida Jardim Marques
Maria Augusta Freitas Barbosa Paiva de Lira

Maria Clara Barreira
Maria Clara Moreira Calheiros de Novaes
Maria Corga
Maria Cristina de Oliveira Santos Miyazaki
Maria Cristina Marques
Maria de Lourdes Guimarães de Carvalho
Maria de Lourdes Santos de Lima
Maria do Rosário Sá Araújo
Maria do Socorro Sousa de Araújo
Maria Eduarda Paixão Lima
Maria Eduarda Ricardo de Barros
Maria Eduarda Vieira Rodrigues
María Elena Tello Macahuachi
Maria Eleuziane dos Santos da Silva
Maria Fernanda Martins-Ortiz
Maria Gorete Vilhena Neves
Maria Inês Ferreira da Silva
Maria Ivanilse Calderon Ribeiro
Maria Jaqueline Coelho Pinto
Maria Luiza Gomes Reis
Maria Nikaele Campos do Carmo Alcantara
Maria Rosa da Luz Lopes da Conceição
Mariana Elizabeth Lopes de Sales
Mariana Linhares Pereira Soares
Mariana Maria Pereira
Mariana Matias Ribeiro Ramos
Mariana Moraes Camacho Reis
Mariana Nunes Letieri
Mariela Mizota Tamada
Marilac Magela dos Santos
Marilene Pessoa da Silva Augusti
Marina Aires
Marina Sias Leal
Mario Marcos Morel
Mario Mollo Neto
Mário Oli do Nascimento
Marly Sanches Cardoso
Maryane de Oliveira Pessôa
Mateus Antônio Nogueira Oliveira
Mateus Chagas dos Santos
Mateus Guimarães da Silva
Mateus Henrique Oliveira Souza
Matheus Albuquerque Athayde da Silva
Matheus Nunes dos Santos
Matheus Querino da Silva
Matheus Teixeira Schumacher
Maurício Araujo Zanardi
Mauro Guterres Barbosa
Maykon Jhuly Martins de Paiva
Melissa Mendes Ferreira

Michele da Silva Feitoza
Michelle Torres Dumith
Milane Lima Pontes
Milena Andrade Déo
Mirella Medeiros Reis
Moacyr Portes Júnior
Moésio da Costa Bastos
Moisés da Silva Gomes Filho
Moisés Simão Santa Rosa de Sousa
Mônica Isaura Corrêa
Monica Marletti Almeida
Monika Fritz
Monize Lopes de Araújo Gomes
Myke Oliveira Gomes
Nadia Wagih El Kadri
Narciso Galástica
Natália Araújo Vieira
Natalia de los Ángeles Toloza Salgado
Natália Talita Araújo Nascimento
Natasha Sales Xavier
Nathalia Bezerra de Souza Rates
Nathalia Margarida Cantuária
Nayanne Deusdara Escobar
Nayara Gomes de Oliveira
Nayolle Barbosa Emerick Santana
Neide Aparecida Micelli Domingos
Neide Garcia Ribeiro
Nelson Marinelli Filho
Nephtalie Moise
Neusa Maria da Costa Gonçalves Salla
Newton Galvão de Campos Leite
Nicole Barbosa Amaral
Nicole Mayumi Carneiro Takano
Nicolly Quirino Barros Vieira
Nilo Nunes
Nilton Carlos Noronha Ferreira
Nívea Regina Marques Aguiar
Noely Corrêa Souza Pereira
Nohelys E. Díaz G.
Nori Paulo Griebeler
Norma Dávila Cota
Nubia Silva Costa
Okelyton Ayres Pacheco
Olivia Fernandes Boretta
Orlando Marcos Quadros Cardoso
Osmar Aparecido Cuoghi
Otávio Silveira Rizzi
Pabline Gonçalves Ferreira da Silva
Pablo Gnutzmann Pereira
Paloma Fernandes Freitas

Pâmela Paes-Pereira
Patrícia Costa de Andrade
Patricia da Silva Chaves
Patrícia de Hollanda Cavalcanti Aragão Costa
Patrícia dos Santos Moutinho Coelho
Patrícia Fonseca Ferreira Fleury
Patrícia Gabrielly da Silva Pires
Patrícia Helena Moraes Rêgo
Patricio Wladimir Gurtiérrez Montecino
Paula Rejane Leal Ferreira Ramos
Paulo Artur da Silva Rodrigues
Paulo Henrique Amorim Martins
Paulo Ricardo dos Santos Silva
Paulo Roberto Alonso Viegas
Paulo Roberto Meloni Monteiro Bressan
Paulo Sérgio Lima e Silva
Pedrinho Antonio Julião Filho
Pedro Augusto Cardoso da Silva
Pedro Filipe de Luna Cunha
Pedro Henrique Soares Silva
Pedro Luiz Teodoro Clemente de Oliveira
Phelipe Matheus Sales Kinack
Plinio Alexandre dos Santos Caetano
Pollyanna Cardoso Pereira
Pollyanna Laurindo de Oliveira
Porfírio Tamayo Contreras
Priscila Bezerra de Lima
Quedna Brito dos Reis
Quésia Guedes da Silva Castilho
Rafael Ávila Lopes
Rafael Ayres Romanholo
Rafael Espinosa Mosqueda
Rafael Gonçalves Campolino
Rafael Lima da Silva
Rafael Pereira Barcelos Severino Borges
Rafael Raimundo Oliveira Albuquerque
Rafael Stuaní Floriano
Rafaela Alves Vicente Rodrigues da Silva
Rafaela Andrade de Vasconcelos
Rafaela Baliot de Souza
Rafaela Orsi Pasiani
Rafaela Timóteo de Souza Ribeiro
Rafaella Antunes Fiorotto de Abreu
Rander Teixeira Barros
Raphaella Farias Rodrigues
Raphaella Aparecida Silva
Raquel Oliveira Santos
Raul da Cunha Lima
Rayanne Ferreira Coelho
Rayssa de Fátima Lopes Arruda Carneiro

Regiane Cristina Neto Okochi	Rosieli Geraldina Merotto Foletto
Regiane de Paula Ferreira da Silva	Sadre Pantoja Alho
Regiane Vieira Silva	Sálvia Viviane Agra Belota
Regina Célia Nascimento dos Santos	Samara Mesquita Monteiro
Reginaldo Teixeira Mendonça	Samara Thais Peixoto de Oliveira
Regis Alves Dourado	Samia Tainar Marques da Silva
Reinaldo Azevedo Barbosa	Samuel Owusu-Baah
Renan Gustavo Coelho de Souza dos Reis	Sannyer Cardoso Carvalho Nery
Renan Gustavo Rodrigues da Luz	Santiago de Matos Fernandes Perez
Renan Pereira Barcelos Severino Borges	Scheivla Suanne de Andrade Rodrigues Tork
Renata Perozini	Sebastián Eduardo Retamal López
Renato Kohler Zanqui	Sérgio Augusto Coelho Bezerra
Renato Rodrigues	Sérgio Bairon
Ricardo Cesar de Oliveira-Borges	Sheylla Susan Moreira da Silva de Almeida
Ricardo Ribeiro Dias	Sidionei Miguel de Souza
Rick Wesley Feitosa Pinto	Sidney Barata de Aguiar
Rickardo Léo Ramos Gomes	Silvana Beatriz D' Ávila Costa Lenzi
Rigoberto Rodriguez-Rios	Sílvia Cardoso Borges
Rita de Cássia Alanna Ribeiro	Silvia dos Santos de Almeida
Rita de Cássia Maia Rebelo	Simone Aparecida dos Santos Silva
Roberta Leonor Mendes de Lima Leal	Simone Justi
Roberto Augusto Caracas Neto	Simone Martins
Roberto Fontes de Souza	Solange de Oliveira Pinheiro
Roberto Miranda Pimentel Fully	Sonia Ferreira Gomes
Roberto Moreira do Nascimento Rodrigues	Stefania Becattini Vaccaro
Roberto Rodrigues Cunha Lima	Stela Regina Pedroso Vilela Torres de Carvalho
Roberval Oliveira da Silva	Stephen Hyslop
Robson da Silva Fernandes	Suane e Silva Duarte Souto
Rodrigo Antonio Pinto de Melo	Suelen Rodrigues Carvalho
Rodrigo Elias Cardoso	Susana Zapata Garcia
Rodrigo Lauria Fonseca	Tabatha Moreira Pacheco
Rodrigo Martins Ribeiro	Tadeu Dote Sá
Rodrigo Ribeiro Salgado Cézar	Taina Serafim Ferreira dos Santos
Rodrigo Viana de Freitas Santos	Talita Cintra Braga
Rogerio Cid Bastos	Tamiris Pacheco da Costa
Ronaldo dos Santos Barbosa	Tânia Aparecida Oliveira Ramos
Ronilson Lopes Brito	Tassyane Martins Bezerra
Rosa Gouvêa de Sousa	Tatiana Maria da Silva
Rosa Mirtes de Souza Oliveira	Tatiana Moraes Camacho de Castro
Rosalina Alves Nantes	Tatiane Balbino Cordeiro Tomaz
Rosalvo Maciel Guimarães Neto	Tatyana Pinheiro Magalhães
Rosana Pereira Medina Freitas	Tecia Vieira Carvalho
Rosane Maria Seibert	Teodora Xavier dos Santos
Rosane Michelli de Castro	Thábata Biazuz Veronese
Rosane Pinheiro Krüger Feijó	Thais Bentes de Oliveira
Rosângela Gomes Vaillant	Thaís Brito Sousa
Rosany Lopes Martins	Thais Farias de Oliveira Bonfim
Rose Mary Gondim Mendonça	Thalita Duque Martins Paes
Roseane Henrique Viana	Thayline Pereira da Silva
Rosemeire Ferrarezi Valiante	Thayna da Silva Raymundo

Thereza D'Ávila Maria Fernandes de Souza
Thiago Corrêa de Sá Ricardo
Thiago Costa Duch
Thiago de Mello Almada Rubbo
Thiago dos Santos Azevedo Damasceno
Thiago Hokai Mendonça
Thiago Socrates F. M. Sousa
Tiago Emanuel Melo Pereira
Tiago Pinheiro Costa
Tito Ricardo Vaz da Costa
Tovyska Braga Dantas
Tulsi Ram Pandey
Uitairany do Prado Lemes
Valdemar Mendes de Moraes Filho
Valéria Caroline Batista Santana
Valeria Cristina de Souza Corrêa
Valéria de Campos Orsi
Valéria de Nazaré de Paula Bessa
Vanessa Cristina Mota da Costa
Vanessa Silva Bermond
Vânia Cristina Ribeiro Brilhante
Vânia Maria Sabadoto Brienze
Vania Targanski Benitez
Vanuza Silva Frazão
Veneziano Guedes de Sousa Rêgo
Vera Lucia Bonfim Tiburzio
Vera Lucia Freitag
Vera Lucia Neves Dias
Victor Abreu dos Santos
Victor Henrique Ahlf Gomes
Victor Pacheco de Campos Neto
Victória Dias da Silva
Vitor Roble de Oliveira
Vitoria Cione Camillo
Vitória Fonseca Eugênio Duarte
Vitória Lindaura Eufrásio Cândido
Vitória Mendonça Mendes
Vitória Régia Araújo Ribeiro
Vitória Xavier Rodrigues
Vivaldo Gomes da Silva Júnior
Vivian Rabelo Cunha
Viviane Chunques Gervasoni
Wagner Fonseca Souza
Wallace Lira
Walter Junior Silva Sousa
Wendel Mattos Pompilho
Weverton dos Santos Faria
Wheriston Silva Neris
Wildson Max Barbosa da Silva

William Donegá Martinez
William Meireles de Souza
William Neves da Silva
William Ralf Santos Costa
Williander de Almeida Marques
Wilson Machado Enes
Wiltemberg de Brito Pereira
Wilton Rabelo Pessoa
Wladimir Rafael de Matos Lamarão
Yaeko Yamashita
Yasmin Alves da Luz Souza
Yasmin Cilento de Rezende
Yésica Mayett-Moreno
Yoko Oshima-Franco
Yoyon Efendi
Yuli Novak Ormeño Torres
Yuri Bittar
Yuri Sotero Bomfim Fraga
Zaka Hadikusuma Ramadan

PRESENTATION

Science is a field of knowledge in which different disciplines intertwine to form a greater whole. **Horizons of Insight: Exploring the Frontiers of Multidisciplinary Science** is a work that expands this interconnection, bringing together 252 articles on various topics, written by experts from different areas of knowledge.

Developed by **Seven Publications**, this book presents a broad overview of the challenges, discoveries and advances in fields such as science fairs, women's empowerment in computing, inclusive chemistry and much more.

SUMMARY

READING THE HISTORY OF ART THROUGH THE LINES OF DRAWING

Kleriston Luis Rocha Neris.

  <https://doi.org/10.56238/sevened2026.008-001>

.....48-64

SCIENCE FAIRS AND INTEGRATED PROJECT EXHIBITIONS AS AN INNOVATIVE SPACE FOR RESEARCH, TEACHING, AND OUTREACH: AN EXPERIENCE REPORT WITH VOCATIONAL TRAINING COURSES

Mairla Meneses Lopes Teles.

  <https://doi.org/10.56238/sevened2026.008-002>

.....65-77

WOMEN'S EMPOWERMENT IN COMPUTING: PROMOTING LEADERSHIP THROUGH EDUCATIONAL ROBOTICS

Maria Ivanilse Calderon Ribeiro, Mariela Mizota Tamada, Marcel Leite Rios.

  <https://doi.org/10.56238/sevened2026.008-003>

.....78-90

TAXATION AND COMPETITIVENESS IN THE SERVICE SECTOR IN THE TRI-BORDER AREA: A COMPARATIVE ANALYSIS BETWEEN BRAZIL, PARAGUAY, AND ARGENTINA

Ed Ernest Taves, Thiago Hokai Mendonça, Leonor Venson de Souza, Alvaro Antônio da Silva.

  <https://doi.org/10.56238/sevened2026.008-004>

.....91-105

DATA CENTERS, ENERGY AND REGULATION: LEGAL AND ECONOMIC CHALLENGES FOR DIGITAL INFRASTRUCTURE IN BRAZIL

Daniel Amin Ferraz, Paulo Roberto Alonso Viegas.

  <https://doi.org/10.56238/sevened2026.008-005>

.....106-121

ALGORITHMIC GOVERNANCE AND THE PUBLIC INTEREST: ETHICAL FOUNDATIONS FOR DECISION-MAKING IN THE PUBLIC SECTOR

Ailton Ferreira Cavalcante.

  <https://doi.org/10.56238/sevened2026.008-006>

.....122-157

COLLABORATIVE TEACHING: PERSPECTIVES, POSSIBILITIES, AND CONTRIBUTIONS TO THE INCLUSION OF STUDENTS WITH AUTISM SPECTRUM DISORDER

Maria Rosa da Luz Lopes da Conceição, Caroline Gisele Santos Silva, Vivaldo Gomes da Silva Júnior, Scheivla Suanne de Andrade Rodrigues Tork, Noely Corrêa Souza Pereira, Maria Gorete Vilhena Neves, Cristina Picanço de Sousa Corrêa, Janiele da Silva Melo Rabelo.

  <https://doi.org/10.56238/sevened2026.008-007>

.....158-176

LAUDATO SÍ, ECOTHEOLOGY AND AGENDA 2030: A BIBLIOMETRIC ANALYSIS OF ARTICLE PRODUCTION IN ENGLISH, PORTUGUESE AND SPANISH (2010-2024)

Guilherme de Azevedo Mendes Corrêa Guimarães.

  <https://doi.org/10.56238/sevened2026.008-008>

.....177-193

AN OVERVIEW OF THE RELATIONSHIP BETWEEN RESTORATIVE JUSTICE, SUSTAINABILITY, AND SHARED KNOWLEDGE PRODUCTION

Carla Boin, Sérgio Bairon.

 <https://doi.org/10.56238/sevened2026.008-009>

.....194-209

LARVICIDAL ACTIVITY AGAINST AEDES AEGYPTI AND ANTIOXIDANT, CYTOTOXIC AND MICROBIOLOGICAL EVALUATION OF THE CRUDE ETHANOLIC EXTRACT OF POGOSTEMON CABLIN BENTH

Lizandra Lima Santos, Rosany Lopes Martins, Heden Robson Monteiro Souza, Janaina Corrêa dos Santos, Cristine Barbosa Malafaia, Cleidjane Gomes Faustino, Fernando Antônio de Medeiros, Ana Luzia Ferreira Farias, Letícia Gomes de Oliveira, Edmilson dos Santos Moraes, Camila Lima dos Santos, Sheylla Susan Moreira da Silva de Almeida.

 <https://doi.org/10.56238/sevened2026.008-010>

.....210-226

TO PUNISH OR TO PROTECT: THE ROLE OF THE PUBLIC DEFENDER'S OFFICE IN THE CRIMINAL ENFORCEMENT OF HOMELESS INDIVIDUALS

Maria Inês Ferreira da Silva, Sidionei Miguel de Souza, Guajarina do Socorro Carmo de Sousa Camarão, Eliney Alessandro Vieira Cardoso, Kaio Henrique Rodrigues Nazário, Graciete Nascimento Barbosa, Eliane do Socorro Ferreira da Silva, Regiane de Paula Ferreira da Silva, Regina Célia Nascimento dos Santos, Ana Cláudia Ferreira da Silva.

 <https://doi.org/10.56238/sevened2026.008-011>

.....227-239

SOCIODEMOGRAPHIC FACTORS AND SELF-PERCEIVED MENTAL BALANCE AMONG MEN INCARCERATED FOR SEXUAL CRIMES

Claudia Regina Biancato Bastos, Ana Laura de Souza Gonçalves, Amanda Myrianne Dobzinski, Nicole Mayumi Carneiro Takano, Gabriela Fernanda Schiochet, Gabrielly Hneda Fadel, Cristina Berger Fadel.

 <https://doi.org/10.56238/sevened2026.008-012>

.....240-255

DINO +: DIGITAL GAME FOR PEOPLE WITH ASD

Luiz Cláudio Machado dos Santos, Maria Adélia Icó M. dos Santos, Jocelma Almeida Rios, Ingrid Winkler, Luis Felipe Coelho Carvalho dos Santos, Adrian Willy da Silva Borges.

 <https://doi.org/10.56238/sevened2026.008-013>

.....256-269

NAVIGATORS: AN EDUCATIONAL GAME WITH VARIOUS INDIGENOUS TERRITORIES

Luiz Cláudio Machado dos Santos, Ingrid Winkler, Daniel Fernandes Argolo, Bianca Bispo dos Santos, Cainã Guimarães Soares.

 <https://doi.org/10.56238/sevened2026.008-014>

.....270-284

COMPARATIVE ANALYSIS OF MACROSCOPIC VS MICROSCOPIC MEASUREMENT CRITERIA OF INDUCED TOOTH MOVEMENT

José Roberto Alves Moreira, Osmar Aparecido Cuoghi, Marcos Rogério de Mendonça, Alberto Consolaro, Maria Fernanda Martins-Ortiz, Henrique Barcelos Brandão, Luiz Gonzaga Gandini Junior, Ary dos Santos Pinto.

 <https://doi.org/10.56238/sevened2026.008-015>

.....285-298

SCIENTIFIC LITERACY THROUGH INCLUSIVE CHEMISTRY TEACHING: A PEDAGOGICAL PROPOSAL FOR 6TH GRADE STUDENTS IN THE FINAL YEARS OF ELEMENTARY SCHOOL IN THE CITY OF CAXIAS-MA

Izamara de Sousa Oliveira, Laiane Pereira Cardoso, Alessandro Morais Cunha, Quésia Guedes da Silva Castilho, Vera Lucia Neves Dias, Mauro Guterres Barbosa, Daniely Verônica Cardoso Carvalho, Camila Gonçalves Ribeiro.

  <https://doi.org/10.56238/sevened2026.008-016>

.....299-316

INTELLECTUAL PROPERTY AS AN AXIS OF TECHNOLOGICAL SOVEREIGNTY IN THE RARE EARTHS VALUE CHAIN: EVIDENCE FROM MINAS GERAIS

Flávio Ribeiro da Costa, Luiz Ricardo Baptista de Godoy, Allynson Takehiro Fujita, Fernando Melo da Silva.

  <https://doi.org/10.56238/sevened2026.008-017>

.....317-340

BRIQUETTES MADE FROM GREEN COCONUT HUSK FIBER – ENERGY AND SUSTAINABILITY

Juliana Zenóbia Costa Dias, Luciano Henrique Pereira da Silva, Klismeryane Costa de Melo, Rafaela Alves Vicente Rodrigues da Silva, Thiago dos Santos Azevedo Damasceno, Roberto Rodrigues Cunha Lima.

  <https://doi.org/10.56238/sevened2026.008-018>

.....341-358

SYSTEMATIC REVIEW OF SIMILARITY CRITERIA FOR IDENTIFYING SIMILAR SEISMIC EVENTS

Jaqueline Alexsandra Azevedo Ferreira.

  <https://doi.org/10.56238/sevened2026.008-019>

.....359-370

FROM CUSTODY TO CONTROL: A BRIEF HISTORICAL ANALYSIS OF THE EMERGENCE OF IMPRISONMENT AS A MEANS OF PUNISHMENT

Bruno de Omena Celestino, João Arthur Alves de Souza.

  <https://doi.org/10.56238/sevened2026.008-020>

.....371-390

MANDIBULAR BONE EROSION ASSOCIATED WITH HYALURONIC ACID FILLER: CBCT CASE REPORT

José Roberto Alves Moreira, Henrique Barcelos Brandão, Ana Thais Bagatini, Marcos Cesar Pitta, Luiz Gonzaga Gandini Junior, Ary dos Santos Pinto.

  <https://doi.org/10.56238/sevened2026.008-021>

.....391-400

THE IMPLEMENTATION OF UNIVERSAL DESIGN FOR LEARNING (UDL) AS AN INCLUSION STRATEGY IN SPECIAL EDUCATION: OVERCOMING THE LOGIC OF INDIVIDUALIZED

Thereza D'Ávila Maria Fernandes de Souza.

  <https://doi.org/10.56238/sevened2026.008-022>

.....401-415

RESULTS OF AN INNOVATIVE ENTREPRENEURSHIP POLICY INSTRUMENT IN THE FEDERAL NETWORK OF PROFESSIONAL, SCIENTIFIC, AND TECHNOLOGICAL EDUCATION

João Paulo do Carmo, Arianne Oliveira Gusmao, Humberto Henrique Ramos Brotto, Gabriel Adolfo Gomes Potin, Filipe Barbosa Martins.

  <https://doi.org/10.56238/sevened2026.008-023>

.....416-432

CIVIL IDENTIFICATION AS AN INSTRUMENT FOR PROTECTING CHILDREN'S RIGHTS IN THE STATE OF PARÁ, BRAZIL

Flávio Marcelo Cavalcante Mota, Nilton Carlos Noronha Ferreira.

 <https://doi.org/10.56238/sevened2026.008-024>

.....433-447

ACCESSIBLE DIALOGUES: BUILDING INCLUSIVE VISUAL NARRATIVES WITH AUDIO DESCRIPTION

Lara Andrade Fachin, Luiz Gustavo Bieberbach Engroff, Aurélia Regina de Souza Honorato.

 <https://doi.org/10.56238/sevened2026.008-025>

.....448-460

PERFORMANCE INDICATORS AND BUSINESS INTELLIGENCE TOOLS APPLIED TO DRINKING WATER QUALITY IN THE FIELD OF REGULATION

Rodrigo Antonio Pinto de Melo, Jane Carla Marinho de Souza Maia, Cícero Henrique Macêdo Soares, Emanuele Ferreira Gomes, Rafael Lima da Silva.

 <https://doi.org/10.56238/sevened2026.008-026>

.....461-480

HYBRID SOCIAL INSURANCE AS A COMPLEMENT TO THE BPC: PREVENTIVE PROTECTION AGAINST INFORMALITY-RELATED RISKS AND FAMILY VULNERABILITY

Ailton Ferreira Cavalcante, Gabriel Jorge Pradera.

 <https://doi.org/10.56238/sevened2026.008-027>

.....481-511

QUILOMBOLA KNOWLEDGE AND SELF-CARE PRACTICES IN THE SÃO DOMINGOS COMMUNITY, CAVALCANTE (GO)

Pabline Gonçalves Ferreira da Silva, Reginaldo Teixeira Mendonça.

 <https://doi.org/10.56238/sevened2026.008-028>

.....512-533

P3D SOFTWARE AS A RESOURCE FOR RETHINKING THE PRACTICE OF TEACHING AND LEARNING SCIENCE

Luzivone Lopes Gomes, Filomena Maria G. da Silva Cordeiro Moita.

 <https://doi.org/10.56238/sevened2026.008-029>

.....534-550

PROPOSAL FOR AN ASSESSMENT ACTIVITY IN GEOGRAPHY USING KEY THEMES FROM THE GLOBAL AND NATIONAL CONTEXT

Marina Aires, Arthur Galvão de Mendonça.

 <https://doi.org/10.56238/sevened2026.008-030>

.....551-557

EDUCATIONAL TECHNOLOGIES IN BIOLOGY TEACHING: AN IMMERSIVE EXPERIENCE WITH 3D SOFTWARE

Luzivone Lopes Gomes, Filomena Maria G. da Silva Cordeiro Moita.

 <https://doi.org/10.56238/sevened2026.008-031>

.....558-572

THE ROLE OF FERMENTED CEREALS IN THE MODULATION OF THE INTESTINAL MICROBIOTA AND THEIR BENEFITS TO HUMAN HEALTH

Luciene dos Santos Sobczak, Jessyca Caroline Rocha Ribas, Leandra da Silva Florentino, Isabela Lima Quadros, Luciana Alves da Silva, Renan Gustavo Rodrigues da Luz, Okelyton Ayres Pacheco, Samara Thais Peixoto de Oliveira.

 <https://doi.org/10.56238/sevened2026.008-032>

.....573-589

PUBLIC GOVERNANCE AND MUNICIPAL FINANCIAL HEALTH: AN INTEGRATED ANALYSIS WITH A FOCUS ON FINANCIAL PSYCHOLOGY AND TAX EDUCATION

Luiz Antonio de Oliveira Dantas, Denis Forte, Nadia Wagih El Kadri.

 <https://doi.org/10.56238/sevened2026.008-033>

.....590-605

NEUROPHYSIOLOGICAL EFFECTS OF ACUPUNCTURE ANALGESIA IN INDIVIDUALS WITH CHRONIC PAIN

Maria Eduarda Vieira Rodrigues, Uitairany do Prado Lemes, Gabrielle Castilho Alves Silva, Hanna Cristina Ferreira Assunção Neves.

 <https://doi.org/10.56238/sevened2026.008-034>

.....606-627

DIAGNOSTIC CHALLENGES IN CREUTZFELDT-JAKOB DISEASE: A CASE STUDY

Elenara Barbosa Machado Neves, Grasielle Mattei Ise dos Santos, Vitória Mendonça Mendes, Lucas Mendes Tavares da Silveira, André Rausch Carellos Silva, Eduardo Dionathas Firmino, Juscelio Clemente de Abreu, Mônica Isaura Corrêa.

 <https://doi.org/10.56238/sevened2026.008-035>

.....628-641

AN OPTIMAL ADAPTIVE CONTROLLER BASED ON ONLINE ACTOR-CRITIC LEARNING FOR A ROBOT MANIPULATOR

Patrícia Helena Moraes Rêgo, Joelson Miller Bezerra de Sousa.

 <https://doi.org/10.56238/sevened2026.008-036>

.....642-668

SOUND POLLUTION IN THE FURNITURE INDUSTRY OF THE FEDERAL DISTRICT

Clarissa Melo Lima, Tito Ricardo Vaz da Costa, Alexandre Nascimento de Almeida, Joaquim Carlos González.

 <https://doi.org/10.56238/sevened2026.008-037>

.....669-680

BLACK WOMEN'S AGING AND NEUROPSYCHOPEDAGOGY: INTERSECTIONAL CHALLENGES AND STRATEGIES FOR QUALITY OF LIFE

Cristiane Almeida Lisboa, Antonio Cordeiro de Souza Junior.

 <https://doi.org/10.56238/sevened2026.008-038>

.....681-695

LIFE CYCLE ASSESSMENT OF RICE HUSK-BASED ELECTRICITY GENERATION IN A THERMAL POWER PLANT

Orlando Marcos Quadros Cardoso, Tamiris Pacheco da Costa, Mateus Guimarães da Silva.

 <https://doi.org/10.56238/sevened2026.008-039>

.....696-710

DIGITAL COMPETENCIES AND CONTINUING TEACHER EDUCATION: AN ANALYSIS IN LIGHT OF THE BNCC AND CETIC.BR INDICATORS

Amanda Queirolo Ribeiro da Cruz, Patrícia Fonseca Ferreira Fleury.

 <https://doi.org/10.56238/sevened2026.008-040>

.....711-734

ENVIRONMENTAL SUSTAINABILITY: EVIDENCE OF ENVIRONMENTAL PRACTICES AND ENVIRONMENTAL BEHAVIOR IN MICRO AND SMALL ENTERPRISES

João Santana Alves, Cristina Gomes de Souza, Marcelo Jasmim Meiriño, Julio Vieira Neto.

 <https://doi.org/10.56238/sevened2026.008-041>

.....735-756

ETHNOMATHEMATICS IN THE AMAZON: PEDAGOGICAL PRACTICES AND TEACHER EDUCATION

Angela Paula da Silva Pessoa, Ádila Marta da Silva e Silva, Ana Claudia da Silva Barroso, José Leandro Santos Pessoa, Francisco Lúcio de Lira Mendonça, Allan Andrade de Souza, Liliane Coelho Ferreira Nascimento, Lucileni Maria Mendonça Sales, Edla dos Anjos Cardoso.

 <https://doi.org/10.56238/sevened2026.008-042>

.....757-772

STUDY OF KINETIC AND EQUILIBRIUM MODELS IN THE ADSORPTION OF ORANGE-FLAVORED SOFT DRINK ON PAPER TOWELS: A SEMIQUANTITATIVE MODEL

Hubert André Nunes Dos Santos, Renan Gustavo Coelho de Souza dos Reis.

 <https://doi.org/10.56238/sevened2026.008-043>

.....773-804

EVALUATION OF COCOA SEED GERMINATION BASED ON LOCATION IN THE FRUIT

Edgard Siza Tribuzy, Flávia Alves do Amaral, Raul da Cunha Lima, Milane Lima Pontes, Daniela Pauletto, Aldeize Santos Tribuzy.

 <https://doi.org/10.56238/sevened2026.008-044>

.....805-817

CONFLUENCE OF PRACTICES BETWEEN CONSCIOUS CAPITALISM AND HUMANIZED COMPANIES

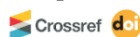
João Pinheiro de Barros Neto, Roberto Moreira do Nascimento Rodrigues.

 <https://doi.org/10.56238/sevened2026.008-045>

.....818-836

AFTER ALL, WHAT IS STRUCTURAL LITIGATION? GENERAL NOTIONS AND PRELIMINARY THEORETICAL FOUNDATIONS

Joaquim Ribeiro de Souza Junior.

 <https://doi.org/10.56238/sevened2026.008-046>

.....837-850

THE PRINCIPLE OF TAX NEUTRALITY AND EXTRAFISCALITY IN THE BRAZILIAN TAX REFORM

Danielle Uessler, Arthur Sandro Golombieski Ferreira, Mariana Matias Ribeiro Ramos.

 <https://doi.org/10.56238/sevened2026.008-047>

.....851-868

INFLUENCE OF THE VARIATION OF THE PERCENTAGE OF INCREASE OF BAUXITE RESIDUE ON THE PHYSICAL AND MECHANICAL PROPERTIES OF SYNTHETIC COARSE AGGREGATES AND THEIR USE IN STRUCTURAL CONCRETE OF NORMAL STRENGTH PORTLAND CEMENT

Robson da Silva Fernandes, João Carlos Lisboa de Lima, Marcella Camilly Dias Ribeiro, Danusa Mayara de Souza, Lucas Miranda Pantoja, Marcelo Martins Farias, Celestina Lima de Rezende Farias, Fabíola Thomaz Maia, Wladimir Rafael de Matos Lamarão, Patricia da Silva Chaves, Elsimar Souza Santos, Lucas Emanuel Mateus Pereira Lopes, William Meireles de Souza, Marcelo de Souza Picanço.

 <https://doi.org/10.56238/sevened2026.008-048>

.....869-887

HATE SPEECH AND THE LGBTQIAPN+ COMMUNITY'S FIGHT FOR THE HUMAN RIGHT TO BE

Gabriela Trentin Zandoná.

 <https://doi.org/10.56238/sevened2026.008-049>

.....888-901

THE ROLE OF GOVERNMENT PROCUREMENT IN DEVELOPING A SUSTAINABILITY CULTURE WITHIN THE FURNITURE INDUSTRY

Clarissa Melo Lima, Tito Ricardo Vaz da Costa, João Batista Melo Lima, Machidovel Trigueiro Filho, Luiz Honorato da Silva Junior, Cecília Leite Oliveira, Rafael Gonçalves Campolino, Joaquim Carlos González.

 <https://doi.org/10.56238/sevened2026.008-050>

.....902-918

VERTICALIZATION, EXPANSION, AND EPISTEMOLOGICAL DISPUTES IN PROFESSIONAL EDUCATION: THE TRAJECTORY OF IF GOIANO – MORRINHOS CAMPUS AND THE CHALLENGES OF INTEGRATED HIGH SCHOOL EDUCATION AS STATE POLICY

José Neto de Oliveira Felipe.

 <https://doi.org/10.56238/sevened2026.008-051>

.....919-949

EMERGENCY REMOTE TEACHING, STRUCTURAL INEQUALITY AND TRANSFORMATION POTENTIALS AN ANALYSIS OF GEOGRAPHY INTERNSHIP REPORTS (2020–2022)

Thiago Socrates F. M. Sousa, Rodrigo Elias Cardoso, Vera Lucia Bonfim Tiburzio.

 <https://doi.org/10.56238/sevened2026.008-052>

.....950-969

THE ROLE OF SOCIAL MEDIA AND GENDER-BASED VIOLENCE: HOW PSYCHOLOGY CAN CONTRIBUTE TO ADDRESSING THESE PRACTICES

Allyson Yann Batista Santos, Juliana Penha Messias, Danubio Freire Gomes de Matos Neto, Francisca Moraes da Silveira.

 <https://doi.org/10.56238/sevened2026.008-053>

.....970-982

AGING IN THE TROPICS: THE POSITION OF OLDER PERSONS IN THE INTER-AMERICAN HUMAN RIGHTS SYSTEM

João Gabriel Wibelinger Holtermann, Lia Mara Wibelinger, Isabela Morette.

 <https://doi.org/10.56238/sevened2026.008-054>

.....983-994

TRENDS AND PREDICTIVE PATTERNS IN THE EVOLUTION OF THE FINANCIAL PERFORMANCE OF PUBLIC HEALTH OPERATORS THROUGH THE USABILITY OF MANAGEMENT ACCOUNTING

Antônio Artur de Souza, Wilson Machado Enes.

 <https://doi.org/10.56238/sevened2026.008-055>

.....995-1015

STRUCTURAL EXTRAJUDICIAL ACTION BY THE PUBLIC PROSECUTOR'S OFFICE: TOOLS FOR ADEQUATE SOLUTIONS TO PROBLEMS

Joaquim Ribeiro de Souza Junior.

 <https://doi.org/10.56238/sevened2026.008-056>

.....1016-1031

NEXIALISM AS AN EMERGING INTERDISCIPLINARY CONSTRUCT: A SYSTEMATIC LITERATURE REVIEW AND PROPOSAL FOR AN OPERATIONAL CONCEPTUAL MODEL

Frederico Cordeiro Martins.

 <https://doi.org/10.56238/sevened2026.008-057>

.....1032-1042

BIOMETRIC DATA: AN ANALYSIS OF BILL 2338/2023 BASED ON THE PARAMETERS ESTABLISHED IN THE EUROPEAN UNION AI ACT

Joaquim Ribeiro de Souza Junior, Glenda Almeida Matos Moreira.

 <https://doi.org/10.56238/sevened2026.008-058>

.....1043-1063

LEADERSHIP THAT INSPIRES IN THE CORPORATE ENVIRONMENT: CHARISMA, EMOTIONAL INTELLIGENCE, AND ORGANIZATIONAL CULTURE AS DEVELOPABLE COMPETENCIES

Monika Fritz.

 <https://doi.org/10.56238/sevened2026.008-059>

.....1064-1074

PLAYFULNESS AND MATHEMATICAL LEARNING: GAMES AS EDUCATIONAL TOOLS

Vitória Lindaura Eufrásio Cândido, Tiago Emanuel Melo Pereira.

 <https://doi.org/10.56238/sevened2026.008-060>

.....1075-1088

BIOSTIMULANTS, PLANT GROWTH REGULATORS, AND MICROORGANISMS IN IRRIGATED AGRICULTURE OF THE MIDDLE SAN FRANCISCO VALLEY: A REVIEW BASED ON DISSERTATIONS FROM 2015 TO 2024

Marcelo da Silva Martins, Susana Zapata Garcia, Laíres Sale Reis, Nicolly Quirino Barros Vieira, William Ralf Santos Costa, Wiltemberg de Brito Pereira, Jadson Miranda Oliveira, Roberval Oliveira da Silva.

 <https://doi.org/10.56238/sevened2026.008-061>

.....1089-1119

NAVIGATING UNCERTAINTY: PALM OIL SECTOR OUTLOOK FOR 2026 THROUGH THE LENS OF SMALLHOLDER WELFARE AND SUSTAINABILITY IMPERATIVES

Loso Judijanto.

 <https://doi.org/10.56238/sevened2026.008-062>

.....1120-1152

THE IMPORTANCE OF THE PARTNERSHIP MODEL IN ACCELERATING OIL PALM SMALLHOLDERS REPLANTING PROGRAM

Loso Judijanto.

 <https://doi.org/10.56238/sevened2026.008-063>

.....1153-1178

THE IMPORTANCE OF MARKET DIVERSIFICATION STRATEGY FOR PALM OIL IN FACING CONTEMPORARY MARKET DYNAMICS

Loso Judijanto.

 <https://doi.org/10.56238/sevened2026.008-064>

.....1179-1203

MAPPING AND ANALYSING NEGATIVE CAMPAIGNS AGAINST PALM OIL

Losojudijanto.

  <https://doi.org/10.56238/sevened2026.008-065>

1204-1228

IMPACT OF STRATEGIC PLANNING ON THE MANAGEMENT OF WATER UTILITY OPERATORS (OOA) IN MEXICO

Rigoberto Rodriguez-Rios, Yésica Mayett-Moreno.

  <https://doi.org/10.56238/sevened2026.008-066>

1229-1249

CLIMATE CHANGE AND LABOR MOBILITY OF AGRICULTURAL HOUSEHOLDS: A REVIEW

Losojudijanto.

  <https://doi.org/10.56238/sevened2026.008-067>

1250-1277

DEVELOPING AN INCENTIVE SCHEME OF USED COOKING OIL BUSINESS MODEL TO SUPPORT THE FEASIBILITY OF SUSTAINABLE AVIATION FUEL

Losojudijanto.

  <https://doi.org/10.56238/sevened2026.008-068>

1278-1303

INTEGRATED COMMUNICATIONS STRATEGY TO COUNTER NEGATIVE CAMPAIGNS AGAINST PALM OIL

Losojudijanto.

  <https://doi.org/10.56238/sevened2026.008-069>

1304-1330

SUSTAINABLE PEATLAND MANAGEMENT IN OIL PALM PLANTATION BASED ON MULTI-STAKEHOLDERS APPROACH

Losojudijanto.

  <https://doi.org/10.56238/sevened2026.008-070>

1331-1358

APPLICATION OF THE IAT AND ROVUC TOOLS FOR PUBLIC USE ANALYSIS IN MANGROVE ECOSYSTEMS: A CASE STUDY IN THE STATE OF RIO DE JANEIRO

Fernando Carrilho da Silva, Julianne Alvim Milward-de-Azevedo.

  <https://doi.org/10.56238/sevened2026.008-071>

1359-1378

ENVIRONMENTAL ASSESSMENT OF RIPARIAN FORESTS IN THE ALTO MEIA PONTE WATERSHED – GO, BRAZIL

Pedro Luiz Teodoro Clemente de Oliveira, Nori Paulo Griebeler, João Ricardo Nobre Ramos.

  <https://doi.org/10.56238/sevened2026.008-072>

1379-1403

MAPPING AND IDENTIFICATION OF IRREGULAR SOLID WASTE DISPOSAL SITES IN THE URBAN AREA OF CHAPADINHA, MARANHÃO

Francisca Vanessa de Carvalho Lima, Adrielle Samara de Castro Bezerra, Jayna Dannice Borges do Nascimento, Jobson Costa Sousa, Cláudio Gonçalves da Silva.

  <https://doi.org/10.56238/sevened2026.008-073>

1404-1413

THE IMPORTANCE OF EARLY DETECTION OF ANXIOUS AND DEPRESSIVE SYMPTOMS IN OLDER ADULTS IN PRIMARY HEALTH CARE

Rafaella Antunes Fiorotto de Abreu, Lívia Cavalcante de Araújo, Ana Luiza Silva Teixeira, Isabela Nunes Tavares, Nayanne Deusdara Escobar, Ianka Lustosa Resplande, Marcela de Souza Sotto Mayor, Maykon Jhuly Martins de Paiva.

 <https://doi.org/10.56238/sevened2026.008-074>

.....1414-1427

THE RIGHT OF POSSESSION OF TRADITIONAL COMMUNITIES AND THE LAND TENURE REGULARIZATION POLICY OF THE STATE OF PARÁ

Jefferson Carvalho Galvão.

 <https://doi.org/10.56238/sevened2026.008-075>

.....1428-1444

USE OF ATLAS.TI SOFTWARE AS A METHODOLOGICAL RESOURCE IN THE STRUCTURING OF DATA IN QUALITATIVE STUDIES

Gerusa Ribeiro, Caroline Scalabrin de Oliveira Alves, Diego Saraiva de Mello, Izabel Cristina Dell'Antônio Piva, Andressa Marjory, Marciele Misiak, Andréa Huhn, Caroline de Medeiros.

 <https://doi.org/10.56238/sevened2026.008-076>

.....1445-1458

INTEGRATION OF MACROALGAE IN FISH FARMING: A SUSTAINABLE APPROACH

Gabriel da Silva Nepomuceno Flores, Michelle Torres Dumith, Alejandra Filippo Gonzalez Neves dos Santos.

 <https://doi.org/10.56238/sevened2026.008-077>

.....1459-1480

DIDACTIC SIMULATION OF A SELF-STABILIZING SYSTEM: A PEDAGOGICAL APPROACH TO TEACHING EMBEDDED SYSTEMS

Antonio Henrique Figueira Louro.

 <https://doi.org/10.56238/sevened2026.008-078>

.....1481-1489

COIL AND THE DEVELOPMENT OF SOFT SKILLS IN VIRTUAL INTERNATIONALIZATION CONTEXTS: AN EXPLORATORY REVIEW

Jesus Enrique Reyes Acevedo, María Elena Tello Macahuachi, Henry Armas Murrieta, Yuli Novak Ormeño Torres.

 <https://doi.org/10.56238/sevened2026.008-079>

.....1490-1515

LAND REGULARIZATION FOR QUILOMBOLA COMMUNITIES IN TOCANTINS: DEMOCRATIC RESISTANCE AND STATE OMISSION IN THE HEART OF BRAZIL

Jonathan Silva Ribeiro, Angela Issa Haonat.

 <https://doi.org/10.56238/sevened2026.008-080>

.....1516-1534

TEMPORAL TRENDS OF GESTATIONAL SYPHILIS IN BRAZIL, 2012-2022

Emile Danielly Amorim Pereira, Emanuelle Vieira Nogueira, Vanuza Silva Frazão.

 <https://doi.org/10.56238/sevened2026.008-081>

.....1535-1552

TEACHING RESEARCH: HOW TEACHING EXPERIENCE INSPIRED A NEW METHOD OF SUPERVISION IN LAW

Ana Paula Fernandes Teixeira, Anna Paula Lemos Santos Peres, Lara Maia Silva Gabrich.

 <https://doi.org/10.56238/sevened2026.008-082>

.....1553-1564

PHOSPHATE FERTILIZATION IMPROVE PRODUCTIVITY AND CHEMICAL-BROMATOLOGICAL COMPOSITION OF LEAF BLADE OF UNBURNED PASTURE

Luiz Carlos da Silva, Francisco de Almeida Lobo.

 <https://doi.org/10.56238/sevened2026.008-083>

.....1565-1583

EMERGENCY APPROACH IN THE MANAGEMENT OF PEDIATRIC PATIENTS IN SEPTIC SHOCK: DIAGNOSIS AND PROTOCOLS

Estela Pazeto Nolêto, Ana Luiza Normanha Ribeiro de Almeida.

 <https://doi.org/10.56238/sevened2026.008-084>

.....1584-1591

RIGHTS AS TRUMPS, JUDICIAL ACTIVISM AND HUMAN DIGNITY IN LIGHT OF DWORKIN'S POLITICAL PHILOSOPHY

Luciano Jesus Hage Martins.

 <https://doi.org/10.56238/sevened2026.008-085>

.....1592-1604

MONITORING OF FIRE OUTBREAKS IN THE LEGAL AMAZON REGION OF MARANHÃO IN THE MUNICIPALITIES OF THE PINDARÉ-MA VALLEY

Angela Maria Corrêa Mouzinho Santos, Eva Dayna Felix Carneiro, Antonio Marcos Nogueira Sodré, Ronilson Lopes Brito, Franscristiany Silva Souza, Flavio Evangelista Silva, Paulo Henrique Amorim Martins.

 <https://doi.org/10.56238/sevened2026.008-086>

.....1605-1623

THE SEARCH OF BRAZILIANS FOR INFORMAL WORK: TRANSFORMATIONS IN THE WORLD OF WORK AND SURVIVAL STRATEGIES

Jadson Justi, Marilac Magela dos Santos.

 <https://doi.org/10.56238/sevened2026.008-087>

.....1624-1638

INDEPENDENT INSTITUTIONS AS INSTRUMENTS OF CHECKS AND BALANCES IN THE BRAZILIAN STATE

Mário Oli do Nascimento, Myke Oliveira Gomes, Wagner Fonseca Souza.

 <https://doi.org/10.56238/sevened2026.008-088>

.....1639-1653

CHILD COACHES AND THE EARLY CONSTRUCTION OF THE IDEAL OF SUCCESS: IMPACTS ON SCHOOL RETENTION OF CHILDREN AND ADOLESCENTS

Jadson Justi, Ana Cristina Figueira de Almeida de Souza Ramos.

 <https://doi.org/10.56238/sevened2026.008-089>

.....1654-1668

GENDER INEQUALITIES IN THE BRAZILIAN EDUCATIONAL TRAJECTORY

Flavio Maracajá, Josué Vicente de Carvalho, Guilherme Pereira Amorim, Marilac Magela dos Santos, Claudio Noel de Toni Junior.

 <https://doi.org/10.56238/sevened2026.008-090>

.....1669-1683

EARLY MOTHERHOOD IN THE NEW GENERATION: PSYCHOLOGICAL, SOCIAL, AND IDENTITY IMPACTS

Everaldo dos Santos Mendes, Antonio Cássio Vaz.

 <https://doi.org/10.56238/sevened2026.008-091>

.....1684-1697

RELATIONSHIPS BETWEEN STALKING AND DOMESTIC VIOLENCE AGAINST WOMEN IN THE MUNICIPALITY OF ANANINDEUA, PARÁ

Andressa Érica Ávila Pinheiro, Silvia dos Santos de Almeida.

 <https://doi.org/10.56238/sevened2026.008-092>

.....1698-1714

SEXUAL CRIMES AGAINST CHILDREN IN THE VIRTUAL ENVIRONMENT: AN ANALYSIS OF PEDOPHILIA IN THE CONTEXT OF HYPERSEXUALIZATION AND THE CULTURE OF SILENCE

José Caetano Serafim Neto.

 <https://doi.org/10.56238/sevened2026.008-093>

.....1715-1741

BAREFOOT VERSUS SHOE-WEARING WEIGHT TRAINING EXERCISES: A SYSTEMATIC REVIEW OF THE BENEFITS AND DRAWBACKS OF SQUATS AND LUNGES

Décio Luiz Meireles Tavares.

 <https://doi.org/10.56238/sevened2026.008-094>

.....1742-1761

CASHEW TREE TANNINS: A BIO-RENEWABLE SOURCE FOR A NEW GENERATION OF WOOD ADHESIVES: A LITERATURE REVIEW

Carolina Aparecida dos Santos, Flávia Maria Silva Brito, Thaís Brito Sousa, Laise de Jesus dos Santos, Rosalvo Maciel Guimarães Neto, José Benedito Guimarães Junior.

 <https://doi.org/10.56238/sevened2026.008-095>

.....1762-1772

INNOVATIONS IN ADHESIVES WITH LIGNIN NANOPARTICLES FOR BONDING IN THE WOOD INDUSTRY: A LITERATURE REVIEW

Carolina Aparecida dos Santos, Flávia Maria Silva Brito, Thaís Brito Sousa, Laise de Jesus dos Santos, Rosalvo Maciel Guimarães Neto, José Benedito Guimarães Junior.

 <https://doi.org/10.56238/sevened2026.008-096>

.....1773-1784

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN RISK MANAGEMENT IN THE ROAD TRANSPORT OF HAZARDOUS PRODUCTS IN BRAZIL: FUNDAMENTALS, APPLICATION, AND COMPLIANCE

Leonardo Lopes Bezerra.

 <https://doi.org/10.56238/sevened2026.008-097>

.....1785-1793

UNIVERSITY TEACHING AS A FORMATIVE PRACTICE: RATIONALITIES, TENSIONS, AND IMPLICATIONS FOR INITIAL TEACHER TRAINING

Ronaldo dos Santos Barbosa, Maria do Rosário Sá Araújo.

 <https://doi.org/10.56238/sevened2026.008-098>

.....1794-1808

LAW AND PUBLIC POLICIES: THE COLLECTIVE CONSTRUCTION PROCESS OF PROTOCOLS FOR PRIOR, FREE AND INFORMED CONSULTATION IN TRADITIONAL COMMUNITIES IN/OFF MARANHÃO

Aldina da Silva Melo, João Ricardo Costa Silva, Maria do Socorro Sousa de Araújo, Wheriston Silva Neris.

 <https://doi.org/10.56238/sevened2026.008-099>

.....1809-1819

BACK TO THE LIGHTNESS OF LIFE: LITERARY STORIES AND (IN) TRANSCULTURALITY

Gisele Giandoni Wolkoff, Dante Gallian, Yuri Bittar.

 <https://doi.org/10.56238/sevened2026.008-100>

.....1820-1829

TEACHERS' NEEDS AND READINESS FOR AI-ASSISTED AUGMENTED REALITY LEARNING MEDIA IN ELEMENTARY EDUCATION 5.0

Febrina Dafit, Zaka Hadikusuma Ramadan, Yoyon Efendi, Latif, Khairil Ansari, Yusnadi.

 <https://doi.org/10.56238/sevened2026.008-101>

.....1830-1853

THE ROLE OF THE TECHNOLOGICAL INNOVATION CENTER IN THE TRANSFER OF CLEANER TECHNOLOGIES IN THE FACE OF THE CARBON ADJUSTMENT MECHANISM AT THE EUROPEAN UNION BORDER

Thais Farias de Oliveira Bonfim, André Luis Rocha de Souza, José Célio Silveira Andrade.

 <https://doi.org/10.56238/sevened2026.008-102>

.....1854-1870

SOCIAL REPRESENTATIONS OF BREASTFEEDING AMONG PREGNANT AND POSTPARTUM WOMEN IN PRIMARY HEALTH CARE

Nayolle Barbosa Emerick Santana, Yasmin Alves da Luz Souza, Emanuely Garcia de Sousa Morais, Mariana Linhares Pereira Soares, Luciano Antonio Rodrigues.

 <https://doi.org/10.56238/sevened2026.008-103>

.....1871-1888

REGULATION AND PUBLIC POLICIES OF SOCIAL AND SOLIDARITY ECONOMY

Caio Nordi Jorge Armani Cirino, Luciana Teixeira Randi, Thiago de Mello Almada Rubbo.

 <https://doi.org/10.56238/sevened2026.008-104>

.....1889-1910

FORENSIC TOXICOLOGY AT THE INTERSECTION OF DRUGS OF ABUSE AND PUBLIC HEALTH

Lucas Dornas Xavier, Lucas Albanaz Vargas, Davi Nunes da Silva, Andressa Carvalho de Oliveira.

 <https://doi.org/10.56238/sevened2026.008-105>

.....1911-1922

SOCIO-ENVIRONMENTAL PERCEPTIONS OF SCIENCE TEACHERS IN THE AMBIENCE OF THE PIABAS STREAM/PB

Carlos Augusto Tenório Cândido, Jair Moisés de Sousa, Veneziano Guedes de Sousa Rêgo.

 <https://doi.org/10.56238/sevened2026.008-106>

.....1923-1936

AUTOMATION OF THE ASSETS SECTOR OF THE AMAZON FOUNDATION FOR SUPPORTING STUDIES AND RESEARCH PARÁ: WAYS TO OPTIMIZE THE INVENTORY SURVEY

Fábia Jaqueline Miranda Nobre, Alessandra Mendes Monteiro.

 <https://doi.org/10.56238/sevened2026.008-107>

.....1937-1955

CONTINUING EDUCATION IN HEALTH, DISCOURSE, AND TRANSFORMATION OF WORK IN THE SUS

Leonardo Gaist, Antonio Escandiel de Souza, Vera Lucia Freitag.

 <https://doi.org/10.56238/sevened2026.008-108>

.....1956-1972

LEADING TO TRANSFORM: LEADERSHIP PRACTICES AND MEXICAN HUMANISM IN TECHNOLOGICAL EDUCATION

Gilberto Rodríguez Montufar.

 <https://doi.org/10.56238/sevened2026.008-109>

.....1973-2005

CAPTURED MALAISE IN CONTEMPORARY CAPITALISM

Francisco José de Oliveira Neto.

 <https://doi.org/10.56238/sevened2026.008-110>

.....2006-2020

LAND REGULARIZATION, SPATIAL JUSTICE, AND THE RIGHT TO THE CITY: AN ANALYSIS FROM THE JUREMA BARRA COMMUNITY, ANANINDEUA-PA

Amanda Diniz Medeiros.

 <https://doi.org/10.56238/sevened2026.008-111>

.....2021-2048

AGRICULTURAL PRODUCTION OF CANNABIS AIMING TO INCREASE CANNABIDIOL (CBD) CONTENT FOR MEDICINAL PURPOSES – A REVIEW

Valéria de Campos Orsi, Larissa Rocha Camargo da Silva, Gabriela Rocha Vidal Silva, Rafaela Orsi Pasiani, Yoko Oshima-Franco.

 <https://doi.org/10.56238/sevened2026.008-112>

.....2049-2065

FROM STANDARD TO TERRITORY: THE ROLE OF NURSES IN IMPLEMENTING THE "NOW THERE ARE SPECIALISTS" PROGRAM IN THE BRAZILIAN AMAZON – AN EXPERIENCE REPORT IN HUMAITÁ/AM, LÁBREA/AM AND THE DISTRICT OF SANTO ANTÔNIO DO MATUPI (MANICORÉ, AM)

José Maria Viana dos Santos.

 <https://doi.org/10.56238/sevened2026.008-113>

.....2066-2081

PROPERTY REGISTRATION AND ENVIRONMENTAL PROTECTION IN BRAZIL: CONTRIBUTIONS TO THE IMPLEMENTATION OF THE PRINCIPLE OF THE SOCIAL FUNCTION OF PROPERTY

Guiomar Rocha Pereira Magalhães Bittencourt, Luciana Turatti.

 <https://doi.org/10.56238/sevened2026.008-114>

.....2082-2100

POST MORTEM PROTECTION OF PERSONALITY RIGHTS IN THE TECHNOLOGICAL SOCIETY

Manuela Ithamar Lima, Joaquim Ribeiro de Souza Junior.

 <https://doi.org/10.56238/sevened2026.008-115>

.....2101-2112

SOCIO-EMOTIONAL SKILLS OF SCHOOL MANAGERS: OPENING PATHWAYS FOR TRAINING AND DEVELOPMENT FOR THE TEAM

Mabel Montecinos-Bustos, Giza Guimarães P. Sales, Betania Jacob Stange Lopes, Rosane Michelli de Castro.

 <https://doi.org/10.56238/sevened2026.008-116>

.....2113-2128

LIBERTARIANISM OR PROPERIALISTISM? SELF-OWNERSHIP AS THE FOUNDATION OF ROBERT NOZICK'S LIBERTARIAN THEORY (2024)

Victor Henrique Ahlf Gomes.

  <https://doi.org/10.56238/sevened2026.008-117>

.....2129-2151

ACCOUNTING AND FISCAL INFORMATION QUALITY INDEX (ICF) IN MUNICIPALITIES OF RONDÔNIA: PERFORMANCE OF THE FIVE MOST POPULOUS MUNICIPALITIES

Dante Matheus de Almeida dos Reis, Gustavo Viana de Lima, Leonardo Pastorin Vieira Costa, Natália Talita Araújo Nascimento.

  <https://doi.org/10.56238/sevened2026.008-118>

.....2152-2175

BETWEEN REFLECTION AND ACTION: POSTPONEMENT OF RETIREMENT AND INCIPIENT PREPARATION AMONG TECHNICAL-ADMINISTRATIVE STAFF AGED 60+ AT A FEDERAL UNIVERSITY

Regiane Vieira Silva, Simone Martins, Stefania Becattini Vaccaro, Alejandro Pérez-Duarte Fernández, Josieli Moris Gomes Calderano.

  <https://doi.org/10.56238/sevened2026.008-119>

.....2176-2202

THE IMPORTANCE OF CASH FLOW IN THE FINANCIAL MANAGEMENT OF MICRO AND SMALL ENTERPRISES: A LITERATURE REVIEW

Camila Silva Campos, Larissa de Macedo Câmara, Leonardo Pastorin Vieira Costa, Natália Talita Araújo Nascimento.

  <https://doi.org/10.56238/sevened2026.008-120>

.....2203-2220

BETWEEN SPEECH AND WRITING: LINGUISTIC-RHETORICAL ANALYSIS OF THE WORDPLAYING GENRE IN THE NORTHEASTERN CANTORIA DE VIOLA IN BRAZIL

Antonio Marinho do Nascimento, Benedito Gomes Bezerra.

  <https://doi.org/10.56238/sevened2026.008-121>

.....2221-2242

PROBLEM-BASED LEARNING: TEACHING EXPERIENCE IN THE CONTEXT OF THE WATER CRISIS

Francisca Marli Rodrigues de Andrade, Daniela Faria de Souza, Wendel Mattos Pompilho.

  <https://doi.org/10.56238/sevened2026.008-122>

.....2243-2263

SPECIAL AND INCLUSIVE EDUCATION IN THE 21ST CENTURY: CHALLENGES AND POSSIBILITIES WITH THE USE OF NEW TECHNOLOGIES IN TEACHING AND LEARNING

Adilson Oliveira Cruz, Áquila Jerard Moulin Ditzz, Athyla Caetano, Camila Bruschi Tonon, Eglalciane de Lyrio Tongo Castro, Evelyn de Oliveira Vieira da Silva, Renata Perozini, Renato Kohler Zanqui, Rosieli Geraldina Merotto Foletto, Silvana Beatriz D'Ávila Costa Lenzi, Thayna da Silva Raymundo.

  <https://doi.org/10.56238/sevened2026.008-123>

.....2264-2277

APPLICATION OF MACHINE LEARNING ALGORITHMS FOR DAILY SALES FORECASTING IN A BRAZILIAN BREWING INDUSTRY

Rodrigo Ribeiro Salgado César, Allana Eduarda Braga Iquegami, Nelson Marinelli Filho, Gil Eduardo Guimarães, Geraldo Nunes Corrêa.

  <https://doi.org/10.56238/sevened2026.008-124>

.....2278-2290

VIOLATIONS IN THE COMMERCIALIZATION OF INFANT FORMULA FOR INFANTS IN COMMERCIAL ESTABLISHMENTS IN MACEIÓ, ALAGOAS

Dayse Andrade Romão, Isabele Luzia Rodrigues Alves de Freitas, Maria Clara Moreira Calheiros de Novaes, Giselle Medeiros do Nascimento, Raphaela Farias Rodrigues, Rafaela Andrade de Vasconcelos, Larissa Silveira de Mendonça Fragoso, Mirella Medeiros Reis.

 <https://doi.org/10.56238/sevened2026.008-125>

.....2291-2312

BIOLOGICAL APPROACHES TO SILYMARIN AND ITS ASSOCIATION WITH METALLIC COMPOUNDS AND ZN(II)

Daniela Braga de Sousa, Luzia Débora Saldanha Marques, Jordana Lima Braga, Wildson Max Barbosa da Silva, Solange de Oliveira Pinheiro, Francisco Ernani Alves Magalhães.

 <https://doi.org/10.56238/sevened2026.008-126>

.....2313-2325

THE TEXTBOOK AS AN OBJECT OF STUDY FOR ETHNIC-RACIAL THEMES

Tatiane Balbino Cordeiro Tomaz, Maria de Lourdes Guimarães de Carvalho.

 <https://doi.org/10.56238/sevened2026.008-127>

.....2326-2353

CREDIT COOPERATIVES AND THEIR STRUCTURE AND DEVELOPMENT: POINTS OF ATTENTION AND OBSERVATION

Ederaldo José Pereira Lima, Jusceliany Rodrigues Leonel Correa, José Ricarte de Lima, Leonardo Socolott Alvarenga.

 <https://doi.org/10.56238/sevened2026.008-128>

.....2354-2370

EXTRAJUDICIAL DISPUTE RESOLUTION: CONSENSUAL MECHANISMS, EFFECTIVENESS, AND PROTECTION OF HEALTH IN RELATION TO DENTISTRY

Beatriz Andreia Melo Silva Cossaros.

 <https://doi.org/10.56238/sevened2026.008-129>

.....2371-2391

THERAPEUTIC MANAGEMENT OF CHRONIC KIDNEY DISEASE (CKD) IN CATS

Átila Bonfim Ferreira Cavalcante, Beatriz Silva Freitas, Paula Rejane Leal Ferreira Ramos, Adria Amanda Carvalho Jacinto, Vitoria Cione Camillo, Laura Gonçalves Maciel, Júlia Mayumi Imamura.

 <https://doi.org/10.56238/sevened2026.008-130>

.....2392-2400

MILKING HYGIENE AND PHYSICOCHEMICAL QUALITY OF MILK

Átila Bonfim Ferreira Cavalcante, Mariana Nunes Letieri, Adriana Silva dos Santos, Bianca Souza Alves França, Luan Costa Ferreira, Maria Eduarda Paixão Lima.

 <https://doi.org/10.56238/sevened2026.008-131>

.....2401-2407

ARTIFICIAL INSEMINATION PROTOCOLS IN CATTLE: TECHNIQUES TO OPTIMIZE CONCEPTION RATES

Leandro Giroux Gomes, Átila Bonfim Ferreira Cavalcante, Ana Edvrigens Vasconcelos de Souza, Jessica Saldanha Martins, Henrique Leite França Comes, Otávio Silveira Rizzi.

 <https://doi.org/10.56238/sevened2026.008-132>

.....2408-2415

RESOLUTION OF CONFLICTS RELATED TO DEJUDICIALIZATION

Carla Maria Caldas Figueiredo.

 <https://doi.org/10.56238/sevened2026.008-133>

.....2416-2431

ANALYSIS OF THE COOPERATION NETWORK WITHIN AN INNOVATION ECOSYSTEM IN THE INTERIOR OF SÃO PAULO STATE

Nívea Regina Marques Aguiar, Mario Mollo Neto.

 <https://doi.org/10.56238/sevened2026.008-134>

.....2432-2461

LAW, VIRTUE AND SUBJECTIVITY: JUSTICE AND ETHICAL FORMATION IN BOOK V OF THE NICOMACHEAN ETHICS

Juscelino Silva, Rafael Raimundo Oliveira Albuquerque, Edson da Silva Barros, Thayline Pereira da Silva, Roseane Henrique Viana, Cezar Ricardo Lima Neves, José Domingos Alves dos Santos, Nubia Silva Costa.

 <https://doi.org/10.56238/sevened2026.008-135>

.....2462-2497

AGING AND PUBLIC EDUCATIONAL POLICIES: PROMOTING LEARNING FOR THE INCLUSION OF THE ELDERLY

Josiette de Nazaré Silva da Costa.

 <https://doi.org/10.56238/sevened2026.008-136>

.....2498-2509

UNITY, INDIVISIBILITY AND FUNCTIONAL INDEPENDENCE: A SYSTEMIC ANALYSIS OF THE CONSTITUTIONAL PRINCIPLES OF THE BRAZILIAN PUBLIC PROSECUTOR'S OFFICE

Joaquim Ribeiro de Souza Junior.

 <https://doi.org/10.56238/sevened2026.008-137>

.....2510-2524

IMPACTS ASSOCIATED WITH GROUNDWATER TABLE LOWERING: ENVIRONMENTAL AND SOCIAL CONSEQUENCES AND STRATEGIES FOR SUSTAINABLE MANAGEMENT

Suelen Rodrigues Carvalho, Álvaro Luiz Jesus dos Santos, Lucas Galvão Pinho, Natasha Sales Xavier, Juliana Do Amor Divino Tavares, Anna Virgínia Muniz Machado, Gustavo Augusto Teixeira de Fatima.

 <https://doi.org/10.56238/sevened2026.008-138>

.....2525-2537

ELECTRIC VEHICLE SAFETY: AN INNOVATIVE AND CRITICAL ANALYSIS OF FIRE RISKS AND MITIGATION STRATEGIES

Ana Katherine Silveira Pereira Caracas, Eduardo Winter, Joel de Abreu Nobre, Rickardo Léo Ramos Gomes, Roberto Augusto Caracas Neto, Tecia Vieira Carvalho, Thiago Costa Duch.

 <https://doi.org/10.56238/sevened2026.008-139>

.....2538-2557

STRATEGIC MAINTENANCE AND TECHNOLOGICAL INNOVATION AS RESPONSES TO STRUCTURAL CHALLENGES IN RENEWABLE ENERGY PRODUCTION CHAINS

Alcides Feitosa Neto, Antonio Werbiton Marinho Almeida, Francisco Fabio Braga Florêncio, Givanildo Ximenes Santana, Irene Mendes Fontes, José Reudson de Souza, Márcio Carneiro Barbosa, Moésio da Costa Bastos, Rickardo Léo Ramos Gomes, Roberto Augusto Caracas Neto, Tovyska Braga Dantas, William Neves da Silva.

 <https://doi.org/10.56238/sevened2026.008-140>

.....2558-2573

MANAGEMENT OF SALMONELLOSIS IN REPTILES: THERAPEUTIC APPROACHES

Átila Bonfim Ferreira Cavalcante, Erica Nunes dos Santos, Isadora Soares Pissanelli, Lucas de Oliveira Rodrigues, Luiza Vaucher Mendes Pereira, Eduarda de Matos Lopes, Davi Victal Pacheco, Camila Soares Ramos.

  <https://doi.org/10.56238/sevened2026.008-141>

.....2574-2582

CHALLENGES AND POTENTIAL OF ENVIRONMENTAL EDUCATION IN THE PMVA: A SOCIAL NETWORK APPROACH

Thábata Biazuz Veronese, Mario Mollo Neto.

  <https://doi.org/10.56238/sevened2026.008-142>

.....2583-2607

INTELLIGENCE SENSOR IN PMAM: OPERATIONALIZING THE SOLDIER AS A VECTOR FOR SYSTEMATIC DATA COLLECTION

Bruno Lucas Ferreira, Evelton Cezar Bitencourt, Flávio Carvalho Cavalcante.

  <https://doi.org/10.56238/sevened2026.008-143>

.....2608-2622

HEALTH HABITS, DIGITAL MEDIA, AND PUBLIC SCHOOL: RESULTS OF A STUDY WITH ADOLESCENTS IN ANANINDEUA, PA (BRAZIL)

Valéria de Nazaré de Paula Bessa, Éder do Vale Palheta, Biratan dos Santos Palmeira, Moisés Simão Santa Rosa de Sousa, Cileide Tavares Borges do Couto, Márcia de Araujo da Costa, Marco Antônio Barros dos Santos, Dario Deivid Silva da Silva.

  <https://doi.org/10.56238/sevened2026.008-144>

.....2623-2638

DEVELOPMENT OF A CUBESAT KIT FOR ACADEMIC PURPOSES: DESIGN, CONSTRUCTION, AND APPLICATIONS

Dafnhê Thor Castro de Martins Barros.

  <https://doi.org/10.56238/sevened2026.008-145>

.....2639-2653

PUPPET THEATRE FOR MIDDLE SCHOOL: HISTORY, MAIN TECHNIQUES, AND PROPOSALS FOR THE 6TH GRADE

Kleriston Luis Rocha Neris.

  <https://doi.org/10.56238/sevened2026.008-146>

.....2654-2673

BETWEEN AVATARS AND ALGORITHMS: GOVERNING PARALLEL UNIVERSES IN THE AGE OF THE METAVERSE

Ailton Ferreira Cavalcante.

  <https://doi.org/10.56238/sevened2026.008-147>

.....2674-2698

PINK OCTOBER PET EXTENSION PROJECT: THE IMPORTANCE OF RAISING AWARENESS AMONG PET OWNERS AND STUDENTS ABOUT BREAST CANCER IN VETERINARY MEDICINE

Maria Augusta Freitas Barbosa Paiva de Lira, Emanuella Maria Elen Moraes Sousa, José Eduardo Vieira da Silva, Isabela de Andrade Lima Barreto Lins, Natália Araújo Vieira, Karine Silva Camargo.

  <https://doi.org/10.56238/sevened2026.008-148>

.....2699-2706

READING MEDIATION ACTIVITIES IN CHEMISTRY CLASSES ON HEALTHY EATING AND THE PERIODIC TABLE

Hélio Nascimento da Paixão Júnior, Josineide Pantoja da Costa, Wilton Rabelo Pessoa.

 <https://doi.org/10.56238/sevened2026.008-149>

.....2707-2780

FROM BENCH TO BEDSIDE: HOW TRANSLATIONAL RESEARCH HAS CONTRIBUTED TO THE TREATMENT OF PANCREATIC CANCER

Karla Laíssa Silva de Oliveira, Daniel Dias Machado, Matheus Albuquerque Athayde da Silva.

 <https://doi.org/10.56238/sevened2026.008-150>

.....2781-2797

THE ILLUSION OF DIGITAL IMPUNITY: WHY THE INTERNET IS NOT A LAWLESS LAND

Andre de Oliveira Melo, Alessandra Gusmão Trajano de Araújo, Adriana Gusmão Trajano de Araújo, Gustavo Davanco Nardi, Carlos Eduardo do Nascimento.

 <https://doi.org/10.56238/sevened2026.008-151>

.....2798-2812

ORGANIZATIONAL CLIMATE MANAGEMENT AS A RESPONSE TO TENSIONS BETWEEN PHYSICAL PRESENCE AND PRODUCTIVITY

Rosângela Gomes Vaillant, Karl Stoeckl, Lázaro César de Sousa Silva.

 <https://doi.org/10.56238/sevened2026.008-152>

.....2813-2828

BETWEEN PUBLIC POLICY AND PEDAGOGICAL PRACTICE: LIMITS OF EDUCATION IN ADDRESSING POVERTY

Everaldo dos Santos Mendes, Gloria de Lourdes Silva de Oliveira Melo, Josué Vicente de Carvalho, Márcio Silva da Conceição, Gilmar Santos Batista.

 <https://doi.org/10.56238/sevened2026.008-153>

.....2829-2842

TESTIMONIAL LITERATURE AGAINST THE GRAIN OF HISTORY: PEASANT MEMORY IN GRACILIANO RAMOS'S VIDAS SECAS

José Luís de Barros Guimarães, Henrique de Sousa Manguiera.

 <https://doi.org/10.56238/sevened2026.008-154>

.....2843-2868

INSTRUMENTAL TRANSCOMMUNICATION IN DIGITAL NETWORKS: HYBRID DEVICES ON THE BORDERLINE OF SCIENCE AND SPIRITUALITY

José Valentim Martins Melo, Edwaldo Costa.

 <https://doi.org/10.56238/sevened2026.008-155>

.....2869-2874

HYDROLOGICAL-HYDRODYNAMIC MODEL OF THE TAMANDARÉ CANAL IN BELÉM-PA FOR THE IMPLEMENTATION OF WORKS PRIOR TO COP 30

Marco Valério de Albuquerque Vinagre, Francisco Denis Pereira Chaves, Alberto Carlos de Melo Lima, Luan da Silva Freitas, Roberto Fontes de Souza, Rodrigo Lauria Fonseca, Edilaine Cristina Pamplona Menezes.

 <https://doi.org/10.56238/sevened2026.008-156>

.....2875-2894

DEVELOPMENT AND VALIDATION OF THE COOPER-PRO APPLICATION FOR THE ASSESSMENT AND PRESCRIPTION OF TRAINING FOR ROAD RUNNERS

Moisés Simão Santa Rosa de Sousa, Luiguy Xavier de Lima, Tatyana Pinheiro Magalhães, Divaldo Martins de Souza, Alaan Ubaiara Brito.

 <https://doi.org/10.56238/sevened2026.008-157>

.....2895-2908

A COLLABORATIVE SYSTEM FOR GEOREFERENCED MONITORING OF NOISE POLLUTION DATA CLASSIFIED BY MACHINE LEARNING MODEL

Fani Tamires de Souza Batista, Sannyer Cardoso Carvalho Nery, Sérgio Augusto Coelho Bezerra, Keiko Verônica Ono Fonseca, José Reginaldo Hughes Carvalho.

 <https://doi.org/10.56238/sevened2026.008-158>

.....2909-2926

EVALUATION OF A CATIONIC POLYSACCHARIDE COAGULANT FOR OPTIMIZING THE TREATMENT OF OILY EFFLUENTS FROM THE MANAUS REFINERY (REAM) – QQS COA S

Fernando André de Oliveira Duarte.

 <https://doi.org/10.56238/sevened2026.008-159>

.....2927-2946

ADVANCE DIRECTIVES: CHALLENGES AND PERSPECTIVES AMONG MULTIDISCIPLINARY HEALTH CARE TEAMS IN BRAZIL

Janaína Aparecida de Sales Floriano, Giuliano Citrini Stipkovic, Neide Aparecida Micelli Domingos, Maria Jaqueline Coelho Pinto, João Daniel de Souza Menezes, Cintia Canato Martins, Christian Guilherme Capobianco dos Santos, Emerson Roberto dos Santos, Loiane Letícia dos Santos, Júlio César André, Eudes Quintino de Oliveira Júnior, Maria Cristina de Oliveira Santos Miyazaki.

 <https://doi.org/10.56238/sevened2026.008-160>

.....2947-2973

SUPPLEMENTARY PENSION IN THE FEDERAL PUBLIC SERVICE: INFORMATIONAL CHALLENGES, CAREER DECISIONS, AND PEOPLE MANAGEMENT IN PUBLIC EDUCATIONAL INSTITUTIONS

Vanessa Cristina Mota da Costa, Taina Serafim Ferreira dos Santos, Plinio Alexandre dos Santos Caetano.

 <https://doi.org/10.56238/sevened2026.008-161>

.....2974-2995

WILMS' TUMOR: GENETIC ASPECTS, DIAGNOSIS AND TREATMENT: A LITERATURE REVIEW

Nathalia Bezerra de Souza Rates, Lívia Maria Della Porta Cosac, Victória Dias da Silva, Luana da Silva Souza, Carlos Alberto Pereira da Silva Junior.

 <https://doi.org/10.56238/sevened2026.008-162>

.....2996-3006

SURVEY ON ACCESSIBILITY OF PACKAGING IN THE COSMETIC INDUSTRY

Fernanda de Medeiros Costa, Giovanna Couto de Sá, Pâmela Paes-Pereira, Everton Moura Arruda, Wallace Lira, Ellen Regina da Costa Paes.

 <https://doi.org/10.56238/sevened2026.008-163>

.....3007-3017

SEXUAL VIOLENCE AGAINST HOMELESS WOMEN IN THE CITY OF MANAUS: A LEGAL ANALYSIS IN LIGHT OF FUNDAMENTAL RIGHTS

Alessandra Souza Garcia, Alexandra Pantoja Monteiro, Dayla Corrêa Campos, Dimas Melo Gonçalves, Elauton Guerra Mota de Farias, Keyciane Cardoso Lima Mascarenhas, Maria Aparecida Jardim Marques, Moisés da Silva Gomes Filho, Rick Wesley Feitosa Pinto, Thais Bentes de Oliveira.

  <https://doi.org/10.56238/sevened2026.008-164>

.....3018-3034

THE INTEGRATED CURRICULUM AS A STRATEGY TO OVERCOME CURRICULUM FRAGMENTATION IN FULL-TIME SCHOOLS

Jardelson de Medeiros Silva.

  <https://doi.org/10.56238/sevened2026.008-165>

.....3035-3048

FRESH PAINT: PHOTOETHNOGRAPHY BETWEEN GRAFFITI, POETRY, AND TRANSCULTURATED VISUAL NARRATIVE

Sidney Barata de Aguiar, Gisele Giandoni Wolkoff.

  <https://doi.org/10.56238/sevened2026.008-166>

.....3049-3069

CALCULATION AND IMPLEMENTATION OF BOTTOM DISCHARGE IN DAMS: THEORETICAL AND PRACTICAL GUIDE

Jonathan Joaquim de Moraes, Girlene Figueiredo Maciel, Rodrigo Martins Ribeiro, Mateus Chagas dos Santos, Amanda da Rosa Lena, Fernán Enrique Vergara Figueroa, Joel Carlos Zukowski Junior.

  <https://doi.org/10.56238/sevened2026.008-167>

.....3070-3086

ONTOLOGICAL PAREIDOLIA AND THE SAFE DISSIPATION HYPOTHESIS: TOWARD A NON-REIFIED LEGAL ONTOLOGY

Flávio Furtado de Farias, Francisco de Sousa Vieira Filho.

  <https://doi.org/10.56238/sevened2026.008-168>

.....3087-3116

INFLUENCE OF THE PRESENCE OF CROTAMINE IN THE COMPOSITION OF THE CROTALUS DURISSUS TERRIFICUS VENOM FACE TO CROTALIC ANTIVENOM, A HISTOLOGICAL APPROACH

Fâni Ribeiro Silva, Nathalia Margarida Cantuária, Jonas Eligio Garcia de Azevedo, Gabriel Ferreira dos Santos, Jocimar de Souza, Leonardo da Silva Rodrigues Calderon, Isabella Ravazoli, José Carlos Cogo, Rafael Stuari Floriano, Stephen Hyslop, Yoko Oshima-Franco.

  <https://doi.org/10.56238/sevened2026.008-169>

.....3117-3138

THE DEVELOPMENT OF THE PROFESSIONAL IDENTITY OF MATHEMATICS TEACHERS IN THE CONTEXT OF DIGITAL CULTURE

André Gomes dos Santos, Heraldo Márcio de Aguiar, Juliano Schimiguel.

  <https://doi.org/10.56238/sevened2026.008-170>

.....3139-3150

RESILIENCE IN NURSING STUDENTS: PSYCHOSOCIAL CHALLENGES AND STRENGTHENING STRATEGIES IN THE UNIVERSITY CONTEXT

Ana Maria Rita Pedroso Vilela Torres de Carvalho Engel, Stela Regina Pedroso Vilela Torres de Carvalho, Diego Mariozi Ferreira, Flávia Cristina Custódio, , João Daniel de Souza Menezes, Matheus Querino da Silva, Andressa Karina Stefani, Camila Aline Lázaro, William Donegá Martinez, Loiane Letícia dos Santos, Vânia Maria Sabadoto Brienze, Júlio Cesar André.

 <https://doi.org/10.56238/sevened2026.008-171>

.....3151-3179

AIRLINES: WHAT EXPLAINS THE CHOICE OF BRAZILIAN TOURISTS?

Viviane Chunques Gervasoni, George Bedinelli Rossi.

 <https://doi.org/10.56238/sevened2026.008-172>

.....3180-3201

CONSUMER PROFILE OF A FAST FOOD RESTAURANT IN MALL PLAZA MAULE, CHILE

Moacyr Portes Júnior, Patricio Wladimir Gurtiérrez Montecino, Marcela de la Paz Inostroza Figueroa, Sebastián Eduardo Retamal López, Natalia de los Ángeles Toloza Salgado, Lisbetty del Pilar Morales Mora.

 <https://doi.org/10.56238/sevened2026.008-173>

.....3202-3218

CONTROLLING THE ABUSE OF POWER AND JUDGMENT OF REASONABLENESS

Felipe Teles Tourounoglou.

 <https://doi.org/10.56238/sevened2026.008-174>

.....3219-3233

GAMEMOVE MOTOR SKILL ASSESSMENT MODE AND ITS APPLICATION IN THE ANALYSIS OF MOTOR PERFORMANCE IN AGING INDIVIDUALS

Geovani Rafaele Lima Cavaleiro, Sílvia Cardoso Borges, Djuli Margô Naissinger Sidekum, Denise Bolzan Berlese, Geraldine Alves dos Santos.

 <https://doi.org/10.56238/sevened2026.008-175>

.....3234-3253

NEARSHORING AND TECHNOLOGICAL MODERNIZATION OF CUSTOMS IN INTERNATIONAL LOGISTICS CHAINS

Porfirio Tamayo Contreras, Rafael Espinosa Mosqueda, Héctor Fabian Gutiérrez Rangel, Ángel Gutiérrez Rodríguez.

 <https://doi.org/10.56238/sevened2026.008-176>

.....3254-3272

LIVING IN A LONG-TERM CARE FACILITY: DOES INSTITUTIONALIZATION REDEFINE QUALITY OF LIFE IN OLD AGE?

Bruna Sthefani Santos Guimarães, Caroline Fofano de Almeida, Elton Silva de Moura, Gabriela Cristina Duarte, Isabela Braga Zanetti, Teodora Xavier dos Santos, Thiago Corrêa de Sá Ricardo, Rosa Gouvêa de Sousa.

 <https://doi.org/10.56238/sevened2026.008-177>

.....3273-3289

BORN TO CARE: GENDER ROLES AND EMOTIONAL OVERLOAD AMONG INFORMAL FEMALE CAREGIVERS

Amanda Cavalcanti Pinheiro Barbas, Bianca Lemos Cobra, Laleska Morais Ferreira, Lorena Lourenço Rosa da Silva, Mateus Henrique Oliveira Souza, Melissa Mendes Ferreira, Santiago de Matos Fernandes Perez, Tatiana Maria da Silva, Rosa Gouvêa de Sousa.

 <https://doi.org/10.56238/sevened2026.008-178>

.....3290-3305

ORALITY IN CIVIL AND FAMILY PROCEDURAL MATTERS IN MEXICO: BRIEF REFLECTIONS ON THE PRINCIPLES GOVERNING IT IN THE NATIONAL CODE

Norma Dávila Cota.

 <https://doi.org/10.56238/sevened2026.008-179>

.....3306-3327

DYNAMICS OF FAMILY PARTICIPATION AND SCHOOL LEARNING: QUALITATIVE ANALYSIS OF TEACHING PERCEPTIONS IN THE STATE PUBLIC NETWORK OF AMAZONAS

Antonio Carlos Cortez Pinheiro.

 <https://doi.org/10.56238/sevened2026.008-180>

.....3328-3342

CRITICAL THINKING AND THE USE OF ARTIFICIAL INTELLIGENCE (AI)

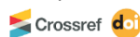
Francisco Roberto Rojas Caldelas, Marco Antonio Marín Álvarez.

 <https://doi.org/10.56238/sevened2026.008-181>

.....3343-3352

PERFORMANCE AND PRODUCTIVITY MANAGEMENT IN THE FOOD INDUSTRY: A CASE STUDY APPLIED TO A SMALL-SCALE AGROINDUSTRY

Pollyanna Cardoso Pereira, Diego Augusto Carneiro Junho, João Pedro Da Silva.

 <https://doi.org/10.56238/sevened2026.008-182>

.....3353-3367

UTILITY MODEL, TECHNOLOGICAL MATURITY, AND DUAL USE IN THE BRAZILIAN DEFENSE INDUSTRIAL BASE: AN ANALYSIS OF PATENT BR 202014017157-1 IN LIGHT OF TRL

Daniel Galvão de França Blaskiewicz, José Seixas de Aquino Filho, Roberto Augusto Caracas Neto, Elizabeth Ferreira da Silva, Eduardo Winter.

 <https://doi.org/10.56238/sevened2026.008-183>

.....3368-3389

ANALYSIS OF WATER LOSS INDICATORS AND THEIR RELATIONSHIP WITH SOCIOECONOMIC INEQUALITY IN THE STATE OF RIO DE JANEIRO

Vitória Xavier Rodrigues, João Victor Abreu Rodrigues, Anna Virginia de Muniz Machado.

 <https://doi.org/10.56238/sevened2026.008-184>

.....3390-3406

INVISIBLE GEARS: UNCONSCIOUS HABITS IN THE FORMATION OF HUMAN PERSONALITY

Gilson Aires de Menezes Júnior.

 <https://doi.org/10.56238/sevened2026.008-185>

.....3407-3424

BETWEEN PLANNING AND DEMOCRACY: BUDGETING, CITIZEN PARTICIPATION, AND THE GIS CYCLE

Ailton Ferreira Cavalcante.

 <https://doi.org/10.56238/sevened2026.008-186>

.....3425-3448

REGULATORY IMPACT AS AN INSTRUMENT OF STATE EFFICIENCY

Felipe Teles Tourounoglou.

 <https://doi.org/10.56238/sevened2026.008-187>

.....3449-3468

REGULATION OF URBAN SPACE IN A COASTAL CITY: THE CASE OF SANTA CATARINA ISLAND (FLORIANÓPOLIS, SC)

Fabiano Prudêncio da Silva.

 <https://doi.org/10.56238/sevened2026.008-188>

.....3469-3489

SIMULATION OF THE RUPTURE OF AN INDUSTRIAL FERTILIZER TAILINGS DAM IN ARRAIAS, TOCANTINS, BRAZIL

Ricardo Ribeiro Dias, Girlene Figueiredo Maciel, Talita Cintra Braga, Rose Mary Gondim Mendonça.

 <https://doi.org/10.56238/sevened2026.008-189>

.....3490-3502

NUMERICAL EVALUATION OF THE STATIC PERFORMANCE OF A SMALL PROPELLER COMPARING TRADITIONAL AND TRANSITIONAL TURBULENCE MODELS

Luiz Carlos Bevilaqua dos Santos Reis, Newton Galvão de Campos Leite, Maurício Araujo Zanardi, Laura Manuci de Andrade, Rodrigo Viana de Freitas Santos.

 <https://doi.org/10.56238/sevened2026.008-190>

.....3503-3525

INTEGRATED MANAGEMENT OF TRAFFIC VIOLATIONS: IMPACTS OF DIGITAL TRANSFORMATION ON STATE PUBLIC ADMINISTRATION

Henrique Ribeiro da Glória Antunes, Luana Amélia de Abreu Teixeira, Lucas Vilas Boas Pacheco, Rita de Cássia Alanna Ribeiro.

 <https://doi.org/10.56238/sevened2026.008-191>

.....3526-3546

ORIGINATING PEOPLES IN THE STATE OF TOCANTINS: VISCERAL LEISHMANIASIS AND ITS EPIDEMIOLOGICAL ASPECTS

Sonia Ferreira Gomes, Regiane Cristina Neto Okochi, Jean Rafael Ribeiro, Keren Sayuri Okochi, Karen Renatta Barros Rodrigues, Claudia Christina Ribeiro Guimarães Neri de Magalhães, Denise Soares de Alcantara, Daurenice Lopes de Araújo Vaz.

 <https://doi.org/10.56238/sevened2026.008-192>

.....3547-3560

MIRINGUAVA RIVER BASIN: TOURISM AS A POTENTIAL ACTIVITY FOR IMPROVING THE SOCIOECONOMIC AND ENVIRONMENTAL CONDITIONS OF SÃO JOSÉ DOS PINHAIS

Cinthia Marie Ota Fraletti, Cezar Augusto Romano.

 <https://doi.org/10.56238/sevened2026.008-193>

.....3561-3577

LEGAL SECURITY IN DIGITAL ECOSYSTEMS: REGULATION BY PRINCIPLES AND SUPERVISED SELF-REGULATION FOR AI AND BLOCKCHAIN IN BRAZIL

Sadre Pantoja Alho.

 <https://doi.org/10.56238/sevened2026.008-194>

.....3578-3599

A BIBLIOGRAPHIC REVIEW APPROACH ON THE USE OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

Luciane de Fatima Rodrigues de Souza, Maria Cristina Marques, Kelen Cristina Crivelaro Silvestre, Pedrinho Antonio Julião Filho.

 <https://doi.org/10.56238/sevened2026.008-195>

.....3600-3612

PERSONAL DATA PROTECTION IN PUBLIC HEALTH IN MANAUS: LEGAL CHALLENGES OF LGPD APPLICATION IN THE PROCESSING OF SENSITIVE DATA

Alessandra Souza Garcia, Alexandra Pantoja Monteiro, Elauton Guerra Mota de Farias, João Lopes Rodrigues, Keyciane Cardoso Lima Mascarenhas, Moisés da Silva Gomes Filho, Rick Wesley Feitosa Pinto, Dimas Melo Gonçalves.

 <https://doi.org/10.56238/sevened2026.008-196>

.....3613-3632

AN ANALYSIS OF THE IMPORTANCE OF MENTAL CALCULATION IN THE 5TH GRADE OF ELEMENTARY SCHOOL AT THE PEDRO LUDOVICO TEIXEIRA MUNICIPAL SCHOOL IN THE MUNICIPALITY OF COLINAS DO TOCANTINS

Marilene Pessoa da Silva Augusti, Margareth Araújo e Silva, Luciana Cristina Porfírio.

 <https://doi.org/10.56238/sevened2026.008-197>

.....3632-3646

MENTAL HEALTH IN CHILDHOOD AND ADOLESCENCE: WELCOMING AND CONTINUOUS SUPPORT

Raquel Oliveira Santos, Sálvia Viviane Agra Belota, Gleyce Adrielle da Silva Rodrigues, Graciene Rabelo Mota e Silva.

 <https://doi.org/10.56238/sevened2026.008-198>

.....3647-3660

DIAGNOSTIC ENGINEERING: PATHOLOGICAL ANALYSIS OF THE FEDERAL GOIANO INSTITUTE – TRINDADE CAMPUS

Ana Clara Alves Nunes, Ana Júlia Bezerra Martins, Arthur Rodrigues Lourenço, Pedro Filipe de Luna Cunha, Vitória Régia Araújo Ribeiro, Andre Augusto Nobrega Dantas.

 <https://doi.org/10.56238/sevened2026.008-199>

.....3661-3681

CHARACTERIZATION AND PERFORMANCE OF SOIL-CEMENT BRICKS PRODUCED WITH SOILS FROM THE ARARIPINA REGION (PE)

Weverton dos Santos Faria, Patrícia Costa de Andrade.

 <https://doi.org/10.56238/sevened2026.008-200>

.....3682-3701

ALBEDOMAPS: PROPOSAL OF A DIGITAL PLATFORM FOR MONITORING URBAN HEAT ISLANDS IN THE CUIABÁ METROPOLITAN REGION

Matheus Nunes dos Santos, Luiz Carlos de Almeida, Mario Marcos Morel, Nayara Gomes de Oliveira, Olivia Fernandes Boretti, Paulo Ricardo dos Santos Silva, Phelipe Matheus Sales Kinack, Quedna Brito dos Reis, Rander Teixeira Barros, Regis Alves Dourado, Gracyeli Santos Souza Guarienti, Lidia Martins da Silva.

 <https://doi.org/10.56238/sevened2026.008-201>

.....3702-3714

AN ALTERNATIVE APPROACH FOR DEFINING PLANT BREEDING

Paulo Sérgio Lima e Silva.

 <https://doi.org/10.56238/sevened2026.008-202>

.....3715-3734

POWER AND PHOTOGRAPHY: SIGNS OF INFORMATION IN PUBLIC AND POLITICAL COMMUNICATION

Bibiana de Paula Friderichs, Alahna de Oliveira Lopes.

 <https://doi.org/10.56238/sevened2026.008-203>

.....3735-3754

PATHOLOGICAL MANIFESTATION IN INTERNAL CERAMIC COATING: A CASE STUDY IN A BUILDING IN GOIÂNIA-GO

Emily Pereira Lima, Pedro Filipe de Luna Cunha, Vitória Régia Araújo Ribeiro, Andre Augusto Nobrega Dantas, Yuri Sotero Bomfim Fraga, Gabriel Lima Oliveira Martins, Pollyanna Laurindo de Oliveira, Jeanisson Cesar Mariano Silva.

 <https://doi.org/10.56238/sevened2026.008-204>

.....3755-377

RAPID ASSESSMENT PROTOCOL AS A PEDAGOGICAL RESOURCE FOR THE SOCIO-ENVIRONMENTAL READING OF URBAN RIVERS: ADAPTATIONS IN THE DEVELOPMENT AND VALIDATION OF A DIDACTIC GUIDE

Helaine de Oliveira Menezes, Felipe Fontana.

 <https://doi.org/10.56238/sevened2026.008-205>

.....3778-3809

THEATRE BETWEEN MANAUS AND PARINTINS: STAGES AND MEMORIES

Dilce Pio Nascimento.

 <https://doi.org/10.56238/sevened2026.008-206>

.....3810-3825

REFLECTIONS ON LEARNING AND MEMORY IN LIGHT OF THE EXECUTIVE FUNCTION OF MEMORY

José Manuel Salum Tomé.

 <https://doi.org/10.56238/sevened2026.008-207>

.....3826-3835

ANALYSIS OF THE INFLUENCE OF TACTICS ON THE EFFICIENT USE OF PLAYING SPACE IN UNIVERSITY SOCCER

Luis da Silva Simoes.

 <https://doi.org/10.56238/sevened2026.008-208>

.....3536-3875

THE UNIVERSITY AS A HUB OF URBAN TERRITORIAL DEVELOPMENT: THE CASE OF THE CITY OF MARINGÁ-PR

Lúcio Paulo Alves Pires.

 <https://doi.org/10.56238/sevened2026.008-209>

.....3876-3887

INNOVATION PROCESS IN TRANSPORTATION: A STUDY ON THE USE OF TELEMETRY IN THE ARTICULATED BUS SYSTEM OF THE BRT-RJ

Cleber Rebelo Israel Reis, Tabatha Moreira Pacheco, Pedro Augusto Cardoso da Silva, Valeria Cristina de Souza Corrêa, Michele da Silva Feitoza, Fernanda Souza de Sales, Daniel Sypriano de Sales, Fabricio Ziviani.

 <https://doi.org/10.56238/sevened2026.008-210>

.....3888-3920

EVOLUTION OF MATHEMATICS AT CRU LOS SANTOS: QUANTITATIVE STUDY OF FOUR DECADES OF ACADEMIC ACTIVITY

Alcibíades Medina M., Nohelys E. Díaz G., Eliecer Cedeño, Narciso Galástica.

 <https://doi.org/10.56238/sevened2026.008-211>

.....3921-3945

REGULATION OF BRAZILIAN AIR TRANSPORTATION AND FUNDAMENTAL RIGHTS: LEGAL CHALLENGES IN THE TRANSPORTATION OF EMOTIONAL SUPPORT ANIMALS

Ana Sheila dos Santos Gomes, Beatriz Barros Silva, Flávia da Silva Fernandes, João Lopes Rodrigues, Kricia Lavareda Mendes Gregório, Laurentino de Sousa Santos, Manuella Pimenta Loureiro, Samia Tainar Marques da Silva, Dimas Melo Gonçalves.

 <https://doi.org/10.56238/sevened2026.008-212>

.....3946-3964

PACKAGING REGULATION AND CHOICES OF SUSTAINABLE MATERIALS: A CRITICAL DIALOGUE BETWEEN THE EUROPEAN PPWR AND BRAZILIAN DECREE NO. 12,688/2025, WITH EMPHASIS ON CARDBOARD AND CORRUGATED CARDBOARD

Leonardo Bezerra.

 <https://doi.org/10.56238/sevened2026.008-213>

.....3965-3970

MIGRATION AND TERRITORIAL DYNAMICS IN BORDER REGIONS: CULTURE, REGIONAL DEVELOPMENT, AND PUBLIC POLICIES

Rosalina Alves Nantes, Rosemeire Ferrarezi Valiante.

 <https://doi.org/10.56238/sevened2026.008-214>

.....3971-3986

BETWEEN SIMPLICITY AND TECHNICAL DIFFICULTIES: PERCEPTIONS OF TECHNOLOGIES FOR MONITORING PUBLIC CONTRACT MANAGEMENT

Carla Sabrina dos Santos Souza, Reinaldo Azevedo Barbosa, Roberto Miranda Pimentel Fully.

 <https://doi.org/10.56238/sevened2026.008-215>

.....3987-4011

THE VALUE AND TEACHINGS OF FAIRY TALES ABOUT FAMILY RELATIONSHIPS FOR CHILDREN: A PSYCHO-PHILOSOPHICAL READING OF SNOW WHITE

Angela Zamora Cilento de Rezende, Eduardo Castedo Abrunhosa, Marcelo Martins Bueno, Yasmin Cilento de Rezende.

 <https://doi.org/10.56238/sevened2026.008-216>

.....4012-4029

AUTO SOLDERING: AUTOMATION OF THE SOLDERING PROCESS FOR TRANSFORMER COIL TERMINALS

Alexandre Holanda Damasceno, Léo Fernando Castelhana Bruno, Maria de Lourdes Santos de Lima, Victor Abreu dos Santos, Luis Felipe Trindade Natário.

 <https://doi.org/10.56238/sevened2026.008-217>

.....4030-4058

RESPONSIBLE MANAGEMENT AND SUSTAINABLE HUMAN REINTEGRATION

Fernanda Caroline Conrado, Kevin Gonçalves Calbusch, Rafael Ávila Lopes, Geovani Broering, Renato Rodrigues.

 <https://doi.org/10.56238/sevened2026.008-218>

.....4059-4065

WELFARE IN PUBLIC POLICIES

Hildeberto Pedro Paixão, Alexandra Aparecida Borges de Souza, Geovani Broering, Renato Rodrigues.

 <https://doi.org/10.56238/sevened2026.008-219>

.....4066-4077

TECHNICAL-ENERGY PERFORMANCE, OVERSIZING, AND SIMULTANEITY IN A RESIDENTIAL SOLAR POWER PLANT WITH ENPHASE MICROINVERTERS AND TRINA 705 W MODULES: A CASE STUDY IN FORTALEZA/CE

Maicom Aparecido Mortol, Rickardo Léo Ramos Gomes.

  <https://doi.org/10.56238/sevened2026.008-220>

.....4078-4091

AI GOVERNANCE IN HUMAN RESOURCES: TRANSPARENCY, COMPLIANCE, AND FAIRNESS IN AUTOMATED PROCESSES

Denilson Albano Portácio, Francisca Elsa Silva Franklin, Francisco José Lopes Cajad, Ilcimar Gomes Vieira Costa, Irene Mendes Fontes, Juliana Alves Coelho, Maria Antônia do Socorro Rabelo Araujo, Ricardo Cesar de Oliveira-Borges, Rickardo Léo Ramos Gomes, Roberto Augusto Caracas Neto, Walter Junior Silva Sousa.

  <https://doi.org/10.56238/sevened2026.008-221>

.....4092-4105

ENERGY TRANSITION, LEGAL CERTAINTY, AND THE NEW ENVIRONMENTAL LICENSING FRAMEWORK: PERSPECTIVES FOR THE GREEN HYDROGEN AND AMMONIA INDUSTRY IN BRAZIL

Tadeu Dote Sá, Givanildo Ximenes Santana, João Guilherme de Oliveira Duarte, Rickardo Léo Ramos Gomes.

  <https://doi.org/10.56238/sevened2026.008-222>

.....4106-4117

BETWEEN STRATEGY AND PRACTICE: LEADERSHIP AND THE CONSTRUCTION OF ORGANIZATIONAL GROWTH IN BUSINESS CONTEXTS

Plinio Alexandre dos Santos Caetano, Ana Flávia Faria Paiva, Grazielle Martins Fraga Nascimento.

  <https://doi.org/10.56238/sevened2026.008-223>

.....4118-4140

THE CONTRIBUTIONS OF LANDSCAPE TO THE URBAN AND ENVIRONMENTAL PLANNING PROCESS AND TO THE INTEGRATED MANAGEMENT OF THE HYDROGRAPHIC BASIN

Elizabeth de Fátima Correia, Nilo Nunes, Laís Samira Correia Nunes, Manuel Enrique Gamero Guandique.

  <https://doi.org/10.56238/sevened2026.008-224>

.....4141-4161

CITIZEN REFLECTIONS BASED ON THE APPROACH TO CHILD SUPPORT IN "VALE TUDO" (2025)

Alessandra Helen Alves Claudino, Gabriela Caroline Alves Claudino.

  <https://doi.org/10.56238/sevened2026.008-225>

.....4162-4178

CONFLICT, MIMETIC RIVALRY AND NONVIOLENCE: FRIENDSHIP AS AN ETHICAL HORIZON OF COEXISTENCE

Antonio Coelho Soares Junior, Joaquim Ribeiro de Souza Junior, Mariana Maria Pereira.

  <https://doi.org/10.56238/sevened2026.008-226>

.....4179-4191

POST-TRAUMATIC STRESS DISORDER: UNDERSTANDING, IMPACTS, AND COPING STRATEGIES FROM ACADEMIC AND COMMUNITY PERSPECTIVES

Felipe Vieira Barbosa, Marina Sias Leal, Rosane Pinheiro Krüger Feijó.

  <https://doi.org/10.56238/sevened2026.008-227>

.....4192-4196

PLANETARY HEALTH IN THE AMAZON: IMPACTS OF CLIMATE CHANGE AND MULTIPROFESSIONAL RESPONSES TO GLOBAL HEALTH CHALLENGES

Patrícia dos Santos Moutinho Coelho, Mariana Elizabeth Lopes de Sales, Vânia Cristina Ribeiro Brilhante, Adriana Almeida dos Santos, Leidiane Braz de Sousa, Amanda Emanuele dos Santos Correa, Patrícia Gabrielly da Silva Pires, Valdemar Mendes de Moraes Filho, Leidson Frank Santana Cardoso, Priscila Bezerra de Lima, Kátia Lamara de Araújo, Jander Marcus Cirino Lopes, Suane e Silva Duarte Souto, Iolene Mara Cardoso de Matos, Amanda Martins Araújo, Eduardo Silva Rodrigues, Jhennifer Stefany Teles Gonçalves, Rafaela Baliot de Souza, Anna Monise Rigon Von Heimburg, Tassiane Martins Bezerra, Grazielle Queiroz Mazete Maran, Jean-Claude Martins de Andrade, Vanessa Silva Bermond, Rosana Pereira Medina Freitas, Lucas de Souza Victor, Neide Garcia Ribeiro.

 <https://doi.org/10.56238/sevened2026.008-228>

.....4197-4211

COMPUTATIONAL MODELING OF THE DOCK CHANNEL IN BELÉM, PARÁ, FOR THE IMPLEMENTATION OF URBAN IMPROVEMENTS PRIOR TO COP30

Marco Valério de Albuquerque Vinagre, Luan da Silva Freitas, Roberto Fontes de Sousa, Rodrigo Lauria Fonseca, Edilaine Cristina Pamplona Menezes, Marly Sanches Cardoso, Larissa Mourão Pantoja.

 <https://doi.org/10.56238/sevened2026.008-229>

.....4212-4231

THE 'RECOMEÇAR LAGES' PROGRAMME: AN INTEGRATED MUNICIPAL POLICY FOR PEOPLE LIVING ON THE STREETS

Kleber de Oliveira, Joshua Pinto Farias de Almeida, Geovani Broering, Renato Rodrigues.

 <https://doi.org/10.56238/sevened2026.008-230>

.....4232-4239

HUMAN RIGHTS AND THE RIGHT TO EDUCATION: A SOCIO-ANTHROPOLOGICAL PERSPECTIVE ON DEAF LEARNERS

Simone Aparecida dos Santos Silva, Jose Santos Xavier.

 <https://doi.org/10.56238/sevened2026.008-231>

.....4240-4252

COMPUTATIONAL TOOL FOR COMPARATIVE ANALYSIS OF DIESEL AND HVO USE IN PORT OPERATIONS: A CASE STUDY AT THE PORT OF ITAQUI

João Vitor Lima Sousa, Felipe Azevedo Rios Silva, Yaeko Yamashita, João Gabriel Gonçalves França Vasconcelos.

 <https://doi.org/10.56238/sevened2026.008-232>

.....4253-4267

ONTOLOGIES AND KNOWLEDGE GRAPHS IN UNIVERSITY PUBLIC MANAGEMENT: IFES-GENIUS-EXT AS A TOOL FOR TRANSPARENCY AND INTELLIGENT AUDITING

Márcio Cledes, Rogerio Cid Bastos.

 <https://doi.org/10.56238/sevened2026.008-233>

.....4268-4283

ECONOMIC, FINANCIAL, AND STRUCTURAL PERFORMANCE AND THE COVID-19 PANDEMIC IMPACTS: A CASE STUDY IN THE HOTEL SECTOR OF RS - BRAZIL

Kalebe Galvani da Silva, Luciana Moro de Souza, Rosane Maria Seibert, Neusa Maria da Costa Gonçalves Salla, Igor Alexandre Klaic.

 <https://doi.org/10.56238/sevened2026.008-234>

.....4284-4305

ANALYSIS OF THE PERCEPTION OF GRADUATES ABOUT THE CONTRIBUTIONS OF UEFS PET ECONOMY TO THEIR ACADEMIC TRAJECTORY

Geovane dos Reis Dantas, Leandro Batista Duarte, Jamile da Silva Teixeira Goes de Jesus, Paloma Fernandes Freitas, Amanda dos Santos Gonçalves, João Vitor dos Santos Sobrinho, Edrei Santos de Lima, Eviny Torres De Jesus, Lucas Mateus Ferreira Oliveira, Valéria Caroline Batista Santana, Milena Andrade Déo, Carlos Adrian Gomes de Oliveira.

 <https://doi.org/10.56238/sevened2026.008-235>

.....4306-4326

WOMEN'S WORK IN RURAL AREAS: INVISIBILITY, GENDER INEQUALITIES, AND SOCIAL SECURITY ISSUES

Larissa Gonçalves Fratari Moreira, Elicardo Heber de Almeida Batista.

 <https://doi.org/10.56238/sevened2026.008-236>

.....4327-4339

CANNABIDIOL IN THE MANAGEMENT OF PAIN ASSOCIATED WITH TEMPOROMANDIBULAR DISORDERS

Andréia de Carvalho Knipp, Vivian Rabelo Cunha, Maria Luiza Gomes Reis, Raphaella Aparecida Silva, Rafaela Timóteo de Souza Ribeiro, Marcela Oliveira Santos, Maria Eduarda Ricardo de Barros, Patrícia de Hollanda Cavalcanti Aragão Costa, Monica Marletti Almeida, João Carlos da Silva, Kayole Alves Landim Borges, Tânia Aparecida Oliveira Ramos, Vitória Fonseca Eugênio Duarte, Cristiano Veloso, João Victor de Vasconcellos Ferreira, Fabiano de Paiva Sales, Samara Mesquita Monteiro, Ana Caroline Justo Bellafronte Rique, Lizandra Cristina Oriel de Sousa, Bruna Maria Silva Frauches, Simone Justi, Cristina Carla Xavier da Silva, Giselle Pestana Godoi, Idalisio Soares Aranha Neto, Rosa Mirtes de Souza Oliveira.

 <https://doi.org/10.56238/sevened2026.008-237>

.....4340-4351

COMPARISON BETWEEN VAGAL MANEUVERS AND ADENOSINE IN PAROXYSMAL SUPRAVENTRICULAR TACHYCARDIA

Isis Souza Rabelo, Fernanda Scharf, Alessandra Aniszewski Kucner, Matheus Teixeira Schumacher, Maryane de Oliveira Pessôa, Marco Antônio Barbieri, Vitor Roble de Oliveira, Giovanna de Souza Frasson, Maria Clara Barreira, Júlia Wagner Pedrazzi, Vania Targanski Benitez, Ana Paula Schonarth, João Pedro Almeida Antunes dos Santos, Samuel Owusu-Baah, Nicole Barbosa Amaral, Luís Otávio Garcia de Oliveira, Rafael Pereira Barcelos Severino Borges, Renan Pereira Barcelos Severino Borges, Victor Pacheco de Campos Neto, Jéssica Carneiro de Camargo, Tiago Pinheiro Costa, Nephtalie Moise, Giuliana Valderano de Lima, Clícia Ferreira Gardenal, Aguida Marques Pereira dos Santos.

 <https://doi.org/10.56238/sevened2026.008-238>

.....4352-4363

INTRANASAL ESKETAMINE AND MAOI COMBINATION IN THE MANAGEMENT OF TREATMENT-RESISTANT DEPRESSION: A CASE REPORT

Paulo Artur da Silva Rodrigues, Giovana dos Santos Couto, Bárbara Corrêa Garcia Simões, Pablo Gnutzmann Pereira.

 <https://doi.org/10.56238/sevened2026.008-239>

.....4364-4372

THE CONVERGENCE OF BEAUTY: AN ANALYTICAL AND FRACTAL APPROACH TO THE SANGAKU CHAIN OF CIRCLES

Fábio Henrique Marinho Cabral.

 <https://doi.org/10.56238/sevened2026.008-240>

.....4373-4386

IMPACT OF TRANSFORMATIONAL LEADERSHIP ON SUSTAINABLE DEVELOPMENT OF NEPALESE HYDROPOWER INDUSTRY

Tulsi Ram Pandey, Khampho Phoungthong, Kuaanan Techato, Flávio de São Pedro Filho, Paulo Roberto Meloni Monteiro Bressan, Aírton Ribeiro dos Santos, João Pedro de Souza Coelho, Adjalma Campos de França Neto, Rafael Ayres Romanholo, Delson Fernando Barcellos Xavier, Fabio Robson Casara Cavalcante, Fabrício Moraes de Almeida.

 <https://doi.org/10.56238/sevened2026.008-241>

.....4387-4409

CLIMATE CHANGE IN THE AMAZON AND THE NEW DISEASE PROFILE: CHALLENGES FOR GLOBAL HEALTH AND MULTIPROFESSIONAL PRACTICE

Mariana Elizabeth Lopes de Sales, Felipe Renato de Castro Rodrigues, Jacqueline Parente de Sousa, Suane e Silva Duarte Souto, Elda Lenilma Palheta Alves, Patrícia Gabrielly da Silva Pires, Jennifer Kelly Abreu Melo, Kátia Lamara de Araújo Santos, Monize Lopes de Araújo Gomes, Gisele dos Santos Mendonça, Amanda Emanuele dos Santos Correa, Dayvison Santos de Oliveira, Rita de Cássia Maia Rebelo, Maria Eleuziane dos Santos da Silva, Júnio Fábio Silva do Vale, Adriana Santos Araujo, Cleiton Mendes Honorato Sousa, Leidson Frank Santana Cardoso, Lauriene Karina Ramos da Costa Ferreira, Gabriel Paz de Lima, Kárita Roberta da Silva Melo, Iva Zaiza Valente Sobral, Roberta Leonor Mendes de Lima Leal, Vânia Cristina Ribeiro Brilhante.

 <https://doi.org/10.56238/sevened2026.008-242>

.....4410-4424

AESTHETIC REHABILITATION USING THE DOUBLE CEMENTATION TECHNIQUE TO MASK DENTAL SUBSTRATES OF DIFFERENT COLORS – CASE REPORT

Adria Stephanie Xavier Barroso, Hévilly Yorrana Alcântara Aguiar, Hêmilly Suélen Sousa Guilherme, Maria Nikaele Campos do Carmo Alcantara, Pedro Henrique Soares Silva, Ana Kellen Parente do Nascimento, Rayssa de Fátima Lopes Arruda Carneiro, Conceição Mikaelly de Vasconcelos Linhares.

 <https://doi.org/10.56238/sevened2026.008-243>

.....4425-4465

MARKETING CONSULTING IN INFORMATION UNITS

Georgete Lopes Freitas, Rayanne Ferreira Coelho.

 <https://doi.org/10.56238/sevened2026.008-244>

.....4466-4548

SHEAR STRENGTH OF ONE-WAY RIBBED SLABS WITH STEEL FIBER CONCRETE

Felipe da Silva Leite, Leomir Rafael Brito Silva, Dênio Ramam Carvalho de Oliveira, Mateus Antônio Nogueira Oliveira, Marcio Rodrigo Nunes de Souza, Willander de Almeida Marques, Francisco Xavier Gomes Pantoja Junior, Edson Igreja Bentes.

 <https://doi.org/10.56238/sevened2026.008-245>

.....4549-4577

NATIONAL PUBLIC POLICIES FOR MICRO AND SMALL ENTERPRISES: MARKET ACCESS AND THE PROMOTION OF INTEGRATIVE POLICIES BETWEEN THE STATE AND CITIZENS

Graziela Fernanda Bonato, Acácia Sayuri Wakasugi, Acácia Sayuri Wakasugi.

 <https://doi.org/10.56238/sevened2026.008-246>

.....4578-4600

SOCIAL REPRESENTATIONS OF INDIGENOUS LANDS AND THE LEGITIMATION OF THE BRAZILIAN SUPREME FEDERAL COURT'S DECISION ON THE "TEMPORAL FRAMEWORK" (MARCO TEMPORAL) IN LIGHT OF MAX WEBER'S INTERPRETIVE SOCIOLOGY

Glenda Almeida Matos Moreira, Joaquim Ribeiro de Souza Junior.

 <https://doi.org/10.56238/sevened2026.008-247>

.....4601-4616

HANNAH ARENDT: FREEDOM, POLITICS, AND LAW

Maria Corga.

  <https://doi.org/10.56238/sevened2026.008-248>

.....4617-4626

EXPENDITURES ON SCIENCE AND TECHNOLOGY (S&T) AND RESEARCH AND DEVELOPMENT (R&D) APPLIED TO THE MINISTRY OF HEALTH: CORRELATION WITH HUMAN RESOURCES TRAINING AND PUBLIC POLICIES FOR THE PERIOD 2014 – 2023

Roberto Augusto Caracas Neto, Marcelo Luiz Soares Pereira, Maira Uchôa Moura, Thalita Duque Martins Paes, Cristiana Maria do Valle Freitas, Eduardo Winter, Evanildo Vieira dos Santos.

  <https://doi.org/10.56238/sevened2026.008-249>

.....4627-4644

LANGUAGE, DISCOURSE AND TOTALITARIANISM: FROM THE REDUCTION OF THE OTHER TO THE DEMOCRATIC PATHS OF DIALOGUE

Antonio Coêlho Soares Junior, Joaquim Ribeiro de Souza Junior, Isabella Holanda da Silva.

  <https://doi.org/10.56238/sevened2026.008-250>

.....4645-4663

THE CHILD AS AUTHOR: CHILDREN'S NARRATIVES AND CREATIVE WRITING IN PUBLIC SCHOOLS

Andréa King de Abreu Yamaguchi, Mariana Moraes Camacho Reis.

  <https://doi.org/10.56238/sevened2026.008-251>

.....4664-4670

REVISITING TO UNDERSTAND: EMOTIONS AND IDENTITY CONSTRUCTION PROCESSES OF YOUNG QUILOMBOLA PEOPLE 16 YEARS LATER

Ana Paula Moraes Camacho Estrela, Andréa King de Abreu Yamaguchi, Mariana Moraes Camacho Reis, Tatiana Moraes Camacho de Castro.

  <https://doi.org/10.56238/sevened2026.008-252>

.....4671-4677

READING THE HISTORY OF ART THROUGH THE LINES OF DRAWING

LER COM OS TRAÇOS DO DESENHO A HISTÓRIA DA ARTE

LEYENDO LA HISTORIA DEL ARTE A TRAVÉS DE LAS LÍNEAS DEL DIBUJO



<https://doi.org/10.56238/sevened2026.008-001>

Kleriston Luis Rocha Neris¹

ABSTRACT

This research aims to present a methodological proposal that uses drawing as a teaching-learning tool in the teaching of Art History. Starting from the understanding of drawing as a visual language and pedagogical resource, the research seeks to enable meaningful learning of Art History content in high school, bridging theory and practice in the classroom. The proposal aims to break with the paradigm that high school is predominantly characterized by theoretical approaches, by encouraging practical activities that stimulate the active participation of students. In this sense, the practice of drawing is developed in an articulated way with historical and artistic content, through the creation of drawing groups, favoring observation and interpretation, and encompassing the different periods and styles of Art History selected by the teacher for the practices. The research is qualitative and uses the Arts-Based Research (ABR) methodology through the methods of Action Research and Participatory Research, where the first aims to solve practical problems with action (attitudes) and constant reflection, while the second aims at the emancipation and social transformation of the participants (researcher and researched). It is concluded that the use of drawing as a pedagogical methodology contributes to the development of aesthetic sensitivity, critical thinking, and student engagement in the learning process.

Keywords: Art Education. Art History. Drawing. Teaching and Learning. Art-Based Research.

RESUMO

A presente pesquisa tem como objetivo apresentar uma proposta metodológica que utilizar o desenho como instrumento de ensino-aprendizagem no ensino de História da Arte. Partindo da compreensão do desenho como linguagem visual e recurso pedagógico, a pesquisa busca possibilitar uma aprendizagem significativa dos conteúdos de História da Arte no Ensino Médio, aproximando teoria e prática em sala de aula. A proposta tem por objetivo romper com o paradigma de que o Ensino Médio se caracteriza predominantemente por abordagens teóricas, ao incentivar atividades práticas que estimulem a participação ativa dos estudantes. Nesse sentido, a prática do desenho é desenvolvida de forma articulada com os conteúdos históricos e artísticos, por meio da criação de grupos de Desenho, favorecendo a observação, a interpretação e abrange os diferentes períodos e estilos da História da Arte selecionados pelo docente para as práticas. A pesquisa é qualitativa e usa

¹ Master's student in Arts. Universidade Federal do Maranhão (UFMA). E-mail: kleristonluis@yahoo.com.br
Orcid: <https://orcid.org/0009-0005-2320-1598>

a metodologia Investigação Baseada em Artes (IBA) pelos métodos da Pesquisa-ação e a Pesquisa participante, onde a primeira objetiva solucionar problemas práticos com ação (atitudes) e reflexão constante, já a segunda visa a emancipação e transformação social dos participantes (pesquisador e pesquisados). Conclui-se que o uso do desenho como metodologia pedagógica contribui para o desenvolvimento da sensibilidade estética, do pensamento crítico e do envolvimento dos alunos no processo de aprendizagem.

Palavras-chave: Ensino de Arte. História da Arte. Desenho. Ensino-aprendizagem. Investigação Baseada em Artes.

RESUMEN

Esta investigación tiene como objetivo presentar una propuesta metodológica que utiliza el dibujo como herramienta de enseñanza-aprendizaje en la enseñanza de la Historia del Arte. Partiendo de la comprensión del dibujo como lenguaje visual y recurso pedagógico, la investigación busca facilitar el aprendizaje significativo de los contenidos de Historia del Arte en secundaria, conectando la teoría con la práctica en el aula. La propuesta pretende romper con el paradigma de que la secundaria se caracteriza predominantemente por enfoques teóricos, fomentando actividades prácticas que estimulen la participación activa del alumnado. En este sentido, la práctica del dibujo se desarrolla de forma articulada con los contenidos históricos y artísticos, mediante la creación de grupos de dibujo, favoreciendo la observación y la interpretación, y abarcando los diferentes períodos y estilos de la Historia del Arte seleccionados por el profesor para las prácticas. La investigación es cualitativa y utiliza la metodología de Investigación Basada en las Artes (RBA) a través de los métodos de Investigación-Acción e Investigación Participativa. La primera busca resolver problemas prácticos mediante la acción (actitudes) y la reflexión constante, mientras que la segunda busca la emancipación y la transformación social de los participantes (investigador e investigado). Se concluye que el uso del dibujo como metodología pedagógica contribuye al desarrollo de la sensibilidad estética, el pensamiento crítico y la participación del alumnado en el proceso de aprendizaje.

Palabras clave: Educación Artística. Historia del Arte. Dibujo. Enseñanza y Aprendizaje. Investigación Basada en el Arte.

1 INTRODUCTION

Although drawing is traditionally understood in Art History as a form of aesthetic and cultural expression, capable of revealing the values, styles and techniques of a given time, the focus of this research differs in proposing drawing as a pedagogical tool for teaching-learning.

In this logic, the practice of drawing is only an object of study or isolated artistic expression, becoming an active means of knowledge construction, favoring the mastery of the contents of Art History in a meaningful and participatory way.

The research is part of the research line Processes of teaching, learning and creation in arts of the Professional Master's Degree in Arts (Prof-Artes/UFMA), whose focus on the development of creative and innovative methodologies for artistic teaching directly contributes to the proposal. This line of study values artistic practice as a space for investigation, reflection and production of knowledge, aligning itself with the proposal of integrating theory and practice in the classroom.

The present research is justified by the need to bring together practice and theory in the teaching of Art History in High School, having drawing as a central tool in the teaching-learning process. By uniting the practice of drawing with historical and artistic contents, the proposal seeks to break with two paradigms, still present, in High School: the first refers to the conception of an excessively theoretical teaching, focused almost exclusively on the preparation for entrance exams and competitions, or sporadically for the world of work. The second paradigm concerns the understanding of drawing only as a technical, playful or illustrative activity, and not as a methodology capable of favoring the learning of Art History contents.

From this perspective, drawing is understood as a language, artistic practice and pedagogical instrument, able to stimulate observation, critical reflection and the construction of meanings about different periods, styles and contexts of Art History. In this way, the student when drawing not only reproduces images, but interprets, rereads, analyzes and re-signifies the works and artistic movements studied, becoming an active subject of their learning.

In addition, the Art curricular component contributes to the critical formation of students in the face of the complexity of the contemporary world, promoting respect for differences and intercultural, pluriethnic and plurilingual dialogue, which are essential aspects for the exercise of citizenship (Brasil, 2017, p.193).

It is up to the art teacher to understand artistic and cultural diversity, in order to

Explore, know, enjoy and critically analyze artistic and cultural practices and productions from their social environment, indigenous peoples, traditional Brazilian

communities and different societies, in different times and spaces, to recognize art as a cultural, historical, social phenomenon that is sensitive to different contexts and to dialogue with diversities (BRASIL, 2017, p. 198).

In addition, by providing exchanges between cultures and the recognition of similarities and differences, the teaching of Art, combined with the practice of drawing, expands students' knowledge about themselves and about others, strengthening social, historical and cultural values that are fundamental for integral education.

The general objective of this work is to present a methodological proposal that uses drawing as a teaching-learning method in the teaching of Art History. With this, it is sought to understand drawing as a pedagogical tool capable of articulating theory and practice, favoring a more dynamic and meaningful approach to the contents worked in the classroom.

As a first specific objective, it is intended to enable a significant learning of the contents of Art History in High School, facilitating a greater understanding of the periods, styles and the language of drawing in times selected by the teacher.

As a second specific objective, the study aims to break with the paradigm that High School is predominantly theoretical, by valuing pedagogical practices of drawing that stimulate the active participation of students. In the context of High School, the teaching of Art History still faces challenges related to this predominance of theoretical approaches, often disconnected from the students' experience.

As a third specific objective, the research seeks to present the practice of drawing in a correlated way to some Art History contents, through drawing groups or varied formats, promoting interaction, choice, creativity and the protagonism of students in the teaching-learning process.

The problem of this research is: how will the practice of drawing enable a meaningful learning of the contents of Art History in High School? It is based on the understanding that, many times, the teaching of this stage is conducted in an excessively theoretical way, which can hinder the assimilation of the contents and distance students from the artistic universe. In view of this, it is questioned how the insertion of drawing as a pedagogical practice can contribute to make the teaching-learning process in art more dynamic, integral and meaningful.

The first hypothesis of this research maintains that the practice of drawing, when integrated with the contents of Art History, can promote a significantly more effective learning in High School. This is due to the fact that drawing does not act only as a technical or recreational activity, but as a pedagogical instrument that allows students to experiment, observe and reflect on the concepts and artistic styles studied.

By making drawings related to specific works, movements or styles, students begin to learn in a concrete way elements with proportion, composition, perspective, color, texture and symbolism, connecting these aspects to the historical and cultural discussions addressed in the classroom. This practical experience allows theoretical concepts to be experienced, analyzed, and resignified, making learning more lasting and deeper.

In addition, drawing stimulates complex cognitive skills, such as attention, visual perception, memory, and critical analysis, while also developing creativity and the ability to express oneself. Artistic practices provide students with a space for safe experimentation, in which mistakes and successes are part of the learning process, corroborating the idea that knowledge is built through action and continuous reflection.

The second hypothesis of the research postulates that many students already have some kind of previous contact with drawing, either as *a hobby*, or as a more structured artistic practice or even as a skill little explored over time. This previous experience is a valuable resource that can and should be used pedagogically to favor the engagement, interest and participation of students in Art History classes.

By recognizing and valuing the skills that students have, the art teacher creates a more inclusive and motivating learning environment, in which each student feels able to add and express themselves. Drawing, in this context, becomes a means of communication and construction of meaning, allowing students to connect their personal experiences with the theoretical content covered, making learning more concrete and relevant.

Thus, this second hypothesis suggests that exploring students' pre-existing competencies enhances student protagonism, stimulating autonomy and creativity. Students who already have contact with drawing tend to feel more confident to experiment with new techniques, interpret works of art, reflect on historical and social contexts, as well as interact critically with subjects.

Likewise, taking advantage of these experiences also fosters collaborative learning, as students with different levels of familiarity with drawing can share knowledge and skills, strengthening group dynamics and the exchange of experiences. In this way, the practice of drawing ceases to be just an individual activity and becomes an instrument of interaction, cooperation and collective development.

The third hypothesis of this study states that the use of drawing as a pedagogical tool plays a fundamental role in stimulating student autonomy, creativity and the development of critical thinking. From this perspective, the introduction of the practice of drawing to the teaching of Art History, students cease to be mere receivers of information and start to act as active subjects in the learning process, building knowledge in a plural and conscious way.

This third hypothesis is based on the understanding that drawing offers its own expressive language, which allows students to interpret, organize and resignify the historical and artistic contents presented in the classroom. By crafting their own, authentic productions, students make connections between theory and practice, historical context, and personal experience, developing a deeper understanding of the movements, styles, techniques, and meanings of art.

In addition, by stimulating autonomy, drawing transforms the dynamics of the classroom, where students become co-authors of knowledge, sharing experiences, dialoguing about different perspectives and collaborating in the collective construction of learning. In this way, the methodology helps for the integral formation of the student, promoting cognitive, artistic, social and cultural skills.

The article is divided into two chapters, in addition to the Introduction chapter that has the theme, the justification, the research problem, the hypotheses and a brief theoretical review. The first chapter is the methodology of the study, focusing on the type of research and its approaches, in addition to its investigation methods. The second chapter deals with the results and preliminary discussions, due to the research is ongoing. Even so, great results have already been demonstrated in the current year for the master's degree in Professional Arts at the Federal University of Maranhão. The last chapter addresses the preliminary considerations of the research in full development and application in the School chosen and described in the chapter of Methodology.

2 METHODOLOGY

The present research is of the applied type, with a qualitative and exploratory approach, since it seeks to investigate and implement the use of drawing as a pedagogical tool for the learning of Art History content in High School.

The research adopts the qualitative approach in order to analyze and interpret the processes of production of drawings and their adaptations to the subjects worked in the classroom, valuing not only the final result, but, above all, the creative and pedagogical path developed by the students. Unlike quantitative research, which focuses on measuring numerical data, qualitative research seeks to explore in depth the experiences, perceptions and meanings attributed by students to the practice of drawing. The qualitative perspective makes it possible to analyze how students construct meanings from the practice of drawing linked to the contents of Art History.

The focus is not only on the final result of the productions, but mainly on the creation process: the choices of theme, techniques, style, problem solving, composition and

interpretation of artistic content. In this way, it analyzes how students apply their previous knowledge, how they transform historical and cultural references into visual expressions (drawings), and how the activity contributes to the development of cognitive, aesthetic and critical skills.

At the same time, the research takes an exploratory approach, as it investigates a field still little addressed in the pedagogical practice of High School: the use of drawing as a resource for integration between theory and practice in Art History. This characteristic allows the investigation to be flexible, open to discoveries and adaptations, making it possible to analyze different forms of approaches, drawing techniques, group dynamics and teaching strategies that best meet the needs and interests of students.

The applied and exploratory nature of the research also allows the results obtained to contribute directly to the improvement of teaching practice, offering subsidies so that art teachers can integrate active methodologies, valuing artistic expression, critical analysis and student protagonism.

As a methodological axis, this research adopts Arts-Based Investigation (IBA), an approach that recognizes artistic practices as legitimate and valuable forms of knowledge production. IBA proposes that artistic creation is not just an object of study or an aesthetic resource, but a means of investigation, analysis and construction of knowledge, integrating practice, theory and critical judgment in the same process.

In this context, drawing takes on multiple roles, can act as an expressive language, allowing students to communicate ideas, perceptions and personal interpretations. It serves as a didactic tool, bringing the theoretical contents of Art History closer to concrete practice and as an instrument of investigation, enabling observation, experimentation and critical evaluation of concepts, techniques and historical contexts. This articulation promotes active learning, in which students participate consciously and creatively in the construction of knowledge.

IBA also emphasizes the processual nature of learning, honoring both the path of artistic creation and the final product. When working with drawing, students explore different materials, techniques, and styles, develop cognitive and aesthetic skills, and reflect on their choices, results, and meanings. This approach ensures that artistic production is simultaneously practical and investigative, fostering a continuous dialogue between action and judgment.

In this way, this methodology encourages active and collaborative participation, allowing students to share experiences, exchange ideas, and engage in critical discussions about art, culture, and history. This dialogical character strengthens beyond individual

learning, encompassing the collective, creating a more lively, inclusive, and stimulating classroom environment. For this purpose, the methods employed are Action Research and Participant Research.

Action research is a central method in this investigation, as its purpose is to intervene directly in the educational reality, promoting significant changes in the teaching-learning process. Unlike purely descriptive or theoretical approaches, action research combines practice and insight, allowing the teacher-researcher to implement planned pedagogical actions, observe their effects, and then review and adjust strategies according to the results obtained.

In this context, action research becomes especially suitable for the teaching of Art History through drawing, as it enables a constant adaptation of activities to the specific needs, abilities and interests of students, as well as to the particularities of the school context. Each pedagogical intervention is critically analysed, allowing the identification of obstacles, potentialities and new learning opportunities.

This method emphasizes the cyclical character of the educational process: planning, acting, observing, reflecting and reapplying. This continuous cycle not only improves teaching practice, but also actively involves students, making them participants in the investigation process. By reflecting on their artistic productions, their choices and the learning acquired, students begin to develop critical awareness, autonomy and self-regulation skills.

Furthermore, action research favors the construction of a more dynamic, collaborative and innovative classroom environment, in which the problems and challenges of teaching are not treated as obstacles, but as opportunities to experiment, create and resignify pedagogical practice. It promotes, therefore, an integration between theory and practice, allowing drawing not to be restricted to a mere technical exercise, but an instrument of analysis, reasoning and integral development of the student.

The Participant Research method, on the other hand, is based on the active collaboration between researcher and participants, considering both as subjects of the investigative process. It proposes a horizontal, non-hierarchical relationship, in which all those involved contribute to the construction of knowledge and the development of educational practices.

This method seeks emancipation and social transformation, stimulating autonomy, critical thinking, responsibility and engagement in the participants (students and teachers). In the use of drawing for the teaching of Art History, this means that students not only perform tasks or practices, but also participate in decisions about themes, techniques, creative processes and ways of presenting their work. By getting actively involved, students become

protagonists of the artistic experience, reasoning about their learning and contributing to the constant improvement of pedagogical practice.

The proposal will be implemented with students from the 2nd and 3rd year of High School at the Santa Teresa Teaching Center, in São Luis do Maranhão, and will involve drawing practices planned bimonthly. That is, every two months, the Art teacher will propose themes articulated with the contents of Art History, allowing students to choose and relate the practice of drawing with the historical concepts, artistic styles and cultural movements studied in the classroom.

Students will make the drawings in different formats, according to the dynamics proposed for each practice: individually, in pairs, trio or groups, stimulating both autonomy and collaborative work. This diversity of organization makes it possible to meet the different preferences and abilities of students, while favoring the exchange of experiences, dialogue, and collective learning.

As an example of practical application, for the 1st bimester of the 2nd year, the proposed theme will be the Cultural Renaissance and the realization of a drawing with a naturalistic approach, representing a historical or artistic personality, public figure or even a family member. This choice seeks to bring students closer to detailed observation, the perception of proportions and shapes, and the critical interpretation of physical and expressive characteristics, essential skills for both drawing and artistic analysis.

Throughout the process, students will be encouraged to reflect on the historical and cultural context of the movement to carry out drawing practices, relating the aesthetic, social, historical and symbolic aspects to the proposed subject. In this way, the constant monitoring of the Art teacher will allow methodological adjustments, specific *feedbacks* and encouragement of technical experimentation, fostering the integration between artistic practice and theoretical learning.

The bimonthly organization and the alternation between different formats of presenting and doing the work seek, therefore, to create an interactive, inclusive and stimulating pedagogical environment, in which drawing works as a methodological tool to bring students closer to History, culture and art, promoting active, creative and conscious learning.

The theoretical foundation of this research is anchored in authors and methodologies that dialogue directly with art education and the teaching of drawing, offering subsidies for the construction of a unique pedagogical practice aligned with the curricular guidelines.

Among the references used, Ana Mae Barbosa (2010) stands out, whose work emphasizes the importance of art as an instrument of expression, experimentation and development of aesthetic sensitivity, in addition to highlighting the role of drawing as a tool

for understanding creative and cultural processes. Barbosa emphasizes the fundamental role of drawing as a qualified pedagogical tool in articulating artistic making, the reading of images and cultural contextualization. For the author, drawing is not limited to a technical skill, but constitutes a means of visual investigation and expression of thought, allowing the student to understand and interpret individual and collective creative processes, as well as the historical and cultural references present in artistic productions.

From this angle, drawing assumes the mediating function in the teaching of Art, as it favors the development of perception, imagination and critical capacity, in addition to privileging the appropriation of diverse visual repertoires. The triangular approach, proposed by Ana Mae Barbosa, reinforces the idea that art education should foster remarkable and plural experiences, in which the student is the subject of the learning process, associating practice, discernment and cultural contextualization.

The National Common Curricular Base (BNCC) is also a central reference, as it guides that the teaching of Art should promote artistic experiences and experiences as social practices, allowing students to be protagonists and creators. The BNCC reinforces the need to articulate theory and practice, develop observation, interpretation and critical analysis, and value cultural and artistic diversity as an essential component of the integral education of students.

Classical authors of the philosophy and theory of art education such as John Dewey (2010), who offer a conceptual basis for understanding learning through practical experience. In his work, specifically in the chapter "Art as experience", Dewey argues that knowledge is not something transmitted passively, but actively constructed by the subject from action, perception and continuous interaction with the world around him.

For this reason, the author reinforces the relevance of drawing as an important means of active and experiential learning. When drawing, the student observes, experiences, interprets and expresses his worldview, relating cognitive, sensory and expressive aspects. Drawing becomes a powerful pedagogical tool, as it fosters the construction of knowledge through direct experience, personal involvement and consideration of one's own practice, in line with the principles of aesthetic education defended by Dewey.

In the field of drawing and visual communication, Donis A. Dondis (1997) contributes to visual perception, graphic language and representation of ideas, providing theoretical and cognitive foundations for the practice of drawing as a teaching-learning tool. The author understands visual communication as a structured system of signs and elements such as point, line, shape, color, texture and composition, which organize visual thinking and enable the reading and production of images. These theoretical and cognitive foundations are

fundamental for the practice of drawing in the educational context, as they help students develop the ability to observe, interpret and visually communicate concepts, ideas and meanings.

Elliot Eisner (2005), in turn, highlights the importance of art education as a way to develop multiple intelligences, critical thoughts and aesthetic sensitivity, arguing that art enables different ways of knowing, interpreting and intervening in the world. Eisner argues that artistic practice stimulates decision-making, the interpretation of meanings, tolerance of ambiguity and studies on processes and results, essential aspects for critical and creative formation.

João Gomes Filho (2008) emphasizes the teaching of drawing as a structuring visual language, highlighting elements such as shape, composition, perception and visual organization. For the author, drawing is a fundamental means of reading and interpreting the world, qualified to develop aesthetic sensitivity, visual reasoning and the capacity for analysis. His approach adds that the teaching of drawing should not be understood as a mere technique, but as a cognitive and expressive process, essential for the learning of Art History contents.

Vincent Lanier (2005), in turn, defends an artistic education focused on experience, creativity and the integral formation of the subject. The author proposes methodologies that value artistic practice as a central axis of teaching, relating production, appreciation and historical contextualization. In this sense, Lanier reinforces the importance of pedagogical strategies that actively involve the student, allowing him to experience, question and interpret the works of art from his own experiences and cultural references.

Marly Ribeiro Meira (2006) emphasizes art as a formative experience, in which the creative process assumes a central role in learning. For the author, artistic practice fosters ideas, feelings and perceptions in the student, developing a more conscious and sensitive relationship with knowledge. Drawing, in this logic, is understood as a space for investigation and expression, where the student experiments with materials, techniques and languages, building their own meanings from their cultural and social experiences. This thinking values the creative process and the final product (work), favoring students' autonomy and confidence in their expressive capacities.

Ralph Smith (2005), in turn, highlights the importance of art education in the formation of aesthetic and critical thinking. The author argues that learning in art involves interpretation, judgment and considerations, allowing students to attribute meanings to their productions and to the works studied. For Smith, drawing works as a means by which students can

explore complex ideas, question concepts, and develop a deeper understanding of art and its historical and cultural contexts.

To develop a work focused on artistic experience and creativity, it is essential to consider the trajectory of art from prehistory to contemporary productions, allowing students to know the evolution of styles, techniques, historical contexts and cultural meanings. In this aspect, the research is based on authors who address different periods and characteristics of Art History, offering theoretical subsidies for the formation of a consistent pedagogical practice.

Nikos Stangos, in "Concepts of Modern Art" (2000), presents a detailed analysis of the artistic avant-garde and conceptual art, bringing together articles by various authors who discuss the main movements of the twentieth century.

The author Graça Proença, in "History of Art" (2010), offers a comprehensive approach that ranges from prehistory to contemporary art, with emphasis on Brazilian art, including indigenous manifestations, peoples of Mesoamerica, African art, art of the East and architectural styles. Her work allows us to understand the cultural and aesthetic diversity present in Brazil, fostering an integrated vision between history, society and artistic expression, central to bringing students closer to the multiple languages of art.

Ernst Hans Gombrich, with the classic "The History of Art" (1999), provides a detailed overview, from the beginnings of artistic production to modernism, going up to the 1980s. His work is a mandatory reference in Art courses, as it combines historical rigor with aesthetic analysis, facilitating the understanding of the transformations in styles and techniques over time.

Carol Strickland, in "Commented Art: from Prehistory to Postmodern" (2014), complements Graça Proença's approach by going through the trajectory of art from prehistory to the beginning of the twenty-first century, highlighting architecture when it is pertinent. His work allows painting, sculpture and architecture to work in an integrated way, expanding the students' repertoire of reference and enabling a broader learning of the artistic area.

To finish the authors, we have Anne Cauquelin with "Contemporary Art: an introduction" (2005), which contributes to the analysis of artistic production after the 2nd world war until the beginning of the twenty-first century, addressing conceptual, cultural and social issues that characterize contemporary art. His work is especially useful for contextualizing current artistic practices, bringing students closer to contemporary discussions about aesthetics, identity, and innovation.

The combination of these theoretical references allows the practice of drawing to be linked to varied historical and aesthetic contents, offering students a broad and critical view

of Art History. This theoretical foundation supports the pedagogical proposal of using drawing as a teaching-learning method, allowing practical, reflective and creative experiences that connect past and present, tradition and innovation, theory and artistic practice.

3 PRELIMINARY RESULTS AND DISCUSSIONS

The preliminary results of this research indicate that the use of drawing as a pedagogical tool in the teaching of Art History has significantly helped the involvement and active participation of high school students at the Santa Teresa Teaching Center. It is observed that the integration between the practice of drawing and the theoretical contents favors greater interest of the students, who start to demonstrate a greater willingness and willingness in class or analyze historical and artistic themes addressed.

Regarding the learning process, the initial data reveal that students are able to establish clearer relationships between the periods, styles and the language of drawing in Art History, when these contents are worked on in a practical way. The realization of the drawings stimulates attentive observation, the interpretation of formal and symbolic elements, as well as the mastery of historical contexts, recognizing that theoretical concepts are internalized in a more solid and substantial way.

The formation of groups or with varied drawing formats proved to be a relevant aspect of the methodology, as it facilitated the exchange of experiences, dialogue and collaboration among students. More advanced students in drawing techniques shared experiences, problems and solutions, stimulating collective learning and contributing to the development of autonomy and confidence in artistic production. This student becomes the subject of the action of learning, he is a protagonist, being a fundamental characteristic of the methodological proposal.

From the methodological point of view, the application of Arts-Based Research (IBA), linked to Action Research and Participant Research, proved to be adequate for the school context in question. The Action Research provided continuous adjustments in the proposed activities, even with the workload of 1 hour per week of the Art Discipline, due to the constant observation and criticism in the process of the practices. Because of this reduced schedule, it is very difficult to do it in the classroom, the themes were made available, but the production of the drawing was done outside the classroom environment, only its final presentation was at school. Participant research, on the other hand, promoted the active inclusion of students in the investigative process, enabling perceptions, choices and experiences to directly influence the progress of activities.

This can be demonstrated in two drawings by a student who authorized, together with his family, the use of his production. We call student A from the 2nd year of High School, who made a drawing based on the Baroque and the artists in the 2nd bimester (figure 01). The material of the drawing in figure 01 was gel pen, sketch with HB pencil, eraser and A4 sheet of paper, in addition to being a linear drawing with shading with hatches, finally, it started covering the clothes on the right side with a black marker pen. In the third bimester, based on Neoclassicism, this student A bought a portable digital table and started, in a self-taught way, the production of digital drawings, for the 3rd bimester (figure 02). The works are properly authentic, original and bring the student's personality.

Figure 1

Baroque - drawing with expressions



Source: Personal file of student A, provided by the family.

In figure 01, we can see the student's mastery of the techniques of tracing, light and shadow and proportion. In its production there were face proportion problems, which the student solved by watching free videos and tutorials on social networks. In figure 02, it is identified that the student transfers his knowledge of drawing on paper to digital, that he reported that pencils are much more practical, but that he wanted to challenge himself, because of his autonomy, he did it very well. And it continues to evolve in digital design. The researcher answers questions, inquires and proposes solutions that can be in person or

remotely through the WhatsApp groups of the classes, as well as the partnership and help of the monitors of each room in the work.

Figure 2

Neoclassicism – on Greek mythology



Source: Personal file of student A, provided by the family.

In general, the preliminary results indicate that the use of drawing as a pedagogical methodology contributes to the development of aesthetic sensitivity, critical, analytical and creative thinking of students. Although the research is still ongoing, the initial observations indicate that the close relationship between theory and practice, through drawing, broadens the possibilities of learning in Art History and produces a more critical, reflective and participatory education in High School.

4 PRELIMINARY CONSIDERATIONS

The preliminary considerations of this research, still in progress, show the relevance of analyzing not only the final results of the students' drawings, but also their technical skills, the creative process and the way these practices contribute to the construction of knowledge in Art History. The use of the drawing methodology in teaching emphasizes the protagonism of students, consenting that they become active in learning, developing cognitive, aesthetic, social and cultural skills in an integrated way.

Art education, in this context, should provide a multifaceted view of culture, functioning as an intersection between past, present and future. This implies the need to look at the artistic tradition from new angles, recognizing that learning is not limited to the reproduction of techniques or theoretical study, but is expanded by experimentation, interpretation and resignification of works and styles. Thus, by constituting itself as a guiding and guided teaching-learning approach, the practice of drawing becomes an instrument of study and personal expression, giving the students' original creations an essential role both in teaching practice and in student practice, moving away from the idea of an isolated activity or without a concrete purpose.

One of the developments proposed for the research is the realization of an exhibition with the drawings produced by the students throughout the year, organized according to the themes proposed by the Art teacher. However, more relevant than the final result is the process: the execution of the drawings, the registration of the productions, the doubts, the studies, the reports and the exchange of experiences lived by the students. This path highlights the importance of the methodology as a teaching-learning tool, showing that artistic practice is capable of promoting remarkable learning, involvement, autonomy, protagonism and a greater knowledge of Art History.

In short, the first analyses indicate that integrating practice and theory through drawing helps to form students who are more critical, creative and aware of their cultural and social role, encouraging not only technical skills, but also the historical, aesthetic and ethical perception of the world around them. Thus, the research reaffirms the need for innovative pedagogical practices that value the student's experience, creative expression and discernment about art as a cultural and educational phenomenon.

REFERENCES

- Barbosa, A. M. (2010). *A imagem no ensino de arte: Anos oitenta e novos tempos. Perspectiva.*
- Brasil. (2015). *Base Nacional Comum Curricular (BNCC).* MEC/CONSED/UNDIME.
- Brasil. Ministério da Educação e Cultura. (1996). *Lei nº 9.394, de 20 de dezembro de 1996. Estabelece as diretrizes e bases da Educação Nacional.* MEC.
- Couquelin, A. (2005). *Arte contemporânea: Uma introdução.* Martins Fontes.
- Dewey, J. (2010). *Ter uma experiência.* In *Arte como experiência* (pp. 109–141). Martins Fontes.
- Dondis, D. A. (1997). *Sintaxe da linguagem visual.* Martins Fontes.
- Eisner, E. (2005). *Estrutura e mágica no ensino da arte.* In A. M. Barbosa (Org.), *Arte-educação: Leitura no subsolo* (6ª ed.). Cortez.

- Gil, A. C. (2002). Como elaborar projetos de pesquisa (4ª ed.). Atlas.
- Gombrich, E. H. (2015). A história da arte (16ª ed.). LTC.
- Gomes Filho, J. (2008). Gestalt do objeto: Sistema de leitura visual da forma. Escrituras Editora.
- Lanier, V. (2005). Devolvendo arte à arte-educação. In A. M. Barbosa (Org.), Arte-educação: Leitura no subsolo (6ª ed.). Cortez.
- Louro, G. L. (2000). Currículo, gênero e sexualidade. Porto Editora.
- Meira, M. R. (2006). Educação estética, arte e cultura do cotidiano. In A. D. Pillar (Org.), A educação do olhar no ensino das artes (4ª ed., pp. 119–140). Mediação.
- Proença, G. (2010). História da arte (17ª ed.). Ática.
- Smith, R. (2005). Excelência no ensino da arte. In A. M. Barbosa (Org.), Arte-educação: Leitura no subsolo (6ª ed.). Cortez.
- Strickland, C. (2014). Arte comentada: Da pré-história ao pós-moderno. Nova Fronteira.
- Thiollent, M. (1986). Metodologia da pesquisa-ação (2ª ed.). Cortez; Autores Associados. (Coleção Temas Básicos de Pesquisa-Ação).
- Wilson, B., & Wilson, M. (2005). Uma visão iconoclasta das fontes de imagem nos desenhos das crianças. In A. M. Barbosa (Org.), Arte-educação: Leitura no subsolo (6ª ed.). Cortez.
- Yin, R. K. (2016). Pesquisa qualitativa do início ao fim (D. Bueno, Trad.; D. da Silva, Rev. técnica). Penso.

SCIENCE FAIRS AND INTEGRATED PROJECT EXHIBITIONS AS AN INNOVATIVE SPACE FOR RESEARCH, TEACHING, AND OUTREACH: AN EXPERIENCE REPORT WITH VOCATIONAL TRAINING COURSES

FEIRAS CIENTÍFICAS E MOSTRAS INTEGRADAS DE PROJETOS COMO ESPAÇO INOVADOR DE PESQUISA, ENSINO E EXTENSÃO: UM RELATO DE EXPERIÊNCIA COM CURSOS DE FORMAÇÃO PROFISSIONAL

FERIAS DE CIENCIA Y EXPOSICIONES DE PROYECTOS INTEGRADOS COMO ESPACIOS INNOVADORES DE INVESTIGACIÓN, DOCENCIA Y DIVULGACIÓN: UN RELATO DE EXPERIENCIA CON CURSOS DE FORMACIÓN PROFESIONAL



<https://doi.org/10.56238/sevened2026.008-002>

Mairla Meneses Lopes Teles¹

ABSTRACT

Vocational and Technological Education (VTE), at both technical and higher education levels, faces the challenge of overcoming excessively instrumentalized training models, strongly oriented towards the logic of efficiency and immediate adaptation to the labor market. In this context, science fairs and integrated project exhibitions emerge as pedagogical and institutional strategies capable of articulating teaching, research, and outreach in a critical, contextualized, and socially committed way. This article aims to analyze the experiences of outreach projects, discussing their contributions to technical-professional training and their social impacts. Methodologically, this is a qualitative, descriptive research, based on experience reports, with data production through document analysis, participant observation, and evaluations by participants and the organizing team, analyzed according to thematic content analysis. The results show that extension programs promote broad academic and social mobilization, with significant participation from students, faculty, and the external community, in addition to strengthening student leadership, interdisciplinarity, the articulation between theory and practice, and the development of skills such as communication, teamwork, critical thinking, and social responsibility. It is concluded that science fairs and integrated exhibitions constitute innovative spaces for training in vocational and technological education, contributing to meaningful learning and strengthening the social role of extension programs.

Keywords: Extension Projects. Student Leadership. Interdisciplinarity. Social Responsibility.

RESUMO

A Educação Profissional e Tecnológica (EPT), nos níveis técnico e superior, enfrenta o desafio de superar modelos formativos excessivamente instrumentalizados, fortemente orientados pela lógica da eficiência e da adequação imediata ao mercado de trabalho. Nesse

¹ Dr. in Business Administration. Instituto Federal do Piauí (IFPI). E-mail: mairlateles@ifpi.edu.br
Orcid: 0000-0002-5750-9268 Lattes: <http://lattes.cnpq.br/6075104431101049>

contexto, as feiras científicas e as mostras integradas de projetos emergem como estratégias pedagógicas e institucionais capazes de articular ensino, pesquisa e extensão de forma crítica, contextualizada e socialmente comprometida. Este artigo tem como objetivo analisar as experiências de projetos de extensão, discutindo suas contribuições para a formação técnico-profissional e seus impactos sociais. Metodologicamente, trata-se de uma pesquisa qualitativa, de natureza descritiva, baseada em relato de experiência, com produção de dados por meio de análise documental, observação participante e avaliações dos participantes e da equipe organizadora, analisadas segundo a análise de conteúdo temática. Os resultados evidenciam que a extensão promove ampla mobilização acadêmica e social, com participação expressiva de estudantes, docentes e comunidade externa, além do fortalecimento do protagonismo discente, da interdisciplinaridade, da articulação entre teoria e prática e do desenvolvimento de competências como comunicação, trabalho em equipe, pensamento crítico e responsabilidade social. Conclui-se que feiras científicas e mostras integradas constituem espaços inovadores de formação na EPT, contribuindo para aprendizagens significativas e para o fortalecimento do papel social da extensão.

Palavras-chave: Projetos de Extensão. Protagonismo Discente. Interdisciplinaridade. Responsabilidade Social.

RESUMEN

La Educación Profesional y Tecnológica (EPT), tanto en los niveles técnico como superior, se enfrenta al reto de superar modelos de formación excesivamente instrumentalizados, fuertemente orientados a la lógica de la eficiencia y la adaptación inmediata al mercado laboral. En este contexto, las ferias de ciencias y las exposiciones de proyectos integrados emergen como estrategias pedagógicas e institucionales capaces de articular la docencia, la investigación y la extensión de forma crítica, contextualizada y socialmente comprometida. Este artículo busca analizar las experiencias de proyectos de extensión, discutiendo sus contribuciones a la formación técnico-profesional y su impacto social. Metodológicamente, se trata de una investigación cualitativa y descriptiva, basada en relatos de experiencia, con producción de datos mediante análisis documental, observación participante y evaluaciones de los participantes y del equipo organizador, analizadas según un análisis de contenido temático. Los resultados muestran que los programas de extensión promueven una amplia movilización académica y social, con una significativa participación de estudiantes, docentes y la comunidad externa, además de fortalecer el liderazgo estudiantil, la interdisciplinariedad, la articulación entre la teoría y la práctica, y el desarrollo de habilidades como la comunicación, el trabajo en equipo, el pensamiento crítico y la responsabilidad social. Se concluye que las ferias de ciencias y las exposiciones integradas constituyen espacios innovadores para la formación en educación vocacional y tecnológica, contribuyendo al aprendizaje significativo y fortaleciendo el rol social de los programas de extensión.

Palabras clave: Proyectos de Extensión. Liderazgo Estudiantil. Interdisciplinariedad. Responsabilidad Social.

1 INTRODUCTION

Professional and Technological Education, which encompasses technical courses and higher education courses, has historically faced the challenge of overcoming an excessively instrumental education, guided by logics of efficiency, productivity and immediate adaptation to the labor market. This orientation, although relevant from a technical point of view, tends to limit students' critical understanding of the social, environmental and ethical impacts of their future professional performance. Excessive focus on theorizing in the classroom can also distance students from the real world where they will work professionally.

In this scenario, research and university extension are presented as a fundamental strategy to tension this logic, by promoting the dialogical interaction between the educational institution and society. Within the scope of the Federal Institutes, extension takes on even greater relevance due to its historical commitment to regional development and social inclusion.

Scientific fairs and integrated project exhibitions are configured as privileged spaces for innovation in the context of Professional and Technological Education, especially when understood not only as occasional events for the dissemination of results, but as pedagogical and institutional strategies that articulate teaching, research and extension.

The innovative character of these initiatives is not restricted to the introduction of new technologies or exhibition formats, but is manifested, above all, in the ways of organizing the training process, in the pedagogical practices mobilized and in the relationships established between institution, students and society.

In the pedagogical sphere, innovation is expressed by the rupture with traditional teaching models centered on the transmission of content and merely reproductive evaluation. By mobilizing active methodologies and problem-solving teaching, fairs and exhibitions move the student from the position of receiver to that of protagonist of the learning process. The investigation of real problems, the collective construction of knowledge and the need to communicate results to different audiences favor significant learning, the development of critical thinking and the articulation between theory and practice, configuring an innovation of a formative nature.

It is in this context that the Integrated Week of Safety and Environment and the I Journey of Knowledge and Diversity (I JSD) held at the Federal Institute of Piauí (IFPI) – Teresina Campus South Zone in 2025 are inserted. They were scientific, cultural and extension events, conceived as spaces that integrate teaching, research and extension activities and promoted with the support of scholarship funding from PIBEX – Institutional

Program for Extension Scholarships and CNPq – National Council for Scientific and Technological Development.

In this article, the objective is to discuss the contributions of events of this nature to technical-professional training, and their social impacts.

2 THEORETICAL FOUNDATION

The national policy of university extension, as recommended by the Forum of Pro-Rectors of Extension (FORPROEX, 2012), is presented as an educational, cultural and scientific process that articulates teaching and research in an inseparable way, promoting a transformative relationship between university and society.

From this point of view, the extension aims to develop citizenship training and strengthens skills such as empathy, communication, teamwork and social responsibility. One of the most significant results is contextualized learning, which is important for professional courses (FORPROEX, 2012).

National and international studies indicate that extension practices contribute significantly to the development of socio-emotional skills, critical thinking and social responsibility, by promoting contextualized learning and direct contact with real problems in society (Forproex, 2012; Silva & Vasconcelos, 2018; Bielefeldt; Paterson; Swan, 2010).

Participation in extension projects broadens students' social awareness, providing experiences that lead them to develop socio-emotional skills, such as listening, dialogue, and professional ethics, which are important for their professional lives (Silva & Vasconcelos, 2018). In the same perspective, Lima, Almeida & Santos (2019) recognize the importance of extension to develop socio-emotional skills and strengthen awareness of social responsibility. This contributes to promoting autonomy and protagonism of the future professional who needs to develop interpersonal skills that are usually little worked on in traditional education.

Experience-based practices (such as extension) broaden critical reflection on professional practice and favor the development of ethical values and social responsibility (Godoy & Antonello, 2017). This dialogues strongly with the adoption of active methodologies in technical and professional courses.

Paulo Freire (2020) also reinforces the importance of dialogue, the problematization of reality, and the valorization of popular knowledge as central elements of emancipatory educational practices, which is strongly present in extension projects.

In the field of technical and professional education, all these didactic and pedagogical contributions of extension projects challenge the logic of strictly economic efficiency, which

has characterized teaching in recent decades, proposing an education more committed to social justice, sustainability and human dignity.

3 METHODOLOGY

This work is characterized as a descriptive study, of a qualitative nature, based on reports of experiences. The research was based on the conception, realization and evaluation of the Integrated Week of Security and Environment and the I Journey of Knowledge and Diversity, events of an integrative nature aimed at the articulation between teaching, research and extension.

The production of data occurred through the documentary analysis of the projects of the events, the programming and the execution reports, as well as the participant observation during the activities developed, with systematized records. In addition, the evaluations carried out by the participants and the organizing team, responsible for the two events, were analyzed, considering perceptions about the training processes experienced.

The data were analyzed in the light of thematic content analysis, with the support of the Atlas TI software, to identify categories related to student protagonism, the integration between teaching, research and extension and the development of critical thinking and social responsibility. The analysis focused on the formative contributions provided by the event to students of technical and higher education courses, in the context of Professional and Technological Education.

4 DESCRIPTION OF THE EXPERIENCE

The events were held with the aim of integrating different institutional actions, including project exhibitions, workshops, lectures, scientific exhibitions and cultural activities that were distributed on various dates, creating an interactive and creative environment for students and teachers, but without intervening in the class schedule. The proposal of the events was conceived in an interdisciplinary way, involving technical courses, higher education and the external community, considering the best way to use financial resources to integrate the entire academic community of the campus as much as possible and involve different social segments.

The events aimed to articulate themes related to Science, Technology, Sustainable Citizenship and Professional Training, promoting interaction between the training axes offered by the campus — Food, Civil Construction, Fashion and Clothing, Informatics and Sanitation. This diversity of areas favored an interdisciplinary and transdisciplinary approach, stimulating the exchange of knowledge and the collective construction of knowledge aimed

at understanding and solving challenges in the world of work, such as: sustainable citizenship, inclusive education, social responsibility, dignity of work and appreciation of diversity.

Both events were aligned with the Sustainable Development Goals (SDGs) and current educational guidelines. This was mainly due to the involvement of the Center for Afro-Brazilian and Indigenous Studies (NEAFRO) and the Center for Assistance to People with Specific Educational Needs (NAPNE).

NEAFRO, a group registered on the CNPQ platform, is an institutional nucleus, common in Federal Institutes and Universities, aimed at promoting studies, educational and extension actions related to Afro-Brazilian history and culture, indigenous peoples, ethnic-racial relations, combating racism and all forms of discrimination and valuing cultural and identity diversity.

This research group works to: (i) support the implementation of Laws No. 10,639/2003 and No. 11,645/2008; (ii) promote anti-racist, inclusive and critical education; (iii) articulate teaching, research and extension with a focus on diversity; and, (iv) dialogue with communities, social movements and traditional knowledge.

The participation of NAPNE, the sector that constitutes the institutional structure of all *IFPI campuses*, contributed to the promotion of accessibility and equity, ensuring that activities were planned and executed in an inclusive manner.

The organizing team of the events was formed by 15 teachers from all teaching centers, in addition to a group of 60 students who acted as monitors; The events had institutional support in various ways, characterizing an action that integrated the academic community of the campus.

The program was planned so that two activities were organized per week, seeking not to interfere with the school calendar. Teachers from different disciplines were invited to develop projects with their students to be exhibited in the scientific exhibitions, and several activities were carried out in the classroom, integrating with the planned contents.

The records of the activities (confirmed registrations and attendance lists) pointed to the participation of about 1,800 participants, including students from the municipal and state school system. It is important to mention that the exhibitions and shows were available to students at different times (morning, afternoon and evening).

The dissemination carried out mainly through social networks was the responsibility of the volunteer students and this made it possible to create creative posts in a language that reached several social groups.

5 RESULTS AND DISCUSSION

This section presents the results and the discussion based on the analysis of the event reports, institutional records and information systematized by the organizing team, with a descriptive focus on the activities developed and the formative contributions observed.

5.1 EXTENSION ACTIONS AS PEDAGOGICAL DEVICES FOR MEANINGFUL LEARNING AND THE DEVELOPMENT OF CRITICAL THINKING

The activities developed within the scope of the Integrated Week of Security and Environment and the I Journey of Knowledge and Diversity show the potential of extension actions as expanded pedagogical devices, capable of articulating teaching, research and extension in an inseparable way. Unlike occasional events of scientific dissemination, the experiences analyzed were conceived as continuous training processes, integrated with the pedagogical practices of technical and higher education courses.

The data from participant observation and evaluations indicate that the diversity of activities — lectures, workshops, project exhibitions, science fairs and extension actions — favored significant learning, to the extent that teaching contents began to be mobilized in concrete, socially contextualized situations. This configuration reinforces the role of extension as a strategic training space in Professional and Technological Education, as recommended by national guidelines.

The analysis of the programming and the practices carried out allows us to identify important convergences in relation to the formative indicators considered in the analysis: student protagonism, investigation of real problems, collective construction of knowledge, scientific and social communication, development of critical thinking and articulation between theory and practice, as can be seen in the synthesis presented in tables 1 and 2.

Table 1

Types of activities developed and training objectives

Type of activity	Training objective
Thematic lectures	Critical reflection on science, technology, sustainable citizenship and professional training.
Workshops and short courses	Development of practical and technical skills in an applied way.
Science Fair	Stimulus to scientific research and student protagonism.
Project Shows	Socialization of teaching, research and extension productions.
Thematic tables	Deepening of interdisciplinary debates.
Extension actions	Interaction with the community and social application of knowledge.

Source: The author.

Table 2

Areas and thematic axes involved

Training axis	Approaches
Food	Food safety, production processes and sustainability.
Civil Construction	Sustainability, safety and socio-environmental impacts.
Informatics	Technology, innovation and digital solutions.
Fashion & Apparel	Sustainable production, creativity and cultural identity.
Sanitation	Environmental health, waste management and quality of life.

Source: The author.

5.2 STUDENT PROTAGONISM IN THE LEARNING PROCESS

In both events, it was observed that the student moved from the position of passive receiver to that of active subject of the training process. Student protagonism was manifested in an expressive way in the presentation of projects, in the conduction of workshops, in the mediation of exhibitions and in direct interaction with the academic and external community.

In the Integrated Week of Safety and Environment, students acted as agents of awareness and guidance, especially in actions related to environmental education, health and safety at work. In the I Journey of Knowledge and Diversity, the protagonism was expanded by the centrality of student productions in the programming and dissemination of the event, strengthening autonomy, collective responsibility and social engagement.

These findings corroborate approaches of active learning methodologies, by showing that the active participation of students contributes to the development of cognitive, social and ethical skills that are fundamental to professional training. Extension projects stimulate a dynamic that breaks with the banking logic of education criticized by Freire (1996).

5.3 INVESTIGATION OF REAL PROBLEMS AND CONTEXTUALIZATION OF KNOWLEDGE

Another convergent aspect between the events analyzed refers to the anchoring of the activities in real, socially situated problems. The topics addressed — such as environmental sustainability, health and safety at work, waste management, inclusion, diversity, social inequalities and relations between work and the environment — emerge from concrete demands of the territory and the institutional context.

This approach dialogues directly with Freire's (1996) problematizing pedagogy, according to which knowledge emerges from the critical reading of reality, and with Dewey (1979), who argues that learning occurs in a more meaningful way when linked to experience. By starting from real situations, the actions favor the attribution of meaning to academic content and expand its social relevance.

In the Integrated Week, the environmental and ergonomic blitzes, the practical workshops and the round tables enabled the critical analysis of situations observable in the daily life of the campus, partner schools and the productive sector. In the I Journey of Knowledge and Diversity, the projects and debates started from real experiences of students and the community, highlighting social, cultural and educational problems often made invisible in traditional curricula.

5.4 COLLECTIVE CONSTRUCTION OF KNOWLEDGE AND INTERDISCIPLINARITY

The two experiences were characterized by a strong emphasis on the collective construction of knowledge, mediated by the dialogue between different subjects and knowledge. The conversation circles, round tables, interdisciplinary exhibitions and collaborative activities favored the interaction between students, professors, external professionals and the community in general.

The I Journey of Knowledge and Diversity stood out for the articulation between academic knowledge, popular knowledge and community experiences, promoting interdisciplinary and transdisciplinary approaches. Similarly, the Integrated Week on Security and the Environment integrated different areas of knowledge, breaking with fragmented approaches and favoring a systemic understanding of socio-environmental problems and the world of work.

This collective character strengthened collaborative learning and contributed to the formation of subjects capable of acting in complex contexts.

5.5 COMMUNICATION OF RESULTS AND DIALOGUE WITH DIVERSE AUDIENCES

The communication of the knowledge produced was a central axis of the two extension actions. The students were challenged to translate technical and scientific concepts for different audiences, including the external community, basic education students, workers, managers and public servants.

The exhibitions, oral presentations, open workshops, educational actions and cultural activities required language adequacy, argumentative clarity and social sensitivity. This exercise contributed to the development of communication skills fundamental to professional training, in addition to reinforcing the social commitment of the public university to the democratization of knowledge.

5.6 MEANINGFUL LEARNING, CRITICAL THINKING AND ARTICULATION BETWEEN THEORY AND PRACTICE

The joint analysis of the two experiences shows that the combination of student protagonism, investigation of real problems, interdisciplinary dialogue and social communication favors significant learning, as recommended by critical and active pedagogical approaches.

The strong presence of conversation circles, round tables and interdisciplinary activities evidences the collective construction of knowledge as a structuring principle of the two experiences. This perspective is close to the notion of ecology of knowledge, proposed by Santos (2005), by recognizing the legitimacy of different forms of knowledge — academic, popular, professional and community.

From the point of view of Theories of Practices, learning can be understood as a socially situated phenomenon, produced in interactions between people, artifacts, discourses and contexts (Schatzki, 2001; Gherardi, 2012). Thus, the extension actions analyzed are configured as social practices that produce knowledge in use, going beyond the simple transmission of formal contents, tensioning the technicist logic still present in Professional and Technological Education.

The activities allowed students to articulate theoretical content discussed in the classroom with concrete practices, promoting critical reflection on topics such as sustainability, ethics, work, diversity and social inequalities. By problematizing these issues in real contexts, the events contributed to the development of critical thinking and to the training of professionals who are more sensitive to the social, environmental and human dimensions of their work.

5.7 INTERPRETATIVE SYNTHESIS

In an articulated way, the Integrated Week of Safety and Environment and the I Journey of Knowledge and Diversity reaffirm university extension as a privileged space for the construction of critical, contextualized and socially committed learning.

Table 3

Analytical synthesis of the pedagogical indicators of the extension actions

Pedagogical indicators	Analytical description	Empirical evidence in the activities developed
Student protagonism in the learning process	The student assumes an active role in the production, mediation and socialization of knowledge, overcoming the passive logic of transmissive learning.	Exhibition and presentation of student projects; conducting workshops and educational blitzes; mediation of activities with the community; student participation in the organization, execution and evaluation of events.
Investigation of real problems	The activities are based on concrete situations in the territory, the world of work and social experiences, promoting contextualized learning.	Discussions on environmental sustainability, health and safety at work, waste management, inclusion and diversity; analysis of problems observed on campus, in partner schools and in the external community.
Collective construction of knowledge	Knowledge is produced in a dialogical, interdisciplinary and collaborative way, integrating different subjects and knowledge.	Conversation circles, round tables and interdisciplinary debates; interaction between students, professors, external professionals, social movements and the community; articulation between academic knowledge and community experiences.
Communication of results to diverse audiences	Students practice the translation and socialization of scientific and technical knowledge for heterogeneous audiences.	Scientific-cultural exhibitions, open workshops, free consultancies, educational blitzes and cultural activities aimed at the academic and external community.
Meaningful learning	Learning occurs from the relationship between theory, practice and social reality, attributing meaning to the contents worked.	Practical application of concepts discussed in the classroom; activities based on "learning by doing"; connection between curricular content and real social demands.
Development of critical thinking	The actions stimulate the problematization of inequalities, naturalizations and the dominant instrumental logic in professional training.	Debates on ethics, work, environment, diversity, social inclusion and institutional responsibility; critical reflection on the social and environmental impacts of professional practices.
Articulation between theory and practice	Integration between theoretical foundations and practical experiences in real contexts of social and educational intervention.	Practical workshops, extension actions, project exhibitions and experience reports that show the application of theoretical concepts in concrete situations.

Source: The author

The results highlight the potential of the events as an innovative training strategy, capable of consolidating the articulation between teaching, research and extension, promoting the integral training of students and contributing to the strengthening of the institution's social role. The tables summarize the thematic categories analyzed.

Table 4

Main formative contributions observed

Formative dimension	Observed evidence
Student protagonism	Students' performance as presenters and mediators.
Interdisciplinarity	Integration between courses and areas of knowledge.
Critical thinking	Discussions about real problems and sustainability.
Communication	Presentation of projects to different audiences.
Social responsibility	Participation in extension actions and dialogue with the community.

Source: The author.

Table 5

Articulation between teaching, research and extension

Dimension	Shape of articulation
Education	Projects linked to disciplines and curricular activities.
Research	Investigation of problems and production of knowledge.
Extension	Interaction with the community and social application of knowledge.

Source: The author.

The results indicate that the events contributed significantly to broaden students' understanding of topics related to social and environmental responsibility. Greater student engagement, development of communication skills and critical reflection on real problems of the community were observed.

The interaction with the external community allowed the students to recognize the limits and possibilities of technical action, reinforcing the importance of an ethical and responsible posture. These findings corroborate the literature that points to extension as a privileged space for comprehensive education in professional and technological education.

6 FINAL CONSIDERATIONS

The experience in carrying out and analyzing the results of the events show the potential of extension projects as a training strategy capable of tensioning the technicist logic still predominant in technical and professional education. By promoting dialogue between knowledge, interdisciplinarity and approximation with social reality, extension projects contribute to the construction of a more critical, humane and socially committed education with the demands of the social scenario in which future professionals are inserted.

REFERENCES

- Bielefeldt, A. R., Paterson, K. G., & Swan, C. W. (2010). Measuring the impacts of project-based service learning. *Journal of Engineering Education*, 99(4), 389–400.
- Brasil. (2014). Lei nº 13.005, de 25 de junho de 2014. Aprova o Plano Nacional de Educação – PNE e dá outras providências. *Diário Oficial da União*, seção 1, Brasília, DF.
- Brasil. Conselho Nacional de Educação. (2018). Resolução nº 7, de 18 de dezembro de 2018. Estabelece as Diretrizes para a Extensão na Educação Superior Brasileira. *Diário Oficial da União*, seção 1, Brasília, DF.
- Bispo, M. de S. (2021). Estudos baseados em práticas: Conceitos, história e perspectivas. Mackenzie.
- Fórum de Pró-Reitores de Extensão das Instituições Públicas de Educação Superior Brasileiras. (2012). Política Nacional de Extensão Universitária. FORPROEX.
- Freire, P. (2019). *Pedagogia do oprimido* (60ª ed.). Paz e Terra.
- Freire, P. (2020). *Pedagogia da autonomia: Saberes necessários à prática educativa* (59ª ed.). Paz e Terra.
- Gherardi, S. (2012). *How to conduct a practice-based study: Problems and methods*. Edward Elgar.
- Godoy, A. S., & Antonello, C. S. (2017). Aprendizagem experiencial e formação profissional. *Revista de Administração Contemporânea*, 21(2), 187–206.
- Guerreiro Ramos, A. (1989). *A nova ciência das organizações: Uma reconceituação da riqueza das nações* (2ª ed.). Editora FGV.
- Laasch, O., & Conaway, R. N. (2015). *Principles of responsible management: Global sustainability, responsibility, and ethics*. Cengage Learning.
- Langmead, S., & Laasch, O. (2021). Responsible management learning: The role of practice and reflection. *Journal of Management Education*, 45(1), 3–31.
- Lima, J. P., Almeida, R. S., & Santos, E. F. (2019). Projetos de extensão universitária e desenvolvimento de competências socioemocionais. *Educação & Sociedade*, 40, Article e021345.
- Nóvoa, A. (1992). *Os professores e a sua formação*. Dom Quixote.
- Santos, B. de S. (2010). *A universidade no século XXI: Para uma reforma democrática e emancipatória da universidade*. Cortez.
- Silva, R. A., & Vasconcelos, M. L. (2018). Extensão universitária e formação crítica na engenharia. *Revista de Ensino de Engenharia*, 37(2), 45–58.
- Souza, M. M., & Bispo, M. de S. (2020). Práticas organizacionais, ética e responsabilidade social. *Revista de Administração Contemporânea*, 24(6), 517–533.
- UNESCO. (2017). *Education for sustainable development goals: Learning objectives*. UNESCO.

WOMEN'S EMPOWERMENT IN COMPUTING: PROMOTING LEADERSHIP THROUGH EDUCATIONAL ROBOTICS

EMPODERAMENTO FEMININO NA COMPUTAÇÃO: PROMOVER O PROTAGONISMO POR MEIO DA ROBÓTICA EDUCACIONAL

EMPODERAMIENTO DE LAS MUJERES EN LA INFORMÁTICA: PROMOVIENDO EL LIDERAZGO A TRAVÉS DE LA ROBÓTICA EDUCATIVA



<https://doi.org/10.56238/sevened2026.008-003>

Maria Ivanilse Calderon Ribeiro¹, Mariela Mizota Tamada², Marcel Leite Rios³

ABSTRACT

The underrepresentation of women in Science, Technology, Engineering, and Mathematics (STEM) and computer science is a sociological challenge that demands incentive strategies from basic education onwards. This article presents the extension project "Robotic Girls: Creative Learning to Attract Girls to Robotics at IFRO". The project arose from the observation that 57.1% of students in the Technical Course in Informatics Concurrent with High School (CTICEM) did not identify with the field of computing, citing as obstacles a lack of confidence in their own abilities, limited access to resources, and financial challenges. The methodology adopted is based on Creative Learning and Problem-Based Learning (PBL), using Educational Robotics (ER) as a tool to connect theory and practice. The activities involved the use of block programming (Scratch), Lego Mindstorms EV3 kits, as well as support via a Virtual Learning Environment (VLE) and YouTube tutorials. The results demonstrate that the initiative promoted a significant increase in engagement: the number of participants rose from a low initial participation to the formation of all-girls teams for the Brazilian Robotics Olympiad (OBR). Beyond technical performance in competitions, the project stimulated female leadership, transforming students into knowledge multipliers through community workshops and visits to public schools. It is concluded that the RE (Research and Education), supported by mentoring programs and a collaborative environment, is an effective means to overcome gender barriers, strengthen self-confidence, and promote the empowerment of women in technology.

Keywords: Educational Robotics. Female Empowerment. Creative Learning. Gender Equality.

¹ Dr. in Computer Science. Instituto Federal de Rondônia (IFRO). E-mail: ivanilse.calderon@ifro.edu.br
Orcid: 0000-0001-9445-3788 Lattes: <http://lattes.cnpq.br/7241625767509371>

² Dr. in Computer Science. Instituto Federal de Rondônia (IFRO). E-mail: mariela.tamada@ifro.edu.br
Orcid: 0000-0002-1842-9310 Lattes: <http://lattes.cnpq.br/3266291168658379>

³ Master's degree in Computer Science. Instituto Federal de Rondônia (IFRO). E-mail: marcel.rios@ifro.edu.br
Orcid: 0009-0006-7048-5332 Lattes: <http://lattes.cnpq.br/6594698257579071>

RESUMO

A sub-representação feminina nas áreas de *Science, Technology, Engineering, and Mathematics* (STEM) e na computação é um desafio sociológico que demanda estratégias de incentivo desde a educação básica. Este artigo apresenta o projeto de extensão "Meninas Robóticas: Aprendizagem criativa para atrair meninas para a robótica no IFRO". O projeto surgiu da observação de que 57,1% das estudantes do Curso Técnico em Informática Concomitante ao Ensino Médio (CTICEM) não se identificavam com a área de computação, citando como obstáculos a falta de confiança nas próprias habilidades, o acesso limitado a recursos e desafios financeiros. A metodologia adotada fundamenta-se na Aprendizagem Criativa e na Aprendizagem Baseada em Problemas (ABP), utilizando a Robótica Educacional (RE) como ferramenta para conectar teoria e prática. As atividades envolveram o uso de programação em blocos (Scratch), kits Lego *Mindstorms* EV3, além de suporte via Ambiente Virtual de Aprendizagem (AVA) e tutoriais no YouTube. Os resultados demonstram que a iniciativa promoveu um aumento significativo no engajamento: o número de participantes subiu de uma adesão inicial baixa para a formação de times exclusivos de meninas para a Olimpíada Brasileira de Robótica (OBR). Além do desempenho técnico nas competições, o projeto estimulou o protagonismo feminino, transformando as estudantes em multiplicadoras de conhecimento em oficinas para a comunidade e visitas a escolas públicas. Conclui-se que a RE, apoiada por programas de mentoria e um ambiente colaborativo, é um meio eficaz para superar barreiras de gênero, fortalecer a autoconfiança e promover o empoderamento das mulheres na tecnologia.

Palavras-chave: Robótica Educacional. Empoderamento Feminino. Aprendizagem Criativa. Igualdade de Gênero.

RESUMEN

La escasa representación femenina en las áreas de Ciencia, Tecnología, Ingeniería y Matemáticas (STEM) y en informática es un desafío sociológico que exige estrategias de incentivos desde la educación básica. Este artículo presenta el proyecto de extensión "Niñas Robóticas: Aprendizaje Creativo para Atraer a las Niñas a la Robótica en IFRO". El proyecto surgió tras observar que el 57,1% del alumnado del Curso Técnico en Informática Concomitante con la Educación Media (CTICEM) no se identificaba con el campo de la informática, citando como obstáculos la falta de confianza en sus propias habilidades, el acceso limitado a recursos y las dificultades económicas. La metodología adoptada se basa en el Aprendizaje Creativo y el Aprendizaje Basado en Problemas (ABP), utilizando la Robótica Educativa (ER) como herramienta para conectar la teoría con la práctica. Las actividades incluyeron programación con bloques (Scratch), kits Lego *Mindstorms* EV3, así como apoyo mediante un Entorno Virtual de Aprendizaje (EVA) y tutoriales de YouTube. Los resultados demuestran que la iniciativa promovió un aumento significativo de la participación: el número de participantes pasó de una baja participación inicial a la formación de equipos exclusivamente femeninos para la Olimpiada Brasileña de Robótica (OBR). Más allá del rendimiento técnico en las competiciones, el proyecto impulsó el liderazgo femenino, transformando a las estudiantes en multiplicadoras de conocimiento mediante talleres comunitarios y visitas a escuelas públicas. Se concluye que la Investigación y Educación (IR), apoyada por programas de mentoría y un entorno colaborativo, es un medio eficaz para superar las barreras de género, fortalecer la autoconfianza y promover el empoderamiento de las mujeres en la tecnología.

Palabras clave: Robótica Educativa. Empoderamiento Femenino. Aprendizaje Creativo. Igualdad de Género.

1 INTRODUCTION

The democratization of digital innovation represents a remarkable sociological shift driven by the advancement of new technologies and the reduction of costs, enabling individuals to create and share their inventions. However, the path towards a sustainable economy and a more balanced society requires a greater engagement of diverse people in innovation. In this sense, it is crucial to highlight the worrying low number of women who opt for training and a career in the field of computing (HAPPE, 2021).

The increase in female representation in the areas of *Science, Technology, Engineering, and Mathematics* (STEM) has been the subject of study in several projects in Brazil and around the world. Carrying out projects, workshops, and meetings that aim to present technology in a more practical way to elementary and high school girls is essential, allowing them to know and feel more comfortable in the areas of technologies (ERENO *et al.*, 2023).

In view of this, we understand that gender equality is one of the fundamental pillars for sustainable development and social progress, especially through teaching and teaching practices, which seek to motivate and engage girls in the area of computing. In this context, working in the Technical Course in Informatics Concomitant to High School (CTICEM), we sought to develop a project that would arouse in students the curiosity and motivation to explore the area beyond the context of the classroom, which resulted in the extension project, Robotic Girls: Creative learning to attract girls to robotics at IFRO, Porto Velho North Zone campus.

In this scenario, the project aims to develop creative learning to attract girls to Educational Robotics (RE). To this end, we adopt creative learning, which is a pedagogical approach that encourages students to engage in hands-on projects and activities, combining art, science, technology, and engineering to stimulate creativity and innovation. The students apply the knowledge acquired in the CTICEM classes in the activities of the RE. Also, the Problem-Based Learning (PBL) methodology was used as access points to guide investigation, dialogue and critical thinking. The main objective of the project is to engage students in studies in the area of computing, especially RE, in order to foster the development of fundamental skills and knowledge that can be applied in the area of technology and science, encourage logical and creative thinking in high school students to face complex challenges efficiently.

RE arose from the theories of Jean Piaget's Constructivism and Seymour Papert's Constructionism. He believed that the child learns during the creation of artifacts and experimentation of his theories (SOKOLONSK, 2020). RE promotes the development of

knowledge through situations that challenge the individual to think of solutions. It allows you to relate theory to practice, applying learning in the classroom and in previous experiences to solve specific problems. Building robots in school offers teachers and students to teach, learn, discover, and invent in collective processes. This activity fosters the connection between theoretical abstractions and the concrete world (FERNANDES *et al.*, 2018).

In the field of computing, historically marked by female underrepresentation, it is essential to support initiatives that not only encourage the participation of women and girls, but also promote their training and the full development of their potential. This article presents an extension project aimed at promoting gender equality and the empowerment of female students in the area of informatics, using participation in the Brazilian Robotics Olympiad (OBR) as an instrument of motivation and training.

2 MATERIAL AND METHODS

Creative learning is a practice that can be stimulated through Project-Based Learning (PBL), where students are driven by meaning (*passion*), produce collaboratively (*peer learning*) and value skills such as creativity, curiosity and resilience (*play*). This concept places students at the center of the educational process, empowering them to plan, create, test, and act proactively in the face of social issues and themes that involve them in real and everyday situations (INEIA *et al.*, 2022).

Therefore, the Problem-Based Learning (PBL) methodology, considered a pedagogical approach considered innovative because it allows the student to participate actively in the construction of knowledge, will be the methodology adopted in this project. The ABP or *Problem Based Learning* (PBL) is a pedagogical practice used in teaching in several areas and is perfectly suitable to be used with educational robotics and to develop computational thinking (CABRAL *et al.*, 2019). AABP guided the Activities carried out by the girls, taking into account their experiences and experiences, in addition to exposing girls to situations that stimulate The reflection.

3 RESULTS AND DISCUSSION

At the beginning of the first semester of 2024, a survey was carried out through a questionnaire to understand the profile and perspectives of the students of the two CTICEM classes on campus. At that time, we had 31 girls enrolled in these classes. The results indicate that most students do not identify with the area. **Figure 1** illustrates that 57.1% of the girls who responded to the questionnaire expressed a lack of interest in computer areas, such as programming, data science, artificial intelligence, digital games, among others. While

28.6% have not yet reflected on the subject, only 14.3% have shown a lot of interest in the area.

Figure 1

Level of interest in areas of computing



Source: Authors.

To understand why 57.1% of girls expressed a lack of interest in computing fields, we asked students about the challenges and difficulties they face when considering studying or working in this field. **Figure 2** shows that 28.6% of the girls indicated limited access to resources as one of the challenges or difficulties they face when considering working in the area of computing. In addition, others mentioned include lack of access to educational resources, lack of confidence in skills, difficulties in specific disciplines, and financial challenges.

Figure 2

Challenges and difficulties pointed out by girls when considering studying or working in the area of computing



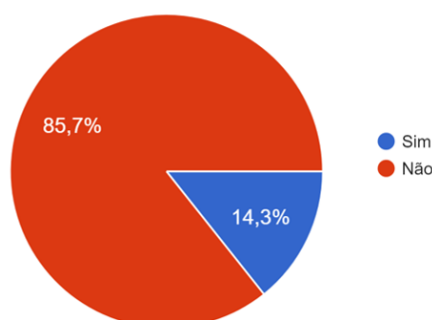
Source: Authors.

Given this scenario, the significant challenge of promoting girls' participation in the area of computing is evident. The fact that most students in CTICEM classes currently on campus do not identify with the area, as demonstrated by the lack of interest expressed by 57.1% of the girls, suggests the existence of significant barriers. By analyzing the challenges and difficulties faced by girls when considering studying or working in the field of computing, we identified a number of obstacles. These factors can contribute to discouraging girls from pursuing careers or studies in computing. Another relevant piece of information is the lack of interest in the participation of the OBR, despite all the girls recognizing the importance of the competition.

Figure 3 presents a scenario that may explain the challenges faced by girls when considering participation in national or state-level competitions. Lack of confidence in their abilities may be a determining factor for disinterest, since 85.7% of the girls did not express interest in participating in the OBR.

Figure 3

Interest in participating in the OBR



Source: Authors.

With this data, we detected that the lack of confidence in girls' abilities is one of the main challenges identified, which can prevent them from fully engaging in robotics and programming activities. To help girls overcome these obstacles, it is essential to adopt approaches that strengthen their confidence and encourage active participation in technology-related activities. Key measures include increasing access to educational resources and opportunities, mentoring programs to bolster girls' self-confidence, and policies to reduce financial barriers. In addition, it is important to maintain the effort to promote an inclusive and diverse culture in the area of computing, highlighting how gender diversity benefits innovation and progress.

The "Robotic Girls" project started on 09/01/2023, derived from an RE project carried out on campus during the first semester of 2023. This first project selected both boys and

girls to learn RE and participate in OBR. However, female participation was low, with only 4 girls initially applying, of which only 2 completed all stages and participated in OBR in August 2023. Against this backdrop, the need to address the low participation of girls has become evident. Thus, we developed the Robotic Girls project, with coordination and vice-coordination of female teachers in the area of Informatics, focused specifically on motivating and arousing the interest of girls in RE. Through practical activities, such as the elaboration of codes and the construction of a robot, we seek to encourage female participation in OBR 2024.

The project's face-to-face meetings took place twice a week, lasting three hours each. They were held at the campus's Center for Technological Innovation (CIT), a space inaugurated in March 2022, equipped with 10 state-of-the-art desktops, a TV, and a digital whiteboard. For the robotics project, through a public notice with resources, 10 complete Lego *Mindstorms* EV3 kits, 2 expansion kits, single sensors, a training track and some elements necessary for participation in the OBR were acquired.

In addition to the physical equipment, the robotics project has a team of mentors and facilitators who guide participants in various areas, from the assembly of the robots to advanced programming. Among them, two students who participated in the OBR 2023 edition were able to contribute with their experience in competitions.

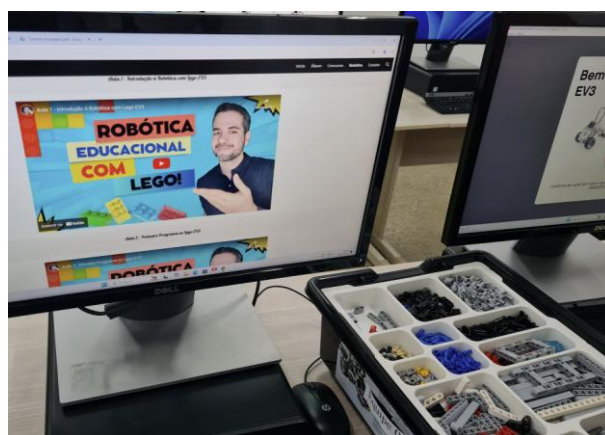
The face-to-face meetings were structured to provide a collaborative and hands-on learning environment where students could work as a team, exchange ideas, and solve challenges together. During the activities at the CIT, participants had access not only to material resources, but also to specific modeling and programming software for the LEGO *Mindstorms* EV3 platform. In addition, the CIT environment provides a space for creativity and experimentation, encouraging students to explore new approaches and innovative solutions to the proposed problems.

The robotics project is not limited to face-to-face meetings at the CIT. Participants also have access to the virtual learning environment (VLE), where they can consult support materials, participate in discussion forums, and interact with mentors outside of face-to-face meeting hours. This combination of face-to-face and virtual activities aims to provide a complete and enriching experience to participants, preparing them not only for the OBR competition, but also for future challenges in the area of robotics and technology.

We also complemented the YouTube Educational Robotics Channel with LEGO with tutorials recorded by faculty members from the campus RE team (**Figure 4**), intensive practice sessions, and *constructive feedback*.

Figure 4

Tutorials on a YouTube channel created by the Educational Robotics professor on campus



Source: Authors.

The positive results of the project include a significant increase in girls' interest and participation. In September 2023, we had the registration of six students, five of whom demonstrated total commitment and engagement in the activities.

The training begins with a module called 'Introduction to block programming', in which students developed programming skills using the Scratch platform, which was chosen for its playful and educational approach. Scratch is a block-based visual programming language, making it easy to create interactive projects such as animations, games, and stories, as well as stimulating creativity and computational thinking.

At the end of this introductory module, the students were challenged to create a game or story in *Scratch* that should include elements such as scenario animation, character movement, dialogues and soundtrack. Overcoming several challenges throughout the process, the girls developed games, demonstrating great evolution and application of the concepts learned.

Figure 5

Girls participating in the robotics project (Sept. 2023-Aug. 2024)



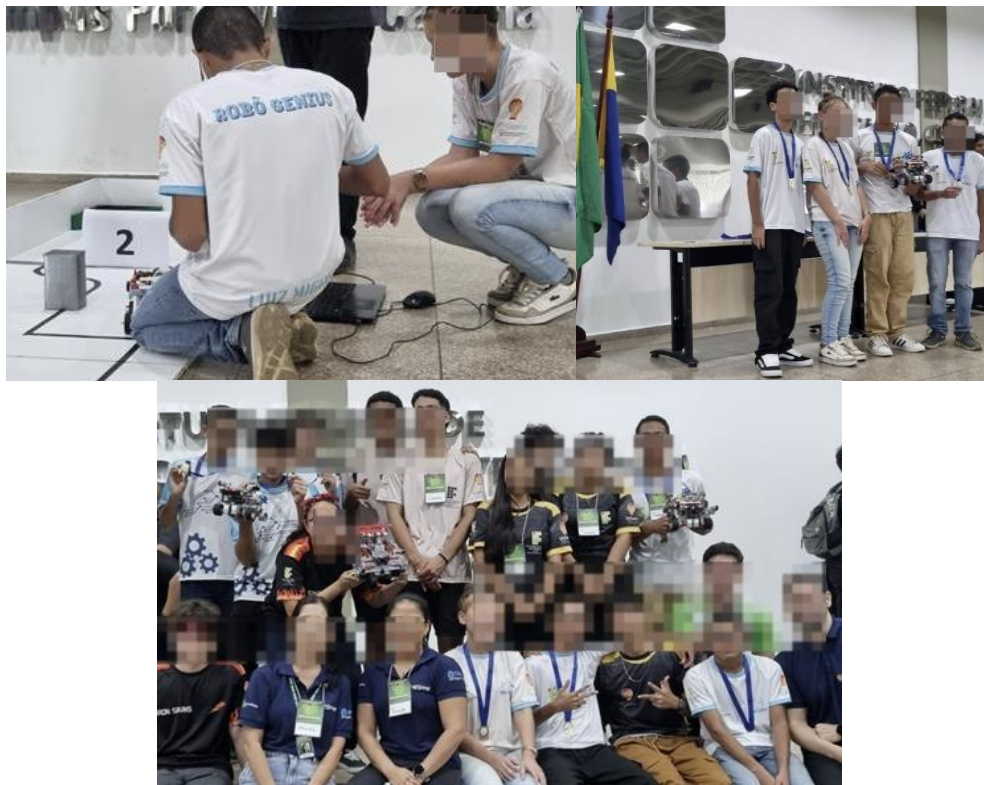
Source: Authors.

Subsequently, (**Figure 5**), the girls prepared for the architectural part in assembling the robots and studied to understand the challenges of OBR through a comprehensive approach that encompasses various aspects of learning and development, organizing their time efficiently, setting goals and schedules to ensure they have enough time to practice programming, Build the robot and prepare for the competitions.

We created a project to make an internal competition on campus as a preparation for OBR with 5 teams of boys and girls, simulating a real competition environment following rules and awards. Finally, the teams presented themselves at the state OBR on September 2nd and 3rd, 2024 (**Figure 6**). Each team performed with the t-shirt created by the members themselves. There were 2 days of competitions with the participation of 20 teams from the state. Our best place was a mixed team that was in 4th place and two more in 10th. and 18th with girls, but the most important was the engagement and companionship developed.

Figure 6

Teams participating in the state OBR (09/03/2024)



Source: Authors.

In October 2024, during the National Science and Technology Week (SNCT), educational robotics workshops were held open to the community. In this context, one of the students had a prominent participation, collaborating both in the organization and in the teaching process of the workshop. Figure 7 shows the student conducting a robotics activity with a group of girls. It is noteworthy that there was no direction or separation of the participants by gender; The composition of the group occurred spontaneously. The image suggests that the performance of a student as a female reference in robotics can contribute to arouse interest and promote greater engagement of other girls in the area.

Figure 7

Robotics student (upper right) supporting the workshop for the external community during the SNCT



Source: Authors.

The challenges initially pointed out by the participants, such as the difficulty in assimilating programming concepts and the complexity involved in building the robot, were gradually overcome throughout the activities, with continuous pedagogical support. This preparation aimed not only at participating in the Brazilian Robotics Olympiad (OBR), but also at developing personal and professional skills, contributing to the formation of relevant skills for future challenges in the field of technology.

Aiming at the sustainability of the project, in September 2024 a new class was started. In this stage, with an improved methodological approach, 11 girls joined, who went through the same training stages, including the introduction to block programming, demonstrating engagement and interest in participating in the next edition of OBR, which took place at the end of August, with the formation of two teams composed exclusively of girls, totaling seven participants. From this experience, the Robotic Girls project gradually consolidated itself as a teaching and extension initiative. As a result of the extension actions, one of the teams carried out activities to disseminate robotics in public schools throughout the second half of 2025, contributing to the dissemination of knowledge and stimulating the interest of basic education students in the technological area.

4 CONCLUSIONS

By addressing these challenges and implementing effective support and encouragement strategies, we can help girls overcome the barriers that prevent them from fully participating in the technology and computing environment. This project not only contributes to teaching, research and extension in Professional and Technological Education (EPT), but also motivates and engages CTICEM students.

Thus, it facilitates the sharing of knowledge both with the internal community, including the class of the Informatics course, and with the external community and the elementary and high schools. In addition, the project stimulates creativity and innovation, encouraging students to find unique and innovative solutions, while developing social and emotional skills, such as collaboration, communication, and leadership, which are fundamental for participation in OBR.

RE has been an effective means to attract more girls to technology, encouraging them to stay in the area and promoting their protagonism as multipliers of knowledge and experiences. Finally, the Robotic Girls project emerges as a direct response to the low female participation in robotics and programming activities, identifying girls' lack of confidence in their abilities as one of the main obstacles. By adopting specific approaches to promote girls' confidence and engagement, such as access to educational resources, mentorship programs, and policies to reduce financial barriers, the project seeks to overcome these challenges and encourage female participation in computing.

ACKNOWLEDGMENTS

We would like to thank the Office of the Dean of Research, Innovation and Graduate Studies (PROPESP) of IFRO for the financial support that made the publication of this article possible. Our recognition to the Research Group on Technologies and Education (GPComp) for its commitment to the development of the project, as well as to the Federal Institute of Education, Science and Technology of Rondônia (IFRO) – Porto Velho Campus North Zone (PVZN) for the financing of the teaching materials used, through Public Notice No. 28/2023/PVZN. AB/IFRO and Public Notice 23/2024/PVZN.

REFERENCES

- Cabral, C. P., Preuss, E., & Passerino, L. (2019). Aprendizagem com robótica educacional: Uma abordagem baseada em problemas. In *Anais dos Workshops do Congresso Brasileiro de Informática na Educação* (p. 682).
- Ereno, L. C., et al. (2023). Aproximando meninas da área de STEM com iniciação a robótica. In *Anais do XVII Women in Information Technology* (pp. 80–90). SBC.
- Fernandes, M., et al. (2018). Robótica educacional: Uma ferramenta para ensino de lógica de programação no ensino fundamental. In *Anais do XXIV Workshop de Informática na Escola* (pp. 315–322). SBC.
- Happe, L., & Buhnova, B. (2021). Frustrations steering women away from software engineering. *IEEE Software*, 39(4), 63–69.

- Ineia, A., et al. (2022). Aprendizagem criativa de robótica educacional na Educação de Jovens e Adultos: Perspectiva de desenvolvimento sustentável e acesso a todos. *Research, Society and Development*, 11(7), Article e28111729994.
- Sokolonski, A. C. (2020). Laboratório de robótica inclusiva: Robótica educacional e raciocínio computacional no ensino médio. In *Anais do XXVI Workshop de Informática na Escola* (pp. 170–178). SBC.

TAXATION AND COMPETITIVENESS IN THE SERVICE SECTOR IN THE TRI-BORDER AREA: A COMPARATIVE ANALYSIS BETWEEN BRAZIL, PARAGUAY, AND ARGENTINA

TRIBUTAÇÃO E COMPETITIVIDADE NO SETOR DE SERVIÇOS NA TRÍPLICE FRONTEIRA: UMA ANÁLISE COMPARATIVA ENTRE BRASIL, PARAGUAI E ARGENTINA

TRIBUTACIÓN Y COMPETITIVIDAD EN EL SECTOR SERVICIOS EN LA TRIPLE FRONTERA: UN ANÁLISIS COMPARATIVO ENTRE BRASIL, PARAGUAY Y ARGENTINA



<https://doi.org/10.56238/sevened2026.008-004>

Ed Ernest Taves¹, Thiago Hokai Mendonça², Leonor Venson de Souza³, Alvaro Antônio da Silva⁴

ABSTRACT

Differences in tax and labor systems among neighboring countries play a strategic role in border regions, where business mobility is high and competitiveness is strongly affected by operational costs. In this context, taxation of the service sector becomes a decisive factor for the attraction or relocation of economic activities. This study provides a comparative analysis of taxation applied to the service sector in the Triple Frontier region, comprising Brazil, Paraguay, and Argentina, based on legislation in force in 2025. The research adopts a descriptive and comparative approach, supported by documentary and bibliographic analysis, focusing on taxes levied on revenue, income, and payroll, as well as mandatory labor charges. The results reveal significant tax asymmetries among the countries, highlighting the high tax burden and regulatory complexity of the Brazilian and Argentine systems, in contrast to the Paraguayan model, which is characterized by a simpler and less burdensome structure. The study concludes that differences in tax and labor systems directly affect regional competitiveness, influencing business location and operational decisions in the service sector within the Triple Frontier.

Keywords: Taxation. Service Sector. Regional Competitiveness. Triple Frontier.

RESUMO

As diferenças nos sistemas tributários e trabalhistas entre países vizinhos tendem a assumir papel estratégico em regiões de fronteira, onde a mobilidade empresarial é elevada e a

¹ Graduated in Accounting Sciences. Centro Universitário Dinâmica das Cataratas (UDC).

E-mail: ed.ernest.taves@outlook.com Orcid: <https://orcid.org/0009-0008-9073-6092>

² Undergraduated student in Accounting Sciences. Centro Universitário Dinâmica das Cataratas (UDC).

E-mail: hokaimendoncathiago@gmail.com Orcid: <https://orcid.org/0009-0005-9504-320X>

³ Dr. in Regional Development. Universidade de Araraquara (UNIARA). E-mail: leonor@udc.edu.br

Orcid: <https://orcid.org/0009-0000-2394-7086>

⁴ Centro Universitário Dinâmica das Cataratas (UDC). E-mail: alvaro.silva@udc.edu.br

Orcid: <https://orcid.org/0000-0003-3538-9821> Lattes: <https://lattes.cnpq.br/2456275365447138>

competitividade é fortemente influenciada por custos operacionais. Nesse contexto, a tributação do setor de serviços torna-se fator decisivo para a atração ou deslocamento de atividades econômicas. Este estudo analisa comparativamente a tributação incidente sobre o setor de serviços na região da Tríplice Fronteira, envolvendo Brasil, Paraguai e Argentina, considerando a legislação vigente em 2025. A pesquisa adota abordagem descritiva e comparativa, fundamentada em análise documental e bibliográfica, com foco nos tributos incidentes sobre o faturamento, a renda e a folha de salários, bem como nos encargos trabalhistas mínimos obrigatórios. Os resultados evidenciam assimetrias tributárias relevantes entre os países analisados, destacando-se a elevada carga fiscal e a complexidade normativa dos sistemas brasileiro e argentino, em contraste com o modelo paraguaio, caracterizado por estrutura mais simples e menos onerosa. Conclui-se que as diferenças nos sistemas tributários e trabalhistas exercem influência direta sobre a competitividade regional, afetando decisões de localização e operação das empresas do setor de serviços na Tríplice Fronteira.

Palavras-chave: Tributação. Setor de Serviços. Competitividade Regional. Tríplice Fronteira.

RESUMEN

Las diferencias en los sistemas tributarios y laborales entre países vecinos suelen desempeñar un papel estratégico en las regiones fronterizas, donde la movilidad empresarial es alta y la competitividad se ve fuertemente influenciada por los costos operativos. En este contexto, la tributación del sector servicios se convierte en un factor decisivo para atraer o reubicar actividades económicas. Este estudio analiza comparativamente la tributación del sector servicios en la región de la Triple Frontera, que abarca a Brasil, Paraguay y Argentina, considerando la legislación vigente en 2025. La investigación adopta un enfoque descriptivo y comparativo, basado en el análisis documental y bibliográfico, centrándose en los impuestos sobre la renta, la renta y la nómina, así como en los cargos laborales mínimos obligatorios. Los resultados destacan las importantes asimetrías tributarias entre los países analizados, destacando la elevada carga tributaria y la complejidad normativa de los sistemas brasileño y argentino, en contraste con el modelo paraguayo, caracterizado por una estructura más simple y menos onerosa. Se concluye que las diferencias en los sistemas tributarios y laborales influyen directamente en la competitividad regional, afectando la ubicación y las decisiones operativas de las empresas del sector servicios en la región de la Triple Frontera.

Palabras clave: Tributación. Sector Servicios. Competitividad Regional. Triple Frontera.

1 INTRODUCTION

The taxation of the service sector has assumed a strategic role in the competitiveness of contemporary economies, especially in contexts in which business mobility is high and operating costs directly influence decisions on productive location. In international border regions, where different tax and labor systems coexist, these differences become even more evident, impacting the cost structure of companies and the regional competitive dynamics.

The Triple Border, formed by the cities of Foz do Iguaçu (Brazil), Ciudad del Este (Paraguay) and Puerto Iguazú (Argentina), is configured as a unique economic space, characterized by the intense circulation of people, goods and services, with a strong predominance of the tertiary sector. In this context, the taxation levied on the service sector, especially that related to revenue, income and payroll, exerts a direct influence on business competitiveness, becoming a relevant factor in the attraction, permanence or displacement of economic activities between bordering countries.

The Brazilian and Argentine tax systems are recognized for their high regulatory complexity and significant tax burden, while Paraguay adopts a more simplified model, with reduced rates and fewer taxes. These asymmetries, when observed in an integrated geographic space such as the Triple Border, tend to produce concrete effects on the behavior of economic agents, affecting prices, profit margins and strategic decisions of companies in the service sector.

In view of this scenario, the following research problem emerges: how does the taxation levied on the service sector, considering taxes and labor charges, differ between Brazil, Paraguay and Argentina and what are its effects on regional competitiveness in the Triple Border?

Thus, the general objective of this study is to comparatively analyze the taxation levied on the service sector in the cities of Foz do Iguaçu, *Ciudad del Este* and *Puerto Iguazú*, identifying the main applicable taxes and labor charges, as well as their effects on regional competitiveness. As specific objectives, it seeks to examine the current legislation, compare the tax burden incurred, identify the charges associated with labor and evaluate the existence of tax incentives for the sector in each location analyzed.

The relevance of the study lies in its contribution to the debate on fiscal competitiveness in border regions, by showing how different tax and labor arrangements influence the economic dynamics of the service sector. In addition, the results offer subsidies for public managers, entrepreneurs and researchers interested in the relationship between taxation, business environment and regional development, especially in the context of recent discussions on tax reform in Brazil and economic integration within Mercosur.

2 THEORETICAL FRAMEWORK

The theoretical framework of this study underpins the analysis of taxation and competitiveness in the service sector, focusing on the concepts of tax planning and business decision-making. The selected literature provides conceptual support to understand how the choice of tax regime influences the economic results and competitiveness of companies.

2.1 TAX PLANNING AND BUSINESS DECISION-MAKING

Tax planning is an essential management tool, especially in economic environments characterized by high tax burden and strong regulatory asymmetry. In this sense, Fabretti (2017, p. 34) defines that "tax planning consists of the prior, lawful and strategic study of the available legal alternatives, with the objective of reducing the tax burden, postponing the payment of taxes or avoiding their incidence". It is, therefore, a tool that goes beyond mere legal compliance, assuming a strategic role in business decision-making.

In the service sector, tax planning acquires even greater relevance, since taxation is predominantly levied on revenues and payroll, directly affecting the cost structure and competitiveness of companies. Decisions related to the location of the enterprise, the way labor is hired, and the organizational structure are strongly influenced by the tax environment, especially in border regions, where different tax systems coexist.

In this context, the absence of planning can compromise the economic sustainability of companies, leading to a loss of competitiveness against competitors established in jurisdictions with a lower tax burden or more simplified regimes. As Crepaldi (2019, p. 78) points out, "the tax burden represents one of the main components of business cost, exerting a direct influence on the competitiveness of organizations, especially in labor-intensive sectors".

2.2 TAX SYSTEMS AND TAXATION OF THE SERVICE SECTOR

The tax systems adopted by countries reflect political and economic choices that directly influence the business environment. In Brazil, the taxation of the service sector is characterized by high regulatory complexity, the multiplicity of taxes and the strong incidence on revenues and payroll, especially the Service Tax (ISS), the Corporate Income Tax (IRPJ), the Social Contribution on Net Income (CSLL), the Contribution to the Social Integration Program (PIS) and the Contribution to the Financing of Social Security (COFINS).

In contrast, countries such as Paraguay and Argentina adopt different models. Paraguay has a tax system that is known to be simpler, with fewer taxes and reduced rates, which has been used as an instrument to attract investments, especially in regions close to

the Brazilian border. Argentina, in turn, combines federal and provincial taxes, resulting in a high tax burden and a higher degree of cumulativeness, although with structural characteristics different from those observed in the Brazilian system.

The taxation of the service sector, especially activities linked to tourism and commerce, is particularly sensitive to these differences, since such activities have high geographic mobility and depend directly on the operational cost to maintain competitiveness. In this sense, Souza and Callado (2020) point out that inadequate tax decisions can significantly compromise the profitability and permanence of companies in highly competitive markets.

From the perspective of tax planning as a decision-making tool, it is essential to analyze the tax systems in which companies are inserted, especially with regard to the taxation of the service sector and its relationship with business competitiveness.

2.3 THE TRIPLE BORDER AS AN ECONOMIC AND FISCAL AREA

The Triple Border region, formed by Brazil, Paraguay and Argentina, is configured as a unique economic space, marked by the intense circulation of people, goods and services. This dynamic means that the tax differences between countries do not remain only at the regulatory level, but materialize in concrete decisions on investment, consumption and business location.

In border regions, disparities between tax systems tend to be immediately perceived by economic agents. Fabretti (2017, p. 112) observes that "in border regions, the differences between tax systems are immediately perceived by economic agents, influencing decisions of location, consumption and investment". In this way, taxation starts to play a strategic role in the organization of regional economic activities.

According to Zilli (2021), border regions show the effects of tax asymmetry more clearly, since economic agents can compare, almost instantaneously, the costs and benefits associated with each tax system. In the service sector, this asymmetry manifests itself both in the structure of taxes levied and in labor charges and tax incentive regimes, generating comparative advantages for certain countries and putting pressure on companies located in more onerous systems.

2.4 TAX INCENTIVES AND REGIONAL COMPETITIVENESS

Tax incentives are instruments widely used by States as a way to stimulate economic development, attract investments and promote job creation. In border regions, such

mechanisms assume even greater relevance, since they compete directly with the tax systems of neighboring countries.

In Paraguay, policies based on reduced tax rates and administrative simplification have contributed to the attraction of companies in the service and trade sector. In Brazil, although there are specific incentives, the high tax burden and the complexity of the system limit its effectiveness. Argentina, in turn, faces challenges related to tax cumulativeness and overlapping fiscal competences, which reduces the positive impact of any incentives.

This reality reinforces the need for comparative analyses capable of understanding how taxation and tax incentives influence business competitiveness in the Triple Border, especially in cost-sensitive sectors such as tourism and commercial services. In the light of these theoretical discussions, the methodological approach presented in the following section is structured.

3 METHODOLOGY

This study is characterized as an applied research, of qualitative and quantitative nature, with a descriptive and comparative approach, with the objective of analyzing the taxation levied on the service sector in the Triple Border region (Brazil, Paraguay and Argentina). The methodological design adopted allows comparing different tax systems, identifying tax asymmetries and their potential impacts on business competitiveness in a cross-border economic space.

As for the technical procedures, a comparative case study was adopted, based on documentary and bibliographic research. The bibliographic research covered books, scientific articles and institutional publications related to taxation, labor charges and regional competitiveness.

The analysis focused on the main taxes levied on revenue, income and payroll, as well as on the minimum labor charges provided for by law, such as working hours, paid vacations, thirteenth salary and employers' social security contributions, considering the legislation in force in 2025. The data were systematized in comparative tables and tables, allowing the identification of fiscal and labor asymmetries and their impacts on the operating cost of companies in the service sector.

It should be noted that the study did not propose to measure macroeconomic impacts or to analyze financial results individualized by company, limiting itself to the normative and structural comparison of the systems analyzed. The conclusions are conditioned to the time frame and normative adopted and may change as a result of future legislative changes, notably those related to the ongoing Brazilian tax reform.

4 RESULTS AND DISCUSSION

This section presents and discusses the results of the comparative analysis of taxation levied on the service sector in the countries that make up the Triple Border (Brazil, Paraguay and Argentina). The analysis includes the main taxes levied on income, revenues and payroll, as well as the main labor charges associated with business activity, with the objective of identifying fiscal asymmetries and their impacts on regional competitiveness.

4.1 TAXATION OF THE SERVICE SECTOR IN BRAZIL

In Brazil, the taxation of companies in the service sector varies significantly according to the tax regime adopted, being levied in a combined manner on turnover, income and payroll. The main regimes applicable to the sector are the Simples Nacional, the Presumed Profit and the Real Profit, each with different structures and impacts on the effective tax burden.

In Simples Nacional, aimed at micro and small companies, taxation occurs in a unified way through the Simples Nacional Collection Document (DAS). For the service sector, the rates vary according to the framework in Annexes III or V of Complementary Law No. 123/2006, and may vary approximately between 6% and 33% of gross revenue, depending on the accumulated revenue of the last twelve months and the relationship between payroll and revenue. Although the regime simplifies the collection, taxation is directly levied on revenue, with a limitation on the deduction of costs and expenses, which can increase the effective burden in labor-intensive activities.

In the Presumed Profit, a regime widely used by medium-sized service companies, the IRPJ calculation basis corresponds to 32% of gross revenue, on which the rate of 15% is applied, plus an additional 10% on the portion of profit that exceeds the legal limit of R\$ 20,000.00 per month or R\$ 60,000.00 in the quarter. The CSLL is levied at the rate of 9%, also on the presumed basis of 32%. In addition, contributions to PIS (0.65%) and COFINS (3%) are levied, under the cumulative regime, as well as ISS, with municipal rates ranging between 2% and 5%. In this regime, the total tax burden on revenue can be, on average, between 13% and 18%, without considering labor charges.

In the Actual Profit, taxation is levied on the company's adjusted accounting result. The IRPJ is applied at the rate of 15%, with an additional 10% on the profit that exceeds the quarterly limit, while the CSLL is levied at the rate of 9%. Contributions to PIS (1.65%) and COFINS (7.6%) are calculated under the non-cumulative regime, allowing the use of credits on certain costs and expenses. Even so, the high joint tax rate of 9.25% on revenues makes

this regime onerous for service companies with reduced margins. Added to this is the incidence of ISS, according to the applicable municipal legislation.

Regardless of the tax regime, service companies in Brazil are subject to high payroll charges, with emphasis on the employer's contribution to the INSS – National Institute of Social Security (20%), the Guarantee Fund for Length of Service (FGTS) at the rate of 8%, in addition to indirect costs arising from the thirteenth salary, paid vacation plus the constitutional third and other obligations provided for in the Consolidation of Labor Laws (CLT). These charges significantly increase the operating cost of companies.

Thus, considering the combination of taxes levied on revenue, income and payroll, the effective tax burden of the service sector in Brazil can exceed 20% of gross revenue, reaching substantially higher levels when considering labor charges.

4.2 TAXATION OF THE SERVICE SECTOR IN PARAGUAY

In Paraguay, the results show a significantly more simplified and less onerous tax structure. The provision of services is subject to the *Impuesto al Valor Agregado* (VAT) at the rate of 10% and to the *Impuesto a la Renta Empresarial* (IRE), also of 10%, according to the legislation in force. For micro and small companies, simplified regimes further reduce the tax burden, either by applying fixed monthly amounts or by excluding the incidence of VAT. In practice, the effective tax burden on the service sector remains considerably lower than in Brazil, reflected in lower operating costs and greater attractiveness for the installation of enterprises.

In the social security sphere, the incidence is concentrated in the *Institute of Social Prediction* (IPS), with an employer's contribution of 16.5% and a worker's contribution of 9%, both calculated on the declared remuneration. This model, simpler and with lower percentages than those practiced in Brazil, contributes to reducing the cost of payroll and reinforces the country's competitive advantage for labor-intensive companies.

In addition to social security charges, the cost of labor in Paraguay is influenced by more flexible labor rules when compared to Brazilian ones. The regular working day is up to 48 hours per week, distributed in up to eight hours per day, according to the *Paraguayan Labor Code*. Annual leave varies according to the length of service, being 12 days after the first year, 18 days after five years and 30 days after ten years of employment.

The *aguinaldo* in Paraguay corresponds to 1/12 of the total remuneration received by the worker throughout the year, equivalent, in the case of fixed salary, to a full monthly salary, and, in the case of variable remuneration, to the annual monthly average. Despite this obligation, the lower employer's social security burden and the simpler structure of labor

obligations result in a total labor cost significantly lower than that observed in Brazil and Argentina, reinforcing the competitiveness of service companies installed in the country.

This lean and predictable tax structure facilitates tax compliance and reduces administrative costs. As a result, Paraguay has used tax policy as an instrument to stimulate economic activity, attracting investments and promoting the formalization of businesses, especially in regions close to the Brazilian border. In the service sector, this advantage is clearly manifested through greater operational flexibility and more competitive pricing.

4.3 TAXATION OF THE SERVICE SECTOR IN ARGENTINA

The taxation of the service sector in Argentina is characterized by the coexistence of federal and provincial taxes, resulting in a high tax burden and strong cumulativeness. Companies are subject to national taxes, such as the *Impuesto al Valor Agregado* (VAT), at the rate of 21%, and the *Impuesto a las Ganancias*, whose rate can reach 30% on profit, in addition to provincial taxes, especially the *Impuesto sobre los Ingresos Brutos*, applied by the provinces, including Misiones, with rates ranging from 2% to 5%, according to economic activity.

This combination of taxes generates a significant incidence on both the revenue and the results of service companies, especially in border regions. In addition, the labor cost in Argentina is pressured by social contributions administered by the AFIP and by obligations provided for in the *Labor Contract Law*.

In the social security cut, the normative basis of the contributory system is established in Law No. 24,241/1993, which established the Integrated System of *Jubilations and Pensions* (SIJP), currently integrated into the Argentine Integrated *Forecast System* (SIPA). The employer's contribution rates are not concentrated in a single legal provision, but are defined by decrees and complementary resolutions published in the Official Gazette, as well as by regulations of the AFIP and ANSES. In practice, employers' social security contributions are, in aggregate, at levels higher than 20% of the payroll, and can reach percentages close to 25%, depending on the size and sectoral framework of the company.

In the field of labor legislation, Argentina has rules that also raise the cost of labor. The standard working day is up to 48 hours per week, under the terms of the *Labor Contract Law*, with a mandatory additional for overtime. Annual leave is granted progressively, varying between 14 and 35 calendar days, depending on the worker's length of service.

The Argentine legal system also provides for the payment of the *Sueldo Anual Complementario* (SAC), equivalent to the thirteenth salary in Brazil or *aguinaldo* in Paraguay, paid in two semiannual installments, corresponding to 50% of the highest monthly

remuneration received in each semester. These labor rights, added to the high employers' social security contributions, significantly increase the cost of labor, impacting the competitiveness of service companies, especially in border regions.

This structure results in a high total tax burden and significant cumulativeness, directly impacting the cost of labor and the sustainability of service companies. In order to summarize the main labor differences between the countries analyzed, Chart 1 presents a comparison of the charges levied on working hours and the remuneration of workers in the service sector.

Table 1

Comparative Labor Charges

Element	Brazil	Paraguay	Argentina
Working hours	Up to 44 hours per week	Up to 48 hours per week	Up to 48 hours per week
Overtime	Minimum additional 50%	Minimum additional 50%	Minimum additional 50%
Holidays	30 days after 12 months + 1/3 constitutional	12 to 30 days, depending on the length of service	14 to 35 calendar days, depending on length of service
13th salary	Yes – Christmas Bonus	Yes – Aguinaldo (1/12 of the annual remuneration)	Yes – Complementary Annual Sueldo (SAC) in 2 installments
Employer's social security contribution	INSS 20% + FGTS 8%	SPI 16.5%	>20% and can reach 25%
Regulatory complexity	High	Low	High
Impact on labor cost	Elevated	Reduced	Elevated

Source: Prepared by the authors based on current labor and social security legislation (2025).

It is noteworthy that chart 1 presents the main labor charges provided for in the general legislation of the countries analyzed, focusing on the minimum mandatory elements applicable to the service sector. A more detailed analysis of labor relations may reveal other rights, additional and benefits, arising from specific norms of professional categories, which were not contemplated in this study. Thus, the data presented should be understood as a basic normative synthesis, suitable for comparison between labor systems, without prejudice to the existence of provisions that are more favorable to workers in specific sectoral or business contexts.

4.4 COMPARISON OF TAX SYSTEMS AND IMPACTS ON COMPETITIVENESS

The comparative analysis shows relevant tax asymmetry between the countries surveyed. Brazil and Argentina have systems characterized by a high tax burden, regulatory complexity, and high labor costs, while Paraguay stands out for a simpler model, with lower tax incidence and reduced operating costs. Chart 2 summarizes the main taxes levied on the

service sector in the Triple Border countries, allowing a comparative view of the structural differences between the tax systems analyzed.

Table 2

Comparison of the Taxation of the Services Sector in the Triple Frontier (2025)

Tribute / Aspect	Brazil	Paraguay	Argentina
Subnational taxation on services	ISS (municipal): 2% to 5%, according to local legislation for companies of the Presumed Profit and Real Profit	Not applicable	Gross Revenues (Provincial): 2% to 5%, depending on the province
Taxation on turnover (national)	Presumed Profit: PIS/COFINS at rates of 3.65% (cumulative); Actual Profit: PIS and CONFINS 9.25% (non-cumulative); Simples Nacional: unified rates between 6% and 33%	VAT: 10%	VAT: 21%
Taxation on income/profit	Actual Profit: IRPJ + CSLL: up to 34% on adjusted net income; Presumed Profit: Base of 32% on revenues at rates of 15% and 9% or direct percentages of 4.8% of IRPJ and 2.88% of CSLL.	IRE: 10%	Impuesto a las Ganancias: up to 30%
Tax cumulativeness	Partial, according to the tax regime adopted	No	Yes
Complexity of the tax system	High (plurality of regimes, taxes and ancillary obligations)	Low	High
Relative tax burden on services	High, especially when considering labor charges	Reduced	Elevated
Impact on regional competitiveness	Unfavorable	Favorable	Unfavorable

Source: Prepared by the authors based on the tax legislation in force in the three countries (2025).

These differences directly influence regional competitiveness, affecting decisions on business location, business structuring and service offering. In a sector that is highly sensitive to costs and with high geographic mobility, taxation plays a decisive role in attracting or displacing economic activities.

4.5 CRITICAL DISCUSSION OF THE RESULTS

The comparative analysis of the tax and labor systems shows that taxation has a direct and relevant impact on the competitiveness of the service sector in the Triple Border. The differences between Brazil, Paraguay and Argentina are not restricted to the normative level, but are materialized in the cost structure, in the formation of prices and in the ability of companies to remain in an environment characterized by high competition and intense geographic integration.

In Brazil, the high tax burden on revenues and income, associated with significant labor charges, such as the employer's contribution to the INSS, the FGTS, the thirteenth salary, paid vacations plus the constitutional third and the normative rigidity of the Consolidation of Labor Laws, results in an operating cost significantly higher than that observed in neighboring countries. This scenario compromises the competitiveness of service companies, especially those that are labor-intensive, predominant in the tourist and commercial segments of the border region.

Argentina, although it has a different tax structure from Brazil, also reveals factors that compromise the competitiveness of the service sector. The cumulative incidence of federal and provincial taxes, associated with employers' social security contributions that can reach levels close to 25% of the payroll, significantly increases the cost of labor and reduces the attractiveness for the installation of new enterprises.

In contrast, Paraguay has a fiscal and labor environment that is more favorable to competitiveness. The reduced rates of the *Impuesto al Valor Agregado* (VAT) and the *Impuesto a la Renta Empresarial*, associated with a less onerous employer's pension structure and more flexible labor rules, result in lower labor costs and greater tax predictability. This configuration allows Paraguayan companies to operate with greater competitiveness in terms of price and attractiveness for investments, especially in border regions.

In addition to the simplified tax structure and lower labor charges, Paraguay has used specific fiscal policy instruments to attract foreign investment, with emphasis on the Maquila regime, instituted by Law No. 1,064/1997 and regulated by complementary rules. This regime allows foreign companies, including Brazilian ones, to carry out production processes or provision of services in Paraguayan territory with reduced taxation, upon payment of a single tax of 1% on the value added in the country, in addition to relevant exemptions on taxes levied on the import of inputs and on the export of the resulting products or services. In practice, the Maquila Law has encouraged the relocation of Brazilian business activities, especially those labor-intensive and cost-sensitive, to regions close to the border, reinforcing Paraguay's competitive advantage in the context of the Triple Border and amplifying the effects of the tax asymmetries identified in this study.

Thus, the results confirm that the competitiveness of the service sector in the Triple Border is strongly conditioned by the tax and labor asymmetries between the countries analyzed. In frontier contexts, in which business location decisions are facilitated by geographical proximity, simpler and less onerous tax systems tend to become decisive

competitive advantages, while more complex and onerous structures impose relevant constraints on the economic performance of companies.

5 FINAL CONSIDERATIONS

This study comparatively analyzed the taxation levied on the service sector in the countries that make up the Triple Border (Brazil, Paraguay and Argentina) and its impacts on business competitiveness in an economic space characterized by high mobility of activities and intense regional integration. The results show that the structural differences between the tax and labor systems exert a direct influence on the decisions of location, operation and sustainability of companies in the service sector.

The analysis showed that the Brazilian tax system imposes a high tax burden and significant administrative complexity on service companies, especially due to the multiplicity of taxes levied on revenue, income and payroll, in addition to significant labor charges. This configuration compromises the competitiveness of companies installed in the Brazilian territory against competitors established in neighboring countries with simpler and less costly systems.

Similarly, Argentina has an onerous tax environment, marked by the cumulativeness of federal and provincial taxes and employers' social security charges, in addition to rigidity in labor standards. These factors increase the cost of labor and reduce the country's attractiveness for the installation and maintenance of enterprises in the service sector, especially in border regions.

In contrast, Paraguay stands out for its leaner tax system, with reduced tax rates, less regulatory complexity, and less onerous labor charges. This model has been used as an economic policy instrument to attract investments, conferring a competitive advantage to companies established there, especially in labor-intensive and cost-sensitive activities, such as those predominant in the service sector of the Triple Border.

It should be noted that the results of this study should be interpreted in light of the context of transition of the Brazilian tax system, resulting from the Tax Reform instituted by Constitutional Amendment No. 132/2023 and regulated by Complementary Law No. 214/2025. This legislation establishes the gradual replacement of taxes levied on consumption, such as the Tax on Services (ISS), the Social Integration Program (PIS) and the Contribution to the Financing of Social Security (COFINS), by the Tax on Goods and Services (IBS) and the Contribution on Goods and Services (CBS), structured under the dual Value Added Tax (VAT) model, with a transition schedule scheduled between the years 2026 and 2033.

From a theoretical point of view, the adoption of the VAT model tends to reduce tax cumulativeness and simplify the system, representing a relevant institutional advance in relation to the previous model, especially for the service sector, historically burdened by multiple incidences on revenue. However, in the context of the Triple Border, the effectiveness of the reform in terms of competitiveness is still uncertain, since the reference rate of the new system may keep Brazil at a higher tax level than that observed in neighboring countries, such as Paraguay and Argentina.

Moreover, while the reform promises gains in simplicity and transparency, there is no evidence to date that the overall tax burden on the services sector will be significantly reduced. For labor-intensive activities, the replacement of taxes on turnover by a VAT with a high rate may not fully eliminate the negative competitive differential identified in this study, especially when the labor and social security charges still in force in the Brazilian legal system are considered together.

Thus, the Brazilian tax reform, although it represents a relevant institutional advance, does not eliminate, at least in the short and medium term, the fiscal asymmetries that affect the competitiveness of the service sector in the Triple Border. The results of this study remain current and relevant, indicating that Brazil will continue to face structural challenges to compete with simpler and less onerous tax systems adopted by neighboring countries.

As a limitation of the study, the predominantly normative and structural focus stands out, without the individualized measurement of financial impacts by company. Even so, the results offer relevant subsidies for the academic and institutional debate on taxation and competitiveness in border regions. It is recommended that future research deepen the empirical analysis, incorporating business case studies and evaluating the practical effects of the Brazilian tax reform and possible tax harmonization processes within the scope of Mercosur.

It is concluded that tax harmonization, the reduction of regulatory complexity and the review of the charges levied on the service sector are fundamental to mitigate tax asymmetries and promote a more balanced competition environment in the Triple Border, contributing to sustainable regional development and strengthening the service sector.

REFERENCES

- Argentina. Administración Federal de Ingresos Públicos. (2023). Sistema tributario argentino. <https://www.afip.gob.ar>
- Argentina. Administración Federal de Ingresos Públicos. (2025). Contribuciones a la seguridad social. <https://www.afip.gob.ar>

- Argentina. Administración Nacional de la Seguridad Social. (2025). Sistema Integrado Previsional Argentino (SIPA). <https://www.anses.gob.ar>
- Argentina. Boletín Oficial de la República Argentina. (2025). Normativa vigente sobre contribuciones a la seguridad social. <https://www.boletinoficial.gob.ar>
- Argentina. Congreso de la Nación Argentina. (1973). Ley nº 20.628. Impuesto a las Ganancias.
- Argentina. Congreso de la Nación Argentina. (1986). Ley nº 23.349. Impuesto al Valor Agregado.
- Brasil. (1988). Constituição da República Federativa do Brasil. Presidência da República.
- Brasil. (2003). Lei Complementar nº 116, de 31 de julho de 2003. Dispõe sobre o Imposto Sobre Serviços de Qualquer Natureza (ISSQN). Diário Oficial da União, Brasília, DF.
- Brasil. (2006). Lei Complementar nº 123, de 14 de dezembro de 2006. Institui o Estatuto Nacional da Microempresa e da Empresa de Pequeno Porte. Diário Oficial da União, Brasília, DF.
- Brasil. (1998). Lei nº 9.718, de 27 de novembro de 1998. Altera a legislação tributária federal relativa ao PIS e à COFINS. Diário Oficial da União, Brasília, DF.
- Brasil. (2002). Lei nº 10.637, de 30 de dezembro de 2002. Dispõe sobre a não cumulatividade da contribuição para o PIS. Diário Oficial da União, Brasília, DF.
- Brasil. (2003). Lei nº 10.833, de 29 de dezembro de 2003. Dispõe sobre a não cumulatividade da COFINS. Diário Oficial da União, Brasília, DF.
- Crepaldi, S. A. (2019). Planejamento tributário: Teoria e prática (2ª ed.). Atlas.
- Fabretti, L. C. (2017). Contabilidade tributária (15ª ed.). Atlas.
- Paraguai. Congreso Nacional. (2019). Ley nº 6.380. De modernización y simplificación del sistema tributario nacional.
- Paraguai. Subsecretaría de Estado de Tributación. (2023). Sistema tributario paraguayo. <https://www.set.gov.py>
- Souza, M. A. de, & Callado, A. A. C. (2020). Planejamento tributário e competitividade empresarial. Atlas.
- Zilli, J. C. (2021). Tributação, competitividade e fronteiras econômicas. Juruá.

DATA CENTERS, ENERGY AND REGULATION: LEGAL AND ECONOMIC CHALLENGES FOR DIGITAL INFRASTRUCTURE IN BRAZIL

CENTROS DE DADOS, ENERGIA E REGULAÇÃO: DESAFIOS JURÍDICOS E ECONÔMICOS PARA A INFRAESTRUTURA DIGITAL NO BRASIL

CENTROS DE DATOS, ENERGÍA Y REGULACIÓN: DESAFÍOS JURÍDICOS Y ECONÓMICOS PARA LA INFRAESTRUTURA DIGITAL EN BRASIL



<https://doi.org/10.56238/sevened2026.008-005>

Daniel Amin Ferraz¹, Paulo Roberto Alonso Viegas²

ABSTRACT

This article analyzes the legal and economic challenges related to the installation and operation of data centers in Brazil, considering their nature as critical infrastructure and their growing importance in the digital economy. It examines energy demand, technological alternatives for continuous electricity supply, as well as environmental and regulatory impacts. Legislative initiatives in progress and public policy proposals aimed at consolidating a specific regulatory framework are evaluated. The thesis defended is that Brazil's competitiveness in the data economy depends on the creation of a stable regulatory environment, integrated with energy and environmental policies, capable of guaranteeing legal certainty and attracting long-term investments.

Keywords: Data Centers. Energy. Regulation. Critical Infrastructure. Economic Law.

RESUMO

O presente artigo analisa os desafios jurídicos e econômicos relacionados à instalação e operação de data centers no Brasil, considerando sua natureza de infraestrutura crítica e sua crescente importância na economia digital. Examina-se a demanda energética, as alternativas tecnológicas para suprimento contínuo de eletricidade, bem como os impactos ambientais e regulatórios. São avaliadas iniciativas legislativas em tramitação e propostas de política pública voltadas à consolidação de um marco regulatório específico. A tese defendida é a de que a competitividade do Brasil na economia de dados depende da criação de um ambiente regulatório estável, integrado às políticas energéticas e ambientais, capaz de garantir segurança jurídica e atrair investimentos de longo prazo.

Palavras-chave: Data Centers. Energia. Regulação. Infraestrutura Crítica. Direito Econômico.

¹ Dr. in International Business Law. Universidade de Valência. Spain. E-mail: daniel.amin@afctf.adv.br

² Master's degree in Economic Sciences. Universidade de Brasília (UnB). Brazil.
E-mail: Attorney-at-law;pviegas@senado.leg.br

RESUMEN

Este artículo analiza los desafíos jurídicos y económicos relacionados con la instalación y operación de centros de datos en Brasil, considerando su naturaleza como infraestructura crítica y su creciente importancia en la economía digital. Se examinan la demanda energética, las alternativas tecnológicas para el suministro continuo de electricidad, así como los impactos ambientales y regulatorios. Se evalúan iniciativas legislativas en curso y propuestas de políticas públicas orientadas a la consolidación de un marco regulatorio específico. La tesis defendida es que la competitividad de Brasil en la economía de los datos depende de la creación de un entorno regulatorio estable, integrado con las políticas energéticas y ambientales, capaz de garantizar seguridad jurídica y atraer inversiones a largo plazo.

Palabras clave: Centros de Datos. Energía. Regulación. Infraestructura Crítica. Derecho Económico.

1 INTRODUCTION

The increasing digitalization of the economy has amplified the relevance of data centers as essential elements of informational infrastructure. These facilities support financial, governmental, logistical, and communication systems, becoming indispensable components for the functioning of contemporary societies. The legal and administrative literature has recognized such structures as critical infrastructure, a term used in Decree No. 9,573 of 2018, which approves the National Policy for Critical Infrastructure Security (PNSIC), to designate services whose disruption severely affects the State and society.

This policy is set forth in the Annex to the aforementioned Decree, defining its essential content and aiming to ensure the security and resilience of the country's critical infrastructures, safeguarding the continuity of their services³.

Critical infrastructures are understood as facilities, services, assets, and systems whose interruption or destruction, in whole or in part, may cause serious social, environmental, economic, political, or international impacts, or threaten the security of the State and society. The policy also defines concepts such as critical infrastructure security, interdependence among critical infrastructures, and resilience.

From a strictly legal standpoint, the investments in large data centers mentioned herein are not expressly contemplated in Brazilian regulations on “critical infrastructures.” However, they may be classified as such should the Executive Branch so determine, given that the current legal regime is open, discretionary, and dependent on complementary administrative acts⁴.

³ The National Policy for Critical Infrastructure Security (PNSIC) is grounded in principles such as prevention and precaution based on risk analysis, integration among the Public Authorities, the business sector, and society, reduction of costs arising from security investments, and safeguarding the interests of national defense and security. Among its objectives are the prevention of interruptions in the activities of critical infrastructures or, if interruptions occur, the mitigation of their impacts; the establishment of guidelines and instruments for the protection of infrastructures essential to national security; the integration of data on threats and risks; the identification of interdependencies; and the development of awareness regarding the subject.

The policy also establishes guidelines for integration with other State policies, federative cooperation, coordination with the Brazilian Intelligence System, incentives for public–private partnerships and international cooperation, exchange of knowledge, continuous monitoring of infrastructures, and the permanent updating of security activities. As instruments, it establishes the National Strategy for Critical Infrastructure Security, the National Plan for Critical Infrastructure Security, and the Integrated Data System for Critical Infrastructure Security, defining their fundamental functions, as well as the competencies of the Foreign Affairs and National Defense Chamber of the Government Council and the Institutional Security Office of the Presidency of the Republic for the formulation, approval, and management of these instruments. See: BRASIL. Decreto nº 9.573, de 22 de novembro de 2018. Dispõe sobre a Política Nacional de Segurança de Infraestruturas Críticas. Diário Oficial da União: seção 1, Brasília, DF, 23 nov. 2018, p. 5–6.

⁴ To date, there is no statute in the Brazilian legal system — in the sense of a law enacted by the Legislative Branch — that specifically addresses the subject of ‘critical infrastructures’ with the breadth and scope set forth in Decree No. 9,573 of 2018 (and its subsequent developments), a decree which, as previously noted, approved the National Policy for Critical Infrastructure Security (PNSIC). Instead, the regime governing the protection of critical infrastructures is regulated through infra-legal normative acts (administrative in nature, such as decrees). Subsequently, Decree No. 10,569 of 2020 approved the National Strategy for Critical Infrastructure Security, an instrument guiding the PNSIC; and, more recently, Decree No. 11,200 of 2022 approved the PLANSIC plan,

The central thesis of this article is to demonstrate the energy- related challenges associated with the expansion of data centers in Brazil and to assess whether the sustainable development of the sector in the country requires a coherent regulatory framework aligned with energy, environmental, and technological policies, in order to ensure legal certainty, economic predictability, and operational efficiency, based on an interdisciplinary analysis that integrates technical, economic, and legal aspects. In any event, as will be discussed, it is possible to infer that Brazil possesses the conditions to become a hub; however, its reliance on fossil- fuel thermal power generation and the intermittency of renewable sources call for specific regulatory reforms.

2 DATA CENTERS AS CRITICAL INFRASTRUCTURE: TECHNICAL AND LEGAL ASPECTS

Data centers are characterized by the continuous and large-scale processing of digital information, requiring redundant power supply systems, efficient cooling, and high-speed connectivity. International protection, environment, etc.), clear obligations applicable to private and public entities beyond the direct federal administration, and the establishment of

establishing operational guidelines, institutional-sectoral responsibilities, and governance mechanisms. In other words, the existing regulatory framework is based on decrees and public policies, not on ordinary or supplementary legislation.

This situation likely arises from several factors: (1) the fact that initiatives for the protection of critical infrastructure in Brazil historically developed within the Executive Branch through decrees and administrative orders, without the Legislative Branch having structured its own legal framework; (2) the fact that specialized public bodies in this area, such as the Institutional Security Office of the Presidency of the Republic (GSI-PR) and the Chamber of Foreign Affairs and National Defense (CREDEN), coordinate security actions by virtue of delegations contained in decrees, rather than by statute; and (3) findings of certain recent audits, which have identified gaps regarding institutionalization, governance structure, and inter-agency integration, thereby demonstrating weaknesses in the implementation of the policy — circumstances that reinforce the notion that a more robust and formal legal framework could be beneficial.

Therefore, the 'critical infrastructure' regime in Brazil depends on higher-order normative acts (decrees), and not on a law enacted by the National Congress, a situation that may generate normative fragility, particularly with respect to long-term predictability, compatibility with other laws (energy, telecommunications, data protection, environment, etc.), clear obligations applicable to private and public entities beyond the direct federal administration, and the establishment of a uniform sanctioning framework.

a uniform sanctioning framework studies⁵ show that hyperscale facilities may exceed 100 MW of installed load, demonstrating their reliance on uninterrupted energy supply⁶.

In Brazil, estimates indicate the existence of data center structures of varying sizes, still insufficient to meet the growth associated with the expected expansion in the use of artificial intelligence⁷. The dependence of these facilities on complex and interdependent systems — such as electricity, telecommunications, and cooling — reinforces their legal characterization as critical infrastructure, subject to specific public policies and high-stability regulatory requirements.

Moreover, the strategic nature of these environments demands legal certainty regarding environmental licensing, access to electricity, and installation in areas compatible with water availability and network infrastructure. The absence of a systematized regulatory framework creates uncertainty for investors, consistent with warnings raised in the economic law literature⁸.

The development of a regulatory framework for the data center sector in Brazil requires a comprehensive normative approach capable of ensuring legal certainty, economic efficiency, personal data protection, operational stability, and environmental sustainability.

⁵ According to the IEA, hyperscale data center facilities rank among the largest individual energy consumers in the digital sector, frequently exceeding 100 MW of installed load— a level comparable to that of medium-sized industrial units. The IEA emphasizes that these facilities operate continuously and are highly sensitive to interruptions or fluctuations in voltage and frequency, which requires stable, redundant, and high-quality electricity supply. The magnitude of this demand poses significant challenges for energy planning, particularly regarding the need for dedicated substations, transmission reinforcement, and integration with high-voltage networks. Moreover, the expansion of these centers — driven by artificial intelligence applications and high-performance computing — puts pressure on generation capacity and raises questions about the compatibility between uninterrupted consumption and the intermittency of renewable sources. In this context, the observation that hyperscale installations may exceed 100 MW demonstrates not only their structural dependence on continuous supply but also the strategic nature of this sector for national power-system planning and security. International Energy Agency (IEA). *Electricity* 2023. Paris, 2023, p. 45-51.

⁶ It is noted that hyperscale infrastructures already exceed 200 MW in a few cases, with a growing trend. INTERNATIONAL ENERGY AGENCY (IEA). *Data Centres and Data Transmission Networks* 2023. Paris: IEA, 2023. p. 23–25; ver também: MCKINSEY & COMPANY. *The Data Center Opportunity*. New York: McKinsey, 2023. p. 11–13; UNITED STATES. Department of Energy (DOE). *Energy Consumption in Data Centers*. Washington, D.C.: DOE, 2022. p. 9–10.

⁷ Some analyses highlight the accelerated increase in the use of artificial intelligence by Brazilian companies, the consequent rise in demand for processing capacity, the fact that data centers dedicated to AI training remain, to a large extent, located outside the country, and the projections for the expansion of installed data center capacity in Brazil (from approximately 740 MW in 2024 to 1,210 MW in 2029). These elements underscore the need to expand existing infrastructure in order to keep pace with AI-driven growth. MOODY'S LOCAL BRASIL. *Setor de data centers no Brasil: fundamentos, perspectivas e tendências*. São Paulo: Moody's Local Brasil, 1 abr. 2025, p. 6 e 7.

⁸ According to Richard Posner, the central function of law is to promote efficiency by reducing social and transactional costs. The author argues that legal uncertainty increases transaction costs, discourages investment, and reduces the market's ability to allocate resources efficiently, whereas clear and predictable rules lower the cost of economic decision-making—hence why efficient legal systems tend to generate greater investment and growth. Moreover, ventures such as large data centers involve extremely high CAPEX with long-term returns—a classic type of activity in which, according to Posner, legal certainty is a condition for economic rationality. After all, for this author, environments characterized by uncertainty lead investors to demand higher risk premiums. POSNER, Richard. *Economic Analysis of Law*. 2007, p. 120-123.

This is a capital -, energy -, and technology-intensive sector, strategic for the country's digital infrastructure, including applications in cloud computing, artificial intelligence, essential public services, and high-capacity communications.

Accordingly, regulation must establish clear parameters for the installation, operation, and oversight of such facilities, in order to harmonize private, collective, and governmental interests.

Initially, it is necessary to define data centers in legal terms, along with their modalities — such as hyperscale, colocation, edge, and public, private, or hybrid clouds — with classification criteria based on size, energy capacity, and level of criticality. From these categories, it becomes possible to regulate environmental and urban licensing, establishing zoning rules, land-use requirements, construction standards, noise limits, and physical security parameters, while observing the particularities of facilities dedicated to processing sensitive data or providing public-interest services.

Another central axis concerns energy infrastructure, given that data centers depend on continuous and stable electrical power. The regulatory framework must include rules for grid connection, energy procurement in the regulated or free markets, the use of renewable sources, efficiency mechanisms (such as PUE⁹, WUE¹⁰, and CUE¹¹ indicators), and redundancy requirements. These measures help ensure operational continuity and encourage the adoption of sustainable cooling, energy- storage, and thermal-management technologies.

In the field of cybersecurity and data protection, the framework must align with the General Data Protection Law (LGPD) and the guidelines of the National Data Protection Authority (ANPD), while also engaging with international technical standards such as ISO

⁹ PUE is the most widely used indicator for measuring the energy efficiency of a data center. It expresses the ratio between 'Total Energy' divided by 'Energy Consumed Exclusively by IT Equipment.' The indicator measures how much energy is spent on auxiliary systems (cooling, UPS, lighting, etc.) relative to effective processing. UNITED STATES. Department of Energy. Energy Efficiency in Data Centers: Best Practices Guide. Washington, D.C.: DOE, 2022. p. 14–17.

¹⁰ WUE measures the water efficiency of a data center and is expressed as 'Water Consumed in the Data Center (liters/year)' divided by 'Energy Consumed by IT Equipment (kWh).' The indicator seeks to capture the water impacts of cooling systems, particularly in facilities that use cooling towers, adiabatic cooling, or evaporative free cooling". THE GREEN GRID. Water Usage Effectiveness (WUE™): A Green Grid Data Center Sustainability Metric. Beaverton: The Green Grid, 2011.p. 4–7.

¹¹ CUE quantifies the carbon impact associated with a data center's energy consumption and is calculated by dividing the facility's 'Annual CO₂ Emissions' by the 'Energy Consumed by IT Equipment (kWh).' This indicator depends on the local electricity mix, as indirect emissions vary according to the energy source (coal, gas, hydropower, solar, nuclear, etc.). INTERNATIONAL ENERGY AGENCY (IEA). Data Centres and Data Transmission Networks 2023. Paris: IEA, 2023. p. 14–18.

27001¹², ISO 27701¹³, and NIST¹⁴. It is essential to establish obligations for incident prevention and notification, auditing mechanisms, business continuity plans, operational redundancy, and specific requirements for processing governmental data and critical infrastructures, thereby ensuring the integrity, confidentiality, and availability of information.

Environmental sustainability constitutes another essential element. Given the high demand for energy and water, particularly for cooling, the framework must establish criteria for water management, energy efficiency, emissions inventories, sustainable construction standards, and recycling of electronic equipment. These parameters promote responsible practices and align the sector with national and international environmental goals.

Connectivity regulation is also relevant, particularly in coordination with the National Telecommunications Agency (Anatel), to address network requirements, link redundancy, service-quality metrics (latency, availability), and compatibility with 5G and 6G policies and edge computing¹⁵. Addressing these aspects is fundamental to ensure interoperability and high availability of the services provided.

¹² ISO 27001 is the leading international standard for information security management, establishing requirements for creating, implementing, maintaining, and continually improving an Information Security Management System (ISMS). Its purpose is to: protect the confidentiality, integrity, and availability of information; establish security controls (technical, administrative, and physical); and standardize cybersecurity risk governance. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION; INTERNATIONAL ELECTROTECHNICAL COMMISSION. ISO/IEC 27001:2022 — Information security, cybersecurity and privacy protection — Information security management systems — Requirements. Geneva: ISO/IEC, 2022. p. v–vi, 1–5.

¹³ ISO 27701 is an extension of ISO 27001 focused on privacy and the protection of personal data, establishing the Privacy Information Management System (PIMS). The purpose of this standard is to: operationalize requirements inspired by data protection laws (such as the LGPD and GDPR); guide measures for data governance, minimization, retention, and privacy controls; define the roles of controller and processor; and enable privacy audits. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION; INTERNATIONAL ELECTROTECHNICAL COMMISSION. ISO/IEC 27701:2019 — Security techniques — Extension to ISO/IEC 27001 and ISO/IEC 27002 for privacy information management — Requirements and guidelines. Geneva: ISO/IEC, 2019. p. 1–8, 15–18.

¹⁴ NIST is not a standard, but rather a United States federal agency responsible for producing technical standards and guidelines widely used in cybersecurity, risk management, and digital infrastructure. The most relevant documents issued by the agency include: the NIST Cybersecurity Framework (NIST CSF), a global reference model for cybersecurity risk management; NIST SP 800-53, a catalog of security controls for information systems; NIST SP 800-171, which establishes requirements for protecting sensitive information in non-governmental environments; and the NIST AI Risk Management Framework (2023), which provides guidelines for governance and risk mitigation in artificial intelligence systems. NIST is today the principal international reference in the field of cybersecurity and, in Brazil as well, its guidelines influence IT practices, public policies, audits, and internal corporate standard. NIST Cybersecurity Framework (CSF) - NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY. The NIST Cybersecurity Framework (CSF) 2.0. Gaithersburg, MD: NIST, 2024. p. 1–7, 11–15; NIST SP 800-53 – Catálogo de controles de segurança - NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY. Security and Privacy Controls for Information Systems and Organizations (NIST SP 800-53, Revision 5). Gaithersburg, MD: NIST, 2020. p. 1–13; NIST AI Risk Management Framework - NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY. Artificial

Intelligence Risk Management Framework (AI RMF 1.0). Gaithersburg, MD: NIST, 2023. p. 1–10, 13–18.

¹⁵ Policies for 5G and 6G refer to the set of governmental and sectoral strategies, regulations, and initiatives aimed at guiding the development, deployment, security, and use of emerging technologies. They are crucial because 5G and 6G (the successor to 5G), as well as edge computing policy, are not merely technological enhancements; rather, they constitute foundational digital infrastructures that reshape the economy, national

The regulatory framework must also consider mechanisms for economic incentives and regional development, such as tax regimes conditioned on efficiency and sustainability targets, the creation of digital-interest zones, and the promotion of technological hubs. In addition, it must provide guidelines for attracting foreign investment, fostering technological partnerships, and supporting research and development in emerging fields such as quantum computing and advanced cooling.

Nonetheless, it is important to emphasize that institutional governance must be clearly structured, defining the competencies of regulatory and supervisory bodies and inspection procedures carried out by the Ministry of Mines and Energy, the Ministry of the Environment and Climate Change, among others. Only through coherent coordination among these institutions will it be possible to ensure the effectiveness of the regulatory framework, avoiding overlaps, gaps, and legal uncertainty.

3 ENERGY, SUSTAINABILITY, AND REGULATORY CHALLENGES

The continuous operation of data centers imposes a high energy demand, with loads exceeding several tens of megawatts. The adoption of renewable sources — solar and wind — faces limitations arising from the natural intermittency of these resources, which compromises the continuous supply required for critical infrastructures.

Although energy storage technologies may mitigate such variability, their cost still represents a significant obstacle¹⁶.

security, and social life. The 5G strategy corresponds to the fifth generation of mobile technology, whereas 6G refers to the sixth generation, encompassing more advanced standards for mobile broadband networks. The expression ‘Edge Computing’ refers to a distributed computing model that brings data processing and storage closer to the source that generated them (referred to as the ‘edge’ of the network), instead of sending them to a centralized data center or to the cloud. Its advantages include: drastically reducing latency and required bandwidth, being essential for real-time applications such as autonomous vehicles, remote surgery, and industrial automation; promoting the development of regional micro-data centers; establishing interoperability standards; ensuring the security and privacy of data processed locally; and fostering business models based on edge services. INTERNATIONAL TELECOMMUNICATION UNION (ITU). IMT-2020: Framework and overall objectives of the future development of IMT for 2020 and beyond (ITU-R M.2083-0). Geneva: ITU, 2015. p. 11–25. INTERNATIONAL TELECOMMUNICATION UNION (ITU). IMT-2030 Framework for 6G (Draft Technical Report). Geneva: ITU, 2023. p. 7–22, 28–35. EUROPEAN UNION AGENCY FOR CYBERSECURITY (ENISA). Edge Computing: Benefits, Risks and Best Practices. Athens: ENISA, 2021. p. 9–23, 31–35. 16 According to Edenhofer, the integration of high and continuous electrical loads—such as those of data centers—faces structural challenges when dependent on intermittent renewable sources, whose variable output does not, by itself, meet the requirements of uninterrupted operation. The report acknowledges that storage technologies may reduce such variability; however, it emphasizes that their costs remain high, limiting large-scale adoption. Thus, the reliability of critical infrastructures depends on technological combinations and energy arrangements capable of ensuring stable and secure supply. EDENHOFER, Ottmar. Climate Change 2014: Mitigation of Climate Change. Cambridge, 2014, p. 879-882.

¹⁶ According to the IAEA, SMRs represent a significant evolution in nuclear technology, characterized by reduced power output, modularity, and the possibility of standardized manufacturing in an industrial environment. This approach allows for lower capital costs, accelerated deployment, and greater siting flexibility, including in regions with limited electrical infrastructure. These reactors incorporate enhanced passive safety features, reducing the need for human intervention and increasing operational robustness. Moreover, they can operate in a stable load regime, making them suitable for supporting electric systems with high penetration of renewables. However,

In this context, other alternatives are evaluated, such as biofuels, whose viability depends on regional logistics; thermal generation, which carries non-negligible environmental impacts; Small Modular Reactors (SMRs)¹⁷, still in a phase of technological maturation¹⁸; and direct connection to the National Interconnected Power System (SIN), viewed as a more stable solution¹⁹.

These options entail legal challenges related to energy policy, decarbonization goals, and environmental licensing, requiring sophisticated regulatory capacity on the part of the State.

In this scenario, the State must also assess the issue of water- based cooling, which, when adopted, tends to rely on closed-loop systems so as to minimize losses. Current examples indicate optimized levels of losses below 2% per year²⁰, thereby reducing environmental pressure associated with water use.

4 LEGISLATIVE INITIATIVES AND PUBLIC POLICIES UNDER DEVELOPMENT

their commercial development depends on regulatory advances, international standardization, and demonstration of economic viability at scale. INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA). *Advances in Small Modular Reactor Technology*. Viena, 2020, p.29- 37.

¹⁷ According to Edenhofer, the integration of high and continuous electrical loads—such as those of data centers—faces structural challenges when dependent on intermittent renewable sources, whose variable output does not, by itself, meet the requirements of uninterrupted operation. The report acknowledges that storage technologies may reduce such variability; however, it emphasizes that their costs remain high, limiting large-scale adoption. Thus, the reliability of critical infrastructures depends on technological combinations and energy arrangements capable of ensuring stable and secure supply. EDENHOFER, Ottmar. *Climate Change 2014: Mitigation of Climate Change*. Cambridge, 2014, p. 879-882.

¹⁸ According to Nayar et al., technological consolidation in the data center sector is directly related to advances in high-power energy storage systems, which are essential for ensuring continuity, stability, and operational efficiency. The authors highlight that data centers require fast response times, high reliability, and the capacity to withstand sudden load variations—factors that drive the adoption of technologies such as lithium-ion batteries, supercapacitors, and flywheels. These solutions have been undergoing a maturation phase, with improvements in energy density, durability, safety, and cost per cycle. Nayar et al. note that intelligent integration among storage, thermal management, and power-quality systems constitutes a central element of this consolidation phase, enabling greater autonomy, emissions reduction, and compatibility with intermittent renewable sources. However, they emphasize that cost and scalability challenges still limit full adoption in large-scale projects. NAYAR, Chemmangot V. et al. *High-Power Energy Storage Systems*. London, 2020, p. 303-320.

¹⁹ Direct connection to the SIN system constitutes, for facilities classified as critical, the most stable and predictable alternative for electricity supply. The SIN offers greater capacity to respond to demand fluctuations; reduced risk of interruptions due to the interconnection of multiple sources and regions; operational standardization through unified quality and safety criteria; and structural redundancy, which mitigates local or regional failures. TRIBUNAL DE CONTAS DA UNIÃO (TCU). *Relatório de Auditoria Operacional sobre Infraestrutura Crítica*. 2021, p. 58-60.

²⁰ According to ASHRAE, liquid cooling systems in data centers require careful technical and regulatory assessment, particularly regarding the use of natural resources and compliance with environmental standards. The organization emphasizes that closed-loop systems are the recommended practice, as they significantly reduce water consumption, achieving losses of less than 2% per year in optimized facilities. These systems enhance thermal efficiency but require appropriate infrastructure, continuous monitoring, and compliance with environmental and safety regulations—factors that pose regulatory challenges for authorities responsible for licensing and energy policy. ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers. *ASHRAE Datacom Series – Liquid Cooling Guidelines for Datacom Equipment Centers*. Atlanta: ASHRAE, 2016. p. 56–62, 103–105.

Brazil currently has no federal statute—meaning a law enacted by the Legislative Branch—that specifically regulates investments in large data centers or establishes a dedicated legal framework for this type of enterprise. What exists today are scattered sectoral norms — concerning telecommunications, electricity, data protection, tax incentives, or innovation — that affect the deployment and operation of data centers but do not constitute a legal regime dedicated to the sector.

Examples of such legislation include the General Telecommunications Law (Law No. 9,472 of 1997), the Brazilian Internet Bill of Rights (Law No. 12,965 of 2014), the General Data Protection Law – LGPD (Law No. 13,709 of 2018), as well as the Electricity Law and related statutes (such as Laws No. 9,074 of 1995 and 9,427 of 1996, among others). None of these laws treat data centers as a distinct regulatory category. They apply indirectly, but none creates obligations, benefits, or specific regulatory treatment for the installation, operation, or attraction of large data centers.

Nevertheless, there are relevant infra-legal norms, although none directed toward investment. In these cases, data centers appear only as essential infrastructure or strategic equipment within certain administrative instruments, such as decrees on digital strategy, cybersecurity, and critical infrastructure (although they do not expressly classify data centers as critical). Norms issued by ANEEL and the electricity system—governing grid access, self-generation, and transmission and distribution tariffs—affect energy costs; resolutions of the National Data Protection Authority (ANPD) govern information security and data governance, but not physical investment; and telecommunications rules from Anatel apply mainly when the data center integrates communication networks. None of these norms establishes incentives, special licensing categories, or a distinct legal status for the sector.

Regarding federal tax incentives, there is no specific or permanent program aimed at major data center investments. Brazil does not, for instance, have a federal policy to attract hyperscalers, unlike Ireland, Chile, the United States, Singapore, or the United Arab Emirates²¹.

²¹ According to ASHRAE, liquid cooling systems in data centers require careful technical and regulatory assessment, particularly regarding the use of natural resources and compliance with environmental standards. The organization emphasizes that closed-loop systems are the recommended practice, as they significantly reduce water consumption, achieving losses of less than 2% per year in optimized facilities. These systems enhance thermal efficiency but require appropriate infrastructure, continuous monitoring, and compliance with environmental and safety regulations—factors that pose regulatory challenges for authorities responsible for licensing and energy policy. ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE Datacom Series – Liquid Cooling Guidelines for Datacom Equipment Centers. Atlanta: ASHRAE, 2016. p. 56–62, 103–105. According to ASHRAE, liquid cooling systems in data centers require careful technical and regulatory assessment, particularly regarding the use of natural resources and compliance with environmental standards. The organization emphasizes that closed-loop systems are the recommended practice, as they significantly reduce water consumption, achieving losses of less than 2% per year in optimized facilities. These systems enhance thermal efficiency but require appropriate infrastructure, continuous

However, certain Brazilian states—particularly São Paulo, Ceará, Rio Grande do Sul, Minas Gerais, and the Federal District—grant ICMS tax benefits for such investments, though these incentives arise from state-level technology promotion programs.

Therefore, it can be said that no federal law exists to regulate investments in large data centers in Brazil, whether as an economic sector, as strategic infrastructure, or as a matter of State policy.

Even so, several bills are currently under consideration— especially those related to digital sovereignty, classification of critical infrastructure, artificial intelligence policy, and the creation of technological zones—which touch upon the need to treat data centers as a strategic sector. Moreover, Congress is presently examining proposals that aim to establish specific rules for data centers, although none has yet been enacted.

Senate Bill No. 3,018 of 2024 addresses data centers dedicated to artificial intelligence, while House Bill No. 2,080 of 2025 creates the National Policy for Energy Efficiency and Socio-environmental Sustainability for Data Centers. Both measures signal a growing awareness of the need for sector-specific regulation.

In parallel, the Executive Branch is preparing the National Data Center Policy (Redata), in the form of a Provisional Measure, providing for tax exemptions, regional development incentives, renewable energy targets, and the reservation of computing capacity for the domestic market. International literature indicates that stable regulatory environments and fiscal incentives play a decisive role in consolidating digital hubs, as demonstrated by the cases of Ireland and Singapore²².

From a legal standpoint, these policies raise issues related to fiscal responsibility, constitutionality of incentives, distribution of competences among federal entities, and integration with sectoral policies— particularly energy and the environment.

Thus, the lack of a specific regulatory framework for large data centers in Brazil results in an environment marked by significant legal uncertainty. Investors seeking to establish or expand such enterprises lack clear normative parameters regarding essential elements such as environmental and urban licensing, energy access and procurement, applicable tax

monitoring, and compliance with environmental and safety regulations—factors that pose regulatory challenges for authorities responsible for licensing and energy policy. ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE Datacom Series – Liquid Cooling Guidelines for Datacom Equipment Centers. Atlanta: ASHRAE, 2016. p. 56–62, 103–105.

²² According to O’Riain, Ireland’s consolidation as a digital hub resulted from a combination of regulatory stability, coordinated industrial policies, and aggressive tax incentives, which attracted major technology companies and fostered strong integration with global value chains. The author shows that legal predictability and an investment- friendly environment were decisive for the establishment of data centers and digital operations in the country. Similar policies appear in other international hubs, such as Singapore, demonstrating that stable regulation and economic incentives are structural factors for the development of competitive digital ecosystems. O’RIAIN, Sean. *The Rise and Fall of Ireland’s Celtic Tiger*. Cambridge, 2014, p. 215-231.

regimes, minimum redundancy requirements, and mandatory technical standards. Even though investments have occurred under these conditions (from companies such as Ascenty, Equinix, Scala, etc.), the volume could be greater if the regulatory environment were more structured. This normative gap increases uncertainty and hinders the planning of capital- and infrastructure-intensive projects.

The situation is worsened by excessive administrative discretion. In the absence of uniform guidelines, critical decisions depend on local interpretations—often divergent—by environmental, energy, or urban management authorities, resulting in regulatory asymmetry between regions and undermining the predictability required for long-term investments. Furthermore, the lack of a legal classification of data centers as critical infrastructure prevents their formal prioritization in policies related to energy supply, public security, and civil protection, even though such facilities are essential for the continuity of banking, governmental, telecommunications, and artificial intelligence services. This lack of definition increases the risk of litigation, as the absence of unified legal standards facilitates administrative and judicial challenges, especially in large-scale projects.

From an economic and strategic perspective, the effects are equally significant. Countries with consolidated regulatory frameworks—such as Ireland, Singapore, the United States, and EU member states—have been preferred by major global operators due to legal predictability and the existence of specific incentive regimes. The absence of normative discipline in Brazil results in loss of international competitiveness and higher capital costs, as regulatory risk increases the weighted average cost of capital (WACC) and makes new facilities more expensive to implement. Additionally, there is systemic risk: interruptions in data centers may affect essential sectors, compromising the operation of cloud- and AI-based systems. The lack of a structured national framework also tends to intensify external dependence, as an increasing volume of computational load is transferred abroad, which has implications for Brazilian digital sovereignty.

From an institutional perspective, the situation is concerning. There is no clearly defined sectoral regulatory authority, resulting in coordination failures among bodies such as the Ministry of Mines and Energy (MME), the ANPD, Anatel, the Institutional Security Office (GSI), and other federal and subnational entities. National energy planning does not incorporate a specific methodology for large data centers. Moreover, the absence of a dedicated tariff classification prevents appropriate price signaling and limits incentives for energy efficiency.

Given this scenario, it is concluded that the absence of a regulatory framework constitutes a significant risk to the public interest, national security, and the business

environment. It is therefore recommended that a federal law be enacted addressing the following elements: classification of data centers as critical infrastructure; creation of a specific legal regime for licensing, resilience, data protection, and energy; establishment of Special Digital Infrastructure Zones; implementation of regulatory and tariff incentives conditioned on efficiency and security targets; and the development of integrated federal planning in coordination with states and municipalities.

5 PROPOSALS FOR A COHERENT REGULATORY FRAMEWORK

The construction of a regulatory framework for data centers in Brazil must rest upon three fundamental dimensions, without which it is impossible to establish a legal environment capable of attracting investment, ensuring operational continuity, and promoting national technological development. The first dimension is legal certainty, which requires the formulation of clear and uniform rules regarding environmental licensing, access to networks and energy sources, and the instruments of promotion and economic incentives applicable to the sector. The absence of objective and predictable parameters undermines decision-making by private actors, increases regulatory risk, and raises the cost of capital, particularly in a sector characterized by large-scale undertakings and long-term return horizons.

The second dimension concerns economic efficiency. Data centers are highly energy - and technology-intensive facilities, which is why the regulatory framework must provide tariff rationality, mechanisms for energy procurement compatible with the needs of predictability and continuity of supply, as well as incentives for innovation, adoption of emerging technologies, and continuous performance improvement. Economic efficiency also demands that the regulatory framework harmonize systemic costs, risks of network congestion, and strategies for expanding digital infrastructure, allowing investments to be allocated rationally and in line with market dynamics.

The third essential dimension is environmental sustainability, which must guide the rational use of natural resources — especially water and energy — and establish clear targets for emissions reduction and the promotion of a low-carbon economy. Considering that large data centers play an increasingly significant role in global energy demand, it is imperative that the regulatory framework incorporate mechanisms that encourage efficiency, minimum standards for energy performance, and support for research and development of technological solutions capable of reducing the environmental footprint of these facilities. The incorporation of environmental criteria is not merely a requirement of public policy but an element of international competitiveness, particularly in a market in which major operators prioritize regulatory environments that align with global decarbonization commitments.

The economic law literature consistently records that capital-intensive sectors — such as the data center industry — depend on high levels of regulatory predictability for long-term investment decisions²³. The absence of a stable regulatory framework hinders cost forecasting, the execution of energy supply contracts, and the formulation of corporate strategies, all of which negatively affect the country's attractiveness. Likewise, contemporary regulatory theories highlight the importance of governance models that are flexible, transparent, and evidence-based, capable of responding to rapid technological transformations and disruptive innovations characteristic of the digital economy²⁴. Regulation, in this context, must be dynamic, coordinated, and guided by regulatory impact assessment, ensuring that norms evolve at the same pace as the technologies they seek to govern, without imposing excessive costs or unjustified barriers to economic activity²⁵.

6 FINAL COMMENTS

Brazil possesses relevant conditions to consolidate itself as a hub of digital infrastructure in Latin America, notably due to its availability of renewable energy sources, strategic geographic position, and the growth of the digital services market. However, the absence of an integrated regulatory framework limits the predictability required to attract large-scale investments.

It follows that the consolidation of the sector depends on: (a) legal certainty and regulatory stability; (b) an energy policy aligned with the needs of data centers; (c) robust environmental and technological governance; and (d) incentive mechanisms compatible with energy transition goals and digital sovereignty.

²³ According to Bercovici, capital-intensive sectors require stable regulatory frameworks capable of reducing uncertainties and guiding long-term investment decisions. The author emphasizes that normative predictability is a condition for economic efficiency, as it lowers transaction costs, increases the confidence of private actors, and facilitates coordination between the State and the market. Without regulatory stability, structural investments—such as those required for digital or industrial infrastructure—tend to be postponed or become more costly, thereby undermining development. Thus, clear and consistent regulation is a central element of economic policy in sectors of high complexity and substantial CAPEX. BERCOVICI, Gilberto. *Direito Econômico*. São Paulo: Malheiros, 2018, p77-85.

²⁴ According to Bercovici, capital-intensive sectors require stable regulatory frameworks capable of reducing uncertainties and guiding long-term investment decisions. The author emphasizes that normative predictability is a condition for economic efficiency, as it lowers transaction costs, increases the confidence of private actors, and facilitates coordination between the State and the market. Without regulatory stability, structural investments—such as those required for digital or industrial infrastructure—tend to be postponed or become more costly, thereby undermining development. Thus, clear and consistent regulation is a central element of economic policy in sectors of high complexity and substantial CAPEX. BERCOVICI, Gilberto. *Direito Econômico*. São Paulo: Malheiros, 2018, p77-85.

²⁵ It must be considered, however, that the existence of the National Interconnected Power System (SIN) is itself a means of mitigating the limitations of each generation source — in other words, the SIN already performs the function of managing the intermittency of It must be considered, however, that the existence of the National Interconnected Power System (SIN) is itself a means of mitigating the limitations of each generation source — in other words, the SIN already performs the function of managing the intermittency of

A coherent regulatory system will enable Brazil to compete globally, strengthen its critical infrastructure, and expand its capacity for innovation.

REFERENCES

- American Society of Heating, Refrigerating and Air-Conditioning Engineers. (2016). ASHRAE Datacom Series: Liquid cooling guidelines for datacom equipment centers. ASHRAE.
- Baldwin, R., Cave, M., & Lodge, M. (2012). Understanding regulation. Oxford University Press.
- Bercovici, G. (2018). Direito econômico. Malheiros.
- Brasil. (2018). Decreto nº 9.573, de 22 de novembro de 2018. Dispõe sobre a Política Nacional de Segurança de Infraestruturas Críticas. Diário Oficial da União, seção 1, Brasília, DF.
- Edenhofer, O. (2014). Climate change 2014: Mitigation of climate change. Cambridge University Press.
- European Union Agency for Cybersecurity. (2021). Edge computing: Benefits, risks and best practices. ENISA.
- International Telecommunication Union. (2015). IMT-2020: Framework and overall objectives of the future development of IMT for 2020 and beyond (ITU-R M.2083-0).
- International Telecommunication Union. (2023). IMT-2030 framework for 6G (Draft Technical Report).
- Moody's Local Brasil. (2025). Setor de data centers no Brasil: Fundamentos, perspectivas e tendências.
- International Atomic Energy Agency. (2020). Advances in small modular reactor technology.
- International Energy Agency. (2023a). Data centres and data transmission networks 2023.
- International Energy Agency. (2023b). Electricity 2023.
- International Organization for Standardization; International Electrotechnical Commission. (2022). ISO/IEC 27001:2022: Information security, cybersecurity and privacy protection — Information security management systems — Requirements.
- International Organization for Standardization; International Electrotechnical Commission. (2019). ISO/IEC 27701:2019: Security techniques — Extension to ISO/IEC 27001 and ISO/IEC 27002 for privacy information management — Requirements and guidelines.
- McKinsey & Company. (2023). The data center opportunity.
- Nayar, C. V., et al. (2020). High-power energy storage systems.
- National Institute of Standards and Technology. (2023). Artificial Intelligence Risk Management Framework (AI RMF 1.0).
- National Institute of Standards and Technology. (2024). The NIST Cybersecurity Framework (CSF) 2.0.
- National Institute of Standards and Technology. (2020). Security and privacy controls for information systems and organizations (NIST SP 800-53, Revision 5).

- O’Riain, S. (2014). The rise and fall of Ireland’s Celtic Tiger. Cambridge University Press.
- Pereira, A. L. C., Araújo, L. A. B., & Giambiagi, F. (Orgs.). (2020). O setor elétrico brasileiro: Desafios e oportunidades. Elsevier.
- The Green Grid. (2011). Water Usage Effectiveness (WUE™): A Green Grid data center sustainability metric.
- Tolmasquim, M. T. (2016). Matriz energética brasileira: Formação, desafios e perspectivas (2ª ed.). Elsevier.
- Tribunal de Contas da União. (2021). Relatório de auditoria operacional sobre infraestrutura crítica.
- United States. Department of Energy. (2022a). Energy consumption in data centers.
- United States. Department of Energy. (2022b). Energy efficiency in data centers: Best practices guide.
- United States Government Accountability Office. (2021). Federal data centers: Optimization, consolidation, and security.

ALGORITHMIC GOVERNANCE AND THE PUBLIC INTEREST: ETHICAL FOUNDATIONS FOR DECISION-MAKING IN THE PUBLIC SECTOR

GOVERNANÇA ALGORÍTMICA E INTERESSE PÚBLICO: BASES ÉTICAS PARA DECISÕES NO SETOR PÚBLICO

GOBERNANZA ALGORÍTMICA E INTERÉS PÚBLICO: BASES ÉTICAS PARA LA TOMA DE DECISIONES EN EL SECTOR PÚBLICO



<https://doi.org/10.56238/sevened2026.008-006>

Ailton Ferreira Cavalcante¹

ABSTRACT

Ongoing technological transformations introduce new layers of decision-making power within the State, particularly through data-driven and algorithmic systems. While these tools can enhance analytical capacity and administrative efficiency, they may also reinforce inequalities, embed invisible biases, and weaken public transparency. This article examines algorithmic governance from an ethical-normative perspective grounded in the principle of the public interest. It engages classical moral philosophy, republican traditions, and contemporary debates on democratic governance, integrating them with the notion of “institutional conscience” and with the GIS Cycle (Governance, Innovation, and Sustainability). Methodologically, this is a theoretical-conceptual study based on a narrative review and critical analysis of legal frameworks and international references. The argument advanced is that the legitimacy of algorithm-mediated decisions depends on four concurrent criteria: universalizability, dignity, transparency, and accountability. From these principles, the article proposes guidelines for public policies involving data and artificial intelligence, including auditability, explainability, bias mitigation, protection of vulnerable groups, and reversibility of automated outcomes. It concludes that, in the digital age, the primacy of the public interest requires institutions to cultivate stable ethical self-control mechanisms capable of aligning technological innovation, social justice, and sustainability. More than a technical matter, algorithmic governance emerges as a profoundly moral and democratic challenge.

Keywords: Governance. Algorithms. Public Ethics. Public Interest. Public Policy. Sustainability.

RESUMO

As transformações tecnológicas em curso introduzem novas camadas de poder decisório no Estado, especialmente por meio de sistemas baseados em dados e algoritmos. Embora ampliem a capacidade analítica e a eficiência administrativa, tais instrumentos também podem reforçar assimetrias, produzir vieses invisíveis e reduzir a transparência pública. Este artigo discute a governança algorítmica a partir de um enfoque ético-normativo orientado

¹ Doctoral student in Public Administration. Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP).
E-mail: prof.ailton@hotmail.com Orcid: <https://orcid.org/0009-0009-2386-1245>
Lattes: <http://lattes.cnpq.br/0389434047626666>

pelo princípio do interesse público. Retomam-se contribuições da filosofia moral, da tradição republicana e dos debates contemporâneos sobre governança democrática, articulando-as com a noção de “consciência institucional” e com o Ciclo GIS (Governança, Inovação e Sustentabilidade). Neste estudo optamos por uma abordagem teórico-conceitual, baseado em revisão narrativa e análise crítica de marcos normativos e referenciais internacionais. Argumenta-se que a legitimidade das decisões mediadas por algoritmos depende da observância simultânea de quatro critérios: universalizabilidade, dignidade, transparência e responsabilização. A partir desses princípios, propõem-se diretrizes para políticas públicas que envolvem dados e inteligência artificial, incluindo auditabilidade, explicabilidade, mitigação de vieses, proteção de grupos vulneráveis e reversibilidade das decisões automatizadas. Conclui-se que, na era digital, a centralidade do interesse público exige que as instituições desenvolvam mecanismos estáveis de autocontrole ético, capazes de alinhar inovação tecnológica, justiça social e sustentabilidade. Mais do que uma questão técnica, a governança algorítmica revela-se um problema de natureza moral e democrática.

Palavras-chave: Governança. Algoritmos. Ética Pública. Interesse Público. Políticas Públicas. Sustentabilidade.

RESUMEN

Las transformaciones tecnológicas actuales introducen nuevas capas de poder decisorio en el Estado, especialmente mediante sistemas basados en datos y algoritmos. Si bien pueden aumentar la capacidad analítica y la eficiencia administrativa, también corren el riesgo de reproducir desigualdades, generar sesgos invisibles y disminuir la transparencia pública. Este artículo analiza la gobernanza algorítmica desde un enfoque ético-normativo sustentado en el principio del interés público. Se articulan aportes de la filosofía moral, de la tradición republicana y de los debates contemporáneos sobre gobernanza democrática, integrándolos con la noción de “conciencia institucional” y con el Ciclo GIS (Gobernanza, Innovación y Sostenibilidad). Metodológicamente, se trata de un estudio teórico-conceptual, basado en revisión narrativa y análisis crítico de marcos normativos y referencias internacionales. Se sostiene que la legitimidad de las decisiones mediadas por algoritmos depende de cuatro criterios concurrentes: universalizabilidad, dignidad, transparencia y rendición de cuentas. A partir de ellos, se proponen directrices para políticas públicas que utilizan datos e inteligencia artificial, incluyendo auditabilidad, explicabilidad, mitigación de sesgos, protección de grupos vulnerables y reversibilidad de decisiones automatizadas. Se concluye que, en la era digital, la centralidad del interés público exige que las instituciones desarrollen mecanismos estables de autocontrol ético capaces de alinear innovación tecnológica, justicia social y sostenibilidad.

Palabras clave: Gobernanza. Algoritmos. Ética Pública. Interés Público. Políticas Públicas. Sostenibilidad.

1 INTRODUCTION

The expansion of data-based technologies, machine learning, and automated decision support systems has profoundly changed the architecture of public power. What was once focused on human deliberation and traditional bureaucratic mediation has increasingly been filtered through statistical models, predictive systems, and digital platforms capable of automatically classifying, prioritizing, and allocating resources. This transformation introduces clear gains in efficiency and analytical capacity; However, it reposes classic questions of political philosophy and administrative law in new forms: who decides? Based on what criteria? And with what impacts on justice and democracy? (O'NEIL, 2016; EU, 2021; OECD, 2019).

Recent literature on algorithmic governance indicates that such systems are not neutral: they carry assumptions, modeling choices, incomplete databases, and statistical biases that can amplify historical inequalities and produce asymmetric distributional effects, often invisible to ordinary citizens (PASQUALE, 2015; NOBLE, 2018). At the same time, the growing technical opacity, derived from the complexity of artificial intelligence models, stresses fundamental values of the democratic rule of law, such as transparency, social controllability, and motivation of administrative decisions (FLOOD; MENÉNDEZ, 2022; CASS, 2020).

It is clear that the discussion cannot be reduced to an exclusively technical problem. Rather, it is an ethical-normative issue, which involves the status of the public interest, the legitimacy of decisions mediated by algorithms, and the need for institutional mechanisms of self-control capable of preventing abuses, reducing discrimination, and aligning technological innovation with fundamental rights (RAWLS, 2008; HABERMAS, 1997; UNESCO, 2021). The growing centrality of data highlights the tension between efficiency and justice, revealing that the mere automation of processes does not guarantee greater rationality, and can, on the contrary, institutionalize unfair practices under the appearance of neutrality.

From a philosophical point of view, there are instruments to illuminate these dilemmas. The Kantian notion of inner moral law, for example, suggests that the legitimacy of actions depends on their capacity for universalization and unconditional respect for human dignity (KANT, 2003). Transposed to the level of institutions, this perspective requires that public policies and algorithmic systems be evaluated according to clear normative criteria, which include public justification, non-discrimination, and protection of the vulnerable. Similarly, contemporary debates on democratic governance emphasize the importance of *accountability*, participation, and transparency as conditions for the legitimate exercise of power (PETERS; PIERRE, 2016; RHODES, 2017).

At the same time, the international literature has been consolidating guiding frameworks for the responsible use of artificial intelligence in the public sector, highlighting principles such as explainability, auditability, proportionality, risk assessment, and reversibility of automated decisions (OECD, 2019; EU, 2021; WORLD BANK, 2020). Although relevant, such guidelines often remain disconnected from a deeper ethical reflection, resulting in programmatic documents with little practical operationalization.

In this scenario, this article proposes an integrated ethical-normative framework for algorithmic governance, based on the principle of public interest and articulated with the GIS Cycle², Governance, Innovation and Sustainability. It is argued that the legitimacy of decisions mediated by algorithms depends on the simultaneous observance of four structuring criteria, namely: *universalizability*, *dignity*, *transparency*, and *accountability*. Based on these foundations, guidelines are developed for the design, implementation, and monitoring of data-based public policies, with special attention to the protection of vulnerable groups and intergenerational impacts.

In terms of methodology, we opted for a theoretical-conceptual study, supported by a narrative review of the specialized literature and a critical analysis of national and international normative frameworks. The objective is to offer an interpretative matrix that helps public managers, policymakers, and researchers to evaluate and guide the use of algorithmic technologies in the State, contributing to a governance model capable of reconciling innovation, social justice, and democratic sustainability.

In the end, it is argued that the consolidation of an institutional awareness, materialized in rules, processes and permanent ethical safeguards, is an indispensable condition for the digital transformation of the public sector not only to produce faster systems, but, above all, fairer, more transparent institutions aligned with the public interest.

2 THEORETICAL FRAMEWORK

Every society is born from the tense encounter between freedom and limit. As human beings made mistakes, learned and disputed meanings, they understood that living together requires more than good intentions: it requires measure, word, pact. It was in this process

² The GIS Cycle (Governance, Innovation and Sustainability) is an analytical model proposed by Ailton Ferreira Cavalcante, within the scope of his doctorate in Public Administration (IDP), which understands state action as a continuous process of formulation, execution, monitoring and feedback of public policies, articulating institutional governance, responsible innovation and sustainability as criteria for creating public value. Although developed in a systematic way in previous studies, the GIS Cycle can be understood, in synthetic terms, as a spiral process of planning, execution, monitoring and institutional learning, in which governance, innovation and sustainability operate as inseparable dimensions of the same movement. It is not just a managerial arrangement, but a normative architecture that guides public decision-making based on criteria of democratic legitimacy, intergenerational responsibility, and continuous creation of public value.

that the garden of innocence gave way to the city, a space where power needs to be contained by rules and where each decision starts to carry, simultaneously, promise and risk.

It is in this horizon that the contemporary debate on algorithms and public decisions is inserted. Digital technologies, far from being just instruments, have become part of the very architecture that organizes collective life, designing flows, defining priorities, and distributing opportunities. They can favor cooperation and justice, but from another angle, they can also erect invisible walls. The central question is not strictly technical: it is to know what kind of world we are helping to shape by delegating increasing portions of our decision-making power to machines.

Understanding this challenge requires returning to traditions that have reflected on truth and appearance, order and freedom, creation and responsibility, and from there reinterpreting the role of public interest and democratic governance in the digital age. The theoretical itinerary that follows follows this path: it starts from human moral ambivalence, dialogues with classical philosophy, revisits contemporary constitutionalism and integrates current debates on governance and algorithms. In the end, these contributions converge in the GIS Cycle³, which will serve as an analytical matrix for subsequent sections, indicating that the digital transformation of the State involves not only new tools, but a new way of interrogating power and responding for it.

2.1 MORAL CONSCIENCE AND HUMAN AMBIVALENCE

Philosophical literature recognizes that the human condition is crossed by a constitutive ambivalence: the capacity for cooperation, compassion and the creation of collective goods coexists with impulses of domination, appropriation and moral indifference. This tension, already intuited in ancient ethical traditions, finds a paradigmatic formulation in Hobbes⁴, for whom the absence of shared norms and legitimate authority places individuals

³ The GIS (Governance, Innovation and Sustainability) Cycle proposes that decisions about the use of algorithms in the public sector be treated as processes of justification and control, and not just as technical decisions. In the Governance phase, the public problem is precisely defined, ethical and legal risks are assessed, alternatives are registered, and it is verified whether the solution can be publicly justified (universalizability and dignity). In the Innovation phase, the development of the system must be interdisciplinary, documented and tested, with prior algorithmic impact assessment, transparent metrics, meaningful human oversight and challenge channels. Finally, the Sustainability phase requires continuous monitoring of errors and distributive effects, periodic reviews, audit trails, real possibility of correction or discontinuation, and public record of lessons learned. The Cycle operates in an iterative manner: problems detected in later stages return for prior adjustments, ensuring that the technology remains subordinate to the public interest, reviewable and responsible.

⁴ In Hobbes, the image of *homo homini lupus* does not describe an essential evil of the human being, but the condition of vulnerability and reciprocal distrust that emerges when common norms and legitimate authority are lacking. In the so-called "state of nature", each individual, seeking self-preservation, becomes a potential threat to others. The social contract and the institution of a common political power thus emerge as rational mechanisms to contain the predatory dimension of human relations and stabilize expectations, converting fear into public security (HOBBS, 2003).

in a state of potential war, synthesized in the expression *homo homini lupus* (HOBBS, 2003). The recourse to the social contract and political authority would therefore not be explained only by organizational efficiency, but by the need to contain the predatory dimension of human relations and produce reciprocal security.

Modernity introduces a decisive shift: the problem of evil and violence cannot be solved exclusively by external means. Kant⁵ shows that morality does not derive primarily from the fear of punishment or the calculation of advantages, but from the discovery of a universalizable practical law, inscribed in reason itself (KANT, 2003). Right action is that which can be conceived as a rule valid for all and which respects humanity, in itself and in others, as an end. In this way, conscience comes to be understood as an inner court, prior to and superior to coercive control, a space in which the subject is confronted with moral obligation even in the absence of external surveillance.

This movement has profound implications for the State and for public policies. If individuals do not become righteous just because they are watched, institutions do not become legitimate just because they are legal. Legitimacy, as contemporary theories of justice argue, depends on the ability to subject collective decisions to standards of public justification, in which any person, considered as free and equal, could recognize acceptable reasons (RAWLS, 2008; HABERMAS, 1997). It is a shift from the exclusive domain of authority to the domain of public reason.

However, human ambivalence reappears within the institutions themselves. Even structures created to protect rights can become instruments of capture, excessive bureaucratization or symbolic exclusion. Hence the relevance of thinking of the State as the bearer of a kind of institutional conscience, materialized in rules, processes and organizational cultures that induce ethical behavior and prevent the naturalization of abuse.

In the digital age, this debate gains additional density. Algorithmic systems, by automating decision criteria, seem to shift the moral problem from the individual to the code. However, far from eliminating human ambivalence, they re-inscribe it in new formats: modeling choices, data curation, definition of weights and thresholds, design of interfaces, and usage policies (PASQUALE, 2015; O'NEIL, 2016). The "court of conscience" does not disappear, it moves to the spaces where technical parameters are defined that will later affect concrete lives.

⁵ In Kant, morality does not derive from desirable consequences, but from the ability of the agent to submit his actions to a law that can be universally valid. The so-called categorical imperative demands that each person always be treated as an end in himself, never only as a means, the foundation of the principle of human dignity. Moral autonomy, in this sense, implies responsibility: to act is to legislate for oneself and for all, which makes the public justification of norms a condition of legitimacy (KANT, 2003).

Thus, understanding algorithmic governance requires recognizing that there is no purely technological shortcut to justice. Technical rationality needs to be anchored in ethical rationality, otherwise automation will only accelerate and reinforce existing inequalities. In these terms, human ambivalence is not an obstacle to be eliminated by technology, but an anthropological truth that imposes the need for reflective institutions, capable of controlling the power they exercise, even when mediated by algorithms.

2.2 TRUTH, APPEARANCE, AND THE MYTH OF THE CAVE

The Myth of the Cave, presented by Plato in Book VII of the Republic, remains one of the most powerful images for understanding the relationship between knowledge, power, and emancipation. In the narrative, prisoners chained since childhood see only shadows projected on the cave wall and, because they have never experienced any other form of perception, they take them as reality itself (Plato, 2000). The process of liberation, marked by pain, vertigo and resistance, symbolizes the passage from the immediate sensible world to intelligibility and, ultimately, to the Good.

The decisive element of the allegory lies in the fact that the shadows are not the result of chance, but result from an organization of the scenery: there is a fire, objects manipulated by others and a wall that functions as a projection surface. In contemporary terms, the myth points to the existence of regimes of visibility, structures that determine what can be seen, understood, and considered true in a society. There, ignorance is not the absence of data, but imprisonment in a field of appearances produced and mediated.

This reading has become particularly fruitful in the digital context. Recent literature shows how platforms, recommendation systems, and predictive models start to filter and prioritize information, creating highly personalized but non-transparent informational environments (ZUBOFF, 2019; KITCHIN, 2017). *Government dashboards*, risk maps, vulnerability indexes, and automated classification tools produce representations of the world that, due to their technical appearance, tend to acquire a status of unquestionable objectivity. However, such representations depend on methodological decisions, cuts, weights, proxies, which are rarely discussed publicly (PASQUALE, 2015).

The ethical-political risk lies not only in the possibility of error, but in the naturalization of a technically sophisticated shadow regime. By confusing representation with reality, space is opened for the replacement of public debate by opaque technicalities. O'Neil's (2016) critique of the so-called "weapons of mathematical destruction" shows that algorithmic models, when applied to security, credit, education, or social assistance policies, can consolidate trajectories of exclusion precisely because they feed back on historical data

marked by inequalities, which suggests that getting out of the cave also requires critically reviewing the data that feeds it.

On the other hand, the myth also points to an ethical dimension of responsibility: the one who comes out of the cave and contemplates the sunlight, a metaphor for the Good, faces the difficult task of returning to share knowledge and contribute to the liberation of others.

However, Plato reminds us that the passage from darkness to light is not immediate: the eyes of the apprentice, not accustomed to brightness, can be dazzled before seeing clearly. Clarification involves a gradual process, which requires time, mediation and pedagogical care.

In this key, politics is not a mere administration of resources, but a permanent effort to clarify, aware that excessively abrupt transparency can produce misunderstanding and resistance.

In democratic governance, this translates into practices of substantive and gradual transparency: making understandable not only the results, but also the processes, criteria, and uncertainties that structure public decisions (FLORIDI et al., 2018).

Finally, the Myth of the Cave illuminates the contemporary debate on algorithmic governance by revealing that the central issue is not only to produce more information, but to ensure conditions of intelligibility and public contestation. Without this, technically efficient systems can trap societies in new, more refined, but equally coercive forms of obscurity.

Thus, the construction of fair public policies requires institutions capable of deliberately promoting movements to "get out of the cave": critical education about data, open models, citizen participation, and auditing mechanisms that restore to the public space the debate about what counts as administrative truth. Such movements, however, demand accompaniment and formative guidance, as the transition between darkness and light is rarely immediate; Without adequate support, transparency itself can overshadow rather than clarify.

2.3 NUMBER, HARMONY, AND THE PYTHAGOREAN SCHOOL

The Pythagorean School⁶ occupies a unique place in the history of thought for articulating, in an unprecedented way, mathematics, metaphysics and ethical formation. More

⁶ The Pythagorean tradition conceived of number as a constitutive principle of reality. More than a tool of calculation, arithmetic expressed a cosmic order that should also guide moral and political life. Harmony, proportion and measure were not only mathematical categories, but criteria of justice and social balance. This view anticipated the idea that forms of quantification can shape the world, and therefore need to be thought of ethically.

than a circle of research in numbers, it was a philosophical community in which the study of the world order was intrinsically linked to the moral improvement of its members (BURKERT, 1972). For the Pythagoreans, number was not a mere tool of calculation; it constituted the very intelligible structure of reality, manifesting itself in musical harmony, in the rhythms of nature, and in the proportions of the human body.

The famous discovery of the numerical relations that underlie musical intervals became a symbol of this vision: that which seems qualitative, beautiful, harmonious, pleasant, reveals itself, at a deeper level, quantitatively structured. This *insight* had lasting consequences for Western science, fueling the conviction that the cosmos can be described by mathematical laws and that to know such laws is, in a sense, to participate in the rationality of the world itself (HADOT, 2002).

However, the Pythagorean heritage includes something often overlooked: mathematics was not conceived as an autonomous activity, detached from life. Access to the order of the cosmos required discipline, inner silence, temperance, and principled community life. In other words, there was no science without ethics. The idea of "harmony" referred both to the ratio between numbers and to the balanced integration of the human soul with the greater order of the universe.

Transposed to the contemporary debate, this perspective offers a critical lens on the growing quantification of government. Performance indicators, scoring systems, risk metrics, and prioritization algorithms seem to materialize the ancient Pythagorean aspiration to rule by number.

Contemporary literature has rightly reminded us that quantification is far from neutral: it always presupposes choices about what goes into account, how it is measured, and for what purpose (KITCHIN, 2017). A vulnerability index, for example, can serve to expand social protection, but it can also be instrumentalized to justify selective cuts. It all depends on the way it is constructed, interpreted and put at the service of public decisions.

This ambiguity shows that numerical rationality can serve both justice and domination. In contexts of structural inequality, apparently objective systems can consolidate hierarchies, especially when statistical criteria are confused with moral judgments.

The Pythagorean School reminds us, in this sense, that the mathematical order needs to be subordinated to an ethical horizon: harmony is not only formal balance, but adequacy to the purposes of the good and the just life.

For algorithmic governance, the lesson is straightforward. Mathematical models that guide decisions about credit, security, social benefits, or urban policies should be evaluated not only for their accuracy, but for their distributive impact, discriminatory potential, and

compatibility with fundamental rights. The "beauty" of a technical solution, its algorithmic elegance, is no substitute for the political question of who wins and who loses with its application.

In conclusion, recovering the Pythagorean heritage means reaffirming that number and ethics are not separate. In a scenario in which data and algorithms progressively shape the action of the State, it becomes essential to reconnect mathematical precision with the demand for justice, preventing the fascination with metrics and models from becoming a new form of practical irrationality. Only in this way will quantification be able to fulfill its emancipatory vocation, contributing to more rational, but also more humane, policies.

2.4 DEMIURGE, FALSE ORDER, AND MODELING POWER

The figure of the Demiurge⁷, presented by Plato in the dialogue *Timaeus*, constitutes a sophisticated metaphor for thinking about the exercise of power. Unlike an arbitrary deity, the Demiurge is described as a cosmic craftsman who, when contemplating the world of Forms, seeks to order chaotic matter according to measure, proportion and Good (Plato, 2001). It does not create from nothing, but gives form to what exists, guided by a principle of rationality that links creation and responsibility.

This image, although belonging to the ancient philosophical imaginary, offers a fruitful key to interpreting the role of contemporary institutions. Governing, whether through laws, policies, or technologies, is, to a large extent, shaping the common world: defining categories, setting priorities, organizing flows, and assigning meanings. The public power, in this sense, assumes a demiurgic function by transforming social chaos into normative, economic and symbolic order. The decisive question, then, is not only how to make this process efficient, but at the service of what values the created order is structured.

The Gnostic tradition radicalizes this reflection by introducing the figure of the false demiurge, a creative instance that institutes a degraded cosmos, marked by domination and ignorance (JONAS, 2006; PAGELS, 1995). In this reading, the order of the world is not necessarily good; It can be oppressive, yet extremely organized. The Gnostic critique works as a warning against the risk of confusing order with justice, reminding us that highly structured systems can serve to perpetuate inequalities when guided by particularistic interests.

⁷ In the Platonic tradition, the Demiurge is not an absolute creator god, but an artificer who organizes chaotic matter according to models of order and beauty. In certain Gnostic readings, however, this figure gains ambiguous traits: the power that organizes can also imprison, producing a "false order" that gives the appearance of necessity to what is, in fact, a human decision. The metaphor helps to think about institutions and technologies that, in shaping the social world, require constant ethical vigilance.

Transposed to the current scenario, this ambivalence is particularly pertinent in the face of the advance of digital infrastructures and algorithmic systems. Such technologies increasingly participate in the very constitution of the social: they classify individuals, distribute visibility, mediate access to services and modulate opportunities. Its performance is not merely instrumental; they produce reality by organizing the modes of interaction and decision. In this sense, algorithms symbolically assume a demiurgic function, they become artisans of a social world mediated by data.

The critical literature has shown that this modeling power is ambivalent. On the one hand, it enables greater coordination, predictability, and analytical capacity to face complex problems. On the other hand, it can result in new forms of silent domination, in which structural decisions are shifted to technical environments that are not very transparent, making public contestation difficult (ZUBOFF, 2019; PASQUALE, 2015). The risk is the constitution of a false technocratic order: an arrangement that presents itself as inevitable and scientifically neutral, when, in fact, it crystallizes preferences and asymmetries of power.

Recognizing this demiurgic dimension of the digital state does not imply demonizing technology, but assuming it as a moral and political issue. If governing is modeling, then every act of institutional or algorithmic design requires public justification and accountability mechanisms. In the absence of these brakes, the creative capacity of power can slide into subtle forms of authoritarianism, no longer imposed by force, but by decision-making architectures that limit alternatives before they can even be discussed.

In this interpretative horizon, recent studies have recovered the metaphor of the Demiurge to think about the responsibility of those who design technosocial systems, suggesting that every institutional architecture is, above all, an ethical decision about the type of order that is intended to be established (CAVALCANTE, 2025). Such a reading reinforces that the central issue is not simply to create efficient systems, but to ensure that efficiency does not become an instrument of injustice.

In this way, the reflection on the Demiurge and its gnostic counterpart contributes to making explicit the normative core of algorithmic governance: the problem is not to create order, but to ensure that the created order is compatible with human dignity, distributive justice, and democratic integrity. It is at this point that ethics ceases to be a theoretical adornment and becomes a condition for the possibility of institutional legitimacy itself in the digital society.

2.5 PUBLIC INTEREST AND SUPREMACY IN A CONSTITUTIONAL KEY

The concept of public interest is one of the pillars of Administrative Law, functioning as a guiding criterion and limit for state action. In traditional readings, the so-called "supremacy of the public interest" was often interpreted as generic authorization for the Administration to restrict individual rights whenever it alleged reasons of collective convenience.

This vision, although functional for the construction of the intervening State, proved to be insufficient in the face of the requirements of contemporary constitutionalism, centered on human dignity and the protection of fundamental rights (DI PIETRO, 2012; JUSTEN FILHO, 2014).

Democratic constitutionalism introduces a decisive shift: the public interest is not a power above the Constitution, but a principle that must be interpreted in the light of the constitutional text and its structuring values. Supremacy thus becomes an argumentative burden: every restriction of rights needs to be rationally justified, proportional, and guided by legitimate purposes (BINENBOJM, 2017). In other words, it is not enough to invoke the public interest, it is necessary to demonstrate it.

This transformation brings Administrative Law closer to broader ethical-political debates. Rawls' theory of justice, for example, proposes that institutional arrangements are legitimate when they could be accepted by free and equal citizens under conditions of impartiality (RAWLS, 2008). Habermas' discourse ethics, on the other hand, emphasizes public justification: norms are only valid when they can find assent in communicative processes free of coercion (Habermas, 1997). Applied to the administrative field, such perspectives suggest that the public interest should be sought through transparent, motivated and socially controllable decisions.

On the practical level, this reinterpretation implies recognizing that the State operates in constant tension between efficiency and the guarantee of rights. Efficiency, an important value in complex societies, cannot serve as a pretext for the compression of individual guarantees, nor for the adoption of technocratic solutions immune to democratic scrutiny. The qualified public interest requires that administrative decisions balance results and procedures, avoiding both paralyzing formalism and opaque decisionism.

The emergence of algorithmic systems puts this debate back on new bases. By transferring a significant part of the decision-making capacity to statistical models, there is a risk of naturalizing exclusion criteria that have not been publicly debated. The literature shows that risk forecasting, benefit distribution, or policy prioritization tools can reproduce existing biases, disproportionately impacting vulnerable groups (EUBANKS, 2018; NOBLE, 2018). In

these cases, the abstract invocation of the public interest, under the argument of efficiency gains, would cover up violations of material equality and substantive due process.

It is important to note that the interpretation of the public interest as an ethical instance that conditions the use of technologies and decision-making models has gained prominence, preventing efficiency from being converted into an absolute criterion. Recent studies show that the uncritical incorporation of technocratic solutions can produce subtle forms of exclusion, especially when automated decisions start to operate as if they were neutral and inevitable (CAVALCANTE, 2025).

For this reason, the supremacy of the public interest, in a constitutional key, must be read as a principle of containment and responsibility. It obliges the manager to demonstrate: (a) the legitimate purpose of the decision, (b) the adequacy of the means used, (c) the need for less onerous alternatives, and (d) proportionality in the strict sense, weighing impacts on fundamental rights. Such requirements become even more relevant when automated systems participate in the decision, requiring impact assessments, minimal explainability, and significant human review.

Thus, the public interest ceases to be a rhetorical concept and begins to operate as an institutional moral law, which links power to the obligation to justify oneself. Far from paralyzing administrative action, this paradigm gives it ethical and democratic density, preventing the transformation of efficiency into an absolute value and ensuring that technological innovation remains subordinated to constitutional purposes.

Ultimately, understanding the supremacy of the public interest from a constitutional perspective means recognizing that the legitimacy of state action, whether analogical or algorithmic, depends on its ability to produce socially just results without giving up transparency, control, and unconditional respect for human dignity.

2.6 DEMOCRATIC GOVERNANCE AND WAVES OF ACCOUNTABILITY

The contemporary debate on governance is based on the recognition that the State is no longer the only instance capable of coordinating collective action. Social complexity, the fragmentation of interests, and the interdependence between public, private, and community actors have produced polycentric decision-making arrangements, in which multiple organizations share responsibilities (PETERS; PIERRE, 2016; RHODES, 2017). In this scenario, governing means less "commanding" and more orchestrating, creating mechanisms of cooperation, coordination and reciprocal control.

The literature identifies, in this process, successive "waves" of accountability. The first, centered on legal-formal control, sought to ensure compliance with standards and

procedures. The second, associated with managerial reforms, emphasized performance, goals and results. A third, more recent wave, replaces the values of transparency, integrity, participation, and social control at the center, articulating legal, managerial, and democratic dimensions in the same framework (BOVENS; SCHILLEMANS; HART, 2008).

This displacement does not eliminate tensions. On the contrary, it reveals that accountability is not a univocal concept, but a field of dispute between different logics of control. While managerial approaches tend to privilege metrics and indicators, democratic perspectives insist that legitimacy requires public justification, deliberation, and the possibility of contestation. Good governance results from the balance between these dimensions, avoiding both procedural formalism and productivism devoid of civic sense.

Digital transformation introduces new challenges to this picture. Information systems, platforms, and algorithms began to structure their own decision-making processes, changing who decides, how they decide, and based on what evidence.

In many cases, critical decisions are mediated by outsourced technical infrastructures, whose operating logic escapes the traditional scrutiny of public institutions. There is then the risk of a shift of power to invisible architectures, in which the criteria for classification, recommendation, and prioritization remain opaque to citizens and even to the managers themselves (PASQUALE, 2015; ZUBOFF, 2019).

This phenomenon requires broadening the concept of *accountability* beyond traditional accountability. There is increasing talk of algorithmic *accountability*, which involves transparency about the data used, model documentation, minimal explainability of results, independent risk assessment, and the possibility of meaningful human review (FLORIDI et al., 2018; WORLD BANK, 2020). It is a matter of recognizing that, when public decisions are mediated by code, the code also becomes part of the law, and must be subject to equivalent controls.

At the same time, democratic governance implies substantive participation. The opening of data and the availability of interfaces are not enough if citizens and social organizations are not integrated into deliberative processes that influence the design and monitoring of public technologies.

In this sense, co-design initiatives, public hearings on automated systems, digital ethics councils, and participatory impact evaluations represent promising ways to repoliticize technical decisions and prevent innovation from becoming a zone of normative exceptionality.

It is important to highlight that such mechanisms do not replace the individual responsibility of managers, but reconfigure it. The public leader is now responsible not only for tangible results, but for institutional architecture choices, including technological ones, that

shape behaviors and opportunities. As already suggested by theories of justice and the public interest, responsibility means being able to give reasons for decisions made and demonstrate how they align with constitutional principles and the protection of vulnerable groups.

In summary, democratic governance in the digital age demands a multidimensional accountability model, which combines: (a) legality and institutional control, (b) evaluation of performance and results, and (c) informed social participation. Without this synthesis, there is a risk of shifting the center of decisions to barely visible technical spheres, weakening public trust and bringing digital management closer to subtle forms of decisionism. With it, on the contrary, it becomes possible to align innovation, efficiency and democracy, paving the way for a governance capable of learning from its own mistakes and correcting directions, an essential condition for any public project guided by the collective interest.

2.7 ALGORITHMIC GOVERNANCE: INTERNATIONAL RISKS AND PRINCIPLES

The advancement of systems based on massive data, machine learning, and decision-making automation has ushered in a new field of ethical and legal concerns often referred to as algorithmic governance. It is about analyzing how algorithms, understood not only as mathematical codes, but as socio-technical arrangements, come to perform functions traditionally associated with public authorities: allocating resources, classifying citizens, estimating risks, and guiding policies (KITCHIN, 2017; PASQUALE, 2015). The growing centrality of these systems requires a normative framework that goes beyond engineering and dialogues with fundamental democratic values.

The specialized literature identifies three main sets of risks. The first concerns opacity. Complex, often proprietary, models make it difficult to understand why certain decisions were made, which weakens the right to explanation and hinders judicial and social control (PASQUALE, 2015).

The second is linked to the reproduction of biases. As algorithms learn from historical data, they tend to replicate and even amplify existing inequalities, disproportionately impacting minorities and vulnerable groups (O'NEIL, 2016; NOBLE, 2018; EUBANKS, 2018).

The third involves systemic effects: the simultaneous use of multiple models in areas such as health, education, security, and assistance can generate unexpected feedbacks, reconfiguring social opportunities without prior public debate.

In response to these challenges, international organizations have been formulating converging principles to guide the responsible use of artificial intelligence and automated systems. The OECD Guidelines uphold values such as inclusive growth, human well-being, transparency, technical robustness and accountability (OECD, 2019). The European Union

proposes a risk approach that combines fundamental rights, impact assessment and the requirement for meaningful human oversight (EU, 2021). UNESCO, for its part, emphasizes justice, cultural diversity, environmental protection, and cooperative global governance (UNESCO, 2021).

Despite important advances, these milestones usually face difficulties in operationalization. Many documents remain at the abstract level, lacking clear instruments to translate principles into everyday administrative practices. From this perspective, methodologies such as algorithmic impact assessments, public model registries, independent audits, and explainability protocols have been highlighted, aimed at making automated decisions and their effects traceable (FLORIDI et al., 2018; WORLD BANK, 2020). Still, the effective implementation of these tools depends on institutional capacities, technical resources, and ethical-oriented organizational culture.

Another sensitive point refers to the outsourcing of decision-making infrastructure. Governments often hire private monitoring, analysis, and prediction solutions, creating informational asymmetry between government and suppliers. This technological dependence can compromise decision-making sovereignty and make it difficult to carry out audits, especially when contracts include commercial secrecy clauses. Hence the importance of transparency by design clauses, open standards, and requiring access to data and models for control and independent research purposes.

In addition, algorithmic governance involves a pedagogical dimension. For principles of justice, non-discrimination and proportionality to be effective, it is necessary to invest in the ethical and technical training of managers, developers and evaluators. Without critical awareness, automated systems can be adopted only because they promise efficiency, without adequately evaluating their social costs. Here, the convergence between moral philosophy, law, and data science becomes essential.

In light of the above, algorithmic governance demands a multi-layered normative architecture: international principles, national legislation, sectoral regulation, responsible public procurement, and everyday organizational practices. Its objective is not to prevent innovation, but to condition it to respect for fundamental rights and the public interest. In this sense, the incorporation of mechanisms of transparency, risk assessment and citizen participation represents a necessary, although not sufficient, condition for decision-making automation in the public sector to go hand in hand with democracy, social justice and ethical responsibility.

2.8 THE GIS CYCLE AS AN INTEGRATING MATRIX

From the previous discussions, it becomes evident that the challenges posed by the digital transformation of the public sector cannot be met by piecemeal approaches. Issues of technique, law, moral philosophy, administration and citizen participation appear interconnected, requiring a conceptual framework capable of integrating multiple dimensions without reducing complexity. From this perspective, the GIS Cycle emerges as an analytical and normative proposal that articulates democratic values, technical rationality and intergenerational responsibility.

The first axis, Governance, refers to the construction of transparent, participatory institutional arrangements with robust accountability mechanisms. It is about recognizing that public decisions mediated by algorithms are not limited to technical choices, but constitute exercises of power that must remain open to criticism and social control. Governance, in this key, is not mere formal regulation: it is a permanent practice of public justification, in which managers explain reasons, listen to counterpoints and review directions when necessary.

The second axis, Innovation, is not to be confused with the uncritical adoption of technologies. On the contrary, it supposes the creation of solutions that expand rights, reduce inequalities and strengthen institutional capacities, always subordinated to the public interest. This implies incorporating, from the design of systems, principles such as bias prevention, auditability, transparent documentation, and the possibility of human review. Ethically-oriented innovation thus translates into processes of continuous institutional learning, in which technologies are evaluated not only for their efficiency, but for their distributive and democratic effects.

The third axis, Sustainability, broadens the time horizon of decisions. The discussion about algorithms cannot be restricted to the immediate impact on performance indicators; it must consider intergenerational, social, environmental and institutional consequences. Systems that concentrate power, erode public trust, or reinforce inequalities can produce short-term gains at the cost of lasting damage to social cohesion and the very legitimacy of the state. Sustainability, in this sense, operates as a long-term safeguard against technological solutions that seem ingenious, but weaken the democratic pact.

The strength of the GIS Cycle lies in their functioning as interdependent dimensions. There is no legitimate innovation without transparent governance; there is no sustainability without responsible innovation; and there is no effective governance without consideration of future consequences. This circularity dialogues with philosophical traditions that see knowledge as a process of self-transformation, getting out of the "caves" of ignorance, harmonizing numbers and ethics, guiding creative power through universal values. In

contemporary language, it means building reflective institutions, capable of learning from their own mistakes and submitting to clear ethical criteria.

From a methodological point of view, the GIS Cycle operates as a matrix for diagnosing policies, guiding the design of systems, and evaluating their implementation. It allows us to formulate structuring questions: (a) who governs and how is he accountable? (b) what innovation is being produced and at the service of whom? (c) What impacts, present and future, are being considered and for whom? Answering these questions helps to transform abstract principles of algorithmic governance into concrete decision-making procedures, bringing ethics, law, and public administration closer together.

Finally, the GIS Cycle does not intend to offer a definitive formula, but a hermeneutic and practical scheme to align technology, justice and democracy. By collecting contributions from classical philosophy, contemporary political theory, and international guidelines for responsible AI, he indicates that the legitimacy of decisions mediated by algorithms depends on the simultaneous observance of four structuring criteria, namely, *universalizability*, *dignity*, *transparency*, and *accountability*, which will guide the proposals presented in the following sections.

In this way, the theoretical framework developed here prepares the ground for normative and applied analysis, demonstrating that the digital transformation of the State is not only a technical challenge, but a historical opportunity to reconfigure the exercise of public power in the light of robust ethical principles.

3 METHODOLOGY

The present study adopts a theoretical-conceptual, qualitative and ethical-normative design, aimed at the construction of an analytical framework capable of interpreting the challenges of algorithmic governance and proposing guidelines compatible with the public interest. It is an analytical-argumentative essay that articulates philosophical tradition, contemporary constitutionalism and recent literature on governance and artificial intelligence, seeking to bring administrative theory and practice closer together (RAWLS, 2008; HABERMAS, 1997; OECD, 2019).

The empirical basis consists of a critical narrative review, appropriate for fields in consolidation and that require interpretive integration between multiple sources (BAKER, 2016). Reference works were selected in: (a) moral and political philosophy; (b) administrative law and public interest; (c) democratic governance and *accountability*; (d) international guidelines on AI and algorithms in the public sector; and (e) critical studies on biases, opacity and social impacts of automated systems (PASQUALE, 2015; O'NEIL, 2016;

EU, 2021; UNESCO, 2021). The inclusion of sources observed three criteria: thematic relevance, academic/institutional recognition, and capacity for dialogue with the Brazilian context.

Also, from the point of view of source selection, the review focused on texts that explicitly articulate technology, public ethics, and collective interest, combining classical contributions from political and moral philosophy with recent normative documents on artificial intelligence and data governance (RAWLS, 2008; HABERMAS, 1997; OECD, 2019; EU, 2021; UNESCO, 2021; WORLD BANK, 2020). The time frame privileged the production of the last decade, without excluding previous works considered structuring for the debate, as well as international reports and guidelines with a direct impact on the design of public policies. Studies of a strictly technical-engineering orientation were deliberately left out, whose focus is limited to the computational performance of the models, without a substantive interface with problems of democratic legitimacy, protection of rights and public interest.

The analysis took place in two complementary stages. First, a conceptual reconstruction of core categories was carried out, namely *truth, order, public interest, responsibility and governance*, examining their evolution and internal tensions. Then, the normative translation of these categories was carried out into evaluative criteria applicable to decisions mediated by algorithms, organized in the Cycle as an interpretative matrix. This procedure allows transforming theoretical foundations into operational principles, preserving ethical density and institutional viability.

Finally, it is recognized that the results result from the internal coherence of the argument and the robustness of the sources mobilized. The study is not a substitute for empirical investigations; rather, it offers a normative framework that can guide future impact assessments, case studies, and comparative analyses on the use of algorithms in the public sector. Finally, it is important to note that no systematic empirical studies have been conducted, which constitutes a future research agenda.

4 RESULTS AND DISCUSSION

Operationally, the GIS Cycle is structured as a spiral movement in four articulated moments: planning, execution, monitoring and feedback. In planning, public problems, criteria of justice and ethical risks are defined; in execution, technologies are tested with safeguards; in monitoring, distributive effects and impacts on rights are evaluated; Finally, in feedback, decisions are reviewed, corrected or interrupted, recording institutional lessons for the following cycles. This dynamic avoids irreversible decisions and transforms technological innovation into a continuous deliberative process.

The paths taken in the previous sections have shown that technology, far from being a mere neutral tool, participates in the very architecture of public power. Algorithms classify, prioritize, and distribute, and in doing so, shape concrete experiences of citizenship. If the theoretical framework has made it possible to understand the philosophical, legal and institutional bases of this phenomenon, the task that is now imposed is another: to translate principles into criteria capable of guiding real decisions.

This section takes up this deliberately difficult passage. Instead of celebrating promises or dramatizing risks, it seeks to organize a normative framework that dialogues with the complexity of the digital world, without losing sight of the public interest. It is based on the assumption that algorithmic systems should not be judged only by their efficiency, but by their compatibility with democratic values and the requirement of justification that underpins the rule of law.

In this way, the results and the discussion presented here convert the theoretical itinerary into four structuring criteria, namely, *universalizability, dignity, transparency and accountability*, integrated by the GIS Cycle. From them, guidelines for the life cycle of algorithmic systems are formulated and institutional tensions and safeguards necessary for technological innovation not to become opaque power are analyzed. More than closed answers, what is offered is a method of judgment: a way of asking, in a systematic and reflective way, what it means to govern with algorithms in a democracy.

An example helps to visualize the GIS Cycle in operation. Suppose the adoption of an algorithm for screening social benefits. In planning, the Administration defines the problem (fraud and delays), establishes fairness criteria, explainability requirements and safeguards for vulnerable groups. In execution, the system is implemented on a pilot basis, with human supervision and dispute channels. In the monitoring, patterns of undue exclusion are identified in certain territories and it is verified that the performance metric favored statistical efficiency to the detriment of equity. In the feedback phase, the parameters are reviewed, the model is independently audited, and the decision rules are rewritten, recording the lessons learned for the next cycle. The result is not just a "more accurate" algorithm, but a public policy that learns about itself and reinforces its democratic legitimacy.

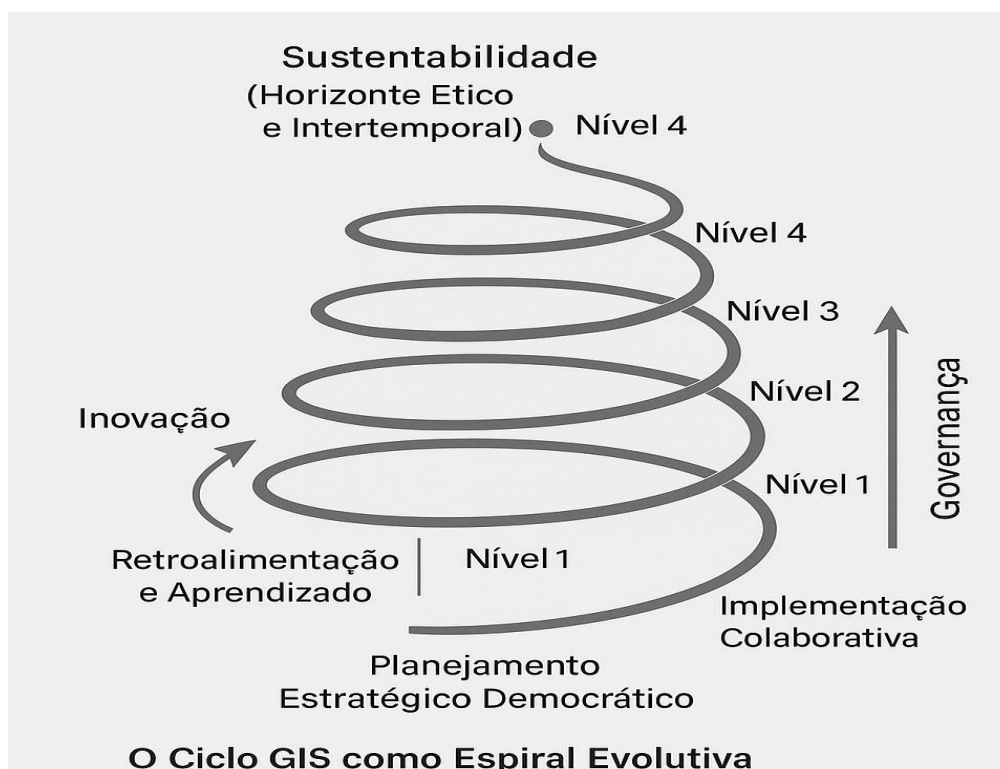
The GIS Cycle is a conceptual and practical arrangement intended to guide contemporary state action, by articulating three dimensions that, historically, tend to appear dissociated: the way of deciding (governance), the ability to transform processes and services (innovation) and the normative horizon that gives meaning to public choices (sustainability). This articulation is not limited to the search for administrative efficiency; it organizes

government action in such a way as to produce legitimate, enduring, and socially recognizable public value.

Represented as an evolutionary spiral, the GIS Cycle expresses a continuous process that combines four interdependent movements: (i) planning guided by participation and evidence; (ii) implementation with institutional cooperation and ethical safeguards; (iii) monitoring and evaluation of results and impacts; and (iv) feedback, in which decisions are reviewed and learning is institutionalized. The ascending character of the spiral symbolizes the progressive improvement of government capacities, with sustainability operating as an ethical and temporal reference that projects decisions beyond the immediate present.

Figure 1

The GIS Cycle as an Evolutionary Spiral of Public Governance



Source: Prepared by the authors (2025).

The figure represents the continuous and ascending dynamics of the public management process structured in the GIS Cycle, articulating: (i) Democratic Strategic Planning, (ii) Collaborative Implementation, (iii) Monitoring and Evaluation, and (iv) Feedback and Learning. The rise of the spiral symbolizes the progressive advance of institutional capacity towards sustainability as an ethical and intertemporal horizon.

4.1 FROM THE THEORETICAL FRAMEWORK TO THE NORMATIVE CRITERIA

Although the analysis is predominantly theoretical, it is possible to visualize its practical developments in recent experiences. Facial recognition systems adopted in security policies, for example, increased false positive rates among racialized populations, evidencing structural biases in training data. In another direction, algorithms used to screen social benefits, when opaque, generated undue exclusions and reduced the capacity for administrative contestation. There are also cases of risk prediction in public health that, by prioritizing statistical efficiency, neglected territorial inequalities. These examples show that automated decisions are not mere technical resources: they reorganize opportunities, distribute burdens, and require robust legitimacy criteria.

The theoretical path developed in this study shows that algorithmic governance is not only a technological advance, but a re-actualization of the classic problem of power: who decides, based on what reasons, for the benefit of whom and under what limits? This question has crossed political philosophy since its origins and reappears mediated, now, by digital infrastructures capable of organizing sensitive dimensions of collective life.

Human moral ambivalence, present since Hobbes and Kant, reveals that social coexistence oscillates between cooperation and conflict, requiring norms that contain predatory impulses without eliminating freedom (HOBBS, 2003; KANT, 2003). In the algorithmic context, this tension intensifies: tools designed for efficiency and precision can reinforce inequalities, produce opaque decisions, and consolidate power asymmetries (PASQUALE, 2015; O'NEIL, 2016; GREEN, 2021). The Platonic image of the cave remains current: societies run the risk of confusing outputs from automated systems with objective truths, forgetting that they result from methodological choices, models and implicit values (Plato, 2000; ZUBOFF, 2019; CRAIG; BROWN, 2022).

In a convergent way, the Pythagorean tradition recalls that number is not neutral: it expresses a conception of order that can harmonize or dominate, according to the ethical horizon that guides it (BURKERT, 1972; HADOT, 2002). Indicators and algorithms not only describe reality, they contribute to constructing it, defining priorities, acceptable risks and forms of social visibility (LESSIG, 1999; BOVENS; ZOURIDIS, 2002). The metaphor of the Demiurge, critically reinterpreted by Gnosticism, deepens this diagnosis: every architecture of order can generate both justice and "false order", highly organized, but excluding (JONAS, 2006; PAGELS, 1995). In the digital public sphere, this means recognizing that algorithms play a creative role and, therefore, demand explicit moral responsibility (CAVALCANTE, 2025; CRAWFORD, 2021).

Contemporary constitutionalism replaces the public interest as a criterion of legitimacy, not as unlimited authorization, but as a duty of justification guided by human dignity and fundamental rights (DI PIETRO, 2012; BANDEIRA DE MELLO, 2015; BINENBOJM, 2017). Consequently, automated decisions need to be evaluated both by their results and by their procedures, preserving transparency, participation and social control (HABERMAS, 1997; PETERS; PIERRE, 2016; HOOD; DIXON, 2015). In Brazil, the debate is also connected to the protection of personal data and the idea of informational self-determination, reinforcing the demand for public justification (DONEDA, 2020; MENDES, 2021).

The convergence of these traditions made it possible to derive, in this work, a set of structuring normative criteria, organized in the GIS Cycle. It is argued that the legitimacy of algorithmically mediated decisions depends on the simultaneous observance of four dimensions described above. Such criteria result: (a) from the requirement that public rules can be accepted as reasonable by any citizen (KANT, 2003; RAWLS, 2008); (b) the prohibition of treating people only as means (KANT, 2003); (c) the need to make intelligible the processes that shape public truth (Plato, 2000; FLORIDI et al., 2018; EU, 2021); and (d) the democratic obligation to answer for decisions that structure collective life (HABERMAS, 1997; WORLD BANK, 2020; OECD, 2019).

The main contribution of this stage is, therefore, the passage from the interpretative to the normative plane. From the theoretical framework, principles capable of acting as ethical and legal filters for automated decisions in the State are identified. The following subsections examine each criterion and show how they are articulated in the GIS Cycle, becoming guidelines for the life cycle of algorithmic systems.

4.2 FOUR CRITERIA FOR ALGORITHMIC GOVERNANCE ORIENTED TO THE PUBLIC INTEREST

From the reconstructed theoretical framework, it becomes possible to derive a set of normative criteria capable of guiding the use of algorithms in public administration. These criteria are not external to technology; on the contrary, they emerge from the recognition that computer systems come to compose the very architecture of decision-making power, reorganizing priorities, filtering information and distributing opportunities and restrictions among citizens (LESSIG, 1999; PASQUALE, 2015). It should be noted that the idea of public interest only maintains its meaning when associated with ethical and legal parameters that condition the exercise of technical power, preventing it from becoming a mere instrumental rationality.

Based on this horizon, the study identifies the four structuring criteria already articulated within the scope of the GIS Cycle. They work as successive and complementary filters. Each one illuminates specific dimensions of the algorithmic problem, but only their joint observance allows us to speak of governance compatible with the Democratic Rule of Law.

The first criterion, *universalizability*, derives from the Kantian tradition and the contemporary theory of justice, according to which legitimate norms are those that could be accepted by any subject under equal conditions (KANT, 2003; RAWLS, 2008). Transferred to the algorithmic sphere, the principle requires that the rules embedded in computational models can be justified publicly, without arbitrary discrimination and without dependence on secret criteria. This means assessing whether automated policies are consistent with constitutional values and whether their effects do not fall disproportionately on vulnerable groups, a problem widely documented in the recent literature on data biases and algorithmic discrimination (O'NEIL, 2016; BAROCAS; SELBST, 2016; GREEN, 2021). Thus, universalizability establishes a substantive limit: decisions that could not be accepted as reasonable by all those affected lack legitimacy, even if they are technically efficient.

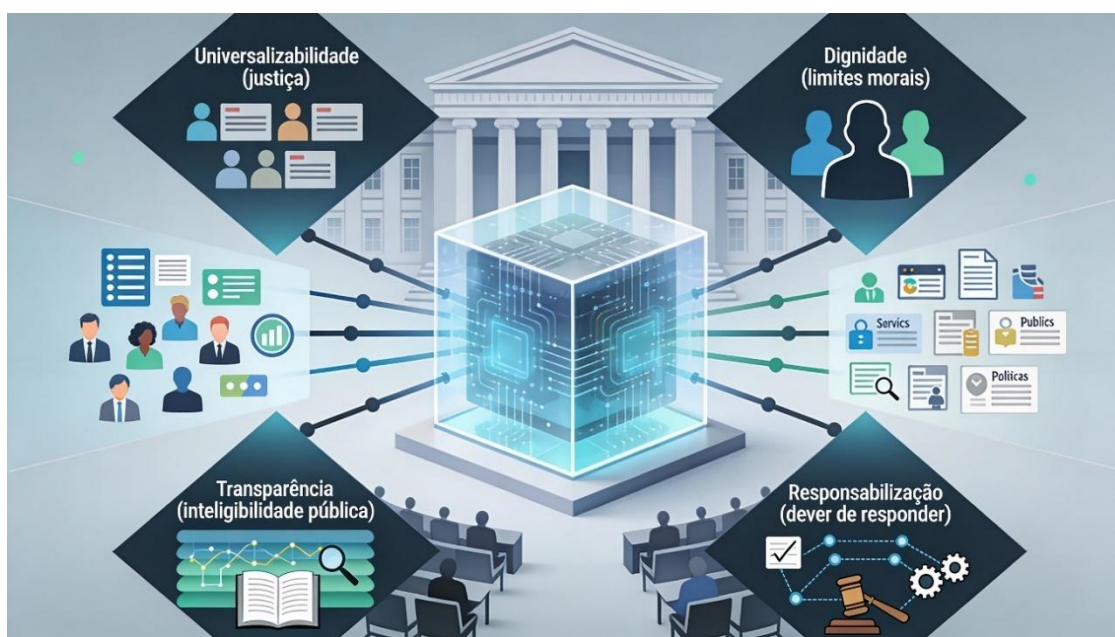
The second criterion, *dignity*, expands this reflection by rejecting any form of reduction of the individual to a mere object of classification, prediction or management. Dignity, the foundation of contemporary constitutionalism, requires that people not be treated only as means to administrative ends (KANT, 2003; BINENBOJM, 2017). In practice, this implies questioning models that fully replace human judgment, that deny possibilities of contestation, or that produce permanent and stigmatizing labeling, for example, risk scores, surveillance profiles, and automated screening mechanisms in social and public security policies (CITRON; PASQUALE, 2014; CRAWFORD, 2021). The criterion of dignity reminds us that, even when data allow for more accurate predictions, there are ethical boundaries that the state cannot cross without compromising its own moral legitimacy.

The third criterion, *transparency*, seeks to respond to the risk that modern societies will live in a "new cave", confusing algorithmic outputs with self-evident truths. Transparency means making visible the purposes, premises and limits of automated systems, allowing citizens, control bodies and researchers to understand their basic logic and submit it to criticism (Plato, 2000; FLORIDI et al., 2018; OECD, 2019). It is not just about disclosing source codes, which are often inaccessible or protected by trade secrets, but about producing explainability and institutional documentation, including through algorithmic impact assessments, public model registries, and clear guidelines for risk communication (EU, 2021; WORLD BANK, 2020). Without transparency, decisions become unappealable and unquestionable, shifting power to technocratic spheres of difficult democratic control.

Finally, the criterion of *accountability* states that, if algorithms model social reality, it is necessary to clearly identify who is responsible for their consequences. The public governance literature warns that decision-making regimes based on automatic rules tend to spread authorship, making it difficult to assign blame, correct errors, and repair damage (BOVENS; ZOURIDIS, 2002; HOOD; DIXON, 2015). Accountability requires the definition of specific duties of diligence for managers, developers, and suppliers; it requires audit trails, review procedures and correction mechanisms when injustices are detected (HABERMAS, 1997; PETERS; PIERRE, 2016). By articulating Governance and Sustainability, this criterion prevents innovation from becoming an act without an author, a "faceless power" that no one can question.

The central contribution of this section is to show that these four criteria are not occasional lists of good practices, but contemporary translations of philosophical and constitutional requirements. They operate as mediations between abstract values and concrete decisions, allowing algorithms to be evaluated not only for their performance, but for their compatibility with justice and democracy. When incorporated into the GIS Cycle, they become stable references for the design, implementation, and monitoring of algorithmic systems, favoring institutions that are more reflective and willing to learn from their own limits.

In summary, the results indicate that the legitimacy of algorithmic governance depends on the simultaneous observance of universalizability (justice), dignity (moral limits), transparency (public intelligibility), and accountability (duty to respond). The following subsections explore how these criteria unfold throughout the life cycle of systems, from planning to discontinuity, and how they can be transformed into operational guidelines for public policies oriented to the collective interest.

Figure 2*Four criteria for Algorithmic Governance*

Source: prepared by the author

To reduce the degree of indeterminacy, each criterion can be associated with operational indicators. Universalizability can be tested through impact analyses on vulnerable groups and non-discrimination audits. Dignity requires verification of meaningful human oversight, the right to object, and limits on permanent labeling. Transparency can be measured by the existence of public documentation, understandable explanations, and records of decisions. Accountability, on the other hand, requires audit trails, clear identification of decision-makers, and reparation procedures. These indicators do not exhaust the problem, but they offer verifiable parameters for institutional control.

4.2.1 Universalizability: from the moral imperative to public policy

The criterion of universalizability is based on the idea that legitimate norms are those that could be accepted by any citizen, considered equal in dignity and autonomy. In the Kantian tradition, a rule is only morally valid when it can be erected into universal law, without contradiction and without privilege (KANT, 2003). Contemporary justice theory reinforces this intuition by arguing that principles of government need to be justified from an impartial position, in which agents ignore contingent advantages and particularistic interests (RAWLS, 2008).

Transposed to the algorithmic sphere, this principle imposes that automated decisions can be publicly justified to those who will be affected. It is not enough for models to be efficient or technically sophisticated; It is necessary to verify whether the criteria embedded in the

computational routines, variables used, weights assigned, and performance metrics stand the test of reasonableness when exposed to democratic criticism. This point is particularly relevant in the face of evidence that algorithms can reproduce historical inequalities, amplifying biases present in the data and disproportionately affecting vulnerable groups (BAROCAS; SELBST, 2016; O'NEIL, 2016; GREEN, 2021).

Thus, universalizability acts as a substantive limit in the GIS Cycle, especially in the Governance axis. By requiring that technical rules can be defended as equitable, the capture of public policies by private rationalities or implicit discriminations is prevented. Algorithmic policies that would not pass the scrutiny of universalization, because they select beneficiaries in an opaque way, stigmatize territories or systematically penalize the same groups, lack legitimacy, regardless of the operational gains they present. Universalizability reintroduces, therefore, the republican ideal that no one should be subject to norms that they could not, in principle, co-sign.

4.2.2 Dignity: limits to instrumental rationality

The criterion of dignity deepens the reflection by recalling that people can never be treated as mere means for administrative, economic or security ends. In the classical formulation, dignity derives from the fact that human beings are ends in themselves, endowed with moral autonomy and the right to self-determination (KANT, 2003). In contemporary constitutionalism, this value becomes the foundation of the State and a parameter for controlling public policies (BINENBOJM, 2017; BANDEIRA DE MELLO, 2015).

Applied to the digital environment, the dignity criterion questions practices that reduce individuals to statistical profiles, risk scores or permanently suspect categories. Automated screening systems in social policies, education, or security can produce labels that are difficult to overcome, restricting future opportunities and naturalizing stigmas (CITRON; PASQUALE, 2014; CRAWFORD, 2021). The risk increases when relevant decisions are fully automated, with no real possibility of human review, converting citizens into objects of silent evaluation by machines.

Within the scope of the GIS Cycle, dignity acts as an ethical counterweight to innovation. She recalls that not every technical possibility is morally admissible. Even when algorithms promise significant efficiency gains, there is still a duty to assess whether the logic used violates essential boundaries of the human person, such as privacy, freedom of expression, equal treatment, and the right to challenge decisions that affect it (DONEDA, 2020; MENDES, 2021). Finally, dignity imposes a clear limit: it is not legitimate to govern by turning citizens into mere objects of calculation.

4.2.3 Transparency: Coming Out of the Cave in the Age of Code

Transparency responds to the danger that societies will live in a new form of cave, in which algorithmic projections acquire the appearance of incontestable truth. Since Plato, it has been known that appearances can imprison when not subjected to critical examination (Plato, 2000). In the digital context, opacity derives from technical complexity, trade secrets, and the probabilistic nature of the models, factors that make it difficult to understand why certain decisions were produced (PASQUALE, 2015; FLORIDI et al., 2018).

Transparency, however, does not mean indiscriminately disclosing everything, but making intelligible the purposes, premises and limitations of the systems used. This involves accessible documentation, algorithmic impact assessments, public model registries, the right to an explanation for affected persons, and institutional mechanisms for clear risk communication (OECD, 2019; EU, 2021; WORLD BANK, 2020). Transparency also presupposes real conditions for independent auditing, including by control bodies and researchers.

Within the GIS Cycle, transparency occupies a central position in the Governance axis, as it enables democratic control. Without it, decisions become unappealable, and authority moves to technocratic spheres that are not very visible. By illuminating decision-making processes, transparency prevents algorithms from operating as "black boxes" and allows society to distinguish between fair outcomes and mere shadows cast by statistical models. It is, therefore, a requirement for technological innovation to remain subordinate to the public sphere, and not the other way around.

4.2.4 Accountability: the power to model and the duty to respond

The criterion of accountability closes the set by stating that, if algorithms model the social world, someone must answer for their consequences. The public administration literature shows that automated systems tend to disseminate the authorship of decisions, making it difficult to identify those responsible and correct injustices (BOVENS; ZOURIDIS, 2002; HOOD; DIXON, 2015). Without clear rules, the phenomenon of "faceless power" occurs, in which errors are attributed to the machine and not to the human choices that configured it.

Accountability, in this context, means establishing duties of diligence throughout the entire life cycle of the system: planning, development, contracting, implementation, monitoring, and discontinuity. Each stage must have clearly identified agents, with obligations to document, test, review and correct when damage is detected (HABERMAS, 1997;

PETERS; PIERRE, 2016). This includes the right to reparation and the existence of institutional channels for contesting and reviewing automated decisions.

In the GIS Cycle, accountability integrates Governance and Sustainability: it prevents innovation from being an act without an author and ensures institutional learning over time. By recognizing that every technological architecture incorporates moral and political choices, the criterion obliges managers to justify, record, and publicly answer for them. With this, it transforms the automation of a democratic risk into an opportunity to strengthen the culture of accountability, an indispensable condition for the use of algorithms to remain compatible with a State that is intended, above all, to be republican and democratic.

4.3 GUIDELINES FOR THE LIFE CYCLE OF ALGORITHMIC SYSTEMS IN THE PUBLIC SECTOR

The normative criteria presented, universalizability, dignity, transparency and accountability, only reveal their full potential when translated into concrete guidelines for the life cycle of algorithmic systems. Recent literature shows that many ethical failures do not stem from bad intentions, but from the absence of institutional processes capable of anticipating risks, monitoring effects, and correcting course (WORLD BANK, 2020; OECD, 2019). Thus, more than listing good practices, it is about organizing a sequence of public decisions consistent with the GIS Cycle, in which governance, innovation, and sustainability act in an integrated way.

From the point of view of public management, the proposal developed here does not intend to replace existing norms, but to offer a decision roadmap. In practical terms, this means incorporating algorithmic impact assessments into contracting processes, recording the technical and legal motivations for choices, instituting formal channels for contestation, and providing for periodic reviews of the systems in place. It is, therefore, a matter of translating ethical principles into verifiable administrative routines, strengthening *accountability* without paralyzing innovation.

4.3.1 Planning: defining the problem before the solution

The first moment is to prevent technology from taking precedence over politics. Before hiring tools or developing models, the government must clearly delimit the public problem, its objectives and the values involved. The initial question is not "which algorithm to use?", but whether the use of algorithms is necessary, proportionate and justifiable, compared to less intrusive alternatives (LESSIG, 1999; MENDES, 2021).

At this stage, it is necessary to explain which goods will be prioritized, reduction of inequalities, expansion of access, improvement of targeting and how such goals dialogue with the criteria of universalizability and dignity. When values and purposes remain implicit, space is opened for technical decisions to replace political choices, shifting democratic deliberation into codes and databases (PASQUALE, 2015).

4.3.2 Design and development: incorporating ethics from the beginning

Once the problem is defined, the design of the system must occur in an interdisciplinary way. Technical teams need to dialogue with professionals in law, philosophy, public policy, and institutional control, preventing modeling from being the exclusive domain of data specialists. The literature emphasizes that apparently neutral options, choice of variables, treatment of missing data, performance metrics, carry normative decisions (BAROCAS; SELBST, 2016; GREEN, 2021).

It is therefore recommended to document justifications, carry out prior algorithmic impact assessments and identify, from the outset, possible discriminatory effects, especially on historically vulnerable groups (EU, 2021; OECD, 2019). In cases of contracting with third parties, transparency clauses, access for auditing, and clear rules for data ownership and sharing become essential. The axis of Governance, in this phase, consists of recognizing that each line of code translates a public policy option.

4.3.3 Implementation: human oversight and right to challenge

During implementation, systems should not fully replace human judgment, especially when they produce high-impact decisions on fundamental rights. The literature points out that public trust depends on the possibility of revision and the existence of a way out for unfair decisions (CITRON; PASQUALE, 2014; DONEDA, 2020).

Thus, it is recommended that algorithms operate as decision support, and not as an indisputable final authority. Affected citizens need to have accessible channels to question results and obtain understandable explanations, which at the same time reinforces the criteria of dignity and transparency. From the point of view of institutional sustainability, this stage requires continuous monitoring, with the collection of evidence on systematic errors, biases, and unforeseen effects, transforming implementation into a learning process.

4.3.4 Monitoring, review, and discontinuity: learning from the effects

No algorithmic system should be considered definitive. Use over time produces externalities, alters behaviors, and can generate dependencies that are difficult to reverse.

For this reason, international best practices recommend periodic reviews, with the participation of control bodies, independent experts and, when possible, representatives of civil society (WORLD BANK, 2020; EU, 2021).

These reviews should evaluate not only technical performance, but also distributive impacts, respect for rights, and compatibility with the public interest. When adverse effects prove to be serious, discrimination, unappealable opacity, erosion of fundamental guarantees, the State needs to have clear mechanisms of correction or discontinuity, including adequate reparation for injured persons (HABERMAS, 1997; PETERS; PIERRE, 2016).

This last movement materializes the axis of Sustainability in the GIS Cycle: recognizing that technological decisions leave institutional and intergenerational traces and, therefore, require the ability to review, record, and respond to the paths adopted.

4.3.5 Synthesis: from technique to self-government

The guidelines presented show that governing algorithms means, ultimately, governing the exercise of power itself. When careful planning, ethical design, responsible implementation, and reflective monitoring are articulated, digital transformation ceases to represent a technocratic threat and becomes an opportunity to deepen democracy.

The key is to understand that technological neutrality is a myth. Algorithmic systems incorporate worldviews, moral choices, and distribution criteria. Submitting them to the GIS Cycle, through the four reconstructed normative criteria, means putting politics and ethics back at the center of the decision-making process, preventing technology from becoming a new incontestable "Demiurge" (JONAS, 2006; CRAWFORD, 2021).

Thus, the results suggest that public policies mediated by algorithms only achieve legitimacy when anchored in processes that deliberate, explain and respond, three verbs that synthesize the passage from technological innovation to a true democratic governance of the digital.

4.4 INSTITUTIONAL TENSIONS, RISKS AND SAFEGUARDS

The analysis carried out so far shows that algorithmic governance does not eliminate historical dilemmas of public power; on the contrary, it reconfigures them into new forms. Instead of conflicts between bureaucracy and politics, or between efficiency and legality, tensions emerge between technical complexity and democratic control, between algorithmic personalization and equality, between massive data and privacy, between speed of innovation and institutional prudence (HOOD; DIXON, 2015; OECD, 2019). Acknowledging

these tensions is a decisive step toward formulating safeguards that don't demonize technology but also don't capitulate to its allure.

A first tension concerns the promise of efficiency. Automated systems are often presented as rational answers to problems of resource allocation and policy focus. However, efficiency gains can occur at the expense of rights, for example, when automation increases the undue exclusion of beneficiaries or makes it difficult to challenge administrative decisions (PASQUALE, 2015; CITRON; PASQUALE, 2014). The literature shows that technological solutions tend to hide values and choices under the appearance of neutrality, shifting moral debates into mathematical models (CRAWFORD, 2021; GREEN, 2021). The criterion of universalizability, in this context, works as a prudential brake, requiring that "efficient" policies also be justifiable to those affected.

A second tension involves structural opacity. Complex models, such as neural networks, have high performance, but make it difficult to explain specific results. When associated with trade secrets and restrictive contracts, they produce zones of public unintelligibility, in which not even managers can explain why someone was selected, classified or excluded (FLORIDI et al., 2018; EU, 2021). Added to this is the risk of excessive "epistemic authority": decisions tend to be accepted simply because "the algorithm said so." Transparency, here, ceases to be a mere administrative virtue and becomes a condition for the possibility of democratic control.

There are also tensions linked to technological dependence and the asymmetry of power between public administrations and large private suppliers. Contracting proprietary systems can generate institutional lock-in, making it difficult to audit, review, and migrate to more rights-compatible alternatives (WORLD BANK, 2020). This scenario increases the importance of contractual clauses that guarantee access to data, documentation, and logs, as well as the need for internal technical capabilities capable of critically dialoguing with providers (BOVENS; ZOURIDIS, 2002). Accountability, distributed throughout the life cycle, prevents structural failures from being naturalized as "inevitable machine errors."

Another relevant risk is the normalization of monitoring. The growth of databases and surveillance devices can stimulate preventive policies based on behavioral prediction, with profound impacts on privacy and freedom. Even when motivated by legitimate ends, such practices threaten to turn citizens into permanent objects of observation, eroding social trust (ZUBOFF, 2019; DONEDA, 2020). In these cases, the criterion of dignity reminds us that not every administrative benefit authorizes sacrificing essential spheres of autonomy.

In the face of this set of tensions, institutional safeguards play a decisive role. International experiences point to three minimum layers. The first is normative, involving data

protection laws, responsible AI frameworks, the requirement for impact assessments, and active advertising rules (OECD, 2019; EU, 2021). The second is organizational, with ethics committees, units specialized in data governance, audit protocols, and formal instances of social participation. The third is cultural, dependent on the continuous training of managers and civil servants to understand that technology is always a political decision mediated by technique, and not a substitute for deliberation.

These safeguards, when integrated into the GIS Cycle, make it possible to transform risks into institutional learning opportunities. Governance creates spaces of justification; innovation is submitted to ethical and legal criteria; Sustainability ensures that decisions can be reviewed in light of their intergenerational effects. The tension does not disappear, but becomes governable.

In summary, the results suggest that the central challenge is not to choose between adopting or rejecting algorithms, but to decide how to adopt them, under what limits, and with what guarantees. Automated systems can deepen inequalities, entrench opacities, and erode rights, but they can also expand administrative capacities and improve resource allocation when anchored in clear criteria. The decisive point is that, in the absence of safeguards, technology tends to assume the role of a new "world orderer", without justification. With robust safeguards, it becomes an instrument subordinate to the democratic project.

5 CONCLUSION

The path developed throughout this article started from an apparently simple concern: what actually changes when the State starts to decide with the support of algorithms? The answer proved to be broader than a mere technological update. By articulating classical philosophy, contemporary constitutionalism, and recent debates on governance and artificial intelligence, it has become evident that the central issue is not the "use of tools", but the reconfiguration of the exercise of power in societies increasingly mediated by data and computational models.

Human ambivalence, the Myth of the Cave, the Pythagorean heritage, the metaphor of the Demiurge, and the reconstruction of the supremacy of the public interest in a constitutional key converged to the same diagnosis: every form of order, including the digital order, carries a normative core. Algorithmic systems don't just describe reality; They model it, defining who shows up, who gets monitored, who will have access to policies, and who will stay on the margins. In this context, insisting on the neutrality of technology is equivalent to confusing, again, shadows with reality, only with more sophisticated mathematical tools.

The main contribution of this work was to transform this finding into a structured normative framework, organized in the GIS Cycle. Based on it, four criteria were identified that should guide public decisions mediated by algorithms: universalizability, dignity, transparency, and accountability. These criteria do not constitute an occasional list of good practices, but a contemporary translation of requirements already present in moral philosophy, in the theory of justice and in administrative law. Universalizability reminds us that decisions are only legitimate when they can be justified to all those affected; dignity imposes limits on the reduction of people to mere objects of calculation; transparency prevents the technique from becoming a new form of cave; accountability ensures that the power to shape reality does not dissolve into the anonymity of the machine.

By applying these criteria to the life cycle of algorithmic systems, from planning to discontinuity, the paper showed that there is no responsible governance without structured processes. Defining the problem before the solution, designing models with interdisciplinary participation, ensuring meaningful human oversight, opening channels of contestation, instituting periodic reviews, and providing for the possibility of interruption of systems incompatible with fundamental rights are not optional gestures: they are minimum conditions for technological innovation to remain subordinate to the public interest, and not the other way around. When these safeguards do not exist, automation tends to reinforce inequalities, opacities, and dependencies; When they exist, real possibilities are opened up to expand state capacities and qualify public policies.

It is important to recognize, however, the limits of the proposal. It is a study of a theoretical-conceptual nature, whose strength lies in the internal coherence of the argument and in the pertinence of the sources mobilized. The normative model presented here does not replace empirical investigations, field experiments or comparative case studies. On the contrary, it intends to prepare the ground so that these surveys can be conducted with greater clarity of criteria, avoiding both technofetishism and technopessimism. A promising agenda involves, for example, the application of the GIS Cycle to the analysis of systems already in use in areas such as health, education, social assistance, public security, and fiscal management, as well as the comparison between different institutional arrangements of algorithmic governance at the national and international levels.

Despite these limits, the central argument remains: there is no technical way out of a problem that is, above all, ethical and political. The growing presence of algorithms in the action of the State does not dispense with democratic deliberation; on the contrary, it makes it more urgent. In a scenario in which decisions tend to be justified by the authority of statistical models, reaffirming the need to justify oneself before concrete citizens and not just before

indicators is a gesture of democratic resistance. It is also a way of remembering that the State, even when digital, remains bound by the commitment to treat each person as an end in himself.

Ultimately, governing algorithms is a way of governing oneself as an institution. By proposing that all technological innovation in the public sector be passed through the sieve of universalizability, dignity, transparency, and accountability, this article suggests that the digital society does not need to be a new chapter of heteronomy imposed by the code. On the contrary, it can become an opportunity to deepen the ideal of a power that knows itself to be dangerous, and therefore limits itself; he knows himself to be fallible, so he lets himself be controlled; he knows he is a creator, so he is responsible for the world he helps to build. If this intuition is taken seriously, the digital transformation of the State will no longer be just a project of administrative modernization and can be understood as what, in fact, is at stake: a new stage in the history of the struggle for a fairer, more reflective, and truly democratic public governance.

REFERENCES

- Arendt, H. (2014). *A condição humana* (10ª ed.). Forense Universitária.
- Bovens, M. (2007). Analysing and assessing accountability: A conceptual framework. *European Law Journal*, 13(4), 447–468.
- Brasil. (2018). Lei nº 13.709, de 14 de agosto de 2018. Lei Geral de Proteção de Dados Pessoais (LGPD). Presidência da República.
- Cavalcante, A. F. (2025). O Demiurgo e a construção do real algorítmico: Ética, poder e responsabilidade no Estado digital. *Revista Aracê*, 7(12), 1–28.
- Cavalcante, A. F., & Lima, J. S. (2025). Entre o planejamento e a democracia: Orçamento, participação popular e o Ciclo GIS. *Revista PPC – Políticas Públicas e Cidades* (no prelo).
- Crawford, K. (2021). *Atlas of AI: Power, politics, and the planetary costs of artificial intelligence*. Yale University Press.
- European Commission. (2021). Proposal for a Regulation laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act).
- Green, B. (2022). *The smart enough city: Putting technology in its place to reclaim our urban future*. MIT Press.
- Habermas, J. (1997). *Direito e democracia: Entre facticidade e validade*. Tempo Brasileiro.
- Hobbes, T. (2003). *Leviatã*. Martins Fontes.
- Jonas, H. (2006). *O princípio responsabilidade*. PUC-Rio; Loyola.
- Kant, I. (2003). *Fundamentação da metafísica dos costumes*. Martins Fontes.
- Kitchin, R. (2017). *The data revolution: Big data, open data, data infrastructures and their consequences*. SAGE.

- Moore, M. (1995). *Creating public value: Strategic management in government*. Harvard University Press.
- Noble, S. U. (2018). *Algorithms of oppression: How search engines reinforce racism*. NYU Press.
- Organisation for Economic Co-operation and Development. (2019). *OECD Principles on Artificial Intelligence*. OECD.
- O'Neil, C. (2016). *Weapons of math destruction*. Crown.
- Osborne, S. (2006). The new public governance? *Public Management Review*, 8(3), 377–387.
- Pasquale, F. (2015). *The black box society*. Harvard University Press.
- Platão. (2006). *A República*. Martins Fontes.
- Rawls, J. (2008). *Uma teoria da justiça*. Martins Fontes.
- United Nations Educational, Scientific and Cultural Organization. (2022). *Recommendation on the Ethics of Artificial Intelligence*. UNESCO.
- Zuboff, S. (2019). *The age of surveillance capitalism*. PublicAffairs.

COLLABORATIVE TEACHING: PERSPECTIVES, POSSIBILITIES, AND CONTRIBUTIONS TO THE INCLUSION OF STUDENTS WITH AUTISM SPECTRUM DISORDER

ENSINO COLABORATIVO: PERSPECTIVAS, POSSIBILIDADES E CONTRIBUIÇÕES PARA A INCLUSÃO DE ALUNOS COM TRANSTORNO DO ESPECTRO AUTISTA

ENSEÑANZA COLABORATIVA: PERSPECTIVAS, POSIBILIDADES Y CONTRIBUCIONES A LA INCLUSIÓN DE ESTUDIANTES CON TRASTORNO DEL ESPECTRO AUTISTA



<https://doi.org/10.56238/sevened2026.008-007>

Maria Rosa da Luz Lopes da Conceição¹, Caroline Gisele Santos Silva², Vivaldo Gomes da Silva Júnior³, Scheivla Suanne de Andrade Rodrigues Tork⁴, Noely Corrêa Souza Pereira⁵, Maria Gorete Vilhena Neves⁶, Cristina Picanço de Sousa Corrêa⁷, Janiele da Silva Melo Rabelo⁸

ABSTRACT

Considering the advancements in inclusive education policies and the significant growth in enrollment of students with Autism Spectrum Disorder (ASD) in basic education, challenges persist regarding the effective implementation of collaborative pedagogical practices between the regular classroom teacher and the special education teacher, justifying this study. The research aimed to analyze, through a literature review, the perspectives, possibilities, and contributions of collaborative teaching to the inclusion of students with ASD in basic education. To this end, a qualitative research study was conducted, specifically a bibliographic review, analyzing national and international scientific publications selected from the Scielo, Google Scholar, and CAPES Periodicals Portal databases, using descriptors related to inclusive education, collaborative teaching, and ASD. Thus, it is observed that collaborative teaching is configured as a relevant pedagogical strategy for improving the teaching and learning process, favoring the participation, academic and social development of students with ASD, in addition to promoting teacher co-responsibility and the articulation between mainstream education and Specialized Educational Services. This leads to the

¹ Master's degree in Public Policy Planning. Universidade Estadual do Ceará (UECE).

E-mail: rosallopes23@gmail.com

² Special Education Specialist. Universidade de Tecnologia do Amapá (FTA).

E-mail: carol.gisele.cg@gmail.com

³ Special Education Specialist. Faculdade Atual (FA). E-mail: vivaldogsjunior@gmail.com

⁴ Special Education Specialist. Faculdade Santa Fe. E-mail: scheivla@gmail.com

⁵ Specialist in Neuropsychology. Universidade Estácio de Sá. E-mail: noelyc9.unimulher@gmail.com

⁶ Specialist in Special and Inclusive Education. Faculdade de Tecnologia do Amapá (FTA).

E-mail: mgneves.40@gmail.com

⁷ Master's student in Special Education. Universidade Federal do Amapá (UNIFAP).

E-mail: cristinacorrea.unifap.t4@gmail.com

⁸ Dr. in Biotechnology and Biodiversity. Universidade de Brasília (UNB). E-mail: janielle.melo@unb.br

conclusion that the effectiveness of collaborative teaching depends on institutional conditions, collective planning, ongoing teacher training, and the integration of pedagogical practices into the school's Political-Pedagogical Project.

Keywords: Inclusive Education. Autism Spectrum Disorder. Collaborative Teaching. Special Education.

RESUMO

Considerando os avanços das políticas de educação inclusiva e o crescimento expressivo das matrículas de estudantes com Transtorno do Espectro Autista (TEA) na educação básica, persistem desafios relacionados à efetivação de práticas pedagógicas colaborativas entre o professor da sala comum e o professor da Educação Especial, o que justifica a realização deste estudo. A pesquisa teve objetivo analisar, a partir de uma revisão da literatura, as perspectivas, possibilidades e contribuições do ensino colaborativo para a inclusão de estudantes com TEA na educação básica. Para tanto, procede-se a uma pesquisa de natureza qualitativa, do tipo revisão bibliográfica, com análise de produções científicas nacionais e internacionais, selecionadas nas bases de dados Scielo, Google Acadêmico e Portal de Periódicos CAPES, utilizando descritores relacionados à educação inclusiva, ensino colaborativo e TEA. Desse modo, observa-se que o ensino colaborativo se configura como uma estratégia pedagógica relevante para a qualificação do processo de ensino e aprendizagem, favorecendo a participação, o desenvolvimento acadêmico e social dos estudantes com TEA, além de promover a corresponsabilização docente e a articulação entre o ensino comum e o Atendimento Educacional Especializado. O que permite concluir que a efetivação do ensino colaborativo depende de condições institucionais, planejamento coletivo, formação continuada dos professores e integração das práticas pedagógicas ao Projeto Político-Pedagógico da escola.

Palavras-chave: Educação Inclusiva. Transtorno do Espectro Autista. Ensino Colaborativo. Educação Especial.

RESUMEN

Considerando los avances en las políticas de educación inclusiva y el crecimiento significativo de la matrícula de estudiantes con Trastorno del Espectro Autista (TEA) en la educación básica, persisten desafíos en cuanto a la implementación efectiva de prácticas pedagógicas colaborativas entre el docente de aula regular y el docente de educación especial, lo que justifica este estudio. La investigación tuvo como objetivo analizar, mediante una revisión bibliográfica, las perspectivas, posibilidades y contribuciones de la enseñanza colaborativa a la inclusión de estudiantes con TEA en la educación básica. Para ello, se realizó una investigación cualitativa, específicamente una revisión bibliográfica, analizando publicaciones científicas nacionales e internacionales seleccionadas de las bases de datos de Scielo, Google Académico y el Portal de Periódicos CAPES, utilizando descriptores relacionados con la educación inclusiva, la enseñanza colaborativa y el TEA. Así, se observa que la enseñanza colaborativa se configura como una estrategia pedagógica relevante para mejorar el proceso de enseñanza y aprendizaje, favoreciendo la participación, el desarrollo académico y social del alumnado con TEA, además de promover la corresponsabilidad docente y la articulación entre la educación regular y los Servicios Educativos Especializados. Esto lleva a la conclusión de que la eficacia de la enseñanza colaborativa depende de las condiciones institucionales, la planificación colectiva, la formación docente continua y la integración de las prácticas pedagógicas en el Proyecto Político-Pedagógico de la escuela.

Palabras clave: Educación Inclusiva. Trastorno del Espectro Autista. Enseñanza Colaborativa. Educación Especial.

1 INTRODUCTION

The consolidation of inclusive education in Brazil has required significant transformations in public policies, in the organization of educational institutions and, above all, in the pedagogical practices developed in everyday school life. Based on the principles of the right to education, access, permanence and learning, the school is now called upon to attend to the diversity of its students, recognizing their singularities and potentialities. In this context, the schooling of students with Autism Spectrum Disorder (ASD) has become one of the great contemporary challenges for educational systems.

ASD is characterized by persistent deficits in communication and social interaction, associated with restricted and repetitive patterns of behavior, interests, and activities, which can directly impact teaching and learning processes. In view of these specificities, it is essential that schools develop pedagogical strategies that promote not only these students' access to regular education, but also their effective participation and the development of meaningful learning. Thus, inclusive education demands practices that overcome segregating models and punctual interventions, moving towards collaborative and integrated pedagogical proposals.

In this scenario, collaborative teaching, also called co-teaching, has been pointed out in the national and international literature as a promising strategy for the inclusion of students who are the target audience of Special Education, especially those with ASD. This approach is based on the partnership between the common room teacher and the Special Education teacher, who share responsibilities in the planning, execution and evaluation of pedagogical activities, working together in the same educational space. By promoting teacher co-responsibility, collaborative teaching contributes to the reorganization of pedagogical practices and to the construction of a more inclusive school environment.

In the context of Brazilian educational policies, normative advances have reinforced the need for articulated and collaborative pedagogical practices. The current legislation establishes that instruments such as the Specialized Educational Service Plan (PAEE) and the Individualized Educational Plan (PEI) must be integrated into the school's Political-Pedagogical Project (PPP), guiding the work developed in the common room, in the Specialized Educational Service (AEE) and in collaborative activities. This normative perspective shows that school inclusion must be understood as an institutional commitment, which involves the entire school community.

Despite legal and theoretical advances, the implementation of collaborative teaching still faces challenges related to teacher training, the organization of pedagogical work and school culture, which highlights the need to deepen discussions about this approach.

In view of this, this article aims to analyze, through a literature review, the contributions of collaborative teaching to the inclusion of students with ASD in basic education, identifying its contributions, its foundations and possibilities, in the light of the scientific literature and the legal frameworks of inclusive education in Brazil.

2 THEORETICAL FRAMEWORK

2.1 AUTISM SPECTRUM DISORDER (ASD)

According to Castro (2020, p.19) the word autism comes "from the Greek autos, which means of oneself turned inwards, associated with the suffix ism, which means belonging to something". This was the name created by Eugen Bleuler in 1908. In the course of research and study, in 2013 autism was renamed Autism Spectrum Disorder (ASD), according to the Statistical Diagnostic Manual of Mental Disorders-DSM 5 (APA, 2013).

A key milestone in autism studies occurred in 1943, when psychiatrist Leo Kanner published pioneering research describing a group of children who had significant difficulties in social interaction and communication. These observations were important because they allowed the identification of behavioral characteristics that, until then, were not clearly understood or differentiated from other conditions of child development (Kanner, 1943).

With the advancement of clinical observation over the years and the deepening of research, the understanding of autism has been expanded. It has come to be recognized that these characteristics do not manifest themselves in a single or homogeneous way, but vary significantly from individual to individual. In this way, autism is no longer understood as a single and restricted condition and is now conceptualized as a spectrum disorder, that is, a set of diverse manifestations that can present different levels of severity, support needs, and forms of expression.

Autism Spectrum Disorder (ASD) is not configured as a closed or fully delimited concept. There is, to date, no scientific consensus regarding its definition or its etiology. This lack of definition stems, to a large extent, from the fact that the exact origin of autism is not yet known, or even if it is possible to attribute it to a specific cause.

The causes of ASD are not unique or simple, as the disorder results from several factors acting together, and not from a single origin. These factors mainly include genetic components, such as hereditary alterations or predispositions, and environmental factors, which can influence neurological development before, during, or after birth. (Velarde; Cárdenas, 2022)

In ASD, there is a wide diversity of manifestations within the spectrum, which involves different interpretations of their possible origins, clinical characteristics, comorbidities,

diagnostic processes, therapeutic approaches, and other related aspects. In view of this plurality, it becomes complex to construct a single and precise definition of Autism Spectrum Disorder. According to Arvigo and Schwartzman, 2020, p. 15, ASD is characterized:

[...] persistent deficits in communication and social interaction, associated with restricted and repetitive patterns of behavior, interests and/or activities. Its symptoms often overlap with those of other conditions, being easily confused with Developmental Language Disorder (LDD), Attention Deficit Hyperactivity Disorder (ADHD), in addition to numerous genetic syndromes such as Rett Syndrome and other conditions that lead to impairments in social, linguistic, motor and/or cognitive behaviors (Arvigo; Schwartzman, 2020, p. 15).

ASD is a neurodevelopmental condition marked mainly by continuous difficulties in communication and social interaction, such as problems expressing oneself, understanding social rules, or establishing interpersonal relationships. In addition, it involves restricted and repetitive behaviors, interests, or activities, such as repetitive movements, rigidity to change, or very specific interests. The signs of the disorder may resemble those of other conditions, which makes the diagnosis more complex. Some genetic syndromes also have similar characteristics.

The Diagnostic and Statistical Manual of Mental Disorders - 5th edition (APA, 2014) explains that ASD is characterized by severe and invasive impairment in some areas of development, such as reciprocal social interaction skills and the non-verbal behaviors used for it, communication skills, socio-emotional reciprocity skills, difficulty developing, maintaining and understanding relationships and the presence of behaviors, stereotyped interests and activities.

Many children with ASD have a delay in starting to speak or use language differently than expected for their age. This delay does not occur in isolation, but is usually associated with other developmental changes. Another characteristic according to DSM-5 is the absence of interest in typical social interactions, such as eye contact, exchange of glances or communication initiative. Children handle objects in a repetitive or functionally limited way, they can also demonstrate specific skills, but at the same time, present difficulties in basic aspects of social communication.

2.2 THE SCHOOLING OF STUDENTS WITH ASD

The right to access and permanence in educational institutions is guaranteed in the Federal Constitution of 1988, which states in Article 206, item I, that: "Education shall be provided based on the following principles: I – equality of conditions for access and permanence in school." (Brazil, 2024, p. 186). In addition, this right is reinforced by other

constitutional provisions, such as Article 205 – Defines education as a right of all and a duty of the State and of the family, aiming at the full development of the person, the exercise of citizenship and qualification for work and Article 208 – Establishes the duties of the State with education, including specialized educational assistance to people with disabilities, preferably in the regular school system. (Brazil, 2024).

Another important provision for the school inclusion of people with ASD is the Law of Guidelines and Bases of National Education - LDBEN, Law 9394/96, which ensures the offer of Special Education as a transversal modality, preferably in the regular school network, ensuring specialized educational care for students with disabilities, global developmental disorders and high abilities or giftedness. According to article 59 of the LDB, education systems must ensure specific curricula, methods, techniques, educational resources and organization to meet the needs of students who are the target audience of Special Education (Brasil, 1996).

In this context, it is pertinent to emphasize that Law No. 12,764/2012 brought specific and extremely relevant rights to the process of inclusion of students with autism. This regulation, which institutes the National Policy for the Protection of the Rights of Persons with Autism Spectrum Disorder, also known as the Berenice Piana Law, ensured people with ASD, for all legal purposes, the same rights conferred on people with disabilities. It specifies, in its article 3, item IV, paragraph "a", among the rights of the person with ASD, the right "to education and vocational training" (Brasil, 2012).

School inclusion is fundamental for the development of children with ASD, as it guarantees them coexistence with other children of the same age group in a common educational environment. This interaction transforms the school into a space not only for academic learning, but also for welcoming differences and social development.

By participating in this context, the person with ASD has their interaction capacities stimulated, which contributes to avoiding prolonged social isolation. Social skills are not innate, but can be learned and developed through the interactions and exchanges that occur during the social learning process. In this sense, interaction with peers is essential for the development of anyone, regardless of whether or not they have ASD, being the basis for the construction of social, emotional and communicative skills (Vieira; Alves; Bringel, 2023).

It is relevant to note that education data in Brazil in recent years according to the School Census have shown a significant growth in enrollment of students with ASD between the years 2023 and 2024, with an increase of 44.4% in the number of students with ASD enrolled in basic education. This growth is demonstrated by the increase from approximately

636 thousand to almost 920 thousand students, which reveals a substantial expansion of this public in the educational system in just one year. (Brazil, 2024)

Students with ASD constitute an important portion of the public served by Special Education. This reinforces the centrality of ASD in inclusive educational policies and practices. There is a growth trend over time, as since 2020, the total number of enrollments in Special Education has grown by 58.7%. (Brazil, 2025).

The continuous and significant growth in enrollment in Special Education in Brazil in the period from 2020 to 2024, indicating advances in both access and school inclusion in regular classes. It is observed that the total number of enrollments went from 1,308,900 in 2020 to 2,076,825 in 2024, representing a significant increase over the five years analyzed. This growth suggests greater identification of students as the target audience of Special Education, expansion of inclusive policies and greater demand for specialized educational services.

2.3 CONCEPT AND FOUNDATIONS OF COLLABORATIVE TEACHING

2.3.1 Definition of collaborative teaching

Co-teaching, also called Collaborative Teaching or collaborative work, is a pedagogical proposal that emerged in the United States in the late 1980s, with the objective of favoring the schooling of students who are the target audience of Special Education (PAEE) in regular education classes, this form of teaching has been considered a promising strategy, as it contributes to the effectiveness of school inclusion, expanding the opportunities for learning, participation and development of these students in the regular school environment (Mendes; Vilaronga; Zerbato, 2023; Capellini; Zerbato, 2019).

According to the international literature, Collaborative Teaching is a pedagogical practice based on the partnership between regular education and special education teachers. In this type of work, both professionals share responsibilities and act together in all stages of the educational process. (Cook; Friend, 1993).

This means that teachers need to plan together and execute classroom activities in an integrated way and also collectively evaluate student performance. In this sense, "collaborative teaching should be understood as a new model of education, in which everyone feels responsible for the process of school inclusion". (Fontes, 2009, p. 42).

The core of Collaborative Teaching is to serve a diverse group of students, recognizing that the class is heterogeneous and that some students have specific educational needs. Thus, "collaborative teaching is a work alternative involving the cooperation between a regular school teacher and a special school teacher, who work together in the same class,

when there is the presence of one or more students who demand differentiated attention" (Marin and Maretti, 2014, p.3).

In this way, this approach seeks to ensure the participation, learning, and development of all, respecting differences and promoting school inclusion. Collaborative teaching is a form of organization of pedagogical work in which two teachers work together in the same classroom. This partnership aims to better serve the students who are the target audience of special education, without removing them from the regular class.

Co-teaching presupposes the integrated performance of two or more professionals, who share responsibilities in the planning, execution of classes and evaluation of student learning. This cooperation breaks with the logic of the teacher's isolated work. Collaboration is not limited to simultaneous presence in the classroom, but involves the collective construction of pedagogical strategies, the definition of methodologies and the joint analysis of learning outcomes. (Santos, 2015).

For Santos (2015), the main objective of this approach is to respond to the different forms and rhythms of learning of students, ensuring that everyone has access to the curriculum and development opportunities. A partnership between regular education and special education, this practice often occurs through the articulation between regular class teachers and special education teachers. In addition to teachers, collaborative teaching can involve other professionals in education and the support area, such as therapists and educational assistants, expanding the possibilities of intervention and support for the educational process.

The collaborative partnership between regular education and special education teachers according to Gately (2001, p. 42) is defined in three stages, after the implementation of the co-teaching proposal, as explained in chart 2:

Table 1*Definition of three stages of cohesive implementation*

Internships	Definition
Early stage	In which both teachers make an effort to relate, but communication is superficial and formal
Commitment stage	In this stage, professionals communicate more openly, with more interaction and more frequently as trust is established, consequently contributing to collaboration in teaching
Collaborative internship	In which interaction and communication occur in a natural and comfortable way for all those involved in working together.

Source: Gately (2001)

Co-teaching is based on the idea that the barriers to learning are not exclusively in the student, but in the way the school is structured. Therefore, he argues that it is the school institution that must change its structure to meet the diversity of students.

The co-teaching work model is based on the social approach because it presupposes that the school must be modified and that it is necessary to qualify the teaching given in regular classes, where the student spends most of the time of his school day. Thus, if teaching in the regular class does not respond to the needs of these students and does not favor their participation and learning, it will be useless to extend their working hours by one or two hours a week to offer SEA, as if the problem were centered on the student with disabilities, and not on the school (Mendes; Vilaronga; Zerbato, 2023, p. 17).

The common classroom is the main space for schooling, so it is in this context that teaching needs to be qualified to ensure, welcoming, participation in the teaching and learning process in an effective way. Therefore, it is not enough to extend the time of SEA if teaching in the regular class is not inclusive. Offering more time than one or two hours per week for SEA does not compensate for exclusionary or inaccessible pedagogical practices in the regular school classroom.

2.3.2 Collaborative practices provided for in the legislation

Decree No. 12,773, of December 8, 2025, reinforces the importance of collaborative work in the field of Special Education, highlighting that actions and activities must involve intersectoral articulation, that is, collaboration between different sectors and professionals to ensure quality education for the special education public. Specifically, article 12 and other provisions mention the need for articulated and collaborative actions, which guide activities both in the common classroom and within the scope of the Specialized Educational Service

(AEE), promoting intersectoral actions for inclusion and adequate support for students with disabilities.

Decree No. 12,773 establishes the obligation to prepare an individualized pedagogical document for the student, which must be updated continuously. This document is the PAEE (Specialized Educational Service Plan) and the PEI (Individualized Educational Plan), and must be built from a case study, that is, from a detailed analysis of the needs, potentialities

It is important to note that Decree No. 12773/2025 follows in its text what is established by CNE/CP Opinion No. 50/2023, which deals with guidelines and proposals for the education of students with Autism Spectrum Disorder (ASD) and other disabilities, in the context of inclusive education in Brazil.

From the proposition of the case study, its instruments are then established: the Specialized Educational Service Plan (PAEE) and the Individualized Educational Plan (PEI), both of a pedagogical nature, which make up the PPP of the school unit. These documents should guide the work to be developed in the common classroom, within the scope of the SEA, in the collaborative activities of the educational unit and in the demands of intersectoral articulation. (Brazil, 2023, p.13).

The proposition of the case study allows us to understand, in depth, the specific educational needs of the student. From this analysis, more appropriate and individualized pedagogical decisions become possible. Based on the case study, two central instruments are established: the PAEE, which organizes the actions of the SEA and the PEI, which defines objectives, strategies, adaptations and resources necessary for the student's teaching and learning process.

In this context, the current legislation is a very important factor for the construction of a cohesive/collaborative teaching between SEA and regular education teachers, because for the elaboration of the instruments the need for continuous planning among these professionals to conduct the pedagogical work in the classroom.

2.3.3 Teachers and co-teaching

Teachers need time, knowledge, organization and planning to meaningfully carry out co-teaching in order to adapt to this new approach in the teaching and learning process. This partnership is built gradually and with the support of the school and other professionals, such as the pedagogue and principal. It is important to note, as Vilaronga and Mendes (2017, p.27) point out, the "co-teaching proposal has the characteristic of being adaptive, therefore, it requires time for contextual changes. It must be intentionally cultivated or developed and also be considered in the processes of formation, both initial and continued".

Part of the difficulties in developing collaborative work is related to values, beliefs and practices historically constructed in the school, such as the view that each teacher acts in isolation or that special education is the exclusive responsibility of a single professional. Breaking with this cultural logic requires profound changes in the way teaching work is understood and organized. This implies abandoning fragmented practices and moving towards joint and co-responsible action.

In this sense, it is extremely relevant to clearly and complement the functions and attributions of the regular education teacher and the special education teacher. This definition is essential to avoid overlaps, omissions, or conflicts and to ensure that both contribute effectively to student learning.

The proposition of a work that has two teachers, or more, sharing the responsibility of teaching, in which students who are the target audience of special education have to be contemplated in school learning, generates certain basic conditions. Among these conditions are: space and time to promote the exchange of experiences and knowledge of the contents of both parties; discussion and theoretical deepening regarding the decisions expressed in the school's Pedagogical Political Project (Michelluzzi; Cordeiro; Selau, 2022).

2.3.4 Main contributions in the school context

The main contributions and results observed in regular education classes, where there are children with ASD in elementary school in the early years, when there is collaborative work involving the regent teacher and the Special Education teacher, according to research by Martins, Santos and Denari (2017), include: intellectual abilities superior to those of neurotypical colleagues, ease of memorization, a wide linguistic repertoire and a lot of property when expressing their ideas.

For Martins, Santos and Denari (2017), specialized educational support, in partnership with the work of the regent teacher, brings good results to the teaching-learning process for these students. In general, collaborative work involving several professionals is seen as a certainty that the schooling process has a greater opportunity to happen successfully.

According to Silva and Junior (2024), collaborative teaching in the inclusion of students with autism enhances the access, permanence and participation of students with ASD in the regular classroom. Collaboration allows the exchange of experiences, knowledge and specific pedagogical strategies, adjusted to the needs of students with ASD, favoring their integral development.

The studies by Cardoso and Pisetta (2024) concluded that collaborative teaching promotes articulation, allowing moments of exchange, listening, and greater knowledge of

the possibilities and potentialities of autistic students, contributing to the articulation between teachers. Collaborative work proves to be an important and powerful means to resignify the school environment, contribute to the articulation between teachers, integrate pedagogical practice and reflect on practice.

Corroborating the study, Vilaronga and Mendes (2014, p. 149) emphasize that "the scientific literature related to co-teaching, although promising, shows the need for more studies on the collaboration between regular teachers and special education teachers in schools". This shows the need for more research and investigations that address the practice of collaborative teaching in educational institutions in the teaching and learning process of students with disabilities and especially those with autism.

3 METHODOLOGY

The present study is characterized as a qualitative research, of the bibliographic review type, whose objective was to analyze how collaborative teaching has been discussed, presented and applied in the scientific literature as a strategy to favor the inclusion of students with ASD in basic education, as well as to identify its main contributions and possibilities in the school context.

The bibliographic review was developed in a systematic and analytical way, contemplating scientific productions and normative documents related to inclusive education, collaborative teaching, schooling of students with ASD and educational public policies. The survey of sources took place in national and international databases recognized in the area of Education, such as SciELO, Google Scholar, CAPES and ERIC Journals, in addition to consulting official documents, including laws, decrees, opinions and guidelines of the Ministry of Education.

To search for publications, the following descriptors were used, in isolation and combined by Boolean operators: collaborative teaching, co-teaching, inclusive education, Autism Spectrum Disorder, ASD, special education, Specialized Educational Service (SES), PAEE and PEI. The inclusion criteria considered: a) scientific articles, books, book chapters and normative documents that directly addressed collaborative teaching and/or the inclusion of students with ASD; b) productions published in Portuguese and English; c) studies with theoretical or empirical relevance to the educational context, especially in the context of basic education.

Materials that did not have a direct relationship with the object of study, duplicate publications, or texts that dealt with the topic in a superficial way, without consistent theoretical foundation, were excluded. The data analysis process occurred in three stages:

exploratory reading, with the objective of identifying the pertinent texts; analytical reading, aimed at the in-depth understanding of the contents; and interpretative reading, in which the data were organized and discussed in the light of the adopted theoretical framework.

Based on this analysis, the studies were grouped into thematic categories, such as: fundamentals of collaborative teaching, implementation models, contributions to the inclusion of students with ASD, challenges faced by teachers and institutional conditions necessary for the effectiveness of this practice.

This methodology enabled a broad and critical view of collaborative teaching as an inclusive pedagogical strategy, contributing to the understanding of its importance in the schooling process of students with ASD and to the reflection on the paths necessary for its consolidation in educational institutions.

4 RESULTS AND DISCUSSIONS

The analysis of the literature allowed us to identify that collaborative teaching has been widely discussed as a promising pedagogical strategy for the inclusion of students with ASD in basic education. The reviewed studies show conceptual, normative and practical advances, while revealing persistent challenges for their effectiveness in the school routine.

For analytical purposes, the results were organized into five thematic categories, in line with the specific objectives of the study: (1) theoretical foundations of collaborative teaching; (2) models and forms of implementation; (3) contributions to the inclusion of students with ASD; (4) challenges faced; and (5) necessary conditions for the effectiveness of collaborative practices.

4.1 FUNDAMENTALS OF COLLABORATIVE TEACHING

The studies analyzed converge in understanding collaborative teaching as an approach that breaks with the traditional and fragmented logic of teaching work. Authors such as Cook and Friend (1993), Capellini and Zerbato (2019) and Mendes, Vilaronga and Zerbato (2023) highlight that this practice is based on pedagogical co-responsibility, joint planning and integrated action between the common room teacher and the Special Education teacher.

In this sense, collaborative teaching is aligned with the principles of inclusive education, by recognizing diversity as constitutive of the school environment and by shifting the focus from the student's difficulties to the reorganization of pedagogical practices and school structure. This conception is in line with the current Brazilian legislation, which assigns to the school the responsibility of ensuring conditions of access, permanence, participation and learning for all students.

4.2 MODELS AND FORMS OF IMPLEMENTATION OF COLLABORATIVE TEACHING

The literature points to different ways of implementing collaborative teaching, varying according to the institutional context, the training of teachers and the level of articulation between the professionals involved. The most recurrent models include simultaneous co-teaching, teaching in stations, alternating teaching and complementary support in a common room.

Table 2 summarizes the main models identified in the literature and their central characteristics.

Table 2

Collaborative teaching models identified in the literature

Co-teaching model	Key features
Simultaneous co-teaching	Both teachers work together in the same activity and with the whole group
Teaching in stations	The class is divided into groups, with activities conducted alternately by the teachers
Alternate teaching	One teacher leads the main activity while the other works with a smaller group
Collaborative support	The Special Education teacher offers pedagogical support in a common room

Source: prepared by the authors (2025)

These models show that collaborative teaching is not configured as a single or rigid practice, but as a flexible and adaptive approach, which must consider the needs of students with ASD and the conditions of the school.

4.3 CONTRIBUTIONS OF COLLABORATIVE TEACHING TO THE INCLUSION OF STUDENTS WITH ASD

The studies analyzed indicate that collaborative teaching contributes significantly to the learning, participation and social development of students with ASD. Among the main contributions highlighted are the expansion of access to the curriculum, the adaptation of pedagogical strategies, the encouragement of social interactions and the appreciation of students' potential.

Research such as those by Martins, Santos and Denari (2017), Silva and Junior (2024) and Cardoso and Pisetta (2024) demonstrate that joint work between teachers favors interventions more adjusted to the needs of students with ASD, promoting greater engagement in school activities and reducing barriers to learning.

Table 3 presents a summary of the main contributions pointed out in the reviewed studies.

Table 3

Contributions of collaborative teaching for students with ASD

Dimension	Identified contributions
Learning	Curricular adaptation, diversification of strategies and greater access to content
Participation	Increased involvement in collective activities and reduced isolation
Social development	Stimulation of communication, interaction with peers and social skills
Teaching practice	Exchange of knowledge, continuing education and reflection on practice

Source: prepared by the authors (2025)

These results reinforce that collaborative teaching not only benefits students with ASD, but also contributes to the qualification of pedagogical work and the construction of a more inclusive school culture.

4.4 CHALLENGES FOR THE IMPLEMENTATION OF COLLABORATIVE TEACHING

Despite the advances pointed out, the literature shows significant challenges for the consolidation of collaborative teaching in schools. Among the main obstacles are the lack of time for joint planning, the absence of specific continuing education, the lack of definition of roles among teachers and the persistence of traditional conceptions that attribute Special Education to a single professional.

Authors such as Mendes, Vilaronga and Zerbato (2018) and Vilaronga and Mendes (2017) highlight that these obstacles are, to a large extent, cultural and institutional, requiring profound changes in the organization of school work and in the understanding of the teaching role.

4.5 NECESSARY CONDITIONS FOR THE EFFECTIVENESS OF COLLABORATIVE PRACTICES

The studies analyzed point out that the effectiveness of collaborative teaching requires structural, pedagogical and formative conditions. Among them, the following stand out: institutionalized time for joint planning, support from school management, clarity in the definition of professional attributions, and integration of the PAEE and PEI into the Political-Pedagogical Project (PPP), as provided for in Decree No. 12,773/2025.

Table 4 summarizes the conditions considered essential for the implementation of collaborative teaching.

Table 4*Conditions for the effectiveness of collaborative teaching*

Category	Necessary conditions
Organizational	Time for planning, management support and reorganization of the school routine
Pedagogical	Integration of the PAEE and PEI to the PPP and shared planning
Formative	Initial and continuing training on inclusion and co-teaching
Cultural	Overcoming isolated work and strengthening co-responsibility

Source: prepared by the authors (2025)

In this context, the results show that collaborative teaching is consolidated as a powerful strategy for the inclusion of students with ASD, as long as it is supported by institutional policies, legal support and collective commitment of the school community.

5 CONCLUSION

This article aimed to analyze, through a literature review, the contributions of collaborative teaching to the inclusion of students with ASD in basic education, as well as to identify its foundations and possibilities in the school context. The analysis of the literature allowed us to verify that collaborative teaching is configured as a relevant and promising pedagogical strategy for the effectiveness of inclusive education, by favoring more articulated, flexible practices centered on the educational needs of students.

The results show that collaborative teaching breaks with traditional and fragmented models of teaching performance, by proposing co-responsibility between the common classroom teacher and the Special Education teacher in all stages of the educational process, planning, execution and evaluation. This approach contributes to the expansion of access to the curriculum, to the diversification of pedagogical strategies and to the strengthening of social interactions, fundamental aspects for the academic and social development of students with ASD.

However, the literature points out significant challenges for the effective implementation of collaborative teaching, such as the absence of institutionalized time for joint planning, the insufficiency of specific continuing education, the lack of definition of professional roles, and the resistance to changes in the organization of school work. These obstacles show that the consolidation of collaborative teaching requires not only individual initiatives, but institutional commitment, support from school management and support in educational public policies.

In this context, the importance of integrating the Specialized Educational Service Plan (PAEE) and the Individualized Educational Plan (PEI) into the school's Political-Pedagogical Project (PPP) is highlighted, as provided for in the current legislation. This integration strengthens collaborative teaching by institutionalizing inclusive practices and ensuring

greater coherence between the pedagogical actions developed in the common room, in the SEA and in collaborative activities.

It is concluded, therefore, that collaborative teaching is a fundamental strategy for the effective school inclusion of students with ASD, as long as it is supported by appropriate organizational, pedagogical and formative conditions. It is recommended that future research advance in the empirical investigation on the implementation of this approach in different educational contexts, contributing to the improvement of inclusive policies and practices in the Brazilian educational system.

REFERENCES

- American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders: DSM-5. American Psychiatric Association.
- Associação de Psiquiatria Americana. (2014). Manual diagnóstico e estatístico de transtornos mentais (DSM-V). Artmed.
- Arvigo, M. C., & Schwartzman, J. S. (2020). Parece, mas não é TEA: Desafios do diagnóstico diferencial nos transtornos do espectro do autismo. In T. Serra (Coord.), *Autismo: Um olhar de 360°*. Literare Books International.
- Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996. Estabelece as diretrizes e bases da Educação Nacional. MEC. https://www.planalto.gov.br/ccivil_03/leis/l9394.htm
- Brasil. (2012). Lei nº 12.764, de 27 de dezembro de 2012. Institui a Política Nacional de Proteção dos Direitos da Pessoa com Transtorno do Espectro Autista. http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12764.htm
- Brasil. Conselho Nacional de Educação. (2023). Parecer CNE/CP nº 50, de 5 de dezembro de 2023. Orientações específicas para o público da educação especial: Atendimento de estudantes com Transtorno do Espectro Autista (TEA).
- Brasil. (2025). Decreto nº 12.774, de 9 de dezembro de 2025. Altera o Decreto nº 12.500, de 11 de junho de 2025. Diário Oficial da União, seção 1. <https://www2.camara.leg.br/legin/fed/decret/2025/decreto-12774-9-dezembro-2025-798462-norma-pe.html>
- Brasil. Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira. (2025). Censo Escolar da Educação Básica 2024: Notas Estatísticas. Inep. <https://www.gov.br/inep/pt-br/areas-de-atuacao/pesquisas-estatisticas-e-indicadores/censo-escolar/resultados>
- Brasil. (2024). Constituição da República Federativa do Brasil [recurso eletrônico]. Supremo Tribunal Federal, Secretaria de Altos Estudos, Pesquisas e Gestão da Informação.
- Capellini, V. L. M. F., & Zerbato, A. P. (2019). *O que é ensino colaborativo?* (1ª ed.). Edicon.
- Cardoso, C. C., & Pisetta, M. A. A. M. (2024). Trabalho colaborativo entre o AEE e a escola comum: Caminho possível para o processo de inclusão do estudante autista. In *Anais do V Congresso Internacional de Educação Inclusiva e V Jornada Chilena Brasileira de Educação Inclusiva* (ISSN 2359-2915). UEPB.

- Cook, L., & Friend, M. (1993). Co-teaching: Guidelines for creating effective practices. *Focus on Exceptional Children*, 28(3), 1–16.
- Fontes, R. S. (2009). *Ensino colaborativo: Uma proposta de educação inclusiva*. Junqueira e Marin Editores.
- Gately, S. E., & Gately, F. J., Jr. (2001). Understanding coteaching components. *Teaching Exceptional Children*, 33(4), 40–47. http://mdestream.mde.k12.ms.us/sped/toolkit/articles/service_delivery/gately.pdf
- Kanner, L. (1968). Autistic disturbances of affective contact. *Acta Paedopsychiatrica*, 35(4), 100–136. <http://www.th-hoffmann.eu/archiv/kanner/kanner.1943.pdf>
- Marin, M., & Maretti, M. (2014). Ensino colaborativo: Estratégias de ensino para a inclusão escolar. In *Anais do 1º Seminário Internacional de Inclusão Escolar: Práticas em diálogo* (pp. 1–8). UERJ.
- Martins, D. M., Santos, R. S. dos, & Denari, F. E. (2017). O trabalho colaborativo: Parcerias entre professores do ensino comum e do ensino especial. *Conjecturas*, 22(3).
- Michelluzi, S., Cordeiro, A. F. M., & Selau, B. (2022). Planejamento educacional na educação especial: A necessidade do trabalho colaborativo. *Revista Humanidades e Inovação*, 9(10).
- Mendes, E. G., Vilaronga, C. A. R., & Zerbato, A. P. (2023). Ensino colaborativo como apoio à inclusão escolar: Unindo esforços entre educação comum e especial. *EdUFSCar*.
- Santos, S. A., et al. (2015). O trabalho colaborativo entre o professor especialista e o professor das disciplinas: O fortalecimento das políticas públicas para a educação especial no Paraná. In *Anais do V Seminário Internacional sobre Profissionalização Docente*. https://educere.bruc.com.br/arquivo/pdf2015/18334_9281.pdf
- Silva, D. K. da, & Junior, M. O. S. (2024). Ensino colaborativo: Caminhos e possibilidades para inclusão de estudantes com TEA nos anos iniciais do ensino fundamental. In *Anais do XVII Seminário de Pesquisa do Programa de Pós-Graduação em Educação* (pp. 62–69). UNESP.
- Velarde, M., & Cárdenas, A. (2022). Trastorno del espectro autista y trastorno por déficit de atención con hiperactividad: Desafíos en el diagnóstico y tratamiento. *Medicina* (Buenos Aires), 82.
- Vieira, L. da S., Alves, F. I. B., & Bringel, M. F. A. (2023). Inclusão da criança autista no âmbito escolar. *Id on Line Revista de Psicologia*, 17(69), 168–179. <https://idonline.emnuvens.com.br/id/article/view/3915>
- Vilaronga, C. A. R., & Mendes, E. G. (2014). Ensino colaborativo para o apoio à inclusão escolar: Práticas colaborativas entre os professores. *Revista Brasileira de Estudos Pedagógicos*, 95(239), 139–151.
- Vilaronga, C. A. R., & Mendes, E. G. (2017). Formação de professores como estratégia para realização do coensino. *Revista Diálogos e Perspectivas em Educação Especial*, 4(1), 19–32. (Edição Especial).

LAUDATO SÍ, ECOTHEOLOGY AND AGENDA 2030: A BIBLIOMETRIC ANALYSIS OF ARTICLE PRODUCTION IN ENGLISH, PORTUGUESE AND SPANISH (2010-2024)

LAUDATO SÍ, ECOTEOLÓGIA E AGENDA 2030: UMA ANÁLISE BIBLIOMÉTRICA DA PRODUÇÃO DE ARTIGOS EM LINGUA INGLESA, PORTUGUESA E ESPANHOLA (2010-2024)

LAUDATO SÍ, ECOTEOLÓGÍA Y AGENDA 2030: UN ANÁLISIS BIBLIOMÉTRICO DE LA PRODUCCIÓN DE ARTÍCULOS EN INGLÉS, PORTUGUÉS Y ESPAÑOL (2010-2024)



<https://doi.org/10.56238/sevened2026.008-008>

Guilherme de Azevedo Mendes Corrêa Guimarães¹

ABSTRACT

This article applies bibliometric techniques to evaluate the impacts of the Encyclical Letter *Laudato Sí* (2015) on the production of academic articles on ecotheology in English, Portuguese, and Spanish between 2010 and 2024, seeking to identify relationships between Catholic faith, ecology, and sustainability. It also sought to identify the extent to which these articles were aligned with themes such as Globalism, Agenda 2030, Sustainable Development Goals (SDGs), and Global Warming. Regarding methodology, the research is classified as applied, exploratory, descriptive, quantitative, and bibliographic. The descriptive analysis used the Web of Science tool to capture the following aspects: keywords, categories of knowledge, language, countries, journals, teaching departments, most productive researchers, funders, and SDGs. In turn, the generation and analysis of author networks and co-occurrences used the VOSviewer software. The search retrieved 729 documents, reduced to 678 when restricted to articles, with 553 in the Religion category. International publications fall within the 17 SDGs, with 185 articles addressing Climate Action (SDG 13). In the Brazilian case, 15 of the 20 articles do not fit into the categories of the 2030 Agenda, while only two address SDG 13.

Keywords: 2030 Agenda. Bibliometrics. Ecotheology. *Laudato Sí*. SDGs.

RESUMO

O presente artigo aplica técnicas bibliométricas para avaliar os impactos da Carta Encíclica *Laudato Sí* (2015) na produção de artigos acadêmicos sobre ecoteologia, nas línguas inglesa, portuguesa e espanhola, entre 2010 e 2024, buscando identificar relações entre fé católica, ecologia e sustentabilidade. Buscou-se também identificar em que medida esses artigos estavam alinhados a temas, tais como Globalismo, Agenda 2030, Objetivos de Desenvolvimento Sustentável - ODS e Aquecimento Global. Quanto à metodologia, a pesquisa é classificada como aplicada, exploratória, descritiva, quantitativa e bibliográfica. A

¹ Dr. in Economics. Universidade Federal Fluminense. E-mail: gguimaraes@id.uff.br
Orcid: <https://orcid.org/0000-0002-5088-0590> Lattes: <https://lattes.cnpq.br/6648462028330433>

análise descritiva utilizou a ferramenta Web of Science para capturar os seguintes aspectos: palavras-chave, categorias de conhecimento, língua, países, periódicos, departamentos de ensino, pesquisadores mais produtivos, financiadores e ODS. Por sua vez, a geração e análise de redes de autores e coocorrências utilizou a *software* VOSviewer. A busca recuperou 729 documentos, reduzidos a 678, quando restrita a artigos, sendo 553 na categoria Religião. As publicações internacionais enquadram-se nos 17 ODS, sendo que 185 artigos versam sobre Ação Climática (ODS 13). No caso brasileiro, 15 dos 20 artigos não se classificam nas categorias da Agenda 2030, enquanto apenas dois contemplam o ODS 13.

Palavras-chave: Agenda 2030. Bibliometria. Ecoteologia. Laudato Sí. ODS.

RESUMEN

Este artículo aplica técnicas bibliométricas para evaluar los impactos de la Carta Encíclica Laudato Sí (2015) en la producción de artículos académicos sobre ecoteología en inglés, portugués y español entre 2010 y 2024, buscando identificar relaciones entre la fe católica, la ecología y la sostenibilidad. También buscó identificar en qué medida estos artículos estaban alineados con temas como el globalismo, la Agenda 2030, los Objetivos de Desarrollo Sostenible (ODS) y el calentamiento global. En cuanto a la metodología, la investigación se clasifica como aplicada, exploratoria, descriptiva, cuantitativa y bibliográfica. El análisis descriptivo utilizó la herramienta Web of Science para capturar los siguientes aspectos: palabras clave, categorías de conocimiento, idioma, países, revistas, departamentos de enseñanza, investigadores más productivos, financiadores y ODS. A su vez, la generación y el análisis de redes de autores y coocurrencias utilizaron el software VOSviewer. La búsqueda recuperó 729 documentos, reducidos a 678 cuando se restringió a artículos, con 553 en la categoría de Religión. Las publicaciones internacionales se enmarcan en los 17 ODS, con 185 artículos que abordan la Acción Climática (ODS 13). En el caso brasileño, 15 de los 20 artículos no se ajustan a las categorías de la Agenda 2030, mientras que solo dos abordan el ODS 13.

Palabras clave: Agenda 2030. Bibliometría. Ecoteología. Laudato Sí. ODS.

1 INTRODUCTION

One of the main concerns today is the environmental issue, marked by climate change, degradation of ecosystems and inequality in access to natural resources.

The occurrence of extreme weather events is evident, as in the case of the recent flood in Rio Grande do Sul, the blackout of electricity in São Paulo, due to winds with speeds above 100 km/h, the growth of fires throughout the Brazilian territory, in addition to several other examples around the planet.

The diagnosis made by a relevant part of the scientific community attributes the crisis to anthropogenic factors, in particular, the emission of greenhouse gases and the predatory use of natural resources, and it is urgent to adopt measures to decarbonize the economy and sustainable use of the environment, in order to stop, or at least mitigate, the effects of climate change.

In line with this diagnosis, multilateral institutions, governments, financial institutions, private and public banks, investors, companies, and consumers are increasingly committed to the ESG (Environment, Social, and Governance) agenda², defining standards and indicators for environmental, social, and sustainable corporate governance management.

An important example of these initiatives was the launch by the UN of the 2030 Agenda, defining 17 Sustainable Development Goals (SDGs) to be pursued by member countries.

In line with the signs of the times, Pope Francis expands the body of the Social Doctrine of the Church - DSI,³ through the publication of the Encyclical Letter *Laudato Sí*.

The document addresses the ecological issue from an integral Christian perspective, contributing to an updated reflection on Creation and the due care that man must give to the environment, helping Catholics and people of good will to raise awareness on the subject and the adoption of sustainable and just environmental practices.

This is the context that motivated this research, where bibliometric techniques were applied to evaluate the impacts of the Encyclical Letter *Laudato Sí* (2015) on the production of academic articles on ecotheology, in English, Portuguese, and Spanish, between 2010 and 2024.

² **ESG** is the acronym for **Environmental, Social, and Governance (ESG)**, a set of criteria used to assess the sustainability and ethical impact of a company or organization. These criteria are adopted by investors and other stakeholders to measure how a company handles environmental, social, and governance issues, as well as to assess its contribution to the well-being of society and the planet. OpenAI (2025).

³ A set of teachings of the Catholic Church that seeks to guide the faithful and society regarding social, economic, political and cultural issues, always based on the Gospel and the Christian tradition. These teachings aim to promote human dignity, social justice, the common good, and respect for creation. OpenAI (2025).

After all, what relationships can be identified between Catholic faith, ecology, and sustainability in post-Laudato Sí academic production? Has this document catalyzed new insights in the field of ecological theology? Did the Encyclical stimulate theologians to respond to the challenges of collective social effort aimed at establishing environmentally sustainable and socially just development initiatives? It is possible to observe an alignment between the published articles and themes such as: Globalism, 2030 Agenda, Sustainable Development Goals - SDGs⁴ and Global Warming. Is it possible to identify a bias in relation to these issues or is it a more neutral approach in the face of the pressures of the international and national agendas?

2 METHODOLOGY

This research seeks to identify the influences of Laudato Sí in the production of articles on ecotheology in English, Portuguese and Spanish, through a bibliometric study, which can be classified, according to Severino (2017), as applied, exploratory, descriptive, quantitative and bibliographic.

The following databases were consulted: Web of Science - WoS, Atla RDB and Google Scholar, and the use of WoS was chosen, given the greater number of articles and better quality of its metadata.

The results of the search resulted from the choice of the following terms: (((((((((ALL=(Laudato Sí)) AND ALL=(eco-theology)) OR ALL=(ecological theology)) OR ALL=(ecotheology⁵)) OR ALL⁶=(integral theology)) OR ALL=(integral theology⁷)) OR ALL=(ecotheology)) OR ALL=(integral theology)) OR ALL=(ecological theology).

The period 2010/2024 was considered, that is, covering five years before and nine years after the publication of Laudato Sí, resulting in 729 documents, or 678, when the search was restricted to articles (including those of conference and review).

⁴ The SDGs are a set of 17 interlinked goals that address key global challenges such as eradicating poverty, protecting the planet, and promoting peace and prosperity: 1. Poverty Eradication, 2. Zero Hunger and Sustainable Agriculture, 3. Health and Well-being, 4. Quality Education, 5. Gender Equality, 6. Clean Water and Sanitation, 8. Decent Work and Economic Growth, 9. Industry, Innovation and Infrastructure, 10. Reduction of Inequalities, 11. Responsible Cities and Communities, 12. Responsible Consumption and Production, 13. Action Against Global Climate Change, 14. Life on Water, 15. Terrestrial Life, 16. Peace, Justice and Effective Institutions, 17. Partnerships and Means of Implementation. United Nations Brazil (2024).

⁵ Ecotheology is a branch of theology that seeks to integrate religious reflection with environmental issues, proposing a spiritual and ethical vision of care for creation and the relationship between human beings and nature. OpenAI (2025).

⁶ Ditto.

⁷ Integral **theology** is a concept that refers to a comprehensive approach to theology, which seeks to understand and integrate all aspects of human life and the world in its entirety, taking into account the spiritual, social, economic, cultural, and environmental dimensions. In the context of **ecotheology** and contemporary issues, integral theology highlights the interconnectedness between faith, social justice, environmental preservation, and the promotion of the common good. OpenAI (2025).

Later, the number of documents was reduced to 553, when the search was refined to consider only the Religion category.

The descriptive analysis was carried out from the data generated by WoS, highlighting the following aspects: keywords, knowledge categories, language, countries, journals, teaching departments, most productive researchers, funders and SDGs.

In turn, the VOSviewer software was used for the analysis of network-based data.

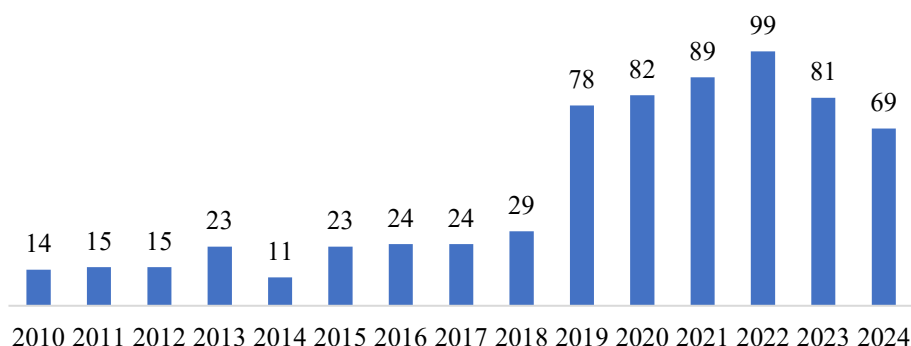
3 DATA ANALYSIS AND DISCUSSION

As shown in Figure 1, the publication of articles on the topic, considering all WoS categories, increased after 2015, with the annual average rising from 15.6 to 59.8 in the comparison between the 2010/2014 and 2015/2024 periods, respectively, suggesting the positive impact of Laudato Si.

It is worth noting the peak that occurred in 2022, eight years after the publication of the Encyclical, reaching 99 publications.

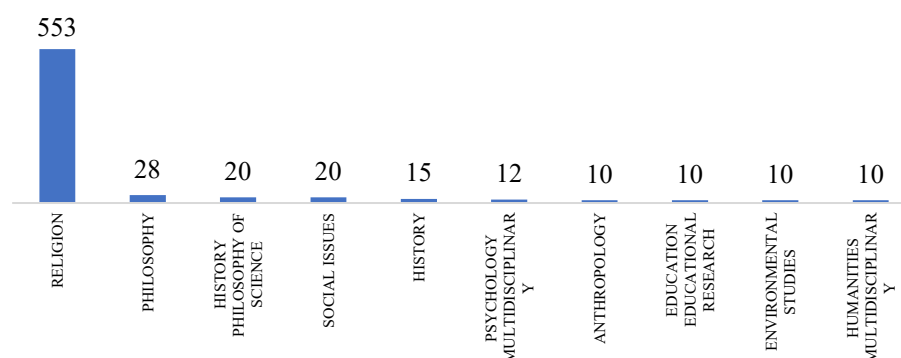
Figure 1

Publications of articles including all WoS categories (2010/2024)



Source: WoS Raw Data

Figure 2 shows, as expected, that the Religion category includes 83% of the publications on the topic researched during the period considered.

Figure 2*WoS article publications by category (2010/2024)*

Source: WoS Raw Data

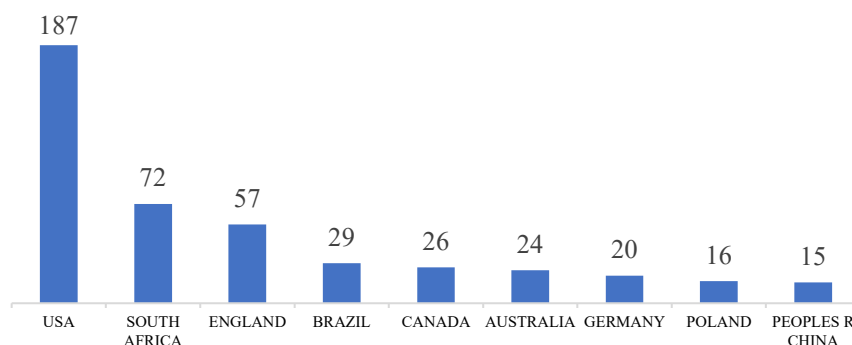
When considering the WoS categories, Figure 3 makes clear the leadership of English-language publications, followed by publications in Portuguese, Spanish, and Chinese.

Figure 3*Article publications by language (2010/2024)*

Source: WoS Raw Data

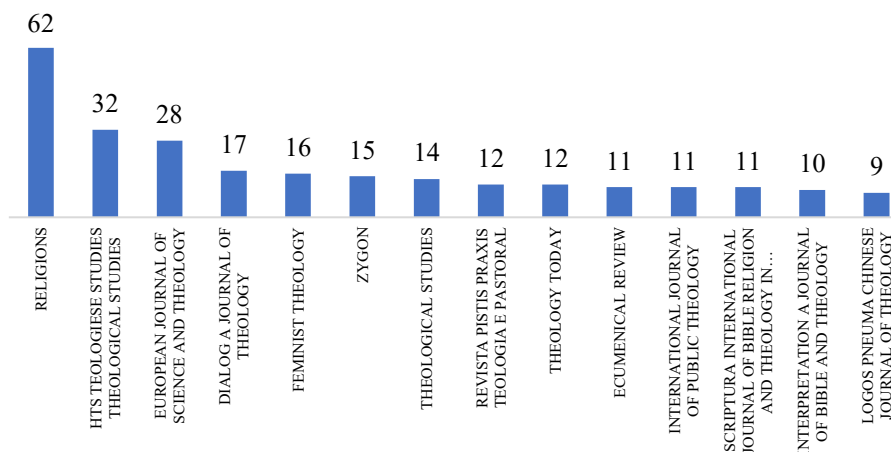
Given its greater representativeness compared to the others, the results presented below consider only the articles in the Religion category.

As shown in Figure 4, the U.S. leads the production of articles, with Brazil and China being among the nine countries with the most contributions.

Figure 4*Article publications by country (2010/2024)*

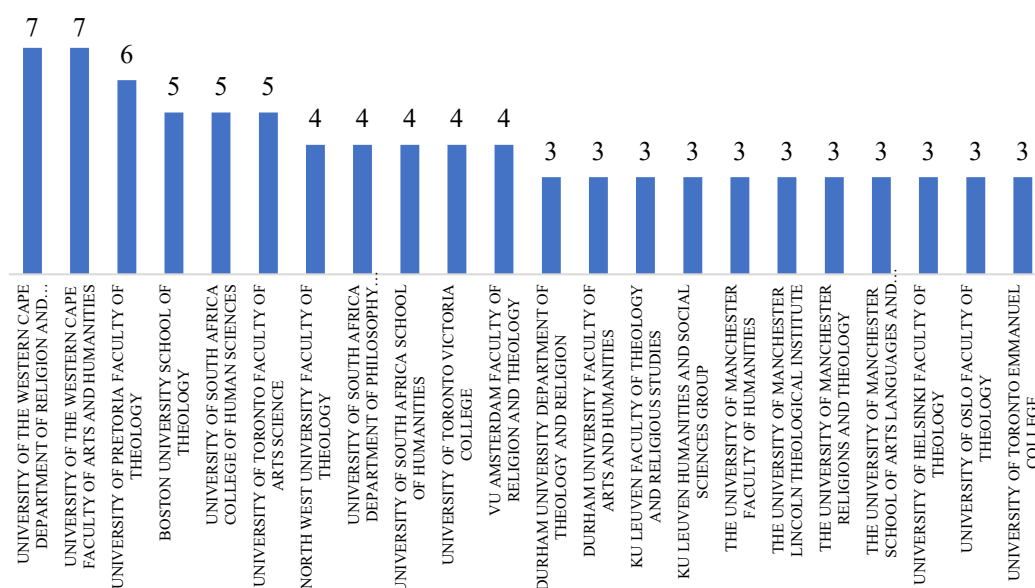
Source: WoS Raw Data

As for the relevance of journals, the Journal Religions stands out on the international scene, and the Journal Pistis & Praxis. Theology and Pastoral, in the Brazilian case.

Figure 5*Publications by journal (2010/2024)*

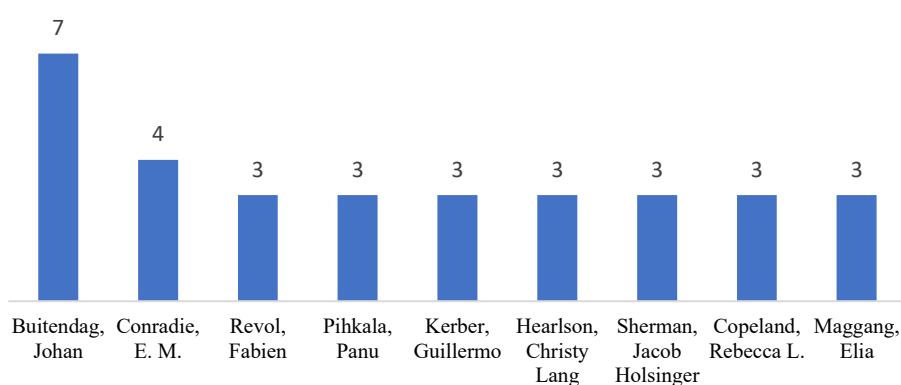
Source: WoS Raw Data

The data presented in Figure 6 reveal something surprising: of the six most productive departments, four are South African.

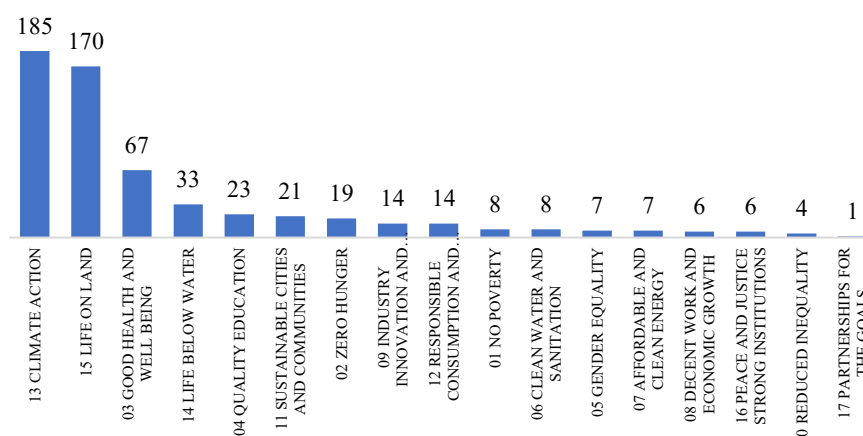
Figure 6*Publications by department (2010/2024)*

Source: WoS Raw Data

As for leadership among researchers, Johan Buitendag was the most productive of the period, as presented below.

Figure 7*Publications of the most productive researchers (2010/2024)*

Source: Authors.

Figure 10*Publications by SDGs (2010/2024)*

Source: WoS Raw Data

The following table presents the 19 most relevant keywords, according to the total strength of the link.

It is worth noting the relevance of the following terms resulting from the research at WoS, such as: ecology, ecological crisis, climate change, theology, ecotheology/ecotheology/ecological theology and *laudato sí*.

Table 1*Keyword occurrences and total link strength (2010/2024)*

Keyword	Occurrences	Total <i>link strength</i>
ecology	10	51
Integral ecology	6	43
theology	6	43
ecological crisis	7	35
liberation theology	5	34
ecotheology	6	33
ecological theology	7	32
public theology	5	31
creation	4	25
Laudato Si'	5	23
Nature	3	23
climate change	3	22
Eco-theology	3	21
practical theology	3	20
ecodomy	2	20
ecological conversion	2	16
The Earth Charter	2	16
Pope Francis	3	15
process theology	3	15

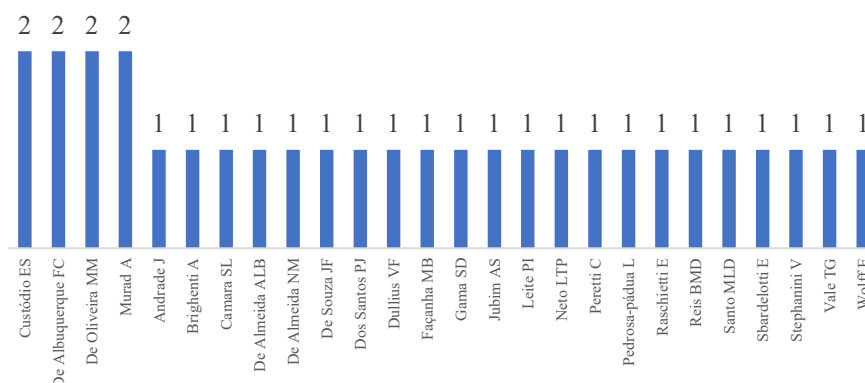
Source: WoS Raw Data

3.1 INDICATORS OF BRAZILIAN PRODUCTION

Figure 11 and Table 1 show the publications on the subject in Portuguese during the period analyzed. The most productive authors were Elivaldo Serrão Custódio, Francico Chagas de Albuquerque, Márcia Maria de Oliveira and Afonso Murad.

Figure 11

Publications in Portuguese by author (2010/2024)



Source: WoS Raw Data

Table 2

Publications in Portuguese by author, title and abstract (2010/2024)

Author	Title
Custodian, Elivaldo S.	Religious expressions of African origin in Protestant quilombos in Macapá-AP
Custodian, Elivaldo S.	Protestant religiosity in the face of the union of blacks in Amapá: the experience of Afro-Protestantism
de Albuquerque, Francisco C.	Evangelization in the Amazon: theology and inculturation
de Albuquerque, Francisco C.	Latin American Theology: The Church and the Kingdom of God According to I. Ellacuria
de Oliveira, Márcia Maria; Sbardelotti, Emerson	Liberation ecotheology in dialogue with poetry in some songs that address the theme
de Oliveira, Márcia Maria	Challenges and perspectives of the process of preparation of the Special Synod on the Amazon
Murad, Afonso	Ecotheology: Science of Faith and Spirituality
Murad, Afonso	Ecofeminist hermeneutics and ecotheology. Interfaces
Andrade, Joachim; Raschietti, Estevão	A synodal and "outgoing" Church in the Amazon: the greatest challenges pointed out by the Brazilian bishops
de Almeida, Nadi M; Brighenti, Agenor	Synod on the Amazon: new paths for the Church and for integral ecology
Vale, T Gurgel; Camara, S Lucas	About spiritual care in the care of extremely premature newborns
Buccato de Almeida, To Luiz	Pope Francis is the specificist of moral theology. Analysis of the discourse to the Alphonsian Academy for its 70th anniversary

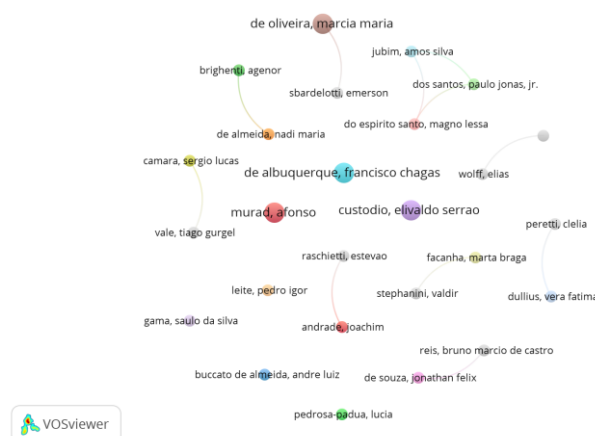
De Souza, J Félix; Reis, B M de Castro	Walking together: groups in adolescence and young women in Catholic schools
Jubim, A Silva; of Espírito Santo, M Lessa; Dos Santos, P Jonas Jr.	Do not be anxious: an exegetical, psychological and pastoral analysis of the possibilities of translating the Greek verb μεριμνάω (merimnaō) in the pericope Mt 6:25-34
Peretti, Clélia; Dullius, V Fatima	Human formation in Higher Education: an onto-anthropological and theological approach of Edith Stein
Façanha, M Braga; Stephanini, Valdir	Aspects of Religious Education in the National Common Curriculum Base: the fundamentals for quality education
Gama, Saulo da Silva	The contribution of an ecological theology in the process of overcoming the socio-environmental crisis generated by the technocratic paradigm
Leite, P Igor	Spiritual root of liberation theology: method and scope in dialogue with Gustavo Gutierrez
Wolff, Elias; Pontes Neto, L Tarquinio	The Theology of Life in Luiz Gonzaga
Pedrosa-Padua, Lucia	Guidelines of Pope Francis' spirituality: a reform from within the Church
Façanha, M Braga; Stephanini, Valdir	Aspects of religious education in the National Common Curricular Base: the foundations for quality education

Source: Authors.

The following figure represents the networks of national authors by occurrence.

Figure 12

Map of Authors' Networks, by occurrence (2010/2024)

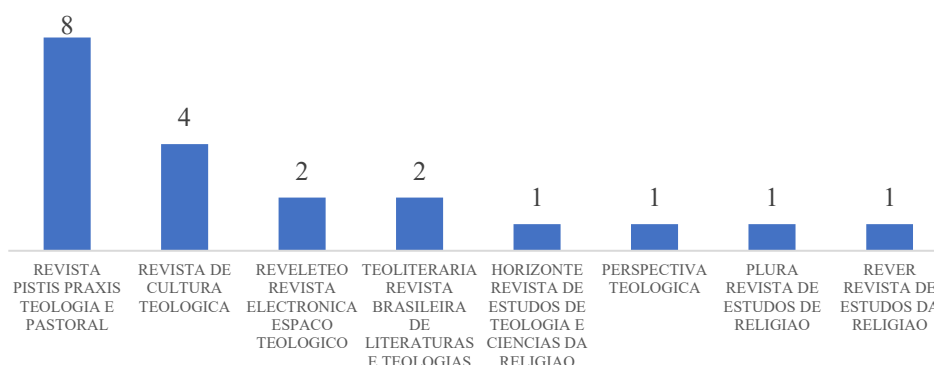


Source: Authors.

As for the prominent journals in the Brazilian case, the leadership is Pistis & Praxis Magazine. Theology and Pastoral Care, from PUCPR, according to Figure 13.

Figure 13

Publications in Portuguese by title (2010/2024)

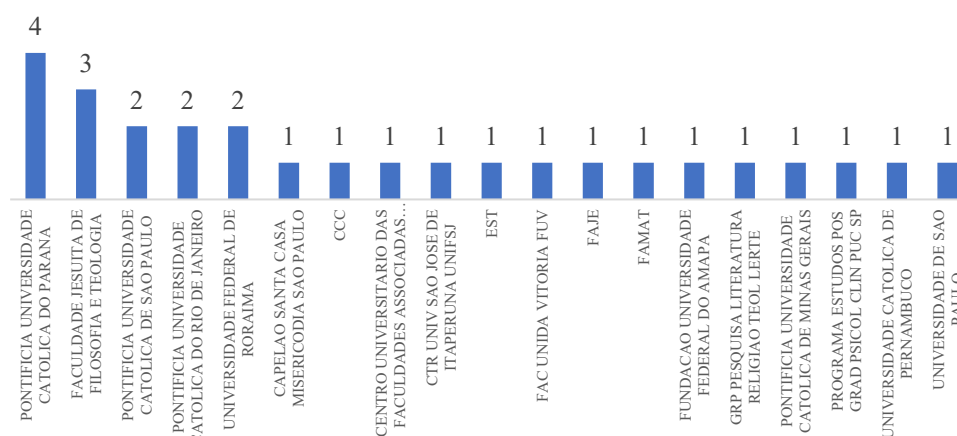


Source: WoS Raw Data

As shown in Figure 14, the Pontifical Catholic University of Paraná leads the publications, with three of the five main departments being from Pontifical Catholic Universities (PR, SP and Rio).

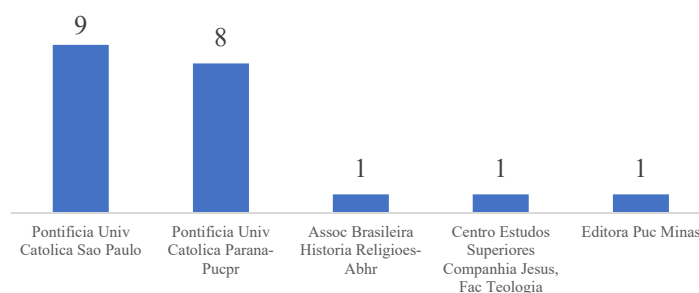
Figure 14

Portuguese-language publications by department (2010/2024)



Source: WoS Raw Data

The trend identified above is reinforced when considering the data in Figure 15: 90% of the editions were carried out by Pontifical Catholic Universities (SP, PR and MG).

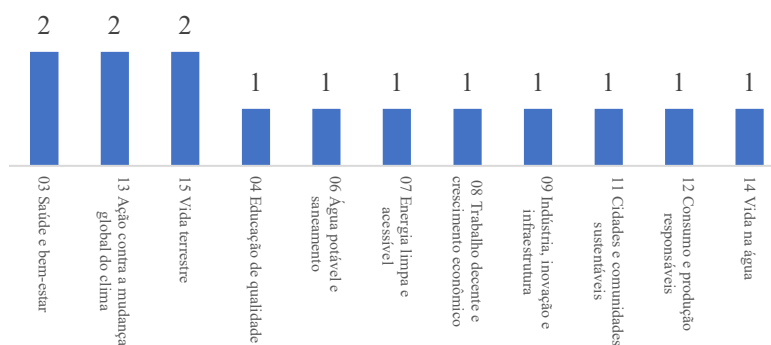
Figure 15*Portuguese-language publications by publisher (2010/2024)*

Source: WoS Raw Data

Regarding the association of publications in Portuguese with the SDGs, Figure 16 points out that the articles address 11 of the 17 UN goals, while two of the 20 articles are considered to be the climate issue.

On the other hand, 15 of the 20 national publications did not address any UN sustainable development goal.

In other words, at least in the case of publications in Portuguese, no evidence was found that the 2030 Agenda had a relevant direct impact on theological production.

Figure 16*Portuguese-language publications by SDGs (2010/2024)*

Source: WoS Raw Data

The following table presents the 20 most relevant keywords, according to the total strength of the links, and shows the relevance of the terms searched for in this research: ecology, ecological crisis, climate change, theology, ecotheology/eco-theology/ecological theology, and *laudato sí*.

The research also sought to identify the extent to which these articles were aligned with themes such as: Globalism, 2030 Agenda, SDGs and Global Warming, analyzing the results of the Web of Science – WoS.

The search recovered 729 documents, reduced to 678, when it was restricted to articles, 553 of which were in the Religion category.

In short, the bibliometric study pointed out the relevance of the themes of ecology and sustainability for the Catholic faith and theology, as well as the influence of the Encyclical Letter *Laudato Si*.

In fact, the results of the survey support the position that there is an alignment between the 553 publications, the 2030 Agenda and the SDGs. However, this understanding loses a lot of strength when we consider only national production.

At first, it was not possible to identify a direct relationship between the articles evaluated and the themes of globalism and global warming.

A suggestion to deepen this point would be to refine the search carried out, restricting it to articles classified in SDG 13.

A bibliographic review of Brazilian articles and the most representative of international production and, in particular, those that deal with Climate Action also seems relevant.

Finally, it would be interesting to replicate the current research to other areas of knowledge.

REFERENCES

- Andrade, J., & Raschietti, E. (2019). Uma igreja sinodal e “em saída” na Amazônia: Os maiores desafios apontados por bispos do Brasil. *Revista Pistis & Praxis*, 11(3).
- Custodio, E. S. (2019). Expressões religiosas de matriz africana em quilombo protestante no Amapá-AP. *PLURA – Revista de Estudos de Religião*, 10(1), 71–90.
- Custódio, E. S. (2020). Religiosidade protestante diante da união dos negros do Amapá: A experiência do afro-protestantismo. *REVER: Revista de Estudos da Religião*, 20(1), 265–280.
- Da Silva Gama, S. (2020). A contribuição de uma teologia ecológica no processo de superação da crise socioambiental gerada pelo paradigma tecnocrático. *Revista Eletrônica Espaço Teológico*, 14(25), 92–105.
- De Albuquerque, F. C. (2022). Teologia Latino-Americana: Igreja e Reino de Deus segundo I. Ellacuría. *Revista Pistis & Praxis*, 14(1).
- De Albuquerque, F. C. (2024). Evangelização na Amazônia: Teologia e inculturação. *Revista Pistis & Praxis*, 16(1), 187–203.

- De Almeida, A. L. B. (2021). Papa Francisco e o específico da teologia moral: Análise do discurso à Academia Afonsiana pelos seus 70 anos de fundação. *Revista de Cultura Teológica*, (98), 153–174.
- De Almeida, N. M., & Brighenti, A. (2019). Sínodo da Amazônia: Novos caminhos para a Igreja e para uma ecologia integral. *Revista Pistis & Praxis*, 11(3).
- De Oliveira, M. M. (2019). Desafios e perspectivas do processo de preparação do Sínodo Especial para a Amazônia. *Revista de Cultura Teológica*, (94), 8–20.
- De Oliveira, M. M., & Sbardelotti, E. (2022). Ecoteologia da Libertação em diálogo com a poesia em algumas canções que abordam a temática. *Teoliterária – Revista de Literaturas e Teologias*, 12(27), 204–227.
- Façanha, M. B., & Stephanini, V. (2021). Aspectos do Ensino Religioso na Base Nacional Comum Curricular: Os fundamentos para educação de qualidade. *Revista Pistis & Praxis*, 13(1).
- Francisco, Papa. (2015). Carta Encíclica Laudato Si. https://www.vatican.va/content/francesco/pt/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html
- Jubim, A. S. J. S. J., et al. (2022). Não andeis ansiosos: Análise exegética, psicológica e pastoral sobre as possibilidades de tradução do verbo grego merimnáō (μεριμνάω) na perícopa Mt 6,25-34. *Revista Pistis & Praxis*, 14(2).
- Leite, P. I. (2022). Raiz espiritual da Teologia da Libertação: Método e escopo em diálogo com Gustavo Gutiérrez. *Revista Eletrônica Espaço Teológico*, 16(30), 7–21.
- Murad, A. (2020). Ecoteologia: Ciência da fé e espiritualidade. *Revista Pistis & Praxis*, 12(3).
- Murad, A. (2022). Hermenêutica ecofeminista e ecoteologia. *Interfaces – Perspectiva Teológica*, (53), 579–606.
- Nações Unidas Brasil. (2024). Objetivos de Desenvolvimento Sustentável. <https://brasil.un.org/pt-br>
- OpenAI. (2024). ChatGPT [modelo de linguagem grande]. <https://chatgpt.com>
- Pedrosa-Pádua, L. (2021). Linhas-força da espiritualidade do Papa Francisco: Uma reforma a partir de dentro da Igreja. *Revista de Cultura Teológica*, (98), 34–66.
- Peretti, C., & Dullius, V. F. (2020). A formação humana na Educação Superior: Abordagem onto-antropológica e teológica de Edith Stein. *Horizonte: Revista de Estudos de Teologia e Ciências da Religião*, 18(55), 149.
- Severino, A. J. (2017). Metodologia do trabalho científico. Cortez.
- Souza, J. F. de, & Reis, B. M. de C. (2021). Caminhar juntos(as): Os grupos nas adolescências e nas juventudes nas escolas católicas. *Revista Pistis & Praxis*, 13(3), 1327–1341.
- Vale, T. G., & Camara, S. L. (2020). Sobre os cuidados espirituais no atendimento a recém-nascidos extremamente prematuros. *Revista de Cultura Teológica*, (96), 130–159.
- Wolff, E., & Neto, L. T. P. (2020). A teologia da vida em Luiz Gonzaga. *Teoliterária – Revista de Literaturas e Teologias*, 10(22), 468–490.

AN OVERVIEW OF THE RELATIONSHIP BETWEEN RESTORATIVE JUSTICE, SUSTAINABILITY, AND SHARED KNOWLEDGE PRODUCTION

PANORAMA DA RELAÇÃO ENTRE JUSTIÇA RESTAURATIVA, SUSTENTABILIDADE E A PRODUÇÃO PARTILHADA DO CONHECIMENTO

PANORAMA DE LA RELACIÓN ENTRE JUSTICIA RESTAURATIVA, SOSTENIBILIDAD Y LA PRODUCCIÓN COMPARTIDA DEL CONOCIMIENTO



<https://doi.org/10.56238/sevened2026.008-009>

Carla Boin¹, Sérgio Bairon ²

ABSTRACT

This article investigates the convergences and divergences between Restorative Justice and Sustainability, innovative paradigms for contemporary challenges, enhanced by mediation (Boin, 2019a) and Shared Knowledge Production (Bairon & Lazaneo, 2013). Restorative Justice, focused on repair and reconciliation through mediated dialogue (Zehr, 2002; Braithwaite, 2002), contrasts with Sustainability, which aims for intergenerational balance (WCED, 1987) and respect for planetary boundaries (Rockström et al., 2009). Both share repair, systemic vision, and community participation. Mediation, as a conflict facilitation tool (Boin, 2019a), and Shared Knowledge Production, co-creating knowledge (Bairon & Lazaneo, 2013), strengthen their integration in socio-environmental conflicts, education, and governance, especially from the perspective of environmental justice (Acseirad, 2009) and the epistemologies of the south (Santos, 2007). Despite resistances, cases like New Zealand and Indigenous productions offer ethical and practical solutions to global crises.

Keywords: Community Participation. Intergenerational Ethics. Reparation. Reconciliation. Restorative Justice. Shared Knowledge Production. Socio-environmental Conflicts. Sustainability. Systemic Vision.

RESUMO

O artigo explora as convergências e divergências entre Justiça Restaurativa e Sustentabilidade, paradigmas inovadores para desafios contemporâneos, enriquecidos pela mediação (Boin, 2019a) e pela Produção Partilhada do Conhecimento (Bairon & Lazaneo, 2013). A Justiça Restaurativa, centrada na reparação e reconciliação via diálogo mediado (Zehr, 2002; Braithwaite, 2002), contrasta com a Sustentabilidade, que busca equilíbrio intergeracional (WCED, 1987) e o respeito aos limites planetários (Rockström et al., 2009). Ambas compartilham reparação, visão sistêmica e participação comunitária. A mediação, como ferramenta facilitadora de conflitos (Boin, 2019a), e a Produção Partilhada, que co-cria saberes (Bairon & Lazaneo, 2013), potencializam sua integração em conflitos socioambientais, educação e governança, especialmente sob a ótica da justiça ambiental (Acseirad, 2009) e das epistemologias do sul (Santos, 2007). Apesar de resistências,

¹ Postdoctoral researcher. Universidade de São Paulo (USP). E-mail: carla@boin.adv.br

² Professor. Universidade de São Paulo (USP). E-mail: bairon@usp.br

exemplos como Nova Zelândia e produções indígenas mostram soluções éticas e práticas para crises globais.

Palavras-chave: Conflitos Socioambientais. Ética Intergeracional. Justiça Restaurativa. Produção Partilhada do Conhecimento. Reparação. Reconciliação. Sustentabilidade. Visão Sistêmica.

RESUMEN

El artículo explora las convergencias y divergencias entre la Justicia Restaurativa y la Sostenibilidad, paradigmas innovadores para desafíos contemporáneos, enriquecidos por la mediación (Boin, 2019a) y por la Producción Compartida del Conocimiento (Bairon & Lazaneo, 2013). La Justicia Restaurativa, centrada en la reparación y reconciliación mediante el diálogo mediado (Zehr, 2002; Braithwaite, 2002), contrasta con la Sostenibilidad, que busca un equilibrio intergeneracional (WCED, 1987) y el respeto a los límites planetarios (Rockström et al., 2009). Ambas comparten elementos como la reparación, la visión sistémica y la participación comunitaria. La mediación, como herramienta facilitadora de conflictos (Boin, 2019a), y la Producción Compartida, que co-crea conocimientos (Bairon & Lazaneo, 2013), potencian su integración en conflictos socioambientales, educación y gobernanza, especialmente desde la óptica de la justicia ambiental (Acsehrad, 2009) y de las epistemologías del sur (Santos, 2007). A pesar de resistencias, ejemplos como Nueva Zelanda y producciones indígenas muestran soluciones éticas y prácticas frente a crisis globales.

Palabras clave: Conflictos Socioambientales. Ética Intergeracional. Justicia Restaurativa. Participación Comunitaria. Producción Compartida del Conocimiento. Reparación. Reconciliación. Sostenibilidad. Visión Sistémica.

1 INTRODUCTION

Contemporary challenges, such as inequality, climate change, and environmental degradation, demand alternative approaches. Restorative Justice, emphasizing reparation and reconciliation (Zehr, 2002), and Sustainability, promoting ethical balance for future generations (WCED, 1987), emerge as complementary paradigms. This article expands this analysis to integrate media, as highlighted by Boin (2019a), which facilitates dialogue between parties in conflict, and the Shared Production of Knowledge (Bairon & Lazaneo, 2013), which co-creates knowledge via digital media. These approaches, exemplified in indigenous practices (Bairon & Lazaneo, 2013) and mediated processes (Boin, 2019b), offer an ethical and practical basis to face global crises, promoting a more just and sustainable future.

On the one hand, Restorative Justice proposes an alternative to the conventional punitive system, focusing on reparation of damages, reconciliation between the parties and not strengthening social relations (Zehr, 2002). On the other hand, Sustainability seeks to harmonize human needs with the preservation of the environment, promoting an ethical and practical balance for future generations (WCED, 1987). Although they operate in different spheres — the first legal and social field, the second in the ecological, economic and social dimensions — both share fundamental values such as harmony, systemic vision, collective responsibility and a commitment to the long term. This article offers a detailed comparative analysis of these concepts, exploring their convergences, divergences and possibilities of synergistic integration. In addition, it seeks to respond to how these approaches can be intertwined to face global crises such as social inequality, climate changes and environmental degradation, contributing to a more just, balanced and resilient future.

Restorative Justice is a paradigm of dispute resolution that rejects the exclusively punitive focus of the traditional retributive system, proposing an approach focused on the reparation and reconstruction of human relationships. Differently from the logic of state punishment, which often perpetuates cycles of exclusion and violence, it emphasizes the dialogue between what is caused or harmed, what is caused or damage and the community, as a path to responsibility and cure (Zehr, 2002; Johnstone, 2011). Howard Zehr, one of the leading theorists in the field, synthesizes his essence in three northern questions: "Who was harmed? What are your needs? Who has the obligation to attend to them?" (Zehr, 2002, p. 21). This model humanizes the judicial process by prioritizing empathy and the active participation of the parties involved, promoting the restoration of social ties instead of just sanctioning or transgressor (Van Ness & Strong, 2014). In addition, Restorative Justice values personal narratives and cultural contexts, recognizing that the damage is not just a

legal violation, but a rupture in human connections (Pranis, 2005). Practical examples, such as peace circles and restorative conferences, demonstrate their effectiveness in diverse contexts, from community disputes to youth systems.

Restorative Justice rejects pure punishment, focusing on repairing and rebuilding relationships (Zehr, 2002). Boin (2019a), highlights mediation as essential iron, structuring or dialogue, we insist, between those who suffered the damage, those who caused the damage and the community to attend to the needs of all (Zehr, 2002, p. 21). This process, humanized by empathy (Pranis, 2005), gains strength with Shared Production, allowing communities to co-produce solutions (Bairon & Lazaneo, 2013).

Sustainability, for the same time, is a multidimensional concept that aims to ensure the continuity of two natural and human systems, guaranteeing that the planet remains habitable and equitable for future generations. Popularized by the Brundtland Report of the World Commission on Environment and Development (WCED, 1987), this paradigm is based on three interdependent pillars: environmental (preservation of ecosystems), economic (prosperity of predatory exploration) and social (justice and inclusion) (Elkington, 1997). Ignacy Sachs (2008) expands this vision for an intergenerational ethics that rejects practices of short term, as the unfreedom extractivism, in favor of strategies that respect the biophysical limits of the planet and promote collective well-being. Sustainability goes to the end of environmental conservation; it requires a cultural and structural transformation that reorients the productive systems and the ways of life that are resilient and equitable (Rockström et al., 2009). Thus, it is both an objective and a continuous process of adaptation to global dynamics, such as climatic changes and biodiversity losses. Such principles are absolutely shared by the proposals of Shared Production (Bairon, 2010), which integrates local knowledge, in terms of mediation (Boin, 2019b) facilitating sustained agreements between conflicting parties.

2 THE METHODOLOGICAL BRIDGE: MEDIATION AND SHARED PRODUCTION OF KNOWLEDGE

Restorative Justice and Sustainability represent the pillars of the Concept, Mediation, and Partial Knowledge Production (PPC) emerge as the methodological approach that makes its integration viable. Far from being mere complements, they are the paths that translate theory into praxis.

Mediation, as detailed by Boin (2019a), is more than a simple negotiation. It is a structured and voluntary process, conducted by an impartial third party, which facilitates communication between the parties in conflict. Its goal is not to impose a solution, but to

create a safe environment where parties can express their needs, understand each other's perspectives, and together build consensual solutions. In the context of Restorative Justice, mediation is the tool that operationalizes the reparative dialogue. In socio-environmental conflicts, it becomes crucial to balance seemingly antagonistic interests — such as those of a community and industry — transforming an adversarial dispute into a collaborative process of seeking a sustainable future for all.

The Shared Production of Knowledge, for the same time, is a research methodology that challenges the traditional hierarchy between academic knowledge and community knowledge (Bairon, 2010). Using multiple image and sound technologies, such as video and digital platforms, PPC allows communities themselves to become producers of knowledge about their reality, their memories and their aspirations (Bairon & Lazaneo, 2013). As seen in the work of indigenous filmmakers such as Divino Tserewahú, this approach hardly documents, but strengthens cultural identity and political autonomy. Restorative Justice has gained a powerful structure for the symbolic reparation of historical damages, as for Sustainability, it is enriched with local knowledge for the construction of ecologically adapted and socially just solutions, in line with the Epistemologies of the South of Boaventura de Sousa Santos (2007).

Together, Mediation and PPC form a virtuous cycle: PPC interacts and prioritizes the knowledge of communities, and Restorative Justice - Mediation structures the dialogue so that these community voices are valued and can negotiate fair and sustainable.

3 SHARED PRINCIPLES

3.1 FOCUS ON REPARATION AND RECONCILIATION

Both Restorative Justice and Sustainability have the idea of reparation at their core. In Restorative Justice, the focus is on repairing the damage caused and on reconciling the parts involved, transforming the conflict in an opportunity to learn and grow (Marshall, 1999). This process hardly restores the broken balance, but it also strengthens social cohesion to enhance the narratives of all affected (Zehr, 2002). In Sustainability, reparation is turned to degraded ecosystems — such as the reforestation of deforested areas or the recovery of polluted rivers — seeking to reconcile humanity and nature (Daly & Farley, 2011). Such actions repair the pasture while building a sustainable future, a direct echo of the restorative principle of transforming us into opportunities (Sachs, 2008). Convergence that shows a common ethics of healing, whether in interpersonal relationships or in the relationship with the planet.

3.2 SYSTEMIC VISION

Both paradigms adopt a holistic perspective that transcends fragmented solutions. Restorative Justice sees harm as an event embedded in a web of social relations, whose causes and consequences reverberate beyond the isolated act (Van Ness & Strong, 2014). This systemic approach is similar to that of Sustainability, which recognizes the interconnectedness between environmental, social, and economic factors (Elkington, 1997). Understanding these interdependent networks is essential for addressing complex problems such as ecological damage (Fritjof Capra, 1996). For example, the policy of a river is not just an environmental issue, but also social (dislocation of communities) and economic (loss of resources), demanding solutions that consider all these dimensions — a logic aligned with Restorative Justice when dealing with the roots of conflicts.

3.3 COMMUNITY PARTICIPATION

The centrality of the community is another point of convergence. In Restorative Justice, the community plays an active role in supporting people who suffer damage, facilitate dialogue and reintegrate people who cause damage, promoting a sense of belonging and collective responsibility (Marshall, 1999; Pranis, 2005). In Sustainability, local communities are protagonists in the management of natural resources, as well as in community conservation initiatives or regenerative agriculture (Ostrom, 1990). Collaborative governance of commons can be more effective than top-down policies, a principle that resonates with the restorative emphasis on cooperation (Elinor Ostrom, 1990). It is precisely this valorization of the collective that underlines the idea that long-lasting solutions depend on the active participation and strengthening of social networks, to repair a damage, to preserve an ecosystem.

4 DIFFERENCES OF SCOPPO AND APPLICATION

4.1 TEMPORAL SCOPUS

A striking difference between the two paradigms lies in the time horizon. Restorative Justice operates predominantly in the course and through practice, focusing on the resolution of specific conflicts and the immediate reparation of damages (Zehr, 2002). This objective is the cure and reconciliation not present, as in cases of community mediation. Sustainability, on the other hand, is projected for the long term, concerned with the intergenerational impacts of current actions, such as carbon emissions or soil erosion (WCED, 1987). This future vision requires non-present sacrifices to guarantee the viability of the planet, contrasting with the restorative urgency of resolving immediate disputes (Daly & Farley, 2011).

4.2 PRIMARY FOCUS

The primary focus also diverges. On the one hand, Restorative Justice is essentially anthropocentric, dealing with human emotions such as guilt, loss and empathy, and seeking to restore interpersonal relationships (Marshall, 1999). On the other hand, Sustainability adopts a balanced ecological approach, prioritizing interdependence between humans and ecosystems (Sachs, 2008). While Zehr (2002) emphasizes the construction of bridges between individuals, Capra (1996) and Naess (1989) defend an ecological ethics that transcends the human, recognizing nature as a final in itself. This difference reflects distinct priorities: social harmony versus planetary harmony.

4.3 METHODS AND TOOLS: FROM MICRO TO MACRO

The clearest distinction between the two fields is distinguished in their methods and offered paths, which operate on different but complementary scales. Restorative Justice acts at the micro level, using qualitative and relational tools. These main instruments are dialogue circles, restorative conferencies, and mediation between those who cause harm and those who cause damage (Van Ness & Strong, 2014; Pranis, 2005). These practices are dialogue-intensive, focused on active listening, empathy, and consensus-building processes. The success is measured by the satisfaction of the parties, by the reparation of the perceived damage and by the restoration of the community areas, results that are eminently qualitative.

Sustentabilidade, now operates predominantly at the macro and structural level, undertaking quantitative and large-scale research. Its proposals include public policies (such as global climate agreements or environmental protection legislation), green technologies (renewable energy, circular economy) and impact indicators (carbon gluing, planetary boundaries) (Elkington, 1997; Rockström et al., 2009). The objective is to promote systemic changes that alter production and consumption patterns. Success is often mediated by quantifiable goals, such as reducing greenhouse gas emissions or preserving hectares of forest.

This disparity, however, opens up a vast field for synergy. The micro approaches of Restorative Justice can be used to build the social consensus necessary for the implementation of macro Sustainability policies. For example, a restorative dialogue process can resolve a local conflict over the installation of a wind farm, ensuring that the energy transition (macro) is socially just (micro). In other words, Sustainability technologies can expand the reach of restorative practices, such as the use of digital platforms to connect distant communities in dialogues about climate justice.

5 PRACTICAL INTERSECTIONS

5.1 SOCIO-ENVIRONMENTAL CONFLICTS

Socio-environmental conflicts, such as disputes over land in the Amazon or industrial policy in vulnerable communities, are fertile ground for practical integration. Restorative Justice dialogues with tensions between affected communities and companies or governments, repairing social damage and promoting collaborative agreements (Marshall, 1999). At the same time, Sustainability offers strategies to protect the ecosystems involved, such as the creation of conservation areas or the adoption of sustainable agricultural practices (Ostrom, 1990). A combination that can align social and environmental justice, especially in regions where predatory exploration exacerbates inequalities (Sachs, 2008).

The indigenous productions "Tsō'rehipäri", directed by Xavante filmmaker Divino Tserewahú, and "Boé Eru Kurireu", made by Paulinho Ecerae Kadojeba with Tserewahú's montage, exemplify in a powerful way the intersection between Restorative Justice and Sustainability, potentiated by the mediation and the Partial Production of Knowledge (Bairon & Lazaneo, 2013). "Tsō'rehipäri" traces the history of the songs of the Salesian mission of Sangradouro, using reflexivity to dialogue with the community and against external narratives, such as Genil Vasconcelos' 1949 film (Bairon & Lazaneo, 2013). This process reflects the restorative principles of reparation and reconciliation, valuing the narratives of the elders and the community to retell their own history, promoting collective healing through historical traumas (Zehr, 2002). In the middle of the context, Tserewahú's method is implicit, which submits the film to community approval, guaranteeing that everyone's needs are attended to (Boin, 2019a).

On the other hand, "Boé Eru Kurireu" presents the bororo funeral ritual from the perspective of who lives in culture, criticizing external representations such as the Fantástico da Rede Globo program (Bairon & Lazaneo, 2013). The collaboration between Paulinho, um bororo, and Divino, um xavante — historically rivals ethnic groups —, exemplifies Shared Production of Knowledge by creating an intercultural bridge that promotes mutual understanding and the appreciation of traditions. This dialogue between different forms of knowledge is fundamental for Sustainability, which depends on cultural diversity to find resilient solutions (Sachs, 2008). Both films will use audiovisual language to strengthen the identity and autonomy of their communities, demonstrate how symbolic reparation (Restorative Justice) and cultural preservation (Sustainability) are intrinsically linked.

5.2 EDUCATION FOR PEACE AND SUSTAINABILITY

Education is a promising field for the integration of these paradigms. Programs that combine education for peace, based on restorative principles, with education for sustainability can form more conscious and engaged citizens (Senge, 2006). Schools that adopt dialogue circles to resolve conflicts and, at the same time, implement community projects or recycling, teach in practice the interconnection between social and environmental well-being. This holistic approach prepares young people to deal with the complexity of two global challenges, promoting a culture of peace and ecological responsibility (Capra, 1996).

5.3 COLLABORATIVE GOVERNANCE

The governance of natural resources and urban spaces can benefit from the fusion of these paradigms. Restorative Justice offers models of participatory decision-making, such as sentencing circles, which can be adapted for the management of common blessings (Ostrom, 1990). For example, in a dispute over the use of water in a hydrographic basin, a restorative process could bring together farmers, industries and riverside communities to build a sustainable management plan that meets the needs of all and guarantees the health of the ecosystem. This collaborative approach, which values dialogue and the cooking of solutions, is more resilient and legitimate than unilaterally imposed policies (Van Ness & Strong, 2014).

6 CHALLENGES AND LIMITATIONS: NAVIGATING COMPLEX WATERS

Despite the potential synergistic, the integration of Restorative Justice with Sustainability is not a path of obstacles. On the contrary, it faces structural, cultural and scale challenges that need to be carefully navigated.

The first and most radical challenge is institutional inertia. Hegemonic legal and economic systems, deeply rooted in the retributive paradigm and not unlimited growth, offer forte resistance. The punitive logic of traditional penal law and the incessant search for profit is fundamentally based on the values of reparation, dialogue and intergenerational care (Johnstone, 2011). Integration, in this context, runs the risk of superficial co-optation, where restorative practices are adopted as a veneer of legitimacy without the underlying power structures being altered.

The second challenge is the issue of scalability. Restorative Justice, with its intensive methods in dialogue and focused on the local context, finds it difficult to be applied to global and systemic problems, such as climate crisis or large-scale biodiversity loss (Rockström et al., 2009). How to escalate a dialogue circle to mediate the conflict between nations over

carbon emission targets? The transposition of micro methods to the macro level is not straightforward and requires significant methodological and institutional innovations.

Finally, there is the risk of depoliticization. Focusing on harmony and interpersonal reconciliation, restorative practices, if misapplied, can inadvertently mask the deep asymmetries of power that are at the root of many socio-environmental conflicts. In a dispute between an indigenous community and a multinational mining company, a dialogue that does not recognize this disparity of power can end up legitimizing injustice, instead of fighting it. Environmental Justice, as formulated by Acseirad (2009), alerts us to the importance of maintaining a critical lens on the political and economic dimensions of conflicts, preventing the search for consensus from overcoming the fight for justice.

Overcoming these barriers requires more than goodwill; It requires a profound cultural transformation that values interdependence and collective responsibility (Senge, 2006), as well as the creation of new institutional arrangements that are flexible, polycentric and capable of articulating local and global scales.

7 CASE STUDY: AOTEAROA (NEW ZEALAND) AND PLURIVERSAL GOVERNANCE

Aotearoa, the Māori name for New Zealand, offers two most advanced and inspiring examples of how the integration between justice, sustainability and indigenous knowledge can be institutionalized. The country was not just a pioneer in the adoption of Restorative Justice in the youth system, but it was also innovative to incorporate Māori cosmology in its legal structure and environmental governance.

The pillar of integration is the Treaty of Waitangi (1840), which established a partnership between the British Commonwealth and the Māori. Although historically neglected, the treaty has been progressively reinterpreted as a basis for governance that recognizes indigenous sovereignty and rights. This manifests itself in concepts such as "Kaitiakitanga", which can be translated as an ethics of guardianship or guardianship, where humans have the responsibility to protect and care for the natural world (the *taonga*, or treasure).

The most radical example of this approach is the Te Urewera Act (2014), a law that granted legal personality to the ancient Te Urewera National Park, a vast area of forest ancestral to the Tūhoe people. The law declares that Te Urewera is "no longer the property of the Crown, nor of anyone," but a living entity in itself, with "rights, powers, duties, and responsibilities." A governing board, composed by Tūhoe and Chorus representatives, was raised to act as guardian and "speak on behalf" of Te Urewera. This legal innovation

represents a radical departure from the Western view of nature as a resource to be exploited, aligning itself with a Māori relational ontology.

This approach can be seen as a practical manifestation of the "pluriverse" advocated by Arturo Escobar (2018) — the construction of a world where multiple worlds (or ontologies) can coexist, a principle fully consistent with Restorative Justice. Instead of imposing a single model of conservation, New Zealand is trying to create a legal system that accommodates different ways of life and relates to the non-human. Restorative processes are often used to resolve disputes over resources, not only to mediate interests, but to redress historical damages and build a shared future. Although does not follow a model of tensions and contradictions, the case of Aotearoa demonstrates that it is possible to achieve social justice, historical reconciliation and ecological sustainability in a collaborative governance quadro (Marshall, 1999).

8 CASE STUDY: THE COMMISSION OF TRUTH AND RECONCILIATION OF SOUTH AFRICA

The Commission of Truth and Reconciliation (CVR) of South Africa, led by Archbishop Desmond Tutu (1999), is an emblematic example of Restorative Justice on a large scale. Although sits main focus on the reparation of apartheid traumas, its principles of dialogue, truth and reconciliation created a propitious environment for the construction of a more just society and, consequently, more sustainable. The CVR did not limit itself to investigating who caused the damage and who suffered the damage; It sought to restore the dignity of the people who suffered damage and reintegrate the people who caused damage to the community, strengthening the social situation of the country (Tutu, 1999).

As for CVR addressing the damage of the past in the last year and in the middle of the process, sustainability in Africa of South Africa has been strengthened through community initiatives that allow for the balance of human needs with environmental preservation in the long period (WCED, 1987). Projects such as sustainable community agriculture and reforestation programs in rural areas, often led by local cooperatives, express this commitment (Sachs, 2008). These actions do not barely combat environmental degradation, but they also address socio-economic inequalities inherited from apartheid, aligning with the pillars of sustainability — environmental, economic and social — proposed by Elkington (1997). Mediated reconciliation created the social conditions necessary for these initiatives to flourish, demonstrating how community stability is a foundation for sustainability.

Community participation is a key driver that unites these two paradigms in South Africa (Ostrom, 1990; Pranis, 2005). The CVR broadly involved the population, with public hearings

and deposits that strengthened the sense of collective responsibility (Tutu, 1999), a principle that echoes in restorative practices (Boin, 2019b). In the same way, community sustainability projects depend on local collaboration, such as urban gardens and cooperatives that promote food security and income management in marginalized areas (Sachs, 2008). This synergy reflects a systemic vision (Capra, 1996), where the reparation of human relationships, facilitated by restorative dialogue, supports efforts to build resilient economic and environmental systems, benefiting both current and future generations.

The Su-African case represents a profound synergistic potential: Restorative Justice, by means of mediated reconciliation, repairs the traumas of the past (Van Ness & Strong, 2014), in terms of Community Sustainability assures a future journey (Boin, 2019b). The CVR hardly promotes social peace, but it also opened the way for communities, now more cohesive, to engage in sustainable practices that combat poverty and environmental degradation. Although the Shared Production of Knowledge (Bairon & Lazaneo, 2013) does not have an explicit component in this example, the use of media platforms to disseminate the stories of the CVR suggests fertile ground for participatory technologies that can amplify this synergy, connecting local experiences to global solutions and strengthening integration between these paradigms (Boin, 2019a).

9 ETHICAL IMPLICATIONS: TOWARDS RADICAL RESPONSIBILITY

The integration of Restorative Justice and Sustainability is not just a question of efficiency, but a profound ethical reorientation. It invites us to transcend the traditional borders and to adopt what could be called a radical responsibility ethic (Boin, 2019b).

Restorative Justice, at its core, challenges the retributive ethic of punishment with an ethic of compassion and mutual responsibility. It tells us that we are related beings and that the damage to a member gives community to all (Zehr, 2002). Sustainability, for the same time, confronts the extractive and consumerist ethics with the ethics of care and intergenerational responsibility. It summons us to consider the impact of our *ações* on future generations and on the life that sustains us (WCED, 1987).

When fused, these two ethics give rise to something greater: an expanded vision of justice that dissolves the dichotomy between the human and the nonhuman. Inspired by Arne Naess's deep ecology (1989), Fritjof Capra's systemic vision (1996) and by the concept of Restorative Justice as addressed by Carla Boin (2019b), these approaches recognize that social justice and environmental justice are separate. It is no longer just about justice *between* humans, but about justice *for how* the living system of which we are a part. This perspective

echoes Bruno Latour's (2018) call to "ground" and acknowledge our deep dependence and entanglement with the Earth, surpassing the modern separation between Nature and Society.

This raises complex and urgent ethical questions: who speaks on behalf of rivers, forests and species in a circle of restorative dialogue? How can we repair damages caused to non-human entities and to generations that are still not born? The answer may lie in the construction of interspecies justice, an emerging field that seeks to give voice and legal representation to non-humans, as seen in the case of New Zealand. To adopt this ethic of radical responsibility means to recognize that the cure of human relationships and the cure of the planet are not separate tasks, but a single and same day.

10 FUTURE PERSPECTIVES: HORIZONS FOR AN INTEGRATED PRAXIS

Looking to the future of the integration between Restorative Justice and Sustainability is to envision the emergence of new forms of governance, technology and culture. It is not a matter of predicting a destination, but of mapping the horizons that open up from this synergy.

In the technological field, the challenge is to go further from the instrumental vision. Instead of just using artificial intelligence to monitor environmental damage (Daly & Farley, 2011), the question is how we can use digital technologies to build a true "ecology of knowledges" (Santos, 2007). The hypermedia platforms, focused on the Partial Production of Knowledge (Bairon & Lazaneo, 2013), can be developed not to extract data, but to connect communities, facilitate intercultural dialogues and allow local and scientific knowledge to co-create solutions, avoiding the risk of a new digital colonialism.

In the field of governance, integration points to models that overcome state centralization (In the field of governance, integration points to models that overcome state centralization The ideology of a "polycentric restorative governance", inspired by Elinor Ostrom's work (1990), emerges as a promising possibility. This model, multiple decision-making centers (local communities, municipalities, civil society organizations, global networks) are articulated in a flexible and adaptive way, using restorative principles to manage the common good, from a local hydrographic basin to the global atmosphere.

Finally, in the cultural and economic field, the integration of these paradigms can find an operational model in Kate Raworth's "Donut Economy" (2017). This model visualizes an economy that operates within a safe and just space: an ecological "teto", defined by planetary boundaries (Rockström et al., 2009), and a social "alicerce", which guarantees that basic human needs are met. Restorative Justice can provide the social processes to negotiate how to live within that foundation, while Sustainability sets the limits of the ceiling. Integration, therefore, is not just an ideal, but a project that demands a profound cultural transformation

in the direction of a systemic and collaborative mentality (Senge, 2006), a horizon that guides us in the construction of a more just and lasting future.

11 CONCLUSION

This article shows that Restorative Justice and Sustainability are different in their foci and methods, but they are not very compatible, but profoundly synergistic. The analysis revealed that its shared principles — repair, systemic vision and community participation — forms a robust base to face the complex and interconnected challenges of the XXI series. Restorative Justice, with its emphasis on healing human relationships (Boin, 2019b)), creates the social capital necessary for Sustainability to flourish. For the same time, Sustainability, to project an equitable and resilient future (WCED, 1987), offers a major purpose for social reconciliation.

The introduction of mediation (Boin, 2019a) and Shared Production of Knowledge (Bairon & Lazaneo, 2013) acts as a catalyst, transforming this theoretical synergy into praxis. In the middle of the journey, we offer the paths to navigate the socio-environmental conflicts, as for *Produção Partilhada* guarantor that the solutions are co-created with the affected communities, respecting and integrating their knowledge, in line with the Epistemologies of Sul (Santos, 2007). The examples of Nova Zealand, South Africa and indigenous audiovisual productions illustrate that this integration is not utopian, but a reality in construction.

However, overcoming institutional resistance and promoting a cultural mutancy that embraces complexity (Senge, 2006) and interdependence (Latour, 2018) are crucial. The way forward is not to choose between repairing people or repairing the planet, but to recognize that they are two faces of the same structure. True sustainability can only be achieved in a socially just world, and full justice will only be possible on an ecologically balanced planet. The use of these paradigms, therefore, is not just an academic purpose, but an ethical and practical imperative for the construction of a future in which human dignity and planetary integrity coexist.

REFERENCES

- Acseirad, H. (2009). O que é justiça ambiental. Garamond.
- Bairon, S. (2010). Antropologia visual e hipermídia. In J. da Silva Ribeiro & S. Bairon (Orgs.), *Antropologia visual e hipermídia*. Edições Afrontamento.
- Bairon, S., & Lazaneo, C. de S. (2013). *Produção partilhada do conhecimento: Do filme à hipermídia*. In J. da Silva Ribeiro & S. Bairon (Orgs.), *Antropologia visual e hipermídia*. Edições Afrontamento.

- Boin, C. Z. (2019a). *Mediação e justiça restaurativa: A humanização do sistema processual como forma de realização dos princípios constitucionais*. Quartier Latin.
- Boin, C. M. Z. (2019b). *Justiça restaurativa no contexto universitário: Caso da Universidade Dalhousie Canadá (Tese de doutorado)*. Universidade de São Paulo.
- Braithwaite, J. (2002). *Restorative justice and responsive regulation*. Oxford University Press.
- Capra, F. (1996). *The web of life: A new scientific understanding of living systems*. Anchor Books.
- Daly, H. E., & Farley, J. (2011). *Ecological economics: Principles and applications (2nd ed.)*. Island Press.
- Elkington, J. (1997). *Cannibals with forks: The triple bottom line of 21st century business*. Capstone Publishing.
- Escobar, A. (2018). *Designs for the pluriverse: Radical interdependence, autonomy, and the making of worlds*. Duke University Press.
- Johnstone, G. (2011). *Restorative justice: Ideas, values, debates (2nd ed.)*. Routledge.
- Latour, B. (2018). *Down to earth: Politics in the new climatic regime*. Polity Press.
- Marshall, T. F. (1999). *Restorative justice: An overview*. Home Office Research Development and Statistics Directorate.
- Naess, A. (1989). *Ecology, community and lifestyle: Outline of an ecosophy*. Cambridge University Press.
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.
- Pranis, K. (2005). *The little book of circle processes: A new/old approach to peacemaking*. Good Books.
- Raworth, K. (2017). *Doughnut economics: Seven ways to think like a 21st-century economist*. Chelsea Green Publishing.
- Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., III, Lambin, E., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., & Foley, J. (2009). A safe operating space for humanity. *Nature*, 461(7263), 472–475.
- Sachs, I. (2008). *Desenvolvimento sustentável e a nova ordem internacional*. Saraiva.
- Santos, B. de S. (2007). Beyond abyssal thinking: From global lines to ecologies of knowledges. *Review*, 30(1), 1–66.
- Senge, P. M. (2006). *The fifth discipline: The art and practice of the learning organization*. Currency/Doubleday.
- Tutu, D. (1999). *No future without forgiveness*. Doubleday.
- Van Ness, D. W., & Strong, K. H. (2014). *Restoring justice: An introduction to restorative justice (5th ed.)*. Routledge.
- World Commission on Environment and Development. (1987). *Our common future*. Oxford University Press.

Zehr, H. (2002). The little book of restorative justice. Good Books.

LARVICIDAL ACTIVITY AGAINST AEDES AEGYPTI AND ANTIOXIDANT, CYTOTOXIC AND MICROBIOLOGICAL EVALUATION OF THE CRUDE ETHANOLIC EXTRACT OF POGOSTEMON CABLIN BENTH

ATIVIDADE LARVICIDA CONTRA AEDES AEGYPTI E AVALIAÇÃO ANTIOXIDANTE, CITOTÓXICA E MICROBIOLÓGICA DO EXTRATO ETANÓLICO BRUTO DE POGOSTEMON CABLIN BENTH

ACTIVIDAD LARVICIDA CONTRA AEDES AEGYPTI Y EVALUACIÓN ANTIOXIDANTE, CITOTÓXICA Y MICROBIOLÓGICA DEL EXTRACTO ETANÓLICO CRUDO DE POGOSTEMON CABLIN BENTH



<https://doi.org/10.56238/sevened2026.008-010>

Lizandra Lima Santos¹, Rosany Lopes Martins², Heden Robson Monteiro Souza³, Janaina Corrêa dos Santos⁴, Cristine Barbosa Malafaia⁵, Cleidjane Gomes Faustino⁶, Fernando Antônio de Medeiros⁷, Ana Luzia Ferreira Farias⁸, Letícia Gomes de Oliveira⁹, Edmilson dos Santos Moraes¹⁰, Camila Lima dos Santos¹¹, Sheylla Susan Moreira da Silva de Almeida¹²

ABSTRACT

The present work aimed to evaluate the larvicidal, antioxidant, microbiological and cytotoxicity activity of the crude ethanolic extract of *Pogostemon cablin* (Blanco) Benth leaves. The chemical characterization was performed through staining and staining reactions for the detection of secondary metabolite classes. The larvicidal activity against *Aedes aegypti* was carried out according to the protocol of the World Health Organization. The antioxidant activity was evaluated by the sequestering ability of 2,2-diphenyl-1-picrylhydrazyl (DPPH). As for the microbiological evaluation, the microplate dilution technique was used against three bacteria, according to the protocol of the Clinical and Laboratory Standards Institute. *P. cablin* presented as classes of secondary metabolites: steroids and triterpenoids, depsides and depsidones, which in synergy with the other substances potentiated the

¹ Dr. in Pharmaceutical Innovation. Universidade Federal do Amapá. E-mail: lizandralsantos@gmail.com

² Dr. in Biodiversity and Biotechnology. Universidade Federal do Amapá. E-mail: rosyufpa@gmail.com

³ Graduated in Pharmacy. Instituto de Ensino Superior do Amapá. E-mail: heden.souza.02@gmail.com

⁴ Master's degree in Science in Health. Universidade Federal do Amapá. E-mail: janaina.correa.enfer@gmail.com

⁵ Graduated in Pharmacy. Instituto de Ensino Superior do Amapá. E-mail: cristimalafaia@gmail.com

⁶ Dr. in Pharmaceutical Innovation. Universidade Federal do Amapá. E-mail: cgfenfermagem@gmail.com

⁷ Dr. in Bioactive Natural and Synthetic Products. Universidade Federal do Pará. E-mail: fernandomedeiros1973@gmail.com

⁸ Dr. in Biodiversity and Biotechnology. Universidade Federal do Amapá. E-mail: analuzia@yahoo.com.br

⁹ Nursing and health specialist. FAMEESP. E-mail: Leti.Oliveira1999@gmail.com

¹⁰ Master's degree in Science in Pharmaceutical Sciences. Universidade Federal do Amapá. E-mail: morais28mcp@gmail.com

¹¹ Specialist in Methodology of Teaching Foreign Languages and Literatures in Spanish. Universidade Federal do Amapá. E-mail: camilasntsri@gmail.com

¹² Dr. in Organic Chemistry. Universidade Federal de São Carlos. E-mail: Sheyllasusan@yahoo.com.br

larvicidal action of the species with an LC₅₀ of 63.91 µg.mL⁻¹ in 24 h. There was no antioxidant activity at the tested concentrations, however, it showed inhibition of bacterial growth against *E. coli* with MIC of 31.25 µg.mL⁻¹. The extract showed moderate toxic action with LC₅₀ of 257.93 µg.mL⁻¹. Therefore, the *P. cablin* species showed significant larvicidal potential, with bacteriostatic action, the absence of antioxidant action and moderate toxicity.

Keywords: Biocide. Patchouli. Lamiaceae. Vector Control. Oriza.

RESUMO

O presente trabalho teve como objetivo avaliar as atividades larvica, antioxidante, microbiológica e de citotoxicidade do extrato etanólico bruto das folhas de *Pogostemon cablin* (Blanco) Benth. A caracterização química foi realizada por meio de reações de coloração e testes específicos para a detecção de classes de metabólitos secundários. A atividade larvica contra *Aedes aegypti* foi conduzida de acordo com o protocolo da Organização Mundial da Saúde. A atividade antioxidante foi avaliada pela capacidade sequestradora do radical 2,2-difenil-1-picrilhidrazil (DPPH). Para a avaliação microbiológica, utilizou-se a técnica de diluição em microplacas contra três bactérias, conforme o protocolo do Clinical and Laboratory Standards Institute. *P. cablin* apresentou como classes de metabólitos secundários: esteroides e triterpenoides, depsídeos e depsídonas, os quais, em sinergia com outras substâncias, potencializaram a ação larvica da espécie, com CL₅₀ de 63,91 µg.mL⁻¹ em 24 h. Não foi observada atividade antioxidante nas concentrações testadas; entretanto, verificou-se inibição do crescimento bacteriano contra *E. coli*, com CIM de 31,25 µg.mL⁻¹. O extrato apresentou ação tóxica moderada, com CL₅₀ de 257,93 µg.mL⁻¹. Assim, a espécie *P. cablin* demonstrou significativo potencial larvica, ação bacteriostática, ausência de atividade antioxidante e toxicidade moderada.

Palavras-chave: Biocida. Patchouli. Lamiaceae. Controle de Vetores. Oriza.

RESUMEN

El presente trabajo tuvo como objetivo evaluar las actividades larvica, antioxidante, microbiológica y de citotoxicidad del extracto etanólico crudo de las hojas de *Pogostemon cablin* (Blanco) Benth. La caracterización química se realizó mediante reacciones de coloración y pruebas específicas para la detección de clases de metabolitos secundarios. La actividad larvica contra *Aedes aegypti* se llevó a cabo de acuerdo con el protocolo de la Organización Mundial de la Salud. La actividad antioxidante se evaluó mediante la capacidad secuestradora del radical 2,2-difenil-1-picrilhidrazilo (DPPH). Para la evaluación microbiológica se utilizó la técnica de dilución en microplacas frente a tres bacterias, conforme al protocolo del Clinical and Laboratory Standards Institute. *P. cablin* presentó como clases de metabolitos secundarios: esteroides y triterpenoides, depsidos y depsídonas, los cuales, en sinergia con otras sustancias, potenciaron la acción larvica de la especie, con una CL₅₀ de 63,91 µg.mL⁻¹ a las 24 h. No se observó actividad antioxidante en las concentraciones evaluadas; sin embargo, se evidenció inhibición del crecimiento bacteriano frente a *E. coli*, con una CIM de 31,25 µg.mL⁻¹. El extracto mostró una acción tóxica moderada, con una CL₅₀ de 257,93 µg.mL⁻¹. Por lo tanto, la especie *P. cablin* presentó un importante potencial larvica, acción bacteriostática, ausencia de actividad antioxidante y toxicidad moderada.

Palabras clave: Biocida. Patchouli. Lamiaceae. Control de Vectores. Oriza.

1 INTRODUCTION

Liquid and solid synthetic insecticides are used in vector control of *A. aegypti*. They are generally accepted as effective, but they are carcinogenic, hazardous to the environment and non-target organisms. The compound N, N-diethyl-3-methylbenzamide, also known as DEET, is the product with significant insect repellency efficiency [1]. However, due to neurotoxicity allied to environmental claims, the population began to worry about its widespread use. [2, 3].

In the last years, the secondary metabolites found in plants have aroused researchers' interest to be used as alternatives to chemical insecticides [4-6]. In fact, insecticides of botanical origin have several advantages such as rapid action and degradation, low toxicity to mammals, greater selectivity and low phytotoxicity [5,7].

The mosquito *A. aegypti* L. (Diptera: Culicidae) is the transmitter of dengue, yellow fever, Chikungunya, and Zika, which cause severe morbidity and mortality in humans [8-10]. The etiology of *A. aegypti* influences its wide dispersion, favored in urban environments, preferably in the domiciliary conditions offered by human's way of living. The presence of the breeding grounds in an environment of human conviviality favors the rapid proliferation of the species, due to two aspects: ideal breeding conditions and feeding sources [1].

The use of insecticides to control adult (adulticidal) and larval (larvicidal) mosquito populations can be done through focal and non-focal treatment by the aerospace spraying of ultra-low volume insecticides (ULV). Repellents can be applied to the individual's skin to repel mosquitoes and avoid stings [11].

However, there is increasing the resistance of mosquitoes to synthetic insecticides, as well as negative impacts on the environment. Thus, it is important to search for alternative methods to be used in the control of *A. aegypti*, which are efficient, low cost, biodegradable and more selective [12].

In this context, species of the Lamiaceae family present potential for obtaining essential oils and plant extracts, they have several biological functions used in the treatment of diseases in folk medicine, as well as reports of anti-influenza, insecticide, repellent, antibacterial and anti-intestinal parasite activities [13].

P. cablin is a species of the Lamiaceae family, popularly known as Oriza or Patchouli, traditionally used for medicinal purposes, especially for the treatment of nausea, headache and heart problems, as well as proven biological activities such as antioxidant, analgesic, anti-inflammatory, antiplatelet, antithrombotic, aphrodisiac, antidepressant, anti-mutagenic, antiemetic, fibrinolytic and cytotoxic [14-17].

Considering the potentiality of species of the Lamiaceae family and the need for more studies aimed at solving public health problems, in particular, those caused by the *A. aegypti* vector, it is important to adopt alternative strategies with greater investments in appropriate methods. Thus, the present research had the objective of studying the larvicidal activity against *A. aegypti* of the crude ethanolic extract of *P. cablin* leaves. This also includes antioxidant, microbiological and cytotoxic activities, which will serve as a complementary study to evaluate the potentiality of the species for future formulation of a natural biocide.

2 MATERIAL AND METHODS

2.1 PLANT MATERIAL

The species *P. cablin* was collected in Fazendinha district (0 ° 01'08 "S and 51 ° 06'17" O) in Macapá-Amapá Municipality, Brazil. For botanical identification, the sample of the species was sent to the Herbarium of the Institute of Scientific and Technological Research of the State of Amapá (IEPA), and it was registered under number 019183.

2.2 VEGETABLE EXTRACT

The leaves of *P. cablin* were oven dried at 50 ° C for a period of 48 hours and manually ground (400g of the plant material). The plant material was placed in a suitable vessel and ethyl alcohol (96%) was added until complete submersion. Every 3 days, the ethanol extract was filtered and placed in a rotary vacuum evaporator (totaling three extractions), under the following conditions: temperature of 50°C and pressure of 500 to 760mmHg [18].

2.3 QUALITATIVE PHYTOCHEMICAL ANALYSIS

The qualitative phytochemical analysis of crude ethanolic extract was performed according to Barbosa et al. [19], in which methods of precipitation and staining reactions were applied to for the detection of cardiac glycosides, catechins, flavonoids, purines, anthraquinones, steroids and triterpenoids, depsides and depsidones, polysaccharides, phenols and tannins, proteins and amino acids, alkaloids, reducing sugars, azulenes, organic acids, and saponins.

2.4 QUANTITATIVE PHYTOCHEMICAL ANALYSIS

2.4.1 Total phenolic content

The quantification of total phenolics was determined by the Folin-Ciocateu method, according to Amorim et al. [20], with modifications. An aqueous solution of gallic acid (5000 µg.mL⁻¹) was prepared for successive dilutions. Subsequently, the calibration curve was

carried out at concentrations of 10 to 500 $\mu\text{g.mL}^{-1}$ and 400 μL of Folin-Ciocateu (10%) aliquots were added to 1600 μL of Na_2CO_3 (75 g.L^{-1}). The mixture was incubated at 25 °C for 2 hours and the absorbance was measured in a spectrophotometer with a wavelength of 760 nm. After reading the calibration curve from the samples, an aqueous solution of extract (1 mg.mL^{-1}) was prepared with 200 μL added in a 10 mL flask, 400 μL of Folin-Ciocateu (10%) and 1600 μL Na_2CO_3 (75 g.L^{-1}), in triplicate, to quantify the total phenolic content. The results were expressed as mg equivalent of gallic acid per gram of extract (mg EAG/g).

2.5 LARVICIDAL ACTIVITY

The larvae of *A. aegypti* used in the bioassay were from the colony kept in the laboratory of the Medical Entomology of the Institute of Scientific and Technological Research of the State of Amapá (IEPA), where the larvicidal test was carried out. Biological assays were conducted under controlled climatic conditions with a temperature of 25 ± 2 °C, relative humidity of 75 ± 5 %, and a photoperiod of 12 h.

The methodology used followed the standard protocol of the World Health Organization [21] with modifications. The extract of *P. cablin* (0.09 g) was dissolved in 85.5 ml of distilled water and 4.5 mL of Tween 80. For the negative control, 1% Tween 80 and distilled water were used. As for the positive control, Malathion larvicide was used in commercial concentration. The extract solution was separated in triplicates at concentrations of 20 to 100 $\mu\text{g.mL}^{-1}$ in Becker of 100 mL, and 25 larvae of the *A. aegypti* mosquito in the 3rd young stage (L3) were added. After 24 and 48 hours, the dead larvae were counted, they being considered as such all those that were unable to reach the surface.

2.6 DETERMINATION OF ANTIOXIDANT ACTIVITY

The antioxidant activity was evaluated according to the methodology of Chen et al. [22] and Lopez-Lutz et al. [23] by the sequestering ability of 2,2-diphenyl-1-picrylhydrazyl (DPPH). The antioxidant activity was calculated [24] as follows:

$$(\%AA) = 100 - \{[(\text{Abs}_{\text{sample}} - \text{Abs}_{\text{white}})100]/\text{Abs}_{\text{control}}\}$$

%AA – percentage of antioxidant activity

$\text{Abs}_{\text{sample}}$ – Sample absorbance

$\text{Abs}_{\text{white}}$ – White absorbance

$\text{Abs}_{\text{control}}$ – Control absorbance

A methanolic solution of DPPH at the concentration of 40 $\mu\text{g.mL}^{-1}$ was prepared. The extract was diluted in methanol at different concentrations of 7.81 to 250 $\mu\text{g.mL}^{-1}$. Triplicates

with 0.3 mL volume of the extract solution per tube were performed with 2.7 mL of the DPPH solution. In parallel, the negative control was prepared with 2.7 mL of methanol and 0.3 mL of the methanolic solution. For the positive control, ascorbic acid was used in the same conditions of preparation of extract. After 30 minutes of incubation at room temperature and protected from light, the absorbance was measured in a spectrophotometer (Biospectro SP-22) at wavelength 517 nm, in a quartz cuvette.

2.7 ANTIMICROBIAL ACTIVITY

2.7.1 Bacterial strains and culture conditions

Two gram-negative bacteria (*Pseudomonas aeruginosa* ATCC 25922 and *Escherichia coli* ATCC 8789) and gram-positive bacteria (*Staphylococcus aureus* ATCC 25922) were used in this bioassay.

A stock culture in BHI (Brain Heart Infusion) environment, with 20% glycerol-preserved at - 80 ° C was prepared for each microorganism. An aliquot of 50 µL of this culture was inoculated into 5 mL of sterile BHI broth environment and incubated for 24 hours at 37 ° C.

2.7.2 Determination of minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC)

The microplate dilution technique (96 wells) was used for determination of MIC and MBC, according to the protocol established by the Clinical and Laboratory Standards Institute [25], with adaptations.

Initially, the bacteria were reactivated with stock cultures and kept in BHI broth for 18 h at 37 °C. The inoculum in 0.9% saline solution was prepared for each microorganism, adjusted for the McFarland 0.5 scale, followed by dilution in BHI and tested at 2×10^6 CFU.mL⁻¹.

For MIC determination, the extract was diluted in Dimethyl sulfoxide (2% DMSO). The first well column of the plate was filled with 0.2 mL of the extract solution at the concentration of 2000 µg.mL⁻¹, the other wells were filled with 0.1 mL of 0.9% NaCl. Subsequently, base two serial dilutions were performed in the ratio of 1: 2 to 1: 128 until the dilution in a final volume of 0.1 mL. The cells (2×10^6 CFU.mL⁻¹) with 0.1 mL adjusted according to the previous item were added to each well, resulting in a final volume of 0.2 mL. There were performed the control of the culture environment, the control of extract, and the negative control (DMSO 2%). For positive control, amoxicillin (50 µL.mL⁻¹) was used. The experiments were carried out in triplicates. The microplates were incubated in an oven at 37 °C for 24 hours. After this time, the plates were read in ELISA reader (DO 630 nm).

The MBC was determined based on the results obtained in the MIC test. Microplate wells were replicated in Müller-Hinton agar and incubated at 37 ° C for 24 h. MBC was established as the lowest extract concentration capable of completely inhibiting microbial growth in Petri dishes after 24-48 hours of growth.

The results were categorized in Microsoft Excel (Version 2010 for Windows) and then, analyzed in GraphPad Prism software (Version 6.0 for Windows, San Diego California USA). Significant differences between the groups were verified using the One-way ANOVA test with Bonferroni post-test, considering $p < 0.001$.

2.8 CYTOTOXIC ACTIVITY

The evaluation of the cytotoxic activity was performed against the larvae of *Artemia salina* Leach [26, 27] with adaptations. A solution of 250 mL of synthetic sea salt at 35 g.L⁻¹ was prepared, 25 mg of exposed saline eggs were incubated in 24 h photoperiod to reach the methanuplion stage. The stock solution was prepared to contain 0.06 g of extract, 28.5 mL of the solution of synthetic sea salt and 1.5 mL of Tween 80. Seven groups of samples were divided in triplicate in the concentrations of 50 to 1000 µg.mL⁻¹, and 10 methanuplii were added in each test tube. In the end, the number of non-survivors for LC₅₀ determination was counted using the SPSS® software PROBIT analysis.

2.9 STATISTICAL ANALYSIS

The data analysis was performed through analysis of variance (ANOVA) and the Tukey test, in the BioEstat program, in order to identify significant differences between the averages. The differences that presented probability levels less than and equal to 5% ($p \leq 0.05$) were considered statistically significant. The results were expressed as mean $\pm$ standard deviation (SD). The LC₅₀ values were determined in the PROBIT regression, through the SPSS program (Statistical Package for the Social Sciences).

3 RESULTS

3.1 QUALITATIVE PHYTOCHEMICAL ANALYSIS

The phytochemical analysis of the extract of the leaves of *P. cablin* showed the presence of steroids and triterpenoids, depsides and depsidones, according to table 1.

Table 1*Identification of the secondary metabolites of the extract of P. cablin*

Tests	Results
Cardiac glycosides	-
Catechins	-
Flavonoids	-
Sesquiterpenolactones and other lactones	-
Purines	-
Anthraquinones	-
Steroids and triterpenoids	+
Depsidones e depsidones	+
Polysaccharides	-
Phenols and catheter tannins	-
Proteins and amino acids	-
Organic acids	-
Saponins	-
Azulenes	-
Alkaloids	-
Reducing sugars	-

Signal (+) indicates presence of secondary metabolite, while signal (-) indicates absence

The identification of steroids and triterpenoids is due to the result of the appearance of the staining that ranges from blue evanescence to persistent green, which occurs due to the loss of the hydroxyl that activates the conjugated system of the steroid nucleus [28]. While depsides are esters of two or more units of hydroxybenzoic acids, and depsidones are biogenetically derived from depsides through an intramolecular oxidative coupling [29], the positive result of this class is indicated by the appearance of green, blue or gray coloration.

3.2 QUANTITATIVE PHYTOCHEMICAL ANALYSIS

Table 2 shows the total phenolic content found in *P. cablin* leaves. The content of phenolic compounds was 4.02%, a relatively low result in which may be related to the absence of antioxidant activity.

Table 2

Total phenolics of extract from leaves of P. cablin

Ethanollic Extract	Phenolic compounds (mg GAE/g)	Phenolic compounds (%)
EE	40,27 µg/pipe	4,02

3.3 LARVICIDAL ACTIVITY

The extract of *P. cablin* presented expressive larvicidal action, with LC₅₀ of 63.91 µg.mL⁻¹ in 24 h, and LC₅₀ of 64.58 µg.mL⁻¹ in 48 h, with R² of 0.914. These did not present statistical difference between the 24 h and 48 h periods with p> 0.05, as shown in table 3.

Table 3

Percentage mortality (%) of A. aegypti larvae at different concentrations of P. cablin extract in two periods

Concentrations (µg.mL ⁻¹)	Larvicidal activity (%)	
	24 h	48 h
20	0.0	0.0
40	4.0	4.0
60	52.0	54.0
80	78.66	78.66
100	80.0	81.33
Control (+)	100	100
Control (-)	0.0	0.0

3.4 ANTIOXIDANT ACTIVITY

In the evaluation of the antioxidant activity, the results showed the absence of this activity, since in the highest concentration (250 µg.mL⁻¹) the DPPH consumption was 24.52%, which was lower than the expected 50% of consumption, which caused a high IC₅₀ of 900.98 µg.mL⁻¹, according to table 4.

Table 4

Mean and standard deviation of the percentage of antioxidant activity of extracts of *P. cablin* in different concentrations.

Concentrations (µg.mL ⁻¹)	% AA
7,81	14.29± 0.25
15,62	15.45± 0.73
31,25	17.80±0.83

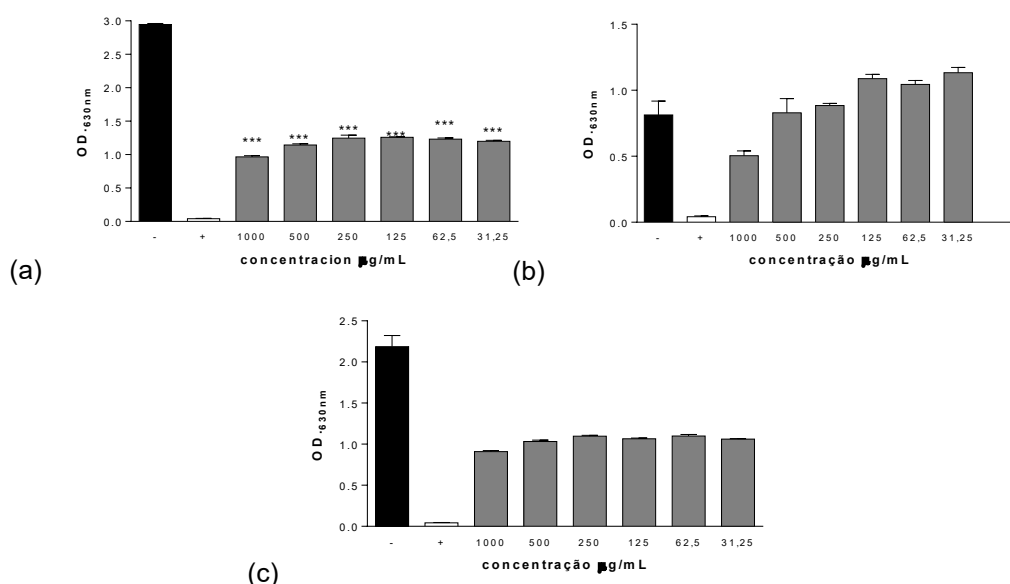
62,5	18.24 ±0.62
125	20.5 ± 0.29
250	24.52 ± 0.42

3.5 ANTIMICROBIAL ACTIVITY

The antimicrobial activity showed that *P. cablin* extract had a better bacteriostatic potential against *E. coli* bacteria, with a MIC of 31.25 mg.mL⁻¹ than for *S. aureus* and *P. aeruginosa* bacteria. Regarding MBC, extract did not demonstrate bactericidal activity against the bacteria under test, according to Figure 1.

Figure 1

Sensitivity Test (MIC) and (MBC) OE of P. cablin against the E. coli, S. aureus and P. aeruginosa



MIC and MBC of the EO of *P. cablin* against (a) *E. coli*, (b) *S. aureus* and (c) *P. aeruginosa* Source: Own author. Substance test (■), BHI with 2% DMSO (□) and Amoxiline (■). * P <0.001 statistically significant in relation to the negative control, # p <0.001 statistically significant in relation to the positive control.

3.6 CYTOTOXIC ACTIVITY

In the evaluation of the cytotoxic activity, the extract of *P. cablin* presented moderate toxic action, with LC₅₀ of 257.93 and R² 0.981, p <0.00. Table 5 shows the mean mortality readings performed in the 24 hour extract exposure against *A. salina* larvae.

Table 5

Percentage of mortality of A. salina larvae of P. cablin extract in different concentrations

Concentrations (µg.mL ⁻¹)	Mortality (%)
50	10.0

100	23.3
250	56.6
500	63.3
750	76.6
1000	86.6

4 DISCUSSION

The study for the development of biocidal herbs against *A. aegypti* is recent, beginning in the 1980s, in order to isolate and characterize such bioactive substances. Many plant-based products have active compounds that act synergistically or in isolation, and they have characteristics that can be effective in controlling and monitoring mosquito populations [30].

The plants have mechanisms against insect action and are able to synthesize, from different metabolic pathways, defense compounds as secondary metabolites and proteins that act as insecticidal toxins [18].

In this context, the phytochemical tests performed with *P. cablin*'s extract, the classes of substances such as steroids and triterpenoids, depsids and depsidones showed positive results.

The identification of the steroids and triterpenoids is due to the result of the appearance of the coloration that goes from the blue evanescence to the persistent green, which occurs due to the loss of the hydroxyl that activates the conjugated system of the steroid nucleus in the reaction [31]. Steroids are derivatives of acetate, in which they act to reduce cholesterol absorption, reduce risks of cardiovascular diseases and inhibit the growth of malignant tumors [28]. The triterpenoids are a condensed compound derived from terpenoids and their biosynthetic source of isoprene. One of its main biological activities is the antispasmodic function, in which it has the function of relaxing the intestinal smooth muscle, reducing cramps [32].

In the staining reaction of depsides and depsidones, there was a positive result from the appearance of the greenish coloration. This class of metabolites consists of phenolic compounds of multiple properties such as antioxidant, antiviral, antibiotic, antitumor, allergen, inhibition of plant growth, anti-tuberculosis and enzyme inhibitory activity [33].

In the determination of the total phenolics, the extract of *P. cablin* presented 4.02%, a significantly low result, suggesting the absence of antioxidant activity, since the phenolic compounds present in the plants are related to the most abundant antioxidants. Therefore, the greater the number of phenolic compounds, the vegetable will have expressive antioxidant activity that contributes to the processes of inhibition of the risk of cardiovascular diseases and may act on oxidative stress, related to several chronic-degenerative

pathologies, such as diabetes, cancer and inflammatory processes [34]. Currently, there is a shortage of studies indicating the content of phenolic compounds in the extract of *P. cablin*.

Studies have proven the activity of plant extracts in the control of different species of mosquito [35-37], including *A. aegypti* [1,4, 8-10, 12,13,30]. These plants synthesize several types of compounds that have recognized entomotoxic potential and arouse the interest of several researchers in the search for alternative strategies for the chemical control of *A. aegypti* [18].

In this context, *P. cablin*'s extract presented a significant larvicidal potential with LC_{50} of $63.91 \mu\text{g.mL}^{-1}$ in 24h, since samples with LC_{50} below $100 \mu\text{g.mL}^{-1}$ are considered to be good larvicidal agents [38]. The significant larvicidal activity may be related to the class of terpenes identified in the preliminary chemical test of this species, considering that biocidal studies of the *P. cablin* [39-42] species considered the sesquiterpenes (among them patchouli alcohol) as main responsible for their larvicidal potentiality.

It is important to emphasize that to relate larvicidal activity to some chemical compound is still a complex task, since the biological effect may reflect the action of the major component or is the result of the synergistic action of the constituents.

As for the antioxidant analysis, Nascimento et al. [43] emphasize that the antioxidant test sample that has high potential in sequestering free radicals has a low IC_{50} value. Thus, from a small amount of sample, there is a decrease in the initial concentration of the DPPH radical by 50%, to inhibit the radical oxidation by 50%. In conclusion, the results observed in this study did not demonstrate antioxidant activity, since the IC_{50} of the correlation between antioxidant activity (%) and the extract concentration was $900.98 \mu\text{g.mL}^{-1}$ when compared to the standard of ascorbic acid (vitamin C) with IC_{50} of $16.71 \mu\text{g.mL}^{-1}$. These results are linked to the phytochemical profile of the species, in which Maqsood et al. [44] state that ketone or phenolic substances present in plants influence the antioxidant activity.

In this scenario of research related to the search of natural bioactive compounds, the use of new substances with antimicrobial activity has aroused the interest of the scientific community, because some bacteria have resistance to synthetic antibiotics [45]. Thus, drugs that are manufactured from natural compounds appear as a promising alternative for the effective treatment of infectious diseases.

The plant extracts have compounds with antimicrobial potential, they act with a mechanism of action on the bacteria interconnected to the disturbance of the cytoplasmic membrane, cytoplasmic coagulation, change in electron flow, disruption of proton power, alteration of active transport and reduction of intracellular ATP pool [46,47].

In this study, in the evaluation of the antimicrobial activity, the extract of *P. cablin* prevented the bacterial growth only against *E. coli* bacteria, with MIC 31.25 $\mu\text{g.mL}^{-1}$, and it showed no bactericidal activity. Liu et al. [48] found the anti-microbial activity of *P. cablin* extract against *Rhizopus nigricans*, demonstrating its efficacy against infectious microorganisms. However, there are limited reports on the potentiality of the microbial activity of *P. cablin* extract, instigating further studies to clarify such biological activity.

The evaluation of the toxicity of a plant species is an important bioassay to verify if it can be used as herbal medicine. In this context, the preliminary toxicological bioassay with *A. salina* allows evaluating if the effects that a compound produces in these microcrustaceans are applicable to humans. It is necessary to make only mathematical corrections to verify the appropriate dose per unit of the body surface since the toxic effects caused in laboratory animals are approximately similar to those caused in humans [49].

The extract of *P. cablin* presented moderate toxicity, according to the classification of Lopez-Lutz et. al [23], in which high toxicity is considered LC_{50} values less than 100 $\mu\text{g.mL}^{-1}$, moderate toxicity between 100 and 500 $\mu\text{g.mL}^{-1}$, weak toxicity between 500 and 1000 $\mu\text{g.mL}^{-1}$, and LC_{50} above 1000 $\mu\text{g.mL}^{-1}$ are considered to be non-toxic.

The level of toxicity of a plant species depends on the chemical compounds that constitute it. In the species *P. cablin* it is estimated that the toxicity is related to the class of terpenes identified in its composition [50]. However, the plant extract of *P. cablin* may be more toxic than its isolated compounds, since the synergy between the substances potentiated the significant toxic action.

5 CONCLUSION

The preliminary chemical composition of *P. cablin* extract indicated the presence of the following classes of secondary metabolites: steroids and triterpenoids, depsides and depsidones.

P. cablin's extract demonstrated significant larvicidal potential and low toxicity in the LC_{50} found in this study, which can be used to control mosquito larvae without causing a cumulative effect in humans and the environment.

As for the antioxidant evaluation, there was no evidence of antioxidant activity by the DPPH radical capture method when compared to the vitamin C standard.

The antimicrobial activity showed that the extract of *P. cablin* presented a bacteriostatic action in the concentration of 31.25 mg.mL^{-1} only against *E. coli* bacteria.

The data show the relevance of the bioassays as a screening of the biological potential of the *P. cablin* species, as well as the importance of these products as a source of biocidal

compounds. Also noteworthy is the lack of studies related to the biocidal activities of *P. cablin's* extract.

ACKNOWLEDGMENTS

Amapá Foundation for Research Support (FAPEAP). To the Research Program of SUS - PPSUS - Ministry of Health.

Coordination of Improvement of Higher Education Personnel (CAPES)/Ministry of Education (MEC).

National Council of Scientific and Technological Development - CNPQ.

To the Laboratory of Microbiology (LEMA) of UNIFAP under the responsibility of Prof. Aldo Proietti Aparecido Júnior.

Pro-rector of research and post-graduation - PROPESPG. Federal University of Amapá - UNIFAP.

To the Laboratory Adolpho Ducke under the responsibility of Eloise Andrade.

REFERENCES

1. Dennis, E.J.; Vosshall, L.B., 2018. DEET feet: *Aedes aegypti* mosquitoes use their tarsi to sense DEET on contact. *BioRxiv*. 1-14. <http://dx.doi.org/10.1101/360222>
2. Legeay, S.; Clere, N.; Apara-Marchais, V.; Faure, S., 2018; Lapied, B. Unusual modes of action of the repellent DEET in insects highlight some human side effects. *European Journal of Pharmacology*. 825, 92-98. <https://doi.org/10.1016/j.ejphar.2018.02.033>
3. Leageay, S. et al., 2016. The insect repellent *N,N*-diethyl-*m*-toluamide (DEET) induces angiogenesis via allosteric modulation of the M3 muscarinic receptor in endothelial cells. *Scientific Reports*. 6, 1-13. DOI: 10.1038/srep28546
4. Marques, A.M.; Kaplan, M.A.C., 2015. Metabolitos activos del género *Piper* contra *Aedes aegypti*: fuentes alternativas naturales para el control de vectores de dengue. *Universitas Scientiarum*. 20, 61-82. doi:10.11144/Javeriana.SC20-1.amgp
5. Galm, U.; Sparks, T.C., 2016. Natural product derived insecticides: discovery and development of spinetoram. *Journal of Industrial Microbiology & Biotechnology*. 43, 185-193. DOI 10.1007/s10295-015-1710-x
6. Bekele, D., 2018. Review on insecticidal and repellent activity of plant products for malaria mosquito control. *Biomedical Research and Reviews*. 2, 1-7. doi:10.15761/BRR.1000114
7. Zhu, F.; Lavine, L.; O'Neal, S.; Lavine, M.; Foss, C.; Walsh, D., 2016. Insecticide Resistance and Management Strategies in Urban Ecosystems. *Insects*. 2, 1-26. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4808782/>
8. Kraemer, M.U.G. et al., 2015. The global compendium of *Aedes aegypti* and *Ae. albopictus* occurrence. *Scientific Data*. 2, 1-8. DOI: 10.1038/sdata.2015.35
9. Liu, Y. et al., 2017. Evolutionary enhancement of Zika virus infectivity in *Aedes aegypti* mosquitoes. *Nature*. 545, 482-498. doi:10.1038/nature22365
10. Drake, L.L., 2015. Functional characterization of aquaporins and aquaglyceroporins of the yellow fever mosquito, *Aedes aegypti*. *Scientific Reports*. 5, 1-7. DOI:10.1038/srep07795

11. Motta, S.; Monti, M., 2015. Insect Repellents. European Handbook of Dermatological Treatments. 1473–1479. doi:10.1007/978-3-662-45139-7_144
12. Vasantha-Srinivasan, P. et al., 2018. Toxicological effects of chemical constituents from Piper against the environmental burden Aedes aegypti Liston and their impact on non-target toxicity evaluation against biomonitoring aquatic insects. 25, 10434-10446. Doi:10.1007/s11356-017-9714-x
13. Ramos, R.S. et al., 2016. Chemical Study, antioxidant analysis and evaluation of the larvicidal potential against Aedes aegypti larvae of essential oil of Ocimum basilicum Linn. European Journal of Medicinal Plants. 11, 1-12. DOI: 10.9734/EJMP/2016/18230
14. Chakrapani, P. et al., 2013. Phytochemical, pharmacological importance of Patchouli (Pogostemon cablin (Blanco) Benth) an aromatic medicinal plant. Int. J. Pharm. Sci. Rev. Res. 21, 7–15. <http://globalresearchonline.net/journalcontents/v21-2/02.pdf>
15. Liu, X.R. et al., 2009. Study on antimicrobial activities of extracts from Pogostemon cablin (Blanco) Benth. Food Sci. Technol. 24, 220–227. http://en.cnki.com.cn/Article_en/CJFDTotat-SSPJ200905066.htm
16. Dongare, P. et al., 2014. A Review on Pogostemon patchouli. Res. J. Pharmacognosy & Phytochem. 691, 41–47. <https://search.proquest.com/openview/ef09ede1077a6fca8e287406f22fd5ad/1?pq-origsite=gscholar&cbl=1096443>
17. Beek, T.A.V.; Joulain, D., 2018. The essential oil of patchouli, Pogostemon cablin: A review. Flavour Fragr J. 33, 6–51. <https://doi.org/10.1002/ffj.3418>
18. Ramos, R.S. et al., 2014. Preliminary Study of the Extract of the Barks of Licania macrophylla Benth: Phytochemicals and Toxicological Aspects. Biota Amazônia. 94-99. <http://dx.doi.org/10.18561/2179-5746/biotaamazonia.v4n1p94-99>
19. Barbosa, W. L. R. et al., 2004. Manual para Análise Fitoquímica e Cromatográfica de Extratos Vegetais. Revista Científica da UFPA. 4, 1-19.
20. Amorim, E.L.C., 2008. A simple and accurate procedure for the determination of tannin and flavonoid levels and some applications in ethnobotany and ethnopharmacology. Functional Ecosystems and Communities. 2, 88-94. https://www.researchgate.net/profile/Tadeu_Sobrinho/publication/260191188
21. World Health Organization, 2005. Guidelines for laboratory and field testing of mosquito larvicides. Switzerland: Geneva, p. 1-39.
22. Chen, Z. et al., 2013. EC₅₀ estimation of antioxidant activity in DPPH assay using several statistical programs. Food chemistry. 138, p.414-420. <https://doi.org/10.1016/j.foodchem.2012.11.001>
23. Lopez-Lutz, D. et al., 2008. Screening of chemical composition, antimicrobial and antioxidant activities of Artemisia essential oil. Phytochemistry. 69, 1732-1738. <https://doi.org/10.1016/j.phytochem.2008.02.014>
24. Souza, C.R.F. et al., 2009. Antioxidant activity and physical-chemical properties of spray and spouted bed dried extracts of Bauhinia forficata. Braz. J. Pharm. Sci. 45, 209-218. <http://dx.doi.org/10.1590/S1984-82502009000200004>
25. Clinical and Laboratory Standards Institute, 2018. Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria that Grow Aerobically, 11 th ed. Clinical and Laboratory Standards: Pennsylvania.

26. Araújo, M.G.F. et al., 2010. Structures of steroidal alkaloid oligoglycosides, robeneosides A and B, and antidiabetogenic constituents from the Brazilian medicinal plant *Solanum lycocarpum*. Journal of Basic and Applied Pharmaceutical Sciences. 31, 205-209. <https://www.researchgate.net/publication/49599620>
27. Milhem, M.M. et al., 2008. Toxicity Testing of Restorative Dental Materials Using Brine Shrimp Larvae (*Artemia salina*). J. Appl. Oral Sci. 18, 297-301. <http://www.scielo.br/pdf/jaos/v16n4/13.pdf>
28. Srinivasulu, N. et al., 2016. Screening, Determination of Phytoconstituents And Antimicrobial Activity of Different Solvent Extracts of Different Parts of *Achyranthes Aspera* on Human Pathogenic Bacteria. Indo American Journal of Pharmaceutical Research. 6, 1-11. <https://www.researchgate.net/publication/305494996>
29. Iqbal, E. et al., 2015. Phytochemical screening, total phenolics and antioxidant activities of bark and leaf extracts of *Goniothalamus velutinus* (Airy Shaw) from Brunei Darussalam. Journal of King Saud University Science. 27, 224-232. <https://doi.org/10.1016/j.jksus.2015.02.003>
30. Santana, H.T. et al., 2015. Essential oils of leaves of *Piper* species display larvicidal activity against the dengue vector, *Aedes aegypti* (Diptera: Culicidae). Rev. Bras. Pl. Med. 17, 105-111. http://dx.doi.org/10.1590/1983-084X/13_052
31. Nair, S.K.P. et al., 2016. Preliminary phytochemical screening of different solvent extracts of leaves of *Echeveria elegans* Rose, an endangered Mexican succulent herb. Journal of Global Biosciences. 5, 3429-3432. <https://www.mutagens.co.in/jgb/vol.05/1/050107.pdf>
32. Hussein, R.A.; El-Anssary, A.A., 2018. Plants Secondary Metabolites: The key drivers of the pharmacological actions of medicinal plants. Herbal medicine. 11-29. doi:10.5772/intechopen.76139
33. Shahidi, F.; Yeo, J., 2018. Bioactivities of Phenolics by Focusing on Suppression of Chronic Diseases: A Review. Molecular Sciences. 19, 1-16. <https://doi.org/10.3390/ijms19061573>
34. Elnour, A.A.M. et al., 2018. Challenges of Extraction Techniques of Natural Antioxidants and Their Potential Applications Opportunities as Anti-Cancer Agents. Health Sci J. 12, 1-25. 10.21767/1791-809X.1000596
35. Liu, X.C. et al., 2015. Larvicidal activity of the essential oil from *Tetradium glabrifolium* fruits and its constituents against *Aedes albopictus*. Pest. Manag. Sci. 71, 1582-1586. <https://doi.org/10.1002/ps.3964>
36. Missah, B. Larvicidal and anti-plasmodial constituents of *Carapa procera* DC. (meliaceae) and *hyptis suaveolens* L. Poit (lamiaceae). MPhil Pharmacognosy's, Thesis, Faculty of Pharmacy and Pharmaceutical Sciences, Kumasi, 2014.
37. Boonyuan, W. et al., 2016. Excito-Repellent Responses between *Culex quinquefasciatus* Permethrin Susceptible and Resistant Mosquitoes. Journal of Insect Behavior. 29, 415-431. doi: <https://10.1007/s10905-016-9570-4>
38. Cheng, S.S. et al., 2003. Bioactivity of selected plant essential oils against the yellow fever mosquito *Aedes aegypti* larvae. Bioresource Technology. 89, 99-102. [https://doi.org/10.1016/S0960-8524\(03\)00008-7](https://doi.org/10.1016/S0960-8524(03)00008-7)
39. Kusuma, H.S. Mahfud, M., 2017. Microwave-assisted Hydrodistillation for Extraction of Essential Oil from Patchouli (*Pogostemon cablin*) Leaves. Period. Polytech. Chem. 61, 82-92. <https://doi.org/10.3311/PPch.8676>

40. Murcia-Meseguer, A. et al., 2018. Insecticidal toxicity of thirteen commercial plant essential oils against *Spodoptera exigua* (Lepidoptera: Noctuidae). *Phytoparasitica*. 46, 233–245. <https://doi.org/10.1007/s12600-018-0655-9>
41. Silva-filho, S.E. et al., 2016. Effect of patchouli (*Pogostemon cablin*) essential oil on in vitro and in vivo leukocytes behavior in acute inflammatory response. *Biomed. Pharmacother.* 1-8. <https://doi.org/10.1016/j.biopha.2016.10.084>
42. Albuquerque, E.L.D. et al., 2013. Insecticidal and repellence activity of the essential oil of *Pogostemon cablin* against urban ants species. *Acta Tropica*. 127, 181–186. <https://doi.org/10.1016/j.actatropica.2013.04.011>
43. Tohidi, B.; Rahimmalek, M. Essential oil composition, total phenolic, flavonoid contents, and antioxidant activity of *Thymus* species collected from different regions of Iran. *Food chemistry*. 220, 153-161. <https://doi.org/10.1016/j.foodchem.2016.09.203>
44. Maqsood, S. et al., 2014. Phenolic Compounds and Plant Phenolic Extracts as Natural Antioxidants in Prevention of Lipid Oxidation in Seafood: A Detailed Review. *Institute of food Technologists*. 13, 1125-1140. <https://doi.org/10.1111/1541-4337.12106>
45. Fair, R.J.; Tor, Y., 2014. Antibiotics and Bacterial Resistance in the 21st Century. *Perspect Medicin Chem.* 6, 25-64. <https://doi.org/10.4137/PMC.S14459>
46. Nazzaro, F. et al., 2013. Effect of Essential Oils on Pathogenic Bacteria. *Pharmacelticals*. 6, 1451-1474. <https://doi.org/10.3390/ph6121451>
47. Burt, S. Essential oils: their antibacterial properties and potential applications in foods--a review. *Inter. Jour. Food.* 94, 223-253. <https://doi.org/10.1016/j.ijfoodmicro.2004.03.022>
48. Liu, X. et al., 2009. Study on antimicrobial activities of extracts from *Pogostemon cablin* (Blanco) Benth. *Food Science and Technology*. 5, 1-8. http://en.cnki.com.cn/Article_en/CJFDTOTAL-SSPJ200905066.htm
49. Pereira, E.J.P. et al., 2018. Chemical Composition, cytotoxicity and larvicidal activity against *Aedes aegypti* of essential oils from *Vitex gardineriana* Schauer. *Bol. Latinoam Caribe Plant. Med. Aromat.* 17, 302-209. <http://revistas.usach.cl/ojs/index.php/blacpma/article/view/3501>
50. Swamy, M.K.; Sinniah, U.R.A., 2015. Comprehensive Review on the Phytochemical Constituents and Pharmacological Activities of *Pogostemon cablin* Benth.: An Aromatic Medicinal Plant of Industrial Importance. *Molecules*. 20, 8521-8547. <https://doi.org/10.3390/molecules20058521>

TO PUNISH OR TO PROTECT: THE ROLE OF THE PUBLIC DEFENDER'S OFFICE IN THE CRIMINAL ENFORCEMENT OF HOMELESS INDIVIDUALS

PUNIR OU PROTEGER: A ATUAÇÃO DA DEFENSORIA PÚBLICA NA EXECUÇÃO PENAL DE PESSOAS EM SITUAÇÃO DE RUA

CASTIGAR O PROTEGER: EL PAPEL DE LA DEFENSORÍA PÚBLICA EN LA PERSECUCIÓN PENAL DE LAS PERSONAS SIN HOGAR



<https://doi.org/10.56238/sevened2026.008-011>

Maria Inês Ferreira da Silva¹, Sidionei Miguel de Souza², Guajarina do Socorro Carmo de Sousa Camarão³, Eliney Alessandro Vieira Cardoso⁴, Kaio Henrique Rodrigues Nazário⁵, Graciete Nascimento Barbosa⁶, Eliane do Socorro Ferreira da Silva⁷, Regiane de Paula Ferreira da Silva⁸, Regina Célia Nascimento dos Santos⁹, Ana Cláudia Ferreira da Silva¹⁰

ABSTRACT

This article aims to discuss the role of the Public Defender's Office in the context of penal execution when applied to homeless individuals. The research intends to investigate the incongruity between punishment and protection in light of human dignity, the guarantees ensured by the Constitution, and social vulnerability. The study was based on a literature review and analysis of legal documents, which provided support for the theoretical debate. It was found that the Public Defender's Office possesses competence and potential regarding punitive practices and to be effective in relation to human rights, especially those of homeless individuals; however, it is necessary to overcome the structural limitations that reduce its performance. It is up to everyone—the State, civil society, and educational institutions—to promote reflections and practices that can lead to social justice.

Keywords: Public Defender's Office. Exclusion. Penal Execution. Homeless Individuals. Vulnerability.

¹ Specialist in Criminal Law. Faculdade Venda Nova Imigrante. E-mail: seniregi@yahoo.com.br

² Graduated Business Administration. Centro de Ensino Superior do Amapá. E-mail: sidioneymiguel.souza.sp@gmail.com

³ Specialist in: Linguistics. Centro de Ensino Superior do Amapá. E-mail: sidioneymiguel.souza.sp@gmail.com

⁴ Graduated in Laws. Faculdade Estácio de Sá. E-mail: eliney910@gmail.com

⁵ Graduated in Laws. Faculdade Estácio de Sá. E-mail: kaiofra263@gmail.com

⁶ Master's degree in Art Education. Universidade Federal do Pará. E-mail: gracietenb7@gmail.com

⁷ Specialist in Special and Inclusive Education. Faculdade Venda Nova Imigrante. E-mail: eliane.mum@gmail.com

⁸ Specialist in Teaching and Management of Higher and Professional Education. Faculdade Madre Tereza. E-mail: regi_ourem@yahoo.com.br

⁹ Specialist in Applied Linguistics. Faculdade de Tecnologia de Macapá (FTA). E-mail: ginacns17@gmail.com

¹⁰ Specialist in Higher Education Teaching. Faculdade de Educação e Tecnologia Iracema. E-mail: acferreira04@gmail.com

RESUMO

O artigo possui como objetivo principal discutir a atuação da Defensoria Pública no cenário da execução penal quando aplicada à pessoas em situação de rua. A pesquisa tem a pretensão de averiguar a incongruência entre punição e proteção em face da dignidade da pessoa humana, das garantias asseguradas na Constituição e da vulnerabilidade social. O estudo fundamentou-se em uma revisão de literatura e análise de documentos legais, os quais deram suporte para o debate teórico. Constatou-se que, a Defensoria Pública possui competência e potencial no que se refere às práticas punitivistas e para ser efetiva em relação aos direitos humanos, principalmente das pessoas que estão em situação de rua, no entanto, é necessário sobrepujar os limites estruturais que reduzem sua atuação. Compete a todos: Estado, sociedade civil, academias educacionais, promover reflexões e práticas que possam se voltar para a justiça social.

Palavras-chave: Defensoria Pública. Exclusão. Execução Penal. Pessoas em Situação de Rua. Vulnerabilidade.

RESUMEN

Este artículo busca analizar el rol de la Defensoría Pública en el contexto de la ejecución penal aplicada a personas en situación de calle. La investigación busca indagar en la incongruencia entre el castigo y la protección a la luz de la dignidad humana, las garantías constitucionales y la vulnerabilidad social. El estudio se basó en una revisión bibliográfica y un análisis de documentos legales que respaldaron el debate teórico. Se concluyó que la Defensoría Pública posee competencia y potencial en materia de prácticas punitivas y para ser eficaz en relación con los derechos humanos, especialmente los de las personas en situación de calle; sin embargo, es necesario superar las limitaciones estructurales que limitan su desempeño. Corresponde a todos —Estado, sociedad civil e instituciones educativas— promover reflexiones y prácticas que conduzcan a la justicia social.

Palabras clave: Defensoría Pública. Exclusión. Ejecución Penal. Personas en Situación de Calle. Vulnerabilidad.

1 INTRODUCTION

People who are on the margins of society make up one of the most marginalized groups within Brazilian society. With regard to the context of criminal law, this vulnerability is made increasingly greater by the scarcity of access to rights, resources, and, above all, appropriate legal representation. From this scenario, the Public Defender's Office emerges as an institution that is necessary and essential to justice, playing a role that goes beyond technical defense in achieving the promotion of constituted and fundamental rights.

There is a duality with regard to penal execution, whose stage is to give visibility to the fulfillment of the sentences imposed, since it reveals a certain mismatch between the system that punishes and the social needs of a portion of the population most in need.

The study is relevant due to the urgency of reflecting on the effectiveness of the State's protection of those most vulnerable, being, therefore, the Defender's Office, the institution that represents access to justice. In addition, it is justified by the full need to promote debates, which can trigger more inclusive public policies. From a social point of view, it seeks to contribute to guaranteeing the rights of the most vulnerable people, alerting to the risks of a penal execution that further accentuates exclusion. Scientifically, it is intended to broaden the debate in academies on critical criminology, social vulnerability, criminal guarantees, and the performance of justice institutions.

It is based on the following objectives to achieve the purpose of the research: general: to research how the Public Defender's Office acts in the criminal execution of homeless individuals and if this operation is close to a more guaranteeing or punitive connection. And the specifics are: mapping the normative foundations that govern criminal execution and the performance of the Public Defender's Office; analyze the fundamental rights of homeless people in the light of the Constitution and the Penal Execution Law; discuss the main legal, institutional and social obstacles to a protective performance of the Public Defender's Office, and systematize academic and institutional proposals that seek to strengthen the protection of hypervulnerable people in the social context.

The methodology used in the study was based on a qualitative research with a descriptive and analytical approach, with literature review and national and international legal document analysis. Texts that bring legality were used, such as the Federal Constitution of 1988, the Penal Execution Law – Law No. 7,210/84 -, the Complementary Law No. 80/94, in addition to international human rights treaties. Doctrines and scientific articles that address the Public Defender's Office, criminal execution and homelessness were also consulted.

2 HOMELESSNESS AND THE PENAL SYSTEM: SOCIAL AND LEGAL ASPECTS

Homelessness is not only a condition of extreme poverty, but an expression of a process of structural exclusion. This condition is marked by social exclusion, lack of access to essential services and, in many cases, a relationship of conflicts with the repressive apparatuses of the State. When it comes to the penal system, this reality acquires even more serious contexts, since hypervulnerable people face obstacles and limitations to the real exercise of their rights, including, and especially, during the penal execution.

When it comes to the Brazilian State, homelessness is one of the phenomena that most attacks society and that gives visibility to a glaring social inequality, as well as criminal selectivity. Historically, this group has always been the target of marginalization with rights violated or neglected, including by the criminal justice system itself. The criminalization of misery is a framework composed of the intersection of extreme poverty, social vulnerability, and incarceration.

Zaffaroni *et al* (2018, p. 65) bring to light the concept of criminal selectivity in the legal sphere, since it constitutes a mechanism by which the penal system concentrates its action in vulnerable sectors.

Criminalization is selective and this selectivity is not a deviation from the system, but rather its own way of functioning. Punishment and criminal proceedings do not apply to everyone equally, but focus primarily on the most vulnerable sectors of society. In other words, the penal system is not a mechanism of global control, but rather an instrument of power directed preferentially against the poor and marginalized. Primary criminalization—the creation of criminal law—may seem neutral, but secondary criminalization—law enforcement—is profoundly selective.

The authors' words reveal a critique of the repressive apparatus that is not neutral, but rather functional to maintain the social order that becomes exclusionary. It is noted that prison, within this context, is seen as a deposit of undesirable individuals, where homeless people are incarcerated for crimes of lesser offensive potential such as hunger theft, possession of drugs for consumption or simply for occupying public spaces.

One should not ignore the work of the Public Defender's Office, which represents a barrier of resistance to all this punitive mechanism. As Silva (2021, p. 87) points out, "the Public Defender's Office has a strategic role in protecting the rights of homeless people, acting not only in judicial defense, but in promoting citizenship and combating the institutionalization of exclusion". This presence in the spaces deprived of liberty makes it possible to design the exclusionary structures of the penal system and guarantee a minimum of dignity to the hypervulnerable.

The Federal Constitution of 1988, in its article 1, item III, enshrines the dignity of the human person as the foundation of the Republic. However, this commitment remains unfulfilled when we see thousands of people living on the streets who are deprived of elementary rights, with arbitrary and illegal arrests, precautionary measures that are disproportionate and the absence of minimum conditions in prisons.

According to data from the Institute of Applied Economic Research – IPEA – "the number of homeless people in Brazil increased by more than 200% between 2012 and 2022" (IPEA, 2022, p. 34). This is a contingent of the population whose condition of vulnerability is multifactorial: homelessness, unemployment, chemical dependency, mental disorders and breakdown of family ties. However, what can be observed is the performance of the penal system as the only visible state response, suppressing the failure of public assistance and housing policies.

This time, the interface between homelessness and the penal system decrees not only a sensible and guaranteeing legal response, but a reconstruction of the role of the State in social protection. The criminalization of poverty, under the veil of formal legality, perpetuates historical inequalities and deepens exclusion. As Foucault (1996, p. 61) asserts, "prison manufactures delinquents, instead of correcting them; exclusion is its most effective product." Therefore, it is urgent to profoundly reformulate public policies, combined with critical and humanized legal action, so that we can break the perverse cycle of vulnerability and punishment (BATISTA, 2015).

3 PUBLIC DEFENDER'S OFFICE AND PENAL EXECUTION: LEGAL AND INSTITUTIONAL FOUNDATIONS

The role of the Public Defender's Office in criminal enforcement is one of the most significant expressions of the realization of fundamental rights within the Brazilian penal system. Since the 1988 Constitution (BRASIL, 1988), especially with the enactment of Constitutional Amendment No. 80/2014, the Public Defender's Office has been recognized as an essential function of justice, in charge of legal guidance, promotion of human rights and defense, at all levels, of the needy, in a comprehensive and free manner (BRASIL, 2014).

Constitutional Amendment No. 80/2014 reinforces the essential role of the Public Defender's Office in promoting social justice and addressing inequalities in the penal system. By determining that the Defender's Office be present in all jurisdictional units within 8 years, the amendment sought to ensure that no citizen, regardless of their social and territorial condition, is left without access to justice. In the context of the criminal execution of homeless

people, this amendment gains special relevance. This group, marked by extreme vulnerability and social exclusion, faces numerous barriers in the justice system (BRASIL, 2014).

In the context of criminal enforcement, the Public Defender's Office plays a crucial role in protecting the rights of people deprived of liberty, who are often forgotten or made invisible by the justice system. Its performance is legally based on the Penal Execution Law itself, Law No. 7,210/1984, especially on articles 16, 81-A and 83, which expressly provide for legal assistance to prisoners, and recognize the Public Defender's Office as one of the organs of penal execution, alongside the Public Prosecutor's Office and the Execution Court (BRASIL, 1984).

Article 16 of the LEP establishes that the "Public Defender's Office shall ensure the regular execution of the sentence and the security measure" (BRASIL, 1984, p. 42). This article confers on the Ombudsman's Office express attribution in the supervision of criminal execution, which includes the verification of legalities, excesses of time, undignified conditions of custody and absence of minimum state assistance. For homeless people, this action is crucial to ensure the exercise of rights that are usually denied to them, such as access to health, prison work, and education in prison.

Article 83 establishes that "the prisoner and the internee may present, in person or through an attorney, a petition, representation or complaint to any authority, in defense of rights or against illegality or abuse of power". Although the article recognizes the right of the prisoner to petition, in practice, without effective legal assistance, this right becomes illusory. The Public Defender's Office, through Article 134 of the CF/88, becomes the channel through which these rights can be claimed in a technical and effective manner.

The Penal Execution Law (LEP), since its origin, has been guided by the rehabilitation of the convict and the protection of his dignity. This principle becomes even more urgent when it comes to homeless people, who accumulate several layers of social and institutional exclusion. (BRAZIL, 2014). In this context, the performance of the Public Defender's Office, strengthened by EC No. 80/2014, is essential to ensure effective compliance with the LEP (BRASIL, 1984).

The Defender's Office's work is not limited to the exercise of technical defense in court, but extends to the protection of fundamental rights in daily prison life, such as access to health, education, family visitation, physical and moral integrity, and regime progression (DU PRAT, 2015). In this area, it acts both individually and collectively, through public civil actions, *collective habeas corpus* and periodic visits to prison units, being a fundamental agent of supervision of the fulfillment of the sentence in the mold of the dignity of the human person (DU PRAT, 2015).

In the conception of Lima (2021, p. 95),

The Public Defender's Office is the main instrument of legal resistance to the selective punitivism of the State, being the only institution that, in an organic way, has as its institutional mission the defense of those who, historically, occupy the most vulnerable positions in the gears of the penal system.

The Public Defender's Office, as the institutional voice of the vulnerable, assumes a fundamental role. As Lima (2021, p. 82) argues, "its performance must transcend the forensic space, inserting itself in the streets, squares, shelters in order to promote real access to justice for those whose citizenship is routinely denied". This extrajudicial and multidisciplinary action becomes essential to denounce abuses, guarantee rights and foster articulation with social protection networks.

However, as long as the State maintains a punitive and hygienist posture – which expels, imprisons or silences bodies that are uncomfortable with public order – breaking the cycle of vulnerability and incarceration will not be possible. As Wacquant (2017) points out, the state government, with neoliberal conceptions, tends to reduce its presence in maintaining the security of social rights, concomitantly intensifies its punitive presence in areas of urban marginality.

To overcome this latent reality, it needs to demand a new paradigm of justice, based on solidarity, equity and the recognition of the intrinsic dignity of all human beings. In Almeida's (2019) view, it is necessary to decriminalize poverty, recognize the structural determinants of exclusion, and ensure effective public policies for housing, mental health, and social assistance. Without this, the penal system will continue to be the inevitable fate of those who have been excluded from all other spaces.

4 BETWEEN PROTECTION AND PUNISHMENT: CHALLENGES IN THE DEFENSE OF HOMELESS PEOPLE

The homeless population represents one of the most vulnerable segments of Brazilian society, marked by multiple forms of social and institutional exclusion. The performance of the justice system in relation to this population shows a constant tension between the bias of social protection and the logic of punishment, especially in the criminal field. The Public Defender's Office emerges as a central protocol actor in the mediation of this duality, and assumes the difficult mission of guaranteeing fundamental rights in a panorama of criminalization of poverty.

The Magna Carta, by establishing the Democratic Rule of Law, enshrined the Principle of the Dignity of the Human Person as one of its foundations – article 1, III-, which implies the

duty of the State to ensure full protection to all citizens, including those in situations of extreme vulnerability. However, it is observed, in practice, that public security and criminal justice mechanisms often operate under a selective and punitive logic, as denounced by Zaffaroni *et al* (2018), when they state that the Latin American penal system does not punish all crimes, but rather selects perpetrators and facts in a discriminatory manner, criminalizing poverty and protecting the interests of the elites.

The Public Defender's Office, as an institution essential to the jurisdictional function of the State, under the terms of article 134 of the Constitution, plays a fundamental role in containing punitive excesses and promoting public policies aimed at inclusion (BRASIL, 1988). His performance in criminal enforcement and in the defense of homeless people requires not only technical knowledge, but also social sensitivity and the ability to articulate between institutions. According to Justice Vieira (2016) in which the Public Defender's Office is present both in the courts and in the spaces of public policy formulation in the promotion of the realization of social rights.

Meanwhile, the challenges facing the Public Defender's Office are great. The absence of civil documentation, the breakdown of family and community ties, barriers to access to public services, and social stigmas make it difficult to build effective defense strategies (GIAMBERNARDINO, 2016). In addition, the precariousness of housing policies, the scarcity of mental health programs, and the dismantling of initiatives aimed at the homeless population contribute to the worsening of the problem. As stated by Ramos and Muszkat (2011), the street is a stage for physical and psychic suffering, in which this individual is deprived of his identity, of his belonging to a society and of the protection of state institutions.

In this sense, it is urgent to rethink the role played by justice institutions in protecting the rights of this portion of the population, and to promote action that is based on the principles of dignity, equality and inclusion (SANTOS, 2014). The Public Defender's Office must be strengthened both at the legal-individual level and at the collective and structural level, whether through public civil actions, inspections or institutional dialogues. To this end, it is necessary to ensure autonomy, resources, and territorial capillarity, as well as training for its members, with a focus on human rights and the intersectionality of vulnerabilities.

5 CRITICAL ANALYSIS OF LITERATURE AND PROPOSITIONS FOR A MORE HUMANIZED PERFORMANCE

The performance of the justice system, especially in the criminal field, over the years, has been guided by practices of exclusion, selectivity and dehumanization of subjects in situations of vulnerability. This finding is supported by a critical analysis of contemporary legal

literature, which reveals the urgency of rethinking the normative and institutional paradigms that govern state action, especially in the face of marginalized populations, such as homeless people, drug users, adolescents in conflict with the law, and black people (KARAM, 2023).

The criticism of the punitive model is shared by authors such as Eugenio Raúl Zaffaroni, Vera Alessandro Barata and Nilo Batista. For Baratta (2002), the Brazilian penal system is heir to a slave-owning and authoritarian logic, which treats the 'social undesirables' as enemies to be eliminated. In this sense, critical criminological literature plays an essential role in unveiling the ideological character of punitive action and proposing action based on human rights, dignity, and inclusion (KARAM, 2023).

It is within this whole context that the Public Defender's Office emerges as an institution focused on the promotion of human rights and the effectiveness of access to justice by the most marginalized groups. However, merely technical action, detached from an empathetic and contextualized look, can reproduce the exclusionary logics of the penal and judicial system. Thus, a more humanized performance of the Public Defender's Office is proposed, based on a human approach as a fundamental hermeneutic vector (COUTINHO, 2017).

Humanization in the Public Defender's Office determines, first of all, the recognition that the recipient of its services is, most of the time, a person in a situation of extreme vulnerability – not only economic, but also social, cultural, racial, psychological and institutional. As Almeida (2019, p. 93) points out, "inequality is structural and operates in a way that marginalizes and dehumanizes historically excluded subjects". Therefore, the public defender and all those who work in the Defender's Office need to be aware of the multiple oppressions that affect their assisted, and must adopt a legal practice that is sensitive to these social markers.

In this sense, it is proposed that the training of public defenders and all those who, directly or indirectly, deal with this clientele, include content on human rights, structural racism, gender, mental health, public policies, and legal anthropology. The performance of a defender, therefore, cannot be limited to formal legality. It also needs to involve commitments to social transformation. By means Streck (2014, p. 132) assures "the Constitution is not an appendix of the legal system, but its reason for being. Legal dogmatics must be constitutionalized."

In addition, humanization involves qualified listening to the assisted. It is necessary to break with the vertical logic in which the defender decides, unilaterally, the best defense strategy. On the contrary, the protagonism of the individual must be promoted, and his autonomy and narrative must be respected. At this point, Boaventura de Sousa Santos (2014)

argues for the need for an 'epistemology of the South', in which popular knowledge is valued as legitimate forms of knowledge and resistance.

Another essential aspect for humanized action is the extrajudicial and collective action of the Public Defender's Office. This includes institutional visits to places of deprivation of liberty, articulation with social movements, the proposition of public civil actions, and active participation in public policies (CONDEGE, 2001). In this way, the National Council of General Public Defenders aims to articulate and institutionally strengthen the Brazilian Public Defender's Office at the national level. Its mission is to promote the integration, strengthening, standardization and development of Public Defenders' Offices, in order to ensure coordinated and effective action in the defense of the fundamental rights of the population, especially people in vulnerable situations (CONDEGE, 2001).

It is also essential to strengthen the institutional structure to enable quality performance. This involves a greater budget, administrative autonomy and internal control mechanisms aimed at ethics and accountability. The humanization of action does not dispense with adequate material conditions and appreciation of civil servants and defenders.

Finally, the trend of criminalization of poverty and criminal selectivity must be combated. The Public Defender's Office has an ethical duty to denounce punitive practices that disproportionately affect the black, peripheral and homeless population. According to Zaffaroni *et al* (2018, p. 165), "the penal system is not blind, but selective; punishes the same as always, perpetuating historical inequalities". Thus, a truly humanized performance must challenge these structures and promote substantive justice.

Therefore, the propositions for a more humanized Public Defender's Office go through a critical, interdisciplinary action focused on social transformation, committed to fundamental rights and the dignity of the human person. It is about rescuing the centrality of the subject of law and promoting equity as a pillar of justice.

6 FINAL CONSIDERATIONS

The present research started from the concern about the role of the Public Defender's Office in the criminal execution of homeless people, in the light of a penal system that is known to be selective, exclusionary and little sensitive to social inequalities. The hypothesis that guided the investigation – that the Defender's Office's performance can represent a more guaranteeist and humanized path in the face of the current punitive logic – was confirmed throughout the theoretical, legal and critical analysis of the data and references used.

By achieving the proposed objectives, especially the general one – to analyze how the Public Defender's Office acts in the criminal execution of homeless people and whether this

action is aligned with a guaranteeing or punitive logic – it could be seen that the Defender's Office, even though it faces institutional, budgetary and structural limitations, constitutes itself as the main way of resistance to the criminal criminalization of the most vulnerable. The study revealed that its work goes beyond forensic limits and also takes place in the extrajudicial field, in the promotion of public policies and in the articulation with protection networks. In this way, the Public Defender's Office is substantially close to a guarantor connection, even if inserted in a structurally punitive system.

In the initial chapter, it was demonstrated how homelessness in Brazil represents not only a condition of material misery, but the most extreme expression of social exclusion. The analysis of IPEA data and legal frameworks showed the lack of structuring public policies and the use of the penal system as a mechanism for controlling and containing social undesirables. Criminal selectivity was approached from Zaffaroni and other authors of critical criminology, showing how criminal law, although apparently neutral, applies unequally, and disproportionately affects the poor, blacks, drug users and, notably, the homeless.

The second chapter reinforced this finding by addressing the legal fundamentals and institutions of the Public Defender's Office, especially its constitutional provision as an essential function of justice and its attribution in the full and free defense of the needy. It was observed that the Defender's Office is supported by the Penal Execution Law and Complementary Law No. 80/94 to act not only in the technical defense, but in the supervision of the execution of the sentence with dignity, which involves the fight against abuses, the guarantee of social rights and the promotion of citizenship in penal establishments.

The investigation also made it possible to achieve the proposed objectives: the normative framework of penal execution and defensive action was mapped; the fundamental rights of homeless people and institutional obstacles were analyzed, such as the absence of documentation, breaking of ties, prejudice and the lack of intersectoral policies; and, finally, propositions aimed at the humanized and structuring performance of the Public Defender's Office were systematized. Among them, the following stand out: continuous training in human rights and intersectionality, the strengthening of institutional visits, collective defense and strategies, and the role of those assisted in the defense process.

The final chapter, by proposing a more humanized performance, consolidated the elements raised earlier, arguing that the practice of defense should break with the rigidity of legal dogmatics and assume an ethical-political commitment to historically invisible subjects. Qualified listening, recognition of the subjectivity of those assisted, and the adoption of interdisciplinary strategies were presented as structural pillars.

Therefore, it is possible to affirm that the Public Defender's Office, although immersed in an unequal and selective justice system, has the potential to resignify its performance and constitute itself as a transforming agent in the criminal execution of homeless people. Such action, in order to be effective, requires institutional strengthening, political commitment to human rights, and the adoption of legal practices sensitive to the complexity of vulnerabilities.

It is concluded that, in the face of a penal system that, according to Foucault, manufactures exclusion and feeds marginalization, the Public Defender's Office must assume the role of resistance, being the bridge between law and social justice. Their humanized performance is not only an ethical option, but a constitutional and historical necessity in the face of the reality of the streets and prisons. Justice, therefore, will only be full when it is able to reach and protect those who are currently kept on the margins, not only of the urban space, but of citizenship itself.

Finally, it should be noted that this article does not intend to exhaust the debate about the role of the Public Defender's Office in the criminal execution of homeless people, nor to offer absolute answers to the challenges surrounding the theme. On the contrary, it is intended that the present analysis serves as a starting point for broader and more in-depth reflections, fostering future investigations on aspects not yet explored, such as local institutional practices, the impacts of intersectoriality in the care of the homeless population and the successful experiences of advocacy in different regions of the country. The complexity of the reality dealt with here establishes a continuous, critical look committed to social justice.

REFERENCES

- Almeida, S. de. (2019). Racismo estrutural. Pólen.
- Baratta, A. (2002). Criminologia crítica e crítica do direito penal: Introdução à sociologia do direito penal. Revan.
- Batista, N. (2015). Introdução crítica ao direito penal brasileiro (4ª ed.). Revan.
- Brasil. (1984). Lei nº 7.210, de 11 de julho de 1984 (Institui a Lei de Execução Penal). Presidência da República.
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. <http://www.planalto.gov.br>
- Brasil. (2014). Emenda Constitucional nº 80, de 4 de junho de 2014. Diário Oficial da União.
- Condege – Conselho Nacional das Defensoras e Defensores Públicos-Gerais. (2001). <https://chatgpt.com/c/68740c8c-f1d0-8011-8b48-5fa3aa4c348d>

- Coutinho, J. N. de M. (2017). *Interpretação garantista da Constituição* (6ª ed.). Juruá.
- Duprat, D. (2015). Direitos humanos e atuação institucional: Possibilidades e limites. *Revista Sur*, (21).
- Foucault, M. (1996). *Vigiar e punir: Nascimento da prisão*. Vozes.
- Giambernardino, A. (2016). *A Defensoria Pública como instrumento de inclusão social*. Juruá.
- Instituto de Pesquisa Econômica Aplicada. (2022). Nota técnica nº 90: Estimativas da população em situação de rua no Brasil (2012–2022). Ipea. <http://www.ipea.gov.br>
- Karam, M. L. (2023). *Juizes sem toga: Defensoria e Ministério Público* (2ª ed.). Lumen Juris.
- Lima, R. B. (2021). A atuação da Defensoria Pública frente à população em situação de rua. *Revista da Defensoria Pública do Estado do Rio de Janeiro*, 12(1).
- Malaguti Batista, V. (2013). *Difíceis ganhos fáceis: Drogas e juventude pobre no Rio de Janeiro*. Garamond.
- Ramos, M. B., & Muszkat, M. (2011). *Moradores de rua e sofrimento psíquico: Desafios e possibilidades*. Hucitec.
- Santos, B. de S. (2014). *Para uma revolução democrática da justiça*. Cortez.
- Silva, C. A. (2021). Defensoria Pública e acesso à justiça: Desafios contemporâneos. *Revista de Direitos Fundamentais*, 8(2).
- Streck, L. L. (2014). *Hermenêutica jurídica e(m) crise: Uma exploração hermenêutica da construção do direito* (10ª ed.). Livraria do Advogado.
- Vieira, R. T. (2016). *Defensoria Pública e efetivação dos direitos humanos*. Lumen Juris.
- Wacquant, L. (2017). *As prisões da miséria*. Zahar.
- Zaffaroni, E. R., & Pierangeli, J. H. (2018). *Manual de direito penal brasileiro* (9ª ed., rev. e atual.). RT.

SOCIODEMOGRAPHIC FACTORS AND SELF-PERCEIVED MENTAL BALANCE AMONG MEN INCARCERATED FOR SEXUAL CRIMES

INFLUÊNCIAS DE FATORES SOCIODEMOGRÁFICOS NA AUTOPERCEPÇÃO DE EQUILÍBRIO MENTAL EM HOMENS ENCARCERADOS POR CRIMES SEXUAIS

FACTORES SOCIODEMOGRÁFICOS Y AUTOPERCEPCIÓN DEL EQUILIBRIO MENTAL EN HOMBRES ENCARCELADOS POR DELITOS SEXUALES



<https://doi.org/10.56238/sevened2026.008-012>

Claudia Regina Biancato Bastos¹, Ana Laura de Souza Gonçalves², Amanda Myrianne Dobzinski³, Nicole Mayumi Carneiro Takano⁴, Gabriela Fernanda Schiochet⁵, Gabrielly Hneda Fadel⁶, Cristina Berger Fadel⁷

ABSTRACT

Considering that men deprived of liberty for sexual crimes are exposed to multiple psychosocial vulnerability factors, such as stigmatization, fragile social bonds, and limitations in access to care actions, it becomes relevant to investigate the self-perception of mental health in this context. This study aims to analyze the self-perception of mental balance among men incarcerated for sexual crimes, associating it with sociodemographic and prison-related characteristics, such as educational level, prison status, participation in activities, and family support. To this end, an exploratory, descriptive, and analytical study with a quantitative approach was conducted with 90 men deprived of liberty in a prison unit in southern Brazil. Data were collected through a structured questionnaire and analyzed using descriptive and inferential statistics, applying the chi-square test and linear trend analysis, with a 5% significance level. Thus, a high prevalence of very negative self-perception of mental health was observed, especially among individuals in pretrial detention and those with lower educational levels. A significant association was also found between participation in activities and better mental balance, as well as a lower frequency of death-related thoughts. These findings allow the conclusion that contextual and institutional factors, such as access to activities and the definition of legal status, exert a relevant influence on mental health in prison, reinforcing the need for intersectoral strategies to promote mental health in the prison system.

Keywords: Mental Health. Prisoners. Prisons. Social Determinants of Health. Rape.

¹ Dr. in Health Technology. Faculdade Sagrada Família. E-mail: cbiancato@yahoo.com.br

² Nurse. Universidade Estadual de Ponta Grossa. E-mail: analauradesouzagoncalves@gmail.com

³ Undergraduate student in Nursing. Faculdade Sagrada Família.

E-mail: amanda117296@redesagradafamilia.com.br

⁴ Undergraduate student in Nursing. Faculdade Sagrada Família. E-mail: niimayumi1@gmail.com

⁵ Doctoral student in Health Sciences. Universidade Estadual de Ponta Grossa (UEPG).

E-mail: gschiochet@hotmail.com

⁶ Medical Student. Centro Universitário Campo Real. E-mail: med-gabriellyfadel@camporeal.edu.br

⁷ Dr. in Preventive and Social Dentistry. Universidade Estadual de Ponta Grossa. E-mail: cfadel@uepg.br

RESUMO

Considerando que homens privados de liberdade por crimes sexuais estão expostos a múltiplos fatores de vulnerabilidade psicossocial, como estigmatização, fragilidade de vínculos sociais e limitações no acesso a ações de cuidado, torna-se relevante investigar a autopercepção da saúde mental nesse contexto. Objetiva-se analisar a autopercepção do equilíbrio mental de homens encarcerados por crimes sexuais, associando-a a características sociodemográficas e prisionais, como escolaridade, condição prisional, participação em atividades e apoio familiar. Para tanto, procede-se a um estudo exploratório, descritivo e analítico, de abordagem quantitativa, realizado com 90 homens privados de liberdade em uma unidade prisional do sul do Brasil. Os dados foram coletados por meio de formulário estruturado e analisados por estatística descritiva e inferencial, utilizando o teste do qui-quadrado e análise de tendência linear, com nível de significância de 5%. Desse modo, observa-se elevada prevalência de autopercepção muito negativa da saúde mental, especialmente entre indivíduos em prisão provisória e com menor escolaridade. Verificou-se ainda associação significativa entre participação em atividades e melhor equilíbrio mental, bem como menor frequência de pensamentos de morte. O que permite concluir que fatores contextuais e institucionais, como acesso a atividades e definição da situação jurídica, exercem influência relevante sobre a saúde mental no cárcere, reforçando a necessidade de estratégias intersetoriais de promoção da saúde mental no sistema prisional.

Palavras-chave: Saúde Mental. População Privada de Liberdade. Prisões. Determinantes Sociais da Saúde. Estupro.

RESUMEN

Considerando que los hombres privados de libertad por delitos sexuales están expuestos a múltiples factores de vulnerabilidad psicosocial, como la estigmatización, la fragilidad de los vínculos sociales y las limitaciones en el acceso a acciones de cuidado, resulta relevante investigar la autopercepción de la salud mental en este contexto. El objetivo de este estudio es analizar la autopercepción del equilibrio mental de hombres encarcelados por delitos sexuales, asociándola con características sociodemográficas y penitenciarias, como el nivel educativo, la situación jurídica, la participación en actividades y el apoyo familiar. Para ello, se realizó un estudio exploratorio, descriptivo y analítico, con enfoque cuantitativo, con 90 hombres privados de libertad en una unidad penitenciaria del sur de Brasil. Los datos se recolectaron mediante un cuestionario estructurado y se analizaron mediante estadística descriptiva e inferencial, utilizando la prueba de chi-cuadrado y el análisis de tendencia lineal, con un nivel de significancia del 5%. De este modo, se observó una elevada prevalencia de autopercepción muy negativa de la salud mental, especialmente entre individuos en prisión preventiva y con menor nivel educativo. Asimismo, se verificó una asociación significativa entre la participación en actividades y un mejor equilibrio mental, así como una menor frecuencia de pensamientos de muerte. Estos hallazgos permiten concluir que factores contextuales e institucionales, como el acceso a actividades y la definición de la situación jurídica, ejercen una influencia relevante sobre la salud mental en el contexto penitenciario, reforzando la necesidad de estrategias intersectoriales de promoción de la salud mental en el sistema penitenciario.

Palabras clave: Salud Mental. Personas Privadas de Libertad. Prisiones. Determinantes Sociales de la Salud. Violación.

1 INTRODUCTION

In the year 2025, Brazil recorded the third largest prison population in the world, surpassed only by the United States and China (ObservaDH, 2024), with more than 900 thousand individuals deprived of liberty either in units of the penitentiary system such as physical cells and house arrests or in other custody facilities (Brasil, 2025). Data from the National Penal Information System (Sisdepen) indicate that, in 2024, the Brazilian prison population was mostly male, with 641,128 men deprived of liberty (95.66%) and 29,137 women (4.34%). In Paraná, this scenario is repeated in the total number of people incarcerated in the state, 38,196 (5.96%) were men and 2,378 (0.51%) were women (Brasil, 2025). In the context of deprivation of liberty for sexual crimes, we did not find statistical data available to make this comparison.

In this context, we often come across data that point to overcrowding, violence, lack of access to essential health services, and little supply of rehabilitation programs. These factors have a direct impact on the worsening of existing mental disorders, as well as on the development of new mental illnesses (Frazão; Souza; Nonato, 2024). According to the World Health Organization (WHO), mental health can be considered a state of well-being experienced by the individual, which enables the development of their personal skills to respond to life's challenges and contribute to the community. However, when we refer to people deprived of liberty, they are already in a situation of vulnerability even before incarceration, since their access to goods and services is limited (Cardoso, et. al. 2024). Upon entering the prison environment, the changes experienced, added to stressful factors, intensify feelings of anxiety, fear, helplessness, isolation, rejection, impotence, and low self-esteem, compromising mental balance (Silva, et. al. 2021).

As a result, deprivation of liberty can directly affect the mental health of individuals deprived of liberty. The situation and conditions of prison increase the risk of developing depression and dissatisfaction with life (YI, et al. 2017). The lack of work and education opportunities in the prison environment is also a risk factor for the emergence of mental disorders (Gabrysch, et al. 2019). In a study by Henry et al. (2020), 12.6% of people deprived of liberty have already experienced a serious mental illness and 25.5% other mental health disorders because they are incarcerated in an inhumane environment, which does not exert its real function of rehabilitation to a large extent. In another study by Gottfried and Christopher (2017) they showed that 63% of the men deprived of liberty in the study had mental health problems.

When addressing the theme of mental balance, another relevant point is family support, since it represents the main form of social interaction during the execution of the

sentence. This support plays a key role in offering emotional and affective support, contributing to the construction of values and behaviors that provide the individual with a sense of identity and belonging (Gato et al, 2022). In a study carried out by Calazans et al. (2022), the results found showed that family relationships are significantly impacted by the process of incarceration of men, so that stigma is also consolidated in family life through prejudice and social isolation. With this, it is also known that in situations of physical, mental or social vulnerability, family support is essential for maintaining the individual's quality of life and recovery. However, family abandonment, often experienced in the prison environment, contributes to the deterioration of the quality of life of people deprived of liberty.

A study conducted in the United States of America with 871 male respondents showed that incarcerated people with adequate mental health were less likely to recidivize after their freedom. This demonstrates that mental health within the prison environment is an important factor in cases of criminal recidivism (Wallace; Wang, 2020). Therefore, with the entry into prison, the State and the penal institution start to manage the basic needs of the individual, such as physical, mental, and social health (Bahiano, 2021).

In 2014, the Ministries of Health and Justice instituted the National Policy for Comprehensive Health Care for Persons Deprived of Liberty (PNAISP), through Ordinance GM/MS No. 02, representing an important advance in ensuring access to basic health services for this population (Brasil, 2014). However, the environment marked by restrictions, strict control, violence and idleness becomes hostile and stressful. Therefore, the health of the prison population is a public health issue, and many authors highlight the importance of research that subsidizes public policies and reduces physical and mental suffering inside and outside prisons (Jesus, et al. 2015).

In view of the problem exposed, the present study aims to analyze the self-perception of mental balance of men incarcerated for sexual crimes, associating it with sociodemographic and prison characteristics, such as education, prison condition, participation in activities and family support.

2 METHODOLOGY

This is an exploratory, descriptive, analytical study with a quantitative approach, developed with men deprived of liberty for sexual crimes.

The study was carried out at the Hildebrando de Souza Public Prison, in the municipality of Ponta Grossa, Paraná, Brazil. The study included 90 men incarcerated for sexual crimes, aged between 20 and 71 years, selected by convenience, according to the eligibility criteria defined by the institution.

Data collection took place between April and June 2025, and was carried out by students from the Nursing course at Faculdade Sagrada Família (FASF) and Dentistry at the State University of Ponta Grossa, previously trained and supervised by responsible professors. The interviews were conducted individually, on previously scheduled days and times, in a place reserved and authorized by the prison unit management, respecting institutional security standards. Sociodemographic information (age, marital status, race/color, education, previous employment status), variables of the prison context (length of incarceration, prison situation, and frequency of family visits) and self-perception of mental balance were collected.

A structured form was used, applied through interviews, containing closed questions. The variable self-perception of mental balance was evaluated based on the participants' self-perception, on an ordinal scale of five categories: very negative, negative, intermediate, positive and very positive.

The data were organized in a spreadsheet and analyzed using descriptive and inferential statistics. Categorical variables were presented in absolute and percentage frequencies. For the inferential analysis, the chi-square test of independence was used, with the objective of verifying associations between the perception of mental balance and the variables age group, length of incarceration and family support. Additionally, the *Linear-by-Linear Association* test was applied in order to identify possible progressive ordinal patterns among the variables analyzed, considering the ordinal nature of the categories. Statistical tests were performed using proprietary software.

In additional exploratory analyses, ordinal variables were converted into numerical scores, preserving the semantic order of the responses, enabling the evaluation of descriptive trends. A significance level of 5% ($p < 0.05$) was adopted.

The study was approved by the Research Ethics Committee, through Plataforma Brasil, under opinion No. 7,608,038/2025, in compliance with the guidelines of Resolution No. 466/2012 of the National Health Council. The research was authorized by the state and local management of the prison unit. All participants voluntarily consented to participate, by signing the Informed Consent Form or fingerprinting in cases of illiteracy.

3 RESULTS AND DISCUSSIONS

The study observed 90 men deprived of liberty, analyzing the self-perception of mental balance, considering variables age group, time of incarceration, family support

Table 1 shows the sociodemographic profile of men deprived of liberty for sexual crimes in the period studied.

Table 1

Sociodemographic profile of men in deprivation of liberty from April to June 2025

Variable	Category	%
Age (years)	Average (min.–max.)	34,7 (20–71)
Marital status	Single	41,2
	Married	14,9
	Divorced	4,1
	Widower	0,7
Race/Color	White	55,6
	Brown	36,7
	Black	7,8
Education	Incomplete Elementary School	61,1
	Complete Elementary School	11,1
	Incomplete high school	14,4
	Complete high school	7,8
	Illiterate	5,6
Previous employment situation	Informal/self-employed work	70,0
	Formal work	30,0
Family support (visits)	Receives no visits or support	45,6
	Receives visits regularly	35,6
	Receives visits sporadically	18,8

Source: the authors, 2025.

The sociodemographic profile observed in this study, characterized by the mean age of young adults, predominance of single individuals, low education and mostly informal labor insertion, is convergent with findings described in the national literature on people deprived of liberty for sexual crimes. Brazilian studies that analyzed men convicted of rape of a vulnerable person and other sexual offenses indicate that most of these subjects have trajectories marked by social vulnerabilities, especially low education and precarious socioeconomic conditions, factors that precede incarceration and influence the way these individuals are inserted in the penal system (Santos; Andrade, 2019; Silva, 2021). The high proportion of individuals with incomplete primary education observed in this sample reinforces the understanding that limited education is a relevant marker of social exclusion among sexual offenders in the Brazilian context, although it should not be interpreted as a causal factor of the crime.

On the international scene, studies conducted with incarcerated sex offenders in countries such as Spain, Turkey, and Taiwan also describe similar sociodemographic profiles,

with wide age variation, male predominance, low or intermediate educational levels, and a history of unstable occupations before prison (García et al., 2020; Yildiz et al., 2022; Tsai et al., 2018). These investigations highlight that, despite the cultural and legal differences between countries, social determinants (such as schooling, working conditions, and fragile family ties) appear recurrently in the characterization of this population. Thus, the analysis of the sociodemographic profile should be understood as a fundamental contextual element for the interpretation of findings related to mental health and emotional balance, contributing to a broader and more integrated approach to the phenomenon of sexual crime and incarceration.

Table 2, which deals with the characterization of age and the perception of mental balance, it was observed that the age group of participants between 20 and 30 years old had the highest perception of mental balance (59.45%).

Table 2

Characterization of the age group and self-perception of mental balance

Age group	Very negative (%)	Negative (%)	Intermediate (%)	Positive (%)	Very positive (%)
20–30 years old	13,51	0,00	16,21	10,81	59,45
31–40 years old	22,85	5,71	14,28	2,85	54,28
41–50 years old	40,00	0,00	10,00	20,00	30,00
51–60 years old	40,00	0,00	0,00	0,00	60,00
61–71 years old	50,00	0,00	50,00	0,00	0,00

Source: the authors, 2025.

The collected data indicate that the perception of mental balance has a different distribution according to the stage of life, while young adults demonstrate greater adaptive capacity and psychosocial resilience, older individuals reveal emotional fragility due to the expanded awareness of the sentence and the aging process in prison. A similarity was observed in a study carried out in Pernambuco with 15 participants, which highlights that incarcerated elderly individuals face specific challenges related to aging, such as social isolation and the emotional impact of prolonged incarceration (Júnio; Silva, 2022).

Recent research reinforces this relationship, highlighting that incarcerated older adults face challenges related to aging, such as social isolation, psychological distress, and forced medicalization, negatively impacting their mental health (Toledo, 2025). Although many incarcerated elderly people do not fully understand the impact of years of exclusion, such as

the absence of autonomy, this factor, for example, exerts a direct influence on their physical and mental health, since incarceration can affect the well-being and quality of life of people deprived of liberty, generating psychological suffering, restrictions on freedom and limitations on the expression of individual autonomy (Vilela; Dias; Sampaio, 2021).

A qualitative study carried out in Bahia analyzed the perception of the incarcerated population for the first time about their adaptation to the prison environment. The findings showed that young adults, especially in the age group of 25 to 30 years, found it easier to adapt to the rules and routines of the penitentiary system. This adaptation may be related to greater emotional and psychological flexibility. In addition, the study showed that young people demonstrate superior ability in building interpersonal relationships within prison, favoring social integration and reducing isolation and loneliness (Bahiano, 2021). These results suggest that youth can function as a protective factor, attenuating mental suffering in the context of prison.

Table 3 examined the relationship between the length of time of incarceration and the perception of mental balance. Among the participants with less than 6 months of incarceration, 56.6% said they had positive mental health, while 24.53% were very negative.

Table 3

Characterization of the time of incarceration and the self-perception of mental balance

Incarceration time	Very negative (%)	Negative (%)	Intermediate (%)	Positive (%)	Very positive (%)
< 6 months	24,53	0,00	13,20	5,67	56,60
6 months – 1 year	10,00	5,00	20,00	10,00	55,00
1 – 3 years	20,00	6,67	13,33	13,33	46,67
> 3 years	50,00	0,00	50,00	0,00	0,00

Source: the authors, 2025.

Regarding the time of incarceration, 56.6% of the participants with less than 6 months of incarceration stated the presence of mental balance, while of the individuals with more than 3 years of incarceration, 50% were undecided and the other 50% perceived the mental balance as very negative. These data suggest that there is a phase of consolidated psychological adaptation during the intermediate time of incarceration, in which the individual develops mechanisms to deal with the prison environment (Oliveira, Valença, 2020). This fact is comparable to the study carried out in Santa Catarina, which identified a lower recidivism rate among individuals with intermediate prison time, suggesting that, during this period, these individuals can develop more effective coping mechanisms and a psychological adaptation that contributes to greater emotional stability (Souza; Golgher; Silva, 2024). On the other hand, the prolongation of time can lead to a worsening of psychic conditions, due

to emotional exhaustion, isolation and lack of social reintegration (Oliveira, Valença, 2020). In addition, Baiano and Faro (2022) reinforce the idea that exposure to prison stressors such as social isolation, and lack of control over one's own life is strongly associated with the worsening of inmates' mental health, especially associated with increased sentences.

Table 4 shows that men who have already been sentenced have better self-perception of mental health compared to those who are still in a provisional situation, but it is also noted that both sentenced and provisional individuals obtained significant percentages regarding negative self-perception of mental health, which reinforces the prison environment as harmful to mental health.

Table 4

Percentage distribution of self-perception of mental health according to prison condition

Situation	Very negative (%)	Negative (%)	Intermediate (%)	Positive (%)	Very positive (%)
Provisional (n=63)	66,7	7,9	15,9	0,0	9,5
Sentenced (n=27)	59,3	3,7	25,9	3,7	7,4

Source: the authors, 2025.

The literature describes incarceration as an environment with a high load of stressors (restriction of freedom, rupture of bonds, institutional violence, deprivation of privacy and limited access to care) and, therefore, associated with relevant psychological suffering. Recent research on the prevalence and risk of mental health in populations deprived of liberty pointed out that disorders and symptoms of anxiety, depression, substance use, and comorbidities appear to be highly prevalent, suggesting that the negative perception may reflect both previous illness and aggravation by factors in the prison environment (Shnyder et al., 2025). These same authors describe that uncertainty about the outcome of the process aggravates mental health, which is in line with other studies focused on inmates that emphasize the high burden of mental health problems in this group, reinforcing that pretrial detainees constitute a population with specific needs and often more acute (Andrade et al., 2023; Albrecht et al., 2025). The literature indicates that people in pretrial custody have specific mental health needs, often more intense than those observed after the sentence is defined, reinforcing the importance of priority attention to this group.

On the other hand, among those sentenced, there was a higher proportion of responses in the intermediate and positive categories, although in modest percentages. This pattern may indicate a gradual process of psychological adaptation to incarceration after the sentence is defined, associated with the predictability of the routine and the reduction of

anxiety related to the uncertainty of the judicial outcome (Andrade et al., 2023). However, the low frequency of positive perceptions in both groups suggests that such adaptation does not eliminate mental distress, but may attenuate extremely negative perceptions over time.

In the Brazilian context, these findings should be analyzed in the light of the structural characteristics of the prison system, marked by a high proportion of pretrial detainees and limitations in the provision of comprehensive mental health care. Institutional reports highlight that the fragility of the psychosocial care network in prison and the difficulty in accessing early interventions contribute to the maintenance of psychological suffering among people deprived of liberty (National Council of Justice, 2024; Ministry of Human Rights and Citizenship, 2023). Thus, the results reinforce the need for mental health screening and follow-up strategies from the beginning of incarceration, with special attention to individuals in pretrial detention.

Table 5 addressed the perception of mental balance in relation to family support, especially due to the frequency of visits received. In this context, there was no significant difference in the perception of mental health with the frequency of visits.

Table 5

Characterization of self-perception of mental balance and family support

Family support	Very negative (%)	Negative (%)	Intermediate (%)	Positive (%)	Very positive (%)
Regular visits	30,30	3,03	9,10	6,06	51,51
Sporadic visits	12,50	0,00	12,50	18,75	56,25
Doesn't receive visitors	17,08	2,43	19,51	4,88	56,10

Source: the authors, 2025.

The descriptive results presented show that family support does not influence the perception of mental balance among individuals deprived of liberty, which goes against studies that identified that the absence of family ties was statistically associated with a higher incidence of depressive symptoms while family relationships acted as a protective factor for the mental health of prisoners (Bahiano; Faro; Turri, 2021). The same study also demonstrated that the presence of the family through regular visits strengthens emotionally, helping to build more stable routines (Bahiano; Faro; Turri, 2021). The family is recognized as a protective link during the period of incarceration, being the main form of social bonding and emotional support. It contributes to the construction of identity, influences behaviors and decisions, and directly impacts the way men and women face the experience of prison (Gato et.al, 2022). It is important to note, however, that even among the participants without family support, most still stated that they agreed with the perception of mental balance. This finding

may indicate the presence of individual coping mechanisms, such as spirituality, peer support, work occupations, or participation in therapeutic projects, which are recognized by the literature as protective factors in the prison context (Oliveira, 2022). Thus, the result of this research demonstrated that, for the participants, the family support present during the visits did not demonstrate a direct effect on the self-perception of the positive mental health of the inmates, contrary to the literary findings.

Table 6 shows that individuals with lower education concentrate a higher proportion of very negative perceptions of mental health. Among the illiterate, 80.0% reported a very negative perception, while among those with incomplete primary education this proportion was 61.8%. A more balanced distribution of responses was observed among participants with complete elementary education, although the positive perception is still a minority. These findings indicate a descriptive trend of worse self-perception of mental health associated with lower levels of education.

Table 6

Percentage distribution of self-perception of mental health according to schooling

Education	Very negative (%)	Negative (%)	Intermediate (%)	Positive (%)	Very positive (%)	Very negative (%)
Illiterate	80,0	0,0	0,0	0,0	20,0	100
Incomplete Elementary School	61,8	9,1	20,0	0,0	9,1	100
Complete Elementary School	50,0	10,0	20,0	10,0	10,0	100
Incomplete high school	69,2	0,0	23,1	0,0	7,7	100
Complete high school	85,7	0,0	14,3	0,0	0,0	100

Source: the authors, 2025.

This pattern found between schooling and mental health is widely discussed in the literature as an expression of the structural social inequalities that precede incarceration and that are intensified in the prison environment, directly affecting the way individuals perceive and cope with psychological suffering (Silva; Oliveira; Santos, 2021; Rocha et al., 2023).

In the Brazilian context, studies show that low education is associated with greater social vulnerability, less access to health information, difficulties in communicating with professionals, and limited development of coping strategies in the face of adverse situations, such as deprivation of liberty (Santos et al., 2020; Silva; Oliveira; Santos, 2021). In prison environments, these limitations can be enhanced by institutional rigidity and the scarcity of structured educational actions, contributing to a more negative perception of mental health among individuals with less education. Thus, the high concentration of very negative

perceptions among illiterate people and people with incomplete primary education evidenced in this study is supported by national surveys that describe schooling as an important social determinant of mental health in private prison.

In the international scenario, research conducted in different prison systems reinforces this association between low education and worse mental health indicators. Studies carried out with incarcerated populations in Europe and North America indicate that individuals with a lower level of education have a higher prevalence of depressive symptoms, anxiety, and psychological distress, as well as a lower perception of control over their own health (Fazel et al., 2016; Albrecht et al., 2025). These authors highlight that schooling plays a mediating role in the relationship between social exclusion, incarceration and mental illness, influencing both the recognition of suffering and the search for institutional support.

Although in this study there was a relatively more balanced distribution of responses among participants with complete elementary education, the positive perception of mental health remains a minority even in this group. This finding suggests that, although schooling has a partial protective effect, the prison context imposes significant limits on psychological well-being, regardless of educational level. In this sense, international studies indicate that incarceration, in itself, represents a risk factor for the worsening of mental health, and can partially neutralize the protective effects of schooling when there are no institutional policies for education, work, and mental health promotion adequately implemented (Who, 2022; Albrecht et al., 2025).

Thus, the result of this research, associated with findings in national and international literature, reinforces the need for intersectoral public policies that expand access to formal education and educational activities in the prison system, not only as a strategy for social reintegration, but also as an action to promote mental health. Schooling should be understood as a central element in the approach to psychological suffering in prison, articulated with other dimensions of care, such as psychosocial support, prison work and strengthening of social bonds, as recommended by national and international guidelines for health care for the population deprived of liberty (Brasil, 2014; Who, 2022).

Table 7 shows the associations between the variables age group, length of incarceration and family support, prison context and perception of mental balance, and the Chi-square statistical tests of independence and *Linear-by-Linear Association*. The tests reinforced the result of statistical non-significance, even though the descriptive data point to different trends in the variables.

Table 7

Sociodemographic variables, prison context and self-perception of mental balance, Chi-square statistical tests of independence and Linear-by-Linear Association (Linear Tendency)

Independent variable	Statistical test	Go od luc k	Statistics	P-value
Age group × Perception of mental balance	Chi-square of independence	16	$\chi^2 = 16,16$	0,442
Age group × Perception of mental balance	Linear-by-Linear Trend Association	1	$Z = -0.23$	0,817
Incarceration time × Perception of mental balance	Chi-square of independence	12	$\chi^2 = 10,02$	0,614
Incarceration time × Perception of mental balance	Linear-by-Linear Trend Association	1	$Z = -0.07$	0,946
Family support × Perception of mental balance	Chi-square of independence	8	$\chi^2 = 7,21$	0,514
Family support × Perception of mental balance	Linear-by-Linear Trend Association	1	$Z = 0.09$	0,926

Legend: GL-Degree of Freedom; χ^2 = chi-square value; Z = linear trend test statistics. A significance level of 5% ($p < 0.05$) was adopted.

Source: the authors, 2025.

Thus, the results indicate that no variable showed a statistically significant trend in isolation to mental balance. However, the prison condition of provisional situation, which indicates legal instability, showed the greatest descriptive tendency to the worst self-perception of mental balance, followed by the fragility of family support. It is noteworthy that even though the data have not been proven through statistical calculation, this result does not invalidate the research, on the contrary, it points to new perspectives for different analyses and new care strategies for the public studied.

4 CONCLUSION

In view of the results presented, we can see that access to activities and definition of the legal situation exert a relevant influence on mental health in prison; the other variables, such as family support present in the visits, were not evidenced as relevant for mental balance, as pointed out in different literatures. Thus, the understanding between the self-perception of psychic balance in prison can help in the understanding and development of psychosocial interventions aimed at this population. By considering the different variables, it is possible to envision more assertive actions that favor the mental balance of the population deprived of liberty, contributing to rehabilitation and reduction of criminal recidivism. Finally, it was noted that there are few studies on self-perception of mental health, especially in prison for sexual crimes.

REFERENCES

- Albrecht, J. N., et al. (2025). Prevalence and risk factors of mental health symptoms of individuals in different detention settings: A cross-sectional study. *BMC Psychiatry*, 25, 1–12. <https://doi.org/10.1186/s12888-025-07255-8>
- Andrade, J., Sousa, M., Gonçalves, R. A., & Castro-Rodrigues, A. (2023). Remand prisoners' specific needs: A systematic review. *Journal of Police and Criminal Psychology*, 38, 942–955.
- Bahiano, M. D., & Turri, G. S. S. (2021). A percepção da experiência de primeiro aprisionamento em uma unidade prisional. *Psicologia: Ciência e Profissão*, 41(4).
- Brasil. Ministério da Saúde. (2014). Portaria interministerial nº 1, de 2 de janeiro de 2014 (Institui a Política Nacional de Atenção Integral das Pessoas Privadas de Liberdade no Sistema Prisional). Gabinete do Ministro.
- Brasil. Ministério da Justiça e Segurança Pública. Secretaria Nacional de Políticas Penais. (2025). Dados estatísticos do sistema penitenciário: 17º ciclo SISDEPEN (julho a dezembro de 2024). MJSP.
- Brasil. Secretaria Nacional de Políticas Penais. (2025). Relatório de informações penais – Relipen 2024. SENAPPEN.
- Brasil. Ministério da Saúde. (2014). Política Nacional de Atenção Integral à Saúde das Pessoas Privadas de Liberdade no Sistema Prisional (PNAISP). Ministério da Saúde.
- Calazans, B. B. A., Delfino, G. A. P., & Amaral, L. A. (2024). Homens em privação de liberdade e relações familiares: Uma análise qualitativa da perspectiva dos familiares. Programa de Iniciação Científica – PIC/UniCEUB: Relatórios de Pesquisa.
- Conselho Nacional de Justiça. (2024). Pessoas com transtorno mental em conflito com a lei no Brasil: Diagnóstico e recomendações (v. 6, n. 1). CNJ/CEBRAP.
- Emilian, C., et al. (2025). Prevalence of severe mental illness among people in prison: A systematic review and meta-analysis. *The Lancet Public Health*, 10(3), e170–e182.
- Fazel, S., et al. (2016). Mental health of prisoners: Prevalence, adverse outcomes, and interventions. *The Lancet Psychiatry*, 3(9), 871–881.
- Frazão, M. A., Souza, I. C. L., & Nonato, I. B. L. (2024). Saúde mental de pessoas privadas de liberdade no sistema penitenciário brasileiro. *Revista FT*, 29.
- Gabrysch, C., Fritsch, R., Priebe, S., & Mundt, A. P. (2019). Mental disorders and mental health symptoms during imprisonment: A three-year follow-up study. *PLOS One*, 14(3), e0213711.
- García, J. A., Martínez, M., & López, F. (2020). Sociodemographic and criminological characteristics of incarcerated sexual offenders. *International Journal of Law and Psychiatry*, 73, 1–8.
- Gato, C. M., et al. (2022). Implicações familiares durante a privação de liberdade e a teoria do apego: Uma metassíntese qualitativa. *Revista Brasileira de Enfermagem*.

- Gottfried, E. D., & Christopher, S. C. (2017). Mental disorders among criminal offenders. *Journal of Correctional Health Care*, 23(3), 336–346.
- Henry, B. F. (2020). Typologies of adversity in childhood and adulthood as determinants of mental health and substance use disorders of adults incarcerated in US prisons. *Child Abuse & Neglect*, 99, 1–9.
- Jesus, A. C. F., et al. (2015). O significado e a vivência do abandono familiar para presidiárias. *Ciência & Saúde*, 8(1).
- Ministério dos Direitos Humanos e da Cidadania. (2023). Relatório anual de direitos humanos 2022. MDHC.
- Oliveira, G. C., & Valença, A. M. (2020). Institucionalização prolongada, transtornos mentais e violência: Uma revisão científica. *Saúde e Sociedade*, 29(4).
- Oliveira, L. L. (2022). Escravização, aprisionamento e uma intervenção sociopsicodramática em uma unidade prisional. *Revista Brasileira de Psicodrama*, 30.
- Rocha, M. V. C., et al. (2023). Determinantes sociais da saúde mental em populações privadas de liberdade. *Physis: Revista de Saúde Coletiva*, 33, e330210.
- Santos, J. R., & Andrade, A. G. (2019). Perfil sociodemográfico e judicial de homens condenados por estupro de vulnerável no Brasil. *Revista Brasileira de Ciências Criminais*, 27(158), 233–252.
- Santos, J. R., et al. (2020). Escolaridade, exclusão social e saúde mental no sistema prisional brasileiro. *Revista Brasileira de Enfermagem*, 73(6), e20190567.
- Silva, L. V. C., et al. (2021). Práticas de cuidado em saúde mental com população privada de liberdade: Revisão de escopo. *Saúde Coletiva*, 11(69).
- Silva, M. C. (2021). Homens condenados por crimes sexuais contra crianças e adolescentes: Análise sociodemográfica e judicial (Tese de doutorado). Universidade Federal do Rio Grande do Sul.
- Silva, M. C., Oliveira, R. A., & Santos, E. M. (2021). Escolaridade e sofrimento psíquico em homens privados de liberdade. *Saúde em Debate*, 45(129), 789–801.
- Silva, S. P. C., & Junior, R. S. S. (2022). Saúde e velhice: Representações sociais de idosos encarcerados. *Psicologia e Saber Social*, 11(2).
- Souza, R. G., Golgher, A. B., & Silva, B. F. A. (2024). Determinantes da reincidência prisional em Santa Catarina utilizando análise de sobrevivência. *Nova Economia*, 34(3).
- Toledo, C. E. R. (2025). Envelhecer em cárcere: Ensaio crítico sobre os impactos do encarceramento na saúde mental de idosos privados de liberdade. *Políticas Públicas e Cidades*, 14(4).
- Tsai, C. H., et al. (2018). Demographic characteristics and criminal patterns of incarcerated sex offenders in Taiwan. *Journal of Forensic Psychiatry & Psychology*, 29(4), 603–617.

- Vilela, D. S. D., Dias, C. M. S. B., & Sampaio, M. A. (2021). Idosos encarcerados no Brasil: Uma revisão sistemática da literatura. *Contextos Clínicos*, 14(1).
- Wallace, D., & Wang, X. (2020). Does in-prison physical and mental health impact recidivism? *SSM – Population Health*, 11, 100569.
- World Health Organization. (2022). Prisons and health. WHO Regional Office for Europe.
- Yi, Y., Turney, K., & Wildeman, C. (2017). Mental health among jail and prison inmates. *American Journal of Men's Health*, 11(4), 900–909.
- Yildiz, M., Kaya, N., & Demir, A. (2022). Paraphilias and sociodemographic profiles of male sexual offenders. *Journal of Forensic Sciences*, 67(3), 1045–1052.

DINO +: DIGITAL GAME FOR PEOPLE WITH ASD

DINO +: JOGO DIGITAL PARA PESSOAS COM TEA

DINO +: JUEGO DIGITAL PARA PERSONAS CON TEA



<https://doi.org/10.56238/sevened2026.008-013>

Luiz Cláudio Machado dos Santos¹, Maria Adélia Icó M. dos Santos², Jocelma Almeida Rios³, Ingrid Winkler⁴, Luis Felipe Coelho Carvalho dos Santos⁵, Adrian Willy da Silva Borges⁶

ABSTRACT

This article discusses the development of a digital game aimed at children with ASD. Digital games are a strategy used in various activities to support the learning process of these children, serving as a link with a multidisciplinary and interdisciplinary team. This article focuses on developing an educational game accessible to people with autism. The objective of this article is to develop a game in Unity by integrating scriptwriting, visual art, and sound composition through programming, addressing autism, and making it usable by teachers, children, and those interested in the subject. The methodological process of this article is based on a literature review, providing a rich and well-founded reference to contribute to the game's development. Finally, a free game is presented in both desktop and web versions, along with a mobile version for Android, available on the mentioned platforms and accessible to any user.

Keywords: Autism. Digital Games. Technology. Accessibility. ASD.

RESUMO

Este artigo aborda o desenvolvimento de um jogo digital voltado para crianças com TEA. Os jogos digitais são uma estratégia utilizada como diversas atividades para o aprendizado dessas crianças, podendo ser o elo, com a equipe multidisciplinar e interdisciplinar. Este artigo pensou-se no desenvolvimento de um jogo educacional acessível às pessoas com autismo. Para este artigo, pensou-se como objetivo: desenvolver o jogo no Unity integrando, roteiro, arte visual e composição sonora através da programação, abordando o autismo e possa ser utilizada por professores, crianças e interessados no assunto. O processo metodológico deste artigo baseou-se em uma revisão literária, possibilitando um referencial rico e embasado para contribuir com o desenvolvimento do jogo. Por fim, é apresentado um

¹ Dr. of Education. Universidade Federal da Bahia (UFBA). E-mail: luizcms@ifba.edu.br

² Master's degree in Applied Computing. Universidade Estadual de Feira de Santana (UEFS). E-mail: adeliaico@ifba.edu.br

³ Dr. in Dissemination of Knowledge. Universidade Federal da Bahia (UFBA). E-mail: jocelmarios@ifba.edu.br

⁴ Postdoctorate researcher. Nanyang Technological University. E-mail: ingrid.winkler@nieb.org.br

⁵ Digital Games Technologist. E-mail: felipeccsantos1@gmail.com

⁶ Undergraduated student in Digital Games. E-mail: adrianwilly22@gmail.com

jogo gratuito em desktop e web e uma versão para dispositivos móveis em Android, disponível nas plataformas citadas e pode ser utilizada por qualquer cidadão.

Palavras-chave: Autismo. Jogos Digitais. Tecnologia. Acessibilidade. TEA.

RESUMEN

Este artículo analiza el desarrollo de un juego digital dirigido a niños con TEA (Trastorno del Espectro Autista). Los juegos digitales son una estrategia utilizada en diversas actividades de aprendizaje para estos niños y pueden servir como enlace con equipos multidisciplinarios e interdisciplinarios. Este artículo se centra en el desarrollo de un juego educativo accesible para personas con autismo. El objetivo fue desarrollar el juego en Unity, integrando guiones, artes visuales y composición sonora mediante programación, abordando el autismo y haciéndolo accesible para docentes, niños y cualquier persona interesada en el tema. El proceso metodológico de este artículo se basó en una revisión bibliográfica, proporcionando una referencia rica y bien fundamentada para contribuir al desarrollo del juego. Finalmente, se presenta una versión gratuita del juego para escritorio y web, así como una versión para dispositivos móviles Android, disponible en las plataformas mencionadas y accesible para cualquier persona.

Palabras clave: Autismo. Juegos Digitales. Tecnología. Accesibilidad. TEA.

1 INTRODUCTION

A neurological condition that impacts people's development, including their social interaction, cognitive development, among others and that can come with symptoms that vary from person to person, such as difficulty in verbal and non-verbal communication, repetitive behaviors and difficulty in changing their routines, characterized by these daily challenges, autism is a global developmental disorder that is diagnosed in several children and adults. Thinking about possibilities and activities to contribute to the development of people with Autism Spectrum Disorder (ASD) is a challenge for the family and for a multidisciplinary team. It is important to note that some of these people with ASD have exceptional abilities in some specific areas. (Soares, et al, 2024).

For (Carvalho and Nunes, 2014), children with ASD often have a forgotten childhood, where interdisciplinary and multidisciplinary work is necessary, sometimes requiring more than one therapist in each meeting. Also in his work, he highlights the therapy that was based on the cognitivist developmental view, defended by researchers such as Piaget and Vygotsky and on autism scholars, such as Kenner, Bosa, Lampréia, Passerino among others with the great objective of stimulating the improvement of social interaction and language of the children served, through multidisciplinary work, involving pedagogues, psychologists, doctors, etc.

Reinforcing the proposal of (Carvalho and Nunes, 2014), the multidisciplinary team and professionals in the area of education have the challenge of proposing activities that contribute to the development and learning of autistic people, through therapy, extracurricular activities, weekly meetings and the use of technology becomes a great ally to support this process. Among the technologies that can be used, electronic games stand out, which through their interaction, entertainment and playful universe, becomes a digital alternative for this audience.

In the therapeutic and educational context, electronic games become a significant tool for autistic people. Through electronic devices, these games approach learning in an engaging and adaptive way, contributing with various skills and aspects in the development of people with ASD. Adapting games that meet the specific needs of this audience has become innovative, facilitating and contributing to their learning, in addition to creating environments that allow interaction and integration, thus favoring the practice of these skills. (Freitas, et al, 2024).

For (Freitas, et al, 2024) traditional approaches are no longer sufficient due to the use of large technologies, making electronic games effective in the development of social skills of autistic people, allowing social interactions in an adapted and controlled environment.

Depending on the games and their mechanics, it is possible to include inclusive activities involving several other people.

Also in his work, (Freitas, et al, 2024) cites (Filho, et al, 2023, p. 75), which demonstrates the power of games, citing that it is possible to have a safe virtual environment, allowing the simulation and practice of social interactions of children with ASD, increasing their engagement and interest in the proposed activities, such as interaction with the characters in the game, real-world simulation and even conflict resolution.

In the work of (Lira, et al, 2023), which he cites (Schell, 2020) brings the information that the game is closely related to the ability to solve problems, and this when intentionally removed ceases to be classified as a game and becomes an activity.

Also, according to (Schell, 2020), cited by (Lira, et al, 2021), it is possible to stimulate autistic children through the elements that make up a game, such as mechanics, story, aesthetics, and technology.

Games are already present in children's daily lives, thus enabling their development and learning. This technology has characteristics of visual dynamism, proposition of challenges, combination of rules and reward mechanisms. That is, at the same time that a digital game can serve as entertainment, it is possible to align with the teaching and learning process. (Ramos and Cruz, 2018).

Among one of the main advantages for the use of games are: cognitive skills, autonomy in decision-making. The new types of games also enable something impressive and that was highlighted in the pandemic period: contact with people in real time and virtually. In addition, it allows it to become a good educational tool, when aligned with the teacher in the classroom. (Ramos and Cruz, 2018).

In view of the above, the use of digital games in the development of social skills in children with autism has proven to be a significant alternative in the educational and therapeutic field. Autism Spectrum Disorder is characterized by difficulties in social interactions, communication, and restricted and repetitive behaviors. The implementation of digital games adapted to the needs of this population has become an innovative strategy, with the aim of facilitating the learning of essential social skills, such as empathy, communication, and conflict resolution. By integrating digital games into the educational and therapeutic context, it is possible to create interactive environments that favor the learning and practice of these skills, in addition to promoting the engagement of children with ASD in a playful and stimulating way.

This article demonstrates a digital game, working with three main aspects: the development and logic, the import of scenarios and characters and finally the script and

application of the game's sound. The proposal will serve to disseminate the theme in all schools in the country, where people can become aware of a very worrying topic among the various professionals adapted to meet the specific needs of people with autism, offering valuable opportunities for learning and development.

It is in this perspective that this work aims to align the concepts of games with a very important theme, but which is often forgotten. And the digital game can make this link, collaborating with the multidisciplinary and interdisciplinary team. Given the importance between the areas, the development of an educational game was considered, with the objective of being accessible to people with autism. The intention is for the game to be freely accessible through the internet, desktop and mobile devices, helping teachers with the educational process in a playful way.

2 THEORETICAL FRAMEWORK

Thinking about possibilities and innovative tools has been highlighted in the advancement of technology and inclusion and accessibility is no different. Specifically for people with ASD, games have become effective resources in cognitive, social, and motor development for these individuals. This chapter aims to contextualize and support the conception of a digital game aimed at children with autism. For the theoretical enrichment of this work, we highlight concepts of ASD and Digital Games, primordial subjects for this research.

2.1 AUTISM SPECTRUM DISORDER

Kanner (1943) conceived autism as a disorder of affective contact, leading to social isolation. In the 1970s and 1980s, there was a departure from Kanner's vision and autism came to be seen as due to cognitive impairment. In 1980, it was classified as a disorder that would lead to a developmental deviation and not to a delay.

ASD is defined as a neurodevelopmental disorder that results in difficulties in communication and social interaction, as well as the presence of restricted and repetitive behaviors or interests. Such core symptoms are recurrent in individuals diagnosed with ASD in varying degrees, resulting in the adoption of the term "autistic spectrum", which encompasses the heterogeneity of responses to stimuli, maintained skills and evidenced impairments (Höher; Bosa, 2009; Schwartzman, 2011).

Also, according to (PAHO/WHO, 2017), the autism process begins at early ages, up to five years of age, persisting in the adolescent phase until adulthood and there are already cases where people are identified late, only in adulthood. It is common for people with this

disorder to have problems such as epilepsy, depression, anxiety, and attention deficit hyperactivity disorder (ADHD). Also, according to PAHO/WHO | Pan American Health Organization, the autism process begins at early ages, up to five years of age, persisting in the adolescent phase until adulthood and there are already cases where people are identified late. It is common for people with this disorder to have problems such as epilepsy, depression, anxiety, and attention deficit hyperactivity disorder (ADHD). It is important to clarify, according to the same guidelines, that the intellectual development of autistic people varies at different levels.

When thinking about the development of a new technology that involves accessibility and inclusion, it is necessary to understand well the definitions that surround this theme. According to (PAHO/WHO, 2017), Autism spectrum disorder is a series of conditions that compromise people's social behavior, including communication and language, where activities become unique with repetitive actions for these people.

2.2 TECHNOLOGY, DIGITAL GAMES AND AUTISM

The child with autism may have a rigid or inflexible behavior and this can lead to problems in terms of acquiring new habits or having recreation. In this sense, (Cunha, 2012) clarifies that pedagogical activities with the objective of developing the skills of children with autism must be observed aspects such as: sensory capacity; spatial capacity; the ability to symbolize; subjectivity; language; cognition; hyperactivity; stereotypies; psychomotricity; socialization and affection. With regard to digital games, there is a growing use of these in rehabilitation and functional development services. Thus, due to the digital characteristic, which requires little physical contact, low sensory load, intermittent learning with positive reinforcement, digital games can bring more comfort and linearity to the objective proposed with use.

In, (Winnicott, 1975) presents the child's relationship with the object, which according to (Saboia, Gosmes, Viodé, Gilles, Ouss and Golse, 2017) this concept postulates the child's ability to make use of this object and how it can interfere with the traits of psychic organization. The feeling of continuity is absent in the use of objects, which is related to the way the autistic child deals with them. In this, the experience is compromised by the non-spontaneous way of using objects, since the symbolic capacity of play requires skills that need to be developed in the child with (Saboia, Gosmes, Viodé, Gilles, Ouss and Golse, 2017). The use of different technologies for learning purposes is the responsibility of the education and health professional to plan the use of these resources, with well-established guidelines and strategies, as presented (Bölte, Golan, Goodwin and Zwaigenbaum, 2010); (Sigafos, 2011);

and (Ploog, Scharf, Nelson and Brooks, 2020) the use of some tools for didactic use with a focus on innovation and good practices.

In his work, (Lira, et al, 2021), he highlights learning strategies using technology, presented by (Bölte, Golan, Goodwin and Zwaigenbaum, 2010); (Sigafos, 2011); and (Ploog, Scharf, Nelson and Brooks, 2013) the use of some tools for didactic use with a focus on innovation and good practices.

(Lira, et al, 2021) highlights that as a result of rigid and inflexible behavior, autistic children have difficulties in acquiring new habits and brings the study by Cunha [8] who manages to demonstrate the development of skills, clarifying that pedagogical activities with the objective of developing the skills of children with autism must be observed aspects, such as: the sensory, spatial capacity to symbolize; Subjectivity; Language; Cognition; Hyperactivity; Stereotypies; Psychomotricity; Socialization and Affection.

Due to its very digital characteristic, requiring little physical contact, the digital game becomes a great ally and in growing use in the most diverse learning, rehabilitation and functional development services. (Lira, et al, 2021) cites the work of (Barbosa, Artoni and Felinto, 2020), which presents an overview of educational digital games for children with autism with a focus on helping communication and literacy present in the market. This research of available games is important for this work, precisely to mark and analyze how expensive some of these games are and therefore not accessible to low-income families.

In his work, (Santos, 2022), he brings the researchers (Alves, Cathcart and Santos, 2017), highlighting that the investment in the accessible games market is still small, due to the low financial return. It also complements the complexity of developing an accessible game, since it involves several characteristics (sound, visual and cognitive).

Still, in his work, (Santos, 2022) highlights (Kettler, et al, 2018), which brings the following reflection: "making a digital environment (website, application, games) inclusive, where all functions are available to all or a large portion of people (users) is the concept of digital accessibility. Collaborating with the difficulties of users. In the environment of a game, this becomes more complex, as a result of the dynamics and differentiated usability that often involves several components for the actions of the characters, thus requiring specific customizations for each type of need."

For Salen and Zimmerman [10] the distinction between "game" and "digital game" is up to the media, particularizing the objectives, strategies and playfulness of the gameplay. The relationship between the two categories (games and digital games) is united by the feasibility of learning through an action. In the context of physical games, which involve board

games, logical reasoning, reading and writing, among others, as educational resources, they stimulate the child's sensory aspects, working on different skills and functionalities.

This section stands out for contextualizing the importance of technology as a potential in helping the development of essential skills for people with autism. Digital games represent an innovative tool and with adaptation will contribute to learning and personal development, in addition to strengthening awareness on the topic proposed here.

3 METHODOLOGICAL PATH

The methodological process begins with a bibliographic survey (scientific articles, digital games on the subject) known as a systematic review of the literature to understand the characteristics and peculiarities related to autism. Among the researches, it was concerned with teaching programs for people with ASD, learning difficulties, accessibility guidelines and related works to understand the difficulties and explore characteristics that had not yet been used. In addition, educational and cognitive activities that could contribute and support the development of the game proposed here were researched.

This process supported the proposal aimed at the development of a game and contributing to the compilation of existing evidence on the use of games and play in the development of children with Autism Spectrum Disorder (ASD). According to Gil (2002), this methodology seeks to identify, evaluate and interpret all relevant research available on a specific topic, providing an understanding of the subject researched.

The databases used for the research were: Scientific Electronic Library Online (SciELO), the Virtual Health Library (VHL) and Google Scholar, in addition to consultations to repositories of theses and dissertations. The terms used in the searches included "Autism Spectrum Disorder", "autism", "digital games", "games for autistics", "games for autistic people", "cognitive functions for ASD", among other related variations.

During the process of documentary research and research in the area of understanding autism, some documents are important to read and among these documents, the DSM-V, the Diagnostic and Statistical Manual of Mental Disorders, a document of the American Psychiatric Association that classifies and organizes the criteria related to mental disorders, is listed. With it, it is possible to find reliable materials and information about disorders, sources, rules, making it a practical, functional and flexible guide organizing information that will help in the diagnosis and collection of evidence.

It is understood that games, because they have great potential for disseminating content, entertainment and motivation, and can be a great tool for the dissemination of knowledge, have become increasingly popular and one of the most promising markets. With

all its versatility, which can be adapted, games can help in the development of motor, cognitive, social and learning skills, serving as a sensory stimulus and contributing to the imitations of each autistic person.

4 DEVELOPED GAME

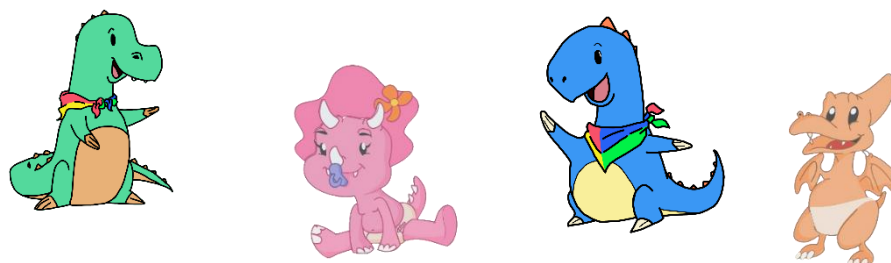
This article demonstrates the development of the digital game proposed here. In the following subsections it is possible to discuss each stage of development.

4.1 CHARACTERS

Here in this subsection we highlight the characters that have been developed for the game. It is important to emphasize that all the art of the games was developed by the students who were part of the team. They were drawn freehand and later transferred to digital software. The green dinosaur is named Tino, while the blue one is Dino. The other characters are Dudinha (the one in pink) and Audism (Orange), represented in figure 1.

Figure 1

Characters: Tino, Dudinha, Dino and Audismo



Authors' Source

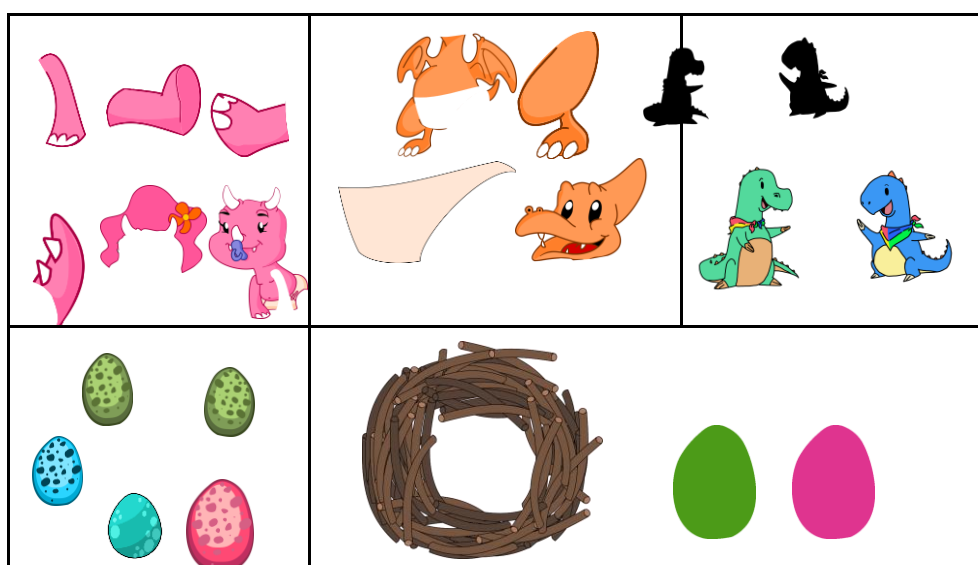
The art developed for this game was based on vector images formed by lines, curves and geometric shapes that have the support of mathematical equations for their definition, contributing to the scalability process, preserving the quality of the image. This is important, as it is a multiplatform proposal and responsiveness is paramount. When comparing it to another art style, such as *pixel art*, for example, it is clear that the visual style is more consistent and modern. When passing this art to the digital medium, the tools used were: Adobe Illustrator and Photoshop and Inkscape.

4.2 GAME MECHANICS

Table 1 describes the sprites developed by the team. Each sprite is used for the mechanics of the game, through the tasks and activities proposed.

Table 1

Sprites of the main characters (separately)



Authors' Source

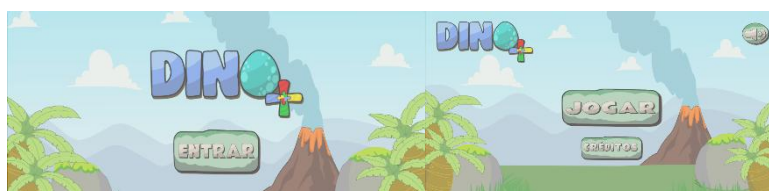
As you can see, the sprites are organized with the body parts, in the case of Dudinha and Audismo. As for the characters Tino and Dean, they overlap another sprite for the correct combination. In this table, the eggs that are part of the first two scenes were also made available, where players need to make the correct association.

4.3 GAME MENUS

Figure 2 highlights the game menus. When you start the game, the main menu appears, and when you click enter, a second menu appears with a play or credits button. In the credits option, the developers and guidance who participated in the development of the game are listed.

Figure 2

Dino Game Menus



Authors' Source

Table 2 highlights the separately sprites that form the game menu, which when starting the main menu appears and when clicking enter another menu appears with a play or credits button.

Table 2

Sprites for forming the menus (separately)



Authors' Source

4.4 THE PHASES OF THE GAME

The first stage to be presented contains a blue egg, where the player needs to drag to the correct combination. When you get it right, an image of congratulations appears and soon after the second phase appears with a degree of difficulty, because now there are 3 eggs and no longer 1. The reasoning is the same, if you hit the 3 combinations a congratulatory image appears with the message of winning. When there is an error in the combination, a simple sound is emitted demonstrating that it was wrong. Represented in figure 3.

Figure 3

Phases 1 and 2 of the Dino Game



Authors' Source

Figure 4 presents the congratulations screen, simple and light. The balloons appear moving so that the player realizes that there is celebration for his or her hit.

Figure 4

In-game congratulations screen

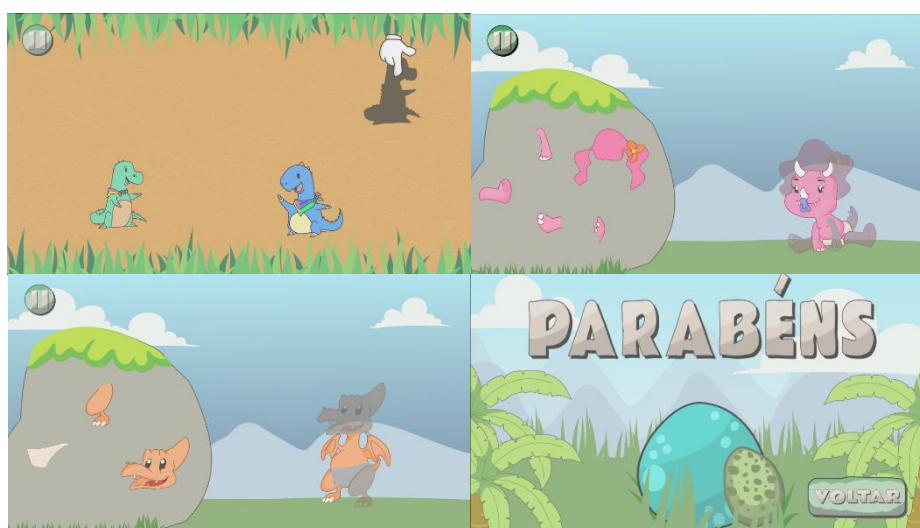


Authors' Source

Figure 5 shows the main phases of the game. In the first image, it is necessary to make the correct association of Tino and Dino. After that, if the player wins, it will be possible to play the Dudinha phase that needs to hit the combination and associate the assets correctly. Finally, Audismo with the same idea as Dudinha. It features the congratulations screen, simple and light. The balloons appear moving so that the player realizes that there is celebration for his or her hit. Each phase was designed to place a support (a hand) to indicate the way and if the player got it right.

Figure 5

Game Levels and Congratulations Screen for Completing All Levels



Authors' Source

4.5 GAME PLATFORMS

Initially, the game proposed here was available on two platforms, including the desktop, available for the Windows operating system and for the *web*. But, with digital convergence and some feedback, a version for mobile devices was developed, but at the moment, only for *Android*. Below, some figures with the game available on mobile are highlighted. A demonstration can be seen in figure 6.

Figure 6

Game Levels and Congratulations Screen for Completing All Levels



Authors' Source

5 OUTCOME AND CONCLUSION

In this article, an educational game was developed that is available to students, education and health professionals and all society that wants to know. The game is aimed at autistic children, allowing them to play in different environments, including residential homes, schools, universities, among others. This game is available on platform *desktop*, *Web* and *Android*. In future versions of this game, it is intended to extend it to the mobile version of the *IOS*.

REFERENCES

- Alves, A. G., Cathcart, K. D. P., & Santos, M. A. S. d. (2017). Projeto de um jogo digital educativo acessível: Um trabalho interdisciplinar na criação do jogo “Desafio do carteiro”. *Computer on the Beach*, 11.
- American Psychiatric Association. (2014). Manual diagnóstico e estatístico de transtornos mentais (5ª ed.; DSM-5). Artmed.
- Barbosa, C., & Artoni, A. (2020). Jogos educativos para crianças com transtorno do espectro autista: Auxílio na comunicação e alfabetização. *Proceedings of SBGames*, 663–672.
- Carvalho, O. M. F. de, & Nunes, L. R. D'O. de P. (2016). Possibilidades do uso de jogos digitais com criança autista: Estudo de caso. In *Autismo: Vivências e caminhos* (pp. 77–90). Blucher. <https://doi.org/10.5151/9788580391329-10>
- Cunha, E. (2012). *Autismo e inclusão: Psicopedagogia, práticas educativas na escola e na família* (4ª ed.). Wak.
- Freitas, J. C. L. de, Gondim, C. da S. R., Mcauchar, E. C. C., Lôbo, Í. M., Silva, K. A. da, & Vieira, P. D. G. (2024). O uso de jogos digitais para o desenvolvimento de habilidades sociais em crianças autistas. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 10(11), 5824–5839. <https://doi.org/10.51891/rease.v10i11.17163>
- Gil, A. C. (2002). Como elaborar projetos de pesquisa (4ª ed., pp. 161–169). Atlas.

- Holton, M., & Alexander, S. (1995). Soft cellular modeling: A technique for the simulation of non-rigid materials. In R. A. Earnshaw & J. A. Vince (Eds.), *Computer graphics: Developments in virtual environments* (pp. 449–460). Academic Press.
- Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child*, 2, 217–250.
- Kettler, R. J., Elliott, S. N., Beddow, P. A., & Kurz, A. (2018). Accessible instruction and testing today. In *Handbook of accessible instruction and testing practices* (pp. 1–16). Springer.
- Knuth, D. E. (1984). *The TeXbook* (15th ed.). Addison-Wesley.
- Lira, M., Gonçalves, C., & Gonçalves, B. S. (2021). Jogo digital e autismo: Análise de dois ambientes por intermédio dos affordances de Janet Murray. *Proceedings of SBGames*. <https://www.sbgames.org/proceedings2021/JogosSaudeFull/218942.pdf>
- Penha, M. C. S. de M., Carvalho, I. E. de, Machado, J. C. C., Lopes, J. M., Almeida, J. do C. S., Neves, L. E. de O., Meroto, M. B. das N., & Feitosa, V. C. A. (2024). Jogos e brincadeiras que ajudam no desenvolvimento de crianças com autismo. *Revista Contemporânea*, 4(1), 3375–3392.
- Ramos, D. K., & Cruz, D. M. (2018). *Jogos digitais em contextos educacionais*. CRV.
- Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. MIT Press.
- Santos, L. C. M. dos. (2022). O mundo não acessível dos jogos digitais: É necessário falar sobre isso!. In S. A. Ferreira & N. Corrent (Eds.), *Ciências humanas e sociais aplicadas: Competências para o desenvolvimento humano* (pp. 76–88). Atena. <https://doi.org/10.22533/at.ed.6422206126>
- Schell, J. (2020). *The art of game design* (3rd ed.). Taylor & Francis.
- Sigafoos, J. (2011). Introduction to the special issue: Evaluating assistive technology in the education of persons with severe disabilities. *Journal of Behavioral Education*, 20, 1–3.
- Silva, M. J. A. G. (2011). A inclusão de um aluno com autismo em uma escola de ensino fundamental do município de Arapiraca.
- Soares, I. V. A., Luz, L. M. A., Escórcio, G. J. de B. M., Fontenele, J. W. N., Costa, K. N., Silva, M. M., et al. (2024). O transtorno do espectro autista: Aspectos clínicos e epidemiológicos. *Brazilian Journal of Implantology and Health Sciences*, 6(4), 1116–1130. <https://doi.org/10.36557/2674-8169.2024v6n4p1116-1130>
- Winnicott, D. W. (1975). *O brincar e a realidade*. Imago.
- World Health Organization. (2017). Autism spectrum disorders. <https://www.who.int/news-room/fact-sheets/detail/autism-spectrum-disorders>
- Yi, Y., Turney, K., & Wildeman, C. (2017). Mental health among jail and prison inmates. *American Journal of Men's Health*, 11(4), 900–909.

NAVIGATORS: AN EDUCATIONAL GAME WITH VARIOUS INDIGENOUS TERRITORIES

NAVEGANTES: UM JOGO EDUCACIONAL SOBRE TERRITÓRIOS INDÍGENAS DE DIVERSOS PAÍSES

NAVEGANTES: UN JUEGO EDUCATIVO SOBRE TERRITORIOS INDÍGENAS DE VARIOS PAÍSES



<https://doi.org/10.56238/sevened2026.008-014>

Luiz Cláudio Machado dos Santos¹, Ingrid Winkler², Daniel Fernandes Argolo³, Bianca Bispo dos Santos⁴, Cainã Guimarães Soares⁵

ABSTRACT

Introduction: This article presents the development of a digital game that tells the story of four Indigenous peoples, addressing the curricular guidelines related to ethnic-racial issues, including Indigenous peoples. **Objective:** The objective is to introduce a mobile game in a 3D platform. **Methodology or Steps:** The methodological process involved a literature and systematic review focused on understanding the main Indigenous groups studied: the Māori, Inuit, Tuareg, and Yanomami peoples. After completing this stage, the construction of the Game Design Document began, aiming to create a game that would reflect the research findings. **Results:** As a result, a 3D mobile game was developed, showcasing the culture of four Indigenous peoples from different parts of the world.

Keywords: Indigenous. Digital Game. Culture. Original Peoples. Interdisciplinary.

RESUMO

Introdução: Este artigo traz o desenvolvimento de um jogo digital, relatando a história de quatro povos originários indígenas, abordando as diretrizes curriculares que tratam das questões étnico raciais, incluindo os povos indígenas. **Objetivo:** O objetivo é apresentar um jogo para dispositivos móveis e em plataforma 3D. **Metodologia ou Etapas:** O processo metodológico se deu com uma revisão literária e sistemática abordando e compreendendo sobre os principais povos indígenas aqui estudados: Maori, Inuit, Tuaregues e Yanomamis. Concluindo essa etapa, iniciou-se a construção do Game Design Document para apresentar um jogo que explorasse o que foi coletado no processo de pesquisa. **Resultados:** Como resultado, apresenta-se um game, desenvolvido para dispositivos móveis, em 3D, abordando a cultura de quatro povos originários de diversos países do planeta.

Palavras-chave: Indígenas. Jogo Digital. Cultura. Povos Originários. Interdisciplinar.

¹ Dr. of Education. Universidade Federal da Bahia (UFBA). E-mail: luizcms@ifba.edu.br

² Postdoctorate researcher. Nanyang Technological University. E-mail: ingrid.winkler@nieb.org.br

³ Undergraduated student in Digital Games. E-mail: Danielfernandesargolo@gmail.com

⁴ Undergraduated student in Digital Games. E-mail: biancabispo19enem@gmail.com

⁵ Undergraduated student in Digital Games. E-mail: kakay0507@gmail.com

RESUMEN

Introducción: Este artículo presenta el desarrollo de un juego digital que narra la historia de cuatro pueblos indígenas, abordando las directrices curriculares que abordan cuestiones étnico-raciales, incluyendo a los pueblos indígenas. **Objetivo:** Presentar un juego para dispositivos móviles en una plataforma 3D. **Metodología o pasos:** El proceso metodológico implicó una revisión sistemática de la literatura para abordar y comprender los principales pueblos indígenas estudiados: maorí, inuit, tuareg y yanomami. Al finalizar esta etapa, se elaboró el Documento de Diseño del Juego para presentar un juego que exploró los resultados de la investigación. **Resultados:** Como resultado, se presenta un juego desarrollado para dispositivos móviles en 3D, que aborda la cultura de cuatro pueblos indígenas de diversos países del mundo.

Palabras clave: Indígena. Juego Digital. Cultura. Pueblos Indígenas. Interdisciplinario.

1 INTRODUCTION

One of the great challenges faced by indigenous communities, quilombolas and others, without a doubt, is to keep their identity, beliefs and culture alive, making it a daily struggle to maintain this legacy. Therefore, it is important that several actions to strengthen culture are carried out to keep an entire legacy alive from generation to generation. Among one of the actions is the use of technologies and playful activities, including digital games. (Compto and Vaz, 2023).

In (Moraes, et al, 2023) present data from the Brazilian Institute of Geography and Statistics (IBGE) (Brazil, 2023), that currently the population declaring as indigenous exceeds more than 1,600,000, identifying a growth when compared to the period from 1991 to 2002, also highlighting that this number is mostly found in the north and northeast regions of Brazil and the country's ethnic groups are the Pataxós, Potiguaras, Guaranis, Tupis, Caiaganges or Cainganges, Guajajaras, Xavantes, Yanomamis, Ticunas, Macuxis and Terenas.

Also in (Moraes, et al, 2023) cites (BRASIL, 2010) bringing that in total there are more than 270 languages in the more than 300 existing ethnicities, that is, even though they have characteristics and belong to indigenous native peoples, among the communities there is still a diversity between languages, cultures and other social characteristics.

When consulting the 2022 census overview, available on the IBGE website, the exact amount available for the indigenous population is 1,694,836 total, of which 1,227,642 are indigenous color or race and 467,194 consider themselves indigenous. In the 2022 IBGE Census, the value of indigenous languages spoken is 274 per 305 ethnic groups. The names of indigenous peoples are Portugueseized and written with a lowercase initial, they stand out as indigenous peoples: Yanomamis, Carajás, Caiapós, Tupis, Cainganges, Guaranis, Uaimiris, Xavantes (Brazil, 2023).

Cited by (Moraes, et al, 2023), (Kayapó and Brito, 2014), it brings a reflection that in current times, valuing culture and customs has been a major problem faced by indigenous peoples. In addition, in the syllabus of schools and even in printed and digital materials, many misconceptions about indigenous culture are reported, including the discovery of Brazil, where there are distortions of this culture.

After so much reflection on the theme proposed here, this article believes that the teaching process is a path to the appreciation of native peoples, and can be expressed in different ways. Acknowledging the interdisciplinary and transversal process, as part of a partnership, this article comes from an integrative project carried out in each semester, which addresses themes required by the National Curriculum Guidelines for the Education of Ethnic-Racial Relations and for the Teaching of Afro-Brazilian and Indigenous History and

Culture (Law No. 11,645 of 03/10/2008; Resolution CNE/CP No. 01 of June 17, 2004), whose contents are worked on in curricular components that already have the objective of acclimatizing the student with the history of Brazil, in order to encourage the creation of games with national themes, involving plurality and the appreciation of Bahian and Brazilian cultures. (Sales, et al, 2024).

The Education of Ethnic-Racial Relations and Afro-Brazilian, African and Indigenous History and Culture has as its legal basis Law No. 9394/1996, as amended by Laws No. 10,639/2003 and No. 11,645/2008, and Resolution CNE/CP No. 1/2004, being based on Opinion CNE/CP No. 3/2004, which establishes: §1 Higher Education Institutions shall include in the contents of disciplines and curricular activities of the courses that teach the Education of Ethnic-Racial Relations, as well as the treatment of issues and themes that concern Afro-descendants, under the terms explained in Opinion CNE/CP 3/2004. (CNE/CP Resolution No. 1/2004). (Sales, et al, 2024).

The legal basis presented places the ethnic-racial issue on the national agenda and reinforces the importance of debating in undergraduate courses the recognition and appreciation of the history, culture and identity of indigenous peoples and African descendants, in an education that encourages the student to develop values, habits and behaviors that respect the differences and characteristics of groups and minorities, and that in their future professional practice will allow them to seek the correction of racial and social inequalities through changes in discourses, reasoning, logic, gestures and postures, developing practices that repudiate prejudice and discrimination. (Sales, et al, 2024).

In the digital age, thinking about working with technology as an ally is a valid pedagogical strategy, becoming one of the actions to strengthen the culture of native and indigenous peoples. Among the existing technologies, games have stood out for their playful and entertaining role, contributing to learning and in a fun way. The case study, presented by (Compto & Vaz, 2023), observes that students from an indigenous municipal school are unaware of the culture of the indigenous Kokama people, an ethnic group that is part of the same region as the school, but unknown to them. So, one of the strategies used by the research is the use of games to strengthen the Kokama indigenous culture so that the students of this school recognize and value the local culture.

Considering the importance of the ethnic-racial issue addressing indigenous culture, the game developed here embarked on an adventure that will unite indigenous peoples from different parts of the world, thus demonstrating that despite having characteristics in common, each territory has its culture, way of eating, its own climate, demonstrating how necessary it is to preserve the culture and customs of the original peoples.

In Navegantes, players embark on an epic journey through a vast open world, exploring territories inspired by four indigenous cultures: the Maori, the Yanomamis, the Tuaregs, and the Inuits. As a mysterious traveler, the player must cross oceans, dense forests, deserts, and icy lands to help these communities restore lost cultural ties. In each region, unique challenges reflect the reality and customs of these peoples, requiring exploration, puzzle-solving, and collaboration to rebuild harmony among civilizations.

The game developed here is available on the 3D platform and *Mobile (Android)* and in addition to the *singleplayer* For the game's campaign mode, the *multiplayer*.

2 THEORETICAL FOUNDATION

This section brings all the foundation and theoretical study, fundamental for the development of the game presented. Knowing each people, custom and culture undoubtedly contributed to the narrative and plot of this proposal.

With a stylized art style and cooperative gameplay, Navegantes highlights the importance of cultural diversity and collaboration to overcome challenges. Each culture brings not only new mechanics and quests, but also rich stories passed down by its elders. By connecting these peoples and rekindling forgotten traditions, the player becomes a true messenger of unity, reflecting on the need to preserve and respect the cultural heritage of indigenous nations around the world. And this knowledge was only possible with a lot of study and search for references for the original peoples mentioned here.

The Maori, inhabitants of the Pacific islands, teach the player the importance of connecting with the ocean, leading challenges based on navigation, canoeing and haka war rituals. In the territories of the Yanomamis, within the Amazon, the player must learn to live with the forest, using traditional knowledge of hunting, gathering and healing with medicinal plants. Once in the Sahara desert, the Tuareg share their wisdom about survival in extreme conditions, involving the player in dune orientation mechanics and nomadic trade. Finally, in the frigid lands of the Inuit, ice fishing, seal hunting, and igloo building become essential skills to face the hostile climate and understand the Inuit's way of life.

In the subsections, we highlight each original people studied.

2.1 ORIGINAL PEOPLE: MAORI

Originally from New Zealand, also known as indigenous people of the land. They are Polynesians, comprising 14% of the country's population. The native language of this people is Maoritanga, which is related to Tahitian and Hawaiian. According to history, it was in the period from the 9th to the 13th century AD that the Maori people of New Zealand migrated to

Polynesia. They inhabited the lands long before the British colonizers. In the year 1980, Maori culture was accepted, respecting traditions, language and history. But a feature that draws attention today is the dance of the warriors. (Bombonato & Xavier, 2021) (Walker, 1997).

2.2 ORIGINAL PEOPLE: YANOMAMI

Living between the Amazon and Orinoco basins, in a region full of mountains and with a unique tropical forest, the Yanomami people are located between the states of Brazil: Roraima and Amazonas and southeastern Venezuela. However, the territory belonging to Brazil is the majority (Lobo & Cardoso, 2023).

The region where this people lived together for many centuries contributed to the distancing of indigenous people from non-indigenous people, precisely because of its relief full of mountains. At the beginning of the twentieth century, the relationship between them began to be possible. (Toledo, et al, 2023). Despite the distance, these people stand out as people of good humor and with great territorial mobility. (Ramos, 2008).

For (Lobo and Cardoso, 2023), which he cites (Ferreira, et al, 2019), this people is subdivided into the following six subgroups: Sanöma, Ninam, Yanonami, Yaroamë, Yãnoma and Yanomam, sharing a cultural and linguistic unity.

In his work, (Lobo and Cardoso, 2023) cites The Lancet (2019):

They live in small villages and move for various reasons: hunting and management of natural resources and gardens; divisions of groups for political or family reasons; visits to strengthen ties and exchanges between groups; participation in ceremonies and rituals. The presence of religious missions, posts of the National Indian Foundation (FUNAI) and platoons of the Brazilian Army (military project of occupation and integration Calha Norte, 1985) interfere with this logic, exerting a centripetal force of population concentration around their installations. Illegal mining, roads and invasions in its territory have explosive magnitude: they drive away, attract, destroy, decimate. This has happened, with fluctuating intensity, over the last few decades, producing an enormous impact on Yanomami life, health, and society. However, in the last four years, it has acquired the contours of genocide, by deliberate government omission and encouragement of illegal activities The Lancet. (2019).

2.3 ORIGINAL PEOPLE: TUAREG

People living in North Africa, originating from the Sahara to Mali, encompassing Niger, Algeria, Libya and extending from the Sahara to Mali, Niger, Algeria, Libya and Burkina Faso. Its language is Berber and Tamasheq. Regarding the population, in the Mali region, there are more numbers in Kidal, which is in the northeast of the country, while in Niger, the population is estimated at 2 million people. In Lebanese territory, they live in the extreme southwest, in

Algeria in the south, in Nigeria in the extreme north of the country and Burkina Faso, the Tuareg live in the country. (Rasmussen, 2010).

Known as semi-nomads, they stand out for their physique and Arab influences and origins from the south of the Sahara. They are practitioners of the Sunni Islamic religion with very traditional beliefs. Another point that stands out are the camels used by them, known as meharis, a fast and resistant breed. (Rasmussen, 2010).

2.4 ORIGINAL PEOPLE: INUIT

Cited by (Silva, 2020), (CLOUTIER, 2005, p. 05) reports that these people live in colder and more extreme regions, so it is necessary to think about habits and logistics to live in an ice region. They inhabit Greenland, Russia, the United States and Canada and activities such as hunting and fishing are highlights in this people.

In his work (ROSA, 2011, p. 111), cited by (Silva, 2020), he estimates that until the year 2004 in Arctic reserves the housing population was 100 thousand. The supply of fat and protein is linked to whaling, through the hunting practices already mentioned in the previous paragraph. The religion of this people is shamanism. Including people from all parts of the world, it is estimated that there are approximately 180,000 Inuit people. Para (PINTO, 2018, p. 14), also cited by (Silva, 2020), presents a petition informing that this people is endangered, with the contribution and collaboration of the United States with predatory actions, thus contributing to environmental imbalance. Among the environmental actions are: environmental neglect, lack of mobilization, lack of actions to mitigate climate ills and actions that protect the Inuit people. (Silva, 2020). Next section, we move on to the developed game.

3 THE DEVELOPED GAME AND METHODOLOGICAL PATH

Before talking about the game developed, this project was based on the same methodological path, brought by (Rios, et al, 2022), classifying this work as a literature review process of an exploratory nature, with the objective of developing a digital game. The platform developed was for mobile, *singleplayer* and *multiplayer* devices, enabling users/players to entertain, learning and understanding all the culture related to the various indigenous indigenous peoples. Of the steps presented in the work by (Rios, et al, 2022), the only step not carried out was the field visit. Still in the methodological process, starting with the GDD (Game Design Document) was fundamental so that the plot and narrative could be developed, so that the construction of characters, scenarios, mechanics, could become reality.

Navegantes is an open-world adventure game that explores cultural diversity and the union between peoples. In the role of Wendel, an orphan raised by travelers on Cultural Island, the player navigates continents inspired by unique cultures, helping communities to reestablish lost ties, must navigate the seas, help isolated communities reestablish ties and seek the truth about the separation of the islands. With a stylized look and cooperative gameplay, the game highlights the importance of cultural connections and collaboration in a divided world. Players are invited to explore and connect culturally rich islands, which have lost touch over time, emphasizing cultural diversity, collaboration, and valuing differences through interactive quests and celebratory events.

The main scenarios are: Cultural Island, a neutral and commercial point, where travelers gather; Maori island, land of navigators, faces a problem with aggressive Kakapos birds; Tuareg Island, a desert inhabited by nomadic traders and finally Yanomami Island, a tropical forest with deep knowledge of nature.

3.1 GAME CHARACTERS

In this section the characters of the game will be demonstrated, the first is Wendell, a young man who grew up on Cultural Island, a port for travelers located in the middle of the ocean. Abandoned as a child, it was created by several navigators and merchants who passed through the island. Always immersed in stories about the outside world, he dreamed of exploring the four territories and discovering more about the mystery of the separation of the continents. Departing from the Cultural Island, you will get to know each of the four imaginary peoples, learning from them and developing your own identity as navigators and conflict mediators. It is represented in Figure 1.

Figure 1

Physical characteristics of the character

Visual	Idade: 15
	Tipo Corporal (Altura/Peso): Corpo ágil e levemente robusto
	Pele: Pardo
	Cabelo: Castanho
	Olhos: xxx
	Face: Quadrática
	Expressões faciais: E
	Trajes: Veste roupas leves de navegante

Source: From the authors

The Cultural Island stands out for being a meeting point for travelers from all over the world. Wendell grew up hearing stories about the unified continent's past and developed a

strong desire to understand its division. Being an orphan, he was raised collectively by the travelers of the Cultural Island, having a strong bond with the merchants, fishermen and storytellers who helped him grow up, spending his childhood helping travelers, observing trade exchanges and learning about navigation. An ancient merchant named Omar and a Maori navigator named Hina, helped create it. Curious and determined, but also realistic about the challenges of the outside world, he always sought to find a peaceful way to solve problems. Its main task is to understand the reason for the separation of the continents and to find a way to unite peoples again. The next characters, represented in figure 2, are the *NPCs* (*non-playable character*) of Maori territory. They are a warrior and spiritual people, deeply connected to the ocean and the traditions of their ancestors. Tattooing and dancing are ways to tell your stories and keep your identity alive.

Figure 2

Physical characteristics of the Maori and the Yanomami

Visual	Idade: 10 - 80	Visual	Idade: 10 - 70
	Tipo Corporal (Altura/Peso): Forte e musculoso, ideal para combate e navegação.		Tipo Corporal (Altura/Peso): Baixa estatura, corpo esguio e ágil
	Pele: Bronzeada pelo sol		Pele: Pardos
	Cabelo: Preto, curto ou longo.		Cabelo: Longo, liso e escuro
	Olhos: xxx		Olhos: xxx
	Face: Quadrática		Face: Quadrática
	Expressões faciais: imponentes		Expressões faciais: Atento
	Trajes: Saias de fibra, colares de ossos e mantos cerimoniais.		Trajes: Saias de fibra vegetal e ornamentos de penas
	Outras/Especiais: Uso de adornos como pulseiras e tornozeleiras		Outras/Especiais: Uso de adornos como colares e pulseiras

Source: From the authors

With the arrival of Wendell, the Maori will further strengthen their connection to the ocean by passing on their navigational techniques. Living in coastal villages or islands, they are structured in the Whānau community (extended family), where everyone protects each other, known as navigators, warriors and masters in the art of tattooing. Alongside the Maori, we have the *NPCs* from the Yanomami territory, who live in the dense Amazon forest, organized in longhouses, maintain a deep connection with nature, believing in the spirits of the forest to guide and protect them. It lives from hunting, fishing and sustainable agriculture and needs to protect the forest and maintain the spiritual balance between human beings and the spirits of nature. Living in cooperative groups, where the sharing of resources and the wisdom of the elders are essential. Healers and shamans serve as spirit guides and protectors of the forest. Each member has a strong connection to the community and the spirits and communicates through stories, chants, and shamanic rituals. The next characters are the *NPCs* of Tuareg territory. The Tuareg are the "blue men of the desert," known for their

indigo robes and their uncanny ability to navigate the Sahara. They are nomads who respect the secrets of the dunes and know the paths of the stars like few others.

Figure 3

Physical characteristics of the Tuareg and Inuit

Visual	Idade: 10 - 70	Visual	Idade: 10 - 65
	Tipo Corporal (Altura/Peso): Altos e esguios, adaptados ao calor extremo.		Tipo Corporal (Altura/Peso): Robusto, adaptado ao frio extremo.
	Pele: Negra, marcada pelo sol escaldante.		Pele: Tons pálidos ou bronzeados pelo frio, protegidos por peles de animais.
	Cabelo: Preto, curto.		Cabelo: Preto ou castanho, geralmente curto e escondido sob capuzes.
	Olhos: xxx		Olhos: xxx
	Face: Quadrática		Face: Quadrática
	Expressões faciais: Serenas e cheias de sabedoria.		Expressões faciais: Serenas e observadoras.
	Trajes: Mantos indigo, longos e protetores contra a areia e o calor.		Trajes: Roupas de pele e couro de animais, resistentes ao frio intenso.

Source: From the authors

The characters constantly move in caravans. They are family members who travel together, sharing stories and teachings. Made up of merchants, guides, warriors and storytellers, their dromedaries and the stars that guide them through the desert. Alongside the Tuareg, the characters stand out *NPCs* Inuit territory. They are a resilient people who live in the icy lands of the Arctic. They possess a deep knowledge of snow and ice, hunting and fishing to survive. The connection with the spirits of the Northern Lights and respect for animals are fundamental in their culture. They seek to keep their traditions alive while facing climate change that threatens their way of life. In small communities isolated on the ice, living from hunting and fishing. The family is united, sharing food and shelter in the midst of the cold. They are hunters, fishermen, igloo builders and spiritual shamans and have their sled dogs.

3.2 CHALLENGES AND GAME PHASES

The Cultural Island (figure 4) is a lush tropical island, with beaches, wooden villas, trading areas and a small port, it is surrounded by calm waters and full of diverse vegetation. Wendel, an orphan raised on Cultural Island, decides to start his journey when he turns 15, it is on this island that he learns the basic mechanics and hears stories that inspire his journey. More than 100 years ago, peoples lived together on a single continent, however, disunity awakened a mysterious force that made the tectonic plates move, separating them into isolated islands, with the exception of the Cultural Island, where differences are set aside in the name of peace and trade.

Figure 4

Cultural island image



Source: From the authors

The player receives a briefing of the main quest: explore the cultural island, learn basic skills, and prepare the raft for the journey. Among the activities are: learning basic navigation skills and interacting with NPCs (non-playable character), non-playable players, to obtain information. After completing these missions, the player prepares to leave Cultural Island, heading for Maori Island.

Figure 5

Maori Island



Source: From the authors

Maori Island (figure 5) is made up of several mountainous islands with coastal villages, agricultural areas, and ceremonial sites. The main village is where the Maori leader resides. The forests where the Kakapos live and where research must be conducted and the area of the ancestral tree is the climbable location of the mission. Wendel is informed about the problem with the Kakapos and the need to gain the trust of the Maori leader.

Figure 6

Kakapos Revolt Mission

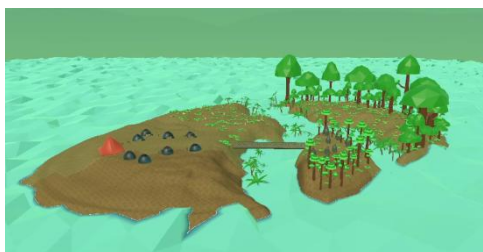


Source: From the authors

After resolving the problem with the Kakapos, the Maori leader thanks Wendel and offers his support. Wendel prepares for his next adventure on Tuareg Island.

Figure 7

Tuareg Island



Source: From the authors

The Tuareg Island is formed by a Great desert with scattered oases and villages in regions with greater vegetation. A large river that cuts the island into three pieces of land, inhabited by animals and a small village under attack from Caracals, where the Caracals must be driven out of the small village. Wendel is informed about the problem with the Caracals and the need to gain the trust of the Tuareg leader.

3.3 SINGLEPLAYER AND MULTIPLAYER

In the *singleplayer campaign*, the player takes on the role of Wendel and embarks on a non-linear narrative, having the freedom to explore other islands, discovering the universe of Navegantes at their own pace. Your mission is to unravel the mysteries of this world and reconnect the tribes. For *multiplayer* mode, 2 to 4 players start on a platform that slowly descends to the sea. In a competitive environment, the most agile player stands out as the survivor, while everyone faces off against a hungry shark that roams the playing area. In addition, items that appear on the stones provide brief moments of relief.

Figure 8

Multiplayer Stage and Shark Enemies



Source: From the authors

Among the technologies and tools used are: for modeling, the *Blender*, for the animation, the *Blender*, *Mixamo* and the *Unity*, the programming to *Unity engine*, for making arts, menus, etc. *Inkscape* and the sound *Pixabay*.

4 CONCLUSION

This article presented the result of a digital game based on iconographic research and specific cultural references of each people portrayed, ensuring respect and visual authenticity.

The characters, creatures, and objects in the game were developed using the software *Blender*, focusing on 3D modeling in the style *Low Poly*. This aesthetic approach not only ensures a stylized and artistic look but also contributes significantly to performance on mobile devices, keeping the game lightweight and accessible to a wider user base.

The animal animations were developed directly in the *Blender* using systems of *rigging* com, allowing the creation of realistic movements such as running, jumping, swimming and interacting with the environment. Animal behavior was adjusted according to the biome (forest, ice, desert, ocean), with specific movements for each context. The multiplayer mode was implemented using the Photon Engine, a robust framework for online games in *Unity*. It allows matches of 2 to 4 players in real time, with efficient synchronization of states and low bandwidth consumption.

The sounds and soundtracks have been carefully selected from Pixabay, ensuring the use of copyright-free materials. The sound curatorship considered the specific settings of each biome represented in the game, resulting in compositions that follow the cultural identity of each region.

For Yanomami Island, forest sounds were used, with bird songs and the flow of rivers; On the Inuit island, crackling ice, biting winds, and distant howls were introduced; On the Maori island, the waves of the sea, the sound of oars and traditional haka rituals stand out; The Tuareg island is set with sandstorms, camel bells and percussive instruments typical of the desert.

Finally, this article developed a digital game for mobile devices, in 3D, exploring the history of different indigenous peoples, with ethnicities, geographic location and cultures totally diverse in other countries of the continent. This game can be used for history and geography classes and for the dissemination of knowledge of various people during classes, pedagogical activities.

REFERENCES

- Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996: Estabelece as diretrizes e bases da educação nacional. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/leis/l9394.htm
- Brasil. (2003). Lei nº 10.639, de 9 de janeiro de 2003. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/leis/2003/l10.639.htm
- Brasil. (2004). Ministério da Educação. Conselho Nacional de Educação. Câmara de Educação Básica. Resolução CNE/CP nº 1, de 17 de junho de 2004. Diário Oficial da União. <http://portal.mec.gov.br/cne/arquivos/pdf/res012004.pdf>
- Brasil. (2004). Ministério da Educação. Conselho Nacional de Educação. Câmara de Educação Básica. Parecer CNE/CP nº 3, de 10 de março de 2004. http://portal.mec.gov.br/dmdocuments/cnecp_003.pdf
- Brasil. (2008). Lei nº 11.645, de 10 de março de 2008. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2008/lei/l11645.htm
- Bombonato, R., & Cury, M. X. (2021). Tuku Iho legado vivo Maori: Arte, interação e autorrepresentação. *Museologia & Interdisciplinaridade*, 10(19), 60–82. <https://doi.org/10.26512/museologia.v10i19.35020>
- Boulic, R., & Renault, O. (1991). 3D hierarchies for animation. In N. Magnenat-Thalmann & D. Thalmann (Eds.), *New trends in animation and visualization*. John Wiley & Sons.
- Cloutier, S. W. (2005). Petition to the Inter-American Commission on Human Rights seeking relief from violations resulting from global warming caused by acts and omissions of the United States. Inuit Circumpolar Council Canada.
- Compto, G., & Vaz, H. (2023). O uso de games na afirmação da etnia indígena Kokama. In *Anais Estendidos do XXII Simpósio Brasileiro de Jogos e Entretenimento Digital* (pp. 462–465). SBC. https://doi.org/10.5753/sbgames_estendido.2023.234197
- Dyer, S., Martin, J., & Zulauf, J. (1995). Motion capture white paper. http://reality.sgi.com/employees/jam_sb/mocap/MoCapWP_v2.0.html
- Ferreira, H. P., Machado, A. M. A., & Senra, E. B. (Orgs.). (2019). *As línguas Yanomami no Brasil: Diversidade e vitalidade*. Instituto Socioambiental; Hutukara Associação Yanomami.
- Holton, M., & Alexander, S. (1995). Soft cellular modeling: A technique for the simulation of non-rigid materials. In R. A. Earnshaw & J. A. Vince (Eds.), *Computer graphics: Developments in virtual environments* (pp. 449–460). Academic Press.
- Instituto Brasileiro de Geografia e Estatística. (2010). Censo demográfico 2010: Características da população e dos domicílios. https://biblioteca.ibge.gov.br/visualizacao/periodicos/93/cd_2010_caracteristicas_populacao_domicilios.pdf
- Instituto Brasileiro de Geografia e Estatística. (2023). Panorama do Censo 2022. <https://censo2022.ibge.gov.br/panorama>

- Kayapó, E., & Brito, T. (2014). A pluralidade étnico-cultural indígena no Brasil: O que a escola tem a ver com isso? *Mneme – Revista de Humanidades*, 15(35), 38–68.
- Knuth, D. E. (1984). *The TeXbook* (15th ed.). Addison-Wesley.
- Lobo, M. S. C., & Cardoso, M. L. M. (2023). Lições de tempos urgentes: A experiência da atenção à saúde Yanomami ontem e hoje. *Cadernos de Saúde Pública*, 39(4), e00065623. <https://doi.org/10.1590/0102-311XPT065623>
- Moraes, J., Santana, F., Souza, D., Silva, E., Leite, F., Souza, F., Jesus, I., & Cirne, V. (2023). Menoari: Cultura indígena e combate à devastação ambiental representados por produção de jogo digital. In *Anais Estendidos do XXII Simpósio Brasileiro de Jogos e Entretenimento Digital* (pp. 146–156). SBC. https://doi.org/10.5753/sbgames_estendido.2023.233663
- Pinto, J. B. M. (2018). *Princípios do direito ambiental*. Escola Superior Dom Helder Câmara.
- Ramos, A. R. (2008). O paraíso ameaçado. *Antípoda*, (7), 101–117.
- Rasmussen, S. J. (2010). Culture summary: Tuareg. Human Relations Area Files. <https://ehrafworldcultures.yale.edu/document?id=ms25-000>
- Rios, J., Santos, L., Santos, M., Conceição, D., Heck, C., Moreno, L., & Paes, L. (2022). A história da baiana Rozete e o acarajé de ouro. In *Anais Estendidos do XXI Simpósio Brasileiro de Jogos e Entretenimento Digital* (pp. 148–157). SBC. https://doi.org/10.5753/sbgames_estendido.2022.226011
- Rosa, R. R. G. (2011). Mitologia e xamanismo nas relações sociais dos Inuit e dos Kaingang. *Espaço Ameríndio*, 5(3), 98–122.
- Silva, P. H. M. (2020). O derretimento do oceano Ártico e os impactos na população tradicional Inuit. *SCIAS – Direitos Humanos e Educação*, 3(1), 202–220.
- Smith, A., & Jones, B. (1999). On the complexity of computing. In *Advances in computer science* (pp. 555–566). Publishing Press.
- The Lancet. (2019). Bolsonaro threatens survival of Brazil's Indigenous population. *The Lancet*, 394(10197), 444. [https://doi.org/10.1016/S0140-6736\(19\)31801-X](https://doi.org/10.1016/S0140-6736(19)31801-X)
- Toledo, A. P., Di Benedetto, S., & Bizawu, K. (2023). Indígenas Yanomami no Brasil. *Veredas do Direito*, 20, e202529. <https://doi.org/10.18623/rvd.v20.2529>
- Walker, R. (1997). Identidade e antropologia Maori na Nova Zelândia. *Mana*, 3(1), 169–178. <https://doi.org/10.1590/S0104-93131997000100007>

COMPARATIVE ANALYSIS OF MACROSCOPIC VS MICROSCOPIC MEASUREMENT CRITERIA OF INDUCED TOOTH MOVEMENT

ANÁLISE COMPARATIVA DOS CRITÉRIOS DE MEDIÇÃO MACROSCÓPICA VERSUS MICROSCÓPICA DO MOVIMENTO DENTÁRIO INDUZIDO

ANÁLISIS COMPARATIVO DE LOS CRITERIOS DE MEDICIÓN MACROSCÓPICA VERSUS MICROSCÓPICA DEL MOVIMIENTO DENTARIO INDUCIDO



<https://doi.org/10.56238/sevened2026.008-015>

José Roberto Alves Moreira¹, Osmar Aparecido Cuoghi², Marcos Rogério de Mendonça³, Alberto Consolaro⁴, Maria Fernanda Martins-Ortiz⁵, Henrique Barcelos Brandão⁶, Luiz Gonzaga Gandini Junior⁷, Ary dos Santos Pinto⁸

ABSTRACT

This study aims to compare microscopic changes in the periodontal ligament (PDL) thickness with macroscopic tooth displacement in a rat model of orthodontic tooth movement. Seventy rats were divided into two experimental groups (GI and GII, N = 30 each) and a control group (GC, N = 10). GI received continuous orthodontic force with a coil spring appliance (50 cN), while GII received interrupted forces, applied in four-day cycles. The experimental groups were randomly subdivided (N = 10 per subgroup), and euthanized on days 8, 16, and 24 post-appliance installation. The distance between the distal face of the last molar and the mesial face of the first molar was measured to assess macroscopic displacement, calculated by subtracting the measurements of the unmoved side. PDL thickness was measured microscopically, and thickness changes (TC) were calculated by subtracting the mean PDL thickness of the control group. Pearson correlation analysis revealed a strong positive

¹ Master's degree of Science in Orthodontics. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: jose.r.moreira@unesp.br Orcid: <https://orcid.org/0009-0003-1790-2051> Lattes: <http://lattes.cnpq.br/5245525150765815>

² Professor. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: osmar.cuoghi@unesp.br Orcid: <https://orcid.org/0000-0001-7085-9249> Lattes: <http://lattes.cnpq.br/8568814008546317>

³ Professor. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: rogerio.mendonca@unesp.br

Orcid: <https://orcid.org/0000-0001-8081-9144> Lattes: <http://lattes.cnpq.br/1245541242013543>

⁴ Professor. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: consolaro@uol.com.br Orcid: <https://orcid.org/0000-0002-5902-5646> Lattes: <http://lattes.cnpq.br/8436597223735064>

⁵ Professor. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: mfmartinsortiz@gmail.com Orcid: <https://orcid.org/0000-0002-7826-0879> Lattes: <http://lattes.cnpq.br/7907345074518109>

⁶ Master's degree of Science in Orthodontics. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: henrique.brandao@unesp.br Orcid: <https://orcid.org/0000-0002-7238-7078> Lattes: <https://lattes.cnpq.br/2053748244308327>

⁷ Professor. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: luiz.gandini@unesp.br Orcid: <https://orcid.org/0000-0001-8656-6010> Lattes: <http://lattes.cnpq.br/6493049604923160>

⁸ Professor. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: ary.santos-pinto@unesp.br Orcid: <https://orcid.org/0000-0003-3355-0001> Lattes: <http://lattes.cnpq.br/6562540057111580>

correlation between PDL TC and tooth displacement across all time points ($r > 0.83$). No significant differences in macroscopic displacement were observed between GI and GII at any time point ($p > 0.05$), however, the PDL TCs were significantly smaller in GI at all time points ($p < 0.02$), suggesting faster bone formation in this group. Microscopic changes in PDL TC correlated strongly with macroscopic tooth displacement in our rat model. Bone formation was achieved faster in the continuous force group compared to the interrupted force group while the final tooth displacement was similar.

Keywords: Orthodontic Tooth Movement. Periodontal Ligament. Microscopic. Macroscopic. Experimental Animal Models.

RESUMO

Este estudo teve como objetivo comparar as alterações microscópicas na espessura do ligamento periodontal (LP) com o deslocamento dentário macroscópico em um modelo de movimentação ortodôntica em ratos. Setenta ratos foram divididos em dois grupos experimentais (GI e GII, $N = 30$ cada) e um grupo controle (GC, $N = 10$). O GI recebeu força ortodôntica contínua por meio de um dispositivo com mola helicoidal (50 cN), enquanto o GII recebeu forças interrompidas, aplicadas em ciclos de quatro dias. Os grupos experimentais foram randomicamente subdivididos ($N = 10$ por subgrupo) e eutanasiados nos dias 8, 16 e 24 após a instalação do aparelho. A distância entre a face distal do último molar e a face mesial do primeiro molar foi medida para avaliar o deslocamento macroscópico, calculado pela subtração das medidas do lado não movimentado. A espessura do LP foi mensurada microscopicamente, e as alterações de espessura (AE) foram calculadas pela subtração da espessura média do LP do grupo controle. A análise de correlação de Pearson revelou forte correlação positiva entre as AE do LP e o deslocamento dentário em todos os tempos avaliados ($r > 0,83$). Não foram observadas diferenças significativas no deslocamento macroscópico entre GI e GII em nenhum tempo avaliado ($p > 0,05$); entretanto, as AE do LP foram significativamente menores no GI em todos os tempos ($p < 0,02$), sugerindo formação óssea mais rápida nesse grupo. As alterações microscópicas na espessura do LP apresentaram forte correlação com o deslocamento dentário macroscópico no modelo experimental em ratos. A formação óssea ocorreu mais rapidamente no grupo de força contínua em comparação ao grupo de força interrompida, embora o deslocamento dentário final tenha sido semelhante.

Palavras-chave: Movimentação Ortodôntica Dentária. Ligamento Periodontal. Microscópico. Macroscópico. Modelos Animais Experimentais.

RESUMEN

Este estudio tuvo como objetivo comparar los cambios microscópicos en el grosor del ligamento periodontal (LP) con el desplazamiento dentario macroscópico en un modelo de movimiento ortodóncico en ratas. Setenta ratas se dividieron en dos grupos experimentales (GI y GII, $N = 30$ cada uno) y un grupo control (GC, $N = 10$). El GI recibió fuerza ortodóncica continua mediante un dispositivo con resorte helicoidal (50 cN), mientras que el GII recibió fuerzas interrumpidas, aplicadas en ciclos de cuatro días. Los grupos experimentales fueron subdivididos aleatoriamente ($N = 10$ por subgrupo) y sacrificados los días 8, 16 y 24 después de la instalación del aparato. La distancia entre la cara distal del último molar y la cara mesial del primer molar se midió para evaluar el desplazamiento macroscópico, calculado mediante la sustracción de las mediciones del lado no movilizado. El grosor del LP se midió microscópicamente, y los cambios de grosor (CG) se calcularon restando el grosor medio del LP del grupo control. El análisis de correlación de Pearson reveló una fuerte correlación positiva entre los CG del LP y el desplazamiento dentario en todos los tiempos evaluados ($r > 0,83$). No se observaron diferencias significativas en el desplazamiento macroscópico entre GI y GII en ningún momento ($p > 0,05$); sin embargo, los CG del LP fueron significativamente

menores en el GI en todos los tiempos ($p < 0,02$), lo que sugiere una formación ósea más rápida en este grupo. Los cambios microscópicos en el grosor del LP se correlacionaron fuertemente con el desplazamiento dentario macroscópico en el modelo experimental en ratas. La formación ósea se logró más rápidamente en el grupo de fuerza continua en comparación con el grupo de fuerza interrumpida, mientras que el desplazamiento dentario final fue similar.

Palabras clave: Movimiento Ortodóncico Dentario. Ligamento Periodontal. Microscópico. Macroscópico. Modelos Animales Experimentales.

1 INTRODUCTION

Orthodontic planning aims to set therapeutic goals for achieving the best relationship between the dental arches and the cranio-mandibular complex. This should result in the desired normocclusion, which, when properly maintained, supports inter-arch stability and enhances facial aesthetics.¹ In vivo experiments are crucial for orthodontic planning, providing information on relationship between applied forces and tissue remodeling. In recent years, rats have become the animal of choice for these in vivo experiments due to their relatively inexpensive housing, simple histological preparation methods, availability of antibodies for molecular studies, and relatively large size (compared to mice) allowing easy application of appliance.^{2,3}

Measuring tooth movement in rat models have proven to be challenging, with many studies inappropriately reporting their measurement technique, not defining reproducible landmarks, or using two-dimensional radiological techniques that have the disadvantage of object superimposition.³

Microscopic evaluation of periodontal ligament (PDL) thickness is a proposed measurement technique for tooth movement.⁴ This technique, has the advantage of providing extra information on histomechanical properties of moved tooth, allowing researchers to assess histology and its relationship with tissue remodeling. Microscopic evaluation of tooth movement can also potentially allow concomitant studying of medications, systemic and local clinical conditions, and types of forces and movements. To this end, we designed this study to find relationship between macroscopic and microscopic measurements of tooth movement, through defining reproducible landmarks for both techniques allowing future researchers to apply both methods in their studies of orthodontic tooth movement (OTM). The main aim of this study was to assess correlation between microscopic measurement of PDL thickness change with macroscopic measurement of tooth displacement in a rat experimental model.

As the secondary aims, we compare interrupted force OTM to uninterrupted continuous force OTM in terms of final macroscopic displacement and microscopic PDL thickness changes. Furthermore, we assess whether displaced teeth revert to their original location following removal of the appliance.

2 METHODOLOGY

This study was designed as an experimental research project and conducted at the XXX. The project was approved by the Animal Experimentation Ethics Committee (CEEA) of the XXX under protocol no. 2008-004460 in accordance with XXX. Seventy male Wistar rats (*Rattus norvegicus*, albinos) weighing between 250 and 350g and approximately 90 days old

were used. The animals, obtained from the XXX, were housed in groups of five per cage and fed granulated chow (XXX) with water provided ad libitum.

The models were divided into Experimental Groups (GI and GII) and a Control Group (GC). All animals in GI and GII had an appliance for inducing tooth movement installed between the upper incisors and the upper right first molar. GI consisted of 30 animals, subjected to continuous forces, and further divided into three subgroups of ten animals each. After the initiation of induced tooth movement, the animals were euthanized at the experimental time points of eight, 16, and 24 days.

GII included the same number of animals as in GI and their respective subgroups, but they were subjected to interrupted continuous forces at the experimental time points of eight, 16, and 24 days. The forces were interrupted by loosening the ligature attached to the incisors, without removing the springs, for a period of four days after their application for the same duration. The animals were euthanized after completing eight days, and those in the 16 and 24-day subgroups repeated the same cycles of interruption and reactivation until completing the experimental period from the onset of induced tooth movement.

Control Group (GC): This group consisted of ten animals that were not subjected to induced tooth movement. The right hemimaxillae of these animals underwent histotechnical processing.

In this research, the tooth movement-inducing appliance developed by Heller and Nanda⁵ was used. The appliance consisted of a three-millimeter closed-coil spring that released 50 cN of force (Sentalloy, COIL SPRINGS model 10-000-25, manufactured by GAC International - Japan), batch numbers A348, A447, A476, A398. The use of these springs for retraction allowed for the verification of continuous force and its interruption.⁶⁻⁹ To enhance the retention of the device and prevent potential displacement, 0.25 mm diameter ligature wires (Morelli, Sorocaba, SP - Brazil), tied to the incisors, were coated with light-curing resin Opallis (FGM Produtos Odontológicos, Joinville, Santa Catarina - Brazil).

During the installation and maintenance of the mechanical device, a mixture of the muscle relaxant Xylazine Hydrochloride (Dopaser) at a dose of 0.03 ml/100 g of body weight and the anesthetic Ketamine Hydrochloride (Vetaset) at a dose of 0.07 ml/100 g of body weight was administered intramuscularly. This combination provided approximately two hours of analgesia, sufficient to safely install the devices while preventing any signs of pain or anxiety in the animals. Analgesia was repeated in Group GII during the periods of force interruption (loosening of the incisor ligatures) as well as during their reactivation.

To acclimate and maintain the subjects prior to experimental procedures, the animals were housed in cages for seven days under a 12/12-hour light cycle and constant

temperature. After completing the adaptation period, the animals assigned to Experimental Groups GI and GII were prepared in advance of the procedures. After weighing, they received appropriate doses of analgesics and relaxants, and were monitored to assess the effectiveness of the administered treatments. Only after confirming efficacy did the installation of the devices begin.

Prior to installation, the terminal rods of the springs were trimmed using a high-speed diamond drill (KG Sorensen 3113F), reducing their length so that they could be properly stretched within the space between the incisors and the upper right first molar, thus allowing effective activation. Using ligatures to attach the springs to the molars, the springs were stretched after secure fixation by tying the other end to the incisors.

To prevent displacements and/or fractures of the appliances during the experimental periods and avoid exclusion of any animal, two preventive measures were established: A. immediately after appliance installation, the lower incisors were reduced by approximately one mm using a high-speed diamond drill (KG Sorensen 3113F) to prevent trauma during mastication; B. granular feed was provided as the regular diet for maintaining the animals, intentionally starting from the acclimatization period. With these precautions, the animals were observed every four days, and the correct positioning of the appliances was checked, with any necessary repositioning carried out as needed.

After completing the experimental periods of eight, 16, and 24 days in GI and GII, the animals were euthanized using a muscle relaxant (Xylazine Hydrochloride 0.03 ml/100 g body weight) and twice the anesthetic dose (Ketamine Hydrochloride 0.14 ml/100 g body weight). Subsequent steps included decapitation and dissection to remove soft tissues, collecting the experimental hemimaxilla with preservation limited to the molar regions. Prior to sectioning the specimens, three observers took two measurements of the maxilla to quantitatively assess the macroscopic movement achieved on the experimental sides and the control side, using a Mitutoyo Absolute Digimatic digital caliper model CD-6"CSX-B (Mitutoyo Sul Americana Ltda., Suzano - SP - Brazil).

To standardize the measurement procedure among examiners, the maxilla was placed on the surgical field, on a clinical table, and under the illumination of a dental reflector. Examiners used a loupe (Intex Brasil), providing 3.5x magnification, and positioned the caliper on the specimen with the tips placed on the most cervical regions of the distal face of the last molar and the mesial face of the first molar. Data were collected from both the moved and unmoved sides.

The displacement quantity after dental movement was obtained using the method of Gameiro et al. (2008),¹⁰ measured as the difference between the moved and unmoved sides. These measurements were collected by three examiners and an average was calculated.

Dissection of the hemimaxilla was restricted and standardized to the region of the first molar to prevent adjacent tissue excess from affecting the demineralization rate, ensuring morphological preservation of the tissues and a good technical outcome. The specimens to be fixed were labeled and stored in cassettes, and immersed in a 10% formalin solution (v/v) (4 g of monosodium phosphate, 6.5 g of disodium phosphate, 900 ml of distilled water, 100 ml of formalin p.a.), in a quantity twenty times greater than their volumes, for 48 hours. At the end of fixation, the specimens were washed in running water for 24 hours and then decalcified in a 5% Disodium Ethylenediaminetetraacetate (EDTA) solution for six weeks, followed by another 24-hour wash in running water.

Following decalcification, dehydration was performed followed by embedding the specimens in paraffin blocks. These blocks were then sectioned using a Leitz microtome (Germany). The sections were carefully positioned and cutting began with constant observation from the removal of the first ribbons to ensure the most parallel alignment possible to the occlusal face. Sections were cut until a ribbon containing the beginning of the interradicular septum was obtained, where the presence of the five well-defined and separated roots was observed. Serial sections, 6 µm in thickness, of the upper right first molar were collected in sets of five, starting from the first section where clear separation of the roots was evident. Subsequently, the five ribbons were properly positioned on slides, ensuring the correct sequence of the cuts, and were stained with Harris hematoxylin and Lison eosin.

Images of the tissue sections were captured using a Canon PowerShot A 640 digital camera, with a ten-megapixel resolution, attached to a Carl Zeiss Axiophot binocular optical microscope (Germany) equipped with a 2.5x / 0.075 objective (for panoramic viewing) and properly calibrated. The focus was primarily on the intermediate vestibular root and mesial root for histometric analysis. Measurements were recorded and stored on a computer using AxioVision 4.6 software (Carl Zeiss, Germany) for future analysis.

The histological sections were digitized to outline and delineate variations in the thickness of the periodontal ligament in the traction (distal) region of the intermediate vestibular root. This region was chosen due to its smaller volume and distance from potential inflammatory areas (distal region of the distal root and mesial region of the mesial root), which might have been affected by the trauma from the ligature wire. Reference lines and points used to measure the periodontal ligament thickness in the intermediate vestibular root were established starting from the mesial root.

Line 1: The greatest mesiodistal length of the pulp canal lumen (mesial root).

Point 1 : Perpendicular to Line 1, at its midpoint, is Point 1.

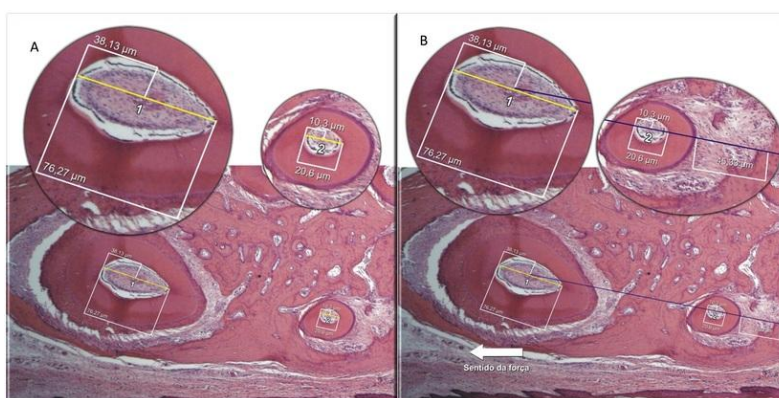
Line 2: The greatest mesiodistal length of the pulp canal lumen (intermediate vestibular root).

Point 2: Perpendicular to Line 2, at its midpoint, is Point 2.

The measurement of the periodontal ligament, captured by AxioVision 4.6 software (Carl Zeiss, Germany), which determined the thickness of the periodontal ligament, was obtained by extending the line connecting Point 1 to Point 2 until it reached the alveolar bone in the distal portion of the intermediate vestibular root (Figure 1A-B). The measurement was taken along this line, recording the distance between the cementum of the intermediate vestibular root and the alveolar bone.

Figure 1

Measurement of periodontal ligament thickness. (A) The union of points 1 and 2, and their extension, determine the line to measure the thickness of the periodontal ligament. (B) Line drawn from point 1, passing through point 2, measuring the thickness of the periodontal ligament over its extension (cementum of the intermediovestibular root to the hard lamina of the alveolar bone distal portion of the intermediovestibular root). Staining - HE, objective - 4 times. Arrow shows the direction of the force



2.1 STATISTICAL ANALYSIS

PDL thickness change (TC) was calculated by subtracting the PDL thickness of the experimental animal from the mean PDL thickness of control animals. Displacement was calculated macroscopically by subtracting the moved side measurement from the unmoved side.

The data tables display the means and standard deviations (SD) of periodontal ligament thickness for each group (GI, GII, and Control) at eight, 16, and 24 days. Intra-group comparisons were made for the 8, 16, and 24-day periods, while inter-group comparisons

between GI and GII at the same time points were performed using the Student's t-test and confirmed by Tukey's test. The correlation between micrometric and macrometric measurements was assessed using the Pearson Correlation Coefficient.

3 RESULTS

From a tissue volume perspective, the periodontal space during induced dental movement was increased compared to the Control Group (Figure 2) at all three time points in both experimental groups.

Figure 2

Increased periodontal space in the experimental groups. (A) Regular periodontal space of approximately 0.12 - 0.16 mm for the Control Group.¹¹ (B) Increased periodontal space in the distal portion in the Experimental Group (HE staining, objective - 2.5 times). (arrow in the distomesial direction)

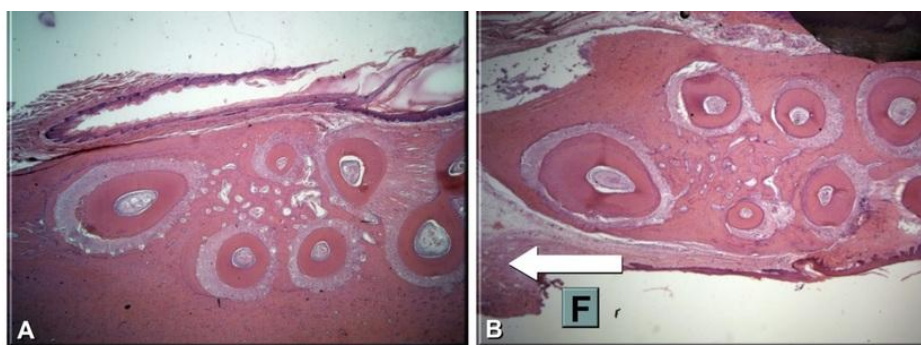


Table 1 shows measurements of PDL thickness, its change from control, and macroscopic displacement at each time point. Both groups showed increased PDL thickness on day eight. In GI, however, mean TC was negative on day 16 and close to zero on day 24. Table 2 shows the t-test results of within group comparison between time points. PDL TC on day eight was significantly different from day 16 ($p = 0.004$) but not from day 24 ($p = 0.27$). In the interrupted group, mean TC $\pm$ SD was lower on day 16 (38.12 ± 20.71) and day 24 (44.53 ± 10.76) compared to day eight ($p = 0.003$ and 0.008 respectively, Table 2). Macroscopically, the highest displacement was measured on day 24 in both GI and GII. T-test showed that between GI and GII, the amount of macroscopic displacement was not significantly different at any time point ($p = 0.23$, 0.52 , and 0.16 for days eight, 16, and 24, respectively), while PDL TC was significantly different ($p < 0.05$ for all time points).

Table 1 shows the correlation between macroscopic displacement and microscopic PDL TC at each time point. On both groups there were strong positive correlation between the two calculations.

Table 1

Measurements, displacements, and correlation between microscopic and macroscopic calculations in rat experimental model of induced tooth movement

		Microscopic measurement (PDL thickness, μm)		Macroscopic measurement (distance*, mm)			Correlation# (r)
	Day	Mean $\pm$ SD	PDL TC, mean $\pm$ SD	Moved side, mean $\pm$ SD	Unmoved side, mean $\pm$ SD	Displacement, mean $\pm$ SD	
GI	8	154.69 $\pm$ 38.89	25.58 $\pm$ 26.28	7.20 $\pm$ 0.13	6.95 $\pm$ 0.12	0.25 $\pm$ 0.10	0.83
	16	127.02 $\pm$ 39.16	-2.09 $\pm$ 26.73	7.31 $\pm$ 0.12	7.00 $\pm$ 0.12	0.31 $\pm$ 0.12	0.95
	24	132.90 $\pm$ 53.86	3.79 $\pm$ 39.56	7.49 $\pm$ 0.13	7.09 $\pm$ 0.13	0.40 $\pm$ 0.13	0.92
GII	8	204.41 $\pm$ 36.15	75.30 $\pm$ 25.36	7.13 $\pm$ 0.07	6.93 $\pm$ 0.10	0.20 $\pm$ 0.08	0.82
	16	167.23 $\pm$ 31.18	38.12 $\pm$ 20.71	7.27 $\pm$ 0.09	6.98 $\pm$ 0.10	0.29 $\pm$ 0.04	0.95
	24	173.64 $\pm$ 26.10	44.53 $\pm$ 10.76	7.43 $\pm$ 0.19	6.96 $\pm$ 0.16	0.47 $\pm$ 0.10	0.92
GC	-	129.11 $\pm$ 18.43	-	-	-	-	

Thickness change in the microscopic measurement was calculated by subtracting the PDL thickness of the experimental animal from the mean PDL thickness of control animals. Displacement was calculated macroscopically by subtracting the moved side measurement from the unmoved side.

(*) Distance between the most cervical region of the distal face of the last molar and the mesial face of the first molar; (#) Pearson correlation coefficient between microscopic PDL thickness change and macroscopic displacement; GI: Group I, underwent uninterrupted (continuous) force; GII: Group II, underwent interrupted force; GC: control group; PDL: periodontal ligament; SD: standard deviation; TC: thickness change.

Table 2

Pearson correlation and paired t-test for within group comparison of induced tooth displacement between different time points

Group		Microscopic displacement				Macroscopic displacement			
		Day 16		Day 24		Day 16		Day 24	
		r	t-test (p)	r	t-test (p)	r	t-test (p)	r	t-test (p)
GI	Day 8	0.84	0.004*	0.91	0.27	0.92	0.18	0.91	0.01*#
	Day 16	-	-	0.97	0.39	-	-	0.92	0.17
GII	Day 8	0.98	0.003*#	0.98	0.006*#	0.95	0.01*#	0.96	<0.001*#
	Day 16	-	-	0.99	0.42	-	-	0.95	<0.001*#

(*) $p < 0.05$: statistically significant; (#) Tukey test confirmed.

4 DISCUSSION

The PDL in humans is a connective tissue, abundant in type I collagen fiber, with an average thickness of 0.2 mm, ranging between 0.15 to 0.38 depending on its location on the root.¹¹ On the root surface, the deposited cementum has a thickness of 0.5 to 0.10 mm in the cervical and middle portions. The internal surface of the alveolus is covered by a thin layer of woven bone, which represents a true alveolar lining of ectomesenchymal origin. On the cementum surface, osteoremodeling units are rarely observed in their Howship's lacunae, but they are frequently present on the bone surface, without significant periodontal irregularities on the alveolar bone surface.

During induced dental movement, numerous osteoremodeling units and Howship's lacunae develop on the alveolar bone surface, creating irregularities associated with the periodontal ligament, which becomes rich in cellular mediators and inflammatory exudate due to cellular compression and hypoxia from reduced blood vessel caliber. OTM in its final stage leads to coordinated resorption and formation of tissues in the surrounding bone and periodontal ligament.^{9,11-13} This new bone formation may explain why PDL thickness in our study initially increased (GI and GII on day eight, Table 1) while it decreased in later days in GI or the amount of change was lowered in GII. The constant positive macroscopic tooth movement (Table 1) in our study indicates possible replacing of PDL with alveolar bone.

In the experimental model of Heller and Nanda,⁵ after the tenth day, the experimental appliances inducing movement, anchored on the incisors, tended to become loose due to wear from attrition and continuous dental eruption. These two phenomena were not observed in the murine molars, only in the incisors, as the latter exhibited continuous odontogenesis. Beyond 8th day of OTM, the incisors may undergo partial rotation in the alveolus causing distal displacement, significantly reducing the distance between the incisors and the first

molar, which has also been moved mesially. This may be another reason that both groups had the thickest PDL on day eight. However, given that the macroscopic tooth movement was not affected, it is unlikely that reduced tension due to reduced distance is causing this discrepancy.

Lastly, the macroscopic measurements were taken at the coronal level, while microscopic measurements were taken at the cervical root level. The discrepancy may mean that the teeth were tilted. Unfortunately, our study is limited due to lack of detailed histological description, including evidence of bone neoformation that could potentially differentiate between tilted tooth and new alveolar bone formation.

After periods of appliance activation and subsequent dissipation of forces, the periodontal tissues tend to repair, with deactivation of osteoremodeling units and reversal of resorptive processes. On the bony surfaces, this reversal is characterized by the disappearance of osteoclasts and the appearance of a basophilic line marking the resumption of bone synthesis and deposition. This line is known as the traumatic calcium line or reversal line. During the process of periodontal tissue reorganization and repair, including fibroblast and collagen fiber rearrangement and reversal of resorptive processes, the reapplication of forces may induce a more extensive or intense disorganization and hypoxia compared to normal tissues.¹⁴⁻¹⁶

In our study, the interruption of forces in GII every four days lead to a greater PDL thickness, despite similar macroscopic dislocation compared to the uninterrupted GI model. This suggests delayed alveolar bone neoformation, possibly due to interrupted osteoblast activity and/or increased inflammation. This exacerbation of periodontal ligament thickness can, in a broad sense, be extrapolated to orthodontic clinical situations characterized by reciprocating movements, such as the use of intermaxillary elastics.¹⁴

Finally, examining the displacement in the interrupted force experimental group (GII) on day eight (Table 1), it can be inferred that after the force was interrupted on day four, the teeth did not completely return to their original position.

5 CONCLUSION

Microscopical measurement of periodontal ligament thickness and its changes during induced tooth movement strongly and positively correlated with macroscopic displacement on days eight, 16, and 24 post-installation. Both interrupted and uninterrupted continuous forces efficiently moved the teeth with comparable results, however, the changes in the periodontal ligament thickness were not similar between groups, suggesting faster bone

formation by continuous uninterrupted force. The teeth did not move back to their original location within four days of removal of the appliance.

ACKNOWLEDGMENTS

We would like to express our deep gratitude to the entire technical team of the animal facility for their support and attention throughout the development of the project, as well as technicians Maria Dirce Colli Boatto and Gilmar Martins de Oliveira for their technical and laboratory support.

This study was designed as an experimental research project and conducted at the Center for Experimental Surgery Research, Prof. Dr. Tetuo Okamoto, at the School of Dentistry of Araçatuba - São Paulo State University (UNESP). The project was approved by the Animal Experimentation Ethics Committee (CEEa) of the School of Dentistry of Araçatuba - UNESP under protocol no. 2008-004460 in accordance with the Ethical Principles in Animal Experimentation of the Brazilian College of Animal Experimentation (COBEA).

Seventy male Wistar rats (*Rattus norvegicus*, albinos) weighing between 250 and 350g and approximately 90 days old were used. The animals, obtained from the Animal Facility of the School of Dentistry of Araçatuba - UNESP, were housed in groups of five per cage and fed granulated chow (Probiotério MP-77, Moinho Primor S.A., São Paulo, Brazil) with water provided ad libitum.

REFERENCES

1. Arnett, G. W., Jelic, J. S., Kim, J., et al. (1999). Soft tissue cephalometric analysis: Diagnosis and treatment planning of dentofacial deformity. *American Journal of Orthodontics and Dentofacial Orthopedics*, 116(3), 239–253. [https://doi.org/10.1016/S0889-5406\(99\)70234-3](https://doi.org/10.1016/S0889-5406(99)70234-3)
2. Ren, Y., Maltha, J. C., & Kuijpers-Jagtman, A. M. (2004). The rat as a model for orthodontic tooth movement: A critical review and a proposed solution. *European Journal of Orthodontics*, 26(5), 483–490. <https://doi.org/10.1093/ejo/26.5.483>
3. Kirschneck, C., Proff, P., Fanghaenel, J., Behr, M., Wahlmann, U., & Roemer, P. (2013). Differentiated analysis of orthodontic tooth movement in rats with an improved rat model and three-dimensional imaging. *Annals of Anatomy*, 195(6), 539–553. <https://doi.org/10.1016/j.aanat.2013.07.001>
4. Cuoghi, O. A., Tondelli, P. M., Aiello, C. A., Mendonça, M. R. de, & Costa, S. C. da. (2013). Importance of periodontal ligament thickness. *Brazilian Oral Research*, 27(1), 76–79. <https://doi.org/10.1590/S1806-83242013000100013>

5. Heller, I. J., & Nanda, R. (1979). Effect of metabolic alteration of periodontal fibers on orthodontic tooth movement: An experimental study. *American Journal of Orthodontics*, 75(3), 239–258. [https://doi.org/10.1016/0002-9416\(79\)90175-4](https://doi.org/10.1016/0002-9416(79)90175-4)
6. Miura, F., Mogi, M., Ohura, Y., & Hamanaka, H. (1986). The super-elastic property of the Japanese NiTi alloy wire for use in orthodontics. *American Journal of Orthodontics and Dentofacial Orthopedics*, 90(1), 1–10. [https://doi.org/10.1016/0889-5406\(86\)90044-1](https://doi.org/10.1016/0889-5406(86)90044-1)
7. Miura, F., Mogi, M., Ohura, Y., & Karibe, M. (1988). The super-elastic Japanese NiTi alloy wire for use in orthodontics. Part III: Studies on the Japanese NiTi alloy coil springs. *American Journal of Orthodontics and Dentofacial Orthopedics*, 94(2), 89–96. [https://doi.org/10.1016/0889-5406\(88\)90004-9](https://doi.org/10.1016/0889-5406(88)90004-9)
8. Gianelly, A. A., Bednar, J., & Dietz, V. S. (1991). Japanese NiTi coils used to move molars distally. *American Journal of Orthodontics and Dentofacial Orthopedics*, 99(6), 564–566. [https://doi.org/10.1016/0889-5406\(91\)70019-5](https://doi.org/10.1016/0889-5406(91)70019-5)
9. King, G. J., Keeling, S. D., McCoy, E. A., & Ward, T. H. (1991). Measuring dental drift and orthodontic tooth movement in response to various initial forces in adult rats. *American Journal of Orthodontics and Dentofacial Orthopedics*, 99(5), 456–465. [https://doi.org/10.1016/0889-5406\(91\)70088-X](https://doi.org/10.1016/0889-5406(91)70088-X)
10. Hauber Gameiro, G., Nouer, D. F., Pereira Neto, J. S., et al. (2008). Effects of short- and long-term celecoxib on orthodontic tooth movement. *The Angle Orthodontist*, 78(5), 860–865. <https://doi.org/10.2319/092907-467.1>
11. Li, Y., Jacox, L. A., Little, S. H., & Ko, C.-C. (2018). Orthodontic tooth movement: The biology and clinical implications. *Kaohsiung Journal of Medical Sciences*, 34(4), 207–214. <https://doi.org/10.1016/j.kjms.2018.01.007>
12. Lv, T., Kang, N., Wang, C., Han, X., Chen, Y., & Bai, D. (2009). Biologic response of rapid tooth movement with periodontal ligament distraction. *American Journal of Orthodontics and Dentofacial Orthopedics*, 136(3), 401–411. <https://doi.org/10.1016/j.ajodo.2007.10.063>
13. Gonçalves, A., Mathelié-Guinlet, Q., Ramires, F., et al. (2024). Biological alterations associated with orthodontic treatment with conventional appliances and aligners: A systematic review of clinical and preclinical evidence. *Heliyon*, 10(12), e32873. <https://doi.org/10.1016/j.heliyon.2024.e32873>
14. Graber, T. M., Vanarsdall, R. L., Jr., & Vig, K. W. L. (2005). *Orthodontics: Current principles and techniques* (4th ed.). Elsevier.
15. Jeon, H. H., Teixeira, H., & Tsai, A. (2021). Mechanistic insight into orthodontic tooth movement based on animal studies: A critical review. *Journal of Clinical Medicine*, 10(8), 1733. <https://doi.org/10.3390/jcm10081733>
16. Nakai, Y., Praneetpong, N., Ono, W., & Ono, N. (2023). Mechanisms of osteoclastogenesis in orthodontic tooth movement and orthodontically induced tooth root resorption. *Journal of Bone Metabolism*, 30(4), 297–310. <https://doi.org/10.11005/jbm.2023.30.4.297>

SCIENTIFIC LITERACY THROUGH INCLUSIVE CHEMISTRY TEACHING: A PEDAGOGICAL PROPOSAL FOR 6TH GRADE STUDENTS IN THE FINAL YEARS OF ELEMENTARY SCHOOL IN THE CITY OF CAXIAS-MA

ALFABETIZAÇÃO CIENTÍFICA ATRAVÉS DO ENSINO DE QUÍMICA DE FORMA INCLUSIVA: UMA PROPOSTA PEDAGÓGICA PARA ALUNOS DO 6.º ANO DO ENSINO FUNDAMENTAL ANOS FINAIS DA CIDADE DE CAXIAS-MA

ALFABETIZACIÓN CIENTÍFICA A TRAVÉS DE LA ENSEÑANZA INCLUSIVA DE LA QUÍMICA: UNA PROPUESTA PEDAGÓGICA PARA ALUMNOS DE 6.º CURSO DE LA ENSEÑANZA PRIMARIA DE LA CIUDAD DE CAXIAS-MA



<https://doi.org/10.56238/sevened2026.008-016>

Izamara de Sousa Oliveira¹, Laiane Pereira Cardoso², Alessandro Moraes Cunha³, Quésia Guedes da Silva Castilho⁴, Vera Lucia Neves Dias⁵, Mauro Guterres Barbosa⁶, Daniely Verônica Cardoso Carvalho⁷, Camila Gonçalves Ribeiro⁸

ABSTRACT

The research is justified because school inclusion involves integrating children into regular education, promoting their participation in school activities in a social, pedagogical, and physical way. To this end, it is necessary to adapt the curriculum, practices, and assessments, ensuring that all students, with or without disabilities, fully participate in the pedagogical and social dynamics of the school. Given this, the central objective of this work is to spark interest in chemistry among 6th-grade students, introducing basic concepts in an accessible, contextualized, and inclusive way. The activities involved classroom intervention, including the development of teaching resources and the application of a chemistry lesson in a 6th-grade class. It was observed that practical and experimental activities, adapted to meet inclusive needs, proved effective in integrating students with and without disabilities, promoting collaborative and accessible learning. It was concluded that the interaction between theory and practice, combined with inclusive strategies, such as the use of Styrofoam balls to build molecules and adapted experimental activities, favored student learning.

¹ Graduated in Chemistry Degree. Universidade Estadual do Maranhão (UEMA).
E-mail: izasousa322@gmail.com

² Graduated in Chemistry Degree. Universidade Estadual do Maranhão (UEMA).
E-mail: laiane.c.pereira00@gmail.com

³ Graduated in Chemistry Degree. Universidade Estadual do Maranhão (UEMA).
E-mail: al3ssandro.moraes@gmail.com

⁴ Dr. in Sciences. Universidade Estadual do Maranhão (UEMA). E-mail: quesiicastilho@professor.uema.br

⁵ Dr. in Sciences. Universidade Estadual do Maranhão (UEMA). E-mail: veraquim01@gmail.com

⁶ Dr. in Science and Mathematics. Universidade Estadual do Maranhão (UEMA).
E-mail: maurobarbosa@professor.uema.br

⁷ Dr. in Sciences. Instituto Federal do Maranhão (IFMA). E-mail: daniely.veronika@gmail.com

⁸ Master's degree in Psychology. Universidade Federal do Maranhão (UFMA).
E-mail: camilagori@hotmail.com

Keywords: Inclusive Education. Chemistry Teaching. Elementary School. Teaching Resources.

RESUMO

Justifica-se a pesquisa pois a inclusão escolar envolve integrar crianças ao ensino regular, promovendo sua participação nas atividades escolares de forma social, pedagógica e física. Para isso, é necessário adaptar o currículo, as práticas e as avaliações, garantindo que todos os alunos, com ou sem deficiência, participem plenamente da dinâmica pedagógica e social da escola. Diante disso, o objetivo central deste trabalho é despertar o interesse pela Química com alunos do 6º ano, introduzindo conceitos básicos de forma acessível, contextualizada e inclusiva. As atividades envolveram, intervenção em sala de aula, incluindo, elaboração de recursos didáticos e aplicação de uma aula sobre química em uma turma do 6º ano. Observou-se que as atividades práticas e experimentais, adaptadas para atender às necessidades inclusivas, demonstraram eficácia na integração de alunos com e sem deficiência, promovendo um aprendizado colaborativo e acessível. Conclui-se que a interação entre teoria e prática, aliada a estratégias inclusivas, como o uso de esferas de isopor para a construção de moléculas e atividades experimentais adaptadas, favoreceu o aprendizado dos estudantes.

Palavras-chave: Educação Inclusiva. Ensino de Química. Ensino Fundamental. Recursos Pedagógicos.

RESUMEN

La investigación se justifica porque la inclusión escolar implica integrar a los niños en la enseñanza regular, promoviendo su participación en las actividades escolares de forma social, pedagógica y física. Para ello, es necesario adaptar el plan de estudios, las prácticas y las evaluaciones, garantizando que todos los alumnos, con o sin discapacidad, participen plenamente en la dinámica pedagógica y social de la escuela. En vista de ello, el objetivo central de este trabajo es despertar el interés por la química en los alumnos de 6.º curso, introduciendo conceptos básicos de forma accesible, contextualizada e inclusiva. Las actividades incluyeron la intervención en el aula, la elaboración de recursos didáticos y la impartición de una clase de química en un curso de 6.º. Se observó que las actividades prácticas y experimentales, adaptadas para satisfacer las necesidades inclusivas, demostraron su eficacia en la integración de alumnos con y sin discapacidad, promoviendo un aprendizaje colaborativo y accesible. Se concluye que la interacción entre la teoría y la práctica, junto con estrategias inclusivas, como el uso de esferas de espuma de poliestireno para la construcción de moléculas y actividades experimentales adaptadas, favoreció el aprendizaje de los estudiantes.

Palabras clave: Educación Inclusiva. Enseñanza de la Química. Educación Primaria. Recursos Pedagógicos.

1 INTRODUCTION

School inclusion is understood as a process that happens by the insertion of the child, in the regular classroom, in the everyday activities of the school, in a social, pedagogical and physical way, in which it is up to the restructuring of the curriculum, practices and evaluation so that the student, regardless of whether or not he has a disability, can participate in the pedagogical and social dynamics of the school. The school, from an inclusive perspective, would meet the demands of these students, in order to respect their peculiarities and provide opportunities for learning school content.

In the educational context, scientific literacy is not only limited to understanding concepts and theories, but also involves developing skills to question, analyze, and apply knowledge ethically and inclusively. In the teaching of Chemistry, inclusive education is a challenge due to the need for abstraction for the understanding of many concepts and the adequacy of language tools and didactic models that contemplate the understanding of all students.

Teaching Chemistry to 6th grade students involves overcoming challenges related to the complexity of the discipline and the often negative perception that students have in relation to science. However, by adopting inclusive and practical pedagogical approaches, it is possible to turn these challenges into meaningful learning opportunities. Studies show that implementing inclusive educational strategies in chemistry teaching can improve student participation and understanding, especially those with special educational needs. These strategies may include the use of assistive technologies, curricular adaptations, and practical activities that promote interaction and experimentation (Santos *et al.*, 2020). Thus, an inclusive approach in teaching Science, especially in Chemistry, ensures that all students, regardless of their initial abilities or socioeconomic backgrounds, can actively participate in and benefit from scientific learning.

In view of the above, this work proposes a proposal for the introduction of basic concepts of chemistry through the exploration of elements of children's daily life, aiming to awaken in them greater interest in science, in a more engaging and inclusive way.

2 DEVELOPMENT

2.1 THEORETICAL FRAMEWORK

2.1.1 History of inclusive education

Inclusive Education emerged at different times and contexts, especially from the 90s when the World Conference on Special Education took place, and in 1994 the Salamanca

Declaration was proclaimed, which "defines policies, principles and practices of Special Education and influences Public Education Policies". (UNESCO, 1994; Souto, 2014).

For a long time, the different was placed on the margins of education: the student with disabilities was attended separately, or simply excluded from the educational process, based on standards of normality. Before inclusive education, there was a model of segregated education, where the education of students with specific educational needs took place in parallel with the so-called regular education. There were the so-called special schools or classes, belonging to the special education subsystems implemented in the various public education networks through the National Center for Special Education (CENESP), created in 1973 (Ferreira; Glat, 2003; Bastos, 2014).

In Brazil, special education has moved from a segregationist model — marked by the creation of isolated institutions such as the Benjamin Constant Institute (1854) and INES (1857) — to an inclusive perspective. Historically, care took place in special classes or parallel institutions (Mazzotta, 2005). However, driven by international frameworks such as the Salamanca Declaration (1994) and LDB No. 9,394/96, the national policy made a commitment to integrate students with disabilities into regular education. From the 2000s onwards, guidelines such as the National Policy on Special Education in the Perspective of Inclusive Education (2008) consolidated the mandatory provision of specialized educational services and the elimination of barriers to access and permanence in school

2.1.2 Teaching of Chemistry in Elementary School

In the early years, it does not exist, according to school curricula (Brasil, 2018; Paraná, 2018) a curricular component of Chemistry, but there is an understanding that chemical, physical and biological concepts are part of the Natural Sciences.

According to the BNCC (Brazil, 2018), the area of Natural Sciences is committed to the development of scientific literacy, involving the ability to understand and transform the world.

Thus, in the final years of elementary school, the area of Natural Sciences through the fields of knowledge seeks to ensure its students contact with scientific thinking, so that these students can have a new look at the world around them.

The practice of teaching Natural Sciences has been carried out according to various educational proposals, which occur as theoretical elaborations, expressing themselves in the most varied ways in the classrooms. Many of these practices are based only on the passage of theoretical contents, using the book and the blackboard as the only didactic resources. Others, on the other hand, are based on innovations that emerge over the years, new

methodologies that help teaching, as well as innovations in science and the way to pass on knowledge about it in particular (Brasil, 1998, p. 19).

Showing Science as a human elaboration for an understanding of the world is a goal for teaching the area in elementary school. Its concepts and procedures contribute to the questioning of what is seen and heard, to interpret the phenomena of nature, to understand how society intervenes in it by using its resources and creating a new social and technological environment. It is necessary to favor the development of a reflective and investigative posture, of non-acceptance, a priori, of ideas and information, as well as the perception of the limits of explanations, including scientific models, collaborating to the construction of autonomy of thought and action (Brasil, 1998, p. 19).

Aiming at this goal and considering the mandatory nature of Elementary Education in Brazil, it is seen that it cannot teach students to act only in the future, but that teaching must contemplate the present so that the student can already act on social issues, expanding "his present possibility of social participation and mental development, in order to enable their full capacity to exercise citizenship" (Brasil, 1998, p. 23).

Thus, the teaching of chemistry should be valued by teachers in this phase of Education, because it is through it that we understand natural phenomena, from the composition of materials to their transformations. With this, it is possible to carry out experimental activities that encourage students to make observations and reach their own conclusions, thus awakening interest in scientific knowledge. Although the contents of the science area are often considered difficult due to their abstract character, many students face challenges in understanding them (Gonzaga; Joffe, 2022).

At the end of the 9th grade, students must "question reality by formulating problems and trying to solve them, using logical thinking, creativity, intuition, the capacity for critical analysis, selecting procedures and verifying their adequacy" (Brasil, 1998, p. 8), which is one of the objectives proposed by the National Curriculum Parameters for Elementary Education.

In the National Common Curricular Base (BNCC), ten general competencies of Basic Education are presented, which are articulated based on the construction of knowledge, the development of skills and the formation of attitudes and values, under the terms of the LDB. "These competencies are defined as the mobilization of knowledge, skills, attitudes and values to solve complex demands of daily life, the full exercise of citizenship and the world of work" (Brasil, 2018, p. 8), in which the student, by developing them, becomes a citizen able to get involved in social issues.

In view of this, working with investigative activities can be an excellent strategy to be used by teachers, making the student build their own knowledge.

For Carvalho (2010 apud Silva *et. al.*, 2018, p.3):

An activity can be considered investigative when it is not limited to memorization, but when it leads the student to reflection, discussion, problematization and questioning, in addition to offering a space for learners to share their ideas and opinions. Thus, it is possible to contemplate the methodology inserted in the classroom more effectively.

This type of investigative activity and practical classes arouse the interest of students, involve students in scientific investigations, develop the ability to solve problems, understand basic concepts, and develop the skills of their students (Gonzaga; Joffe, 2022).

With this, it is possible to perceive the importance of the educator's role in modifying the daily life of the classroom, because even without receiving extra financial aid in schools or external, many of them seek to vary and awaken the student to knowledge (Rosso *et al.*, 2012).

2.1.3 Scientific Literacy through an inclusive bias

To understand the concept of scientific literacy, it is essential to initially understand the meaning of literacy. Although often associated only with the act of learning to read and write, literacy encompasses a much broader concept. Reading and writing represent only the first stage of this broader process.

The practice of Scientific Literacy is configured as a fundamental model to enhance the alternative of a more open teaching and learning process to expand the didactics of Science and stimulate the effective participation of students in the construction of their knowledge, as the researcher Chassot (2003, p. 3) says, to become scientifically literate is to enable the student to "know how to read the language in which it is written in nature" and I add, It is also knowing how to interpret the social environment in which it is inserted.

According to Sasseron and Carvalho (2011), Scientific Literacy (CA) can occur in different categories, namely: functional CA, conceptual and procedural CA, and multidimensional CA. Functional CA is related to appropriating scientific terms and concepts used in science; Conceptual and procedural CA emphasizes the fact that the student perceives the relationship between concepts and experiments with daily activities, verifying the importance of science in his daily life. Multidimensional CA would be the junction of previous ideas, that is, the student appropriates concepts and knows how to apply them in their daily lives.

One of the challenges encountered in carrying out the process of scientific literacy from the perspective of inclusion is the mastery of their language.

Scientific language is composed of laws, theories, concepts, principles and structures that other types of knowledge do not have, which, at first, makes the teacher's work difficult. Thus, mastering this language is essential for teachers and students to be able to establish the proper relationships between science, society and the environment (Vilela-Ribeiro; Benite, 2013, p. 782).

Without mastery of this language, teachers are unable to carry out an adequate transposition that guarantees all students an understanding of knowledge with meaning for their experience outside of school.

The development of Scientific Literacy is based on axes that lead to the practice of teaching by investigation and argumentation in the classroom. The promotion of science teaching by investigation requires the presentation of problem-situations, related to the daily life of students, which position them in front of a process of analysis and interpretation of data to solve the proposed problem through reflection, characterizing a didactic approach (Sasseron, 2015).

The search for new perspectives and methodological strategies in education have directed the school's profile towards the formation of critical individuals, who know how to consciously reflect on their actions and on the actions carried out by others (Chassot, 2010). Thus, teaching as well as society need new tools that prioritize the development of the formative process of all students, including students with specific needs.

Science literacy methods with an inclusive bias are essential to ensure that all learners, regardless of their abilities, backgrounds, or educational needs, can access and understand fundamental scientific concepts. These methods aim to create a learning environment that values diversity and allows all students to develop critical skills to interact in an informed manner with the world around them.

One of the most effective methods is the adaptation of content and methodologies. This involves modifying teaching materials and pedagogical approaches to meet the different needs of students. Using visuals, audio-visuals, and simplified texts can facilitate the understanding of complex concepts, while assistive technologies, such as reading software and assistive devices, help students with disabilities to fully participate in scientific activities.

In view of this, it is clear that in order to advance in the implementation of inclusive scientific literacy, it is important to reflect on how pedagogical practice can be adjusted to meet the needs of all students. The adaptation of methodologies and content is crucial to ensure that the diversity of skills and needs is considered in the teaching process. In this sense, as highlighted by Vilela-Ribeiro and Benite (2013), the ability of teachers to master scientific language and adapt their approaches is vital for effective inclusion. Without this

competence, the transposition of knowledge can become an obstacle to students' understanding, limiting the impact of science education on their lives.

2.2 METHODOLOGY

This work used a qualitative and descriptive approach, organized in structured stages for the planning, execution and evaluation of a pedagogical proposal aimed at intervention in Elementary Education. The steps are described below.

The target audience of this project was the children of the 6th grade of Elementary School, in the afternoon shift, of the Achilles Cruz School, located in the Cangalheiro neighborhood, in the city of Caxias-MA.

Chart 1 shows the five topics of this proposal to be worked on in a dynamic and inclusive way. Among these proposed subjects, the subject "What is Chemistry? - Exploring matter and the mysteries of its transformations".

Table 1

Subjects proposed to work on in the 6th year of elementary school, didactic sequence with the objective and teaching strategy

Subject	Objective	Teaching strategy
Lesson 1: What is Chemistry	Understand the concept of chemistry, understand its importance and how it facilitates everyday life.	Explain the concepts of atoms, molecule/substance formation, and chemistry using illustrative (self-explanatory) images from the story of the bricklayer Peter, a fictional character who represents chemistry. Bricks represent atoms and constructions are molecules. Activity of building molecules using Styrofoam spheres and conducting experiments to demonstrate the transformations of matter, from which we acquire new materials.
Lecture 2: Physical States of Matter	Understand physical transformations and their importance in everyday life, such as transportation, storage, framing, among others.	Use sensory experiments to feel, describe and differentiate the textures of each state. Perform ice melting, and use cold, warm water, dry sand, wet sand and pebbles, as well as other materials to expand the experience.
Lesson 3: The mixtures	Understand the concept of mixture, understand that substances exist in the form of mixtures, that mixtures are essential to obtain a multitude of materials and understand the danger of some combinations at home.	Build different homogeneous and heterogeneous mixtures to feel, observe and differentiate characteristics through touch and sight. Mixtures such as water and sand, water and beans, liquid milk and others. From these experiences, complete and/or assemble a small mental map of the children's observations as a complementary activity.
Lesson 4: Fluoride and health	Discuss and understand the role of fluoride in caries prevention and bone health.	Make a brief explanation of what fluoride is and where it can be found (water, toothpaste, food). Using visual resources such as images and short, accessible videos about fluoride and its importance. Encourage the creation of educational materials (drawings on posters, simple models and models, videos with images and subtitles and interpretation in Libras).

Lesson 5: Acids and alkaline bases	Understand what an acid and a base are, understand their role in daily life, such as health and cleaning, understand the dangers related to these substances preventing domestic accidents.	Experimental practices to observe through the senses some characteristics, such as textures, flavors and aromas characteristic of acidic and alkaline products that DO NOT offer risks, such as fruits, soaps, eggs and others. Conduct safe identification experiments on these products.
---	---	--

Source: Author, 2025.

One of the topics of the pedagogical proposal was applied in the classroom, seeking to observe the receptivity and impact of the strategies employed in the teaching-learning process. Visual resources were prepared, such as illustrations and tactile models, so that, through the various senses, students had greater clarity and understanding of the concepts and transformations. The class applied in the classroom intervention was Class 1 - What is Chemistry? - Exploring matter and the mysteries of its transformations.

The didactic sequence containing the classroom actions, described in Chart 2, refers to the applied class, which was planned to provide an inclusive, dynamic and interactive teaching experience for students in the 6th grade of Elementary School at the Achilles Cruz school. Each stage was designed to develop scientific skills, stimulate interest and curiosity about Chemistry content, while meeting the educational needs of all students, including those with disabilities.

Table 2

Actions of the class on "What is Chemistry"

Classroom actions	Objectives	Number of classes/timetable
Conversation circle	Probing of previous knowledge about chemistry.	3 Schedules
Introductory lecture on the concept of Chemistry	Understanding of the initial concepts of Chemistry, addressing the relationship between atoms, molecules and substances, from the use of slides and objects present.	
Collective reading of the Comic Story.	Understanding, through HQ, of the concepts of atoms as the basic unit that forms all matter.	
Practical activity: Construction of molecules with Styrofoam spheres.	Evaluation of learning about the formation of different substances and promotion of interest in playful practical activities.	
Sensory experiment on transformations of matter - CO ₂ production.	Recognition of a chemical phenomenon through volume change as visual evidence.	

Source: Author, 2025.

For the analysis of the suggested proposal, photos, pictures and images of the day of application in the classroom were used. Texts were used to present the results. Reports of

experiences argued in terms of the results obtained, based on experience and references from other authors.

3 RESULTS AND DISCUSSION

In this item, the results of the suggested pedagogical proposal will be discussed, as well as the reports of the experience of the intervention in the classroom carried out.

In the class on "What is Chemistry", a class that was applied in the classroom, visual resources were used, such as self-explanatory illustrative images that represented fundamental concepts of Chemistry. The construction of Styrofoam spheres was carried out, as an inclusive tool, to assist in the understanding of the content worked. These materials were complemented by the story of the fictional character Pedro, who, through a comic book, made the concepts more understandable to the students. Materials and resources

In the application of the proposal developed in the school, the theme "What is Chemistry" was addressed, aiming to probe the students' previous understanding of Chemistry, understand the concept of Chemistry, its importance, how it facilitates daily life and introduce fundamental concepts. Through a conversation circle, complemented by images, texts and illustrations in the form of slides, we sought to engage the participants. A brief theoretical explanation about atoms, molecules and substances was reinforced using the story of the fictional character Pedro, the bricklayer (Figure 1) as a didactic resource promoting understanding through analogies, a strategy recognized for its effectiveness (Andrade, 2000; Santos, 2018).

Figure 1

Story of the fictional character Pedro



Source: Author, 2025.

For the creation of the comic book (HQ), first, the plot of the story was elaborated. This included establishing the main conflict, the setting, and the characters, and planning the beginning, development, and outcome of the plot. After the script, the layout was created, where the page outlines were drawn. At this stage, each frame was positioned to optimize reading and ensure that the scenes followed a logical and engaging sequence. Then, it was time to illustration, where the characters, scenarios and elements of the story were detailed and finalized. At this stage, the strokes and colors were also defined, which helped to create the atmosphere of the comic. Finally, dialogues and balloons are added, essential to give voice to the characters and to advance the narrative. In this story, the bricks represented the atoms and the constructions symbolized the molecules, making the concepts more accessible and easier to understand.

Figure 2 shows the students attentive to Pedro's story, showing that the resource used aroused their interest and, therefore, being a good choice and having satisfactory support. Historically, there was a time when comics were not allowed in the classroom by teachers. However, this view has changed over time, and comics have come to occupy a prominent place in education. More than pedagogical tools, they were incorporated as part of educational policy, especially after the enactment of the Law of Guidelines and Bases of National Education (LDB), which opened the doors of teaching to innovative resources such as comics (Vergueiro, 2015).

Figure 2

Photo of the moment of the theoretical explanation of concepts and collective reading of the comic



Source: Author, 2025.

During the theoretical presentation, illustrative images were used (Figure 3), which helped to visualize the relationship between atoms and molecules. These images were crucial in clarifying the concepts in a visual and clear way. According to Toyama (2019), the use of visual resources in teaching is essential to ensure adequate access to information,

especially in contexts of inclusion. In addition, studies on inclusive pedagogical practices indicate that adapted methodologies, such as visual representations, are effective in overcoming learning difficulties in disciplines that require abstraction, such as Chemistry (Lima, 2016).

Figure 3

Slides containing the illustrative images used to visualize the relationship between atoms and molecules



Source: Author, 2025.

Then, the students participated in a practical activity, where they built molecules using Styrofoam spheres (Figure 4). Styrofoam spheres were customized to represent atoms, a tactile resource to meet the needs of visually impaired children. With this in mind, printed materials were produced and beads were glued to the Styrofoam spheres to identify the atoms in Braille, in addition to another identification in Libras. Adaptations like this are necessary to meet the needs of inclusion students (Pereira, 2018). The different colors of the spheres, on the other hand, aim not only to differentiate the chemical elements, but also to make the representations of everyday elements such as carbon, hydrogen and oxygen more visually attractive. According to Balbinot (2005), the use of physical models favors the understanding of more abstract concepts, being more attractive and fun.

The colors red, black, white, green, light blue, and blue represent, respectively, the atoms of oxygen, carbon, hydrogen, chlorine, sodium, and nitrogen. This playful activity allowed students to apply the concepts of substance formation in a practical way, promoting an interactive and fun experience. As evidenced in innovative pedagogical practices, the use of colored and tactile models reinforces visual and motor perception, essential to fix complex content and engage students of different profiles. This approach not only improves the understanding of scientific concepts, but also stimulates critical thinking and creativity by

allowing students to explore chemical properties and relationships in an intuitive and meaningful way (Silva; Souza; Filho, 2012; Silva; Yamaguchi, 2023).

Figure 4

Photo of the moment of the construction of molecules, carried out by the student



Source: Author, 2025.

This type of approach is echoed in other inclusive educational experiences, such as a workshop reported at the 57th Brazilian Congress of Chemistry, where tactile molecular models were used to help visually impaired students. The Styrofoam spheres were differentiated not only by color, but also by textures, to facilitate the identification of elements and chemical compounds. In addition, the construction of these models has also been shown to be attractive to students without disabilities, promoting integration and collaborative learning (Alves; Mendes; Ferreira, 2016).

Another work that aligns with this perspective is the study by Silva and Yamaguchi (2023), which describes the development of inclusive teaching materials for the teaching of chemistry, using resources that are also accessible and low-cost. Among the materials developed are three-dimensional models representing atoms and molecules, a periodic table adapted for sign language and braille, as well as sensory experiments on the separation of mixtures.

Additionally, to illustrate the transformations of matter, an experiment was carried out using sodium bicarbonate, vinegar, dyes and water. An experimental script was devised to clearly demonstrate evidence of a chemical reaction perceptible by the senses of sight, smell, and touch, such as changes in volume, aroma, and temperature. The students observed the chemical changes during the reaction, which helped them understand how atoms and molecules interact to form new materials.

The experiment generated the production of CO₂ by the reaction between vinegar and bicarbonate, which resulted in the inflation of a bladder, offering a fun and economical demonstration of the process. According to Borges (2002), the experimental activities developed in science classes are a way to overcome the learning obstacles that the student

may have in relation to the content, in addition to being dynamic, motivating and challenging, resulting in learning in a way that is meaningful to them. It is evidenced that these activities offer opportunities for experience, observation and investigation, connecting theory to everyday reality. They promote more active and reflective learning, which is essential for developing scientific skills and relating science, technology, and society (Sondré, 2018). Figure 5 shows photographic records of the moment the experiment was carried out in the classroom.

Figure 5

Photos of the moment of the experiments, proving the chemical phenomenon between bicarbonate and vinegar



Source: Author, 2025

As observed in the images mentioned above, the class was successful because it effectively integrated theory and practice, stimulating the students' interest in Chemistry and its application in everyday life. Thus, it is up to chemistry teaching professionals to seek alternative didactics that promote the improvement of learning, showing students that chemistry is a science whose concepts and laws are a direct consequence of the behavior of nature (Silva; Souza; Filho, 2012).

In the context of inclusive education, it is essential to highlight that the commitment to inclusion must be continuous and start from early childhood education, providing a solid foundation for the integral development of students. Inclusion promotes not only academic learning, but also respect for differences and appreciation of diversity. In this sense, the continuing education of teachers is crucial to enable them to meet the demands of an inclusive classroom and to ensure that all students, regardless of their needs, have equal learning opportunities (Neves; Rahme; Ferreira, 2019; Ferreira *et al.*, 2024).

4 FINAL CONSIDERATIONS

In view of the objectives proposed for the research, it was possible to conclude that the implementation of the pedagogical proposal focused on the teaching of Chemistry to

students of the 6th year of Elementary School, through dynamic, accessible and inclusive strategies, satisfactorily met the initial expectations. The approach adopted, using resources such as conversation circles, comic books, playful materials and practical experiments, allowed the introduction of chemical concepts in an engaging, contextualized way that considered the different needs of the students.

The interaction between theory and practice, combined with inclusive strategies, such as the use of Styrofoam spheres for the construction of molecules and adapted experimental activities, favored the students' learning. The active participation of students, both with and without disabilities, in the proposed activities, demonstrated the effectiveness of methodologies that value diversity and promote a collaborative environment.

The results showed that the use of visual, tactile and interactive resources actually contribute to the understanding of abstract concepts, such as atomic structure and the formation of molecules, in addition to stimulating students' curiosity and critical thinking. The realization of practical experiments, such as the reaction between baking soda and vinegar, made it possible to experience chemical phenomena in a concrete way, promoting the connection between the content learned and everyday situations.

Thus, the pedagogical proposal developed not only achieved the planned objectives, but also demonstrated the potential of inclusive practices in the teaching of Chemistry, making the concepts more accessible and meaningful for all students, regardless of their limitations. This approach contributes to the construction of a more equitable and richer chemical education, which can serve as a model for future pedagogical practices in science education.

REFERENCES

- Alves, D. F. S., Mendes, C. F. P., & Ferreira, I. J. (2016). Uso de modelos moleculares na perspectiva inclusiva: Relatos de experiências de uma oficina voltada à educação inclusiva de pessoas com deficiência visual. In *Anais do 57º Congresso Brasileiro de Química*. Rio de Janeiro. <https://www.abq.org.br/cbq/2017/trabalhos/6/11398-23015.html>
- Andrade, B. L. de, Zylbersztajn, A., & Ferrari, N. (2000). As analogias e metáforas no ensino de ciências à luz da epistemologia de Gaston Bachelard. *Ensaio: Pesquisa em Educação em Ciências*, 2(2), 182–192. <https://www.scielo.br/j/eped/a/jQy5DqkTSvZzmVcSXX9m46F>
- Balbinot, M. C. (2005). Uso de modelos, numa perspectiva lúdica, no ensino de ciências. In *Anais do IV Encontro Ibero-Americano de Coletivos Escolares e Redes de Professores que Fazem Investigação na Sua Escola*. Univates. http://www.educadores.diaadia.pr.gov.br/arquivos/File/2010/artigos_teses/2010/Ciencias/Artigos/perspectiva_ludica.pdf
- Bastos, A. de S. (2014). A educação química inclusiva na concepção de professores de química de Anápolis. Instituto Federal de Goiás.

- Benite, A. M. C., Benite, C. R. M., & Vilela-Ribeiro, E. B. (2015). Educação inclusiva, ensino de ciências e linguagem científica: Possíveis relações. *Revista Educação Especial*, 28, 81–89.
- Borges, T. (2002). Novos rumos para o laboratório escolar de ciências. *Caderno Brasileiro de Ensino de Física*, 19(3), 291–313.
- Brasil. Ministério da Educação. (1998). Parâmetros curriculares nacionais: Adaptações curriculares – Estratégias para educação de alunos com necessidades educacionais especiais. MEC/SEF/SEESP.
- Brasil. Ministério da Educação. (2003). Dados da educação nacional. INEP.
- Brasil. Ministério da Educação. (2008). Política nacional de educação especial na perspectiva da educação inclusiva. MEC.
- Brasil. Ministério da Educação. (2018). Base Nacional Comum Curricular. MEC.
- Carvalho, A. M. P., et al. (2010). Ciências no ensino fundamental: O conhecimento físico. Scipione.
- Chassot, A. (2003). Alfabetização científica: Questões e desafios para a educação (3ª ed.). Unijuí.
- Chassot, A. (2010). Alfabetização científica: Questões e desafios para a educação (4ª ed.). Unijuí.
- Chassot, A. (2018). Alfabetização científica: Questões e desafios para a educação (8ª ed.). Editora Unijuí.
- Costa, M. C. A., et al. (2020). Educação inclusiva e o ensino regular. *Revista Científica Multidisciplinar Núcleo do Conhecimento*, 5(10), 16–25.
- Felício, N., Nascimento, A., & Souza, J. (2022). Alfabetização científica e educação inclusiva no ensino de ciências: Uma revisão bibliográfica. *REIN*, 7(2). <https://revista.uepb.edu.br/REIN/article/view/797/1210>
- Ferreira, A. M., et al. (2024). Formação continuada para professores na educação especial e inclusiva: Um caminho para a equidade na aprendizagem. *Revista Foco*, 17(7), e5478. <https://ojs.focopublicacoes.com.br/foco/article/view/5478>
- Ferreira, J. R., & Glat, R. (2003). Reformas educacionais pós-LDB: A inclusão do aluno com necessidades especiais no contexto da municipalização. In D. B. Souza & L. C. M. Faria (Orgs.), *Descentralização, municipalização e financiamento da educação no Brasil pós-LDB* (pp. 372–390). DP&A.
- Garghetti, F. C., Medeiros, J. G., & Nuernberg, A. H. (2013). Breve história da deficiência intelectual. *Revista Electrónica de Investigación y Docencia*, (10).
- Gonzaga, A. R., & Joffe, M. E. (2022). O ensino de química nos anos iniciais do ensino fundamental: Caminhos para alfabetização científica. IFPR.

- Lima, B. S. M. C. de. (2016). Inclusão no ensino de química e aprendizagem de estudantes surdos: Interações com uso de recursos visuais (Trabalho de conclusão de curso). Universidade Federal de Pernambuco. <https://repositorio.ufpe.br/bitstream/123456789/39607/1/LIMA,%20Brunna%20Stephan%20Mac%C3%AAdo%20Coelho%20de.pdf>
- Neves, L. R., Rahme, M. M. F., & Ferreira, C. M. R. J. (2019). Política de educação especial e os desafios de uma perspectiva inclusiva. *Educação & Realidade*, 44(1). <https://www.scielo.br/j/edreal/a/J8j5ZYK99htRZyQnW7Cqbrs>
- Pereira, F., et al. (2018). Educação inclusiva: Manual de apoio à prática. Ministério da Educação – DGE.
- Radmann, T., & Pastoriza, B. S. (2016). Educação inclusiva no ensino de química. In *Anais do XVIII Encontro Nacional de Ensino de Química*. Florianópolis.
- Rosso, P., et al. (2012). Diagnóstico do ensino de ciências em escolas da rede pública municipal de Criciúma, SC. In *Anais do IX ANPED Sul*. Universidade de Caxias do Sul.
- Santos, F. A., & Santana, I. C. H. (2018). Investigando as pesquisas sobre analogias. *Educação*, 43(4), 757–772.
- Santos, P. M. S., et al. (2020). Educação inclusiva no ensino de química: Uma análise em periódicos nacionais. *Revista Educação Especial*, 33, 1–19. <https://www.redalyc.org/journal/3131/313162288005/html>
- Sasseron, L. H. (2015). Alfabetização científica, ensino por investigação e argumentação. *Revista Ensaio*, 17(especial), 49–67.
- Sasseron, L. H., & Carvalho, A. M. P. (2011). Alfabetização científica: Uma revisão bibliográfica. *Investigações em Ensino de Ciências*, 16(1), 59–77.
- Silva, J. B., & Yamaguchi, K. K. L. (2023). Materiais didáticos para a educação inclusiva no ensino de química. *Scientia Naturalis*, 5(2), 765–778. <https://doi.org/10.29327/269504.5.2-19>
- Silva, M. D., et al. (2018). Atividade investigativa: Um caminho para a construção do conhecimento. In *Anais do V Congresso Internacional das Licenciaturas (COINTER)*.
- Silva, T. S., Souza, J. J. N. de, & Filho, J. R. de C. (2012). Construção de modelos moleculares com material alternativo. *Experiências em Ensino de Ciências*, 12(2).
- Sondré, G. F., et al. (2018). Balão que enche sozinho. In *Anais do 59º Congresso Brasileiro de Química*. Mato Grosso.
- Souto, M. T. de. (2014). Educação inclusiva no Brasil: Contexto histórico e contemporaneidade. UEPB.
- Toyama, K. S. F. (2019). Orientações didáticas para o ensino de química na perspectiva inclusiva. UTFPR.
- UNESCO. (1994). Declaração de Salamanca e linha de ação sobre necessidades educativas especiais. CORDE.

Vergueiro, V. (2015). Quadrinhos na educação. Contexto.

Vilela-Ribeiro, E. B., & Benite, A. M. C. (2013). Alfabetização científica e educação inclusiva. *Ciência & Educação*, 19(3), 781–794.

INTELLECTUAL PROPERTY AS AN AXIS OF TECHNOLOGICAL SOVEREIGNTY IN THE RARE EARTHS VALUE CHAIN: EVIDENCE FROM MINAS GERAIS

PROPRIEDADE INTELECTUAL COMO EIXO DE SOBERANIA TECNOLÓGICA NA CADEIA DAS TERRAS RARAS: EVIDÊNCIAS DE MINAS GERAIS

LA PROPIEDAD INTELECTUAL COMO EJE DE LA SOBERANÍA TECNOLÓGICA EN LA CADENA DE LAS TIERRAS RARAS: EVIDENCIAS DE MINAS GERAIS



<https://doi.org/10.56238/sevened2026.008-017>

Flávio Ribeiro da Costa¹, Luiz Ricardo Baptista de Godoy², Allynson Takehiro Fujita³,
Fernando Melo da Silva⁴

ABSTRACT

Rare earth elements constitute strategic mineral resources due to their application in technology-intensive sectors such as renewable energy, electric mobility, advanced electronics, and defense, assuming growing geopolitical relevance. Although Brazil holds significant geological potential for these elements, especially in Minas Gerais, its insertion into global value chains remains concentrated in the initial stages of mineral exploitation, revealing a mismatch between resource abundance and technological mastery. In this context, the article analyzes the role of the Industrial Property Law (Law No. 9,279/1996) as an instrument of technological sovereignty, linking the debate to international dynamics of control over critical minerals. A qualitative, exploratory, and analytical-descriptive approach is adopted, based on bibliographic and documentary review on geology, processing technologies, innovation, and territorial governance. The results indicate that the strategic value of rare earths depends more on the mastery of critical technological processes than on mere mineral extraction. It is concluded that technological sovereignty requires an integrated institutional arrangement, articulating innovation, intellectual property, and public policies oriented toward sustainable development.

Keywords: Rare Earths. Intellectual Property. Technological Sovereignty. Geopolitics of Strategic Resources. Minas Gerais.

¹ Master's student in Intellectual Property and Technology Transfer for Innovation. Universidade do Estado de Minas Gerais (UEMG). Minas Gerais, Brazil. Orcid: 0009-0001-4202-0830

² Master's student in Intellectual Property and Technology Transfer for Innovation. Universidade do Estado de Minas Gerais (UEMG). Minas Gerais, Brazil. Orcid: 0009-0009-3033-3619

³ Dr. in Analytical Chemistry. Universidade do Estado de Minas Gerais (UEMG). Minas Gerais, Brazil. Orcid: 0000-0002-9848-8299

⁴ Dr. in Law. Universidade do Estado de Minas Gerais (UEMG). Minas Gerais, Brazil. Orcid: 0000-0002-9848-8299

RESUMO

As terras raras constituem recursos minerais estratégicos devido à sua aplicação em setores intensivos em tecnologia, como energias renováveis, mobilidade elétrica, eletrônica avançada e defesa, assumindo crescente relevância geopolítica. Embora o Brasil detenha expressivo potencial geológico desses elementos, especialmente em Minas Gerais, sua inserção nas cadeias globais de valor permanece concentrada nas etapas iniciais da exploração mineral, revelando um descompasso entre abundância de recursos e domínio tecnológico. Nesse contexto, o artigo analisa o papel da Lei da Propriedade Industrial (Lei nº 9.279/1996) como instrumento de soberania tecnológica, articulando o debate às dinâmicas internacionais de controle dos minerais críticos. Adota-se abordagem qualitativa, exploratória e analítico-descritiva, com base em revisão bibliográfica e documental sobre geologia, tecnologias de beneficiamento, inovação e governança territorial. Os resultados indicam que o valor estratégico das terras raras depende do domínio de processos tecnológicos críticos, mais do que da simples extração mineral. Conclui-se que a soberania tecnológica requer um arranjo institucional integrado, articulando inovação, propriedade intelectual e políticas públicas orientadas ao desenvolvimento sustentável.

Palavras-chave: Terras Raras. Propriedade Intelectual. Soberania Tecnológica. Geopolítica dos Recursos Estratégicos. Minas Gerais.

RESUMEN

Las tierras raras constituyen recursos minerales estratégicos debido a su aplicación en sectores intensivos en tecnología, como las energías renovables, la movilidad eléctrica, la electrónica avanzada y la defensa, adquiriendo una creciente relevancia geopolítica. Aunque Brasil posee un significativo potencial geológico de estos elementos, especialmente en Minas Gerais, su inserción en las cadenas globales de valor permanece concentrada en las etapas iniciales de la explotación minera, lo que revela un desajuste entre la abundancia de recursos y el dominio tecnológico. En este contexto, el artículo analiza el papel de la Ley de Propiedad Industrial (Ley n.º 9.279/1996) como instrumento de soberanía tecnológica, articulando el debate con las dinámicas internacionales de control de los minerales críticos. Se adopta un enfoque cualitativo, exploratorio y analítico-descriptivo, basado en una revisión bibliográfica y documental sobre geología, tecnologías de beneficio, innovación y gobernanza territorial. Los resultados indican que el valor estratégico de las tierras raras depende más del dominio de procesos tecnológicos críticos que de la simple extracción minera. Se concluye que la soberanía tecnológica requiere un arreglo institucional integrado, que articule innovación, propiedad intelectual y políticas públicas orientadas al desarrollo sostenible.

Palabras clave: Tierras Raras. Propiedad Intelectual. Soberanía Tecnológica. Geopolítica de los Recursos Estratégicos. Minas Gerais.

1 INTRODUCTION

Rare earth elements (REEs) are a group of chemical elements formed by lanthanides, plus yttrium and scandium, whose unique physicochemical properties make them strategic inputs for the contemporary high-tech industry. Despite the historical name, these elements are not geologically scarce, but they have a high dispersion in the Earth's crust and chemical complexity that makes it difficult for them to be concentrated, separated and individually purified, which explains their economic and geopolitical relevance (Abrão, 1994; Castor & Hedrick, 2006). Lanthanid contraction, a phenomenon responsible for the similarity of ionic rays and oxidation states, imposes significant technological challenges to the beneficiation and refining processes, increasing costs and requiring advanced technological solutions (Abrão, 1994).

In recent decades, the intensification of global demand for REEs has been driven by the expansion of strategic sectors such as renewable energy, electric mobility, information technology, defense, industrial catalysis, and high-performance electronic devices. Permanent magnets based on neodymium, dysprosium and praseodymium, catalysts, phosphors, special alloys and optical components illustrate the centrality of these elements for the energy transition and for the so-called low-carbon economy (Chakmouradian & Wall, 2012; Haque et al., 2014).

In this context, the concentration of global production and processing, historically dominated by China, has transformed rare earths into strategic assets associated with the economic security and technological sovereignty of national states.

Brazil stands out in this scenario for having one of the largest known reserves of rare earths in the world, with a significant increase in estimates based on the incorporation of deposits located, above all, in the states of Minas Gerais and Goiás. Recent studies indicate that the country has come to occupy a prominent position in the global ranking of reserves, although it still has a marginal participation in the production of oxides and, mainly, in the aggregation of technological value (DNPM, 2014; Souza, Nascimento & Giese, 2019)

Such asymmetry reveals a recurring paradox of the Brazilian mineral economy: geological abundance coexisting with technological and industrial dependence.

Minas Gerais plays a central role in this debate, due to the occurrence of deposits associated with alkaline and alkaline-carbonatite complexes, such as those of Araxá and the Poços de Caldas Plateau, as well as ionic adsorption clays and mineral tailings with potential for secondary recovery. The technological characterization of these resources demonstrates that, although the levels are significant, economic viability depends on the mastery of

sophisticated extraction, separation, and purification processes, including hydrometallurgical and biohydrometallurgical routes (Antoniassi, 2017; Gupta & Krishnamurthy, 2005).

Recent literature also points to the advancement of technologies based on bioleaching and biosorption as more environmentally sustainable alternatives, capable of reducing energy consumption and waste generation, expanding the potential for the use of low-grade ores (Barnettler et al., 2016; Amin et al., 2014; Souza, Nascimento & Giese, 2019)

These technological advances, however, highlight the need for legal protection of the knowledge generated along the rare earths production chain. Innovative processes of beneficiation, solvent separation, bioleaching, biosorption, development of advanced materials and industrial applications constitute strategic intangible assets, whose misappropriation can compromise the national ability to compete in technology-intensive global value chains.

In this sense, the **Intellectual Property Law (Law No. 9,279/1996)** emerges as a fundamental instrument for the protection of inventions, utility models and industrial secrets related to the mineral sector, functioning as a mechanism to encourage innovation, technology transfer and technological sovereignty.

Unlike an approach focused exclusively on primary exploitation, protection via intellectual property allows for the articulation of mining, science, technology and innovation, transforming natural resources into platforms for technological development.

In the case of rare earths, this articulation is particularly relevant, since the economic value of these elements is less associated with the extraction itself and more with the mastery of the technological processes that enable their application in high value-added products.

Thus, the absence of intellectual protection strategies tends to perpetuate patterns of external dependence, while their adoption strengthens the capacity of the State and national companies to retain value, stimulate applied research and consolidate technological skills.

In this context, this article analyzes the role of the **Intellectual Property Law as an instrument of technological sovereignty**, based on the case of rare earths in Minas Gerais, articulating geological, technological and institutional evidence. It is based on the assumption that technological sovereignty does not result only from the possession of natural resources, but from the ability to transform them into protected knowledge, industrial innovation and sustainable territorial development.

2 THEORETICAL BACKGROUND

2.1 RARE EARTHS AS STRATEGIC MINERAL RESOURCES

Rare earth elements (REEs) are strategic mineral resources due to their transversal application in sectors that are intensive in technology and innovation. Although they are not rare from a geological point of view, their economic exploitation is conditioned by mineralogical, geochemical and technological factors that make their individual separation and purification difficult, significantly increasing production costs (Abrão, 1994; Castor & Hedrick, 2006). The chemical similarity resulting from lanthanide contraction imposes relevant metallurgical challenges, requiring sophisticated technological routes to obtain oxides and metals of high purity, an indispensable condition for advanced industrial applications (Gupta & Krishnamurthy, 2005).

The strategic importance of rare earths has intensified in recent decades due to the energy transition, the digitalization of the economy and the growth of so-called green industries. Permanent magnets, catalysts, batteries, optical and electronic components illustrate the centrality of these elements for production chains considered critical to the economic and technological security of national states (Chakmouradian & Wall, 2012; Haque et al., 2014). In this context, the high concentration of global production and refining, historically led by China, reinforced the geopolitical character of rare earths, transforming them into instruments of economic and technological power.

In Brazil, although reserves are significant, the country's insertion in the global value chain remains limited, focusing mainly on the extraction and export of raw materials or low value-added products. Such a scenario reveals a dissociation between geological potential and technological capacity, configuring a pattern of dependence that compromises industrial and technological sovereignty (DNPM, 2014; Souza, Nascimento & Giese, 2019).

2.2 MINAS GERAIS AND THE TECHNOLOGICAL POTENTIAL OF RARE EARTHS

Minas Gerais occupies a central position in the geography of rare earths in Brazil, housing important deposits associated with alkaline and alkaline-carbonatite complexes, such as Araxá and the Poços de Caldas Plateau, as well as occurrences in ionic adsorption clays and mineral tailings that can be reused. Technological characterization studies show that these geological environments have relevant potential, but require high technical mastery to make their exploration economically viable (Antoniassi, 2017).

The literature points out that the main rare earth bearing minerals in the Brazilian territory include monazite, bastnasite, xenotime, and ionic adsorption clays, each with specific challenges related to radioactivity, low grade, mineralogical complexity, and environmental

impacts (Abrão, 1994; Haque et al., 2014). Because of these limitations, conventional extraction methods, based predominantly on energy-intensive hydrometallurgical routes and chemical reagents, present economic and environmental constraints, especially for low-grade ores (Gupta & Krishnamurthy, 2005).

In this context, recent advances in biotechnology applied to mining have been pointed out as promising alternatives. Bioleaching and biosorption techniques, based on the action of microorganisms and organic metabolites, have demonstrated potential for the recovery of rare earths from mineral matrices and residues, with lower energy consumption and lower environmental impact (Barmettler et al., 2016; Amin et al., 2014; Brisson et al., 2015). Studies conducted in Brazil indicate significant recovery efficiencies, especially in processes involving monazite, clays, and industrial waste, reinforcing the role of technological innovation in the sustainable viability of the production chain (Souza, Nascimento & Giese, 2019)

2.3 INDUSTRIAL PROPERTY, INNOVATION AND TECHNOLOGICAL SOVEREIGNTY

The transformation of strategic mineral resources into lasting competitive advantages depends, fundamentally, on the ability to generate, protect and exploit technological knowledge. In this sense, industrial property assumes a central role by guaranteeing temporary exclusivity over inventions, processes and industrial applications, encouraging investments in research, development and innovation. Law No. 9,279/1996, by disciplining invention patents and utility models, constitutes an essential legal instrument for the protection of intangible assets associated with the rare earth chain.

In the mineral sector, protection through industrial property does not focus on the natural resource itself, but on the technological processes that enable its efficient, sustainable and economically competitive exploitation. Innovative routes for processing, separation, purification, bioleaching, biosorption and development of advanced materials are strategic assets that can be protected, whose misappropriation can compromise national technological autonomy. Thus, the absence of intellectual protection strategies tends to perpetuate the country's peripheral position in the global value chain, while their adoption strengthens technological and industrial sovereignty.

From this perspective, technological sovereignty is not limited to the availability of natural resources, but involves the ability to control critical technologies, retain economic value, and guide territorial development strategically. In the case of Minas Gerais, the articulation between geological potential, technological innovation and protection via industrial property is fundamental to break with the traditional extractive model and promote a more qualified insertion of the state and the country in the knowledge economy.

This article aims to analyze the role of the **Industrial Property Law (Law No. 9,279/1996)** as an instrument of **technological sovereignty**, based on the case of **rare earths in Minas Gerais**, considering the strategic relevance of these elements for technology- and innovation-intensive production chains. Initially, it seeks to characterize rare earths as strategic mineral resources, highlighting their chemical properties, industrial applications and geopolitical importance, according to the specialized literature (Abrão, 1994; Chakmouradian & Wall, 2012; Haque et al., 2014).

Next, it is intended to examine the geological and technological potential of rare earth occurrences in the territory of Minas Gerais, with emphasis on alkaline and alkaline-carbonatitic complexes and the technical limitations associated with their economic use (Antoniassi, 2017; Souza, Nascimento & Giese, 2019).

The study also aims to discuss the main technological challenges related to the processes of extraction, separation and purification of these elements, including the emerging role of hydrometallurgical and biohydrometallurgical routes as more sustainable alternatives (Amin et al., 2014; Barmettler et al., 2016).

Finally, it seeks to evaluate the importance of protecting innovations associated with the rare earths production chain through industrial property, showing how the adoption of technological protection strategies can contribute to the reduction of external dependence, the aggregation of value to the mineral resource and the strengthening of technological sovereignty and territorial development in Minas Gerais.

The Role of the Geological Survey of Brazil in the Identification and Valuation of the Potential of Rare Earths and Strategic Minerals

The **Geological Survey of Brazil (SGB)** has played a central role in the production of the geoscientific knowledge necessary to guide public policies, investments and development strategies related to strategic mineral resources, especially **rare earths**. According to a note released by the SGB itself in 2025, Brazil holds about **23% of the world's reserves of rare earths**, estimated at approximately 21 million tons, positioning itself as one of the main global holders of these critical elements, although national production remains extremely limited, with about 20 tons produced in 2024, representing less than 1% of world production that year (SGB, 2025).

This diagnosis highlights one of the main challenges for the implementation of a strategic mineral policy: the discrepancy between the **abundant geological potential and the technological and institutional capacity to transform this potential into production and competitive added value**. The SGB CEO emphasizes that it is necessary to expand the geological knowledge of the national territory and "transform the enormous geological

potential of strategic mineral resources into exploitable and well-known mineral reserves", overcoming technological, logistical and infrastructure limitations (Brasil Mineral, 2025).

Within this agenda, the SGB conducts systematic geological mapping research and evaluation of occurrences in several Brazilian states, including programs such as the evaluation of potentials in unprecedented areas, for example, in **the Parnaíba Basin**, where dozens of new occurrences associated with rare earth elements and uranium were identified, indicating additional possibilities for expanding Brazilian mineral knowledge.

Other efforts include initiatives in Goiás, Tocantins, Bahia, Paraná, São Paulo, Amazonas, Roraima, Rondônia, Pará, and Piauí, as part of projects that aim to identify and characterize promising mineralogical regions in different geological frameworks, expanding the database necessary for public and private decision-making.

The SGB's work also includes the production of collaborative technical reports, such as the publication "Brazil's role in the Global Agenda for Critical and Strategic Minerals", the result of a partnership with institutions such as CEBRI, IBRAM, CETEM and Cenergia (Coppe/UFRJ). This report combines analysis of national demand, supply potential, and the positions that the country can occupy in the energy transition and in global supply chains, reinforcing the need to diversify the supply and processing of critical minerals as a way to reduce geopolitical risks and strengthen Brazil's presence in strategic markets, Mineral Connection (2025).

These geoscientific efforts assume crucial relevance when articulated with the broader normative and public policy debate, especially in light of legislative initiatives such as the National Policy on Critical and Strategic Minerals, approved by the Economic Affairs Commission (CAE) of the Federal Senate, which aims to establish guidelines for the processing and internal industrialization of these minerals. In this sense, the data produced by the SGB will not only subsidize the formulation of more robust mineral policy instruments, but will also guide the allocation of resources for research, technological development and institutional training, essential elements to convert mineral potential into national productive and technological competences.

In addition, the ability to map occurrences and characterize deposits in different geological contexts contributes directly to territorial governance, by providing information that allows balancing the interests of economic development, environmental protection and social inclusion. This process is essential to ensure that the exploitation of rare earths occurs in a sustainable, responsible and integrated manner with regional development strategies that take into account local knowledge and the participation of affected communities.

As a whole, the performance of the Geological Survey of Brazil demonstrates that the production of geoscientific knowledge is an indispensable pillar for the formulation of effective public policies in the strategic mineral sector. By integrating cutting-edge research, detailed geological mapping, and information production for planning and decision-making, the SGB provides the necessary technical-scientific basis for Brazil to move towards broader technological sovereignty, reducing external dependence and expanding its participation in global critical mineral chains, in line with the environmental and technological challenges of the 21st century.

3 METHODOLOGY

This article adopts a **qualitative approach**, of an **exploratory and analytical-descriptive nature**, suitable for the investigation of complex phenomena that involve the articulation between strategic mineral resources, technological development and legal instruments for the protection of innovation. The choice of this approach is justified by the need to understand, in an integrated way, the geological, technological and institutional aspects related to rare earths in Minas Gerais, as well as the role of the Industrial Property Law in the promotion of technological sovereignty.

From the point of view of technical procedures, the research is based on a **bibliographic and documentary review**, carried out from national and international secondary sources. The literature review focused on classic and contemporary works on rare earth chemistry and technology, extractive metallurgy, biotechnology applied to mining, and economics of strategic mineral resources, with emphasis on the works of Abram (1994), Gupta and Krishnamurthy (2005), Castor and Hedrick (2006), Chakmouradian and Wall (2012), Haque et al. (2014), Antoniassi (2017) and Souza, Nascimento and Giese (2019). These studies provided the theoretical basis for understanding the chemical properties, the technological challenges of extraction and the recent trends of innovation in the rare earth production chain.

The documentary analysis included technical and institutional reports from public agencies and research centers, such as the National Department of Mineral Production/National Mining Agency, the Center for Mineral Technology (CETEM) and specialized publications that deal with the reserves, production and technological challenges associated with rare earths in Brazil, with emphasis on the state of Minas Gerais. Normative and legal documents were also examined, especially **Law No. 9,279/1996 (Industrial Property Law)**, in order to identify the legal protection mechanisms applicable to technological innovations developed in the field of mining and mineral processing.

The spatial focus of the research is concentrated in the **state of Minas Gerais**, due to its geological and strategic relevance in the Brazilian context of rare earths, especially with regard to the alkaline and alkaline-carbonatitic complexes and the recent initiatives of technological characterization and reuse of mineral waste. Such a delimitation allows for a more in-depth analysis of the relationship between territory, natural resources and innovation policies.

The analysis of the collected data was carried out through **qualitative content analysis**, seeking to identify convergences, gaps and tensions between the existing geological potential, the stage of technological development of the extractive routes and the legal framework for the protection of industrial property. This analysis made it possible to discuss how the protection of technological innovations associated with rare earths can contribute to the aggregation of value to the mineral resource, to the reduction of external dependence and to the strengthening of technological sovereignty.

The recent literature on rare earths in Brazil has emphasized the existence of a "Brazilian paradox", characterized by the coexistence between an expressive geological endowment and a still incipient production, especially with regard to the higher value-added stages of the production chain. In this sense, Júlio Edstron Secundino Santos has highlighted that, although Brazil is among the countries with the largest known reserves of rare earths, its insertion in global chains remains limited to the export of raw materials or low-processing products, which compromises the strategic use of these elements in the context of energy transition and sustainable development. This reading reinforces the idea that mineral abundance, by itself, does not automatically translate into technological sovereignty, and that it is necessary to articulate industrial policies, innovation and knowledge protection.

In addition, Fernando Landgraf points out that the country has not only relevant natural resources, but also installed technical-scientific capacity, capable of sustaining more ambitious strategies for the rare earths sector. For the author, the central challenge lies in overcoming institutional, regulatory and coordination obstacles between public and private actors, in order to transform geological wealth into a competitive industrial base. This perspective dialogues directly with the notion of long-term strategic planning defended by contemporary science, technology, and innovation policies.

In the field of applied technology, the work of André Nunis, a researcher at the Institute for Technological Research (IPT), shows concrete advances in the construction of a national chain for the production of permanent magnets made of rare earths, such as the MAGBS project. These initiatives demonstrate that Brazil already has the technical competence to advance in strategic segments of the production chain, especially those associated with the

high-tech industry, such as electric motors, renewable energy generation and electric mobility. The existence of these projects reinforces the importance of protection via industrial property, as a way to safeguard the knowledge generated and avoid its external appropriation.

From a sociopolitical perspective, Elaine Santos, in an article published in *Jornal da USP* in December 2025, analyzes the debate on rare earths in light of structural inequalities and the risks of reproduction of a primary-export model. The author draws attention to the need to incorporate social, environmental, and territorial criteria into mineral exploration strategies, preventing the race for critical minerals from reinforcing regional asymmetries and compromising the rights of local communities. This approach broadens the technical debate by incorporating sociological and institutional dimensions into the discussion on technological sovereignty.

In the field of geological research, teams linked to federal universities such as UFSM, UFRGS and Unipampa, in Rio Grande do Sul, and the Federal University of Roraima have identified new occurrences and relevant concentrations of rare earths in different geological contexts. These studies reinforce the role of public research institutions in expanding national geoscientific knowledge and reducing exploratory uncertainties, an essential element for the strategic planning of the mineral sector and for the formulation of evidence-based public policies.

At the international level, recent research has also contributed to deepening the understanding of the technological and geopolitical challenges associated with rare earths. Juan Diego Rodriguez-Blanco and Melanie Maddin of Trinity College Dublin published in 2024 a study that revisits the formation models of bastnäsite, one of the main rare earth bearing minerals, demonstrating the complexity of the geochemical processes involved and questioning previously accepted simplified models. These scientific advances reinforce the idea that the technological mastery of the rare earth chain depends on frontier research and the constant updating of geological and metallurgical models.

The geopolitical dimension of the topic is widely discussed by Kalim Siddiqui, who, in a 2025 report, analyzes the emerging tensions around critical minerals and rare earths, with emphasis on the high concentration of supply and processing in China. The author argues that this concentration generates strategic vulnerabilities for import-dependent countries, intensifying trade disputes and encouraging national policies of reindustrialization and security of supply, a scenario in which Brazil occupies a potentially strategic position, as long as it advances in policies of value addition and innovation.

Additionally, international studies in the area of ecotoxicology, conducted by authors such as R. R. Samal, Ź. Arciszewska, C. Figueiredo and M. Andrade, have evidenced the

environmental impacts associated with the dispersion of rare earths in aquatic ecosystems and their interaction with biomacromolecules. These works reinforce the need for environmentally responsible extraction and processing technologies, as well as regulatory frameworks capable of mitigating socio-environmental risks, a central aspect for the social legitimacy of mineral policies.

Finally, strategic reports prepared by authors such as Karl Friedhoff, from the *Chicago Council on Global Affairs*, and by institutions such as the International Energy Agency (IEA) and the London School of Economics (LSE) highlight that the future of the global rare earths market will depend on the diversification of supply chains, the strengthening of national industrial policies, and continuous investment in science, technology and innovation. These analyses converge in pointing out that countries endowed with mineral resources, such as Brazil, will only be able to occupy a relevant position in this scenario if they are able to articulate scientific knowledge, legal protection, strategic planning and territorial governance.

The methodology adopted allowed the integration of different fields of knowledge geosciences, mineral technology, biotechnology and industrial property law in an interdisciplinary way, consistent with the objectives of the study and with the level of depth required in a scientific academic article.

Legislative Advances in the National Policy on Critical and Strategic Minerals Implications for Rare Earths and Technological Sovereignty

On December 9, 2025, the **Committee on Economic Affairs (CAE)** of the Federal Senate approved the report that establishes the **National Policy on Critical and Strategic Minerals**, through the substitute for *Bill No. 4443/2025*, authored by Senator Renan Calheiros, with a favorable opinion from the rapporteur Senator Esperidião Amin (PP-SC). This approval represents a relevant institutional milestone for the development of the strategic minerals chain in Brazil, including rare earth elements, and reaffirms the need for structured public policies that promote the aggregation of value, mineral processing in the national territory and the security of the national industry in the face of contemporary geopolitical challenges (SENADO FEDERAL, 2025).

The proposal approved in the CAE provides for instruments aimed at stimulating the processing and industrialization of critical minerals in the country, with the determination that a relevant part of the ore extracted, such as **up to 80% of rare earths, be processed and industrialized in Brazilian territory**, as a way to **ensure control over mineral wealth and prevent the export exclusively of raw inputs** (FEDERAL SENATE, 2025).

This requirement for national processing directly articulates the technical-legal debate on the importance of transforming mineral resources into **technologies, processes and**

products with higher added value, overcoming a historical pattern of commodity exports and reinforcing the **country's technological and industrial sovereignty**.

The substitute also includes the periodic updating of the **Brazilian List of Critical and Strategic Minerals**, the creation of **Mineral Transformation Processing Zones (ZPTMs)**, specific tax and credit incentives, financing mechanisms, public-private partnerships and research consortia, all interpreted as indispensable instruments to promote technological innovation and competitiveness of the mineral sector (FEDERAL SENATE, 2025). These instruments align with recent debates that advocate the need **for long-term strategic planning for critical minerals**, integrating research and development (R&D), technological capacity building, and industrial policies that go beyond simple geological exploitation, promoting **sustainable and inclusive innovation strategies**.

In addition, the proposition approved in the CAE amends provisions of **the Mining Code** with the objective of accelerating the return of unexplored areas and reducing speculative mechanisms for withholding mining rights, which may contribute to a more efficient and transparent territorial governance structure, reducing administrative obstacles and promoting greater predictability for mining and industrial transformation projects (FEDERAL SENATE, 2025). This regulatory dimension reinforces the importance of a legal framework that articulates **strategic planning, governance, and sustainability**, creating conditions for Brazil to develop technological and productive competencies essential to the twenty-first century.

From a political-institutional point of view, the approval of the substitute by the Senate is part of a broader context of public policy formulation that recognizes the role of critical minerals in the **energy transition, economic security, and the dispute over global value chains**. The agenda reflects not only national interests, but also international pressures and expectations regarding Brazil's positioning as a reliable and sustainable supplier of strategic minerals for advanced technologies, contributing to overcoming structural vulnerabilities and external dependencies already identified in the rare earths sector (BNAMERICAS, 2025).

Finally, the approval in the CAE indicates a significant advance for the implementation of a **regulatory framework that combines control of natural resources with stimulation of technological innovation and legal protection of innovative processes**, elements that, when articulated with instruments such as the **Industrial Property Law**, have the potential to transform the competitiveness profile of the Brazilian mineral sector. By promoting domestic industrialization and encouraging the development of extraction, processing and recycling technologies, including in synergy with socio-environmental sustainability

measures, this National Policy signals a concrete unfolding of the debate on **technological sovereignty, value aggregation and sustainable territorial development** in Brazil.

4 RESULTS AND DISCUSSION

A critical reading of the bibliographic and documentary set analyzed allows us to affirm that the "strategic value" of rare earths does not derive only from the existence of deposits, but above all from the ability to **convert geological potential into technological competence**, with institutional, environmental and legal support. In practical terms, this means that the Brazilian comparative advantage tends to remain incomplete as long as the country does not robustly master the stages of **concentration, separation, purification and transformation** into industrial inputs (oxides and metals) and, mainly, into **goods with higher added value**, such as alloys and permanent magnets, critical components for the energy transition (ABRÃO, 1994; CASTOR; HEDRICK, 2006; CHAKMOURADIAN; WALL, 2012; HAQUE et al., 2014).

From a technical point of view, the literature confirms that a relevant part of the cost and industrial risk is associated with the very nature of REEs: the similarity of chemical behavior between lanthanides linked to lanthanide contraction imposes complex separation and refining routes, usually intensive in energy and reactants, with direct effects on economic viability and environmental control requirements (ABRÃO, 1994; GUPTA; KRISHNAMURTHY, 2005).

This finding is particularly relevant for Minas Gerais, whose importance stands out for deposits associated with alkaline and alkaline-carbonatitic complexes (such as Araxá) and for mineralogical and metallogenetic contexts that require detailed characterization to guide technological and economic decisions (ANTONIASSI, 2017; TRAVERSA et al., 2001; NEWMANN; MEDEIROS, 2015; ISSA FILHO; LIMA; SOUZA, 1984).

In this context, a central interpretative result of the study is the identification of a **"middle of the chain" bottleneck** in Brazil: even if there are relevant reserves, the consolidation of a national chain depends less on the mining itself and more on the industrial domain of processing and separation, as well as on the creation of transformation capacities into strategic products.

This gap helps to explain the "paradox" reiterated in the recent literature: **geological opulence coexisting with low industrial production and external dependence**, especially in the technological stages with the highest density of knowledge (DNPM, 2014; SOUZA; NASCIMENTO; GIESE, 2019).

In the field of technological alternatives, the findings discussed reinforce that conventional routes do not need to be abandoned, but **complemented and modernized** by solutions with less impact and greater efficiency.

The reviewed literature indicates that biohydrometallurgical routes such as **bioleaching and biosorption** have been gaining ground due to their potential to reduce energy consumption and chemical load, in addition to increasing the feasibility of using low-grade and waste matrices, bringing mining closer to a circular economy logic (AMIN et al., 2014; BARMETTLER et al., 2016; BRISSON; ZHUANG; ALVAREZ-COHEN, 2015; SOUZA; NASCIMENTO; GIESE, 2019).

In this sense, the discussion points out that technological innovation is not only an "efficiency improvement", but a structuring element to reconcile competitiveness with sustainability, especially in scenarios where environmental and social aspects influence access to markets and financing.

Still in this axis, the research shows that the **recycling of REEs** tends to consolidate itself as an inevitable strategic dimension. Recovery from industrial waste, electrical and electronic equipment and permanent magnets can reduce vulnerabilities related to external volatility and geopolitical asymmetries of supply, functioning as a complement to primary mining and as a vector of innovation in separation processes.

The absence of a robust and coordinated national policy for rare earth recycling emerges as a relevant institutional weakness, as it limits the construction of resilient chains and hinders the use of urban mining as a technological-industrial asset.

At the institutional and informational level, the analysis of the role of the Geological Survey of Brazil (SGB) shows that **geoscientific knowledge is a strategic infrastructure of the State**. By disclosing estimates and clarifying the mismatch between reserves and production, the SGB supports an evidence-based public policy agenda, drawing attention to the need to transform geological potential into technically known and economically exploitable reserves, overcoming technological, logistical and infrastructure limitations (SGB, 2025; BRASIL MINERAL, 2025; MINERAL CONNECTION, 2025). For Minas Gerais, this reinforces the importance of integrating mapping, mineralogical characterization and technological evaluation as preconditions to reduce uncertainties and guide choices about processing routes and industrial projects.

The legal-institutional dimension appears as a decisive vector of the results: **Law No. 9,279/1996** becomes especially relevant because the capture of value in rare earths occurs, to a large extent, in the sphere of **processes** (separation, purification, hydrometallurgical and

biohydrometallurgical routes), **advanced materials** (alloys, magnets, catalysts) and **industrial applications**. that is, in the domain of codifiable and securable knowledge.

The discussion indicates that the absence of industrial property strategies tends to perpetuate technological dependencies, while their adoption creates conditions for value retention, investment attraction, and strengthening of the national capacity for innovation and technology transfer.

At this juncture, the results of the study gain political density by dialoguing with the recent legislative agenda. The approval, in the CAE of the Federal Senate, of the report that establishes the National Policy on Critical and Strategic Minerals (within the scope of the substitute for PL No. 4,443/2025) signals a relevant inflection: the policy proposes instruments to stimulate processing and industrialization in the national territory and explains the guideline to expand the internal processing of critical minerals, articulating incentives, processing zones, financing mechanisms, and periodic updating of the list of strategic minerals (FEDERAL SENATE, 2025).

In analytical terms, it is a movement that tries to shift Brazil from a predominantly primary-export position to an **industrialization strategy guided by technological sovereignty**, capable of internalizing stages of greater added value.

In addition, the provision of regulatory adjustments, including measures aimed at rationalizing the use of mining areas and addressing speculative retentions, tends to directly influence the governance of the sector and the predictability of industrial and ST&I projects, a central aspect when it comes to critical minerals, whose attractiveness depends on institutional stability and long-term planning (FEDERAL SENATE, 2025).

The debate also connects to international pressures for safe and sustainable supply chains, in which Brazil is often seen as a potential supplier of strategic minerals; this expectation can be an opportunity (investment attraction) or a risk (reprimarization), depending on the institutional design and the degree of domestic value added (BNAMERICAS, 2025).

Thus, the discussion converges on a key point: it is not enough to "have" rare earths; it is necessary to govern them as a State policy, articulating a robust geoscientific base, a ST&I agenda oriented to the bottlenecks of separation, refining, recycling and development of advanced materials, economic and regulatory instruments capable of encouraging internal industrialization, a consistent industrial property strategy to protect and scale the knowledge generated, and territorial governance that reduces conflicts, distribute benefits and strengthen regional capacities, especially in Minas Gerais.

Why the Immediate Environmental Licensing of Rare Earths in Minas Gerais is a Wrong Decision

The repeated postponement of the vote on the environmental licensing of large rare earth exploration projects in Minas Gerais reveals more than mere procedural obstacles: it exposes structural weaknesses in the decision-making model adopted for the management of a strategic mineral resource whose exploitation involves environmental, social and technological risks that are still insufficiently understood in the Brazilian context. In this sense, within the scope of Civil Inquiry No. 1.22.000.004558/2022-65, the Federal Public Prosecutor's Office issued MPF/MG Recommendation No. 30, of September 3, 2025, directing the competent state agencies, notably the State Secretariat for the Environment and Sustainable Development, the State Environmental Foundation and the State Council for Environmental Policy to suspend the analysis of the environmental licensing processes related to the Colossus projects, in Poços de Caldas, and Caldeira, in the municipality of Caldas. The recommendation was based on the insufficiency of independent technical studies and the need to deepen the analysis of the potential environmental and social impacts of these projects, whose complexity goes beyond the parameters ordinarily used in licensing processes.

The MPF's action is expressly anchored in the precautionary principle, according to which the absence of scientific certainty cannot be invoked as a justification for the adoption of decisions potentially causing serious or irreversible damage. Among the concerns highlighted in the inquiry and the recommendation are the environmental and nuclear risks associated with the extraction of rare earths often linked to the presence of radioactive elements, as well as the water impacts resulting from the movement of large volumes of clay and the use of chemical leaching techniques. Such practices can compromise strategic aquifers, such as the Poços de Caldas Alkaline Aquifer, the main source of supply in the region, in addition to producing cumulative effects on ecosystems interconnected to the Atlantic Forest biome. In addition, the MPF highlighted the possibility of violation of the right to prior, free and informed consultation of potentially affected traditional peoples and communities, in line with grounds already adopted in similar recommendations involving lithium mining in Minas Gerais. Notwithstanding the clarity of the ministerial orientation, the maintenance of some of these processes on the Copam voting agenda generated institutional controversies and successive decision-making postponements, evidencing tensions between the logic of economic acceleration and the constitutional requirements of environmental protection and collective rights. (RÁDIO DA FAMÍLIA, 2025).

In addition, factors such as the proximity of deactivated nuclear areas such as the Caldas Decommissioning Unit (UDC) of Indústrias Nucleares do Brasil and the absence of broad participation of local populations, including traditional communities, aggravate the complexity of the licensing process. The MPF also pointed out the need for regionalized studies and the performance of a Strategic or Integrated Environmental Assessment for the Poços de Caldas Plateau, instead of a fragmented licensing focused on isolated projects, which does not capture the synergistic effects of multiple mining operations in the same region (RACISMO AMBIENTAL, 2025).

The attempt to move quickly with licensing represents a mistake from an environmental, social and territorial governance point of view, as it underestimates the complexity of the risks involved and ignores the importance of a more robust and transparent deliberative process. Permit approval is mistakenly assumed to be a mere bureaucratic step, when in fact it can trigger lasting impacts on water quality, local biodiversity, public infrastructure, and the livelihoods of communities directly affected.

From a strategic point of view, this stance also ignores what economic analysts emphasize about the sector: the central challenge for Brazil is not only the release of areas for exploration, but the sustainable and technological transformation of reserves into an effective supply of strategic products. As highlighted in recent analyses, the country's main difficulty in converting its high geological potential into concrete economic or technological power does not stem from legal restrictions on foreign access or concession per se, but from gaps in processing technology, refining, integrated industrial policy, and investment in innovation (CNN Brasil, 2025)

Moving forward in a hasty manner with exploration licenses, without a solid scientific basis, effective environmental monitoring mechanisms, guarantees of broad consultation with affected populations and clear strategies for mitigating cumulative impacts, can result not only in significant environmental damage, but also in socioeconomic costs that burden the State and weaken the legitimacy of mineral public policies. The example of Minas Gerais illustrates that the race for rare earths cannot be treated as an end in itself, but must be articulated with agendas of sustainable development, technological sovereignty and respect for the constitutional principles of protection of the environment and the rights of traditional communities.

In short, the decision to repeatedly postpone environmental licensing reflects not only the necessary prudence in the face of scientific uncertainties, but also the need to rethink the way Brazil and Minas Gerais in particular equate the exploration of critical minerals with the

protection of environmental, social and territorial assets. Without this balance, hasty licensing policies can become more of a strategic mistake than a lever for development.

In short, the repeated postponement of environmental licensing for the exploration of rare earths in Minas Gerais should not be interpreted only as an administrative obstacle, but as an indication of the need to rethink, in a structural way, the model adopted for the management of critical minerals in Brazil. The hasty granting of licenses, dissociated from technological, institutional and strategic criteria, tends to reproduce a historical pattern of primary exploitation, with high environmental and social risks and with limited capacity to retain value in the territory.

In this context, licensing, when treated as a mere authorizing instrument, can become a strategic error, as it favors the immediate exploitation of resources without guaranteeing counterparts in terms of innovation, industrialization and regional development.

Geopolitics of Strategic Resources: The Attack on Venezuela and the Impacts on the Global Oil and Rare Earths Market

The intensification of geopolitical tensions involving Venezuela, especially after the political, economic, and diplomatic offensive conducted by the United States starting in 2025 and deepening in early 2026, highlights the centrality of strategic natural resources in the contemporary reorganization of global value chains. Although the international debate has focused predominantly on the immediate effects on the global oil market, recent analyses indicate that the consequences of this conflict go beyond the energy sector, also reaching critical minerals, such as rare earths, essential inputs for the energy transition, the high-tech industry, and defense systems (G1, 2026).

Venezuela holds one of the largest oil reserves in the world and occupies a historical position of relevance in global energy geopolitics. The adoption of unilateral measures and external offensive actions, often justified under discourses of hemispheric security and resumption of regional influence – associated with the so-called Monroe Doctrine – caused instability in international energy markets. As a result, there was an increase in oil prices, an increase in volatility, and an increase in the perception of systemic risk, leading large economies to reinforce strategies for diversifying suppliers and supply routes, with emphasis on China's strategic repositioning in the face of the uncertainty scenario (G1, 2026; AGÊNCIA BRASIL, 2025).

According to financial market analyses, the U.S. offensive against Venezuela has also produced relevant indirect effects on peripheral and emerging economies, including Brazil. The increase in global uncertainty impacted investment flows, exchange rates, commodity prices, and industrial expectations, reinforcing the vulnerability of countries dependent on the

import of strategic inputs and the export of primary products (INFOMONEY, 2026). These chain effects show how geopolitical shocks in the energy sector tend to radiate impacts to other strategic segments of the global economy.

In this context, rare earths assume an increasingly sensitive role in international geopolitical dynamics. Like oil, these elements are not only strategic because of their geological existence, but above all because of the technological and political control of the critical stages of their production chain. The global concentration of beneficiation, separation, purification, and industrial application activities confers significant geoeconomic power to countries that master these technologies, making the others vulnerable to supply interruptions, trade pressures, and exogenous geopolitical decisions. The instability observed in Venezuela, added to global trade and technological disputes, reinforces the trend of securitization of critical mineral chains, bringing them closer and closer to the logic historically applied to oil (AGÊNCIA BRASIL, 2025).

For Brazil, and particularly for Minas Gerais, this international scenario works as a strategic alert. The historical dependence on primary-export models, associated with the fragility in the protection of innovation and the absence of integrated industrial policies, creates the risk of reproduction, in the rare earths sector, of the same logic of structural vulnerability observed in the Latin American oil market. The pressure for accelerated environmental licensing, dissociated from institutional, technological, and legal strengthening, tends to insert the country in a subordinate way in global value chains, promoting the transfer of knowledge, added value, and decision-making power to external actors (INFOMONEY, 2026).

Thus, the offensive against Venezuela should not be interpreted only as an isolated episode in energy geopolitics, but as a clear indication that strategic resources – are not the only ones – to be seen in the country. In this context, the articulation between mineral policy, technological innovation, and intellectual property protection emerges as an indispensable element to break historical cycles of dependence, allowing countries rich in natural resources to advance to higher stages of the value chains and reduce their exposure to external shocks and geopolitical decisions alien to their national interests

In light of the geopolitical scenario analyzed, especially the international tensions unleashed around Venezuela and their repercussions on global markets for strategic oil and minerals, this article argues that the technological sovereignty associated with rare earths should be conceived as an integrated and strategically oriented institutional arrangement.

In this arrangement, environmental licensing ceases to be a merely authorizing instrument and starts to play an inductive function, articulating with specific mechanisms for

the protection of the national interest. Such mechanisms include the requirement of processing and adding value in the national territory, the protection of innovations through industrial property instruments, the strengthening of territorial governance and the definition of safeguards capable of avoiding the exclusive appropriation of these resources by foreign capital. Only from an approach that transcends the traditional extractivist logic and that subordinates mineral exploration to clear industrial, scientific and technological policy objectives will it be possible to convert rare earths into structuring platforms for sustainable industrial, scientific and territorial development, compatible with a long-term project of national sovereignty and less vulnerable to external geopolitical shocks.

5 CONCLUSION

The analysis developed throughout this article shows that the debate on rare earths in Minas Gerais and in Brazil more broadly goes beyond the limits of geology and mining activity, inserting itself in the strategic core of science, technology, innovation and national sovereignty policies. In an international scenario marked by the intensification of geopolitical disputes, instability in global supply chains and high technological concentration, the mere availability of mineral reserves, although relevant, is insufficient to ensure technological autonomy, economic security or long-term development.

The results obtained indicate that the main Brazilian challenge lies in the ability to convert geological potential into endogenous technological and industrial skills. Such conversion presupposes mastery of the most sensitive and strategic stages of the rare earths chain: processing, separation, purification, recycling and the development of advanced industrial applications in which most of the added value and geoeconomic power is concentrated.

In this sense, technological innovation, including the development of advanced hydrometallurgical routes and biohydrometallurgical alternatives, emerges as a structuring element to reconcile economic competitiveness, environmental sustainability and reduction of external vulnerabilities.

The discussion also demonstrates that the governance of critical minerals cannot be dissociated from the legal-institutional framework. The Industrial Property Law plays a central role in the protection of the knowledge generated, in the prevention of the misappropriation of strategic technologies and in the creation of conditions for the retention of value in the national territory. The protection of innovations associated with rare earths shifts the axis from the exploitation of simple access to natural resources to the control of critical technologies, configuring itself as an indispensable pillar of a strategy of technological sovereignty.

At the political-institutional level, recent advances related to the National Policy on Critical and Strategic Minerals represent a relevant inflection in the Brazilian public agenda. However, the study maintains that such initiatives will only be effective if accompanied by robust coordination mechanisms between the Union, states and municipalities, by clear requirements for the aggregation of local value and by instruments capable of avoiding the exclusive capture of these resources by external interests. In this context, environmental licensing should not be understood only as an authorizing procedure, but as a strategic tool to induce technological development, innovation and sustainable territorial planning.

Finally, it is concluded that the construction of a consistent policy for rare earths in Minas Gerais requires an integrated and prospective approach, capable of articulating geoscientific knowledge, technological innovation, legal protection, territorial governance and long-term strategic planning. Only from this integration will it be possible to transform rare earths from a finite and vulnerable mineral asset into a structuring vector of industrial, scientific and sustainable development, aligned with national interests, technological sovereignty and the economic, environmental and geopolitical requirements of the 21st century.

ACKNOWLEDGMENTS

The author thanks the **State University of Minas Gerais (UEMG)**, especially the **Professional Master's Program in Intellectual Property and Technology Transfer for Innovation (PROFNIT)**, for the academic environment of excellence and for the critical and interdisciplinary training provided throughout the course. It is worth noting, in particular, the recognition of the **UEMG Graduate Scholarship Program (ProBPG/UEMG)** for the educational incentive granted, whose financial support was fundamental for the dedication to research, study and scientific production activities. The funding offered contributed decisively to the development of this work, reaffirming the role of public policies to support graduate studies in the promotion of science, innovation and qualified training of human resources.

REFERENCES

- Abrão, A. (1994). Química e tecnologia das terras-raras. CETEM/MCTIC.
- Agência Brasil. (2025, outubro). Ação dos EUA na Venezuela é precedente perigoso, dizem analistas. <https://agenciabrasil.ebc.com.br/internacional/noticia/2025-10/acao-dos-eua-na-enezuela-e-precedente-perigoso-dizem-analistas>

- Amin, M. M., et al. (2014). Fungal leaching of rare earth elements from lower carboniferous shales, southwestern Sinai, Egypt. *Romanian Journal of Biophysics*, 24(1), 25–41.
- Antoniassi, J. L. (2017). Caracterização tecnológica de recursos minerais de terras raras em complexos alcalinos e alcalino-carbonatíticos do Brasil [Tese de doutorado, Universidade de São Paulo].
- Barmettler, F., et al. (2016). Microbial mobilization of rare earth elements (REE) from mineral solids – A mini review. *AIMS Microbiology*, 3(2), 190–204.
- BNamericas. (2025). Brazil considers policies to strengthen critical minerals processing. <https://www.bnamericas.com/>
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. https://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (1996). Lei nº 9.279, de 14 de maio de 1996. Regula direitos e obrigações relativos à propriedade industrial. Presidência da República. https://www.planalto.gov.br/ccivil_03/leis/l9279.htm
- Brasil. (2025). Projeto de Lei nº 4.443, de 2025. Institui a Política Nacional de Minerais Críticos e Estratégicos. Senado Federal.
- Brasil Mineral. (2025). SGB afirma que Brasil tem cerca de 23% das reservas mundiais de terras raras. <https://www.brasilmineral.com.br/>
- Brisson, V. L., Zhuang, W. Q., & Alvarez-Cohen, L. (2015). Bioleaching of rare earth elements from monazite sands. *Biotechnology and Bioengineering*, 113(2), 339–348.
- Castor, S. B., & Hedrick, J. B. (2006). Rare earth elements. In *SME mining engineering handbook* (pp. 769–792). Society for Mining, Metallurgy and Exploration.
- Chakmouradian, A. R., & Wall, F. (2012). Rare elements: Minerals, mines, magnets (and more). *Elements*, 8(5), 333–340.
- CNN Brasil. (2025). Terras raras: Pragmatismo econômico vai além da Lei Magnitsky. <https://www.cnnbrasil.com.br/blogs/pedro-cortes/economia/macroeconomia/terras-raras-pragmatismo-economico-vai-alem-da-lei-magnitsky/>
- Conexão Mineral. (2025). O papel do Serviço Geológico do Brasil na agenda de minerais estratégicos como as terras raras. <https://www.conexaomineral.com.br/>
- Departamento Nacional de Produção Mineral. (2014). Sumário mineral 2014. DNPM. <http://www.dnpm.gov.br>
- G1. (2026, janeiro 3). Petróleo, China e Doutrina Monroe: O que está por trás da ofensiva de Trump na Venezuela. <https://g1.globo.com/economia/noticia/2026/01/03/petroleo-china-doutrina-monroe-o-que-esta-por-tras-da-ofensiva-de-trump-na-venezuela.ghtml>
- Giese, E. C. (2017). Biolixiviação: Uma avaliação das inovações tecnológicas na biomineração de minerais sulfetados no período de 1991 a 2015. *Tecnologia em Metalurgia, Materiais e Mineração*, 14(3), 192–203.

- Gupta, C. K., & Krishnamurthy, N. (2005). Extractive metallurgy of rare earths. CRC Press.
- Haque, N., et al. (2014). Rare earth elements: Overview of mining, mineralogy, uses, sustainability and environmental impact. *Resources*, 3(4), 614–635.
- InfoMoney. (2026). Ataque dos EUA à Venezuela eleva incerteza e traz efeitos para o mercado brasileiro, avalia estrategista. <https://www.infomoney.com.br/mercados/ataque-dos-eua-a-venezuela-eleva-incerteza-e-traz-3-efeitos-para-o-mercado-brasileiro-avalia-estrategista/>
- Issa Filho, A., Lima, P. R. A. S., & Souza, O. M. (1984). Aspectos da geologia do complexo carbonatítico do Barreiro, Araxá, MG. In *Complexos carbonatíticos do Brasil: Geologia* (pp. 20–44). CBMM.
- Newmann, R., & Medeiros, E. R. (2015). Comprehensive mineralogical and technological characterisation of the Araxá complex REE (Nb-P) ore. *International Journal of Mineral Processing*, 144, 1–10.
- Rádio da Família. (2025). MPF recomenda suspensão de votação sobre licenciamento para exploração de terras raras em MG. <https://www.radiodafamilia.com.br/>
- Racismo Ambiental. (2025, novembro 26). MPF recomenda a retirada de pauta de votação de processos de licenciamento sobre terras raras em MG. <https://racismoambiental.net.br/>
- Senado Federal. (2025, dezembro 9). CAE aprova política nacional para processamento de minerais críticos. Agência Senado. <https://www12.senado.leg.br/noticias>
- Serviço Geológico do Brasil. (2025). Serviço Geológico do Brasil esclarece dúvidas sobre potencial do país para terras raras e minerais estratégicos. <https://www.sgb.gov.br/>
- Souza, M., Nascimento, M., & Giese, E. C. (2019). Avaliação tecnológica e sustentabilidade na exploração de terras raras no Brasil. *HOLOS*, 35(1), Article e8274.
- Traversa, G., et al. (2001). Petrography and mineral chemistry of carbonatites and mica-rich rocks from the Araxá complex. *Anais da Academia Brasileira de Ciências*, 73, 71–98.

BRIQUETTES MADE FROM GREEN COCONUT HUSK FIBER – ENERGY AND SUSTAINABILITY

BRIQUETES DE FIBRA DA CASCA DO COCO VERDE – ENERGIA E SUSTENTABILIDADE

BRIQUETAS DE FIBRA DE CÁSCARA DE COCO VERDE – ENERGÍA Y SOSTENIBILIDAD



<https://doi.org/10.56238/sevened2026.008-018>

Juliana Zenóbia Costa Dias¹, Luciano Henrique Pereira da Silva², Klismeryane Costa de Melo³, Rafaela Alves Vicente Rodrigues da Silva⁴, Thiago dos Santos Azevedo Damasceno⁵, Roberto Rodrigues Cunha Lima⁶

ABSTRACT

The need to readjust energy production methods to reduce environmental impact involves the strategic use of biomass. Through biomass densification, which can be made up of agricultural waste, it is possible, using the briquetting technique, to obtain high-density blocks with a high degree of compaction, defined as briquettes. Briquettes are high-energy materials that can significantly contribute to the energy matrices of various countries. A proposal for the development of studies aimed at guaranteeing and optimizing the production of briquettes using green coconut husk residue mixed with crude glycerol (resulting from the biodiesel production process) could optimize the production of high-quality coated briquettes with a sustainable character. The proposal is based on studies already developed and found in the literature, in which green coconut fiber is collected, used in its natural state or transformed into charcoal by slow pyrolysis, mixed in predefined proportions with glycerol to obtain briquettes. The physicochemical properties of these briquettes are evaluated simultaneously with characterization tests, with the aim of determining an ideal proportion of the mixtures of the components involved that result in briquettes with better energy performance for specific applications. The development of proposals such as this implies a scientific contribution to the current energy transition process and can also solve local and/or regional problems related to the high production and inadequate disposal of green coconut husks. Although the demand for briquettes made from green coconut waste in Brazil and other coconut-producing

¹ Environmental Management Specialist. Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte. Rio Grande do Norte, Brazil. E-mail: c.zenobia@escolar.ifrn.edu.br

² Civil Engineer. Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte. Rio Grande do Norte, Brazil. E-mail: henriqueluciano.albino@gmail.com

³ Dr. in Chemical Engineering. Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte. Rio Grande do Norte, Brazil. E-mail: klismeryane.costa@ifrn.edu.br

⁴ Master's degree in Chemical Engineering. Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte. Rio Grande do Norte, Brazil. E-mail: rafaela.alves@ifrn.edu.br

⁵ Master's degree in Business Administration. Universidade Federal do Rio Grande do Norte. Rio Grande do Norte, Brazil. E-mail: thiagotos@gmail.com

⁶ Dr. in Materials Science and Engineering. Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte. Rio Grande do Norte, Brazil. E-mail: roberto.lima@ifrn.edu.br

regions is influenced by several factors, its market potential in the industrial, commercial, and residential sectors can be considered. Although it is challenging to precisely quantify the current demand for green coconut waste briquettes in Brazil without access to specific market data, the significant potential for growth in this demand is evident, driven by the need for low-carbon energy sources, sustainability, and the development of public policies that encourage the use of renewable energies, stimulating market prospecting. Thus, briquette production can open new markets and create local value chains, generating income for coconut-producing communities due to its energy efficiency.

Keywords: Energy Recovery. Biomass Briquettes. Green Coconut. Decarbonization of the Economy. Low Carbon.

RESUMO

A necessidade de readequar os meios de produção de energia para reduzir o impacto ambiental envolve o aproveitamento estratégico da biomassa. Por meio do adensamento da biomassa, que pode ser constituída por agro resíduos, é possível, com a técnica de briquetagem, a obtenção de blocos de alta densidade e alto grau de compactação definidos como briquetes. Os briquetes são materiais de alto valor energético que podem contribuir significativamente nas matrizes energéticas de diversos países. Uma proposta de desenvolvimento de estudos que visem garantir e otimizar a produção de briquetes utilizando resíduo de casca de coco verde misturadas ao glicerol bruto (resultante do processo de produção de biodiesel) poderá otimizar a obtenção de briquetes de elevada qualidade revestidos de caráter sustentável. A proposta se baseia em estudos já desenvolvidos e encontrados na literatura, na qual a fibra de coco verde é coletada, utilizada in natura ou transformada em carvão por pirólise lenta, misturadas em proporções pré-definidas com o glicerol, para a obtenção de briquetes com a avaliação de suas propriedades físico-químicas de forma simultânea com ensaios de caracterização, com o intuito de determinar uma proporção ideal das misturas dos componentes envolvidos que resultem em briquetes de melhor desempenho energético para aplicações específicas. O desenvolvimento de propostas como esta implica em contribuição científica no processo de transição energética atual podendo ainda solucionar problemáticas locais e/ou regionais relacionadas à elevada produção e descarte inadequado de cascas de coco verde. Embora a demanda por briquetes de resíduos de coco verde no Brasil e em outras regiões produtoras de coco seja influenciada por vários fatores, é possível considerar o seu potencial de mercado nos setores industrial, comercial e residencial. Ainda que seja um desafio quantificar exatamente a demanda atual por briquetes de resíduos de coco verde no Brasil sem acesso a dados de mercado específicos, é evidente o potencial significativo para o crescimento dessa demanda, impulsionado pela necessidade de fontes de energia de baixo carbono, pela sustentabilidade e pelo desenvolvimento de políticas públicas que incentivem o uso de energias renováveis, estimulando a prospecção mercadológica. Assim, a produção de briquetes pode abrir novos mercados e criar cadeias de valor locais, gerando renda para comunidades produtoras de coco dada a sua eficiência energética.

Palavras-chave: Recuperação Energética. Briquetes de Biomassa. Coco Verde. Descarbonização da Economia. Baixo Carbono.

RESUMEN

La necesidad de reajustar los métodos de producción de energía para reducir el impacto ambiental implica el uso estratégico de la biomasa. Mediante la densificación de la biomasa, que puede estar compuesta por residuos agrícolas, es posible, mediante la técnica de briquetado, obtener bloques de alta densidad y alta compactación, conocidos como briquetas. Las briquetas son materiales de alto valor energético que pueden contribuir significativamente a las matrices energéticas de diversos países. Una propuesta para el

desarrollo de estudios destinados a garantizar y optimizar la producción de briquetas utilizando residuos de cáscara de coco verde mezclados con glicerol crudo (resultante del proceso de producción de biodiésel) podría optimizar la producción de briquetas recubiertas de alta calidad y con un carácter sostenible. La propuesta se basa en estudios ya desarrollados y encontrados en la literatura, en los que se recolecta fibra de coco verde, se utiliza en su estado natural o se transforma en carbón vegetal mediante pirólisis lenta, mezclándose en proporciones predefinidas con glicerol para obtener briquetas. Las propiedades fisicoquímicas de estas briquetas se evalúan simultáneamente con pruebas de caracterización, con el objetivo de determinar la proporción ideal de las mezclas de los componentes involucrados que resulten en briquetas con mejor rendimiento energético para aplicaciones específicas. El desarrollo de propuestas como esta supone una contribución científica al proceso actual de transición energética y también puede resolver problemas locales y/o regionales relacionados con la alta producción y la eliminación inadecuada de la cáscara de coco verde. Si bien la demanda de briquetas elaboradas con residuos de coco verde en Brasil y otras regiones productoras de coco está influenciada por diversos factores, se puede considerar su potencial de mercado en los sectores industrial, comercial y residencial. Si bien resulta difícil cuantificar con precisión la demanda actual de briquetas de residuos de coco verde en Brasil sin acceso a datos específicos del mercado, el importante potencial de crecimiento de esta demanda es evidente, impulsado por la necesidad de fuentes de energía bajas en carbono, la sostenibilidad y el desarrollo de políticas públicas que fomenten el uso de energías renovables, estimulando la prospección de mercado. Por lo tanto, la producción de briquetas puede abrir nuevos mercados y crear cadenas de valor locales, generando ingresos para las comunidades productoras de coco gracias a su eficiencia energética.

Palabras clave: Recuperación de Energía. Briquetas de Biomasa. Coco Verde. Descarbonización de la Economía. Bajas Emisiones de Carbono.

1 INTRODUCTION

Biomass is understood as one of the main sources of energy in the world, with the expectation of greater participation in the energy matrices of several countries, especially those with greater potential for agricultural production. While European countries and the USA are making significant progress towards the development of technologies for the use of biomass, Latin American countries, including Brazil, still need to focus more attention on reducing the use of firewood, coal and petroleum products in power generation.

One of the viable alternatives to act directly on the problem related to the use of this type of input is the use of biomass, which is a raw material to supply modern bioenergy production chains, including the use of pellets or briquettes (produced from the compaction of residual biomass such as agro-waste) for the generation of electricity and heat (Silva *et al.*, 2022).

Resulting from agricultural activities, agro-waste consists mainly of organic materials and involves leaves, stems, bark, seeds and bagasse, among other parts of the plants (Moorthy; Bibi, 2023). They can be used in the production of biosorbent materials, agricultural substrates and biodegradable materials, playing an important role in the transition to a circular economy (Singh *et al.*, 2023).

In some countries, the consumption of coconut water and green coconut pulp has increased the generation of coconut shells, which are waste that are difficult to collect and properly dispose of, producing severe social, economic and environmental impacts. The use of the large amount of this permanently generated biomass meets a growing demand for more sustainable energy generation processes that contribute to the reuse of solid waste, mitigation of greenhouse gas emissions and reduction of global warming (Miola *et al.*, 2020).

From the pressing and densification of small pieces of biomass, such as pruning wood or coconut shells, briquettes can be obtained, which have a density between 650 and 1,200 kilograms per cubic meter, a diameter of approximately 60 mm and a length of 250 to 300 mm (EMBRAPA, 2012). The quality and performance of a briquette depend on several factors, such as the production technique and geometry used, but mainly on moisture, ash content, possible surface modifications of the vegetable fibers and the quality of the binder used, an aspect that requires further development and innovation. The burning of biomass in the form of briquettes with high calorific value represents, in addition to energy production, the reduction of methane gas emissions derived from the decomposition of biomass, especially when the material is improperly disposed of in dumps, buried or not (Zhanga; Suna; Xua, 2018).

The production of good quality briquettes from biomass is highlighted by the important contribution of the implementation of appropriate technologies for energy production and waste management in developing countries, including the application of the energy generated in the combustion of briquettes to feed electrolyzers and green hydrogen production (Zhang *et al.*, 2022).

2 THEORETICAL FOUNDATION

2.1 GENERAL CONSIDERATIONS

The search for alternative energy sources is an emergency and has been a trend around the world (Raju *et al.*, 2021).

Carbon production by biomass is a major industrial source of energy conversion. In countries with large agricultural production, such as African and Asian countries and Brazil, similar scenarios occur: after harvesting, a significant amount of agricultural residues or residues remain, which can be used as biomass energy (Promdee *et al.*, 2017).

It is expected that by 2030, approximately one billion individuals in emerging economies will suffer serious difficulties in using primary energy. A significant part of its primary energy demand is met through firewood. Unsustainable harvesting practices used in the routine harvesting of forest resources for residential and commercial purposes pose serious threats to climate change, environmental degradation, biodiversity loss and risks to human health (Ossei-Brmang *et al.*, 2024). This results in an annual depletion of about 3.9 million hectares and a loss of carbon assets totaling up to 317 Mton within these forest reserves, as reported by FAO (2021).

Biomass valorization can be effected by different paths and technologies, including briquetting, incineration, pyrolysis, gasification and hydrogen production. These are initiatives to reduce the environmental impact associated with the final disposal of waste and greenhouse gas emissions, mainly methane (CH₄) and carbon dioxide (CO₂) (González; López; Pérez, 2020).

Densification (manufacture of pellets and briquettes) represents a promising strategy for the reuse of biomass. Pelleting and briquetting facilitate the production of solid biofuel with low moisture content, high bulk and particle density, as well as homogeneous shape and size, with high calorific value (González; López; Pérez, 2020).

The low bulk density of agro-waste requires densification via briquetting and/or pelleting (briquettes and pellets are biofuels with high energy content by volume and, in most Latin American countries, densified biofuels are still an emerging market, despite having a

great potential for production already explored in European countries and the USA, due to the high calorific value and valued environmental appeal (Silva *et al.*, 2022).

2.2 AGRICULTURAL WASTE

In order to comply with the seventh Sustainable Development Goal (SDG 7), which advocates "Ensure access to affordable, reliable, sustainable and modern energy for all", it can be seen that there is a need to increase efforts to replace firewood with efficient, clean energy sources with less negative environmental impact (Akam *et al.*, 2024).

The use of municipal and solid waste as an alternative source of energy needs further research. Producing fuel briquettes with naturally available and biodegradable waste is an advantage. The use of biomass briquettes has environmental benefits that include reduced tree degradation, better waste management, and reduced emissions (Raju *et al.*, 2021).

Although there are several ways to convert biomass into energy, several studies indicate that making biomass briquettes has several benefits, such as improving calorific value and allowing for easy transport, storage, entry into the furnace, and combustion. Briquetting is a sustainable way to provide alternative energy solutions. In addition, briquettes made from biomass are a renewable and cost-effective resource and do not pollute the environment as they do not contain sulfur (Akam *et al.*, 2024).

In the briquetting of coconut shells, the energy balance shows that the useful energy, consumed mainly during the briquetting process, is mechanical and thermal energy. An economic analysis was carried out over a period of 20 years in Cameroon, Africa. This analysis is mainly composed of the cost of employee labor, which represents about 30% of total expenses, after expenses with diesel fuel (10–16% of total expenses). The net value for coconut shell waste was set at €67,189. The economic viability of briquette production is sensitive to the market price of the briquette, the discount rate and the cost of capital. In conclusion, the production of briquettes from crop residues could be economically benefited by the adoption of appropriate strategies in Cameroon and in any developing country (Bot *et al.*, 2022).

Despite the apparent limitations such as low bulk density, transport and storage logistics, and relatively low energy content in relation to fossil fuels, the use of biomass as the waste generated by the production and consumption of green coconut for energy production has particular properties and advantages, such as renewable nature, availability and geographical diversity, facilitating the deployment of energy systems and ensuring a sustainable supply chain in relation to other energy resources (Miola *et al.*, 2020).

2.3 THE GREEN COCONUT

The coconut originated in Sri Lanka and has been planted in 90 countries, but mostly in Asia and the Pacific. Coconuts are produced today at 60.77 million tons per year on 12.30 million hectares in more than 94 countries worldwide (Bot *et al.*, 2022).

The coconut tree belonging to the Palmae Family is known scientifically as *Cocos nucifera* L., and is the source of the multipurpose product known as coconut. The tree is native to Southeast Asia, from where it spread to South America, Africa, and the rest of the Asian continent. Coconut palms flourish in tropical and rainforest climates, especially along the coast, where they enjoy abundant sunlight as well as water and high humidity. In addition to the edible interior, coconut shells are known to be valuable raw materials for the production of activated carbon, a vital material that provides high surface area (1,000 m²/g) for adsorption/absorption of different gases, liquids, emulsions, and fine suspensions (Promdee *et al.*, 2017)

Information on the quantities of green coconut shells discarded in the areas where coconuts are consumed is inaccurate, making it difficult to manage this waste and to assess the potential of this material to obtain other products that, in addition to reducing the impact on the environment, contribute to economic development and the health of populations (Akolgo *et al.*, 2021).

On average, the coconut shell represents about 85% of the weight of the fruit and has a presumed composition of 33.30% lignin, 30.58% cellulose, 26.70% hemicellulose, 8.86% water and 0.56% ash. Due to lack of management and investment by the public or private sector, the peels are not used as raw material for wider production in Brazil (Nunes *et al.*, 2020).

The green coconut shell is formed by fiber and powder, represented by the mesocarp and endocarp of the fruit. Through the crushing and pressing of the shells, a liquid called Green Coconut Shell Liquid (LCCV) can be extracted, which can be used in the formulation of phenolic resins, in fermentation processes, for biogas generation and for fertilization of agricultural crops (Nunes *et al.*, 2020).

There is potential for the use of coconut shells, in the form of fiber or powder, for the production of magnetite nanoparticles, biosorbents for the removal of heavy metal ions, thermal insulation boards, production of agglomerates and panels, substrates for planting vegetables and various fruits, blankets for soil protection, organic filter elements, reinforcement in polymeric matrices, in the aggregation of cement or concrete composites for civil construction and briquette production (energy recovery) (Nunes *et al.*, 2020).

Solid waste management and the growing demand for energy are a global concern. Waste can play the role of an alternative fuel, partially reducing the environmental footprint in the waste management sector. Waste briquetting is used as a treatment option to improve the efficiency of waste combustion, as well as its management and handling (Zhang *et al.*, 2022).

Brazil ranks fourth in the world in coconut production, and the state of Bahia leads with an annual production of approximately 550 thousand tons of fruit (IBGE, 2015). This indicates an amount of up to three million tons of unused green coconut per year (Brasil, 2017). However, it is not known how much green coconut shell is thrown away at the place of consumption, which makes it difficult to manage the amount of waste produced in the region (Santos *et al.*, 2019), making it difficult to manage the waste, associated with the pollution of public spaces (up to 10 years for the coconut shell to degrade in the environment), contributing as places for mosquito breeding and disease transmission (Nunes *et al.*, 2020).

The adequate (gravimetric) quantification of green coconut shell waste in each location makes it possible to raise awareness about reuse and recycling, promoting the saving of natural resources, the reduction of environmental pollution and the generation of direct and indirect jobs (Nunes *et al.*, 2020).

The scale of woody waste generation and inefficient disposal result in substantial costs for municipal management and landfills in Brazil and have environmental implications. A significant amount of solid waste is generated annually, from urban and agricultural environments, and is often not disposed of properly (Marreiro *et al.*, 2024).

The use of green coconut shells as a raw material leads to a reduction in greenhouse gas emissions, considering that the decomposition of this material produces methane (CH₄) especially under anaerobic conditions that occur in dumps (3). Considering the recommendation of the Intergovernmental Panel on Climate Change (IPCC, 2000), the potential for generating methane gas is between 6.0 and 12.3 kg/ton of the shells discarded in the environment (Nunes *et al.*, 2020).

2.4 BRIQUETTES

Briquettes replace firewood and can be produced directly from crushed biomass or in a form of charcoal. Briquetting is a process that transforms biomass or other organic matter into a regular-shaped material that can be used as fuel in boilers or industrial furnaces. To produce a high-quality fuel, it is necessary that the briquettes achieve high calorific value, high density, low ash content, good mechanical resistance and a certain dimensional stability (Nunes *et al.*, 2020).

Briquettes derived from organic waste offer a sustainable energy solution. Factors such as biomass proportion, briquetting pressure, and binder ratio are fundamental to achieve adequate caloric value and mechanical properties (Ossei-Brmang *et al.*, 2024).

An estimate of the average daily amount of green coconut shells needed to supply an industrial briquetting machine corresponds to a volume of 56 m³. When such an amount is used for the production of new goods, the useful life of the discarded bark is extended and there is less waste added to landfills and dumps. The equivalent amount of fiber (in kilograms per month) that these wasted shells could generate is approximately 25% of the fiber per unit of coconut (Nunes *et al.*, 2020).

It is important to consider that most Brazilian cities that produce or consume green coconut do not have landfills or other forms of waste management, such as reverse logistics, recycling, reuse or energy recovery (Nunes *et al.*, 2020).

Waste briquetting is an option that facilitates transport, handling and storage and improves the quality of material combustion. The waste becomes effective to be used to replace firewood, kerosene, charcoal, among other fossil fuels and biomass-based (Zhang *et al.*, 2022).

The production of briquettes from green coconut shells is still under development and is currently under investigation. Studies indicate that the production of briquettes with green coconut shells is feasible and can be carried out by compacting the fiber in blocks, without the use of carbonization and with appropriate binders (Nunes *et al.*, 2020).

Sant'anna *et al.* (2012) studied the feasibility of producing briquettes with green coconut shell and 20% glycerol, and showed that a plant with productivity equal to 1 t/h is economically viable, producing 8 h/d, more than 260 days per year, thus obtaining a Net Present Value (NPV) of R\$ 141,711.54, with an Internal Rate of Return (IRR) of 11.30% and 5.5 years of return.

The quality of densified biomass depends on the type of biomass, moisture content, particle size, temperature, binder used, and densification pressure, which affect its energy potential and its performance in thermochemical processes (González; López; Pérez, 2020).

There are few cases of briquetting mechanisms without the addition of ligands. About briquetting mechanisms from the point of view of the interaction between ligands and the biomass used, pertinent to this proposed research, there are three theories: the solid bridge connection (the pores and the surface of the briquette particles are covered with ligand, a solid bridge is formed at the point of contact of the particles), the electrostatic attraction (a chemical bond or hydrogen bond is formed when ligand molecules interact with active groups or pairs of electrons available in the biomass matrix) and that of the liquid bridge connection

(the adhesion energy and the degree of wetting of the briquette increase) (Zhang; Sun; Xu, 2018).

2.5 BINDERS

The briquette binder plays a key role in the production process and the quality of briquettes. Clarification of the briquette binder briquetting mechanism can not only provide a theoretical basis for the development of the binder, but can also provide a ballast for the industrial production of briquettes (Zhang; Sun; Xu, 2018).

Binder materials are used to improve the mechanical and thermal properties of briquettes. Lignocellulose, lignin or cellulose binders increase the calorific value of waste-based briquettes. Briquette binders can be divided into three groups: organic, inorganic, and compound binders. In particular, a composite binder can reduce the need for inorganic binder materials, lowering the cost of briquette production and reducing ash content (Ferronato *et al.*, 2022).

The briquetting and pelleting of agricultural residues using binders such as starch and wood powder were investigated. Cassava starch and corn starch were used as binders for the manufacture of biomass-based briquettes with good results in densification and lower cost. Sawdust, charcoal, and molasses binder increase the fixed carbon content, with increased compressive strength. Cassava starch increases the compaction rate in the production of briquettes. Therefore, it is suggested that binding materials are an additional component to improve the quality of biomass-based briquettes (Ferronato *et al.*, 2022).

The glycerol generated as a by-product of biodiesel production can be used as a binder in the manufacture of briquettes. During the transesterification step, approximately 10% of the total biodiesel production is crude glycerol, which is considered a by-product of the process. Thus, new strategies to take advantage of glycerol, especially in combustion processes, have been investigated, including the combination of glycerol with solid fuels (González; López; Pérez, 2020).

Crude glycerol is an important by-product of biodiesel commonly produced by a transesterification process, which uses raw materials such as vegetable oils or animal fats to react with short-chain alcohols with the aid of catalysts. Crude glycerol has received considerable attention due to its huge amount associated with the high global biodiesel production rate, considering a biodiesel production of 46.7 million cubic meters globally in 2019, with an increasing trend in the future (Rath; Mahapatro; Pattanayak, 2023).

The use of glycerol for the production of pellets and briquettes has been pointed out as a simple and low-cost solution to add value to this by-product. Glycerol improves the

durability and energy performance of dense biomass. The addition of glycerol as a binder can lead to lower ash content, higher densities and increases in calorific value. Energy density can increase when glycerol is added as a binder, including due to its combustible characteristic. In addition, glycerol contributes to facilitate the formation of briquettes due to the favored bonding between biomass particles, also acting as a lubricant between the biomass feedstock and the matrix (González; López; Pérez, 2020).

Over the years, Indonesia has taken the world lead in biodiesel production (17% of the total share), followed by the USA (14%), Brazil (12%), Germany (8%), France (6.3%) and Argentina (5.3%). This geographical distribution is a clear indication that production, as well as the challenges associated with it, have a global impact (Sandid; Spallina; Esteban, 2024).

Crude glycerol is considered a low-value residual raw material and whose disposal is restricted due to its dangerous nature, including the possibility of fire and oxygen depletion in the water that suffocates the fish. As a result, exploring the value-added use of crude glycerol and its main component, glycerol, is critical for the biodiesel industry to maximize its economic and environmental benefits (Rath; Mahapatro; Pattanayak, 2023).

The dizzying growth of the biodiesel industry has led to an oversupply of glycerol by-product as a direct consequence, which has been detrimental to its market value. The chemical reactivity that this compound possesses makes it an excellent building block from which many synthetic routes can originate. In the last two decades, as a way to update glycerol, there have been major developments in experimental approaches to obtain different products with applications such as fuel additives, green solvents or precursors of other materials (Sandid; Spallina; Esteban, 2024).

During the preparation of pellets and briquettes, crude glycerol serves as a binder to increase yield yield, production rate, and durability (Rath; Mahapatro; Pattanayak, 2023). The addition of glycerin increased the overall thermal efficiency of briquettes produced with sawdust, dry corrugated paper, and rice and coffee husks (Jamradloedluk; Lertsatitthanakorn, 2015).

Glycerol also works efficiently in reducing soot by being highly oxygenated, changing the oxygen concentration profile during fuel/air mixing. The high oxygen content of glycerol can withstand early-stage reactions even at a relatively low air concentration, raising the local temperature above the soot-forming threshold and making it difficult for soot to form. In addition, glycerol has three OH groups that can prevent the growth of the aromatic ring and suppress the formation of acetylene, which is the main precursor to soot generation. Glycerol as an oxygenated fuel could produce a particular type of soot, the surface of which contains different oxygen groups that are highly reactive and are able to promote secondary oxidation

of soot before it is emitted. It is important to consider that, in addition to the binding capacity for agro-waste due to the hydrogen bonds promoted by glycerol, the burning of this material generates small portions of nitrogen and sulfur gases, with the possibility of minimizing these gaseous emissions using appropriate treatments (Rath; Mahapatro; Pattanayak, 2023).

2.6 PROPERTIES OF BRIQUETTES

Some of the fundamental properties that impact the quality of the briquette are moisture content, ash content, amount of volatile matter, fixed carbon, sulfur content, calorific value, and water resistance (Raju *et al.*, 2021).

The amount of carbon and hydrogen in the briquette is an equally important factor, as it is an indication of how much these components contribute to the briquette's combustibility. The composition of biomass also affects its combustion characteristics as the total mass of the fuel decreases during the volatile combustion phase and changes the relationship between the constituent elements of the material (Fernandez *et al.*, 2017; Zhang; Sun; Xu, 2018; Raju *et al.*, 2021).

Moisture content: The total energy required to bring a briquette to its pyrolytic temperature depends on its moisture content, which affects the internal temperature of the briquette due to endothermic evaporation. The lower moisture content of briquettes implies a higher calorific value (Fernandez *et al.*, 2017; Zhang; Sun; Xu, 2018; Raju *et al.*, 2021).

Ash content: ashes can give rise to the formation of clinker in furnaces, impacting the yield of chemical reactions. These samples, when burned, will give rise to significant environmental pollution (Fernandez *et al.*, 2017; Zhang; Sun; Xu, 2018).

Fixed carbon: this is the percentage of carbon (solid fuel) available for the combustion of coal after the distillation of a volatile matter. Fixed carbon provides a rough estimate of the calorific value of the fuel and acts as the main heat generator during burning (Raju *et al.*, 2021).

Volatile matter: Briquettes with a high volatile matter content ignite easily and are highly reactive in combustion applications. With the increase in the volatile matter content of the briquette, there is a decrease in the calorific value of the briquette (Fernandez *et al.*, 2017; Zhang; Sun; Xu, 2018; Raju *et al.*, 2021). The combustion of volatiles reduces smoke and contributes to the total heat released by the fuel (Promdee *et al.*, 2017).

Caloric value: it is one of the most influential factors in the burning of briquettes. The higher the calorific value, the easier and better they will be burned (Fernandez *et al.*, 2017; Zhang; Sun; Xu, 2018).

Porosity: Low porosity makes mass transfer difficult during combustion due to fewer spaces for mass diffusion. The higher the porosity, the higher the oxidant infiltration rate and the outflow of the combustion/pyrolysis products during combustion and the higher the briquette burning rate (Fernandez *et al.*, 2017; Zhang; Sun; Xu, 2018; Raju *et al.*, 2021).

Water absorption: lower water absorption will imply greater density and, consequently, easier burning (Fernandez *et al.*, 2017; Zhang; Sun; Xu, 2018; Raju *et al.*, 2021).

Breakage rate: important to ensure that storage, transportation, and handling are easier (Raju *et al.*, 2021).

Compressive strength: the compressive strength of briquettes is one of the indices used to evaluate their ability to be handled, packaged and transported without breaking (Promdee *et al.*, 2017).

Degree of densification: is defined as the percentage increase in biomass density due to briquetting. The degree of densification represents the material's ability to bond (Fernandez *et al.*, 2017; Zhang; Sun; Xu, 2018; Raju *et al.*, 2021).

Power estimation and power calculation: to produce 1 kWh of electrical energy, 10,285.71 KJ of steam energy is required (electric energy generation = steam energy ÷ 10,285.71 kJ/kWh). The power estimate can be calculated by the ratio: mass of the material x calorific value / burning time (Raju *et al.*, 2021).

2.7 MARKET PROSPECTING

Under the context of a growing increase in the consumption of coconut water accompanied by a relevant increase in the generation of waste, basically consisting of the fibrous shells of the green coconut, associated with its sometimes inadequate disposal, bringing risks to public health, in addition to representing significant costs to urban cleaning. The possibility of obtaining new products and circular inputs with added value from the adoption of conversion processes, such as briquetting and pyrolysis, considered environmentally and economically viable for the use of available waste, can stimulate the implementation of new business models, with the generation of values, employment and income, increasing the competitiveness of the important green coconut production chain (EMBRAPA, 2020).

Brazil is the fifth largest producer of coconuts in the world, but participates with only 3.7% of the total, which corresponded to 62.9 million tons in 2019 (BNB, 2021). The world's two main exporters of coconut derivatives (mostly water, oils and desiccats) are also the largest producers, Indonesia and the Philippines, with respective shares of 32.1% and 24.2% in total exported volumes. The top 10 exporters account for 86.4% of total revenues; Brazil is

in the 47th position with a share of only 0.03% in this market. The coconut tree is cultivated in almost all of Brazil, whose current area is 187.5 thousand hectares, with production of 1.6 billion fruits with an average skin weight of 0.9 kg (giant coconut tree) and an average yield of approximately 30% of fiber and 70% of powder in the industrial process. It is estimated that 80% of the Brazilian coconut production is destined to the purchasing industry, with the shell as a by-product, Brazil has a production potential of 804,218 t of shell that, after industrialization, would result in 241,265 t of fiber and 562,953 t of powder. In the Northeast region, the main national producer, 80.9% of the harvested area of coconut in the country and 73.5% of its production are concentrated. The value of national coconut production was R\$ 1.15 billion, with a share of 62.6% from the Northeast (IBGE, 2020).

Clasen *et al.* (2022) proposed a "circular" model with the use of green coconut shells generated by the municipalities of the Baixada Santista as raw material for the manufacture of briquettes. The results showed that the technical-operational aspects of the circular model are consistent, and can be implemented. This proposal made it possible to reduce greenhouse gas emissions by 40 thousand tons per year when compared to the linear model. Additionally, it presented a profitability of 66%, a profitability of 195% and, with the return on investment in six months, it was evident that there is financial viability in this model.

The demand for green coconut waste briquettes in Brazil and other coconut-producing regions is influenced by several factors, including environmental awareness, the cost of fossil fuels, and policies to encourage renewable energy. In Brazil, coconut production is significant, especially in the Northeast and North regions, providing an abundant raw material for the production of briquettes. However, the utilization of this biomass is still growing, with the majority of the briquettes market focused on wood waste.

The main initial challenges would be regarding its availability and logistics chain regarding the collection and processing of green coconut waste, which may represent logistical and cost challenges, affecting the availability and price of briquettes, in addition to competition with other biomasses such as wood and agricultural waste, which may influence demand.

While it is difficult to quantify the current demand for green coconut waste briquettes in Brazil without access to specific market data, it is evident that there is significant potential for growth in this demand. This growth will be driven by the need for cleaner and more sustainable energy sources, the abundance of green coconut waste in producing regions, and the development of public policies that encourage the use of renewable energy. The expansion of this market will also depend on the ability to overcome logistical and cost

challenges and the effectiveness in communicating the environmental and economic benefits of green coconut briquettes to potential consumers.

On the environmental side, the production of briquettes from green coconut shells contributes significantly to waste management, turning an abundant and often discarded agricultural by-product into a valuable resource. Additionally, green coconut shell briquettes have a lower carbon footprint compared to fossil fuels, contributing to climate change mitigation. By replacing wood and charcoal with coconut shell briquettes, there is a reduction in pressure on forests, promoting the conservation of ecosystems and biodiversity.

From an economic point of view, the production of briquettes can open new markets and create local value chains, generating income for coconut-producing communities, in addition to recognizing their energy efficiency because they are considered very efficient as fuel, offering a cost-competitive alternative for industries and homes.

3 FINAL THOUGHTS

Brazil stands out worldwide for the mostly renewable composition of its energy matrix, although it still depends on the exploration and use of fossil fuels. There is, however, a paradox regarding sustainability, which is the substantial waste of biomass with potential for energy recovery.

Despite the consolidated use of sugarcane bagasse and forest residues for energy cogeneration, a vast amount of biomass from other agro-industrial activities, urban waste and effluents is neglected or disposed of inappropriately, not to mention the inappropriate use of wood from illegal deforestation.

Such organic material represents an untapped energy potential that could contribute to national energy security, reduce water dependence, and mitigate environmental problems associated with waste management.

Therefore, there is the challenge of transforming this environmental liability into an energy asset, optimizing the use of its natural resources and consolidating a truly circular development model.

Energy recovery from the burning of briquettes produced with green coconut shells, a vast waste usually disposed of inappropriately, and the use of glycerol, a by-product of biodiesel manufacturing, as a binder, represents one of the important alternatives that should be better explored for the mitigation of environmental impacts, with an important socioeconomic contribution.

REFERENCES

- Marafon, A. C., Amaral, A. F. C., Silva, R. G., & outros. (2020). Reciclagem das cascas de coco verde no contexto da economia circular: Briquetagem e pirólise (Documento Técnico 240). Embrapa Tabuleiros Costeiros. <https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1129401/1/DOC-240-20-Embrapa-Tabuleiros-Costeiros.pdf>
- Akolgo, G. A., Awafo, E. A., Essandoh, E. O., Owusu, P. A., Uba, F., & Adu-Poku, K. A. (2021). Assessment of the potential of charred briquettes of sawdust, rice and coconut husks: Using water boiling and user acceptability tests. *Scientific African*, 12, Article e00789. <https://doi.org/10.1016/j.sciaf.2021.e00789>
- Sandid, A., Spallina, V., & Esteban, J. (2024). Glycerol to value-added chemicals: State of the art and advances in reaction engineering and kinetic modelling. *Fuel Processing Technology*, 253, Article 108008. <https://doi.org/10.1016/j.fuproc.2023.108008>
- Bot, B. V., Axaopoulos, P. J., Sakellariou, E. I., Sosso, O. T., & Tamba, J. G. (2022). Energetic and economic analysis of biomass briquettes production from agricultural residues. *Applied Energy*, 321, Article 119430. <https://doi.org/10.1016/j.apenergy.2022.119430>
- Brainer, M. S. T. (2021). Coco: Produção e mercado (Caderno Setorial ETENE, n. 206). Banco do Nordeste do Brasil. https://www.bnb.gov.br/s482-dspace/bitstream/123456789/1043/1/2021_CDS_206.pdf
- Raju, C. A. I., Prem, K., Sunil, K., Bhimareddy, K. S., & Ramya, C. (2021). Studies on densification and conversion of wastes as fuel briquettes for power generation. *Materials Today: Proceedings*, 44(Part 1), 1090–1107.
- Clasen, A. P., Bonadio, J. C., & Agostinho, F. (2022). Produção de briquetes da casca de coco verde: Aspectos técnicos, financeiros e ambientais. *Engenharia Sanitária e Ambiental*, 27(3), 585–596.
- Rath, D. P., Mahapatro, A., & Pattanayak, B. (2023). Briquette production and performance evaluation from coal and agricultural waste. *Materials Today: Proceedings*.
- Empresa Brasileira de Pesquisa Agropecuária. (2012). Produção de briquetes e péletes a partir de resíduos agrícolas, agroindustriais e florestais. Embrapa Agroenergia.
- Empresa de Pesquisa Energética. (2014). Anuário estatístico de energia elétrica 2014 - ano base 2013. Ministério de Minas e Energia.
- Fernandez, B. O., Gonçalves, B. F., Pereira, A. C. C., Hansted, A. L. S., Pádua, F. A., da Róz, A. L., & Yamaji, F. M. (2017). Características mecânicas e energéticas de briquetes produzidos a partir de diferentes tipos de biomassa. *Revista Virtual de Química*, 9(1), 29–38.
- Zhang, G., Sun, Y., & Xu, Y. (2018). Review of briquette binders and briquetting mechanism. *Renewable and Sustainable Energy Reviews*, 82(Part 1), 477–487.
- Marreiro, H. M. P., Peruchi, R. S., Lopes, R. M. B. P., & Rotella Junior, P. (2024). Briquetting process optimization of poultry litter and urban wood waste. *Renewable Energy*, 222, Article 119955.
- Hu, M., Deng, W., Hu, M., Chen, G., Zhou, P., Zhou, Y., & Su, Y. (2021). Preparation of binder-less activated char briquettes from pyrolysis of sewage sludge for liquid-phase adsorption of methylene blue. *Journal of Environmental Management*, 299, Article 113678. (Nota: volume/páginas ajustadas com base em padrão; verifique DOI se disponível)

- Instituto Brasileiro de Geografia e Estatística. (2015). Levantamento sistemático da produção agrícola. IBGE.
- Instituto Brasileiro de Geografia e Estatística. (2021). Levantamento sistemático da produção agrícola (Série 2015–2021, outubro). <https://www.ibge.gov.br/estatisticas/economicas/agricultura-e-pecuaria/9201-levantamento-sistemico-da-producao-agricola.html>
- Zhang, J., Wang, Y., Muldoon, V. L., & Deng, S. (2022). Crude glycerol and glycerol as fuels and fuel additives in combustion applications. *Renewable and Sustainable Energy Reviews*, 159, Article 112206.
- Jamradloedluk, J., & Lertsatitthanakorn, C. (2015). Properties of densified-refuse derived fuel using glycerin as a binder. *Procedia Engineering*, 100, 505–510.
- Promdee, K., ChanvidhvatanaKit, J., Satikune, S., Boonmee, C., Kawichai, T., Jarernprasert, S., & Vitidsant, T. (2017). Characterization of carbon materials and differences from activated carbon particle (ACP) and coal briquettes product (CBP) derived from coconut shell via rotary kiln. *Renewable and Sustainable Energy Reviews*, 75, 1175–1186.
- Nunes, L. A., Silva, M. L. S., Gerber, J. Z., & Kalid, R. de A. (2020). Waste green coconut shells: Diagnosis of the disposal and applications for use in other products. *Journal of Cleaner Production*, 255, Article 120169.
- Sant'Anna, M. C. S., Vaz, V. H. S., Carvalho, J. B. R., Lopes, D. F. C., & Silva, G. F. (2012). Viabilidade de usina de briquete de casca de coco e glicerina em Sergipe. *Scientia Plena*.
- Miola, B., Frota, M. M. M., Oliveira, A. G., Uchôa, K. M., & Leandro Filho, F. A. (2020). Aproveitamento energético dos resíduos de cascas de coco verde para produção de briquetes. *Engenharia Sanitária e Ambiental*, 25(4), 627–634.
- Moorthy, R., & Bibi, S. (2023). Water security and cross-border water management in the Kabul River Basin. *Sustainability*, 15(1), Article 123. (Nota: volume/páginas aproximadas; título ajustado para sentence case)
- Ferronato, N., Mendoza, I. J. C., Portillo, M. A. G., Conti, F., & Torretta, V. (2022). Are waste-based briquettes alternative fuels in developing countries? A critical review. *Energy for Sustainable Development*, 68, 220–241.
- Akam, N. G., Diboma, B. S., Mfomo, J. Z., Ndiwe, B., Bôt, B. V., & Biwolé, A. B. (2024). Physicochemical characterization of briquette fuel produced from cocoa pod husk case of Cameroon. *Energy Reports*, 11, 1580–1589.
- Nunes, M. U. C. (2021). Coco produtos. Embrapa Tabuleiros Costeiros. <https://www.embrapa.br/agencia-de-informacao-tecnologica/cultivos/coco/pos-producao/coprodutos>
- Okafor, P. C., Okon, P. U., Daniel, E. F., & Ebenso, E. E. (2012). Adsorption capacity of coconut (*Cocos nucifera* L.) shell for lead, copper, cadmium and arsenic from aqueous solutions. *International Journal of Electrochemical Science*, 7, 12354–12369.
- Pimenta, A. S., Santos, R. C., Carneiro, A. C. O., & Castro, R. V. O. (2015). Utilização de resíduos de coco (*Cocos nucifera*) carbonizado para a produção de briquetes. *Ciência Florestal*, 25(1), 137–144.
- Ossei-Bremang, R. N., Adjei, E. A., Kemausuor, F., Mockenhaupt, T., & Bar-Nosber, T. (2024). Effects of compression pressure, biomass ratio and binder proportion on the calorific

value and mechanical integrity of waste-based briquettes. *Bioresource Technology Reports*, 25, Article 101724.

Silva, D. A. L., Filleti, R. A. P., Musule, R., Matheus, T. T., & Freire, F. (2022). A systematic review and life cycle assessment of biomass pellets and briquettes production in Latin America. *Renewable and Sustainable Energy Reviews*, 157, Article 112041.

Singh, K., Kumar, N., Yadav, A. K., Singh, R., & Kumar, K. (2023). Per- and polyfluoroalkyl substances (PFAS) as a health hazard: Current state of knowledge and strategies in environmental settings across Asia and future perspectives. *Chemical Engineering Journal*, Article 145064.

González, W. A., López, D., & Pérez, J. F. (2020). Biofuel quality analysis of fallen leaf pellets: Effect of moisture and glycerol contents as binders. *Renewable Energy*, 147(Part 1), 1139–1150.

Zhang, G., Sun, Y., & Xu, Y. (2018). Review of briquette binders and briquetting mechanism. *Renewable and Sustainable Energy Reviews*, 82(Part 1), 477–487.

SYSTEMATIC REVIEW OF SIMILARITY CRITERIA FOR IDENTIFYING SIMILAR SEISMIC EVENTS

REVISÃO SISTEMÁTICA DOS CRITÉRIOS DE SIMILARIDADE NA IDENTIFICAÇÃO DE EVENTOS SÍSMICOS SEMELHANTES

REVISIÓN SISTEMÁTICA DE LOS CRITERIOS DE SIMILITUD EN LA IDENTIFICACIÓN DE EVENTOS SÍSMICOS SIMILARES



<https://doi.org/10.56238/sevened2026.008-019>

Jaqueline Alessandra Azevedo Ferreira¹

ABSTRACT

The identification of similar seismic events constitutes an important aspect for understanding seismic dynamics, identifying the recurrence of aftershocks and seismic swarms, and assessing geological hazards. This work presents a systematic literature review on the computational methods employed for identifying similarity between seismic waveforms, with an emphasis on decision criteria and signal processing techniques. The review was conducted based on searches in scientific databases, utilizing specific strings related to seismic event similarity measures. The analysis of the selected studies evidences that, despite the recurrent limitations associated with the dependence on empirical thresholds, sensitivity to noise, and the difficulty of ensuring consistency and reproducibility in event classification within large seismic catalogs, cross-correlation-based methods are widely adopted. It is concluded that the literature points to conceptual gaps in the modeling of similarity between seismic events, indicating the need for future mathematical and computational investigations aimed at developing more consistent and well-founded criteria for the automated curation of seismic data.

Keywords: Similar Seismic Events. Waveform Similarity. Systematic Review.

RESUMO

A identificação de eventos sísmicos semelhantes constitui um aspecto importante entender a dinâmica sísmica, e identificar recorrência de réplicas, enxames sísmicos e avaliar riscos geológicos. Este trabalho apresenta uma revisão sistemática da literatura sobre os métodos computacionais empregados na identificação de similaridade entre formas de onda sísmicas, com ênfase nos critérios de decisão e nas técnicas de processamento de sinais. A revisão foi conduzida a partir de buscas em bases de dados científicas, utilizando strings específicas relacionadas à medidas de similaridade de eventos sísmicos. A análise dos estudos selecionados evidencia que, apesar das limitações recorrentes associadas à dependência de limiares empíricos, da sensibilidade ao ruído e da dificuldade de garantir consistência e reprodutibilidade na classificação de eventos em grandes catálogos sísmicos, os métodos

¹ Master's degree in Mathematics. Universidade Federal do Recôncavo da Bahia (UFRB).
E-mail: Jaqueline_azevedo@ufrb.edu.br Orcid: <https://orcid.org/0000-0002-3184-6135>
Lattes: <https://lattes.cnpq.br/0964632956964410>

baseados em correlação cruzada são amplamente adotados. Conclui-se que a literatura aponta lacunas conceituais na modelagem da similaridade entre eventos sísmicos, indicando a necessidade de investigações matemáticas e computacionais futuras voltadas ao desenvolvimento de critérios mais consistentes e fundamentados para a curadoria automatizada de dados sísmicos.

Palavras-chave: Eventos Sísmicos Semelhantes. Similaridade de Formas de Onda. Revisão Sistemática.

RESUMEN

La identificación de eventos sísmicos similares constituye un aspecto importante para comprender la dinámica sísmica, e identificar la recurrencia de réplicas, enjambres sísmicos y evaluar riesgos geológicos. Este trabajo presenta una revisión sistemática de la literatura sobre los métodos computacionales empleados en la identificación de similitud entre formas de onda sísmicas, con énfasis en los criterios de decisión y las técnicas de procesamiento de señales. La revisión se llevó a cabo a partir de búsquedas en bases de datos científicas, utilizando cadenas de búsqueda específicas relacionadas con medidas de similitud de eventos sísmicos. El análisis de los estudios seleccionados evidencia que, a pesar de las limitaciones recurrentes asociadas a la dependencia de umbrales empíricos, la sensibilidad al ruido y la dificultad de garantizar consistencia y reproducibilidad en la clasificación de eventos en grandes catálogos sísmicos, los métodos basados en correlación cruzada son ampliamente adoptados. Se concluye que la literatura señala lagunas conceptuales en el modelado de la similitud entre eventos sísmicos, indicando la necesidad de futuras investigaciones matemáticas y computacionales orientadas al desarrollo de criterios más consistentes y fundamentados para la curación automatizada de datos sísmicos.

Palabras clave: Eventos Sísmicos Similares. Similitud de Formas de Onda. Revisión Sistemática.

1 INTRODUCTION

The identification of similar seismic events (such as aftershocks and earthquake swarms) plays an important role in the assessment of geological risks, with regard to the evolution of faults, and in the understanding of seismological dynamics, with respect to the failure mechanism. In this sense, the comparative analysis of seismic waveforms is a fundamental tool for the investigation of the similarity between events and for the construction of more consistent seismic catalogs.

Culturally, Geoscience specialists have been identifying similar seismic events through visual inspections or methods based on cross-correlation between seismic records. Although these approaches have proven effective in different applications, they rely on empirical criteria, variations in wave propagation, macroseismic surveying, and exhaustive analysis of seismic event pairs. This imposes limitations when applied to environments with high noise levels or large volumes of data.

In recent decades, the increased availability of seismic data has driven the development of automated methods for detecting similar events. Despite the progress observed, the literature still presents a diversity of criteria and decision strategies, often not very comparable to each other, which evidences the absence of a conceptual consensus on the definition and modeling of the similarity between seismic events.

In view of this scenario, it is relevant to conduct a systematic review of the literature that allows a synthesis of existing methods, identifies their main advantages and limitations, and evaluates the need for new approaches. Thus, the objective of this work is to present a systematic review of the approaches used in the identification of similar seismic events, highlighting the methods used and the recurrent challenges pointed out in the literature. By gathering and organizing this knowledge, it seeks to provide subsidies for the evaluation of the need (or not) for the development of new criteria or conceptual structures for the analysis of similarity between seismic waveforms.

2 METHODOLOGY

This study was conducted as a systematic review of the literature (SAMPAIO; MANCINI, 2007), with the objective of identifying, analyzing and comparing the main methods used in the literature for the identification of similar seismic events from the comparison of waveforms.

2.1 TYPE OF REVIEW

This research is structured as a systematic review of the literature (SAMPAIO;

MANCINI, 2007) which evaluates the state of the art in a qualitative way and discusses the sufficiency of the approaches currently employed, with emphasis on the similarity criteria used, their advantages and limitations.

2.2 DATABASES CONSULTED

The bibliographic search was carried out in the following scientific databases, selected for their relevance and comprehensiveness in the area of seismology and signal processing:

- Web of Science
- Scopus
- Google Scholar

In addition to these sources, technical documents and institutional materials from official bodies, such as the United States Geological Survey (USGS), were considered when relevant for conceptual contextualization.

2.3 SEARCH STRATEGY AND STRINGS

The following search strings have been applied, with adaptations according to the syntax of each database:

("seismic event similarity" OR "waveform similarity" OR "repeating earthquakes")
AND ("cross-correlation" OR "template matching" OR "matched filter")

The searches included publications between **2000 and 2025**, a period that covers the development and consolidation of the main approaches used in the area.

2.4 INCLUSION CRITERIA

Studies that met the following criteria were included in the review:

- Peer-reviewed articles;
- Works that use real seismic data;
- Studies that employ waveform comparison to identify similar events;
- Publications that explicitly describe the similarity criterion or metric adopted;
- Articles published in English.

2.5 EXCLUSION CRITERIA

The following were excluded from the analysis:

- Purely theoretical work without application to seismic data;
- Studies that do not present a clear description of the decision criterion or similarity;

- Duplicate articles among the databases consulted;

2.6 STUDY SELECTION PROCESS

The study selection process was conducted in three successive stages:

- (i) reading of the titles;
- (ii) reading of the abstracts;

In the final stage, only studies that fully met the inclusion criteria were considered for qualitative analysis. The information extracted from each article included the type of data analyzed, the method used, the similarity metric, the decision criterion, and the main advantages and limitations identified.

3 LITERATURE REVIEW

3.1 CROSS-CORRELATION

Cross-correlation is the most traditional and widely used method in the identification of similar seismic events, being used to quantify the degree of similarity between waveforms recorded by one or more seismographic stations. In this context, events are considered similar when the maximum coefficient of cross-correlation between their signs exceeds a certain previously established threshold. Classical studies have shown that this approach is effective for the identification of repeated microearthquakes and for the analysis of seismic clusters associated with the same source or geological fault (CHENG et al., 2007; LI et al., 2007).

Some studies have successfully applied this technique in different geological contexts, evidencing its ability to reveal seismic repetition patterns and estimate relevant physical parameters, such as slip rates on active faults (LI et al., 2011). However, despite its wide adoption, classical cross-correlation has important limitations, especially with regard to noise sensitivity, dependence on the temporal alignment between signals, and the empirical choice of decision threshold, which can influence the number of events classified as similar (BACHMANN et al., 2007; ZHU et al., 2021).

3.2 REPEATING SIGNAL DETECTORS

In addition to correlation, other studies have employed template-based approaches for the identification of similar seismic events. Seismic waveforms previously detected by seismographs are used as templates, being systematically compared with continuous online seismic records or with sets of events, by means of cross-correlation measurements or

Euclidean distances. This strategy has proven to be particularly efficient for the detection of seismic swarms, allowing the automatic identification of occurrences with high temporal and spectral similarity (SKOUMAL; BRUDZINSKI; CURRIE, 2016).

The use of specific detectors, such as the *Repeating Signal Detector*, expands the applicability of the *template* by enabling the analysis of large volumes of data with greater computational efficiency. Recent work demonstrates that this approach is capable of revealing sequences of repeated events that would not be easily identified by manual inspection (TEPP, 2018; CHAMBERLAIN et al., 2020). However, template-based methods and tools also have limitations related to the choice of *templates*, to the definition of correlation thresholds, since events with characteristics different from the previously selected waveforms may not be identified, due to environmental issues external to the event at that moment, restricting the scope of the analysis.

In addition to the methods described, specialists use *templates* in computer tools for the automated identification of similar seismic events. PyMPA (Python Matching Phase Algorithm) is a package aimed at automatic seismic phase matching (PYMPA DEVELOPERS, 2025), while SCDetect consists of a module of the SeisComP environment based on cross-correlation for the detection of earthquakes from waveforms (SCDETECT DEVELOPERS, 2025). These tools show the predominance of approaches based on cross-correlation and empirical thresholds.

3.3 CLUSTERING METHODS APPLIED TO SEISMIC SIMILARITY

In addition to approaches based on direct comparisons between pairs of events, some studies have employed clustering methods to organize sets of similar seismic events based on measures of similarity between waveforms. From this perspective, the cross-correlation metric is applied in clustering algorithms with the objective of identifying groups of events associated with the same seismic source or similar rupture mechanisms (WALDHAUSER; SCHAFF, 2007; BACHMANN et al., 2007).

These approaches allow for a more global analysis of the relationships between events, reducing the reliance on one-off comparisons. Recent studies have shown that clustering techniques can reveal internal structures in seismic data that are not evident through methods based exclusively on correlation thresholds, contributing to the understanding of the spatial and temporal organization of seismicity (WALDHAUSER; SCHAFF, 2021; GAO; KAO; LIU, 2023).

3.4 MACHINE LEARNING-BASED APPROACHES IN IDENTIFYING SIMILAR SEISMIC EVENTS

Machine learning-based approaches have been explored for the identification and classification of similar seismic events, especially in contexts characterized by complex signals and with large volumes of seismic data. These methods use supervised learning techniques to extract relevant characteristics from seismic waveforms, allowing automatic comparison between events from representations that are learned from the data, and in this case, are not restricted to explicitly defined similarity metrics (LI et al., 2018).

Machine learning models can be more robust in the face of noise and variations in seismic wave propagation conditions, when compared to traditional methods based exclusively on cross-correlation. In addition, these approaches have been successfully applied in the classification and grouping of seismic events, expanding the ability to detect complex and nonlinear patterns in the data (SI et al., 2023). However, despite their potential, machine learning-based methods have relevant limitations, such as the dependence on large labeled datasets, the lower physical interpretability of the results, and the difficulty of generalizing to regions or geological contexts other than those used in the training, which imposes challenges to their systematic application in seismic similarity studies.

4 RESULTS

The application of the search strategy defined in this systematic review initially resulted in a broad set of studies related to the identification of similar seismic events. After applying the inclusion and exclusion criteria and removing duplicates, a final set of materials considered relevant for the analysis was obtained. These studies cover classical methods based on cross-correlation, Euclidean distance, repeating signal detection techniques, and newer machine learning-based approaches.

The selected studies predominantly use methods based on the direct comparison of seismic waveforms, with emphasis on cross-correlation as a measure of similarity. Classical and widely cited works employ this coefficient to identify repeated or similar events, exploiting the temporal alignment of waves and maximizing the correlation value. In addition, approaches were identified that combine cross-correlation with pre-processing methods, such as spectral filtering, in order to reduce the influence of noise and external variations.

Some studies have used sliding windows to identify possible events, while others propose specific detectors for recurrent signals, capable of identifying multiple occurrences of similar events over large volumes of seismic data.

In addition to the classical methods, part of the analyzed works explores clustering techniques and machine learning algorithms for the identification of similar seismic events. Approaches include unsupervised methods, such as distance-based clustering, as well as supervised models aimed at classifying previously observed seismic events. In general, these methods use characteristics extracted from waveforms or representations in the time and frequency domains, seeking to automate the process of identifying recurring patterns in seismic catalog logos extracted from different seismic stations.

The analysis of the studies shows that the similarity criteria adopted in the literature vary considerably, being predominantly based on quantitative measures between pairs of events, such as correlation coefficients, distances in space of features or metrics derived from spectral transforms. Although these criteria allow the identification of similar events in different contexts, it is observed that there is no consensus on a unified model for representing the similarity between multiple events, which results in the coexistence of diverse approaches, adapted to specific objectives and data sets.

Table 1

Comparative synthesis of the main methods used in the identification of similar seismic events in the literature

Author(s)	Year	Main Method	Similarity criterion	Type of data analyzed
Bachmann et al.	2007	Cross-correlation	Maximum correlation coefficient between time-aligned waveforms	Seismic records of natural events
Li et al.	2007	Cross-correlation and spatial clustering	Waveform similarity associated with spatial proximity	Microearthquakes along active faults
Cheng et al.	2007	Cross-correlation	High correlation between repeated events	Microearthquakes recorded in Japan
Zhu et al.	2021	Re-evaluation of cross-correlation	Cross-correlation with pre-processing adjustments	Regional seismic catalogs

Skoumal et al.	2016	Repeating Signal Detector (RSD)	Correlation-based similarity and temporal recurrence	Seismic swarms
Tepp	2018	Repeating Signal Detector	Identifying recurring patterns in the signal	Continuous seismic data
Li et al.	2011	Cross-correlation	Repeated Event Similarity for Estimation of Slip Rates	Deep microearthquakes
Gonzales & Wintz	1987	Digital signal processing	Euclidean Distance	Discreet digital images
Li et al.	2018	Machine learning	Similarity in the Feature Space	Automatically classified seismic data
USGS	2024	Observational analysis	Physical and temporal criteria	Seismic events and aftershocks

Source: Authors.

5 DISCUSSIONS

The analysis of the studies selected in this systematic review shows the predominance of techniques based on the cross-correlation metric. This confirms the relevance of this metric as a fundamental tool for the comparison of waveforms, especially in contexts involving repeated events or seismic aftershocks. However, the way this metric is employed varies significantly between studies, both in terms of pre-processing and the definition of decision thresholds.

The use of empirical parameters is a recurrent aspect identified in the literature. They are often adjusted according to the local geology. Although this flexibility allows the methods to be adapted to different geological contexts, it introduces subjectivity into the process of identifying similar events, making it difficult to directly compare studies and reproduce results in different scenarios. This limitation is very relevant in analyses involving large seismic catalogs, where small variations in the parameters can result in very different classifications.

It was also observed that most approaches deal with the similarity between events by pairs, without considering the global structure of the relationships established between multiple events in the same database. This characteristic can lead to details that may not be well observed regarding comparisons between seismic waveforms, such as the absence of the transitivity relationship of the similarity between seismic events, which makes it difficult to

interpret the groupings. Although clustering techniques and machine learning-based methods have been proposed as alternatives to deal with this issue, such approaches often present additional challenges related to the choice of appropriate parameters.

Another relevant point refers to the sensitivity of methods for identifying seismic events similar to the conditions of data acquisition and the presence of external noise. Differences in the location of the installation of the stations and in the propagation characteristics of the waves can significantly affect the similarity measurements, even between events originating from the same seismic source. In order to mitigate these effects, several studies have adopted pre-processing strategies, including spectral filtering for noise reduction and temporal alignment of waveforms before calculating similarity metrics (BACHMANN et al., 2007; BARANI; FERRETTI, 2007). More recent approaches, such as multichannel waveform clustering methods, also incorporate these filtering, normalization, and alignment steps as a way to improve the robustness of cross-event comparisons (CASTELLANOS; VAN DER BAAN, 2015). Despite these advances, it was identified that there is still no consensus in the literature regarding a standard procedure capable of ensuring consistent performance in different seismic scenarios, especially when considering large catalogs and variable acquisition and noise conditions (ZHU et al., 2021). In general, the results of this review indicate that, despite the advances achieved in recent decades, methodological gaps still persist in modeling the similarity between seismic events. The absence of unified criteria and formal structures that adequately capture the relationships between multiple events suggests the need for further investigations aimed at developing more consistent approaches. In this context, this critical analysis contributes to the understanding of the state of the art and establishes a solid basis for future research that seeks to improve the criteria for identifying similar seismic waveforms.

6 CONCLUSION

This work presents a systematic review of the literature focused on techniques for identifying similar seismic events. The synthesis of the studies showed that, although there are a variety of approaches available, most methods are based on direct comparisons between pairs of events, often based on cross-correlation measures and empirical decision criteria that depend on the local geology.

The results seen in this systematic review indicated that the approaches have recurrent limitations related to noise sensitivity, dependence on data acquisition conditions, and inconsistency in the classification of similar events regarding the form of seismic waves throughout large seismic catalogs. In addition, the absence of unified conceptual frameworks

for modeling the similarity between multiple events contributes to inconsistencies in the interpretation of clusters and in the comparison between different studies. It is observed that the identification of similar seismic events remains dependent on the complexity of the data analyzed. Thus, future investigations may benefit from the incorporation of interdisciplinary approaches that explore mathematical concepts applied to the normalization, interpolation and noise filtering of seismic waveforms, in order to promote a more consistent standardization of data and enable fairer comparisons between events. This integration between Geosciences, Mathematics and Computing represents a promising path for the improvement of similarity criteria and for the development of more robust computational tools in seismic analysis.

Thus, the critical synthesis conducted in this systematic review reinforces the importance of future investigations aimed at the development and evaluation of more consistent, interpretable and theoretically grounded similarity criteria, capable of dealing with the heterogeneity of seismic waveforms collected by seismological stations. In this sense, this work provides an overview of the state of the art and establishes a conceptual basis for subsequent research that seeks to advance the curation and automated analysis of seismic data.

REFERENCES

- Bachmann, C., Wiemer, S., Woessner, J., & Hainzl, S. (2007). Analysis of seismic event similarity using cross-correlation. *Geophysical Journal International*, 168(2), 459–473. <https://doi.org/10.1111/j.1365-246X.2006.03199.x>
- Barani, S., & Ferretti, G. (2007). The waveform similarity approach to identify dependent events in instrumental seismic catalogues. *Geophysical Journal International*, 168(1), 100–108. <https://doi.org/10.1111/j.1365-246X.2006.03193.x>
- Castellanos, J., & van der Baan, M. (2015). Multi-channel waveform clustering for seismic event analysis. *Journal of Seismology*, 19(2), 273–289. <https://doi.org/10.1007/s10950-014-9465-7>
- Cheng, X., Niu, F., Silver, P. G., Horiuchi, S., Takai, K., Iio, Y., & Ito, H. (2007). Similar microearthquakes observed in western Nagano, Japan, and implications for rupture mechanics. *Journal of Geophysical Research: Solid Earth*, 112(B4), Article B04306. <https://doi.org/10.1029/2006JB004416>
- Gao, D., Kao, H., & Liu, J. (2023). Identification of repeating earthquakes: Controversy and rectification. *Seismological Research Letters*, 94(6), 2655–2665. <https://doi.org/10.1785/0220230124>
- Kanasewich, E. R. (1981). *Time sequence analysis in geophysics*. University of Alberta Press.
- Li, L., Chen, Q. F., Cheng, X., & Niu, F. (2007). Spatial clustering and repeating of seismic events observed along the 1976 Tangshan fault, North China. *Geophysical Research Letters*, 34(23), Article L23309. <https://doi.org/10.1029/2007GL031594>

- Li, L., Chen, Q. F., Niu, F., & Su, J. (2011). Deep slip rates along the Longmen Shan fault zone estimated from repeating microearthquakes. *Journal of Geophysical Research: Solid Earth*, 116(B9), Article B09310. <https://doi.org/10.1029/2011JB008406>
- Li, W., Nakshatra, Narvekar, N., Raut, N., Sirkeci, B., & Gao, J. (2018). Seismic data classification using machine learning. In 2018 IEEE Fourth International Conference on Big Data Computing Service and Applications (pp. 1–8). IEEE. <https://doi.org/10.1109/BigDataService.2018.00009>
- PyMPA Developers. (n.d.). PyMPA — Python Matching Phase Algorithm. <https://pympa37.readthedocs.io/en/latest/index.html>
- Sampaio, R. F., & Mancini, M. C. (2007). Estudos de revisão sistemática: Um guia para síntese criteriosa da evidência científica. *Revista Brasileira de Fisioterapia*, 11(1), 83–89.
- SCDetect Developers. (n.d.). SCDetect: SeisComP package for waveform cross-correlation based earthquake detection. <https://scdetect.readthedocs.io/en/stable/>
- Skoumal, R. J., Brudzinski, M. R., & Currie, B. S. (2016). An efficient repeating signal detector to investigate earthquake swarms. *Journal of Geophysical Research: Solid Earth*, 121(8), 5880–5897. <https://doi.org/10.1002/2016JB012981>
- Smith, S. W. (1997). *The scientist and engineer's guide to digital signal processing*. California Technical Publishing.
- Tepp, B. (2018). Repeating signal detection using the repeating signal detector algorithm. *Seismic Detection Methods*, 15(1), 15–29.
- U.S. Geological Survey. (n.d.). What is an earthquake and what causes them to happen? <https://www.usgs.gov/faqs/what-earthquake-and-what-causes-them-happen>
- van Etten, W. C. (2006). *Introduction to random signals and noise*. John Wiley & Sons.
- Wikipedia Contributors. (2025). Cross-correlation. In Wikipedia. <https://en.wikipedia.org/wiki/Cross-correlation>
- Zhu, T., et al. (2021). Reassessing cross-correlation for seismic event identification. *Journal of Seismology*, 25(3), 789–802.

FROM CUSTODY TO CONTROL: A BRIEF HISTORICAL ANALYSIS OF THE EMERGENCE OF IMPRISONMENT AS A MEANS OF PUNISHMENT

DA CUSTÓDIA AO CONTROLE: UMA BREVE ANÁLISE HISTÓRICA DO SURGIMENTO DA PRISÃO COMO MEIO DE PUNIÇÃO

DE LA CUSTODIA AL CONTROL: UN BREVE ANÁLISIS HISTÓRICO DEL SURGIMIENTO DE LA PRISIÓN COMO MEDIO DE CASTIGO



<https://doi.org/10.56238/sevened2026.008-020>

Bruno de Omena Celestino¹, João Arthur Alves de Souza²

ABSTRACT

The theme of imprisonment is a contemporary reality, present in both public and private debate and at various levels of social life. Due to the significant presence of this issue in social discourse, the impression is created that imprisonment as punishment has been part of this institution since its earliest records. In fact, places of confinement have existed since Antiquity, being observed in Egyptian, Mesopotamian, Hellenic, and Roman civilizations, extending into the Middle Ages. However, during this period, prisons served primarily as a means of custody, with rare examples of imprisonment having punitive purposes. At the end of the Middle Ages, some monastic orders of the Roman Catholic Church began to use confinement in cells as a means of discipline and correction of clergy, and it was occasionally applied to laypersons as punishment for the commission of offenses regarded as serious in light of Catholic dogma. Only in the Modern period did the first prison facilities begin to acquire new functions, as a result of changes in the economic and social system.

Keywords: Prison. Custody. Transformation. Social Control.

RESUMO

O tema prisão é uma realidade contemporânea, presente no debate público e privado e em diversos níveis do convívio social. Em razão da presença significativa da temática no debate social, cria-se a impressão de que prender para punir faça parte dessa instituição desde seus primeiros registros. De fato, cárceres existem desde a Antiguidade, sendo observados em civilizações egípcias, mesopotâmicas, helênicas e romanas, estendendo-se até o Medievo. No entanto, as prisões durante esse período serviam como meio de custódia, sendo raros os exemplos de prisões com finalidades punitivas. No final da Idade Média, algumas ordens monásticas da Igreja Católica romana passaram a utilizar o recolhimento em celas como meio de disciplina e correção de clérigos, tendo, algumas vezes, sido utilizado também para a punição de leigos em face do cometimento de infrações reputadas sérias diante dos

¹ Dr. of Laws. Pontifícia Universidade Católica de São Paulo (PUC-SP). E-mail: bocelestino@yahoo.com.br
Lattes: <http://lattes.cnpq.br/6448977991914914>

² Master's degree of Public Law. Universidade Federal de Alagoas (UFAL). E-mail: joao.souza@umj.edu.br
Lattes: <http://lattes.cnpq.br/3651820656787150>

dogmas católicos. Apenas na Modernidade as primeiras instalações prisionais passaram a adquirir novas funções, em razão das mudanças do sistema econômico e social.

Palavras-chave: Prisão. Custódia. Transformação. Controle Social.

RESUMEN

El tema de la prisión es una realidad contemporánea, presente en el debate público y privado, y en diversos niveles de la vida social. Debido a su importante presencia en el debate social, da la impresión de que el encarcelamiento como castigo ha formado parte de esta institución desde sus primeros registros. De hecho, las cárceles han existido desde la antigüedad, existiendo en las civilizaciones egipcia, mesopotámica, helénica y romana, extendiéndose hasta la Edad Media. Sin embargo, durante este período, las cárceles sirvieron como medio de custodia, siendo escasos los ejemplos de prisiones con fines punitivos. A finales de la Edad Media, algunas órdenes monásticas de la Iglesia Católica Romana comenzaron a utilizar el confinamiento en celdas como medio para disciplinar y corregir al clero, a veces también para castigar a los laicos por cometer infracciones consideradas graves según el dogma católico. Fue en la Edad Moderna cuando las primeras instalaciones penitenciarias comenzaron a adquirir nuevas funciones, debido a los cambios en el sistema económico y social.

Palabras clave: Prisión. Custodia. Transformación. Control Social.

1 INTRODUCTION

Arresting someone to punish as a result of a crime committed is an almost omnipresent reality in contemporary society. It is an immanent activity in the practice of modern states, not least because it is one of the most visible forms of exercising state power. As if that were not enough, it is a recurring theme in the mass media, being practically daily on the agenda of newsrooms and editorials. In the everyday imaginary, prison occupies a relevant space, being the object of many cinematographic, literary, musical works, etc., when it is not a subjective reality, lived and suffered by a significant portion of the population. In fact, at some point the topic of imprisonment has already occupied space in people's lives, even if in trivial conversations. This means that prison is more than a mere punitive instrument, constituting a social and political institution that occupies multiple segments in society and, not infrequently, is the object of long studies and debates.

Its presence does not mean unanimity, as there are those who see it as a highly harmful and inhumane modality, in which, for the most radical, proscription would be an alternative. However, there are others who see it as an acceptable and more humane means of punishment compared to other means of punishment already tried in history. On the other hand, there are those who see it as an insufficient means, especially when it is used for certain types of violent crimes, and should be relegated to the background in favor of other more incisive means of punishment, such as capital punishment. However, although permeated with criticism, there is no current state that dispenses with its use as the main means of punishment.

In this context, since prison is impregnated in the collective imagination and in legal systems around the world, it ends up appearing to be a very ancient punitive institution, which would be present since the first civilizations, causing the debate about this form of punishment to be harmed by the construction of a common sense of this almost ethereal nature, as if it were an immutable reality from the beginning and that should be included in all analyses of this punishment in society.

In this vein, this article seeks to understand at what moment prison as a means of punishment has its root, that is, when does prison effectively acquire this new function?

To answer the problem, it is necessary to analyze the historical context in which prison begins to encompass a punitive function, meeting the primary objective of unveiling the point of change in prison functions and using the methodology of bibliographic review. To this end, it is essential to meet some secondary objectives that are summarized, first, in the analysis of the historical functions of prison from Antiquity and, later, in the emergence of the first punitive prison devices. However, considering the large temporal elastic that a historical

analysis presupposes and the need to maintain strict adherence to the problem and objectives proposed in this article, it will be limited only to the relevant historical points in which it is possible to highlight the inflection point of the functions of prison, not analyzing the problems and consequences that arise from the establishment of prison as a means of punishment, leaving these questions to other works on the subject that are abundant in the scientific literature.

2 DEVELOPMENT

2.1 IMPRISONMENT OR IMPRISONMENT?

In penology and penitentiary, the words *prison* and *prison* are similar ideas, but not identical. There would be a distinction in the use of the expressions, since *prison* would precede *prison*, since the first would identify places, even if rudimentary, intended for the custody of a person, while the second would be close to the meaning of penitentiary or prison, where a sentence imposed in the face of a sentence is served.

According to Neuman (1971, p. 24):

Prison (word and institute) precedes prison, prison and penitentiary, which specifically designate different modes of execution and places of execution of the custodial sentence. From this it is indisputable that the expression prison historically and technically designates the place or building in which the accused or accused are housed (what the French call *prévenus*); and prison, prison or penitentiary, indicates, on the other hand, the place intended for those convicted judicially.

However, the distinction of the expressions does not seem relevant to us, since the expression prison does not represent its own legal category in various legal systems. In Brazil, the expression prison is generic and encompasses both the various types of establishments intended for the restriction of liberty (jails, prisons and penitentiaries) while the expression prison is intended more to name the legal institutes that deprive someone's liberty, such as temporary detention, preventive detention, civil prison, etc. Certainly, the very idea of distinguishing the expressions *prison* and *prison* is artificial, since the distinction was made *a posteriori* due to new functions added to incarceration.

Thus, we consider the idea of imprisonment as a generic expression that encompasses any and all establishments intended for the imprisonment of a person, whatever its purpose. Thus, in order to facilitate the exposition, we will treat the expressions prison and prison as synonymous, discarding merely formalistic linguistic rigors.

2.2 PRISONS IN ANTIQUITY

In Egyptian civilization, prisons were known, but in the overwhelming majority of cases, they typically had custodial functions. Arrests for punitive purposes were not an Egyptian practice, despite the fact that a prisoner could be taken into custody because he had been subjected to slavery or forced labor.

Gusmão (2010) states that the usual punishments were batons, mutilations, exiles, death, including by incineration at the stake, while Dotti (2010) points out that, in this period, death penalties, enslavement, mutilation and other types of corporal punishment were common, in addition to forced labor in mines.

Peters (1995) mentions that there are records of prisons in Ancient Egypt from the so-called Middle Kingdom, especially for the public function performed by the pharaohs in maintaining the so-called *maat* (a concept that could be approximated to justice or order, and on which the balance of the universe would depend), with prison being highlighted, along with physical punishment, compared to the death penalty. These prisons could be resembled fortresses with cells, dungeons, or institutions such as future *workhouses* or labor camps, since it seems that inmates are expected to work during incarceration.

Peters (1995) continues that, in these places, there was no distinction between classes of prisoners, and people who were there for various reasons were allocated, such as those who were waiting for their cases to be heard, who were waiting for punishment or who were indefinitely held for the purpose of forced labor. It was also suitable for people suspected of being spies, disgraced officers, or to hold foreign captives who were captured in war.

In the cultural and religious imagination, perhaps the most vivid example of the existence of prisons in Ancient Egypt is recorded in a passage from the biblical book of Genesis (Gen 39:19-23), sacred in common to both Christianity and Judaism, where it is mentioned that Joseph, one of the twelve sons of the patriarch Jacob, enslaved in Egypt, was incarcerated in an Egyptian prison after being unjustly accused by the wife of his captor of committing a crime (Bible, 2021).

Prison in Egyptian civilization, therefore, was an instrument of custody in essence, especially for the purpose of exploiting forced labor and enslavement, which can be seen by most of the colossal Egyptian historical monuments that largely used enslaved or forced labor, with prison being a preponderant place of custody of forced labor.

In the kingdoms of the civilizations of the region of the Euphrates and Tigris rivers there are also sparse records of arrests, although, as in other civilizations, they were intended for custody. The forms of punishment were predominantly corporal, when they did not involve the death of the punished.

Gusmão (2010) describes that the Babylonian legislation bet on capital punishment through drowning, crucifixion, with penalties of mutilation, enslavement, pecuniary penalties, amputations, payment of fines, etc. According to Peters (1995), prisons were rarely mentioned in the historical codifications of that period, being mentioned in other sources of literature, indicating that they were used for cases of debts, thefts, bribes, slave rebellions and captured foreigners.

In the Assyrian Empire, Peters (1995) points out that traffickers, thieves, deserters and tax evaders were imprisoned in places intended for the submission of those in custody to forced labor. Babylonian terms such as *bit asiri* designated forced labor for captured foreigners, and *biti kili* would be places similar to prisons where criminals, kidnapped, rebels, etc. However, Dotti (2010) points out that Assyrian practices were generally cruel and bet on the profligacy of death penalties and cruel punishments.

In the Hebrew civilization, the main forms of punishment were death and exile, with the purpose of eliminating from the community those who violated the order of society and, in the spiritual conception, the purity of the people, which could attract the wrath of God on the community. Strongly inspired by the ordinations of the Pentateuch (the first five books of the Bible), the sanctions aimed at

According to Peters (1995), the main forms of execution were stoning, incineration, decapitation or strangulation, as well as the punishments of mutilation, physical punishment, payment of fines, compensation and mandatory sacrifices. The existence of prisons is rarely mentioned, although there is news, mainly from records in sacred books, of the existence of prisons with custodial characteristics, despite the fact that Mirabete and Fabbrini (2009) point out that, through the Talmud, there was a progressive replacement of talionic punishments by other sanctions, such as forced labor.

Within the scope of Hellenic civilization, depending on the *polis*, punitive practices varied. They could range from moral and political punishments (such as enslavement, ostracism from public life, banishment, etc.) to pecuniary punishments and corporal punishment. However, as in other civilizational experiences, prison, despite not being a punitive practice in itself, was also a reality as a custody.

Taking the example of Athens, Peters (1995) states that prisons had a temporary custody function, as a means of forcing the payment of debts, places for the practice of torture and as places where individuals with long or life punishments could be placed, not having a great punitive role, being more common death penalties, fines and exile, although they were used with some frequency (Peters, 1995).

It was in Rome, however, that the prisons would be more visible and their use as punishment would have their first records.

Carrara (2002) mentioned, in his famous program, that Roman imprisonment was not about punishment, but about custody. He did not deny their existence, acknowledging the presence of several prisons in Ancient Rome, but emphasizing that they did not have a punitive purpose. Lyra (1955) stated that historians would not agree on the existence of public prisons of a penal nature, except for custody, although there were limitations on freedom, enslavement and the so-called *condemnatio ad metalla* (Lyra, 1955).

Peters (1995) mentions that the Law of the Twelve Tables, although it did not directly provide for the management of prisons, authorized private imprisonment executed by creditors against debtors for a period of six days to coerce them to pay the debt or, ultimately, subject them to slavery. Furthermore, considering the power that the male head of the Roman family possessed (*pater familias*), he was not forbidden to maintain a domestic prison to discipline the members of his family, to imprison rebellious slaves or to enclose those recalcitrant for work, in what was called *ergastulum*.

However, in addition to private prisons, there are records of the practice of incarceration in Roman public society through the *latumiae*, which were a kind of prison-quarry, being part of a prison complex located in the lower part of the Roman Capitoline Hill. Near this place there was also an underground complex named *Tullianum*, later renamed *Carcer Mamertinus*, built around the third century BC, in the northeastern part of the Roman forum known as *Comitium*, where many matters of a judicial nature were handled, so it is thought that it was idealized for the convenience of being close to the courts, being destined for custody and executions. The author, however, mentions that it was difficult to imagine such places as prisons as an instrument of long-term punishment, even because of the terrible conditions of the places, but that it would be possible to imagine them as a place of custody for prisoners of war and those sentenced to long, even life, punishments, although such cases were rare (Peters, 1995).

This same impression is placed by Ferrajoli (2011), acknowledging that the prison is a very ancient institution, noting the existence of the Tullian prison, later called Mamertino, something that would have already been mentioned by Sallust and Livy and given rise to the legend that the prison would have been built by King Ancus Márcio to instill fear in the plebs. The author also points out that, in Rome, in addition to capital punishments, penalties such as *damnatio ad metalla*, a kind of forced labor, *deportatio in insulam*, *relegatio ad tempus* or *in perpetuum*, were foreseen, while Emperor Zeno would later have established the eminently public character of prison, and Emperor Justinian would have reaffirmed that no one could

be arrested without an order from the magistrate. However, it should be noted that, during the Roman period, imprisonment was not seen as punishment, and the author highlights Ulpian's adage: *carcer enim ad continendos homines, non ad puniendos haberi debet*.

If analyzed from a structural perspective, it is seen that prison is an appropriate place to prevent someone from escaping, keeping him available for the purposes that are in the best interest of the captor. That is why, originally, it was not intended to punish a person, but to guard him so that, later, he would be subjected to the true sanction, primarily corporal, such as the infliction of injuries, amputations or death. There were exceptions, but imprisonment, primarily, was placed to ensure the execution of corporal punishment³.

2.3 PRISONS IN THE MEDIEVAL PERIOD

In the Middle Ages, the prison went through a slow process of historical resignification from the point of view of its functions, without, however, losing its function as an instrument of custody.

There are reports, according to Peters (1995), that the Franks, in the region of the ancient Roman province of Gaul, used monasteries to guard rebels, but most of the time, like the Lombards, the use of sanctions such as fines, enslavement, mutilation and death penalties was preferred.

In the attempts to rescue the Roman legal tradition through edicts of the Germanic kingdoms, which occupied the political space of the former Western Roman Empire⁴, it is possible to find mentions of the use of prisons, although they are rarely mentioned.

Dotti (2010) mentions the use of prison in an eighth-century edict of King Liuprand, of the Lombards, requiring each city to have a prison to imprison people accused of being thieves for a period of up to two years, as well as in a capitular of Emperor Charlemagne, in the ninth century, determining that people of *boni generi* could be imprisoned until they could amend, which would have already been cited in the doctrine as a rare situation, in the period, of imprisonment as a sanction.

³ Despite the non-existence of the institution of prison as a means of punishment in Ancient Rome, it is curious to find in historical records current discussions about the problems related to contemporary prisons. On this point, Peters (1995) mentions the Code of Theodosius – which, in fact, was a compilation of several previous edicts – which contains an edict of Constantine, from the year 320, preventing custodians from being kept chained with instruments that injured the bones, determining that those in custody were kept in bright places and in good health, as well as other norms that determined that judges should make periodic visits to prisons, they ensured food at the expense of the Roman treasury and the right of these to go to the baths accompanied by guards.

⁴ This movement gave rise to the codifications that can be classified as part of the Vulgar Roman Law, having as examples, according to Paulo Dourado de Gusmão, the historical *Lex Romana Wisigothorum*, of the Visigoths, *Lex Romana Burgundionum*, of the Burgundians, and the *Edictum Theodorici*, of the Ostrogoths (Gusmão, 2010).

Bruno (1978, v. 3) points out that the exclusively precautionary purposes of the existing prisons were maintained during the Middle Ages, considering the prominence of corporal punishment, infamous punishment and capital punishment. However, it identifies some situations where prisons were used with some sanctioning characteristics, such as in the Edict of Liuprando, king of the Lombards, of 720, for some cases of theft, indefinite imprisonment by edict of Charlemagne, in addition to provisions in the ancient criminal law of Nuremberg, where incarceration was provided as a model of punishment for some crimes. In addition, several medieval German and Italian cities had prisons for detention, substitution of fines, and punishment of petty crimes.

Peters (1995) also mentions the edict of King Liuprando as a rare example of the standardization of prisons in the early eighth century, adding the information that it was up to the judges to build the prisons in their respective district. Also according to the author, the Visigoths, in the region of present-day Spain, were strongly influenced by Roman legal practices, highlighting the existence of Visigothic laws that mentioned imprisonment as an instrument of custody of prisoners for later execution.

In the period of the Late Middle Ages, with the beginning of the slow process of replacing the old traditional and decentralized monarchies with models that, henceforth, would give way to monarchies centralized in the figure of a sovereign, the use of prisons becomes better documented and with facilities (castles, forts, palaces, etc.) adapted to be transformed into prisons, without, With this, one can speak of the use of prison as a penalty.

According to Neuman (1971), except for sporadic cases at the end of the sixteenth century, the idea of deprivation of liberty was not known in the Middle Ages. In fact, incarceration took place in underground cells called *vade in pace* or in dungeons, rooms in fortresses and palaces adapted for incarceration, such as the Tower of London, initially a fortified palace, the Bastille Fortress in Paris, originally a palace and treasury of the Templars, the *Bicêtre*, which would have been built to be an episcopal palace or *Piombi di Venezia*, apartments of the Venetian ducal palace.

In the Kingdom of England, Peters (1995) points to the Tower of London, built by order of King William I and which was used as a prison to guard the king's enemies. In other prison buildings, it was already possible to find people in custody by order of local judges, as they were prisoners of war or hostages. In addition, when the *Assizes of Clarendon* was issued in 1166 by King Henry II, the *sheriffs* were ordered to build local jails in their respective counties, for the custody of prisoners accused of offenses until the arrival of the itinerant royal judges, who would promote the respective trials.

The arrests of these periods maintained clear precautionary purposes, intended to keep the prisoners in custody until their trials. Also according to Peters (1995), punishment in English law was made to be quick and discourage the practice of other crimes, and the forms of punishment were vexatious, involving mutilation, branding, public flogging, in addition to death penalties that could be given by hanging, drowning, incineration, live burial or decapitation, without forgetting the possibility of inflicting previous torments.

In the French Kingdom, a similar situation was found. The justice system of that period consisted of decentralized levels of administration of justice, where, alongside royal justice, the justice of the nobility, municipalities and ecclesiastical courts coexisted, a reality that, in fact, would persist until the appearance of the Napoleonic codifications. It was during this period that well-known fortifications began to be used as prisons. The best known and most emblematic were the fortifications of the *Châtelet*, on the banks of the Seine River, which had already been used for the custody of detainees around 1200, and the emblematic fortress of the Bastille, which, although it was designed as a defensive structure of Paris, was successively modified in the following kingdoms, becoming a prison facility (Peters, 1995).

It is necessary to recognize that, even though penitentiary facilities have existed in France since the period of the Late Middle Ages and in the centuries that followed, the use of prison as a punishment was not the main means of sanction. Hence the warning of Carrara (2002, v. 2) that it was only with the enactment of the Penal Code of 1791 – therefore, after the events that determined the outbreak of the French Revolution and the end of the Modern Age – that prison began to be used properly as a penalty.

In the Iberian Kingdoms there were prisons and, like many models spread in the Western world, they were intended for the custody of individuals so that, in the future, they would be the object of the common punishments of the period. However, what draws attention in some of these kingdoms is the existence of advanced legislation dealing with prisons, which found no parallel in many of the kingdoms that were contemporary with them.

Peters (1995) alludes to the *Siete Partidas*, a collection of laws organized and published in 1265 by King Alfonso X of the Kingdom of Castile, which contained the most extensive discussion of the use of prisons in that medieval period. If it is not possible to know the extent of the de facto application of this legislation to Castilian prisons, the existence of a legislative work of this magnitude would indicate a concern with the situation of prisons, and it is not a legislation that was a mere copy of ancient Roman laws or laws of the Kingdom of France.

However, if there is a medieval institution that developed the purposes of imprisonment in the period, it was the Roman Catholic Church. Originally, the juridical questions with which

the Catholic Church dealt were of an ecclesiastical nature. However, with the increasing intervention in worldly affairs, the Church began to position itself as the authority to regulate matters that would involve the entire Christian community or Christendom.

According to Peters (1995), bishops assumed responsibility for broad matters of interest to the clergy, as well as those related to the property of the Church itself and immoral behaviors within their communities. Writings of bishops and religious of the city of Rome, which contained legislative and consultative acts, had their authority accepted in much of European Christendom. Furthermore, from the sixth century A.D., as various materials of a legal nature were produced by local ecclesiastical assemblies, individual books of penance, liturgical books and edicts of Germanic kings, they began to be the object of study and systematization by scholars, and from the twelfth century onwards, they began to receive the referendum of the Church, having as its starting point the *Decretum* of 1140 ("Concurrence and Disagreement of the Canons")⁵.

Imprisonment will appear in Canon Law as a punitive and correctional alternative, a true disciplinary instrument seeking the punishment and expiation of sins by cellular isolation.

Dotti (2010) notes that punitive practice in canon law was responsible for clearly introducing the punitive nature of an individual's submission to prison. The prison would have the function of subjecting the sinner to the awareness of his sin and his consequent expiation through imprisonment.

Mirabete and Fabbrini (2019, v. 1) highlight the contribution of canon law to add another purpose to punishment, which, in addition to being an expiatory means, should also be regenerating.

For Peters (1995), the development of canon laws in the cases of monks, secular clergy and laity can be understood as a remote articulation of an institutionalized system of discipline, based on the ideal of correction and penitentiary atonement, where the prison emerges with a new function.

There is no certain date as to when the use of imprisonment as a means of punishment by Canon Law begins. According to Peters (1995) one could point to the recovery of the Roman practice of *ergastulum* in monasteries, since during the Synod of Tribur, in 895, a letter from the bishop of Tarragona, at the end of the fourth century, was republished, containing in that document the defense that rebellious monks and nuns should be enclosed in *ergastula*, separate compartments in the monasteries where they would receive discipline

⁵ Also according to Peters (1995), the *Decretum* of 1140 would be a collection carried out by Gratian, which came to be accepted as a basis for the study of ecclesiastical or canonical laws. Canon laws were widely recognized by various political entities of the time, such as individual monarchies, principalities, and free cities, until the advent of the Reformation in the sixteenth century.

through forced labor. This practice was included in the collection of the *Decretum* of 1140. As if that were not enough, from the sixth century onwards, many monastic constitutions, although not part of the *legislative corpus* of the Roman Catholic Church, used the expression *cárcere* (*carcer*) to designate a place of penitentiary enclosure at the discretionary disposal of the abbot, including, in some more extreme cases, perpetual enclosure being possible. With the systematization of canon law at the end of the twelfth century, it was already expected that each monastery would have a prison or something similar, and in the thirteenth century, monastic enclosure was already formally mentioned as a punishment, being compared by many writers of the time, when perpetual, as comparable to the death penalties imposed in the secular sphere.

In this point, he points out:

Monastic prisons also served to confine the secular clergy under the supervision of bishops. The process was known as *detrusio in monasterium* ('confinement in the monastery'), and this may suggest either living as a monk in a normal monastic discipline or being held in a monastic prison. During the twelfth century, bishops were expected to have their own diocesan prisons for the criminal punishment of clergy. The episcopal use of imprisonment as punishment was regularized in a decree entitled '*Quamvis*' and published by Pope Boniface VIII in his legal collection, *Liber sextus*, of 1298. Addressing the doctrine of Roman law that prisons should serve as places of confinement, not punishment, Boniface nevertheless allowed abbots and bishops to punish offenders with *poena carceris* ('prison sentence') either for a period or in perpetuity. Boniface VIII was the first sovereign authority in the Western tradition to define that imprisonment as punishment was a legitimate instrument of a universal legal system (Peters, 1995, p. 28-29).

Although monastic enclosure was used primarily for internal disciplinary matters, the influence and interference of the Roman Rite Catholic Church in the daily life of the laity meant that, at a certain point, there are also records that it was used as a means of punishment to the detriment of the laity.

For Peters (1995), Catholic religious discipline imposed that it was the duty of the Church to ensure the expiation of the sins of the faithful, which, *a priori*, was done through penances in the face of sinners who confessed their sins in secret. However, in some cases, when the sins were public and caused scandal that offended the Christian community, they were required to be regarded as criminal sins and the object of public penances, admitting, in some cases, extreme measures such as exclusion from the Church, exclusion from the sacraments, and the imposition of public penalties of various kinds, including confinement in monastic prisons. In several councils held during the eighth and ninth centuries, incarceration was directly insisted upon as a means of dealing with public sins, such as incest, witchcraft, and divination.

Neuman (1971) emphasizes the possibility of applying imprisonment outside the clerical ranks, highlighting the difference between the *detrusum in monasterium*, applied to the detriment of clerics who violated ecclesiastical norms, and the punishments imposed to the detriment of "heretics", highlighting the difference, even, in regimes, such as the one called common or *murus largus* from those of a cellular nature or *murus arctus o arctissimus*.

Gradually, therefore, the monastic prison is transformed from an instrument for the disciplinary issues of the Catholic clergy into a means of punishment that can be enforceable against the other individuals over whom the authority of the Church was in fact exercised, which can be explained by the political decentralization of the period, where the Catholic Church, through the prestige of its Roman heritage, of its organization and political hierarchy, was one of the rare examples, in the Middle Ages, of a minimally organized legal structure that managed to make itself respected to the point of having the authority to impose sanctions.

However, even though the prisons existing in the medieval period had maintained the preponderantly precautionary purposes, it is already observed, in that period, the appearance of structural problems faced in many contemporary penitentiary systems. Peters (1995), using the English example, points out that, with the growth of criminal matters, jails began to suffer from overcrowding, leading the Crown to appoint commissions to solve penitentiary problems as early as the thirteenth century. there are records of prisons maintained by nobles or under a franchise regime, where the right to imprison people in exchange for remuneration was assured.

2.4 THE FIRST PRISON EXPERIENCES OF MODERNITY

With the beginning of the Modern Age, the first prison institutions begin to take shape. The change in the functionality of the prisons was not immediate, but gradual. As Prado (2013, v. 3, p. 113) points out, "[...] prison, until the eighteenth century, continued as an instrument of procedural custody, so that those institutions remained with an exceptional character".

Pimentel (1989) states that the radical of prisons is located in the Middle Ages, through the monastic cells dedicated to the penance of monks and clerics who were absent, in a place where, due to isolation, they would dedicate themselves to silence, meditation and repentance. However, the first prison facilities for the incarceration of criminals have as precursors the experiences of the *houses of correction*, built in London in the sixteenth century, which were replicated in Amsterdam at the end of the century, in male and female establishments, and later in what would be present-day Germany, in the seventeenth century,

while, in the eighteenth century, they would also spread in what would be present-day Belgium, also remembering the creation of the Hospital of St. Michael, in Rome, by the work of Pope Clement IX.

In England, around the sixteenth century, the so-called Houses of Correction or *Bridewells* appeared. According to Lyra (1995, v. 2), the British and Americans understand the *bridewells* as being the first examples of facilities intended for the fulfillment of sentences, being sketches of the sentences of correctional houses. This conception is further noted by Bruno (1978, v. 3), for whom Bridewell was the first experience of a house of correction, which began in London around the second half of the sixteenth century A.D., and which ended up being repeated not only in England, but also in other centers, in Amsterdam, German cities and even in the aforementioned correctional centers for minors in the Italian peninsula.

Melossi (2010) mentions that Bridewell Castle was intended to welcome vagabonds, idlers and thieves who committed minor crimes, with the aim of reforming the unemployed through strong discipline and submission to work, as well as discouraging other people from following such a path. Due to the apparent success, the other houses of correction that followed also came to be called *bridewells*. These *bridewells*, however, functioned as a means of forcing people to work in the condition offered to them, whatever it might be, under penalty of authorizing judges to submit idlers capable of working to prisons.

In the region of the present-day Netherlands – generalized inaccurately as the Netherlands – there were also institutions for incarceration and the imposition of work on prisoners, known as workhouses (*Tuchthuis*) or even as *Rasphuis* and *Spinhuis*.

They have peculiarities that do not necessarily make them mere repetitions of the English *workhouses*, being known as *tuchthuis*, whose main activity was the scraping of wood so that dyes could be produced from this process, something profitable at the time and which is related to the history of Brazil, considering that one of the raw materials for such activities was brazilwood wood, extracted in abundance in the Brazilian colonial period. Such institutions would also have been known as *rasphuis*, as they were the houses of correction intended for men, while the *spinhuis* were those intended for the gathering of women.

Melossi (2010) states that the Dutch workhouses were not necessarily directly influenced by the English *houses of correction*, as the *tuchthuis* would have reached a high degree of development due to the economic context of the period. For the author, there was a context of stimulation of forced labor due to the changes caused by the Protestant Reformation throughout Europe, as well as the growth of the mercantile traffic, which increased the labor market and began to demand instruments to regulate the available labor forces through changes in punitive instruments, especially due to the fear that there would

be a high cost of this labor. Furthermore, in addition to controlling remuneration, it sought to control the workforce itself, educating and domesticating it.

Also according to Melossi (2010), the beginning of this institution had as its starting point the installation, in 1596, in a convent in the city of Amsterdam, due to a decision by the local magistrates to install a house so that vagabonds, evildoers and braggarts could be arrested to be punished and occupied with work for as long as the magistrates deemed convenient. The institution was designed to be self-sustaining with the work of prisoners, although it did not aim at personal profit, even for its leaders. In addition, the penalties would be brief and would admit modification through the behavior of the prisoner. Furthermore, the creation of this institution would not have replaced the other forms of punishment, becoming just another punitive instrument intermediate between pecuniary punishments and physical punishments and the penalties of banishment and capital.

The nomenclature, in turn, comes from the type of forced labor that began to be carried out in these institutions: the scraping of wood for the purpose of producing dyes, being a kind of manufacture, a means of production until then dominant, much thought out for idle and lazy people, due to its strenuous nature, which could cause serious injuries, although it did not translate into quality, as there were already complaints that the quality of the powder produced would not be as good as that produced in the mills. In addition, these places were assured the monopoly of production, typical of a mercantilist structure, which caused problems with municipalities that sought modern means of production (Melossi; Pavarini, 2010).

In a similar vein, Prado (2013, v. 3), highlighting that the appearance of these institutions took place in 1596, in Amsterdam, reinforces that the *rasphuis* were those work facilities intended for men, while the *spinhuis* for women, being houses of correction that influenced the proliferation, in Germany, of similar establishments.

As can be seen, the influence of the *tuchthuis* in the history of prison is very much felt in Europe, either because they represent a model of institution very similar to the houses of correction, attributing a different purpose to the prison from that of mere custody, or because they proved useful according to the mercantile and colonialist model of the period, marked by the exploitation of both the natural resources of the overseas colonies and the labor of captives and prisoners.

In addition to the houses of correction that originated in the sixteenth century in what is now the United Kingdom and the Netherlands, another type of correctional institution was operationalized in the late seventeenth and early eighteenth centuries in the Italian peninsula: the so-called hospices or hospitals for young delinquents, whose nomenclature should not

be confused with the contemporary institutions of the same name. but it concerned a kind of houses of correction that were structured to collect young people accused of crimes so that they could, by rigid discipline typical of monastic prisons, reform them.

Carrara (2002, v. 2), although he states that prison sentences took shape after the liberal revolutions, recalls that there were monasteries in the seventh century, used for penitentiary purposes, recalling that it was already pointed out that there were already prisons for young delinquents in the Hospital of San Miguel, in Rome, in 1703, and in San Felipe, in the city of Florence, in the year 1701.

Prado (2013, v. 3) indicates that in the second half of the seventeenth century, the priest Filippo Franci created the Hospice of St. Philip Neri, in Florence, intended for the correction of young people; however, it was in Rome, in 1704, that Pope Clement XI himself created the institution of the Hospice of St. Michael, in the wake of the reforming ideas, being a house of correction that subjected young people to a penitentiary regime of daytime silence and nighttime cell collection for the purpose of reform.

2.5 THE ATTRIBUTION OF THE NEW FUNCTION TO PRISON: PUNISHING TO CONTROL

With the emergence of the first modern prison experiences, there is then a turning point: new functions begin to be attributed to prison. From a means of custody, the embryonic prison establishments become a means in themselves.

The reasons are varied. On the one hand, there are theories that identify that its emergence was due to humanitarian or utilitarian reasons, either because of the lesser harm when compared to other corporal punishments, or because of the impossibility of applying some types of punishment en masse, such as capital punishment.

Lyra (1955, v. 2) pointed to several factors that culminated in the appearance of the first modern prison experiences. On the one hand, the religious conception of penance that encouraged incarceration for the purpose of correction and expiation of sins. On the other hand, the increase in crime in the sixteenth and seventeenth centuries and the impossibility of mass application of corporal punishment generated imprisonment as a viable alternative. Thus, the first attempts to solve this problem were practices of seclusion with the imposition of forced labor, citing as examples installations in Amsterdam, between the years 1595 and 1597, Bremen in 1609, Lubuque in 1616, Hamburg in 1622 and Danzig in 1629. The author also mentions places identified as houses of refuge for minors, which welcomed such people, such as in Florence in the period from 1650 to 1667, prisons on Giulia Street, in Rome, around 1655, and the Hospital of San Miguel, in 1703.

On the other hand, however, there are those who see that the punitive function attributed to imprisonment is related, first, to the need to create a new mechanism of social control that could adapt to the new economic and social context of the capitalist production system of the State.

Melossi (2010) emphasizes the changes of an economic and cultural nature as preponderant for the appearance of the modern prison. He states that, with the changes in the structure of production observed at the beginning of the modern period, as well as the processes of secularization of properties due to religious reforms, there was the dismantling of Church properties that practiced charity and were used for the sustenance of peasants, resulting in the appearance of a large number of helpless masses who ended up becoming unemployed and resorting to begging. Seen as vagabonds, they were not only listed as such, but also objects of various laws that sought to repress this condition of misery, which imposed physical punishment, banishment or even capital punishment.

Van der Slice (1936) pointed out that, since the reign of Henry VIII, legal statutes have been issued to punish beggars or vagrants who did not have certain licenses granted by *justices of peace*, and that they could be physically punished, even mutilated. In this way, the laws enacted sought to solve the problem of poverty and unemployment through measures of a criminal nature. However, despite the severity of the measures, such problems not only persisted, but increased, with space emerging for the adoption of experimental measures, including incarceration for correction purposes in the so-called *houses of correction*.

Also according to Van der Slice (1936), people were initially collected at the Bridewell fortification. Petty offenders, thieves and vains were collected, but there were also people who were detained merely because they had become a problem in a certain city. In that place, the ideal of the reform of the person through discipline and work was believed, being distributed according to the greater or lesser aptitude of the prisoners. The services were varied, the supply increasing over time, but included services in loom rooms, bakeries, mills, etc. The work was paid and the food provided by the watchmen. In addition to the discipline of work, physical punishment of prisoners was practiced by means of whippings, food restrictions and torture. In a short time, similar *houses of correction* began to be applied in cities such as Oxford, Salisbury, Norwich, Gloucester, Ipswich, Acle and Chester.

Fenton (1954) points out that punishments in England in the sixteenth century were severe and corporal, and only in this period did the use of prisons for punishment purposes begin. However, its use was not based on humanitarian issues, but with the management of poverty due to the collapse of the feudal model and the new legislation on land fencing. In

this way, many people were incarcerated in institutions that were precursors to penitentiary facilities such as Bridewell, and the other institutions were called *Bridewells*.

Baratta (1982) also points out that the new functions attributed to the prison and the factory work regime have historical similarities, since both are aimed at controlling the peasant masses separated from the means of production, adapting them to the models of discipline of modern factories, so that the understanding of the penitentiary institution is born together with the idea of capitalist society, although this single element is not sufficient to explain the current relationship between prison and society, but by analyzing its origin⁶.

Foucault (1999), analyzing the resignification of the function of prison, highlights that the use of prison was restricted to custody. At one point, its use was even seen as a despotic means of justice. In spite of this, what we saw was that, from being a semi-proscribed, it became an institution of generalized punishment, which could not be explained only by humanitarian reasons. He then pointed to the *rasphuis* as a precursor, highlighting the influence of this model as an instrument of control through the exploitation of labor and the economic dynamics as possible remote causes of this change.

According to Vacani (2015), it is during mercantilism that imprisonment gradually becomes a punitive form and thus due to the new economic-social program that Western states acquired.

According to the author:

Prisons manifested themselves as diverse spaces in which people deprived of liberty were housed (galleys, mines, military and naval prisons, border forts and forts) throughout the Middle Ages and early Modern Ages. At the same time, the idea of exploiting the labor force of prisoners and rehabilitating them for this purpose appears in the sixteenth century as a practice aimed at training all that population excluded from this social structure. Thus, the first attempts to bring together the strategy of excluding the inadmissible other (from the leper to the beggar, passing through the one who commits a crime or professes another faith) with the disciplining of the useful other (Vacani, 2015, p. 120)

Bustos Ramírez and Hormazábal Malarée (1997, v. 1), despite thinking that the appearance of the prison sentence was related to the consolidation of the liberal State, attributing humanizing, utilitarian and resocializing functions to prison, recognize that antecedents could already be observed since the sixteenth, seventeenth and eighteenth centuries, especially in the experiences of the *tuchthuis* and of the correction houses, which

⁶ However, Baratta (1982) states that the function of the prison to produce unequal individuals would still be important in the economic dynamics, because the prison would produce a stigmatizing and reductive effect, either in the dynamics of the labor market, as well as outside this dynamic, such as, e.g., by providing human and material means for criminal practices such as the crime industry, the drug cycle, etc.

would have the function of forcing marginals to work in favor of the State, fulfilling both an economic function in favor of the new model of capital accumulation and of overcoming the monopoly of craft corporations, a concept that would have been extended to France and England.

3 CONCLUSION

Prison as a means of punishment, in historical terms, is a recent reality, but with remote antecedents. Prisons are reported during much of Classical Antiquity, despite their use not being recurrent, existing in the overwhelming majority of times as custody facilities in favor of the future application of other punishments, especially corporal punishment.

During the Middle Ages, this system of using prisons as a means of custody was maintained, however, it was already possible to see the use of prisons as an instrument of custody and exercise of power, as in the case of fortified facilities adapted to receive prisoners of war and political opponents. However, the use of prison as an instrument of correction and control is recorded in this historical period, mainly due to the contribution of the clerical practice of using prison as an instrument of correction and ecclesiastical discipline, with records of its use also in the face of lay people.

The turning point of the purposes of prison, from the institution of precautionary purposes to a means of punishment, is linked to the new purposes that have been attributed to it. Since the *bridewells* in present-day England and *Tuchthuis*, *Rasphuis* and *Spinhuis* in the present-day Netherlands, modern antecedents of the current penitentiaries, there has been a change in the function of the old prisons, in order to attribute correctional-punitive objectives to those through the submission of prisoners to work due to changes in the context of the means of production and social control.

REFERENCES

- Baratta, A. (1982). Observaciones sobre las funciones de la cárcel en la producción de las relaciones sociales de desigualdad. *Nuevo Foro Penal*, 15, 737–749.
- Bíblia Sagrada: Antigo e Novo Testamento. (2021). Nova Versão Internacional. Casa Publicadora Paulista. (Original work published ca. 1400 BCE–100 CE)
- Bruno, A. (1978). *Direito penal: Parte geral* (4ª ed., Vol. 3). Forense.
- Bustos Ramírez, J. J., & Hormazábal Malarée, H. (1997). *Lecciones de derecho penal* (Vol. 1). Editorial Trotta.
- Carrara, F. (2002). *Programa do curso de direito criminal: Parte geral* (R. R. Gama, Trad.; Vol. 2). LZN Editora. (Original work published 1871)
- Dotti, R. A. (2010). *Curso de direito penal: Parte geral* (3ª ed.). Revista dos Tribunais.

- Ferrajoli, L. (2011). *Diritto e ragione: Teoria del garantismo penale* (10ª ed.). Editori Laterza.
- Fenton, R. (1954). *Historia de las prisiones: De la masmorra subterránea a la prisión modelo*. *Revista el Correo, UNESCO*, 8(10), 11–19.
- Foucault, M. (1999). *Vigiar e punir: Nascimento da prisão* (R. Ramallete, Trad.; 20ª ed.). Vozes. (Original work published 1975)
- Gusmão, P. D. de. (2010). *Introdução ao estudo do direito* (42ª ed.). Forense.
- Lyra, R. (1955). *Comentários ao Código Penal: Arts. 29 a 34* (2ª ed., Vol. 2). Forense.
- Melossi, D. (2014). *A gênese da instituição carcerária moderna na Europa*. In D. Melossi & M. Pavarini, *Cárcere e fábrica: As origens do sistema penitenciário (séculos XVI e XIX)* (2ª ed.). Revan; Instituto Carioca de Criminologia.
- Mirabete, J. F., & Fabbrini, R. N. (2009). *Manual de direito penal: Parte geral – Arts. 1º a 120 do CP* (25ª ed., Vol. 1). Atlas.
- Neuman, E. (1971). *Evolución de la pena privativa de libertad y regímenes penitenciarios*. Ediciones Pannedille.
- Peters, E. M. (1995). *Prison before the prison: The ancient and medieval worlds*. In N. Morris & D. J. Rothman (Eds.), *The Oxford history of the prison: The practice of punishment in Western society*. Oxford University Press.
- Prado, L. R. (2013). *Tratado de direito penal* (Vol. 3). *Revista dos Tribunais*.
- Reale Júnior, M. (2004). *Instituições de direito penal* (2ª ed., Vol. 2). Forense.
- Rothman, D. J. (1995). *Perfecting the prison: United States, 1789–1865*. In N. Morris & D. J. Rothman (Eds.), *The Oxford history of the prison: The practice of punishment in Western society*. Oxford University Press.
- Van der Slice, A. (1936). *Elizabethan houses of correction*. *Journal of Criminal Law and Criminology*, 27(1), 45–87.
- Vacani, P. A. (2015). *La configuración histórica en la legitimación de los métodos punitivos*. *Revista de Historia de las Prisiones*, 1, 117–135.

MANDIBULAR BONE EROSION ASSOCIATED WITH HYALURONIC ACID FILLER: CBCT CASE REPORT

EROSÃO ÓSSEA MANDIBULAR ASSOCIADA AO PREENCHIMENTO COM ÁCIDO HIALURÔNICO: RELATO DE CASO POR TCFC (CBCT)

EROSIÓN ÓSEA MANDIBULAR ASOCIADA AL RELLENO CON ÁCIDO HIALURÓNICO: REPORTE DE CASO MEDIANTE TCFC (CBCT)



<https://doi.org/10.56238/sevened2026.008-021>

José Roberto Alves Moreira¹, Henrique Barcelos Brandão², Ana Thais Bagatini³, Marcos Cesar Pitta⁴, Luiz Gonzaga Gandini Junior⁵, Ary dos Santos Pinto⁶

ABSTRACT

We report a case of bone erosion in the mental region associated with hyaluronic acid (HA) injection for cosmetic purposes, incidentally identified in a patient undergoing orthodontic treatment with miniscrew-assisted rapid palatal expansion (MARPE). This case offers rare sequential radiographic documentation using cone-beam computed tomography (CBCT) both before and after HA injection, along with intraoperative confirmation of the lesion. These findings provide further support for the hypothesis of HA-induced bone resorption. This report underscores the critical role of imaging in interdisciplinary clinical practice and contributes meaningful evidence regarding the potential adverse effects of facial fillers on underlying osseous structures.

Keywords: Orthodontics. Cone-Beam Computed Tomography. PET CT Scan. Palatal Expansion Technique. Orthodontic Anchorage Procedures. Hyaluronic Acid.

RESUMO

Relatamos um caso de erosão óssea na região mental associada à injeção de ácido hialurônico (AH) para fins estéticos, identificada incidentalmente em uma paciente submetida a tratamento ortodôntico com expansão rápida da maxila assistida por mini-implantes

¹ Master's degree of Science in Orthodontics. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: jose.r.moreira@unesp.br Orcid: <https://orcid.org/0009-0003-1790-2051> Lattes: <http://lattes.cnpq.br/5245525150765815>

² Master's degree of Science in Orthodontics. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: henrique.brandao@unesp.br Orcid: <https://orcid.org/0000-0002-7238-7078> Lattes: <https://lattes.cnpq.br/2053748244308327>

³ Master's degree of Science in Orthodontics. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: ana.bagatini@unesp.br Orcid: <https://orcid.org/0000-0002-0517-2595> Lattes: <http://lattes.cnpq.br/4107446824355207>

⁴ MSc in Oral and Maxillofacial Surgery. Private Practice. São Paulo, Brazil. E-mail: mc.pitta@uol.com.br Orcid: <https://orcid.org/0000-0003-2671-0732> Lattes: <http://lattes.cnpq.br/3487914682644475>

⁵ Professor. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: luiz.gandini@unesp.br Orcid: <https://orcid.org/0000-0001-8656-6010> Lattes: <http://lattes.cnpq.br/6493049604923160>

⁶ Professor. Universidade Estadual Paulista (UNESP). São Paulo, Brazil. E-mail: ary.santos-pinto@unesp.br Orcid: <https://orcid.org/0000-0003-3355-0001> Lattes: <http://lattes.cnpq.br/6562540057111580>

(MARPE). Este caso apresenta uma rara documentação radiográfica sequencial por meio de tomografia computadorizada de feixe cônico (TCFC), realizada antes e após a aplicação do AH, além da confirmação intraoperatória da lesão. Esses achados fornecem suporte adicional à hipótese de reabsorção óssea induzida pelo ácido hialurônico. O presente relato destaca o papel fundamental dos exames de imagem na prática clínica interdisciplinar e contribui com evidências relevantes acerca dos potenciais efeitos adversos dos preenchedores faciais sobre as estruturas ósseas subjacentes.

Palavras-chave: Ortodontia. Tomografia Computadorizada de Feixe Cônico. PET-CT. Técnica de Expansão Palatina. Procedimentos de Ancoragem Ortodôntica. Ácido Hialurônico.

RESUMEN

Se reporta un caso de erosión ósea en la región mentoniana asociada a la inyección de ácido hialurónico (AH) con fines estéticos, identificado de forma incidental en una paciente sometida a tratamiento ortodóncico con expansión rápida del maxilar asistida por miniimplantes (MARPE). Este caso presenta una rara documentación radiográfica secuencial mediante tomografía computarizada de haz cónico (TCFC), realizada antes y después de la aplicación de AH, además de la confirmación intraoperatoria de la lesión. Estos hallazgos aportan mayor respaldo a la hipótesis de reabsorción ósea inducida por el ácido hialurónico. El presente informe destaca el papel fundamental de las técnicas de imagen en la práctica clínica interdisciplinaria y contribuye con evidencia relevante sobre los posibles efectos adversos de los rellenos faciales en las estructuras óseas subyacentes.

Palabras clave: Ortodoncia. Tomografía Computarizada de Haz Cónico. PET-CT. Técnica de Expansión Palatina. Procedimientos de Anclaje Ortodóncico. Ácido Hialurónico.

1 INTRODUCTION

Miniscrew-Assisted Rapid Palatal Expansion (MARPE)¹ has established itself as an effective alternative for the treatment of transverse maxillary deficiencies in young and adult patients, promoting predominantly skeletal movements with minimal dentoalveolar repercussions. The protocol often involves the use of cone beam computed tomography (CBCT) both in planning and post-treatment evaluation, providing a detailed view of the craniofacial bone structures involved in the procedure.²

At the same time, the use of hyaluronic acid (HA)-based dermal fillers has become widely popular in minimally invasive facial aesthetic procedures, especially in the mental region.³ Although they are considered safe, reports in the literature have described rare cases of complications, including localized bone resorption, possibly from chronic inflammatory reactions or vascular compression.^{4,5}

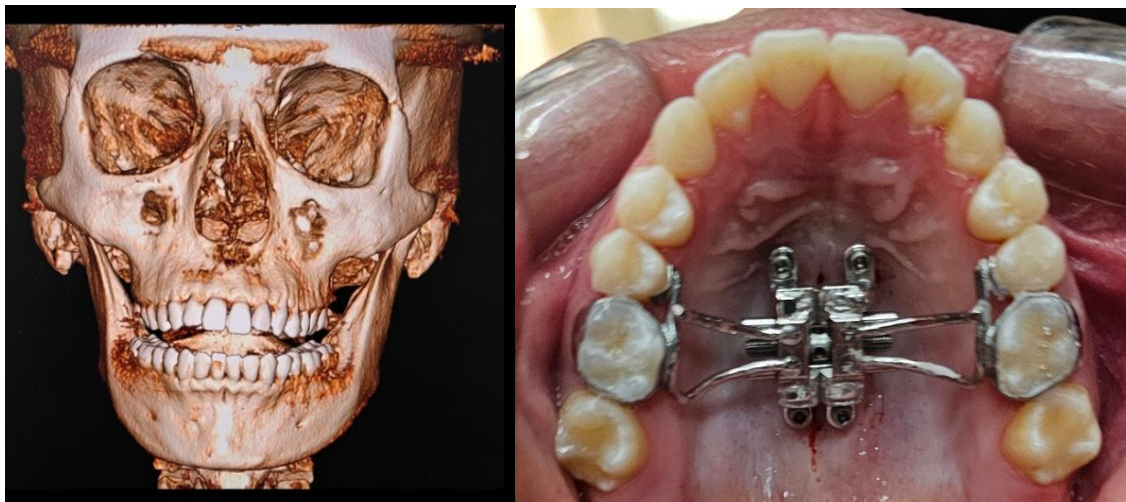
In this context, we report a clinical case of bone erosion in the mandibular body region, incidentally identified by tomography performed for post-expansion evaluation with MARPE. The patient had a history of HA application in the mental region, and the radiographic finding suggests a possible association between the aesthetic procedure and the observed bone resorption. This case reinforces the importance of imaging evaluation and interdisciplinary dialogue between orthodontists and orofacial aesthetics professionals.

2 CASE REPORT

A 21-year-old female patient sought orthodontic treatment with the chief complaint of anterior open bite, masticatory difficulty, and a narrow smile. Clinical examination and cephalometric analysis revealed a constricted maxilla with moderate transverse deficiency, a Class I maxillomandibular dental relationship, mild mandibular retrusion, and no facial asymmetries.^{6,7} CBCT was requested for treatment planning and demonstrated stage C maturation of the midpalatal suture according to Angilieri's classification.² Considering the patient's advanced age for conventional rapid palatal expansion using a Hyrax or Haas-type expander, MARPE was selected as the treatment approach.⁸ A MARPE EX 13 mm expander (Peclab) was installed and four mini-implants anchored in: two anterior (code: 5500) HS MARPE 1.8 × 7 × 8 mm and two posterior (code: 2926) HS MARPE 1.8 × 7 × 4 mm orthodontic mini-implants (Peclab, Belo Horizonte, Brazil), registered with ANVISA under number 80041470004. The mini-implants were positioned in the paramedian region of the palate. Immediately after the success achieved through this procedure, orthodontic completion with aligners was started (Fig. 1A, B).

Figure 1

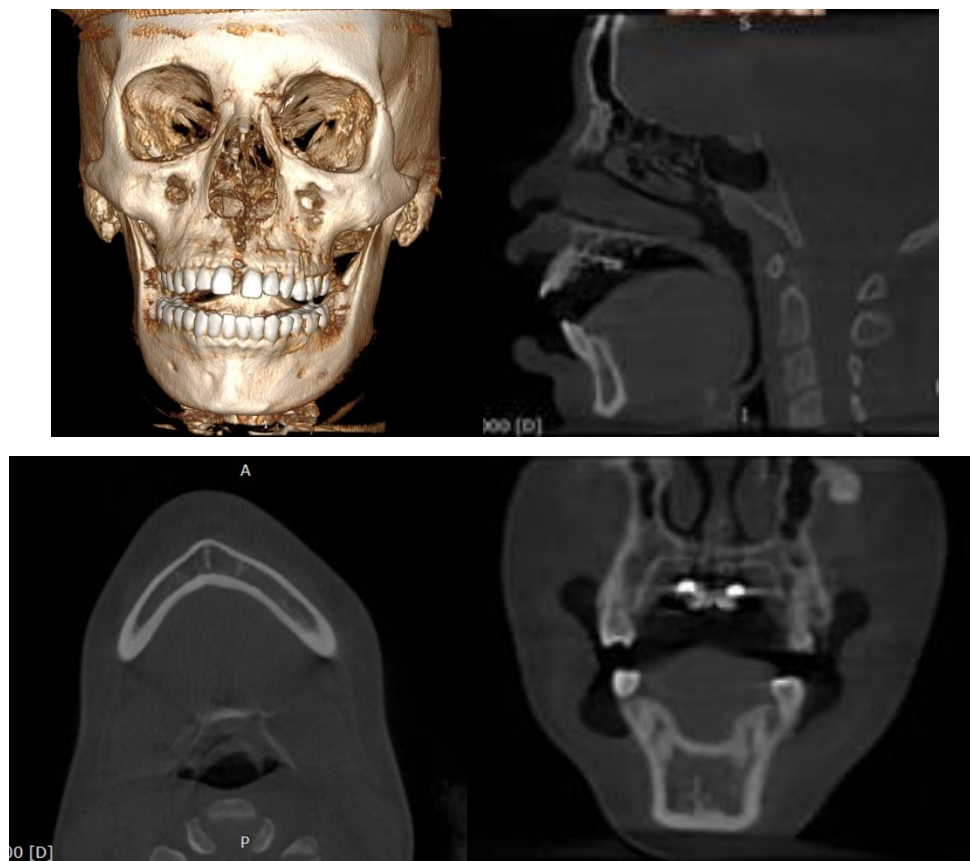
A. Initial 3D CBCT reconstruction performed for planning of the MARPE device. B. Intraoral occlusal photograph showing the MARPE appliance installed, anchored by four mini-implants



Activation was performed according to protocol (1/4 turn per day), totaling 18 activations in approximately 19 days.¹ The success of the procedure was confirmed clinically by the diastema between the central incisors, and radiographically, by the opening of the midpalatal suture observed in the follow-up CBCT (Fig. 2A-D). After eight months transverse stability was achieved and removal of the MARPE device was planned. A new CBCT was requested to evaluate bone consolidation. The objective of scan was to reevaluate the bone anatomy before removal of the mini-implants.⁹

Figure 2

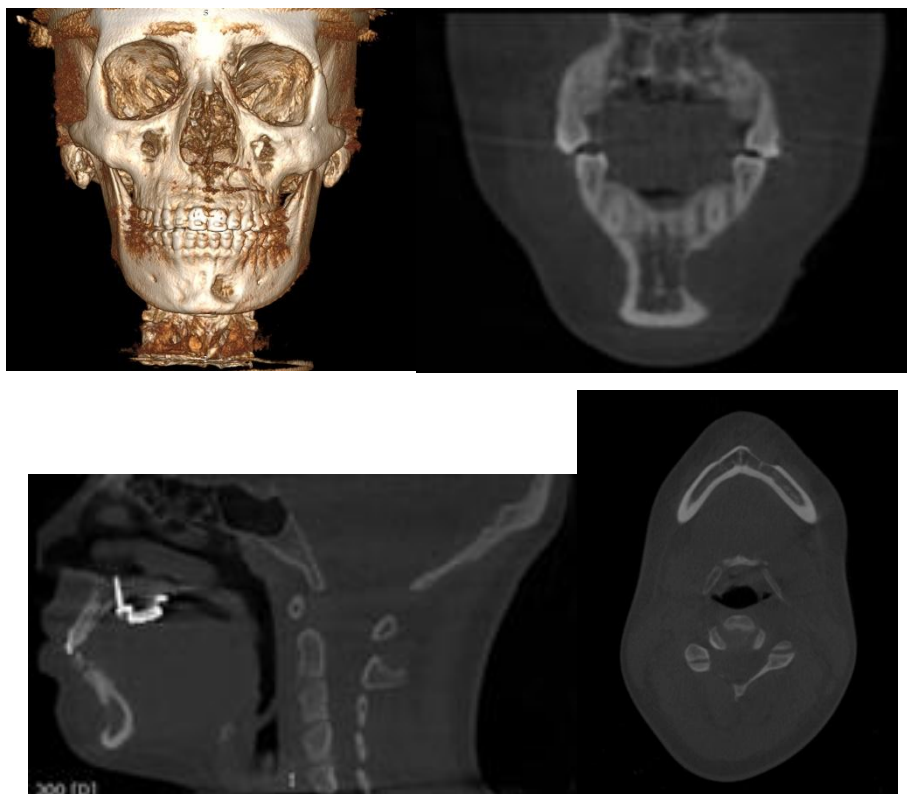
A. Post-expansion 3D CBCT confirming midpalatal suture opening. 2A. Sagittal CBCT slice obtained 15 days before soft tissue filler injection, showing intact mandibular symphysis. 3A. Axial slice confirming no bone erosion in the mentum prior to filler placement. 4A. Coronal CBCT image showing intact cortical and trabecular structure of the anterior mandible before aesthetic procedures



In the analysis of the tomographic image, a well-defined area of bone resorption 1.32cm high x 1.52cm wide x 2.79mm deep was observed in the mandibular body. The lesion showed partial loss of the buccal cortex, with evident reabsorption of the trabecular bone, characterizing an erosive process compatible with chronic and localized involvement of the bone tissue (Fig. 3A-D). When questioned about it, the patient reported no history of trauma in that region and denied pain, paresthesia, or symptoms suggestive of local inflammation. However, she reported a history of application of 1ml of HA in the mental region 7.5 months prior, 15 days after the MARPE locking, by a professional specialized in orofacial harmonization.

Figure 3

A. CBCT 3D reconstruction performed 8 months after MARPE treatment and 7.5 months after HA filler injection in the mental region, revealing erosive lesion in the mentum. 3B–D. Axial, sagittal, and coronal CBCT slices showing the extent of bone erosion in the mandibular symphysis



Given the finding, the patient was referred to an endodontics specialist, who assessed the pulp vitality of the adjacent teeth by periapical and panoramic radiographs. The studies were negative for necrosis, and the patient was then advised to also undergo an evaluation by a bucomaxillofacial surgeon to consult on the best course of action.

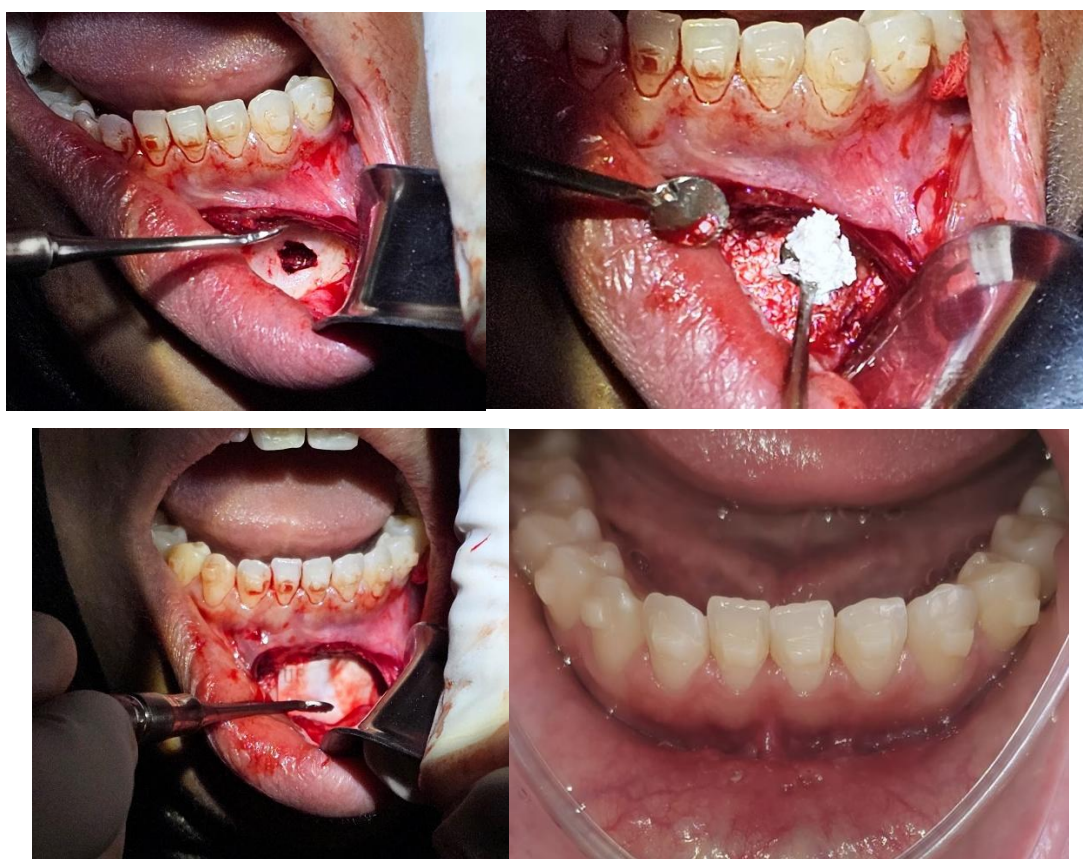
PET/CT scans performed to assess the presence of granulomatous lesions in other regions of the body did not show changes compatible with this condition, ruling out systemic inflammatory processes. These findings hypothetically suggest that the observed lesion may be related to the pressure exerted by the filling material with highly cross-linked hyaluronic acid.¹⁰

Ultimately, surgery was decided due to the size of the lesion and concern for inducing aseptic necrosis in the teeth involved in the adjacent area (teeth 31, 32, and 33). During exploratory surgery, signs of reabsorption of the buccal cortex as well as the trabecular area measuring 1.32cm x 1.52cm x 2.79mm was found in the mental region on the left side. In the region on the right side, three foveas without invasion of the trabecular only in the buccal cortex were also detected. after being curetted, as well as the one on the left side, were filled

with Geistlich Bio-Oss® (spongy granules 0.25–1 mm, 2 g; Geistlich Pharma AG, Wolhusen, Switzerland), with ANVISA registration number 80696930002 and Geistlich Bio-Gide® collagen membrane (Geistlich Pharma AG, Wolhusen, Switzerland) registered with ANVISA under number 80696930003, sutured and surgery completed with guided radiographic follow-up after 3 months. No materials were collected for examinations, as reabsorption occurred due to pressure.⁴ (Fig. 4A-D).

Figure 4

A1. Exploratory surgery revealing a buccal cortical bone defect and exposure of trabecular bone in the region of the filler application. A2. Bone cavity filled with deproteinized bovine bone graft (Bio-Oss®, Geistlich Pharma, Switzerland). A3. Adaptation of the resorbable membrane over the grafted area. A4. Clinical aspect after 7 days of healing and suture removal



3 DISCUSSION

Recent evidence suggests that bone resorption associated with the use of hyaluronic acid-based dermal fillers may be more prevalent than previously reported. Studies have shown that a significant proportion of patients develop bony changes in the mental region after such procedures, highlighting the need for careful evaluation and appropriate

radiographic follow-up.^{11,12} The present clinical case describes an incidental finding, identified by computed tomography requested for orthodontic purposes after completion of the active expansion phase with MARPE. The temporal association with the application of HA in this region suggests a possible causal relationship, as discussed in previous reports.^{4,5,11,12}

Furthermore, as highlighted by Bass et al.,³ the injection technique is critical to achieving excellent results with dermal fillers. Techniques such as threading, fanning, cross-hatching, bleb, and pillar must be mastered to ensure the safety and efficacy of the procedure. Technical execution can only match, but not exceed, the quality of the aesthetic analysis. In the case presented, the absence of clinical symptoms and the incidental detection of the bone lesion highlight the importance of a careful technical approach and a detailed aesthetic evaluation to minimize risks and complications associated with the use of dermal fillers.³

Corroborating this evidence, Guo et al. (2020)⁴ reported a series of Asian cases in a retrospective cohort study that identified bone resorption in the mental region following HA filler application. The authors observed that, even in asymptomatic patients, structural bone changes could occur insidiously. The study raises the hypothesis that the prolonged presence of the filler, combined with the pressure exerted on the cortical bone of the mental region, may trigger an unexpected resorption process.

The case reported by Nakagawa et al. (2022)⁵ described a patient with skeletal Class II deformity and significant bone resorption in the mental region, associated with prolonged use of hyaluronic acid. The authors suggest that chronic compression and/or low-grade inflammatory reactions induced by the material may lead to adverse bone remodeling, particularly when the filler is applied deeply or in close proximity to the periosteum.

Although the radiographic finding raises the hypothesis of bone remodeling associated with the use of dermal fillers, there is insufficient evidence in the literature to state that such alterations require intervention or specific imaging monitoring in healthy patients without symptoms. Therefore, the indication for computed tomography should always be based on clear clinical criteria, respecting the principles of justification and optimization of radiographic exposure.

From an anatomical perspective, the mental region comprises dense cortical bone with limited vascularization, rendering it more susceptible to necrosis or bone resorption when exposed to chronic pressure—either from the intrinsic synergistic action of the mentalis muscle or from vascular compromise. Although HA is widely regarded as a biocompatible and resorbable material, its prolonged presence—particularly in cases of repeated applications—may induce alterations in bone architecture.⁴

This case underscores the importance of an interdisciplinary approach, particularly involving orthodontists, radiologists, and facial aesthetic practitioners. It also emphasizes the critical role of comprehensive documentation of the patient's aesthetic history. Moreover, it highlights the diagnostic value of cone-beam computed tomography, not only as an essential tool for orthodontic planning but also for the identification of incidental findings with potential medical or surgical relevance.

4 CONCLUSION

This case report illustrates the importance of radiographic evaluation using computed tomography in patients undergoing orthodontic treatment, particularly when devices such as MARPE are employed. The incidental detection of a bone lesion in the mental region, associated with prior HA filler application, highlights the necessity for integration across multiple healthcare disciplines, including orthodontics, radiology, and facial aesthetics. Clinical and radiographic follow-up is essential in such cases and reinforces the need for greater awareness regarding the potential adverse effects of dermal fillers on deep bony structures.

REFERENCES

1. Angelieri, F., Cevidanes, L. H. S., Franchi, L., Gonçalves, J. R., Benavides, E., & McNamara, J. A., Jr. (2013). Midpalatal suture maturation: Classification method for individual assessment before rapid maxillary expansion. *American Journal of Orthodontics and Dentofacial Orthopedics*, 144(5), 759–769. <https://doi.org/10.1016/j.ajodo.2013.04.022>
2. Angell, E. H. (1860). Treatment of irregularity of the permanent or adult teeth. *Dental Cosmos*, 1, 540–544, 599–600.
3. Arnett, G. W., & Bergman, R. T. (1993). Facial keys to orthodontic diagnosis and treatment planning. Part I. *American Journal of Orthodontics and Dentofacial Orthopedics*, 103(4), 299–312. [https://doi.org/10.1016/0889-5406\(93\)70010-L](https://doi.org/10.1016/0889-5406(93)70010-L)
4. Bass, L. S. (2015). Injectable filler techniques for facial rejuvenation, volumization, and augmentation. *Facial Plastic Surgery Clinics of North America*, 23(4), 479–488. <https://doi.org/10.1016/j.fsc.2015.07.004>
5. Cantarella, D., Dominguez-Mompell, R., Mallya, S. M., Moschik, C., & Siciliani, G. (2018). Changes in the midpalatal and pterygopalatine sutures induced by micro-implant-supported skeletal expander, analyzed with a novel 3D method based on CBCT imaging. *Progress in Orthodontics*, 19(1), Article 4.
6. Guo, X., Zhao, J., Song, G., Zong, X., Zhang, D., Lai, C., & Jin, X. (2020). Unexpected bone resorption in mentum induced by the soft-tissue filler hyaluronic acid: A preliminary

- retrospective cohort study of Asian patients. *Plastic and Reconstructive Surgery*, 146(2), 147e–155e. <https://doi.org/10.1097/PRS.00000000000006979>
7. Guo, X., Zong, X., Song, G., Zhao, J., Lai, C., Zhang, D., & Jin, X. (2024). Would hyaluronic acid-induced mental bone resorption be a concern? A prospective controlled cohort study and an updated retrospective cohort study. *International Journal of Surgery*, 110(3), 1502–1510. <https://doi.org/10.1097/JS9.0000000000000955>
 8. Haas, A. J. (1961). Rapid expansion of the maxillary dental arch and nasal cavity by opening the midpalatal suture. *Angle Orthodontist*, 31(2), 73–90.
 9. Karam, M. B., Baratto, L., Sheikhabahaei, S., Werner, R. A., Solnes, L. B., Rowe, S. P., & et al. (2021). Role of 18F-FDG PET in the management of sarcoidosis and other granulomatous diseases. *AJR. American Journal of Roentgenology*, 216(2), 285–294. <https://doi.org/10.2214/AJR.20.23430>
 10. Lee, K. J., Park, Y. C., Park, J. Y., & Hwang, W. S. (2010). Mini screw assisted nonsurgical palatal expansion before orthognathic surgery for a patient with severe mandibular prognathism. *American Journal of Orthodontics and Dentofacial Orthopedics*, 137(6), 830–839.
 11. Nakagawa, T., Ono, S., Sakuma, M., & et al. (2022). A case of bone resorption in the mentum caused by HA filler in a patient with skeletal Class II jaw deformity. *Oral Radiology*, 38(1), 185–190.
 12. Shu, K. Y., Feng, W. R., & Zhao, J. L. (2024). Bone resorption of HA fillers injection induced in chin augmentation: A retrospective study. *Journal of Craniofacial Surgery*. Advance online publication. <https://doi.org/10.1097/SCS.00000000000011033>

THE IMPLEMENTATION OF UNIVERSAL DESIGN FOR LEARNING (UDL) AS AN INCLUSION STRATEGY IN SPECIAL EDUCATION: OVERCOMING THE LOGIC OF INDIVIDUALIZED

A IMPLEMENTAÇÃO DO DESENHO UNIVERSAL PARA A APRENDIZAGEM (DUA) COMO ESTRATÉGIA DE INCLUSÃO NA EDUCAÇÃO ESPECIAL: SUPERANDO A LÓGICA DA ADAPTAÇÃO INDIVIDUALIZADA

LA IMPLEMENTACIÓN DEL DISEÑO UNIVERSAL PARA EL APRENDIZAJE (DUA) COMO ESTRATEGIA DE INCLUSIÓN EN LA EDUCACIÓN ESPECIAL: SUPERANDO LA LÓGICA DE LA ADAPTACIÓN INDIVIDUALIZADA



<https://doi.org/10.56238/sevened2026.008-022>

Thereza D'Ávila Maria Fernandes de Souza¹

ABSTRACT

Contemporary inclusive education demands a transition from the integration model to a perspective of full inclusion, questioning the effectiveness of reactive curricular adaptations. This study aims to analyze the implementation of Universal Design for Learning (UDL) as a fundamental strategy to replace individualized adaptation practices with a teaching model that is accessible and inclusive from its conception. Methodologically, the research is characterized as a qualitative bibliographic study using a deductive method, based on databases such as SciELO and Google Scholar, with theoretical support from authors such as Zerbato, Pletsch, and Sebastián-Heredero. The results indicate that UDL, grounded in neuroscience and structured around the pillars of engagement, representation, action, and expression, enables the creation of flexible curricula that recognize brain variability as the norm. Unlike a posteriori accommodations, which often stigmatize students with disabilities and reduce learning expectations, universal planning eliminates systemic barriers and promotes the autonomy of all learners. It is concluded that the application of UDL represents a necessary paradigmatic shift, moving the focus from the pathology of the individual to the rigidity of the curriculum. The implementation of this approach requires a reconfiguration of teaching culture and instructional design, transforming the school into a democratically accessible space where diversity is valued as pedagogical potential and equity is organically ensured, consolidating the inalienable right to knowledge for all students.

Keywords: Universal Design for Learning. Special Education. School Inclusion. Curricular Accessibility. Pedagogical Practices.

RESUMO

A educação inclusiva contemporânea demanda a transição do modelo de integração para uma perspectiva de inclusão plena, questionando a eficácia das adaptações curriculares reativas. Este estudo tem como objetivo geral analisar a implementação do Desenho

¹ Master's degree of Science in Education. Universidad San Carlos (USC). E-mail: therezadavilaf@gmail.com

Universal para a Aprendizagem (DUA) como estratégia fundamental para substituir as práticas de adaptação individualizada por um modelo de ensino acessível e inclusivo desde a sua concepção. Metodologicamente, a pesquisa caracteriza-se como um estudo bibliográfico de natureza qualitativa e método dedutivo, fundamentado em bases de dados como SciELO e Google Acadêmico, com suporte teórico em autores como Zerbato, Pletsch e Sebastian-Heredero. Os resultados indicam que o DUA, alicerçado nas neurociências e nos pilares do engajamento, representação, ação e expressão, permite a criação de currículos flexíveis que reconhecem a variabilidade cerebral como regra. Diferente das adequações a posteriori, que frequentemente estigmatizam o aluno com deficiência e reduzem expectativas de aprendizagem, o planejamento universal elimina barreiras sistêmicas e promove a autonomia de todos os estudantes. Conclui-se que a aplicação do DUA representa uma ruptura paradigmática necessária, deslocando o foco da patologia do sujeito para a rigidez do currículo. A implementação dessa abordagem exige uma reconfiguração da cultura docente e do design instrucional, transformando a escola em um espaço democraticamente acessível, onde a diversidade é valorizada como potência pedagógica e a equidade é garantida de forma orgânica, consolidando o direito inalienável ao conhecimento para todos os discentes.

Palavras-chave: Desenho Universal para a Aprendizagem. Educação Especial. Inclusão Escolar. Acessibilidade Curricular. Práticas Pedagógicas.

RESUMEN

La educación inclusiva contemporánea exige la transición del modelo de integración hacia una perspectiva de inclusión plena, cuestionando la eficacia de las adaptaciones curriculares reactivas. Este estudio tiene como objetivo analizar la implementación del Diseño Universal para el Aprendizaje (DUA) como estrategia fundamental para sustituir las prácticas de adaptación individualizada por un modelo de enseñanza accesible e inclusivo desde su concepción. Metodológicamente, la investigación se caracteriza como un estudio bibliográfico de naturaleza cualitativa y método deductivo, fundamentado en bases de datos como SciELO y Google Académico, con soporte teórico en autores como Zerbato, Pletsch y Sebastián-Heredero. Los resultados indican que el DUA, sustentado en las neurociencias y estructurado en los pilares del compromiso, la representación, la acción y la expresión, permite la creación de currículos flexibles que reconocen la variabilidad cerebral como norma. A diferencia de las adecuaciones a posteriori, que con frecuencia estigmatizan al alumnado con discapacidad y reducen las expectativas de aprendizaje, la planificación universal elimina barreras sistémicas y promueve la autonomía de todos los estudiantes. Se concluye que la aplicación del DUA representa una ruptura paradigmática necesaria, desplazando el foco de la patología del sujeto hacia la rigidez del currículo. La implementación de este enfoque exige una reconfiguración de la cultura docente y del diseño instruccional, transformando la escuela en un espacio democráticamente accesible, donde la diversidad se valora como potencia pedagógica y la equidad se garantiza de forma orgánica, consolidando el derecho inalienable al conocimiento para todos los discentes.

Palabras clave: Diseño Universal para el Aprendizaje. Educación Especial. Inclusión Escolar. Accesibilidad Curricular. Prácticas Pedagógicas.

1 INTRODUCTION

Contemporary inclusive education requires a movement that goes beyond the simple integration of students with disabilities in the school environment, demanding a reconfiguration of pedagogical practices. In this scenario, Universal Design for Learning (UDL) emerges as a revolutionary approach that aims to plan teaching in order to meet human diversity from its conception. Unlike traditional models, which focus on remediating difficulties after planning, UDL proposes the creation of flexible curricula and learning environments that eliminate barriers for all students, recognizing variability as the rule rather than the exception.

Historically, Special Education has been guided by the logic of individualized adaptation, in which the curriculum is designed for an "average student" and, later, "adjusted" for those who do not fit this standard. This practice ends up indirectly segregating the student, burdening the teacher with the need to create multiple lesson plans and keeping the focus on the disability instead of the potential. The problem lies in the fact that these specific adaptations are usually reactive and insufficient to guarantee autonomy and effective engagement, perpetuating a clinical view of inclusion that ignores the systemic barriers of the education system itself. In view of this, this work sought to answer the following Central Question: How can the implementation of the principles of Universal Design for Learning contribute to overcoming the logic of individualized curricular adaptation and promote effective inclusion in Special Education?

The general objective of this study was to analyze the implementation of Universal Design for Learning (UDL) as a fundamental strategy to replace individualized adaptation practices with an accessible and inclusive teaching model from its conception. And as specific: 1 - Identify the main theoretical foundations and the three pillars of UDL (engagement, representation, action and expression) in the context of Special Education; 2 - To contrast the limitations of reactive curricular adaptations against the potentialities of a universally planned curriculum; 3 - Propose pedagogical guidelines that assist teachers in the practical application of UDL to minimize learning barriers in different classrooms.

The choice of this theme is justified by the urgency of updating teaching methodologies in view of the national inclusion guidelines. The persistence in individualized "adjustment" models has proven to be exhausting for educators and ineffective for the integral development of students. By studying UDL, it seeks to offer a methodological path that not only facilitates the teaching work, but also transforms the school into a space where accessibility is a right guaranteed in an organic and transversal way.

From a social point of view, this research contributes to the democratization of knowledge and to the appreciation of diversity, combating the stigma associated with Special Education. Scientifically, the work enriches the field of pedagogy and inclusive education by providing theoretical and practical subsidies on an approach based on neuroscientific evidence. The relevance lies in fostering a paradigm shift: moving from an education that "corrects the student" to an education that "corrects the curriculum", promoting equity and academic excellence for all.

2 METHODOLOGICAL PROCEDURES

The research was characterized as a bibliographic study, developed with the aim of analyzing the implementation of the Universal Design for Learning (UDL) from theoretical contributions already published. The study method adopted was deductive, starting from the general premises about school inclusion to investigate the specificity of the UDL strategy in overcoming individualized adaptations. This choice allowed a deep dive into the specialized literature, ensuring that the topic was explored from different theoretical and empirical perspectives. As Gil (2002, p. 44) has argued, the bibliographic research "is developed based on material already prepared, consisting mainly of books and scientific articles", which provided the necessary basis to sustain the argument about the transition from the medical-clinical model to the social model of learning in the context of Special Education.

The way to obtain the data occurred through a systematic survey in digital libraries and databases such as SciELO and Google Scholar, using specific descriptors related to curricular accessibility and UDL. The treatment and analysis of the data were carried out in an analytical-descriptive manner, organizing the collected material in order to identify patterns, divergences and convergences in contemporary inclusion practices. For Lakatos and Marconi (2003, p. 183), bibliographic research "is not a mere repetition of what has already been said or written on a certain subject, but the examination of a theme under a new focus or approach, reaching innovative conclusions". Thus, the treatment of the information sought not only to describe the concept of Universal Design, but to critically analyze its effectiveness in deconstructing the logic of reactive adaptation, which often segregates the student with disabilities from the common curriculum.

Regarding ethical issues, the research was guided by absolute respect for intellectual property and the reliability of the sources consulted, ensuring that all ideas from third parties were duly credited. Although the bibliographic research does not require registration in Ethics Committees because it does not involve direct intervention with human beings, the commitment to scientific integrity and impartiality in the interpretation of the texts was

maintained. As explained by Severino (2007, p. 122), scientific work must be conducted with rigor, because "research is an activity of investigation that produces knowledge, being a procedure that is both theoretical and practical". Thus, the methodological path was carried out with transparency and academic honesty, ensuring that the data analysis ethically reflected the reality of the advances and challenges of school inclusion through the UDL.

The main theoretical foundations and the three pillars of UDL (engagement, representation, action and expression) in the context of Special Education

Historically, Special Education has been marked by processes of exclusion that restricted the full participation of students with functional specificities in the common education system. In the contemporary scenario, the transition to a truly inclusive model lacks tools that subvert the logic of curricular standardization, focused on a supposed "ideal student" who disregards human singularities. Universal Design for Learning (UDL) is a pedagogical philosophy that recognizes brain variability as a rule, proposing that the environment adapts to the individual and not the other way around. In this context, the scientific literature asserts that "UDL aims to remove barriers to learning and increase opportunities for all students, regardless of their abilities" (Zerbato, 2021, p. 150). Such a premise shifts the focus from the subject's pathology to the rigidity of teaching, requiring that educational planning foresees cognitive plurality from its initial conception, without the need for subsequent patches that only reinforce the stigma of difference.

Neuroscientifically, UDL is based on the functioning of three primordial neural networks that dictate how the brain processes knowledge. The understanding that each student has a unique neurocognitive profile invalidates linear or homogeneous methodologies that once dominated classrooms. When the school ignores this biological reality, it ends up marginalizing those whose psychic processing deviates from the statistical norm, generating insurmountable obstacles to academic progress. As the Brazilian research highlights, "educational evaluation requires a sensitive look at the particularities of the subject's cognitive development" (Anache, 2022, p. 45). Recognizing such pedagogical sensitivity means accepting that the instruction process lacks a biopsychosocial foundation that values human potential to the detriment of the diagnosed limitation, promoting an environment of full intellectual acceptance.

Engagement is the first structuring pillar of this model, operating directly in the affective networks of the brain to arouse the student's motivation and sustained interest. Without the emotional involvement and pragmatic sense of what is being taught, concept retention becomes an arduous task for students facing sensory or intellectual barriers. Providing individual choices and safe environments for experimenting with error is essential to keep the

student active in his or her path of discovery. Reinforcing this need, the theory postulates that "inclusion policies aim to overcome the barrier of physical access to ensure the appropriation of scientific knowledge" (Pletsch, 2020, p. 22). Engagement, therefore, acts as the engine that drives the desire to learn, transforming the classroom into a space of belonging and not just physical presence.

Representing information in various ways configures the second pillar, focusing on recognition networks that allow the student to identify and interpret sensory patterns. In the context of Special Education, the provision of content only by textual or oral means summarily excludes students with visual or hearing impairments or neurodevelopmental disorders. The diversification of visual, auditory and tactile stimuli ensures that the reception of the message occurs without noise, respecting the different ways of decoding the world. According to the specialized literature, "the visual support and structuring of the environment facilitate pedagogical mediation for students with ASD" (Nunes, 2021, p. 88). By making the presentation of content more flexible, the teacher removes the obstacles that prevent access to semantics and formal knowledge, ensuring that knowledge reaches everyone in a clear and intelligible way.

Enabling action and expression represents the third pillar of UDL, aimed at the strategic networks that manage the planning and execution of motor and cognitive tasks. Many students with disabilities possess the knowledge but encounter physical or intellectual barriers to demonstrating it through traditional written tests. Offering alternatives such as oral presentations, videos, concept maps or the use of assistive technologies allows the student to reveal their learning in an authentic way. Zerbato corroborates this view by stating that "curricular flexibility constitutes the basis for teaching to cease to be standardized and become accessible" (Zerbato, 2021, p. 158). The freedom to express what has been learned through different paths ensures that the evaluation is a reflection of real progress and not a punishment for the functional limitations of the subject.

From the perspective of pedagogical mediation, the dialogue between the pillars of the UDL and Special Education reveals that inclusion is not limited to isolated assistive technology resources. The integration of these fundamentals requires a change in school culture, where accessibility is thought of universally and not as a favor granted to a few. Anache complements this idea by emphasizing that "each individual has a biological and social rhythm that directly interferes in the appropriation of school content" (Anache, 2022, p. 52). Thus, the teaching practice lacks a clinical-pedagogical look that identifies the student's potential, using the pillars of engagement and representation as foundations for a solid and isonomic intellectual construction.

Teachers who work in the Specialized Educational Service (AEE) find in the DUA a robust theoretical framework to guide collaborative work with teachers in the common room. The articulation between these professionals is the nodal point for the curriculum to stop being a burden and become a path of possibilities. Pletsch observes that "SEA is configured as a service that supplements or complements the training of students with disabilities" (Pletsch, 2020, p. 30). When the principles of action and expression are applied in a coordinated way, the chances of school success increase dramatically, as the student realizes that his or her unique ways of acting in the world are valued and legitimized by the educational institution.

Concomitantly, the use of diversified sensory stimuli favors not only students with disabilities, but the entire heterogeneous group present in the classroom. Neuroplasticity is stimulated when the brain is challenged by multiple languages, promoting deeper and longer-lasting learning. Nunes points out that "the diversification of sensory stimuli promotes greater attention retention in children with developmental disorders" (Nunes, 2021, p. 101). This finding reinforces that Universal Design is not a specific method for disability, but an approach that qualifies teaching for all, transforming heterogeneity into a pedagogical richness instead of a problem to be solved.

Monolithic and rigid curricula represent the greatest barrier to the effectiveness of school democracy, as they presuppose that everyone must learn in the same way and at the same time. The UDL proposes to break this paradigm by suggesting that flexibility should be imbued at the core of institutional planning. Zerbato points out that "brain variability implies that there is no single path for processing information" (Zerbato, 2021, p. 144). By adopting this perspective, the school assumes the ethical commitment to leave no one behind, ensuring that the curricular structure is fluid enough to accommodate the multiple intelligences and the various ways of existing.

Through the critical analysis of evaluation practices, it is perceived that the focus often falls on what the student cannot do, ignoring his qualitative progress. The pillar of action and expression invites the educator to rethink the evaluation instruments, making them less punitive and more procedural. Anache asserts that "the pedagogical diagnosis moves away from the clinical view to focus on the student's learning possibilities" (Anache, 2022, p. 60). This change in mentality is crucial for students with intellectual or physical disabilities to feel capable of overcoming their limits, seeing the school as a space for empowerment and the construction of their citizen autonomy.

Criticism of the traditional teaching model intensifies when we observe that the mere presence of the student in the regular classroom does not guarantee his superior psychic

development. Inclusion lacks pedagogical intentionality and an architecture that supports difference without segregating it into parallel and decontextualized activities. Pletsch stresses that "the inclusive school demands a reorganization of teaching work and school time" (Pletsch, 2020, p. 35). Without this structural reorganization based on the three pillars of UDL, the discourse of diversity remains in the field of intentions, failing to provide an education that is, in fact, an inalienable right and accessible to each and every human being.

Synthesizing the fundamentals exposed, the implementation of UDL in Special Education transcends technique to achieve human dignity in the act of learning. The intertwining of engagement, representation, and expression creates a network of intellectual protection that prevents veiled exclusion within the academic environment. Recognizing the uniqueness of each student is the path to a practice that values existence in its fullness. As the contemporary literature summarizes, "social interactions mediated by language become the engine of higher psychic development" (Nunes, 2021, p. 110). This analysis ends by reaffirming that quality education depends on the courage to break with static curricula in favor of a school open to all minds.

The limitations of reactive curricular adaptations in the face of the potential of a universally planned curriculum

The transition from a clinical perspective to an educational approach based on Universal Design for Learning (UDL) requires the abandonment of segregating practices that have historically guided school inclusion. The rigid curriculum, by ignoring human variability, requires constant tinkering that rarely touches the essence of the pedagogical process. "The Universal Design for Learning presupposes that the barrier is not in the student, but in the curriculum and in the teaching environment, which need to be designed for everyone" (Zerato, 2018, p. 25). Such an inversion of values shifts the focus from individual disability to advance planning, establishing that accessibility should constitute the central pillar of didactic architecture from its primordial conception.

The model of reactive curricular adaptations operates under a logic of exception, intervening only when school failure becomes evident or exclusion manifests itself. This palliative method overloads the teacher and stigmatizes the student, reinforcing the idea that learning needs simplifications instead of diversified paths. "Curricular adaptations, because they are made a posteriori, end up keeping the focus on the student's limitation and not on the flexibility of the environment" (Pletsch, 2020, p. 42). The maintenance of this fragmented system prevents the school institution from reaching a level of institutional maturity where diversity is the standard and not the deviation.

Unlike the improvisation of late adjustments, universal planning foresees multiple means of engagement, representation and expression, ensuring that knowledge is assimilated through different sensory and cognitive pathways. The structure of the UDL is based on neurosciences, seeking to stimulate distinct neural networks that optimize information retention. "The application of the principles of UDL requires the offer of varied options so that the learner can access the content according to their characteristics" (Nunes, 2021, p. 88). When the teacher designs his class contemplating such premises, he eliminates in advance obstacles that would be insurmountable in a traditional and monolithic format.

The criticism lies in the fact that the inflexible curriculum generates an artificial need for specialized support, transforming the regular classroom into a space of merely physical coexistence, devoid of effective learning. The effort to adapt content after it has been developed consumes temporal and intellectual resources that would be better used in an inclusive instructional design. "Often, curricular adaptation is seen as a simplification of content, which reduces learning expectations about students with disabilities" (Zerato, 2018, p. 30). This reductive view restricts intellectual development, depriving the student of access to complex concepts in their entirety.

Establishing a dialogue between the foundations of UDL and teaching practice requires the teacher to assume the role of learning designer, abandoning passive and unidirectional transmission. The multiplicity of technological and methodological resources currently available allows instruction to occur in a fluid way, without the need for visible differentiations that segregate the groups within the same space. "Planning from the perspective of UDL allows the teacher to organize teaching strategies that reach everyone simultaneously" (Nunes, 2021, p. 95). The simultaneity of the pedagogical offer guarantees genuine belonging, strengthening the affective bond with knowledge and with the school community.

It is observed that the rigidity of the evaluation systems constitutes one of the greatest obstacles to the implementation of a universally planned curriculum, since the measurement of performance is usually standardized. The reactivity of the adaptations is reflected in tests that only mask the exclusion, without actually allowing the student to demonstrate his competence in alternative ways. "The evaluation must be consistent with the teaching process, allowing the student to express his knowledge through multiple modalities" (Pletsch, 2020, p. 55). Without a reform in the evaluation instruments, UDL remains a theoretical concept, far from the bureaucratic reality of contemporary educational institutions.

Considering the scenario of educational policies, teacher training lacks a critical basis that replaces the habit of "adapting for one" with "planning for all". Knowledge of the brain

networks involved in learning — recognition, strategic, and affective — provides the scientific substrate for this paradigm shift. "Understanding executive functions is essential to propose strategies that help students in the planning and execution of their tasks" (Prazeres, 2022, p. 112). The technical training of educators becomes the engine that drives the deconstruction of static curricula and the construction of dynamic and responsive learning environments.

The effectiveness of the UDL is manifested in the reduction of the feeling of inadequacy on the part of the student body, promoting a culture of autonomy and self-regulation. When access to information is guaranteed by various formats — visual, auditory, tactile or interactive — the language or sensory barrier is no longer an impediment to academic progress. "Curricular accessibility is not limited to physical space, but encompasses access to knowledge and communication" (Zerato, 2018, p. 45). The distancing from reactive practices allows the school to fulfill its social function of promoting the full development of all human potentialities without prior distinctions.

Paradoxically, institutional resistance often rests on the false premise that UDL would require Herculean work, when in fact it simplifies classroom management over time. Punctual adaptations generate a vicious cycle of dependence on specific materials and tutors, while the universal curriculum fosters learner independence. "By offering choices within the curriculum, the educator stimulates the student's intrinsic motivation and engagement in his own process" (Prazeres, 2022, p. 128). Engagement becomes the catalyst for persistence, minimizing the dropout and disinterest commonly associated with traditional teaching models.

Pletsch (2020) asserts that inclusion requires deep structural changes that go beyond the simple discourse of acceptance, reaching the hard core of didactics and school organization. The limitations of curricular adaptations lie in their remedial character, treating diversity as a problem to be solved and not as an intrinsic characteristic of the collectivity. "School inclusion demands a review of pedagogical practices so that the curriculum is accessible to all students, without exception" (Pletsch, 2020, p. 60). This revision assumes that universality is the initial parameter of any educational proposal, eliminating the dichotomy between regular and special education.

Nunes (2021) corroborates the thesis that flexibility needs to be inscribed in the marrow of teaching plans, allowing each individual to find their point of connection with knowledge. The fragmentation of the curriculum into "common" and "adapted" creates a silent hierarchy that perpetuates exclusion within inclusion itself, limiting the horizon of possibilities of the subjects. "Universal design does not propose a single method for everyone, but rather a variety of methods that meet the uniqueness of each one" (Nunes, 2021, p. 102). The

multiplicity of pedagogical paths enriches the collective experience, preparing citizens for a world characterized by plurality and constant transformation.

It is concluded that the abandonment of reactive strategies in favor of Universal Design for Learning represents the scientific maturation of contemporary pedagogy. Replacing adaptation with universal planning ensures that the architecture of education is robust enough to accommodate variability without collapsing or excluding. "Only through a universally designed curriculum can we ensure that the right to education is fully exercised by all subjects" (Prazeres, 2022, p. 140). The construction of a truly accessible school depends on the intellectual courage to reformulate the curricular foundations, establishing diversity as the cornerstone of the entire educational process.

Pedagogical guidelines that assist teachers in the practical application of UDL to minimize learning barriers in diverse classrooms

The reconfiguration of educational environments under the aegis of Universal Design for Learning (UDL) presupposes the recognition of neurological variability as an inherent norm of the student collective. Pedagogical planning, by moving away from standardized models, seeks to anticipate solutions that contemplate the plurality of cognitive profiles present in contemporary classrooms. "UDL proposes that teaching be planned in such a way as to offer multiple forms of representation, expression, and engagement, removing barriers before they impede learning" (Bock, 2019, p. 115). This proactive posture breaks with the tradition of emergency adjustments, establishing that accessibility must be inscribed in the genetic code of the curricular proposal.

Unlike one-off interventions, universal guidelines seek to base teaching on scientific evidence that explains how the brain processes information and maintains focus. The diversification of sensory stimuli allows knowledge to reach the student through alternative paths, ensuring that specific limitations do not translate into cognitive exclusion. "The application of UDL in teaching practice requires the teacher to know the neural networks of their students to offer diversified learning paths" (Sebastian-Heredero, 2020, p. 58). By understanding the recognition networks, the educator selects visual, auditory and tactile supports that facilitate the decoding of complex concepts autonomously.

Strategies focused on action and expression enable individuals to demonstrate their competencies without the constraints of rigid evaluation instruments. Formal rigidity often prevents subjects with distinct abilities from manifesting their mastery over content, generating performance metrics that do not reflect intellectual reality. "It is necessary to ensure that the student has different means to express what he has learned, using technologies or other languages that surpass traditional writing" (Gewehr, 2021, p. 74). The

offer of options for the execution of tasks promotes a scenario where creativity and critical reasoning prevail over the mere mechanical repetition of pre-established patterns.

Fostering engagement requires that the teacher establish connections between academic knowledge and the reality experienced by the learner, arousing genuine interest through practical relevance. When the curriculum ignores intrinsic affections and motivations, the educational process becomes an exercise in resistance and apathy. "Engagement is the engine of learning and depends on offering appropriate challenges that keep the student motivated and focused on the task" (Oliveira, 2023, p. 42). Providing individual choices about the level of difficulty or the format of the activities strengthens self-regulation, allowing the student to manage his own route with greater security.

Sebastian-Heredero (2020) emphasizes that universal design is not to be confused with the facilitation of content, but rather with the provision of scaffolding that supports access to rigorous knowledge. The distinction between the essential and the accessory in the teaching plan allows the teacher to maintain high expectations while making the ways of achieving the proposed objectives more flexible. "Accessibility in UDL does not mean lowering the level of demand, but rather offering the necessary support for everyone to achieve the same learning objectives" (Sebastian-Heredero, 2020, p. 65). Such a perspective combats the pedagogical prejudice that limits the development horizon of students with atypical trajectories.

Bock (2019) argues that the transition to this model requires a deep reflection on the role of assistive technology, which must be integrated invisibly and fluidly into school daily life. The use of reading software, adapted keyboards or transcription resources benefits the entire class, optimizing the flow of communication between peers. "Technology should act as a mediation resource that enhances human capabilities, eliminating physical or communicational impediments in the school environment" (Bock, 2019, p. 128). Technology, from the perspective of UDL, ceases to be an instrument of segregation to become a catalyst for collective intelligence.

Gewehr (2021) highlights that the support offered by the teacher needs to be dynamic, adapting to the fluctuations of student development throughout the school year. Constant monitoring of progress allows the educator to adjust support resources, withdrawing them as autonomy is consolidated. "Effective pedagogical mediation is one that identifies the needs of the group and adjusts teaching materials to ensure full access to information" (Gewehr, 2021, p. 89). This thorough monitoring ensures that no student remains stagnant due to lack of adequate tools or excessive ease, keeping the learning flow balanced.

Oliveira (2023) analyzes that the construction of inclusive environments depends on the institutional capacity to organize times and spaces in a less linear way. Classrooms that allow different grouping configurations and active methodologies favor the implementation of universal guidelines, as they welcome different work rhythms. "Universally planned learning environments are spaces that celebrate difference and encourage cooperation among peers as a teaching strategy" (Oliveira, 2023, p. 55). Collaboration among students, mediated by the teacher, transforms diversity into a valuable didactic resource, promoting the exchange of knowledge and the strengthening of social bonds.

Considering teacher training, it is observed the urgency of technical knowledge that equips the professional for instructional design. Knowing how to design a class that already contains subtitles, image descriptions and voice syntheses requires a competence that goes beyond traditional didactics. "Teacher training for UDL requires mastery of digital tools and a new understanding of how the brain works in the learning process" (Sebastian-Heredero, 2020, p. 72). The scientific updating of teaching becomes, therefore, the guarantee that learning barriers are systematically identified and removed from daily practice.

Bock (2019) reinforces that the removal of attitudinal barriers is the biggest challenge for the consolidation of universal curricula in educational institutions. The belief in the existence of a standard student prevents methodological innovations from gaining scale, keeping the system in a cycle of veiled exclusion. "Overcoming the view that special education is a parallel system is the first step towards implementing a truly universal curriculum" (Bock, 2019, p. 142). The unification of pedagogical practices under the umbrella of UDL strengthens the school as a democratic space, where the right to know is not mediated by clinical diagnoses.

Gewehr (2021) points out that the sustainability of a proposal based on UDL lies in the creation of professional learning communities where experiences are shared and refined. Teacher isolation prevents creative solutions from circulating and benefiting other educational contexts within the same school unit. "Collaborative work among education professionals is essential to create pedagogical guidelines that respond to the complexity of the diverse classroom" (Gewehr, 2021, p. 101). The exchange of successful practices accelerates the process of curricular flexibility, reducing the individual workload and increasing the effectiveness of interventions.

Oliveira (2023) concludes that the success of universal guidelines is manifested in the full social and academic participation of all subjects, without anyone needing to be "integrated" through late patches. Universal design for learning offers the roadmap for a school that recognizes the beauty of human uniqueness and transforms it into educational

power. "A universally planned curriculum is the maximum expression of respect for diversity and commitment to human development in all its dimensions" (Oliveira, 2023, p. 68). The practical application of these principles ensures that the educational institution fulfills its mission of forming autonomous, critical citizens who are able to contribute to a plural society.

3 CONSIDERATIONS

The implementation of Universal Design for Learning (UDL) at the heart of Special Education represents a paradigmatic break with the logic of exclusion and instructional standardization. By moving from a clinical perspective, centered on the pathology of the individual, to a critical analysis of curricular rigidity, the school institution recognizes its responsibility in the genesis of pedagogical barriers. This philosophy is based on the premise that neurocognitive variability is the biological norm, not the deviation, requiring the educational ecosystem to adapt to human plurality. Thus, accessibility ceases to be a reactive adjustment and becomes a constitutive pillar of planning, ensuring that the right to education transcends rhetoric and materializes in effective participation.

The structuring axes of UDL — engagement, representation, and action and expression — provide the scientific substrate for the operationalization of an inclusive praxis. By stimulating the affective, recognition, and strategic networks of the brain, instructional design ensures that knowledge is mediated by multiple sensory inputs and processed under conditions of sustained motivation. This approach overcomes the insufficiency of a *posteriori* curricular adaptations, which often stigmatize the student and promote conceptual reductionism. On the other hand, universal planning anticipates diversity, offering supports that allow students to internalize and externalize knowledge in an authentic and equitable way.

In the context of pedagogical mediation, the transition to this model requires a reconfiguration of the teaching culture and the architecture of school times. Assistive technology and the diversification of stimuli are no longer peripheral resources of the Specialized Educational Service (AEE) to integrate the core of regency in common rooms, benefiting the entire student body. When the educator assumes the role of architect of learning, prioritizing the provision of dynamic supports to the detriment of passive transmission, he fosters self-regulation and intellectual autonomy. Such transformation is essential for heterogeneity to be converted into pedagogical power, mitigating the feeling of inadequacy and strengthening the bonds with the object of knowledge.

Thus, the maturation of contemporary Special Education lies in the consolidation of fluid curricula that replace the deficient view with the valorization of subjective potentialities.

The overcoming of monolithic models in favor of universal learning paths ensures the fulfillment of the social function of the school in an isonomic and democratic manner. By institutionalizing diversity as a cornerstone of the educational process, the education system breaks with veiled forms of segregation and establishes a territory of genuine belonging. The rigorous implementation of UDL therefore sets the path to quality education that respects human dignity and promotes the integral development of all subjects.

REFERENCES

- Anache, A. A. (2022). Avaliação educacional e deficiência intelectual: Caminhos e descaminhos. Editora UFMS.
- Bock, G. L. K. (2019). O desenho universal para a aprendizagem: Potencialidades e desafios na educação inclusiva. Editora CRV.
- Gewehr, D. (2021). Práticas pedagógicas inclusivas: O desenho universal para a aprendizagem em foco. Editora da UFRGS.
- Gil, A. C. (2002). Como elaborar projetos de pesquisa (4ª ed.). Atlas.
- Lakatos, E. M., & Marconi, M. de A. (2003). Fundamentos de metodologia científica (5ª ed.). Atlas.
- Nunes, A. C. R. (2021). Neurociência e educação: O desenho universal para a aprendizagem na prática. Editora Acadêmica.
- Nunes, D. R. P. (2021). Estratégias pedagógicas e transtorno do espectro autista. Revista Brasileira de Educação Especial, 27, 85–115.
- Oliveira, R. M. (2023). Engajamento e diversidade: Estratégias do DUA para a sala de aula contemporânea. Summus.
- Pletsch, M. D. (2020). O atendimento educacional especializado no contexto da BNCC. Cadernos de Pesquisa, 50(176), 20–40.
- Pletsch, M. L. (2020). Educação especial e inclusão escolar: Currículo e práticas pedagógicas. Nau Editora.
- Prazeres, M. S. (2022). O design instrucional inclusivo: Caminhos para o desenho universal. Autêntica.
- Sebastian-Heredero, E. (2020). Diretrizes para o desenho universal para a aprendizagem (DUA). Revista Brasileira de Educação Especial, 26, 55–78.
- Severino, A. J. (2007). Metodologia do trabalho científico (23ª ed.). Cortez.
- Zerato, S. A. (2018). Desenho universal para a aprendizagem na formação de professores. Editora UFSCar.
- Zerbato, A. P., & Mendes, E. G. (2021). Desenho universal para a aprendizagem como estratégia de inclusão escolar. Revista Educação Especial, 34, 145–165.

RESULTS OF AN INNOVATIVE ENTREPRENEURSHIP POLICY INSTRUMENT IN THE FEDERAL NETWORK OF PROFESSIONAL, SCIENTIFIC, AND TECHNOLOGICAL EDUCATION

RESULTADOS DE UM INSTRUMENTO DE POLÍTICA DE EMPREENDEDORISMO INOVADOR NA REDE FEDERAL DE EDUCAÇÃO PROFISSIONAL, CIENTÍFICA E TECNOLÓGICA

RESULTADOS DE UN INSTRUMENTO DE POLÍTICA DE EMPRENDIMIENTO INNOVADOR EN LA RED FEDERAL DE EDUCACIÓN PROFESIONAL, CIENTÍFICA Y TECNOLÓGICA



<https://doi.org/10.56238/sevened2026.008-023>

**João Paulo do Carmo¹, Ariana Oliveira Gusmao², Humberto Henrique Ramos Brotto³,
Gabriel Adolfo Gomes Potin⁴, Filipe Barbosa Martins⁵**

ABSTRACT

Considering the need to strengthen innovation and entrepreneurship within public education institutions, this research analyzes the outcomes of the Innovative Entrepreneurship (IE) project, an initiative of the Ministério da Educação (MEC) - Brazilian Ministry of Education aimed, at the Rede Federal de Educação Profissional, Científica e Tecnológica (RFEPCT) - Federal Network of Professional, Scientific, and Technological Education. The study aims to evaluate the project's impacts on the consolidation of entrepreneurial culture, research infrastructure, and institutional capacity for innovation generation and dissemination. To this end, a qualitative and quantitative methodological approach was adopted, based on the analysis of secondary data, surveys, and interviews with institutional actors involved in the project's implementation. Thus, the findings indicate that the IE project significantly contributed to improving research conditions, expanding access to applied knowledge, and strengthening entrepreneurial practices within academic environments. However, challenges related to startup creation and innovation commercialization persist. This allows the conclusion that fostering innovative entrepreneurship in developing economies requires integrated public policies that align capacity building, technological innovation, and sustainable growth strategies to unlock long-term entrepreneurial potential.

¹ Master's degree in Business Administration. Universidade Federal do Espírito Santo (UFES).
E-mail: joao.carmo@ifes.edu.br

² Master's degree in Sustainable Technologies. Instituto Federal do Espírito Santo (IFES).
E-mail: ariana.gusmao@ifes.edu.br

³ Master's degree in Intellectual Property and Technology Transfer for Innovation. Instituto Federal do Espírito Santo (IFES). E-mail: humbertobrotto@ifes.edu.br

⁴ Master's degree in Economics. Universidade Federal do Espírito Santo (UFES).
E-mail: gabrielpotin@ifes.edu.br

⁵ Master's degree in Agronomy. Universidade Federal do Espírito Santo (UFES).
E-mail: filipebarbosazooteecnista@gmail.com

Keywords: Innovative Entrepreneurship. Startups. Economy 4.0. Public Policy. Innovation Policy.

RESUMO

Considerando a necessidade de fortalecimento da inovação e do empreendedorismo no âmbito das instituições públicas de ensino, esta pesquisa analisa os resultados do projeto Empreendedorismo Inovador (EI), iniciativa do Ministério da Educação (MEC) voltada à Rede Federal de Educação Profissional, Científica e Tecnológica (RFEPT). Objetiva-se avaliar os impactos do projeto na consolidação da cultura empreendedora, na infraestrutura de pesquisa e na capacidade institucional de geração e difusão de inovações. Para tanto, procede-se a uma abordagem metodológica de natureza qualitativa e quantitativa, baseada na análise de dados secundários, aplicação de questionários e realização de entrevistas com atores institucionais envolvidos na execução do projeto. Desse modo, observa-se que o EI contribuiu significativamente para a melhoria das condições de pesquisa, ampliação do acesso ao conhecimento aplicado e fortalecimento de práticas empreendedoras no ambiente acadêmico. Contudo, permanecem desafios relacionados à criação de startups e à comercialização das inovações desenvolvidas. O que permite concluir que a promoção do empreendedorismo inovador em economias em desenvolvimento demanda políticas públicas integradas, capazes de articular capacitação, inovação tecnológica e estratégias de crescimento sustentável, de modo a potencializar resultados de longo prazo.

Palavras-chave: Empreendedorismo Inovador. Startup. Economia 4.0. Políticas Públicas. Política de Inovação.

RESUMEN

Considerando la necesidad de fortalecer la innovación y el emprendimiento en el ámbito de las instituciones públicas de educación, esta investigación analiza los resultados del proyecto Emprendimiento Innovador (EI), una iniciativa del Ministério da Educação (MEC) - Ministerio de Educación de Brasil orientada a la Rede Federal de Educação, Profissional, Científica e Tecnológica (RFEPT) - Red Federal de Educación Profesional, Científica y Tecnológica. El estudio tiene como objetivo evaluar los impactos del proyecto en la consolidación de la cultura emprendedora, en la infraestructura de investigación y en la capacidad institucional para la generación y difusión de innovaciones. Para ello, se adopta una metodología de enfoque cualitativo y cuantitativo, basada en el análisis de datos secundarios, la aplicación de cuestionarios y la realización de entrevistas con actores institucionales involucrados en la ejecución del proyecto. De este modo, se observa que el EI contribuyó de manera significativa a la mejora de las condiciones de investigación, a la ampliación del acceso al conocimiento aplicado y al fortalecimiento de prácticas emprendedoras en el entorno académico. No obstante, persisten desafíos relacionados con la creación de startups y la comercialización de las innovaciones desarrolladas. Lo que permite concluir que la promoción del emprendimiento innovador en economías en desarrollo requiere políticas públicas integradas, capaces de articular la formación de capacidades, la innovación tecnológica y estrategias de crecimiento sostenible, con el fin de potenciar resultados a largo plazo.

Palabras clave: Emprendimiento Innovador. Startups. Economía 4.0. Políticas Públicas. Política de Innovación.

1 INTRODUCTION

Entrepreneurship is defined as the generation of value through the creation or expansion of economic activities through new products, processes, or markets (Rauch et al., 2009). Innovation is what distinguishes dynamic entrepreneurship from static entrepreneurship (Gianesini et al., 2018), and when combined with entrepreneurship, it forms the concept of 'Innovative Entrepreneurship' (EI), focused on new ventures and *startups* based on innovative ideas (Balkienė & Jagminas, 2014; Szabo & Herman, 2012).

In Brazil, despite high levels of entrepreneurship, many businesses are created out of necessity and are not innovative or high-growth (Ogliastri et al., 2019). The country has faced challenges in business innovation, with slow progress and weak indicators compared to other emerging economies (Koeller, 2017).

In 2020, the Ministry of Education (MEC) launched the first explicit government initiative of 'Innovative Entrepreneurship', directing resources to institutions in the Federal Network to develop applied research projects in the areas of Economy 4.0 (Industry, Agriculture and Services). 60 projects were selected in 31 institutions from all regions of Brazil, with the aim of creating startups and innovative solutions related to digital transformation (Rippa & Secundo, 2019). However, little is known about EI initiatives in developing economies.

This study seeks to evaluate the results of Brazilian support to EI, investigating whether the Project has stimulated the creation of favorable environments for innovation and business development based on technological solutions aligned with the demands of Economy 4.0. The research addresses documents related to the projects and includes interviews with the project coordinators. The central research question is: "To what extent has MEC's Innovative Entrepreneurship project promoted innovation and the creation of businesses aligned with Economy 4.0 in the institutions of the Federal Network?".

2 THEORETICAL FRAMEWORK

Innovation is widely recognized as a central element for the economic growth, competitiveness and sustainable development of nations. In contexts marked by globalization and the intensification of technological transformations, innovative processes are no longer linear and begin to require institutional coordination, strategic management, and articulation between different actors in the productive and scientific system. In this sense, the classic literature highlights innovation as a systemic phenomenon, dependent on the interaction between companies, universities, government and society (Kline et al., 1986; Freeman & Soete, 2008).

In Brazil, the construction of a policy focused on science, technology and innovation (ST&I) has its antecedents in the 1950s, with the creation of fundamental institutions such as the National Council for Scientific and Technological Development (CNPq) and the Coordination for the Improvement of Higher Education Personnel (CAPES). These institutional frameworks contributed to the consolidation of the national scientific base and to the training of qualified human resources. This evolutionary process culminated, in 1985, in the creation of the then Ministry of Science and Technology, later expanded to incorporate the innovation dimension, reflecting the recognition of the strategic role of ST&I in national development (Pelaez et al., 2017).

A significant advance occurred with the enactment of the Innovation Law (Law No. 10,973/2004), which established legal mechanisms to stimulate cooperation between universities, research institutes, and the productive sector. Among its main contributions, the institutionalization of the Technological Innovation Centers (NITs), responsible for the management of intellectual property and the promotion of technology transfer within scientific and technological institutions, stands out. The Innovation Law also boosted the creation of articulation bodies, such as the Forum of Innovation and Technology Transfer Managers (Fortec), and was complemented by the Good Law (Law No. 11,196/2005), which introduced tax incentives for business research and development.

In the following years, the country began to structure policies and programs specifically aimed at innovative entrepreneurship, with emphasis on initiatives such as Startup Brasil, InovAtiva Brasil and the expansion of incubators and accelerators linked to universities and public institutions. These actions sought to bring together entrepreneurs, investors and support agents, contributing to the formation of a more dynamic startup ecosystem (Carmo & Costa, 2016; Roncaratti, 2017; Aranha, 2016). Despite these advances, the literature points out that structural obstacles, such as excessive bureaucracy, regulatory complexity, and high tax burden, continue to limit the full development of entrepreneurial activities in the country.

More recently, the formulation of the National Innovation Policy (PNI), in 2020, and the National Strategy for Science, Technology, and Innovation (ENCTI 2016–2022) reinforced the Brazilian State's effort to integrate ST&I policies with market demands and the challenges of economic and social development. These instruments establish guidelines aimed at increasing productivity, reducing regional inequalities and strengthening the National Innovation System, evidencing the country's commitment to innovation as a structuring axis of development. However, the challenge remains to transform legal frameworks and institutional programs into effective and sustainable results, capable of positioning Brazil more competitively on the global stage (MCTIC, 2016; Vonortas & Castillo, 2022).

3 THE BRAZILIAN PROJECT OF INNOVATIVE ENTREPRENEURSHIP

The Innovative Entrepreneurship (EI) project was structured as a continuous public policy initiative, implemented through successive public calls, with the objective of fostering innovative entrepreneurship in the Federal Network of Professional, Scientific and Technological Education (RFEPCT). The action was conceived by the Secretariat of Professional and Technological Education of the Ministry of Education (Setec/MEC) and executed by the Federal Institute of Espírito Santo (Ifes), in partnership with the Foundation for Support to the Development of Science and Technology (Facto), assuming a national character since its first edition.

The first cycle of the project was launched in 2020, through Ifes Notice No. 05/2020, focusing on innovative entrepreneurship associated with Economy 4.0 technologies, covering the areas of Agriculture 4.0, Industry 4.0 and Services 4.0. This public notice provided for the execution of the projects for 24 months and resulted in the selection of 60 institutional projects, distributed among different Federal Institutes in the country, with criteria that integrated teaching, research and extension, in addition to technological impact, market potential and social impact.

Based on the accumulated experience, the project advanced to a second edition, which began in 2022, lasting 12 months and selecting 25 projects. However, the present study focuses exclusively on the analysis of the first cycle of the project, since it was fully completed at the time of data collection and analysis, allowing a more consistent evaluation of its results and institutional effects.

In general, the supported projects contributed to the promotion of the culture of innovation and entrepreneurship in the academic environment, to the development of applied technologies and to the formation of technical, managerial and entrepreneurial skills. Thus, the time frame between 2020 and 2023 shows the consolidation of Innovative Entrepreneurship as a relevant instrument of educational and innovation public policy, by articulating financing, training, and institutional governance, while establishing analytical bases for future evaluations of its subsequent editions.

3.1 THE STRUCTURING OF THE PROJECT

The Innovative Entrepreneurship (IE) project aimed to support the selection and development of innovation and entrepreneurship projects within the scope of the Brazilian Federal Network of Professional, Scientific and Technological Education (RFEPCT). These projects were expected to contribute to the emergence of startups and innovative companies, especially in areas related to the digital technologies of the so-called Economy 4.0, such as

the Internet of Things, *Big Data* and Artificial Intelligence.

Instruments such as research grants, tax incentives, and specialized consultancies are widely used in innovation policies at the international level, and the IE project followed this approach by offering research grants and infrastructure resources to the 60 selected projects. Coordinated by the Secretariat of Professional and Technological Education of the Ministry of Education (Setec/MEC), the project had financial and administrative support for its implementation in the RFEPECT institutions.

Created in 2008, the Federal Network plays a strategic role in professional education and socioeconomic development in the country, being supported by institutional partners such as Sebrae and the Foundation for the Support of the Development of Science and Technology (Facto), which acted in the provision of financial support, training and administrative management, strengthening the innovation ecosystem linked to the participating institutions.

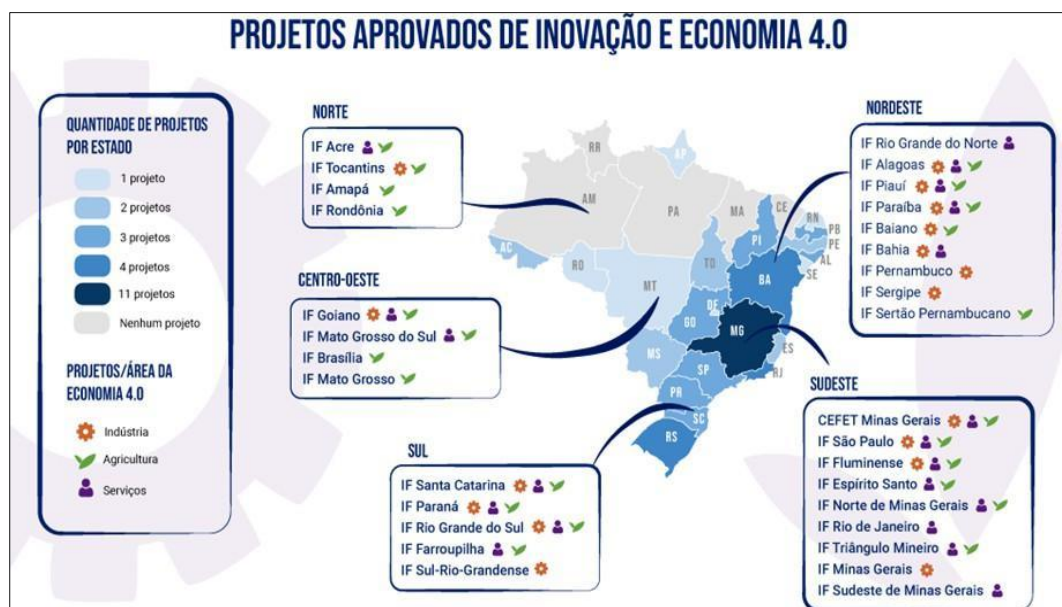
Also noteworthy is the participation of the National Association of Entities Promoting Innovative Enterprises (Anprotec), an entity that acts as a national network of innovation environments and promotes the strengthening of its members for the benefit of the economy and society. As a partner of the EI project, Anprotec was responsible for carrying out activities to diagnose the maturity of innovation environments, for the *online qualification* of leaders in the management of innovative environments and for the preparation of the Implementation, Development and Operation Plans of the innovation environments of each Federal Institute.

The institutional governance arrangement demonstrates the articulation between government agencies, institutions of the Federal Network and support entities, highlighting the strategic coordination of Setec/MEC, the operational execution by Ifes, the technical and financial support of partners such as Sebrae, Anprotec and Facto, and the role of the institutions of the Federal Network in the implementation of the projects. This configuration reflects a collaborative model of public policy aimed at strengthening the ecosystem of innovation and entrepreneurship in the educational sphere.

Regarding the approved projects, Figure 1 shows the distribution of the 60 approved proposals, which included all regions of Brazil, with the Southeast standing out with 18 projects (30% of the total), especially in Minas Gerais, which had 9 approved projects (15%). The Northeast was also well represented with 17 projects (28%). The projects were divided among the areas of Economy 4.0, 23 in Agriculture 4.0 (38.3%), 17 in Industry 4.0 (28.3%) and 20 in Services 4.0 (33.4%).

Figure 1

Distribution of projects approved in the Innovative Entrepreneurship Notice



Source: The authors (2025).

In total, 1,127 people, including students, professors and civil servants, participated in these projects. There is a predominance of professors and administrative technicians, totaling 659 participants, evidencing the central role of these professionals in the coordination, orientation and execution of project activities. In relation to the student body, the participation of secondary/technical level (237) and higher education (229) students stands out, which reinforces the integration between different levels of training within the scope of the Federal Network. On the other hand, the participation of graduate students, as volunteers, is significantly lower (2), indicating a still incipient involvement of this specific public in the project's actions. In general, the data show the multidisciplinary and interinstitutional character of the initiative, as well as its ability to mobilize different profiles of actors in the educational innovation ecosystem.

4 METHODOLOGY

To evaluate the results of the Innovative Entrepreneurship Project, a methodological approach was adopted based on the triangulation of different types of data, combining primary and secondary sources, with the objective of increasing the analytical robustness and reliability of the results. The triangulation allowed the confrontation of perceptions, documentary evidence and empirical data, enabling a more comprehensive analysis of the effects of the project within the scope of the Federal Network of Professional, Scientific and Technological Education.

With regard to secondary data, two main sets of sources were considered: (i)

institutional documents related to the Innovative Entrepreneurship Project, including public notices, technical reports, normative instruments and accompanying materials; and (ii) scientific, technical, and legal productions related to innovation, entrepreneurship, and Economy 4.0 policies. These sources supported the theoretical, institutional and normative contextualization of the study, in addition to supporting the interpretation of the empirical data.

As for the primary data, structured questionnaires were applied and in-depth interviews were conducted with coordinators of the projects selected within the scope of the IE. Quantitative data collection was carried out through the SurveyMonkey platform, using a questionnaire composed of 28 closed questions, organized into previously defined analytical categories. The categories and their respective objectives are described in Chart 1.

Table 1

Analysis categories and objectives

Category	Purpose of the questions
Profile	Profile of respondents, projects and institutions.
Perception	Capture the coordinators' vision on innovative entrepreneurship and promotion strategy, including priorities, selection criteria and integration with other initiatives.
RD&I resources	Evaluate the facilities and material support for RD&I activities, as well as the coordinators' satisfaction with the human, financial and technological resources provided by the Innovative Entrepreneurship Project.
Arrangement political-institutional	Evaluate the institutional arrangement established, the role of the agents involved in the implementation and management of the program and the respective counterparts.
Side Effects (<i>Spillovers</i>)	Identify the results and impacts achieved (direct, indirect, foreseen and unforeseen) with the development of projects, in the various dimensions of Economy 4.0 and in society.

Source: Prepared by the authors (2025).

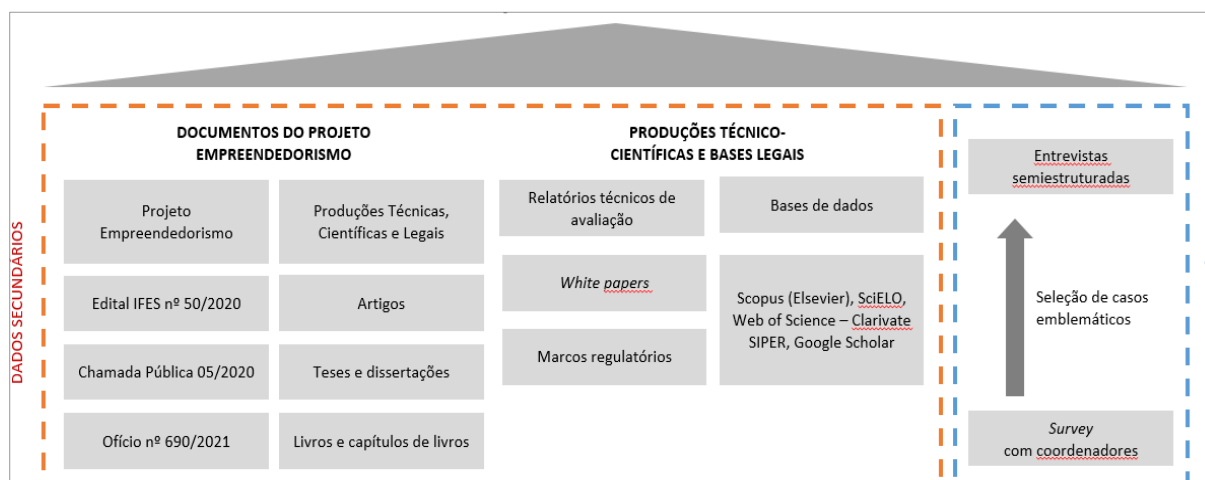
All participants were previously informed about the objectives of the research, ensuring transparency and consent. All coordinators answered the questionnaire, configuring a complete census of the supported projects. In addition, six in-depth interviews were conducted, selected based on the criterion of diversity of the innovation results presented by the projects, which allowed the qualitative exploration of aspects not fully captured by the quantitative instrument. Data analysis was conducted in an integrated manner, articulating primary and secondary information.

Figure 2 summarizes the data sources and collection techniques used in the research, evidencing the methodological triangulation strategy adopted in the study. Integration between secondary and primary data is observed, in order to increase the analytical consistency of the results. In the set of secondary data, the institutional documents of the Innovative Entrepreneurship Project stand out, as well as technical-scientific productions and

legal bases, including evaluation reports, articles, theses, dissertations, books, *white papers*, regulatory frameworks and specialized databases.

Figure 2

Data sources and evaluation techniques



Source: Prepared by the authors (2025).

The primary data, in turn, were obtained through the application of a survey with project coordinators and semi-structured interviews, based on the selection of emblematic cases. This methodological arrangement allowed the articulation of different perspectives and levels of evidence, strengthening the analysis of the results and the understanding of the project's impacts.

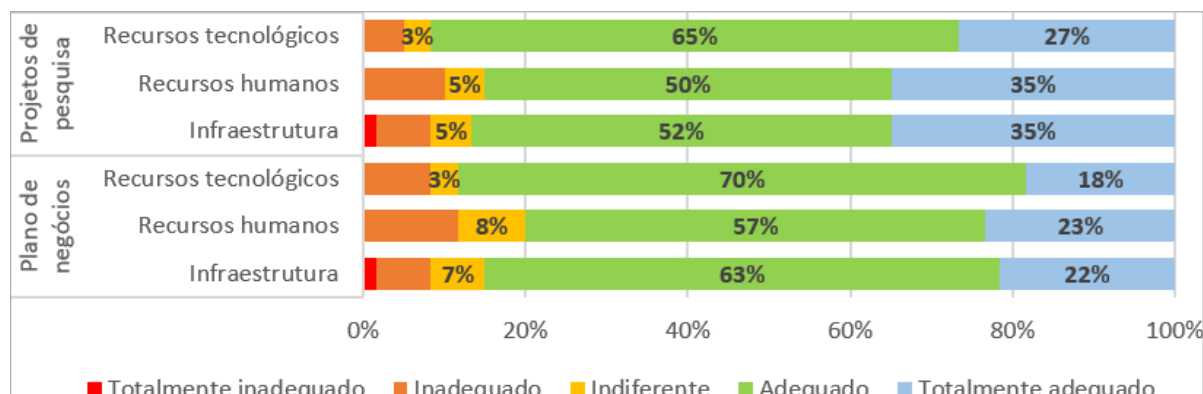
5 RESULTS AND DISCUSSIONS

The results obtained from the questionnaires applied to the project coordinators and from the in-depth interviews were organized into seven analytical categories: (i) research and development (R&D) activities that generate innovation; (ii) learning and generation of skills; (iii) technical and scientific publications; (iv) new products, processes and services; (v) dissemination of the culture of entrepreneurship and innovation; (vi) intellectual property; and (vii) new ventures. The following empirical findings are presented and discussed in an integrated manner, in line with the objectives of the study:

(i) Research and development (R&D) activities that generate innovation: the resources made available by Setec/MEC were mainly directed to the expansion of the research infrastructure of the institutions of the Federal Network, enabling the acquisition of specialized software, databases and technological equipment. According to the survey data, 91% of the coordinators stated that the funding positively impacted the research infrastructure and the scientific and technological knowledge base of their institutions (Figure 3).

Figure 3

Evaluation of the adequacy of the inputs provided for the development of research projects and business plans



Source: Prepared by the authors (2025).

The testimonies collected reinforce this result, indicating that, in many cases, the projects filled pre-existing structural gaps in laboratories and research environments. Despite this, some of the coordinators reported difficulties related to the processes of management and provision of materials, considered bureaucratic or inadequate to the deadlines of the projects. Even so, the investments contributed to institutional strengthening, including the incorporation of advanced equipment, such as 3D printers, which boosted new research and partnerships.

From an analytical point of view, these results corroborate the literature that points to infrastructure as a central element for strengthening innovative capacities in public institutions, especially in regional contexts where resources are historically limited. The IE project, in this sense, acted as an instrument to reduce structural asymmetries within the Federal Network.

(ii) Learning and competence generation: the results indicate that the IE project contributed significantly to the development of technical, intellectual and behavioral skills among students and teachers. Coordinators reported advances in skills such as critical thinking, creativity, communication, leadership, teamwork, and problem-solving. The involvement of students in practical innovation and extension activities increased their self-confidence and favored reflections on professional trajectories that began to include entrepreneurship and applied research as concrete possibilities.

The interviews also show relevant impacts on the professors, especially in the development of managerial and leadership skills, associated with the coordination of more complex projects. For many researchers, this was the first structured experience of managing multidisciplinary teams and interacting with agents outside the academic environment.

These findings dialogue with studies on entrepreneurial education, which highlight experiential learning as a key factor for the formation of entrepreneurial skills. The IE project proved to be relevant by promoting a gradual change in the way students and researchers perceive the relationship between research, innovation and practical application.

(iii) Technical and scientific publications: although the generation of publications was not a central objective for all projects, the results indicate that 22 initiatives produced articles, books or chapters, including publications in high-impact international journals. These productions contributed to increasing the visibility of the projects and strengthening academic and institutional collaboration networks.

Part of the teams chose to postpone scientific dissemination, following guidelines from the National Sebrae related to the preservation of the novelty of the solutions developed, especially in cases with potential for intellectual protection. This result highlights a recurrent tension between the times of open science and the strategies for the protection and economic valorization of knowledge.

(iv) New products, processes and services: more than half of the projects (57%) reported some type of innovation. Most of these innovations were classified as incremental, focusing on regional markets, especially in the agricultural sector. These are, in general, improvements in existing products, processes or services, adapted to the territorial specificities of the participating institutions.

As can be seen in Figure 4, almost half of the innovations developed (47%) are associated with some intellectual property protection mechanism, mainly patents and *software registrations*. In cases where there was no generation of final products, the coordinators highlighted the relevance of the institutional experimentation and learning process, reinforcing the role of the project as a space for testing and capacity development.

Figure 4

Characteristics of the type of innovation produced and its scope



Source: Prepared by the authors (2025).

These results indicate that the EI contributed more strongly to the generation of incremental and contextualized innovations than to disruptive innovations, which is compatible with the profile of the institutions and the stage of technological maturity of the projects.

(v) Dissemination of the culture of entrepreneurship and innovation: the data show that the performance of Anprotec and Sebrae was widely recognized by the coordinators as a central element for the dissemination of the culture of entrepreneurship and innovation. The training actions, mentoring and events favored the incorporation of entrepreneurial practices both in research activities and in teaching.

More than 60% of respondents reported involvement in organizing or leading events focused on innovation, promoting interaction between universities, companies and other organizations. These results suggest that the project generated lasting effects on the institutional culture, going beyond the formal period of validity of the supported initiatives.

(vi) Intellectual Property: at the time of the survey, 63% of innovations were not yet protected by formal intellectual property mechanisms. Part of the projects were in the process of protection, while others opted for industrial secrecy or evaluated the protection as unnecessary, either due to technical limitations or market strategy.

Despite this, the projects that advanced in protection processes reported relevant gains in terms of skills associated with intellectual property management, including market

analysis, branding strategies and valuation of intangible assets. These results reinforce the role of the IE project as a training space also in the field of IP.

(vii) New ventures: the main motivation for accessing the resources of the Innovative Entrepreneurship project was the performance of research, development and innovation (R&D) activities, pointed out by 51.7% of the coordinators, followed by the development of digital technological innovations, as shown in Figure 5. The creation of new ventures appeared as a secondary objective in the set of projects analyzed, reflected in the constitution of four startups at the end of the period studied. This result indicates that, although the project has contributed to the strengthening of the entrepreneurial culture and to the generation of technological solutions, the direct conversion of initiatives into companies was still limited in the first cycle of the policy.

Figure 5

Ranking of motivations for access to EI project resources



Source: Prepared by the authors (2025).

This result indicates that, although the Innovative Entrepreneurship project has consistently contributed to the strengthening of the entrepreneurial culture within the Federal Network, the direct conversion of projects into new ventures remained limited in the first cycle analyzed. This scenario can be explained by a set of structural and institutional factors, among which the still incipient contact of the teams with investors and market agents, the low technological maturity of part of the solutions developed and the priority attributed by the

coordinators to applied research activities to the detriment of the immediate incorporation of companies stand out.

From a public policy perspective, these findings suggest that instruments such as the Innovative Entrepreneurship project are particularly effective in strengthening institutional capacities, building entrepreneurial skills, and generating incremental innovations, especially in educational and scientific settings. However, in order to expand the creation of new ventures and the commercialization of the solutions developed, it is necessary to articulate with complementary mechanisms, such as investment funds, technological scaling programs, test environments and more robust policies for technology transfer and approximation with the productive sector.

The investments made by Setec/MEC had a relevant impact on the research infrastructure of the institutions of the Federal Network, by enabling the acquisition of software, advanced equipment and other essential inputs for research, development and innovation activities. These investments contributed to the creation of an institutional environment more favorable to experimentation, interinstitutional cooperation and the formation of partnerships, in addition to potentially favoring the integration of these institutions into national initiatives for sharing scientific and technological infrastructure.

In addition to the structural effects, the projects analyzed provided participants with significant opportunities to develop entrepreneurial skills, such as creativity, leadership, adaptability, and teamwork, skills considered central in contexts of high uncertainty. The intensification of collaboration between universities, companies and support organizations, combined with training actions conducted by entities such as Sebrae, contributed to the dissemination of a culture of entrepreneurship and innovation with lasting effects on academic practices, teaching activities and professional trajectories of students and teachers.

Despite these advances, the low prioritization of the creation of new enterprises by the project coordinators highlights important limits of the policy analyzed. The experience reinforces that the transition from applied research to the market requires not only financial resources and training, but also greater integration between entrepreneurial education, market strategies and competitive dynamics of the productive sectors. In this sense, the survey underlines the importance of strengthening entrepreneurial training with a focus on business models, market validation, and technological scaling.

Finally, the results dialogue with broader challenges of the Brazilian national innovation system, marked by weaknesses in university-industry interactions and by an entrepreneurship pattern characterized by a high rate of early-stage initiatives, but low innovative intensity and reduced generation of qualified jobs, which is a phenomenon often

described as an "entrepreneurial trap". Overcoming this situation requires policies that balance stimulating the creation of new ventures with strengthening innovation capacity and growth ambitions, avoiding an excessively restricted focus on Economy 4.0 technologies and incorporating other strategic areas for economic and social development.

6 CONCLUSION

This article analyzed the implementation and results of the Innovative Entrepreneurship project, launched by the Ministry of Education (MEC) in 2020, with the objective of supporting and developing innovation and entrepreneurship projects in the institutions of the Federal Network of Professional, Scientific and Technological Education. The initiative sought to strengthen the articulation between education, science and innovation, exploring the potential of these institutions in the generation of applied knowledge and technological solutions, especially in the context of Economy 4.0.

The results showed significant impacts on the research infrastructure and knowledge base of the participating institutions. The funding made available by Setec/MEC proved to be fundamental for the acquisition of technological inputs, software and equipment, contributing to the strengthening of institutional capacities for research, development and innovation. In addition, the project favored the consolidation of applied research and entrepreneurship practices, expanding the institutions' performance in strategic technological areas.

A relevant social impact was also observed associated with research and innovation grants, which contributed to the permanence and income of students involved in the projects, while promoting the development of technical, managerial and entrepreneurial skills among students and professors. The dissemination of the culture of entrepreneurship and innovation occurred through a comprehensive strategy, supported by institutional partnerships, scientific events, training and participation in fairs and business events.

However, the findings indicate that the creation of new ventures was not the main motivation of the coordinators to join the project, reflecting in a limited number of *startups* generated. This result highlights challenges related to the technological maturity of the solutions, the approach to investors and the need to deepen entrepreneurial training, connecting more effectively the concepts of innovation to market dynamics.

By inserting these results in the broader context of the Brazilian entrepreneurial environment, the study dialogues with the literature that points out weaknesses in the university-industry articulation and the persistence of the so-called "entrepreneurial trap", characterized by high entrepreneurial activity with low levels of innovation and generation of qualified jobs. In this sense, the research reinforces that the advancement of innovative

entrepreneurship in Brazil requires a balance between the number of entrepreneurs, their capacity for innovation and their growth ambitions.

Finally, the results indicate that the consolidation of innovative entrepreneurship in the country requires the expansion of the strategic focus of public policies beyond the technologies associated with Economy 4.0, incorporating other economic sectors with potential for regional development and value generation. The strengthening of entrepreneurial education, the intensification of the articulation between academia and industry, support for the commercialization of innovation and the encouragement of the protection of intellectual property emerge as central elements. In this context, the continuity, improvement and institutionalization of the Innovative Entrepreneurship project as a structuring public policy are essential to promote innovation, productive diversification and sustainable economic growth in the country.

REFERENCES

- ANPROTEC & SEBRAE. (2016). Estudo de impacto econômico: Segmento de incubadoras de empresas do Brasil. Associação Nacional de Entidades Promotoras de Empreendedorismo e Inovação; Serviço Brasileiro de Apoio às Micro e Pequenas Empresas.
- Aranha, J. A. S. (2016). Mecanismos de geração de empreendimentos inovadores: Mudanças na organização e na dinâmica dos ambientes e o surgimento de novos atores (Série Tendências). ANPROTEC.
- Balkienė, K., & Jagminas, J. (2010). Public policy references: Innovative entrepreneurship. *Public Policy and Administration*, 34(1), 5–17.
- Brasil. (2004, 2 de dezembro). Lei nº 10.973, de 2 de dezembro de 2004. Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo. *Diário Oficial da União*.
- Brasil. (2008, 29 de dezembro). Lei nº 11.892, de 29 de dezembro de 2008. Institui a Rede Federal de Educação Profissional, Científica e Tecnológica. *Diário Oficial da União*.
- Carmo, J. P., & Costa, L. (2016). Análise da sustentabilidade econômica de um núcleo de inovação tecnológica integrado a uma incubadora de empresas. In *Anais do Congresso de Administração, Sociedade e Inovação*.
- Freeman, C., & Soete, L. (2008). *A economia da inovação industrial*. Editora da UNICAMP.
- Gianesini, G., Cubico, S., Favretto, G., & Leitão, J. (2018). Entrepreneurial competencies: Comparing and contrasting models and taxonomies. In *Entrepreneurship and the industry life cycle* (pp. 13–32). Springer.
- Kline, S. J., Rosenberg, N., & Landau, R. (1986). *The positive sum strategy: Harnessing technology for economic growth*. National Academy Press.
- Koeller, P. (2017). *Dinâmica da inovação no Brasil em contraposição a países selecionados (Radar)*. Instituto de Pesquisa Econômica Aplicada.

- Ministério da Ciência, Tecnologia, Inovações e Comunicações. (2016). Estratégia Nacional de Ciência, Tecnologia e Inovação (ENCTI) 2016–2022. MCTIC.
- Organisation for Economic Co-operation and Development. (2018). OECD science, technology and innovation outlook 2018: Adapting to technological and societal disruption. OECD Publishing. https://doi.org/10.1787/sti_in_outlook-2018-en
- Pelaez, V., Invernizzi, N., Fuck, M. P., Bagatolli, C., & Oliveira, M. R. (2017). A volatilidade da agenda política de ciência e tecnologia no Brasil. *Revista de Administração Pública*, 51(5), 788–809.
- Rauch, A., Wiklund, J., Lumpkin, G. T., & Frese, M. (2009). Entrepreneurial orientation and business performance: An assessment of past research and suggestions for the future. *Entrepreneurship Theory and Practice*, 33(3), 761–787.
- Rippa, P., & Secondo, G. (2019). Digital academic entrepreneurship: The potential of digital technologies on academic entrepreneurship. *Technological Forecasting and Social Change*, 146, 900–911.
- Roncaratti, L. S. A. (2017). Incentivos a startups no Brasil: Os casos do Startup Brasil, InovAtiva e InovApps. In P. Cavalcante et al. (Eds.), *Inovação no setor público: Teoria, tendências e casos no Brasil*. ENAP; IPEA.
- Szabo, Z. K., & Herman, E. (2012). Innovative entrepreneurship for economic development in the EU. *Procedia Economics and Finance*, 3, 268–275.
- Vonortas, N. S., & Castillo, J. C. (2022). A general assessment of policies for science, technology and innovation (STI) in highly developed economies [Relatório]. Fundação de Amparo à Pesquisa do Estado de São Paulo.

CIVIL IDENTIFICATION AS AN INSTRUMENT FOR PROTECTING CHILDREN'S RIGHTS IN THE STATE OF PARÁ, BRAZIL

A IDENTIFICAÇÃO CIVIL COMO INSTRUMENTO DE PROTEÇÃO DOS DIREITOS DA CRIANÇA NO ESTADO DO PARÁ, BRASIL

LA IDENTIFICACIÓN CIVIL COMO INSTRUMENTO DE PROTECCIÓN DE LOS DERECHOS DE LA NIÑEZ EN EL ESTADO DE PARÁ, BRASIL



<https://doi.org/10.56238/sevened2026.008-024>

Flávio Marcelo Cavalcante Mota¹, Nilton Carlos Noronha Ferreira²

ABSTRACT

The article analyzes the civil identification of children as a strategic instrument for comprehensive protection in early childhood, with a focus on the State of Pará. The research adopts a qualitative approach, with exploratory and descriptive characteristics, grounded in a bibliographic review of theoretical works, legislation, institutional reports, and empirical studies on under-registration, child vulnerability, and public policies. Content analysis is employed to systematize categories related to identity, documentation, territorial inequalities, and protection mechanisms, allowing for the interpretation of discourses and regulations from an interdisciplinary perspective. The analysis shows that Pará presents high rates of under-registration and deep territorial inequalities, especially in rural, riverside, indigenous, and quilombola areas, where access to civil registration services is limited. The study also identifies weaknesses in the integration among maternity units, civil registry offices, health services, social assistance, and public security, which undermines the effectiveness of protection policies. Finally, it proposes guidelines to strengthen the civil identification of children, including the universalization of neonatal identification, the expansion of identity card issuance for children aged 0 to 6, the creation of a State Protocol for Child Identification, and permanent awareness campaigns. It concludes that civil identification is an essential public policy to ensure citizenship, prevent violence, and strengthen the Child and Adolescent Rights Guarantee System.

Keywords: Under Registration. Early Childhood. Civil Registration.

RESUMO

O artigo analisa a identificação civil de crianças como instrumento estratégico de proteção integral na primeira infância, com foco no Estado do Pará. A pesquisa adota uma abordagem qualitativa, de caráter exploratório e descritivo, fundamentada em levantamento bibliográfico de obras teóricas, legislações, relatórios institucionais e estudos empíricos sobre sub-registro, vulnerabilidade infantil e políticas públicas. Utiliza-se a técnica de análise de conteúdo para sistematizar categorias relacionadas à identidade, documentação, desigualdades territoriais e mecanismos de proteção, permitindo interpretar discursos e

¹ Master's Degree in Public Security. Universidade Federal do Pará (UFPA). E-mail: flavio.mota@icj.ufpa.br

² Master's Degree of Laws. Universidade Federal do Pará (UFPA). E-mail: niltonnoronha@ufpa.br

normativas sob uma perspectiva interdisciplinar. A análise evidencia que o Pará apresenta elevados índices de sub-registro e profundas desigualdades territoriais, especialmente em áreas rurais, ribeirinhas, indígenas e quilombolas, onde o acesso a serviços de registro civil é limitado. O estudo também aponta fragilidades na integração entre maternidades, cartórios, saúde, assistência social e segurança pública, comprometendo a eficácia das políticas de proteção. Ao final, propõe diretrizes para o fortalecimento da identificação civil de crianças, incluindo a universalização da identificação neonatal, a ampliação da emissão de carteiras de identidade para crianças de 0 a 6 anos, a criação de um Protocolo Estadual de Identificação Infantil e campanhas permanentes de sensibilização. Conclui que a identificação civil é política pública essencial para garantir cidadania, prevenir violências e fortalecer o Sistema de Garantia de Direitos da Criança e do Adolescente.

Palavras-chave: Sub-Registro. Primeira Infância. Registro Civil.

RESUMEN

El artículo analiza la identificación civil de niñas y niños como un instrumento estratégico de protección integral en la primera infancia, con énfasis en el Estado de Pará. La investigación adopta un enfoque cualitativo, de carácter exploratorio y descriptivo, fundamentado en un levantamiento bibliográfico de obras teóricas, legislaciones, informes institucionales y estudios empíricos sobre subregistro, vulnerabilidad infantil y políticas públicas. Se utiliza la técnica de análisis de contenido para sistematizar categorías relacionadas con la identidad, la documentación, las desigualdades territoriales y los mecanismos de protección, permitiendo interpretar discursos y normativas desde una perspectiva interdisciplinaria. El análisis evidencia que Pará presenta altos índices de subregistro y profundas desigualdades territoriales, especialmente en áreas rurales, ribereñas, indígenas y quilombolas, donde el acceso a los servicios de registro civil es limitado. El estudio también señala fragilidades en la integración entre maternidades, registros civiles, salud, asistencia social y seguridad pública, lo que compromete la eficacia de las políticas de protección. Finalmente, propone directrices para el fortalecimiento de la identificación civil de niñas y niños, incluyendo la universalización de la identificación neonatal, la ampliación de la emisión de documentos de identidad para menores de 0 a 6 años, la creación de un Protocolo Estatal de Identificación Infantil y campañas permanentes de sensibilización. Concluye que la identificación civil constituye una política pública esencial para garantizar ciudadanía, prevenir violencias y fortalecer el Sistema de Garantía de Derechos de la Niñez y la Adolescencia.

Palabras clave: Subregistro. Primera Infancia. Registro Civil.

1 INTRODUCTION

The civil identification of children is one of the fundamental pillars for the guarantee of human rights and for the construction of public policies for the protection of children. In the Brazilian context, especially in the State of Pará, the topic assumes marked relevance due to the high rates of under-registration (IBGE, 2018). Although the Federal Constitution establishes citizenship and the dignity of the human person as structuring foundations of the Democratic Rule of Law, these principles are weakened when children remain invisible to civil registration systems and official identification databases.

Identification, as an attribute of human identity, articulates philosophical, juridical and sociological dimensions. From the philosophical point of view, identity is essential to the theory of knowledge and is established as a logical absolute. It affirms a truth without the need for demonstration, because each thing is unique and distinct, not to be confused with others. This axiom, known as the Principle of Identity or Law of Identity, was enunciated by Aristotle in the three laws of thought as follows: "a thing cannot, at the same time, be and not be" (RABELLO, 2024, p. 10).

In the Brazilian legal system, identification as an essential attribute of human identity occupies a central position. It not only allows the formal recognition of the individual by the State, but also functions as an instrument for the protection of fundamental rights, accountability and legal certainty (BRASIL, 1988)

For Sociology, each and every identity is constructed. The question is how this construction process takes place, its origin, purpose and peculiarities, as Castells indicates.

The construction of identities makes use of the raw material provided by history, geography, biology, productive and reproductive institutions, collective memory and personal fantasies, power apparatuses and revelations of a religious nature. However, all these materials are processed by individuals, social groups and societies, which organize their meaning according to social trends and cultural projects rooted in their social structure, as well as in their time/space vision. (CASTELLS, 2008, p. 23).

Dominant institutions can also form identities when social actors internalize them, constructing their meaning based on this internalization. Castells (2008) presents, in addition to the individual, the collective identity and says that the social construction of identity occurs through power relations between forms and origins.

For Bauman (2005), identity goes through a continuous process of construction, thus always remaining incomplete. This is because modernity has generated a fluid world where identities easily unravel following the rhythm of liquid modernity: "The ease of getting rid of an identity when it ceases to be satisfactory, or ceases to be attractive due to competition

with other more seductive identities, is much more important than the realism of the identity sought or momentarily appropriated".

The civil identification of children, at the same time that it materializes the state's recognition of the child's existence, acts as an instrument of full protection, as determined by the Statute of the Child and Adolescent (BRASIL, 1990). The absence or fragility of these records, however, deepens inequalities and exposes children to violence, making it difficult to access essential public policies such as health, education, social assistance and security (LIMA, 2015). In the Amazonian context, geographical distances, difficulty in accessing notary services, poverty, and cultural aspects of traditional communities dramatically aggravate this scenario (BARROS, 2017; FONSECA, 2016).

In this article, we propose to analyze child civil identification as an instrument for the protection of children's rights in the State of Pará, articulating three axes: a) theoretical foundations on identity and identification; b) national and international normative framework aimed at civil identification and child protection; c) interdisciplinary analysis of the structural vulnerabilities of childhood in Pará, with emphasis on the relationship between underreporting, invisibility and violence.

In addition to discussing the current reality, the article presents recommendations for strengthening the state policy for civil identification of children, proposing guidelines that can be incorporated by public security, health, social assistance and education institutions, aligning with the System for the Guarantee of the Rights of Children and Adolescents.

2 IDENTITY AND IDENTIFICATION

2.1 IDENTITY: PHILOSOPHICAL, SOCIOLOGICAL AND LEGAL BASES

The concept of identity has a long theoretical trajectory and is present in several philosophical traditions. For Aristotle, identity is a fundamental logical principle, which establishes that each being is identical to itself and distinct from the others (RABELLO, 2024). This definition, although abstract, provides the initial framework for understanding individualization as an ontological phenomenon.

Habermas (1988) expands this view by stating that human identity is dialectically constructed between self-identification and the identification recognized by others. For the author, identity is processual, the result of social interactions and the subject's self-understanding. This perspective is close to the contemporary sociological notion, according to which identity is not fixed, but a permanent social construction (CASTELLS, 2008; WOODWARD, 2000).

Bauman (2005) contributes by conceptualizing "liquid modernity", in which identities become fluid and unstable, shaped by dynamic social and cultural contexts. Although such reflections are mainly directed to adult life, they also help to understand the construction of children's identity, which develops in the midst of intense social flows, marked by digital culture and family and community transformations.

In the legal field, identity has material relevance. It represents an attribute of personality and a requirement for the exercise of civil, social, cultural and political rights (SANTOS, 2018). The civil registry, in this sense, ceases to be a mere bureaucratic procedure and assumes the character of legal-existential recognition. It is the act that inaugurates the legal presence of the child in the world of law.

2.2 IDENTIFICATION: TECHNICAL AND APPLIED DIMENSION

If identity is the essence of the individual, identification represents the technical process that allows recognizing this essence through objective attributes. Vanrell and Borborema (2019) highlight that identification involves the determination of individual anatomical, morphological, physiological, or biometric elements capable of distinguishing a person from others. Figini (2012) differentiates objective identification (biological and biometric elements) from subjective identification (self-image, name, personal history), emphasizing that both are essential for human individualization.

Biometrics, especially fingerprints, neonatal plantar prints and facial recognition, have been consolidated as the main identification instrument in the field of public security since the seventeenth century, with the observations of Malpighi (FIGINI, 2012), and later with the development of scientific methods by Bertillon and Galton. Today, automated biometric recognition technologies are part of civil and criminal identification systems in several countries (JAIN; ROSS; PRABHAKAR, 2004).

In Brazil, the responsibility for civil and criminal identification is the responsibility of the Identification Institutes. In Pará, this assignment is performed by the Directorate of Identification "Enéas Martins" (DIDEM), the directorate of the Civil Police of the State of Pará responsible for issuing the Identity Card and for criminal identification procedures and papiloscopic expertise.

3 METHODOLOGY

The present research is characterized as a qualitative study, of descriptive and exploratory character, aimed at analyzing the civil identification of children as an instrument of integral protection in the State of Pará. According to Gil (2019), exploratory research is

appropriate when the objective is to provide greater familiarity with a problem, making it more explicit and allowing the construction of new analytical perspectives. In the same sense, Marconi and Lakatos (2017) state that the qualitative approach is appropriate for studies that seek to understand complex social phenomena, especially those related to human rights, public policies, and social vulnerabilities.

The choice for the qualitative approach is justified by the need to interpret meanings, institutional practices and socio-territorial contexts that influence the civil under-registration and invisibility of children in Pará. As Gil (2019) points out, this type of approach allows capturing subjective and structural dimensions that cannot be reduced to numerical data, being essential to understand social phenomena in depth.

From the point of view of technical procedures, this is a bibliographic research. Bibliographic research consists of the survey, selection and analysis of works, scientific articles, legislation, institutional reports and official documents that deal with the theme of identity, civil identification, child protection and public policies (MARCONI; LAKATOS, 2017). This procedure enabled the construction of the interdisciplinary theoretical framework that underlies the study, articulating contributions from Philosophy, Sociology, Law and Public Security.

As for the objectives, the research is descriptive, as it seeks to characterize phenomena and relationships between underreporting, vulnerability and child protection. Gil (2019) explains that descriptive research has as its main purpose the description of the characteristics of a certain population or phenomenon, which suits the purpose of analyzing the reality of Pará and its territorial inequalities. In addition, the study assumes an explanatory character, as it seeks to identify factors that contribute to documentary invisibility and the exposure of children to risks, as advised by Marconi and Lakatos (2017).

The method of analysis used was content analysis, as proposed by Bardin (2016), applied to the bibliographic material collected. This technique allowed the identification of thematic categories related to identity, underreporting, vulnerability, public policies, and full protection. Content analysis, according to Lakatos and Marconi (2017), is suitable for qualitative research that seeks to interpret discourses, documents and legislation, enabling the construction of systematic inferences and interpretations.

Finally, the research adopts an interdisciplinary perspective, articulating theoretical and empirical elements from different areas of knowledge. Gil (2019) highlights that interdisciplinarity is fundamental in studies involving complex social phenomena, as it allows for the integration of multiple dimensions of reality. In the case of child civil identification, this

approach makes it possible to understand the phenomenon not only as a legal issue, but also as a sociological, cultural, territorial and public security problem.

4 CIVIL IDENTIFICATION OF CHILDREN AND THE LEGAL FRAMEWORK FOR CHILD PROTECTION

The civil identification of children in Brazil is one of the normative pillars of the full protection of children and is supported by an articulated set of constitutional, infra-constitutional and international norms. At the center of this framework is the Statute of the Child and Adolescent (ECA), Law No. 8,069/1990, which enshrines the child as a subject of rights and imposes on the State, the family and society the duty to ensure, with absolute priority, the realization of these rights (BRASIL, 1990)

Article 10 of the ECA establishes that hospitals and other health care establishments for pregnant women, whether public or private, are required to identify the newborn through the collection of plantar or fingerprints, as well as the identification of the mother, and such information must be included in the Certificate of Live Birth (DNV). The DNV is the prior and indispensable document for the civil registration of birth, as regulated by Ordinance No. 116/2009 of the Ministry of Health, and represents the link between biological birth and the legal recognition of the child's existence (BRASIL, 2009).

The obligation of civil registration of birth is reaffirmed in article 9 of the ECA, which determines that legal guardians must promote registration in the first civil registry office, within the legal deadline. The absence of this record constitutes a form of violation of rights, as it prevents access to essential public policies such as health, education, social assistance and legal protection. As Santos (2018) points out, civil registration is more than a notarial act: it is the legal recognition of the child's existence as a subject of rights.

In addition, the ECA typifies conducts related to the subtraction, concealment and irregular delivery of children as crimes, in articles 237 to 239, recognizing the seriousness of these practices and their direct relationship with the absence of official documentation. The lack of civil identification makes it difficult to promptly locate missing children, weakens the accountability of perpetrators of crimes, and compromises the performance of bodies such as the Guardianship Council, the Public Prosecutor's Office, and the Civil Police (INTERID, 2023).

The centrality of civil identification in full protection is also expressed in the absolute priority of children's rights, provided for in article 227 of the Federal Constitution of 1988, which imposes on the State the duty to ensure, with primacy, the right to life, health, identity, family and community life. The UN Convention on the Rights of the Child (1989), ratified by

Brazil through Decree No. 99,710/1990, reinforces this commitment by establishing, in its article 7, that every child has the right to a name, nationality and, as far as possible, to know his or her parents and to be cared for by them (UN, 1989)

The absence of civil registration, therefore, is not only an administrative omission, but a violation of human rights, which compromises the dignity of the child and its full insertion in society. As Lima (2015) observes, underreporting is a phenomenon that disproportionately affects populations in situations of social and territorial vulnerability, such as indigenous, riverside and quilombola communities, especially in the northern region of the country.

Child civil identification should be understood as a transversal public policy, which articulates the fields of law, health, social assistance and public security. Its implementation requires integration between maternity hospitals, registry offices, information systems, and protection agencies, as guided by the National Policy for the Search for Missing Persons (Law No. 13,812/2019), which recognizes identification as an essential element for locating missing children (BRASIL, 2019).

In summary, child civil identification in Brazil is supported by a robust normative framework that recognizes its structuring function in the full protection of children. However, its effectiveness still faces operational challenges, especially in contexts of territorial inequality and social exclusion. Overcoming these barriers requires not only compliance with legal standards, but also the strengthening of intersectoral public policies aimed at eradicating under-registration and guaranteeing the right to identity from birth.

5 THE CONTEXT OF PARÁ: UNDER-REGISTRATION, VULNERABILITY AND CHILD INVISIBILITY

The reality of the State of Pará reveals a scenario marked by structural inequalities, vast geographical areas of difficult access, traditional communities in a situation of socio-territorial isolation and persistent gaps in the supply of public services. Such conditions accentuate vulnerabilities historically associated with childhood in the Amazon, such as the difficulty in obtaining civil registration, the lack of personal documents, and the difficulty of integration between protection, health, assistance, and public security systems (PARÁ, 2023).

According to the IBGE (2018), Pará has one of the highest rates of under-registration of births in the country, reaching between 14% and 16% of children without registration in the first year of life. Several factors contribute to the underreporting of birth records in Pará. Among them are the lack of access to notary offices in remote regions, economic difficulties

for families, lack of information about the importance of civil registration, and cultural barriers in some indigenous communities (BARROS, 2017).

According to Fonseca (2016), the scarcity of infrastructure and public services in the most remote areas further aggravates this situation. The absence of civil registration has serious consequences for children, who are deprived of basic rights such as access to education, health, and social protection. They are also more vulnerable to various forms of exploitation and abuse.

The literature points out that children without birth registration are deprived of access to fundamental public policies, such as vaccination, school enrollment, assistance programs and social benefits. In addition, they become invisible to the State, hindering public planning and depriving the System for the Guarantee of the Rights of Children and Adolescents itself of essential information for the monitoring and prevention of violence (LIMA, 2015).

In the field of public security, document invisibility has even more serious consequences. Children without civil identification are more likely to be victims of abduction, disappearance, trafficking and other forms of exploitation, since the absence of official data weakens both the search process and the accountability of the perpetrators. International studies demonstrate a strong relationship between lack of documentation and recruitment for forced labor, illegal adoptions, and transnational trafficking (ECPAT INTERNATIONAL, 2020; UNICEF, 2018).

6 CIVIL IDENTIFICATION AS A TOOL FOR PREVENTING VIOLATIONS AND STRENGTHENING FULL PROTECTION

6.1 THE RELATIONSHIP BETWEEN DOCUMENTATION AND PREVENTION OF CRIMES AGAINST CHILDREN

Civil identification of children plays a crucial role in the strategy for preventing violations, especially with regard to the disappearance and abduction of children. As observed in the database analyzed in the State of Pará, young children, especially between 0 and 6 years old, constitute the most vulnerable group to this type of crime, representing more than 70% of the victims registered between 2013 and 2023 (SEGUP, 2024).

The lack of official documents, such as birth certificates and identity cards, makes it difficult to promptly identify the victim, making the stages of investigation, location and restitution to family life more complex. In some cases, children who have been abducted may remain for years without correct identification, making it difficult for the Guardianship Council, the Public Prosecutor's Office, the Civil Police, and social assistance organizations to act (INTERID, 2023; ESCÓSSIA, 2021).

The literature highlights that adequate civil identification is a decisive factor in reducing the risk of human trafficking, irregular adoption, and illegal international displacement, considering that biometric documents hinder forgery and allow greater control by border agencies (ILO, 2017; JAIN; ROSS; PRABHAKAR, 2004).

6.2 NEONATAL IDENTIFICATION AS A STRATEGIC PUBLIC POLICY

The Statute of the Child and Adolescent (art. 10) establishes the obligation to record the newborn's plantar and fingerprints, in addition to the mother's identification. However, in practice, this stage still faces challenges in maternity hospitals in Pará, especially in the more inland regions, where medical infrastructure is limited and the integration between health and civil identification is incipient (BRASIL, 1990; PARÁ, 2020)

The lack of standardization between hospital units results in inconsistencies or even non-existence of neonatal impressions, leaving gaps for errors, baby changes and future identification difficulties. The literature shows that biometric procedures performed in the first 48 hours of life, when properly recorded and stored, are highly reliable and can accompany the individual throughout life (FIGINI, 2012). In addition, the World Health Organization and UNICEF advocate the integration between maternity hospitals and civil registration systems as an essential strategy to prevent violence against newborns and young children (UNICEF, 2019).

In Pará, the civil identification of children also faces the challenge of the lack of interoperability between databases. Maternity hospitals, registry offices, police units and Guardianship Councils often operate in a fragmented manner, limiting the capacity for institutional response to urgent cases.

The Directorate of Identification "Enéas Martins" – DIDEM, has a central role in the state policy of civil and criminal identification. However, the absence of immediate integration with municipal health and social assistance systems prevents the continuous monitoring of newly documented children and limits the effectiveness of the protection flow. Positive experiences in other states demonstrate that the secure sharing of biometric data between health, safety, and justice significantly enhances the prevention and solution of cases of child disappearance (SILVA, 2021).

7 PROPOSALS FOR STRENGTHENING CHILD CIVIL IDENTIFICATION IN PARÁ

From the interdisciplinary analysis carried out, it becomes evident that the civil identification of children is a strategic element to prevent the abduction of children, reduce rights violations and strengthen the investigative capacity of the State. In view of the scenario observed in Pará marked by under-registration, gaps in institutional integration and structural vulnerabilities, the following guidelines are proposed.

7.1 FULL IMPLEMENTATION OF NEWBORN IDENTIFICATION IN MATERNITY HOSPITALS

The full implementation of neonatal identification in maternity hospitals remains a challenge in Pará. Although this obligation is provided for in the Statute of the Child and Adolescent (BRASIL, 1990), the procedure is not yet universalized in the state. To overcome this gap, it is essential to standardize the collection of plantar and fingerprints in the first 48 hours of life, ensuring that this data is automatically integrated into the Declaration of Live Birth (DNV) and the state civil identification system.

The biometric registration of the mother is also essential, ensuring the mother-baby bond from birth, in addition to the continuous training of nursing and obstetrics professionals responsible for these stages. Both public and private hospitals must adopt uniform protocols and submit them to periodic audits, in order to prevent failures, reduce risks and avoid situations of error or exchange of newborns.

7.2 EXPANSION OF IDENTITY CARD ISSUANCE FOR CHILDREN AGED 0 TO 6 YEARS

The expansion of the issuance of the Identity Card for children from 0 to 6 years old is an essential measure to strengthen full protection in early childhood. For this to occur effectively, it is important to promote annual child identification campaigns in schools, daycare centers, health units, CRAS and traditional communities, expanding the reach of actions and reducing territorial barriers. It is also strategic to carry out coordinated joint efforts between DIDEM, the Department of Health and the Guardianship Councils, ensuring intersectoral action and capillarity in care.

Issuance should be simplified for low-income families, ensuring that socioeconomic status is not an obstacle to access to basic documentation. In addition, the inclusion of biometric data compatible with the age group contributes to greater accuracy in identification. The early issuance of the RG for children, especially when associated with biometrics, reinforces the Rights Guarantee System and expands the State's capacity to protect children in vulnerable situations.

7.3 STATE PROTOCOL FOR THE IDENTIFICATION OF CHILDREN

The State may institute an Institutional Protocol for the Identification of Children, consolidating in a single normative instrument all the essential steps to guarantee the right to identity from birth. This protocol can establish neonatal identification in maternity hospitals as an initial and mandatory step, followed by the first civil identification up to 12 months of life, ensuring that no child exceeds the first year without basic documentation. It can also provide for the periodic updating of the child's ID every five years, in order to monitor physical development and ensure greater biometric accuracy.

Another fundamental axis is the creation of a unified flow for action in cases of disappearance, allowing faster and more coordinated responses between the bodies of the Rights Guarantee System. The document may also include a specific action guide for Guardianship Councils, guiding procedures and standardizing referrals, in addition to defining uniform criteria for child biometric collection throughout the state. To acquire normative force and administrative effectiveness, this protocol must be formalized by means of a SEGUP Ordinance or by State Decree, ensuring its mandatory adoption by all institutions involved.

7.4 PERMANENT AWARENESS CAMPAIGNS

Permanent awareness-raising campaigns should play a central role in promoting the right to identity and preventing violations affecting children. They need to emphasize the importance of civil registration as a gateway to all other rights, warn about the risks associated with the absence of identification, and reinforce practices to prevent child abduction and disappearance. It is also essential that these actions reach schools, daycare centers, health units and community leaders, expanding awareness and strengthening local protection networks. Indigenous, riverside and quilombola communities must receive special attention, with bilingual materials and itinerant teams capable of dialoguing with the cultural and territorial specificities of these groups, ensuring that information arrives in an accessible and effective way.

8 FINAL CONSIDERATIONS

This article demonstrated that the civil identification of children is one of the most important instruments for the protection of children's rights, especially in contexts of high social vulnerability. The theoretical, normative and empirical analysis shows that the absence or fragility of civil records significantly increases the risks of subtraction, disappearance and other forms of violence against young children.

The study reinforces that civil identification is not a merely bureaucratic step, but a mechanism to guarantee citizenship, full protection and public safety. The full implementation of neonatal identification, the early issuance of identity cards and the adoption of a state protocol are necessary measures to strengthen the System for the Guarantee of the Rights of Children and Adolescents.

The civil identification of children, although often treated as a notarial procedure, represents a transversal axis of public policies for the protection of children. It articulates legal, sociological, technological, and public security dimensions, being able to reduce structural vulnerabilities. In Pará, the intersection between under-registration, territorial inequality and children's invisibility creates an environment conducive to serious violations. Therefore, civil identification cannot be understood only as a bureaucratic instrument. It is the first state protection mechanism, essential to ensure that children have a name, history, belonging, identity, and access to rights (SANTOS, 2018).

From a sociological point of view, child identity should be understood as a relational construction, influenced by family, community and institutional dynamics (CASTELLS, 2008; BAUMAN, 2005). The absence of state recognition materialized in the civil registry constitutes a form of symbolic and structural violence, as it deprives the child of being fully recognized as a subject.

In the field of public security, early identification reduces the risks of trafficking, disappearance, irregular adoption, and subtraction (ECPAT, 2020). From a forensic point of view, it strengthens the investigation, as it provides reliable biometric elements for location and recognition (JAIN; ROSS; PRABHAKAR, 2004). Interdisciplinarity, therefore, reveals that the civil identification of children should be treated as a strategic human rights policy.

REFERENCES

- Bardin, L. (2016). *Análise de conteúdo*. Edições 70.
- Barros, A. C. (2017). Registro civil tardio na Amazônia: Desafios e perspectivas. *Revista Brasileira de Estudos Populacionais*, 34.
- Bauman, Z. (2005). *Identidade: Entrevista a Benedetto Vecchi*. Zahar.

- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Senado Federal.
- Brasil. (1990, 16 de julho). Lei nº 8.069, de 13 de julho de 1990. Dispõe sobre o Estatuto da Criança e do Adolescente e dá outras providências. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/leis/l8069.htm
- Brasil. (2019, 18 de março). Lei nº 13.812, de 16 de março de 2019. Institui a Política Nacional de Busca de Pessoas Desaparecidas e cria o Cadastro Nacional de Pessoas Desaparecidas. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2019/lei/L13812.htm
- Brasil. Ministério da Saúde. (2009, 11 de fevereiro). Portaria nº 116, de 11 de fevereiro de 2009. Regulamenta a coleta de dados, fluxo e periodicidade de envio das informações sobre óbitos e nascidos vivos para os Sistemas de Informações em Saúde. https://bvsms.saude.gov.br/bvs/saudelegis/svs/2009/prt0116_11_02_2009.html
- Castells, M. (2008). A construção da identidade. In *A sociedade em rede* (8ª ed.). Paz e Terra.
- ECPAT International. (2020). Global study on sexual exploitation of children.
- Escóssia, F. da. (2025). *Invisíveis: Uma etnografia sobre brasileiros sem documentos*. FGV.
- Figini, L. (2012). *Identificação humana: Fundamentos conceituais e técnicos*. Millennium.
- Fonseca, C. C. (2016). O desafio do registro civil em áreas rurais da Amazônia. *Serviço Social & Sociedade*, (126).
- Gil, A. C. (2019). *Métodos e técnicas de pesquisa social* (7ª ed.). Atlas.
- Habermas, J. (1988). *The theory of communicative action*. Beacon Press.
- IBGE. (2018). *Estatísticas do registro civil*.
- ILO. (2017). *Global estimates of child labour*.
- InterID. (2023). InterID aborda a questão das crianças desaparecidas: Relatório do MJSP e a importância da identificação. <https://interid.org/interid-aborda-a-questao-das-criancas-desaparecidas-relatorio-do-mjsp-e-a-importancia-da-identificacao/>
- Jain, A., Ross, A., & Prabhakar, S. (2004). An introduction to biometric recognition. *IEEE Transactions on Circuits and Systems for Video Technology*, 14(1), 4–20.
- Lima, C. (2015). Documentação civil e inclusão social. *Revista de Políticas Públicas*.
- Marconi, M. de A., & Lakatos, E. M. (2017). *Fundamentos de metodologia científica* (8ª ed.). Atlas.
- ONU. (1989). Convenção sobre os Direitos da Criança. Adotada pela Assembleia Geral das Nações Unidas em 20 de novembro de 1989. Promulgada no Brasil pelo Decreto nº 99.710, de 21 de novembro de 1990. <https://www.unicef.org/child-rights-convention>
- Pará. Secretaria de Estado de Assistência Social, Trabalho, Emprego e Renda. (2020, 12 de outubro). Projeto visa erradicar o sub-registro de nascimento nas maternidades do Pará. Agência Pará. <https://agenciapara.com.br/noticia/22741>
- Pará. Secretaria de Estado de Assistência Social, Trabalho, Emprego e Renda. (2023). Seaster reforça ações e garante registro civil à população em situação de vulnerabilidade. Agência Pará. <https://agenciapara.com.br/noticia/48506/seaster-reforca-acoes-e-garante-registro-civil-a-populacao-em-situacao-de-vulnerabilidade>
- Rabello, M. (2024). *Princípios aristotélicos da identidade*. Loyola.

- Santos, A. (2018). Justiça social e documentação civil. *Revista Direito & Sociedade*, 3(2).
- SEGUP – Secretaria de Estado de Segurança Pública e Defesa Social. (2024). Registros de subtração de crianças.
- Silva, B. D. (2021). Perícia papiloscópica e investigações modernas. *Revista de Segurança Pública*.
- UNICEF. (2019). Birth registration for every child by 2030: Are we on track?
- Vanrell, J., & Borborema, W. (2019). Identificação humana: Teoria e prática. *Forense*.
- Woodward, K. (2000). Identidade e diferença. *DP&A*.

ACCESSIBLE DIALOGUES: BUILDING INCLUSIVE VISUAL NARRATIVES WITH AUDIO DESCRIPTION

DIÁLOGOS ACESSÍVEIS: CONSTRUINDO NARRATIVAS VISUAIS INCLUSIVAS COM A AUDIODESCRIÇÃO

DIÁLOGOS ACCESIBLES: CONSTRUYENDO NARRATIVAS VISUALES INCLUSIVAS CON AUDIODESCRIPCIÓN



<https://doi.org/10.56238/sevened2026.008-025>

Lara Andrade Fachin¹, Luiz Gustavo Bieberbach Engroff², Aurélia Regina de Souza Honorato³

ABSTRACT

This article proposes a reflection on audio description (AD) as a creative act, addressing it not only as a mediation tool but as an artistic experience that transforms the perception and sharing of art. By shifting the focus from access to the sensitive, the research reveals that accessibility is also a form of creation, capable of broadening the aesthetic and political horizons of artistic production. The methodology employed is a case study with a shadow theatre group that uses shadow description, a modality of audio description integrated into the creative process. The analysis is constructed from interviews with one of the group's actresses and a blind spectator and audio description consultant. The research articulates empirical and theoretical dimensions, drawing on authors from critical disability studies and crip theory, such as McRuer, Garland-Thomson, and Siebers. These frameworks allow us to understand disability as a productive difference and accessibility as a political gesture, revealing that inclusive art is also transformative art—capable of reinventing ways of seeing, hearing, feeling, and imagining. This overview points to the need for a paradigm shift in culture: from accessibility as a normative obligation to accessibility as an aesthetic language and emancipatory practice.

Keywords: Audio Description. Accessibility. Art. Culture.

RESUMO

Este artigo propõe uma reflexão sobre a audiodescrição (AD) como ato criador, abordando-a não apenas como ferramenta de mediação, mas como experiência artística que transforma a percepção e o compartilhamento da arte. Ao deslocar o foco do acesso para o sensível, a pesquisa revela que a acessibilidade é também uma forma de criação, capaz de ampliar os

¹ Graduated in Visual Arts. Universidade do Extremo Sul Catarinense (UNESC).

E-mail: laraafachin@gmail.com Lattes: <http://lattes.cnpq.br/2565128043116161>

² Dr. of Literature. Universidade do Extremo Sul Catarinense (UNESC).

E-mail: gustavo.bieberbach@unes.net Orcid: <https://orcid.org/0000-0001-9980-6837>

Lattes: <http://lattes.cnpq.br/8471478402112117>

³ Dr. in Language Sciences. Universidade do Extremo Sul Catarinense (UNESC). E-mail: arh@unes.net

Orcid: <https://orcid.org/0000-0003-3432-2932> Lattes: <http://lattes.cnpq.br/5183610256488469>

horizontes estéticos e políticos da produção artística. Como metodologia realiza-se um estudo de caso com um grupo de teatro de sombras que utiliza a sombradescrição, uma modalidade de audiodescrição integrada ao processo criativo. A análise é construída a partir de entrevistas com uma das atrizes do grupo e uma espectadora cega e consultora de audiodescrição. A pesquisa articula dimensões empíricas e teóricas, apoiando-se em autores dos estudos críticos da deficiência e da teoria crip, como McRuer, Garland-Thomson e Siebers. Esses referenciais permitem compreender a deficiência como diferença produtiva e a acessibilidade como gesto político, revelando que a arte inclusiva é também uma arte transformadora — capaz de reinventar os modos de ver, ouvir, sentir e imaginar. Esse panorama aponta para a necessidade de uma mudança de paradigma na cultura: da acessibilidade como obrigação normativa para a acessibilidade como linguagem estética e prática emancipadora.

Palavras-chave: Audiodescrição. Acessibilidade. Arte. Cultura.

RESUMEN

Este artículo propone una reflexión sobre la audiodescripción (AD) como acto creativo, abordándola no solo como herramienta de mediación, sino como una experiencia artística que transforma la percepción y la difusión del arte. Al desplazar el enfoque del acceso a lo sensible, la investigación revela que la accesibilidad también es una forma de creación, capaz de ampliar los horizontes estéticos y políticos de la producción artística. La metodología empleada consiste en un estudio de caso con un grupo de teatro de sombras que utiliza la descripción de sombras, una modalidad de audiodescripción integrada en el proceso creativo. El análisis se construye a partir de entrevistas con una de las actrices del grupo y un espectador ciego y consultor de audiodescripción. La investigación articula dimensiones empíricas y teóricas, basándose en autores de estudios críticos sobre discapacidad y la teoría de la discapacidad, como McRuer, Garland-Thomson y Siebers. Estos marcos nos permiten comprender la discapacidad como una diferencia productiva y la accesibilidad como un gesto político, revelando que el arte inclusivo es también arte transformador, capaz de reinventar formas de ver, oír, sentir e imaginar. Este panorama general señala la necesidad de un cambio de paradigma en la cultura: de la accesibilidad como obligación normativa a la accesibilidad como lenguaje estético y práctica emancipadora.

Palabras clave: Audiodescripción. Accesibilidad. Arte. Cultura.

1 INTRODUCTION

The development of actions that promote accessibility in cultural productions and spaces has become an increasingly recurrent and urgent theme in the field of contemporary art. This urgency is not limited to the technical adequacy of spaces, but involves a transformation in the ways of conceiving, creating, and sharing artistic experiences. In the Brazilian Inclusion Law (LBI), article 8 reaffirms society's ethical and political commitment to the guarantee of human rights, recognizing that accessibility and cultural participation are inseparable dimensions of citizenship:

It is the duty of the State, society and the family to ensure that people with disabilities, as a priority, are given the realization of the rights related to life, health, sexuality, paternity and maternity, food, housing, education, professionalization, work, social security, habilitation and rehabilitation, transportation, accessibility, culture, sports, tourism, leisure, information, communication, scientific and technological advances, dignity, respect, freedom, family and community life, among others arising from the Federal Constitution, the Convention on the Rights of Persons with Disabilities and its Optional Protocol and the laws and other norms that guarantee their personal well-being, social and economic. (Brazil, 2015)

In the cultural field, these principles translate into the right to participation of people with disabilities (PwD) in the artistic life of the community. The National Plan of Culture reinforces this perspective by stating that it is the duty of the State:

To protect and promote cultural diversity, artistic creation and its manifestations and the cultural expressions, individual or collective, of all ethnic groups and their social derivations, recognizing the scope of the notion of culture throughout the national territory and ensuring the multiplicity of its values and formations. (Brazil, 2010)

These regulations expand the understanding that access to culture is a fundamental right and that inclusion should be thought of not only as a guarantee of presence, but as a possibility of creation and expression. To enable accessible cultural spaces, it is necessary to recognize people with disabilities as protagonists — not only as a target audience, but as active subjects of the aesthetic experience. This change implies understanding accessibility as a factor of invention, and not as a normative imposition. It implies thinking about life in its diversities. Thus, accessible art is not restricted to adapting existing works, but proposes new ways of existing and feeling in cultural spaces.

Cultural accessibility has been asserting itself as a field of debate and creation in the arts. Increasingly, artists and institutions seek practices that guarantee the right to participation of people with disabilities in cultural productions and spaces. However, it is still common for these actions to be treated as complementary, limited to the technical or legal

dimension. This reduced look ends up ignoring the aesthetic potential of difference and the political role of accessibility.

As professor and researcher Rosemarie Garland-Thomson (2011) observes in *Misfits: A Feminist Materialist Disability Concept*, disability is the story of bodies that encounter worlds that were not made for them. From this perspective, accessible art does not seek to correct the body, but to create forms of fitting between body and environment. Starting from this tension between technique and creation, this article proposes a reflection on audio description (DA) as a creative act. It is about understanding DA not only as a technical and mediation tool, but as an artistic experience that can change the way we perceive and share art.

By focusing on the sensitive — and not just on access — the research seeks to show that accessibility is also a form of creation, and that audio description, as a tool, expands the artistic and political field, producing new ways of seeing, hearing, feeling and imagining. To explore this question, a case study is carried out with *Cia. O Sombrista*, a shadow theater group from Turvo/SC, which uses the resource called shadowdescription, a modality of audio description integrated into the creative process and the staging of the show *Às Sombras de Anita* (2020). The reflections are woven from interviews with Diana Manenti, actress and member of the group, and Daiane Rodrigues, blind spectator and audio description consultant.

The analysis articulates empirical and conceptual dimensions, supported by authors of critical disability studies and crip theory, such as McRuer (2006), Garland-Thomson (2011) and Siebers (2010). These references allow us to understand disability as a productive difference and accessibility as a political gesture, revealing that inclusive art is also a transformative art.

2 THEORETICAL FRAMEWORK

2.1 DISABILITY AS AN AESTHETIC POWER

Historically, cultural accessibility policies have been structured under a normative and functional logic, aimed mainly at eliminating physical, architectural, and communicational barriers. This approach is important and fundamental to guarantee the right of access of people with disabilities, but insufficient, as it maintains disability as a category of absence — as something to be compensated, corrected or adjusted — which reinforces the idea of "normality" as a universal standard.

Critical disability studies emerge, in this context, as a theoretical field that shifts the focus of disability from the medical and rehabilitative domain to a social, political, and

epistemological dimension. Instead of understanding disability as a failure, it is seen as a legitimate form of existence and a way of producing knowledge. Thus, disability is not absence, but creative presence—a force that challenges regimes of normality and broadens ways of seeing, feeling, and thinking about the world. It is necessary to think of disability not as a deviation, but as a difference that reconfigures the very concept of functionality. In dialogue with the crip theory, proposed by Robert McRuer (2006), it is understood that bodies considered "unproductive" or "deficient" are not on the margins, but at the center of the tensions that reveal the normative structure. To be a crip is to inhabit deviance—to transform inadequacy into a form of resistance and invention. This attitude, according to McRuer, is a gesture of disobedience in the face of the standards of productivity and efficiency that govern contemporary capitalism.

In this same horizon, Garland-Thomson presents the concept of *misfitting* — the "disconnection" between body and environment. The author explains that disengagement is a dynamic relationship between body and space; When the environment changes, the disengagement also changes. This idea is crucial for thinking about accessible art, as it shows that the problem is never in the body itself, but in the way the world is organized for some and not for others. Art, by creating other sensory arrangements, reconfigures the environment, transforming *misfitting* into an encounter.

The theorist Tobin Siebers (2010), in *Disability Aesthetics*, reinforces this view by stating that the marks of disability do not impoverish art — on the contrary, they enrich and humanize it. For the author, the presence of disability in the arts broadens the scope of the sensible and questions the traditional criteria of aesthetic value, making art truer, and closer to the human experience.

Disability, therefore, must be understood as a relational phenomenon. It emerges from a social and aesthetic context that privileges certain bodies, senses, and modes of perception. To recognize this is to admit that accessible artistic practices are not simple adaptations, but reconfigurations of the sensible — gestures that question who has the right to perceive, create, and be perceived.

In this horizon, accessibility is no longer a favor or concession: it becomes a political act. Audio description, when incorporated into artistic creation, should not be treated as a neutral translation, but as an exercise of imagination between those who describe and those who listen. This change in perspective underlies the analysis proposed in this article: to understand audio description as a tool capable of expanding the experience of art and repositioning disability as a creative force.

2.2 AUDIO DESCRIPTION AS A POLITICAL AND POETIC GESTURE

Audio description has often been associated with technical accessibility, linked to legal obligation and the elimination of sensory barriers. However, when integrated into the artistic process, it goes beyond the informative function and acquires a poetic and performative value. In this perspective, the concept of poetic audio description (ADp) comes in, a resource that can constitute a device of sensitive fruition, expanding the reach of imagination and aesthetic experience. Poetic audio description does not intend to translate the image, but to follow its movement, breathing along with it. The audio describer is not a mere technical mediator, but a co-author of the experience. By describing bodies, gestures, and atmospheres, he creates a shared space of listening and imagination — a territory in which the gaze is remade by the word. ADp, therefore, is not limited to explaining what is seen; It produces new sound images, which transform the way the public relates to art.

In art, this approach resignifies the relationship between seeing and hearing. ADp creates sensory bridges, where sound and word take the place of the gaze. Disability is a way of seeing and feeling that makes aesthetics more inclusive, because it expands the possibilities of the sensitive. This expansion displaces vision as the center of the artistic experience, establishing an aesthetics in which the sensitive is shared in a multiple and collective way. To think of audio description as aesthetics is, therefore, to think of art as an encounter. The experience shared between those who see and those who listen creates a zone of coexistence, where disability is not absence, but a presence that produces new forms of art.

Audio description displaces the traditional axis of the artistic experience: what was previously centered on the gaze, is now based on listening and imagination. The act of listening becomes, in itself, a creative exercise. DA establishes, therefore, an aesthetics of listening, in which sound becomes a vehicle of presence and imagination. In the case of the blind person, sound and speech are some of the ways that allow an aesthetic experience that goes beyond the visual domain. However, this experience is not restricted to people with visual impairment; It also reaches the sighted public, who starts to perceive the spectacle differently, moving from an absolute gaze to a more open, empathetic and plural attention.

3 METHODOLOGY

3.1 BUILDING ACCESSIBLE VISUAL NARRATIVES

The analysis of practical experiences is essential to understand in a concrete way how accessibility resources are incorporated into artistic making and how they impact the relationship between work and audience. In this research, we analyze the experiences of Cia

O Sombrista⁴ in the implementation of accessibility practices in its projects and in parallel the experiences of a visually impaired spectator who participated in several presentations of the group. This practical approach allows us to observe accessibility as a field of creation and as a lived experience, revealing how it affects bodies, perceptions and sensibilities. From the interviews conducted with Diana Manenti⁵, actress and member of the group, and Daiane Rodrigues⁶, the spectator, it seeks to understand how the inclusion of audio description transformed the audience's experience and contributed to the construction of a more inclusive and accessible theater.

The methodology used in the interviews with Diana and Daiane occurs in a dialogue format, without a previous script or an established questionnaire. The intention was to carry out a natural conversation, which would enable a direct exchange of experiences and experiences, without the intervention of a rigid scheme.

Cia. O Sombrista premiered the show "Às Sombras de Anita" in 2020, which presents itself as a performance that explores the universe of the historical figure of Anita Garibaldi⁷, connecting to contemporary issues such as gender and inclusion. The montage features open audio description and programs in braille, reaffirming the group's commitment to the right to full participation in cultural life. In this production, audio description is named as *shadowdescription*⁸, and plays a key role in ensuring that shadow theatre, which relies heavily on visual elements, can also be enjoyed by people with visual impairments. The group uses this resource in an integrated way to the narrative, offering detailed descriptions of the shadows and actions in the scene, in order to create a rich and immersive experience for the audience. The *shadow-description*, therefore, translates the aesthetic and narrative elements of the show, without interfering with the fluidity of the presentation, providing a broad understanding of the story and the emotions transmitted.

⁴ Cia O Sombrista is a theater group from Turvo/SC that, since 2018, has combined its art and commitment to inclusion. The group embraces the mission of providing meaningful experiences for audiences and performers, using shadow theater as a powerful tool to amplify voices and foster dialogue on important social issues.

⁵ Diana Manenti is an actress, broadcaster and voice actress with more than 15 years of experience in the advertising, videos, audio description and audiobooks market.

⁶ Daiane Rodrigues is a bocce athlete and provides audio description consulting. She lost her sight in 2012 after suffering a cerebral venous thrombosis (CVT).

⁷ Anita Garibaldi (1821-1849) was a Brazilian revolutionary, also known as the "Heroine of the Two Worlds", who actively participated in republican movements in Brazil, such as the Farroupilha Revolution, and in Italy (Bonavides, 2001).

⁸ Shadowdescription is an accessibility feature developed to describe visual scenes in shadow theater shows, allowing people who are blind or have low vision to understand the narrative and visual details of the performances. Like audio description, shadow description describes essential elements for understanding the work, such as the projected shapes, the movements of the shadows, the interactions between the characters, and the scenarios created by these projections. The goal is to translate what is being shown visually into an accessible format, expanding the participation of different audiences in the shows.

In addition, Cia O Sombrista seeks to incorporate *shadow description* as part of an inclusive artistic proposal, which values the diversity of its audience. They understand that accessibility goes beyond a simple technical adaptation and involves a transformation in the way the show is conceived and presented. Through *shadowdescription*, the company not only expands access to shadow theater, but also explores new ways of telling stories and creating sensory experiences, expanding the possibilities of theater as a space for coexistence and cultural exchange.

During the interviews, the importance of audio description was widely discussed within the context of creating a truly inclusive cultural space. Diana highlighted that AD is not just a way of translating images into words, but rather an experience of integration. The company understands that making theatre accessible implies rethinking the ways of creation and reception. Audio description, in this context, is not a translation, but a rewriting of the scene — a way of re-inscribing the sensible for all bodies.

DIANA: I think art has this capacity, right? To provide transportation for them to come. And I think, too, to draw the attention of people who don't have disabilities.⁹

This statement shows the understanding that accessibility is not only a gesture of inclusion, but also of affectation — a way of moving the sensibility of those who see and those who do not see. The public is transformed when they realize that art can be shared in different ways. It reinforces how art has the power to bring people together from different contexts, promoting interactions and reflections that go beyond the aesthetic experience. One of the most impactful experiences of the group, reported by Diana, was a presentation of the show "Às Sombras de Anita", held in Florianópolis/SC, where the audience was composed of blind and non-blind people in practically equal proportion. According to her, this was a unique opportunity to observe how cultural accessibility affects both people with disabilities and those without disabilities:

DIANA: And the fact that you bring the two groups together, like that, half and half, you know? [...] It was half-half. There were a lot of blind people. And we realized that it affected people who do not have disabilities a lot.¹⁰

This account confirms the potential of accessible art as a space for coexistence and displacement of perspectives. As Garland-Thomson (2011, p. 13) proposes, "disability reveals how much our cultural practices define what counts as human". Thus, by creating a

⁹ Interview with actress and producer Diana Manenti, given on October 16, 2024.

¹⁰ According to footnote number 6.

shared space between different bodies, Cia. O Sombrista makes visible the political character of accessibility: it redistributes the aesthetic experience among all, without hierarchies.

The challenge of accessibility, especially for people with visual impairments, involves more than simple technological or architectural adaptations. The culture of prejudice and fear often isolates these people, as Diana points out:

DIANA: The point is that I think that the blind child, he has all this margin of prejudice from the family that is very afraid, you know? So, I think that really the families, they end up kind of locking the blind inside the house. And we see them very little on the street. Because the environment is very hostile even if you think about it, for a blind person. At school, she needs an even greater adaptation for a blind child.¹¹

The statement highlights the cultural barrier imposed for visual impairment, which aggravates the invisibility of these people in daily life. In addition, she points to the need for cultural and educational environments that are better prepared to receive people with disabilities, so that these barriers are gradually eliminated.

This need is also highlighted in the experience shared by Daiane, when she was invited to watch the show "Às Sombras de Anita" for the first time. She reveals that, since she lost her sight in 2012, she has avoided going to cultural spaces, such as theaters and cinemas, due to the difficulty of understanding the stagings:

DAIANE: With audio description in the theater, my first time was there with O Sombrista. And then, when I was invited to go, I was already very anxious, like, to know what it would be like, because I always liked theater, cinema, film, show, these things, and since I had gone blind, in 2012, I had not been to these places anymore, because you go and many times there are parts of a show that is just the staging, You don't know what's going on, and then the person stays with you, by your side, or if you go alone, you don't know what happens, but someone else has to keep describing you there. Then the person doesn't pay attention and describes the spectacle to you. So, I stopped attending, consuming the theater, the cinema, for this reason.¹²

This lack of understanding generates a feeling of exclusion and often leads people to give up participating in cultural life. Audio description, as Daiane describes, is not just a technical resource, but a bridge that connects the blind audience to the show. Her emotion when watching the presentation with audio description was palpable:

DAIANE: And when I was invited there, and it was that open audio description, wow, I was very moved, because it was something that touched me a lot because it was a shadow theater, which blind people would never be able to watch if it didn't have

¹¹ According to footnote number 6.

¹² Interview with Daiane Rodrigues, given on October 16, 2024.

Diana's description there. So, if here in the city, there will be a shadow theater, talking about Anitta, 'such, such, such', it would be something I was going to say, wow, how interesting, but I wouldn't. So, the description impacts in this sense, that we feel like participating, because you get there and know that you will understand everything that is being said. You don't feel like a fish out of water, you feel included in that show, in that audience, and you say, wow, I can be where the visionaries can be, and that breaks many barriers for us. Because, nowadays, many blind people give up on living, like, a life, they survive, we say, they give up on living a cultural life, a social life, for this reason.¹³

This emotional connection underscores the importance of audio description, allowing blind people to not only watch but feel part of a community. Diana also highlights the fundamental role of audio description in social participation. She emphasizes the artist's mission to exercise creativity in the use of this resource, regardless of the order of facts in which it is used, whether from the beginning of a production or after the work is ready:

DIANA: I'm seeing within your study, of a kind of putting accessibility from the beginning or putting it later. For people with disabilities, the important thing is to be accessible. If it will tell before or after, it is a journey much more of the artist from there, I think it goes much more to the axis of creation, you know? Than for the benefit of the person. Because Dai¹⁴ talks about it. She says if it's a poetic AD, great, but if it has audio description, as much as it's an audio description like that, *flat*¹⁵, you know? That it doesn't have too much interpretation, it's not too poetic, but if it's accessible to us, it's already wonderful. What I think is that we can be more creative in the application of these resources. What I've been thinking about today, which is in line with what you're talking about, to insert this from the beginning. More than that, I think we can be creative in exhibitions, we can be creative in theater shows, you know? Use our creativity in favor of resources. So that they do not need to be used only in this watertight way. So that we can have more and more works that have a greater possibility of enjoyment, like this. That in a little while we will arrive at a time when in the future we don't even talk about accessibility anymore. Which is obviously already accessible, you know? That it is already built thinking, right?¹⁶

A relevant point about accessibility through AD is that it is not limited to just meeting the needs of blind people. Daiane points out that audio description can also benefit other audiences, such as people with ASD and ADHD:

DAIANE: Is AD good for the visually impaired? Yes, it's great! But also for autistic people, for those who have ADHD, who can't focus, pay attention. So, sometimes, she is there in something else, but her ear is attentive to what is being said, and that is

¹³ According to footnote number 9.

¹⁴ Diana refers to Daiane as Dai.

¹⁵ *Flat* is an English word that means "flat". Within the context of the sentence, Diana refers to a flat audio description in the sense of being a straight audio description, with no room for interpretation, focusing only on visual translation.

¹⁶ According to footnote number 6.

entering her little head. So, audio description, like this, is incredible, even in this sense, even for other types of disabilities.¹⁷

This perspective broadens the horizon on the usefulness of audio description, showing that it is a valuable resource for a variety of audiences. A crucial point raised by Daiane is that "theater is not only for sighted people, theater is for all people". This statement reflects a fundamental truth that art should be inclusive and accessible to all. This vision is necessary to transform the cultural experience into a truly inclusive space.

In addition to the direct impact on people with disabilities, ageism was addressed in the conversation, highlighting how accessible resources also benefit this group, allowing them to continue actively participating in social and cultural life. Emphasizing the importance of thinking about accessibility as a right that crosses the stages of life and affects everyone at different times.

DIANA: We get into this issue of ageism that we live in our society. Prejudice against the old person. The person gets old, he becomes disposable. It is no longer useful to produce in society, so now it matters little [...] And accessibility boosts help older people a lot.¹⁸

To overcome these obstacles, it is necessary to raise awareness and create accessible spaces that contemplate the diversity of the public. Accessibility should be thought of broadly, not only for people with visual impairments, but for anyone who may, at some point in life, need accessible resources. Accessibility should be seen not as a favor or a charity, but as a universal need that can benefit any individual throughout their life.

Daiane's experience in shadow theater with audio description was not only a new cultural opportunity, but also a rediscovery of her role in society. "I had felt part of something," she says, underlining the importance of audio description in creating a sense of community and belonging. Daiane also mentions that audio description should be a common practice in all cultural manifestations:

DAIANE: I think that everything cultural has to have audio description, because, as we say, we also like to consume these things, right? So, if there is audio description, there will certainly be blind people there to be able to participate.¹⁹

Through the conversation with Diana and Daiane, it is evident that audio description is a transformative tool for the accessibility of people with disabilities in cultural contexts. The

¹⁷ According to footnote number 9.

¹⁸ According to footnote number 6.

¹⁹ According to footnote number 9.

experiences they share highlight not only the need for accessible resources, but also the importance of fostering an environment where everyone can be included. Art, after all, should be a space of connection, where each person, regardless of their abilities, can experience and celebrate culture, as Daiane mentions:

DAIANE: I was very moved, really excited, because it was a very touching experience for me. I, for the first time, in a long time, felt part of something, you know? I had felt, wow, I'm in a theater, I'm here, with a lot of people and I'm getting to know everything that's going on, without someone having to say in my ear what's happening. And some people have also felt uncomfortable and bothered by audio description, because it's the new one, right? The person, sometimes, thought that it was not necessary, but when he heard the testimonies, he saw that it was necessary, because the theater there is not only for sighted people, the theater is for all people, right?²⁰

Diana and Daiane's testimonies highlight the relevance of audio description as a practice that goes beyond technical accessibility, it is an act of social and cultural participation. From the shared experiences, it is understood that the true democratization of art requires a constant and sensitive adaptation to the needs of all. Thus, art fulfills its role of being a space of belonging and exchange, where barriers are overcome.

4 CONCLUSION

This research aimed to investigate how art and culture can establish meaningful relationships with people with disabilities, exploring how these interactions reconfigure our understanding of the artistic experience. Throughout the study, we sought to understand the role of audio description as an essential tool to make art and culture accessible to a diverse audience. From the analysis carried out, it is possible to observe that cultural accessibility not only expands the reach of art, but also promotes a transformation in the way it is experienced, including new looks and perspectives.

Based on the experience of Cia. O Sombrista, this study demonstrated that audio description can be understood as an aesthetic and political language, capable of reconfiguring the experience of art and the notion of accessibility. By adopting the perspective of critical studies, the research recognizes that disability is not an obstacle, but a creative lens—a way of thinking and feeling the world. Audio description, in this sense, is more than a bridge between the visible and the invisible: it is an act of sharing, a gesture that makes art a space for sensory coexistence.

²⁰ According to footnote number 9.

Diana and Daiane's speeches reveal that accessibility is also emotion, belonging and creation. They show that accessible art is not an extension of existing art, but a new field of creation, where difference is inventive force. At a time when disability is still associated with absence, the work of Cia. O Sombrista points to another direction: that of art as a practice of listening and care, where the sensitive is shared and the other is presence.

To think about accessibility from the perspective of aesthetics — and not just technique — is to think of an artistic and social future in which diversity is the principle of creation. Audio description, in this horizon, becomes a symbol of an expanded, inclusive and transformative art, after all, accessibility in art goes far beyond the fulfillment of legal requirements. It represents a fundamental step towards an inclusive culture, where participation and appreciation of art are seen as fundamental rights of all, regardless of their physical or sensory conditions. And in this way, it reconfigures the artistic experience by challenging traditional notions of perception and appreciation of art, incorporating the experiences and interpretations of an audience left on the margins of experiences with culture and art.

It is essential to reaffirm that the development of accessible and inclusive art is an essential step towards building a society that values diversity and respect for differences. Accessibility in art and culture represents a paradigm shift, in which the right to artistic participation is understood as a universal human right. Thus, audio description and other accessible resources not only democratize access, but promote the artistic experience by enabling a plural experience.

REFERENCES

- Bonavides, P. (2001). Anita Garibaldi: A heroína dos dois mundos. Paz e Terra.
- Brasil. (2010, 3 de dezembro). Lei nº 12.343, de 2 de dezembro de 2010. Dispõe sobre o Plano Nacional de Cultura e dá outras providências. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12343.htm
- Brasil. (2015, 7 de julho). Lei nº 13.146, de 6 de julho de 2015. Institui a Lei Brasileira de Inclusão da Pessoa com Deficiência. Diário Oficial da União, seção 1, 2. https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13146.htm
- Garland-Thomson, R. (2011). Misfits: A feminist materialist disability concept. *Hypatia*, 26(3), 591–609.
- McRuer, R. (2006). *Crip theory: Cultural signs of queerness and disability*. New York University Press.
- Siebers, T. (2010). *Disability aesthetics*. University of Michigan Press.

PERFORMANCE INDICATORS AND BUSINESS INTELLIGENCE TOOLS APPLIED TO DRINKING WATER QUALITY IN THE FIELD OF REGULATION

INDICADORES DE DESEMPENHO E FERRAMENTAS DE BUSINESS INTELLIGENCE APLICADA À QUALIDADE DA ÁGUA PARA CONSUMO HUMANO NO CAMPO DA REGULAÇÃO

INDICADORES DE DESEMPEÑO Y HERRAMIENTAS DE INTELIGENCIA DE NEGOCIOS APLICADOS A LA CALIDAD DEL AGUA POTABLE EN EL ÁMBITO DE LA REGULACIÓN



<https://doi.org/10.56238/sevened2026.008-026>

Rodrigo Antonio Pinto de Melo¹, Jane Carla Marinho de Souza Maia², Cícero Henrique Macêdo Soares³, Emanuele Ferreira Gomes⁴, Rafael Lima da Silva⁵

ABSTRACT

In the context of exposure regulation, a system of performance indicators combined with Extraction, Transformation, and Loading (ETL) methods, coupled with dashboard analysis, is an important tool for evaluating the performance of a product's quality. Therefore, this work aims to present the functionalities and applications of a performance indicator system implemented for evaluating the quality of drinking water, considering parameters that demonstrate the effectiveness of the product's quality. The indicator evaluation system was built using an ETL process of the data, executed by Microsoft Power BI®, as it offers excellent functionalities for developing dashboards and devices that promote transparency and interaction mechanisms. It was possible to evaluate and analyze the quality of drinking water at production points and in the distribution network with the aid of graphic elements related to effectiveness and efficiency. Tools such as performance papers and data download options were made available on the dashboard, promoting transparency and joint participation by users and key stakeholders in basic sanitation management. Finally, the tool allowed for a comparison of the water quality performance produced at Water Treatment Plants (WTPs)

¹ Master's degree of Science in Chemical Engineering. Agência de Regulação de Pernambuco (Arpe). E-mail: rodrigo.antonio@arpe.pe.gov.br Orcid: <https://orcid.org/0000-0001-5777-0696> Lattes: <http://lattes.cnpq.br/8196167792694984>

² Postgraduate certificate in Environmental Engineering and Quality Indicators. Agência de Regulação de Pernambuco (Arpe). E-mail: jane.maia@arpe.pe.gov.br Orcid: <https://orcid.org/0009-0007-1030-578X> Lattes: <http://lattes.cnpq.br/1562253785423379>

³ Dr. in Chemical Engineering. Agência de Regulação de Pernambuco (Arpe). E-mail: cicero.henrique@arpe.pe.gov.br Orcid: <https://orcid.org/0009-0006-0757-9985> Lattes: <https://lattes.cnpq.br/1893151002890072>

⁴ Master's degree in Civil and Environmental Engineering. Agência de Regulação de Pernambuco (Arpe). E-mail: emanuele.ferreira@arpe.pe.gov.br Orcid: <https://orcid.org/0009-0003-8002-2241> Lattes: <http://lattes.cnpq.br/7983041023518052>

⁵ Undergraduate student in Agricultural and Environmental Engineering. Agência de Regulação de Pernambuco (Arpe). E-mail: rafaellima.silva@arpe.pe.gov.br Orcid: <https://orcid.org/0000-0001-9747-3442> Lattes: <https://lattes.cnpq.br/4061600745017173>

with the targets established in Municipal Basic Sanitation Contracts or Plans (PMSB), and for directing inspections when the result was unsatisfactory.

Keywords: Quality. Performance Indicators. Drinking Water. Exposure Regulation.

RESUMO

No contexto da regulação por exposição, um sistema de indicadores de desempenho aliados a métodos de Extração, Transformação e Carga (ETL) somado à análise através de Painéis (Dashboards) é ferramenta importante na avaliação do desempenho da qualidade de um produto ofertado. Assim, este trabalho tem por objetivo apresentar as funcionalidades e aplicações de um sistema de indicadores de desempenho implementado para avaliação da qualidade da água para consumo humano, no qual foram considerados parâmetros que comprovassem a eficácia da qualidade do produto. O sistema de avaliação dos indicadores foi construído por um processo de ETL dos dados, que foi executado pela ferramenta Microsoft Power BI®, visto que oferece ótimas funcionalidades para desenvolvimento de painéis (Dashboards) e dispositivos que possibilitam promover mecanismos de transparência e interação. Foi possível avaliar e analisar a qualidade da água para consumo humano nos pontos de produção e rede de distribuição com o auxílio de elementos gráficos que estavam relacionados a eficácia e eficiência. Ferramentas como Paper de desempenho e a opção de downloads de dados foram disponibilizadas no Pannel, promovendo mecanismo de transparência e participação conjunta por parte de usuários e principais stakeholders da gestão do saneamento básico. Finalmente, a ferramenta permitiu comparar o desempenho da qualidade da água produzida nas Estações de Tratamento de Água (ETAs) com as metas existentes em Contratos ou Planos Municipais de Saneamento Básico (PMSB) e direcionar as fiscalizações diretas quando o resultado foi insatisfatório.

Palavras-chave: Qualidade. Indicadores de Desempenho. Água Potável. Regulação por Exposição.

RESUMEN

En el contexto de la regulación de la exposición, un sistema de indicadores de desempeño combinado con métodos de Extracción, Transformación y Carga (ETL), junto con el análisis de tableros de control, constituye una herramienta importante para evaluar el desempeño de la calidad de un producto. Por lo tanto, este trabajo busca presentar las funcionalidades y aplicaciones de un sistema de indicadores de desempeño implementado para evaluar la calidad del agua potable, considerando parámetros que demuestran la efectividad de la calidad del producto. El sistema de evaluación de indicadores se construyó mediante un proceso ETL de datos, ejecutado por Microsoft Power BI®, ya que ofrece excelentes funcionalidades para el desarrollo de tableros de control y dispositivos que promueven la transparencia y los mecanismos de interacción. Fue posible evaluar y analizar la calidad del agua potable en los puntos de producción y en la red de distribución con la ayuda de elementos gráficos relacionados con la efectividad y la eficiencia. Herramientas como informes de desempeño y opciones de descarga de datos se pusieron a disposición en el tablero de control, promoviendo la transparencia y la participación conjunta de los usuarios y los actores clave en la gestión del saneamiento básico. Finalmente, la herramienta permitió comparar el desempeño de la calidad del agua producida en las Plantas de Tratamiento de Agua (PTA) con los objetivos establecidos en los Contratos o Planes Municipales de Saneamiento Básico (PMSB), y dirigir inspecciones cuando el resultado fue insatisfactorio.

Palabras clave: Calidad. Indicadores de Desempeño. Agua Potable. Regulación de la Exposición.

1 INTRODUCTION/OBJECTIVES

One of the main ways in which regulatory agencies act is related to the mechanism involving data transparency and regulation by exposure, being a very interesting way of regulating because it brings elements that offer integration and joint management action.

In the Concept of Water Quality for human consumption, Annex XX of the Consolidation Ordinance GM/MS No. 5, of September 28, 2017, of the Ministry of Health, establishes the maximum and minimum parameters and values allowed for them, in addition to establishing the two basic activities that aim to ensure the quality of drinking water, namely, control and surveillance, exercised by the system operator and public health entities, respectively. The Infra-national Regulation Agencies act in relation to the quality of water for human consumption according to the National Guidelines for Basic Sanitation outlined through Law No. 11,445, of January 5, 2007, amended by Law No. 14,026, of July 15, 2020. His expertise is mainly the performance through indicators to verify the performance and quality of service provision and the fulfillment of contractual goals and the Municipal Basic Sanitation Plan (PMSB).

In this context, the use of performance indicators to assess the quality of water for human consumption together with tools that maximize its usefulness in the field of regulation is a key part of the analysis of data from Water Treatment Plants (WTPs) carried out by the Agencies. In view of this importance, it is necessary that more studies of the methodologies applied by the Regulatory Agencies be carried out.

Thus, this work aims to present the functionalities and applications of a system of performance indicators aimed at the evaluation of the quality of water for human consumption in the Pernambuco Regulation Agency, in which parameters that prove the effectiveness of the quality of the product were considered.

2 METHODOLOGY

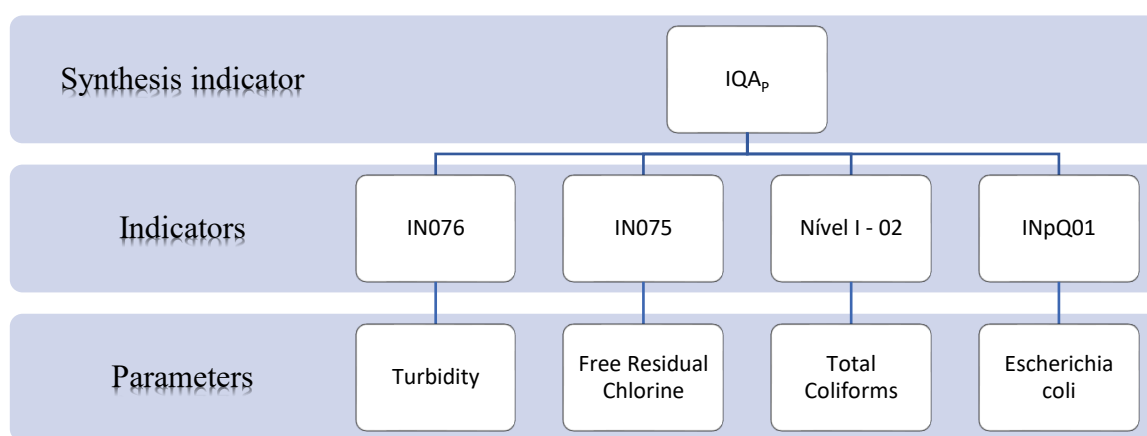
This work adopts a quantitative and qualitative approach, employing a case study as a research strategy. The object of analysis is the system of performance indicators used by the Pernambuco Regulation Agency to evaluate the quality of water for human consumption.

Data collection was carried out through documentary analysis of the agency's internal files, including technical reports, procedure manuals and regulations. The main source of data was the historical series obtained from the service provider in relation to the control of the quality of water for human consumption. The analysis consisted of a detailed description of the methodology adopted, the selected indicators, their relevance in the regulatory context and the way they are used to identify trends and challenges in ensuring potability.

The selection of 4 parameters was proposed to obtain a systemic view of water quality: Turbidity, Free Residual Chlorine, Total Coliforms and Escherichia coli. The incidence indicator of the analyses within the standard is applied to each specific parameter, totaling four indicators for evaluating the quality of drinking water. To add managerial value to the indicators, a Drinking Water Quality Index was proposed to summarize the result of the four indicators in just one, allowing better analysis in the decision-making of an inspection. Figure 1 illustrates the composition of the indicators.

Figure 1

Composition of indicators through water quality parameters



Source: Prepared by the authors (2025)

Table 1 describes the calculation formulation of the indicators and their respective references and nomenclatures.

Table 1

Description of the calculation and reference formulas of the indicators

Indicator	Description	References	Calculation formula
IN075	Incidence of residual chlorine analyses within the standard	SNIS	$IN075 = \left(\frac{QD007}{QD006} \right) \times 100$ QD007 - Quantity of samples for residual chlorine within the standard (analyzed) QD006 - Quantity of Residual Chlorine Samples Analyzed
IN076	Incidence of turbidity analyses within the standard	SNIS	$IN076 = \left(\frac{QD009}{QD008} \right) \times 100$ QD009 - Number of Samples for In-Standard Turbidity (Analyzed) QD008 - Number of Samples for Turbidity Analyzed
Nível I – 02	Incidence of total coliform analyses within the standard	ANA	$Nível I - 02 = \left(\frac{QD027}{QD026} \right) \times 100$ QD027 - Number of samples for total coliforms within the standard (analyzed) QD026 - Amount of samples for total coliforms analyzed
IN_PQ01	Incidence of E.coli analyses within the standard	Arpe	$IN_PQ01 = \left(\frac{QD017}{QD016} \right) \times 100$ QD017 - Number of samples for E.coli within the standard (analyzed) QD016 - Number of samples for E.coli analyzed

Source: Prepared by the authors (2025)

The calculation of the weight *w*, related to the portion of influence of the indicators in the formulation of the IQAp, is carried out through a quantitative and qualitative evaluation of the risks that non-conformities of the quality parameters entail for the supply system. To characterize the risk of each parameter, we used scores for the following aspects: severity (S), occurrence (O) and detection (D) of the hazard. The scores given to the aspects range from 1 to 3, with 1 for low, 2 for moderate, and 3 for high. A better description of this type of methodology can be seen in Rodrigues (2014). Table 2 illustrates the calculation formulation for the Drinking Water Quality Index (IQAp).

Table 2

Methodology for calculating the Drinking Water Quality Index (IQAp)

Indicator	Description	Origin	Calculation formula
			$IQA_p = \sum_{i=1}^n [q_i * w_i]$ $\sum_{i=1}^n w_i = 1$ $w_i = \frac{R_i}{R_{total}}$
IQA_p	Drinking Water Quality Index	Arpe	$R_i = \text{severidade}(S) \times \text{ocorrência}(O) \times \text{detecção}(D)$ $= S \times O \times D$ $R_{total} = R_{CRL} + R_{turbidez} + R_{C.T} + R_{E.coli}$ Where: n - number of water quality parameters assessed locally in the SAA I - Evaluated parameter qi - Incidence of analyses within the standard of parameter i wi - Weight assigned to parameter i

Source: Prepared by the authors (2025)

Table 3 below reports the scores and justifications given to the severity (S) aspect.

Table 3

Score for the severity aspect

Severity Score		
Classification	Justification	Score
High	Substance very harmful to the environment, causes serious effects on human health, has characteristics of toxicity and pathogenicity.	3
Moderate	Substances that are harmful to the environment, cause mild effects on human health (irritations or allergies)	2
Low	Substances that are not harmful to the environment, cause negative effects on human health	1

Source (adapted): (Rodrigues, 2014)

Tables 4, 5, 6 and 7 below report the scores and justifications that are given to the occurrence (O) aspect according to the frequency of non-compliance for the parameters Free Residual Chlorine, Turbidity, Total Coliforms and Escherichia coli.

Table 4

Score for the occurrence aspect for the Free Residual Chlorine parameter

Score for Occurrence (Free Residual Chlorine)		
Classification	Justification	Score
High	The environmental impact or health risk occurs at a high frequency for the parameter (13 or more non-conformities per year)	3
Moderate	The environmental impact or health risk occurs at a moderate frequency for the parameter (7 to 12 non-conformities per year)	2
Low	The environmental impact or health risk occurs at a low frequency for the parameter (up to 6 non-conformities per year)	1

Source (adapted): (Rodrigues, 2014)

Table 5

Score for the occurrence aspect for the Turbidity parameter

Score for Occurrence (Turbidity)		
Classification	Justification	Score
High	The environmental impact occurs at a high frequency for the parameter (above 30 non-conformities per year)	3
Moderate	The environmental impact occurs at a moderate frequency for the parameter (11 to 30 non-conformities per year)	2
Low	The environmental impact occurs at a low frequency for the parameter (up to 10 non-conformities per year)	1

Source (adapted): (Rodrigues, 2014)

Table 6

Score for the occurrence aspect for the Total Coliforms parameter

Score for Occurrence (Total Coliforms)		
Classification	Justification	Score
High	The environmental impact occurs at a high frequency for the parameter (above 6 non-conformities per year)	3
Moderate	The environmental impact occurs at a moderate frequency for the parameter (3 to 6 non-conformities per year)	2
Low	The environmental impact occurs at a low frequency for the parameter (up to 2 non-conformities per year)	1

Source (adapted): (Rodrigues, 2014)

Table 7

Score for the occurrence aspect for the Escherichia coli parameter

Score for Occurrence (Escherichia coli)		
Classification	Justification	Score
High	The environmental impact and the health risk occur at a high frequency for the parameter (above 3 non-conformities per year)	3

Moderate	The environmental impact occurs at a moderate frequency for the parameter (1 to 3 non-conformities per year)	2
Low	The environmental impact occurs at a low frequency for the parameter (up to 1 non-compliance per year)	1

Source (adapted): (Rodrigues, 2014)

Table 8 reports the scores and justifications given to the detection aspect (D).

Table 8

Score for the detection aspect

Detection Score		
Classification	Justification	Score
High	To detect non-conformity, medium to high complexity methods are used, requiring several steps for the success of the method, causing an execution time usually greater than 1 day.	3
Moderate	Non-compliance is perceived with the use of simple meters, with a measurement time generally less than 30 minutes (turbidimeters, photocolorimeters, titrations, etc.)	2
Low	Non-compliance can be perceived visually	1

Source (adapted): (Rodrigues, 2014)

Tables 9 and 10 describe the reasons why the non-conformities received their scores for each aspect in the positions of the treatment outlet and the distribution network, respectively.

Table 9

Explanation form of severities, occurrences and detections for treatment exit

Parameter	Severity (S)	Occurrence (O)	Detection (D)	Risk
Free Residual Chlorine	It can cause significant problems to human health due to its exposure in high concentrations	Depends on the frequency of non-compliance	CRL analysis is done using simple equipment. (Photocolorimeter)	$R = S \times D \times O$
	May increase the likelihood of the presence of pathogenic microorganisms due to the absence of residues in the water		On average, the full test takes about 10 minutes or less.	$R = 3 \times 2 \times O$
				$R = 6 \times O$
	Score: 2			
Score: 3				
Turbidity	Considered an indicator of efficiency of the water clarification process.	Depends on the frequency of non-compliance	Turbidity analysis is done using simple equipment. (Turbidity meter).	$R = S \times D \times O$ $R = 3 \times 2 \times O$ $R = 6 \times O$

Parameter	Severity (S)	Occurrence (O)	Detection (D)	Risk
	May interfere with disinfection efficiency Indicator of efficiency in the process of removing oocysts from Protozoa. Its positivity in relation to the current norm has the effect of indirectly pointing to the increase in the probability of the presence of Protozoa. Score: 3		On average, the full test takes about 10 minutes or less. Score: 2	
Total Coliforms	Parameter used as a counter-test for the sentinel parameters Turbidity and Free Residual Chlorine Bacteriological removal efficiency indicator Its positivity in relation to the current norm has the effect of pointing to an increase in the probability of the presence of pathogenic microorganisms Score: 3	Depends on the frequency of non-compliance	Complex test, requires specialized personnel, takes more than a day to complete execution Score: 3	$R = S \times D \times O$ $R = 3 \times 3 \times O$ $R = 9 \times O$
Fecal Coliforms (Escherichia coli)	It can cause significant problem to human health. Proves the compromise of the quality of water for human consumption Faecal contamination indicator Score: 3	Depends on the frequency of non-compliance	Complex test, requires specialized personnel, takes more than a day to complete execution Score: 3	$R = S \times D \times O$ $R = 3 \times 3 \times O$ $R = 9 \times O$

Source (adapted): (Ogata, 2011)

Table 10

Explanation form of severities, occurrences and detections for treatment exit

Parameter	Severity (S)	Occurrence (O)	Detection (D)	Risk
Free Residual Chlorine	It can cause significant problems to human health due to its exposure in high concentrations May increase the likelihood of the presence of pathogenic microorganisms due to the absence of residues in the water Score: 3	Depends on the frequency of non-compliance	CRL analysis is done using simple equipment. (Photocolorimeter) On average, the full test takes about 10 minutes or less. Score: 2	$R = S \times D \times O$ $R = 3 \times 2 \times O$ $R = 6 \times O$

Parameter	Severity (S)	Occurrence (O)	Detection (D)	Risk
Turbidity	May interfere with the efficiency of residual chlorine		Turbidity analysis is done using simple equipment. (Turbidity meter).	$R = S \times D \times O$
	Non-compliance is related to measuring only organoleptic aspects	Depends on the frequency of non-compliance	On average, the full test takes about 10 minutes or less.	$R = 2 \times 2 \times O$
				$R = 4 \times O$
	Score: 1		Score: 2	
Total Coliforms	Parameter used as a counter-test for the sentinel parameters Turbidity and Free Residual Chlorine		Complex test, requires specialized personnel, takes more than a day to complete execution	$R = S \times D \times O$
	Bacteriological removal efficiency indicator	Depends on the frequency of non-compliance		$R = 2 \times 3 \times O$
	Its positivity in relation to the current norm has the effect of pointing to an increase in the probability of the presence of pathogenic microorganisms			$R = 9 \times O$
	Score; 3		Score: 3	
Fecal Coliforms (Escherichia coli)	It can cause significant problem to human health.		Complex test, requires specialized personnel, takes more than a day to complete execution	$R = S \times D \times O$
	Proves the compromise of the quality of water for human consumption	Depends on the frequency of non-compliance		$R = 3 \times 3 \times O$
	Faecal contamination indicator			$R = 9 \times O$
	Score: 3		Score: 3	

Source (adapted): (Ogata, 2011)

Table 11 below summarizes the reference values adopted for the qualitative evaluation of the performance indicators.

Table 11

Benchmarks for performance indicators

Performance indicators	Reference values		
	Ideal 	Satisfactory 	Unsatisfactory
IQAp IN075 IN076 Level I - 02 INpQ01	IQAp >= 95% IN075 = 100% IN076 >= 95% Level I – 02 >= 95% INpQ01= 100%	90% <= IQAp < 95% - 85% <= IN076 < 95% - -	IQAp < 90% IN075 < 100% IN076 < 85% Level I – 02 < 95% INpQ01< 100%

Source: Prepared by the authors (2025)

In the evaluation stage, an ETL (Extraction, Transformation and Loading) process of the data was used in order to obtain a better fit of the data. The interaction with users and managers is carried out through a performance panel, which allows, in addition to the visualization of indicators in tables and graphs with pictorial elements, the printing of *performance papers* by municipality. Figure 2 shows the data *download* page and the performance report of the indicators. The user can access and print the results of the municipal indicators in a historical series of the last five years, accompanied by a qualitative evaluation based on the classification by reference value ranges.

Figure 2

a) Page for data downloads; b) Performance paper for printing

(a)

(b)

Source: Prepared by the authors (2025)

This methodology allowed an in-depth understanding of the practical application of the evaluation system and its effectiveness in detecting problems and promoting improvements

in water quality, contributing to the improvement of regulatory practices. Regarding the objectives of this methodology, three were identified as essential: (a) Evaluate the quality of water for human consumption from Water Treatment Plants (WTPs) through a system of performance indicators, (b) Provide a means of aid in decision making and (c) Apply a *business intelligence* tool for use in exposure regulation.

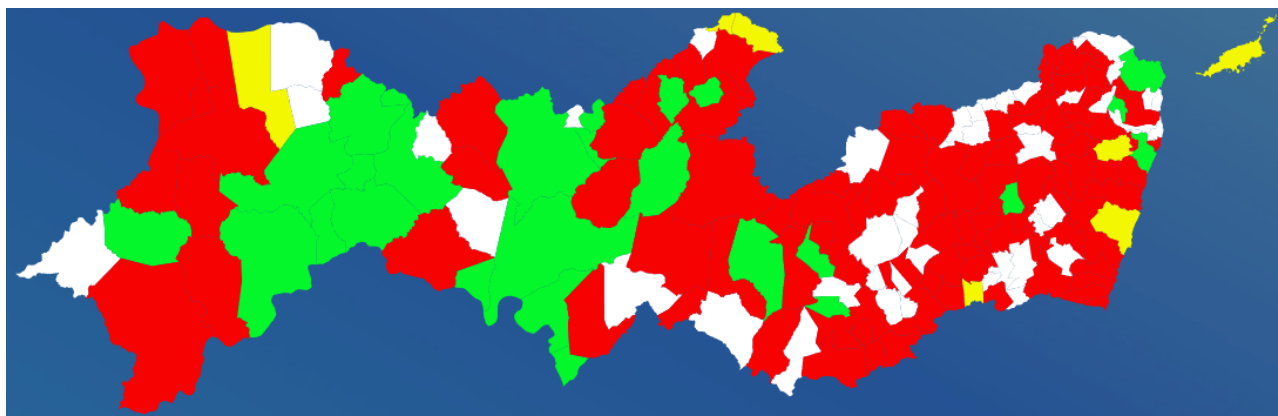
3 RESULTS AND DISCUSSION

The analysis of the agency's files allowed us to identify that the system's data sources come from the control function of water for human consumption, which is defined by Annex XX of the Consolidation Ordinance GM/MS No. 5, of September 28, 2017, of the Ministry of Health, and which is executed by the operator of the water supply system. Statistical data is received that is passed through a process of extraction, transformation and loading for subsequent calculation of the indicators. In the performance panels, the indicators are visualized with quantitative values and with qualitative elements classified according to range or reference values.

To exemplify the result of the performance evaluation of the quality of water for human consumption in relation to the provision of basic sanitation service in the state of Pernambuco, the base year of 2024 was considered and the data extracted come from the Performance Panel of the Pernambuco Regulation Agency – Arpe on drinking water quality.

We chose to show and analyze the result of the indicators in qualitative maps of the state of Pernambuco for technical reasons of visualization and spatial understanding of non-conformities. It should be noted that the absence of data, represented by the white color on the maps for certain municipalities, is justified by three factors: technical issues, municipalities that were not part of the agency's regulatory framework in the base year, or by the methodology of the indicators, in which municipalities that do not have Water Treatment Plants do not generate data at the treatment output.

At first, we present the results of the IQAp indicator, which has the function of summarizing the results of the other four indicators in a single piece of information for decision making. As seen in Figure 3, which reports the PQI at the end of treatment, it is observed that most municipalities have their PQI classification as unsatisfactory (red), which may probably evidence some systemic problem in ensuring the standard established by Annex XX of Consolidation Ordinance No. 5 GM/MS in relation to one of the four indicators that compose it.

Figure 3*IQAp at treatment discharge (base year 2024)*

Source: Water Quality Dashboard - Arpe (2025)

Figure 4 shows the result of the aqi for the distribution network, showing a very different contrast in relation to the treatment output. Most municipalities have the IQAp classified as ideal (green), reporting only a few cases in isolation with the classification of unsatisfactory.

Detailing the analysis for the indicators that make up the IQAp, the first being IN075, an indicator of residual chlorine compliance according to the standard of Annex XX of Consolidation Ordinance No. 5 GM/MS.

Figure 4*IQAp in the distribution network (base year 2024)*

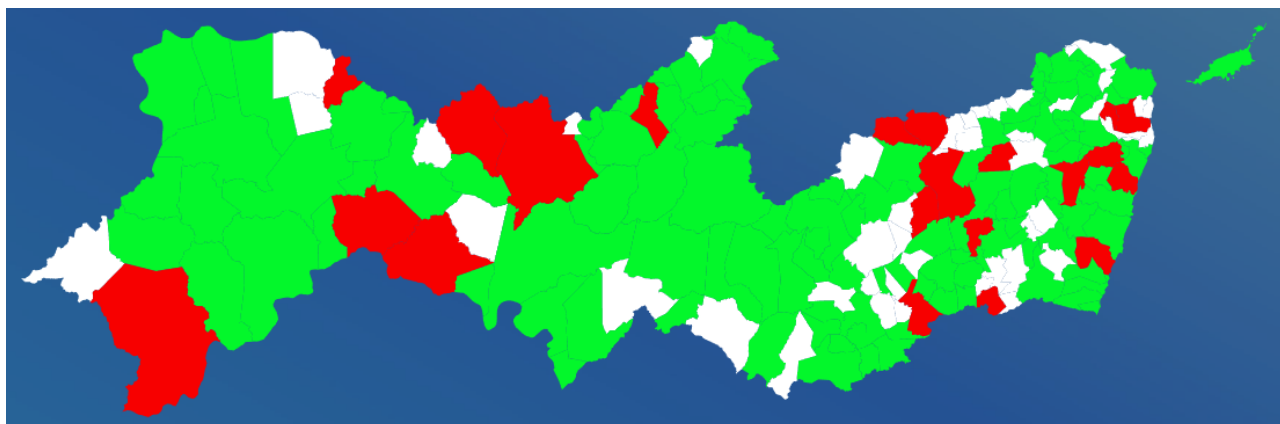
Source: Water Quality Dashboard - Arpe (2025)

Figure 5 shows that for this indicator its qualitative classification was ideal (green) at the end of treatment for most of the municipalities operated by the basic sanitation service provider. While in the network, Figure 6, most municipalities also obtained the qualitative classification of ideal, but with more clustered points of municipalities with an unsatisfactory classification. Depending on the quantitative value of the indicator, these municipalities may

be subject to a direct inspection (*in loco*) to verify the chlorination system of the WTPs and guarantee the quality of the product in relation to the Contractual and PMSB goals.

Figure 5

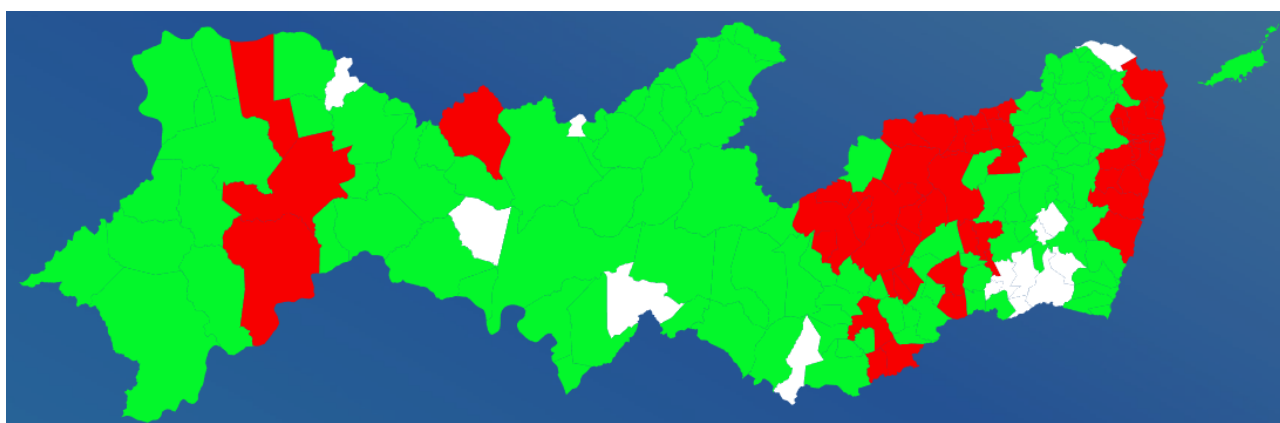
IN075 at treatment exit (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

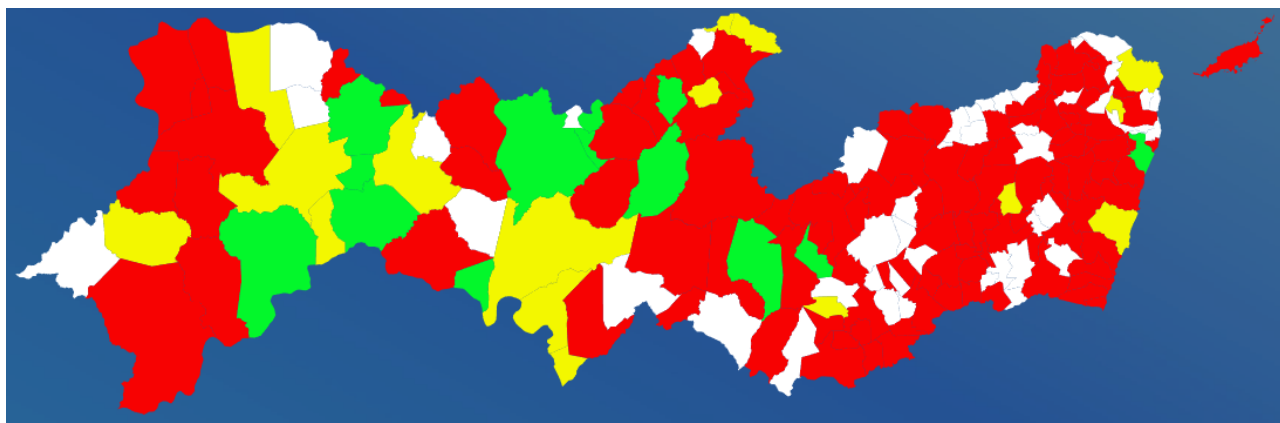
Figure 6

IN075 in the distribution network (base year 2024)



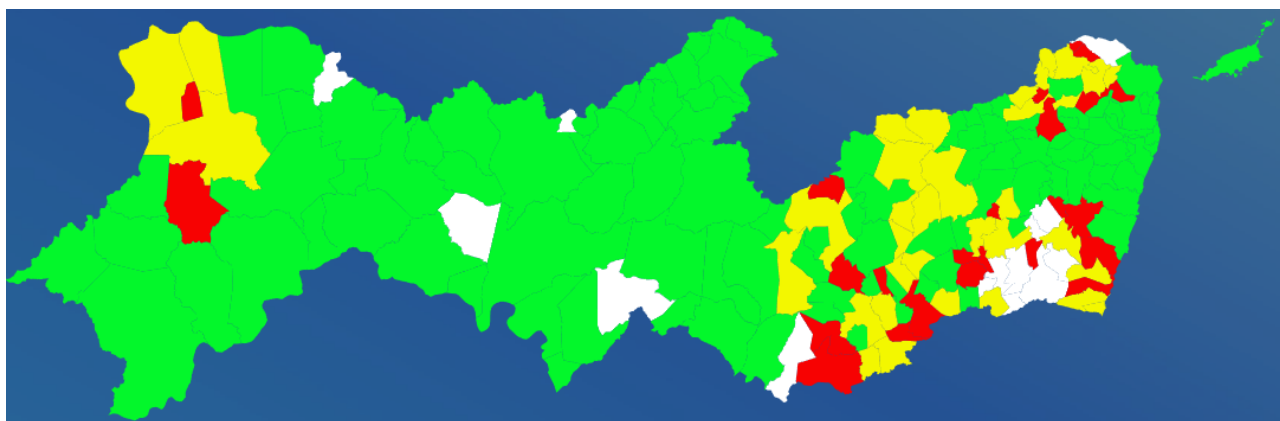
Source: Water Quality Dashboard - Arpe (2025)

Analyzing the indicator IN076 for turbidity compliance according to Annex XX of Consolidation Ordinance No. 5 GM/MS, it is verified that at the end of the treatment, Figure 7, most municipalities have their classification as unsatisfactory and that the colorimetric map is very similar to the graph in Figure 3. It is notable that the deficiency of the IQAp comes from most of the IN076 indicator, which has low compliance yields in the municipalities of the state. Achieving the potability standard for water turbidity after filtration, 0.5 NTU in 95% of samples and the remaining 5% up to 1 NTU, is a major challenge.

Figure 7*IN076 at treatment exit (base year 2024)*

Source: Water Quality Dashboard - Arpe (2025)

Figure 8 illustrates the indicator IN076 in the distribution network, where it is possible to see a very different panorama of the treatment output, most municipalities have an IN076 classification as ideal, which is justifiable due to the potability standard being organoleptic, maximum value allowed up to 5 NTU, while at the treatment output it is much more restrictive because it is linked to efficiency issues in the elimination of cysts and oocysts of Protozoa in the filtration process.

Figure 8*IN076 in the distribution network (base year 2024)*

Source: Water Quality Dashboard - Arpe (2025)

The yield of this indicator is often impacted by a series of challenges, such as the degradation of water quality in water sources and the water crisis, which causes the depletion and collapse of these sources. Added to this is the problem of undersized Water Treatment Plants (WTPs), either due to inadequate design or the inability to keep up with the increase in population demand, the consequence is the prioritization of the amount of water produced,

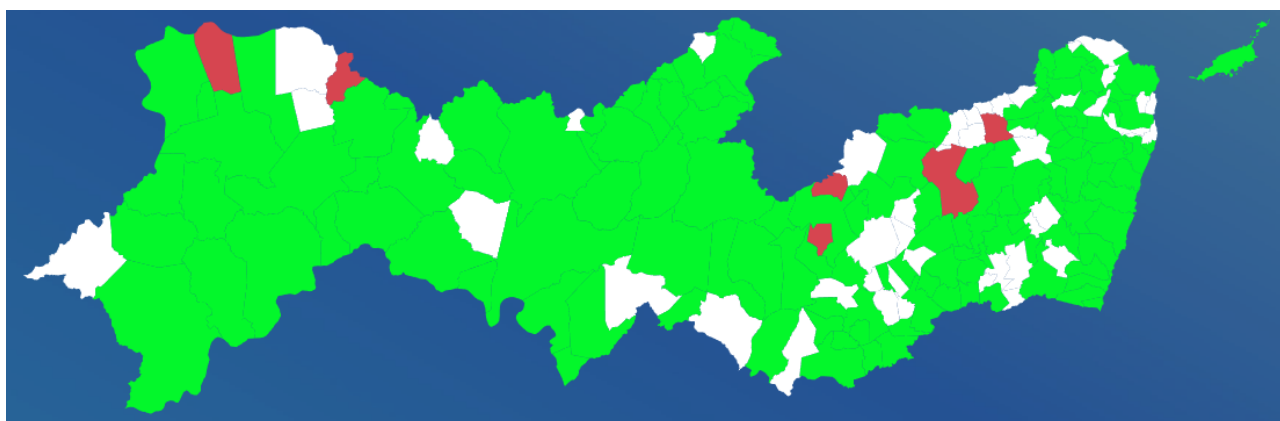
to the detriment of the quality and efficiency of treatment. All these aspects have contributed to the performance of this indicator being often compromised.

Reaching the potability standard for the IN076 indicator at the filtration outlet is a systemic deficiency for most WTPs in the municipalities of Pernambuco, with the exception of those that have their abstraction from springs with good water quality, such as the São Francisco River, or those that have a very robust treatment system.

The Level I-2 indicator is found in ANA reference standard No. 09 and measures the compliance of total coliform samples in relation to the standards established in Annex XX of Consolidation Ordinance No. 5 GM/MS, being related to treatment efficiency and is used to verify it.

Figure 9

Level I – 2 at treatment exit (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

Figure 10

Level I – 2 in the distribution network (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

Figure 9 above shows the positivities of this indicator in the base year, which implies a deficiency in water treatment for few municipalities in the state in relation to the treatment

output and should also be analyzed quantitatively for planning direct inspections. For the distribution network, Figure 10 also shows few municipalities classified as unsatisfactory, which leads us to infer that for the year 2024 most municipalities presented good yields in their treatment system and microbiological protection of the network.

The INpQ01 indicator points to fecal contamination of the water, and should not present positivity in any way in the treatment system, but even so, we find it in our state, mainly due to three factors that reflect on the inefficiency of the treatment system: poor water quality source, undersized Water Treatment Plants and old distribution networks. As can be seen in Figures 11 and 12, some municipalities were positive for *Escherichia coli* at the end of the treatment and in the distribution network. Both the Level I - 2 indicator and the INpQ01 are the main pointers used by the Agency in relation to product quality to direct direct inspection.

Figure 11

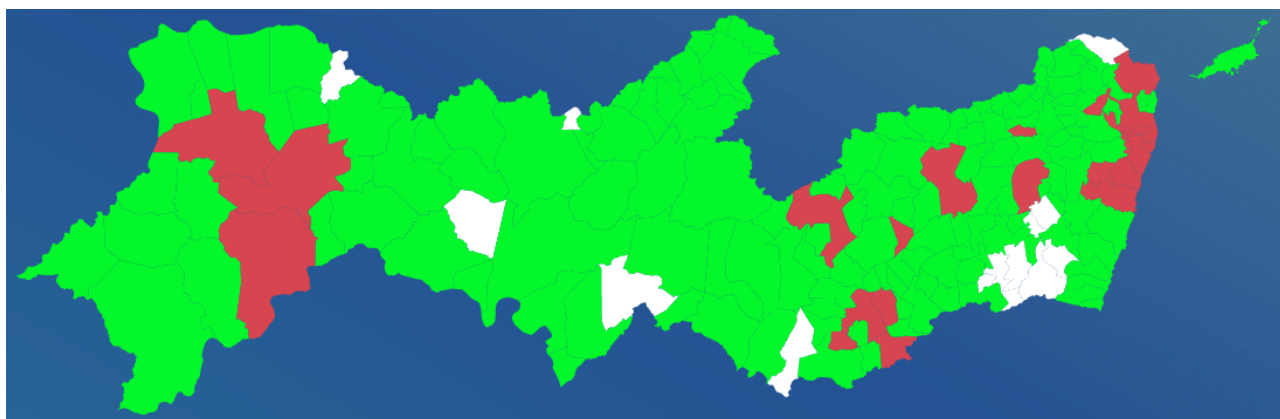
INpQ01 at treatment exit (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

Figure 12

INpQ01 in the distribution network (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

The analysis carried out was explained qualitatively in order to show its ease of interpretation, being subject to analysis by service users and main *stakeholders* of the management of the basic sanitation sector. It was possible to understand how the application of *business intelligence* techniques used in the evaluation and analysis of water quality is a useful tool, especially with regard to regulation by exposure, and not just a tool that would point out the problem and direct decision-making.

4 CONCLUSION

The model showed good results both to point out specific problems related to water quality and to more generalized problems, always related to the systemic formulation of the indicators.

The system of performance indicators for evaluating the quality of water for human consumption combined with *business intelligence* tools proved to be an interesting resource in the work developed by Arpe, allowing not only the evaluation of performance for decision making, but also offering instruments that allow a better dissemination of the indicators. The availability of a performance *paper* that allowed the user to print the data of the indicators by municipality, in an accessible way, was a positive aspect in favor of active transparency.

The mechanisms of regulation by exposure provided by the model presented in this work, favoring the dissemination of performance indicators to the user or managers of basic sanitation, direct the regulator's action towards effectiveness in monitoring the quality of the water offered to the population.

REFERENCES

- Agência de Regulação de Pernambuco. (2025). Dashboard de qualidade da água para consumo humano. <https://www.arpe.pe.gov.br/saneamento2/metas-e-indicadores-de-desempenho>
- Câmara Técnica de Saneamento (ABAR). (2017). Saneamento básico regulação 2017: Documento de referência. Atuação das agências reguladoras na fiscalização da qualidade da água.
- Ministério da Saúde. Gabinete do Ministro. (2017). Anexo XX da Portaria de Consolidação N° 05. https://bvsms.saude.gov.br/bvs/saudelegis/gm/2017/prc0005_03_10_2017.html#ANEXOXX
- Ogata, I. S. (2011). Avaliação de risco da qualidade da água potável do sistema de abastecimento da cidade de Campina Grande (PB) [Trabalho de conclusão de curso, Universidade Estadual da Paraíba]. Campina Grande, PB.
- Presidência da República. Casa Civil. (2007). Lei N° 11.445, de 5 de janeiro de 2007. Estabelece as diretrizes nacionais para o saneamento básico; altera as Leis nos 6.766, de 19 de dezembro de 1979, 8.036, de 11 de maio de 1990, 8.666, de 21 de junho de

1993, 8.987, de 13 de fevereiro de 1995; revoga a Lei no 6.528, de 11 de maio de 1978; e dá outras providências. https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/L11445compilado.htm

Rodrigues, A. B. (2014). Avaliação de risco da qualidade da água de abastecimento de um hospital público regional de urgência e emergência [Dissertação de mestrado, Universidade Federal de Campina Grande]. Campina Grande, PB.

HYBRID SOCIAL INSURANCE AS A COMPLEMENT TO THE BPC: PREVENTIVE PROTECTION AGAINST INFORMALITY-RELATED RISKS AND FAMILY VULNERABILITY

SEGURO SOCIAL HÍBRIDO COMO COMPLEMENTO AO BPC: PROTEÇÃO PREVENTIVA CONTRA RISCOS DE INFORMALIDADE E VULNERABILIDADE FAMILIAR

SEGURO SOCIAL HÍBRIDO COMO COMPLEMENTO AL BPC: PROTECCIÓN PREVENTIVA FRENTE A LOS RIESGOS DE INFORMALIDAD Y VULNERABILIDAD FAMILIAR



<https://doi.org/10.56238/sevened2026.008-027>

Ailton Ferreira Cavalcante¹, Gabriel Jorge Pradera²

ABSTRACT

This article examines the feasibility of a Hybrid Social Insurance scheme as a complementary mechanism to Brazil's Benefício de Prestação Continuada (BPC), aimed at providing preventive protection for low-income families facing premature death or work disability of the household provider, particularly in contexts of high informality. The analysis begins from the premise that the Brazilian social protection system remains predominantly reactive and ex post, activated only after social damage is consolidated, thereby reinforcing persistent poverty cycles and long-term welfare dependency. Drawing on literature review, legal-institutional analysis, and a synthesis of international experiences with micro-insurance and co-financed social schemes, the study proposes a conceptual design grounded on three pillars: (i) public-private co-financing, (ii) simple parametric triggers, and (iii) institutional integration with SUAS and BPC, avoiding benefit overlap. The paper argues that such a model can reduce intergenerational vulnerability, mitigate the socioeconomic effects of incapacity events, and simultaneously lower future fiscal pressure on social assistance by acting preventively. It concludes by outlining an applied research agenda, including actuarial modeling, distributive assessment, and governance evaluation, to support future empirical development in comparative settings and within Brazil.

Keywords: Social Protection. BPC. Informality. Hybrid Insurance. Public Policy. Preventive Welfare.

¹ Doctoral student in Public Administration. Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP). E-mail: prof.ailton@hotmail.com Orcid: <https://orcid.org/0009-0009-2386-1245> Lattes: <http://lattes.cnpq.br/0389434047626666>

² Doctoral student in Public Administration. Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP). E-mail: gabriel_pradera@hotmail.com Orcid: <https://orcid.org/0009-0008-7967-6826> Lattes: <http://lattes.cnpq.br/2088287037207127>

RESUMO

Este artigo discute a viabilidade de um Seguro Social Híbrido como mecanismo complementar ao Benefício de Prestação Continuada (BPC), orientado à proteção preventiva de famílias de baixa renda afetadas pela morte precoce ou incapacidade laboral do provedor, especialmente em contextos de alta informalidade. Parte-se do diagnóstico de que o modelo brasileiro de proteção social permanece fortemente reparador e ex post, acionado somente após a consolidação do dano social, produzindo ciclos de empobrecimento duradouro e dependência assistencial. A partir de revisão bibliográfica, análise normativa e sistematização de experiências internacionais de microseguros sociais e arranjos cofinanciados, o estudo propõe um desenho conceitual de seguro híbrido baseado em três pilares: (i) cofinanciamento público-privado, (ii) gatilhos paramétricos simples, e (iii) integração com o SUAS e o BPC, sem sobreposição de benefícios. Argumenta-se que o modelo possui potencial para reduzir vulnerabilidade intergeracional, mitigar impactos socioeconômicos de eventos incapacitantes e, simultaneamente, produzir economia futura para a assistência social, ao atuar antes da queda definitiva da renda. O artigo encerra apresentando uma agenda de pesquisa aplicada, incluindo modelagem atuarial, avaliação distributiva e análise de governança, que fundamenta o desenvolvimento posterior do tema em estudos empíricos comparados e no contexto brasileiro.

Palavras-chave: Proteção Social. BPC. Informalidade. Seguro Híbrido. Políticas Públicas. Prevenção Social.

RESUMEN

Este artículo analiza la viabilidad de un Seguro Social Híbrido como mecanismo complementario al Beneficio de Prestación Continuada (BPC), orientado a ofrecer protección preventiva a familias de bajos ingresos frente a la muerte precoz o incapacidad laboral del proveedor, especialmente en contextos de alta informalidad. Se parte del diagnóstico de que el sistema brasileño de protección social continúa siendo mayormente reparador y ex post, activándose sólo después de la consolidación del daño social, lo que genera ciclos persistentes de pobreza y dependencia asistencial. A partir de revisión bibliográfica, análisis normativo y sistematización de experiencias internacionales de microseguros y esquemas cofinanciados, el estudio propone un diseño conceptual basado en tres pilares: (i) cofinanciamento público-privado, (ii) disparadores paramétricos simples, y (iii) integración institucional con el SUAS y el BPC, evitando superposición de beneficios. Se sostiene que el modelo puede reducir la vulnerabilidad intergeneracional, mitigar impactos socioeconómicos de eventos incapacitantes y, al mismo tiempo, disminuir presiones futuras sobre la asistencia social al actuar preventivamente. El artículo concluye proponiendo una agenda de investigación aplicada, con modelación actuarial, evaluación distributiva y análisis de gobernanza, que servirá de base para desarrollos empíricos posteriores en Brasil y en perspectiva comparada.

Palabras clave: Protección Social. BPC. Informalidad. Seguro Híbrido. Política Pública. Prevención Social.

1 INTRODUCTION

Historically, Brazilian social protection operates with a predominance of post-event responses, that is, mechanisms that are activated only when the socioeconomic damage has already been consolidated. In the case of the Continuous Cash Benefit (BPC³), this characteristic becomes particularly visible: the benefit ensures minimum income to the elderly and people with disabilities in poverty, but only after the definitive rupture of the household's ability to sustain itself. Created under the 1988 Constitution and later regulated by the Organic Law of Social Assistance, the BPC represents a civilizational milestone; even so, it remains circumscribed to an essentially reparative model (BRASIL, 1988; BRAZIL, 1993). In a labor market marked by high informality and contributory fragility, the early death or incapacity of the provider quickly turns into an abrupt drop in well-being, with lasting impacts on the life cycle of families. As Barr (2020, p. 41) states, *"welfare systems that act only after the catastrophe tend to spend more and protect less"*.

The economic literature on poverty and vulnerability confirms that unexpected income shocks, especially those associated with health events, disability, or death, amplify inequalities and produce persistent intergenerational effects. Banerjee and Duflo (2019, p. 112) note that "poor households rarely have formal instruments to mitigate risks, so a single negative event can permanently reset their income trajectory." In Brazil, where a large part of the active population moves between precarious occupations and irregular contributions, the absence of preventive protection instruments becomes an involuntary stimulus to judicialization and prolonged care dependence. Studies on the phenomenon indicate that the expansion of lawsuits has functioned as a substitute mechanism for insufficient institutional design, straining the public budget and producing uncoordinated decisions (BARROSO, 2012; VIANNA et al., 2020).

In recent years, international experiences of social microinsurance and co-financed parametric arrangements have begun to explore solutions that act before the financial collapse of families. These models combine operational simplicity, risk sharing, and a focus on high-probability events and strong distributional impact. Churchill (2007) demonstrates that structured microinsurance for vulnerable populations reduces catastrophic losses and increases resilience. In a convergent way, Dercon (2022) argues that systems that articulate

³ The Continuous Cash Benefit (BPC) is a monthly transfer of a minimum wage for elderly people aged 65 or over and for people with disabilities who prove inability to provide for their own maintenance and per capita family income below the legal limit. It is a benefit of an assistance nature, not contributory, provided for in article 203, V, of the Federal Constitution and regulated by the Organic Law of Social Assistance (Law No. 8,742/1993). Unlike social security benefits, the BPC does not generate a 13th salary or pension, and does not require prior contributions, fulfilling the function of guaranteeing a minimum floor of dignity to populations in situations of extreme vulnerability.

insurance and social protection tend to stabilize productive trajectories. Fiszbein and Schady (2009) show that programs that "anticipate" protection can reduce future costs for the State and mitigate significant human losses. Even so, the Brazilian debate remains focused on incremental reforms of the existing apparatus, with limited attention to instruments that combine insurance, assistance and prevention.

This article proposes to discuss the feasibility of a Hybrid Social Insurance as a complement to the BPC, aimed at protecting low-income households in the face of early death or incapacity to work of the provider, especially in informal contexts. The central hypothesis is that a mechanism structured on three axes, public-private cofinancing, clear parametric triggers, and institutional integration with the Unified Social Assistance System (SUAS),⁴ without overlapping with the BPC, can cushion income shocks, reduce intergenerational effects of impoverishment, and, in parallel, alleviate future pressures on permanent assistance programs. In terms of public savings, it is about shifting part of spending from an essentially restorative logic to a protective investment strategy, in which "prevention is both cheaper and fairer" (ATKINSON, 2019, p. 67). The SUAS, designed to organize social assistance protection in a decentralized and articulated way, offers precisely the institutional environment for this transition (SILVA; YAZBEK; GIOVANNI, 2020).

The argument also dialogues with a perspective of preventive governance, close to what Cavalcante (2024) calls the GIS Cycle, in which state action moves from reactive responses to arrangements that combine governance, innovation, and sustainability as a structuring axis of public policies. Instead of creating a new substitute benefit, hybrid insurance is conceived as an intermediate layer, capable of acting between the risk event and the definitive drop in income, preserving family autonomy and reducing future social costs.

The reflection develops in three movements. Initially, a critical reading of the limits of the Brazilian model of predominantly ex post protection is presented. Then, international evidence on social insurance, parametric mechanisms, and hybrid arrangements is systematized. Finally, a conceptual design for hybrid social insurance is outlined, with economic, legal and institutional foundations, accompanied by an applied research agenda aimed at the empirical testing of the model. The objective is not to offer a conclusive solution,

⁴ The Unified Social Assistance System (SUAS) is the public policy responsible for the organization, at the national level, of social assistance actions in Brazil. Established in 2005, the SUAS establishes a decentralized and participatory model, in which the Union, states and municipalities share responsibilities for financing, management and provision of services. Its network includes equipment such as the Social Assistance Reference Centers (CRAS) and the Specialized Social Assistance Reference Centers (CREAS), aimed at family monitoring, risk prevention and social protection. Unlike policies focused only on cash transfers, SUAS combines income, services, and continuous monitoring, seeking to strengthen community bonds and reduce vulnerabilities in a structured way.

but to contribute to a necessary debate on how to incorporate the logic of economic prevention into the core of Brazilian social security.

Table 1 reinforces this diagnosis by showing the significant expansion of the BPC in a scenario of persistent informality. Between 2004 and 2025, the monthly amount transferred multiplied more than twentyfold, while the informality rate remained high. These data indicate that the current model absorbs social shocks without having structured preventive mechanisms, which concentrates efforts on the reparative phase and increases future costs. Thus, the Hybrid Social Security is presented as an incremental alternative that acts before the definitive drop in income, protecting family trajectories and preserving the function of the BPC as a policy of last resort.

In fact, data from VIS Data (Ministry of Citizenship) show the exponential growth of the BPC between 2004 and 2025, with monthly amounts transferred jumping from R\$ 0.41 billion to R\$ 9.86 billion (Sep/2025), reflecting the expansion of demand in a context of persistent informality (38-42% of the workforce, PNAD/IBGE).

Table 1

Evolution of the BPC and context of informality (2004-2025)

Period	Total monthly value (R\$ billion)	Beneficiaries (millions, approx.)	National informality rate
2004	0,41	0,8	~45% IPEA
2010	1,73	2,2	42% ftp.ibge
2015	3,33	4,0	40% IPEA
2020	4,87	5,7	39% agenciabrasil.ebc
2025	9.86 (Sep)	7.6 (+33% since 2020)	38% CNNB+1

Source: VIS Data 3 beta (MDS); Continuous PNAD (IBGE).

These numbers show how the BPC's reparative model absorbs informality shocks without preventive mechanisms, with greater weight in the North/Northeast regions (rates >50%) where concessions for disability and judicialization grow faster. Such dynamics reinforce the need for an intermediate layer, such as the proposed Hybrid Social Security, to act before the definitive drop in family income.

2 THEORETICAL FRAMEWORK

The discussion that follows is not just an inventory of authors and concepts. It is a journey that invites the reader to revisit social protection from a little-explored lens: the lens of risk before collapse.

The theoretical framework opens this path in layers. It begins by examining how poverty and vulnerability cease to be isolated events and become trajectories, shaped by shocks that the state often faces too late.

Then, it illuminates the place of the BPC and the SUAS, civilizing achievements, but still stuck in an essentially reparative temporality. The text then moves to international experiences of microinsurance and parametric mechanisms, revealing that other societies have been experimenting with preventive responses, combining insurance, co-financing and operational simplicity.

Later on, the tensions between judicialization, institutional design and governance emerge, showing how architectural failures end up converting social demands into permanent litigation.

The end of this trajectory resumes the dimension of rights and citizenship, asking what it means to protect fairly in a context of fiscal restrictions and persistent inequalities.

By integrating these strands, the framework prepares the ground for the next step of the article: the presentation of a Hybrid Social Security model, thought not as a rupture, but as an evolution, a preventive layer capable of dialoguing with the BPC, preserving family trajectories and inaugurating a new level of protection in the country.

Dear reader, we invite you to go ahead and observe how these ideas take shape into a concrete proposal, capable of being tested, evaluated and applied, not only promising, but practicable.

2.1 SOCIAL PROTECTION, POVERTY AND RISK

The contemporary discussion on social protection shifts the exclusive focus from cash transfer to intelligent risk management throughout the life cycle. In different welfare traditions, the crucial point lies less in the size of state spending and more in the institutional capacity to prevent predictable shocks, illness, disability, unemployment, and early death, from pushing families into permanent trajectories of vulnerability. Esping-Andersen (1990) already indicated that mature protection systems are able to decommodify these risks, removing them from the individual sphere and distributing them collectively. Recent literature reinforces this intuition: when policies combine social insurance, assistance networks, and redistributive instruments, simultaneous gains in macroeconomic stability and reduction of inequalities are observed (DERCON, 2022).

In the field of development economics, the debate has gained sophistication by relating adverse shocks to defensive decisions that shape the future of families. Banerjee and Duflo (2019) show that, without formal risk mitigation instruments, poor households tend to adopt conservative strategies, reducing productive investments, selling assets, and retracting essential consumption, which deepen poverty in the long run. These are what some authors

see as vulnerability traps: one-off events, when not cushioned, permanently reconfigure the possibilities of income and mobility.

Structural informality intensifies this process. Segmented labour markets, fragile contracts and irregular contributions reduce the reach of pension systems and create grey areas between contributory protection and social assistance. Perry et al. (2007) demonstrate that economies with high informality coexist with greater income volatility and lower insurance coverage, a situation that is reproduced in a remarkable way in Brazil. The absence of preventive mechanisms causes predictable risks to become *ex post* demands to the State, often through judicialization, with increasing fiscal costs and low institutional coordination.

The international literature has responded to this dilemma with renewed emphasis on the notion of preventive social protection. Barr (2020) argues that models based solely on remediation overestimate their own efficiency as they ignore the cumulative cost of unmanaged risk. In a similar perspective, studies on agricultural insurance, microlife insurance and parametric mechanisms reveal that the anticipation of public support produces relevant distributive effects, while avoiding the irreversible degradation of family assets. What emerges is an agenda that does not replace assistance policies, but repositions them within a broader risk management arrangement.

This theoretical movement offers a promising reading key for countries that, like Brazil, have built robust instruments of protection after the damage, but have not yet consolidated an institutional layer between risk and collapse of income. The reflection proposed in this article is inserted exactly at this inflection point: to explore how hybrid mechanisms, combining insurance, co-financing and integration with the social assistance network, can inaugurate a preventive level capable of reducing future vulnerabilities without giving up the universalist character of social protection.

2.2 THE BPC, THE SUAS AND THE LIMITS OF A PREDOMINANTLY REPAIRING MODEL

The Continuous Cash Benefit has consolidated itself as one of the most expressive pillars of Brazilian social security. By guaranteeing basic income to elderly people and people with disabilities in poverty, the BPC materializes the constitutional principle of human dignity and makes explicit the State's commitment to the protection of historically excluded groups (BRASIL, 1988; BRAZIL, 1993).

It is a subjective, non-contributory right, which operates as a last resort in the face of the exhaustion of other forms of support. This characteristic gives the program great social legitimacy, but it also reveals its place within an arrangement that acts, above all, when vulnerability has already become chronic.

The institutionalization of the Unified Social Assistance System (SUAS) reorganized the assistance policy around principles of territoriality, decentralization and federative coordination. With the creation of standardized flows of services, family monitoring and intersectoral articulation, the SUAS reduced the historical fragmentation of the sector and expanded its response capacity (SILVA; YAZBEK; GIOVANNI, 2020).

Even so, most of the lawsuits continue to be triggered after the risk occurs: death of the provider, prolonged work incapacity or permanent loss of income. The institutional design, while protecting, comes too late to prevent the deterioration of family trajectories.

The specialized literature recognizes this dilemma. Research on the dynamics of the BPC shows that its reparative function is indispensable, but its temporality produces long-term effects that are difficult to reverse. Once included in a permanent benefit, many families find reduced incentives and objective conditions to regain autonomy, especially in territories where informality dominates job opportunities (PAIVA; JACCOUD; MESQUITA, 2022).

This process does not stem from individual choices, but from an architecture that offers protection only after collapse, when the alternatives have already been consumed.

Another phenomenon associated with the *ex post nature* of the model is the expansion of judicialization. Individual demands come to the courts seeking to repair coverage gaps, make income criteria more flexible, or anticipate administrative decisions.

Barroso (2012) observes that the Judiciary, in these situations, acts as a substitute channel for poorly balanced public policies, producing fragmented solutions, often disconnected from medium-term strategies. Vianna et al. (2020) add that this dynamic redistributes resources without planning and puts pressure on local budgets, while weakening federative coordination of care.

The tension between the guarantee of rights and distributive rationality becomes even more evident in scenarios of high informality. Families that move between precarious occupations or without a contributory link find limits in social security protections and, when they suffer a shock, death or incapacity of the provider, they end up entering directly into the care route.

What could be a temporary phase often becomes a permanent condition. Barr (2020) suggests that systems that operate in this way not only respond late, but create an "institutionalized dependence on misfortune."

It is not, however, a matter of reducing the role of the BPC or the SUAS. What the literature points to is the need to recompose the temporality of protection. Instead of concentrating resources only in the final phase of the vulnerability cycle, public policies can

intervene before the definitive drop in income, preventing families from entering permanent benefits without preventive mechanisms having been activated.

In this sense, parametric instruments, low-cost social insurance, and co-financing arrangements open up a promising field of complementarity: the BPC preserves its civilizing function, while a preventive layer reduces the probability of its judicialization and unnecessary prolongation.

The debate on institutional innovation converges, at this point, with reflections on governance. Models that articulate prevention, federative coordination and fiscal sustainability are close to approaches that understand public policy as a continuous cycle of learning and adaptation. By integrating assistance protection with preventive instruments, the State ceases to act only in the face of disaster and begins to organize capacities to anticipate its effects. This interpretative key helps to understand the relevance of discussing hybrid mechanisms as a complement, and not a replacement, of the existing arrangement.

2.3 MICROINSURANCE, PARAMETRIC MECHANISMS AND CO-FINANCING: INTERNATIONAL LESSONS FOR SOCIAL PREVENTION

The search for instruments capable of cushioning shocks before they become social crises has led several countries to experiment with microinsurance formats and parametric arrangements aimed at low-income populations. These mechanisms are based on a simple principle: when the risk is predictable and recurrent, protection can be designed with clear rules, reduced costs, and automatic activation, avoiding bureaucracies that slow down the response and financially disorganize families.

In the field of microinsurance, Churchill (2007) shows that products adapted to the irregular income profile, with affordable premiums, standardized coverage and contractual transparency, increase the capacity for resilience without imposing requirements that are incompatible with the reality of informality.

Experiences in Asian and African countries indicate that the combination of small premiums and objective triggers reduces exposure to catastrophic losses, preserving productive assets that, in traditional contexts, would be liquidated to face emergencies.

Parametric mechanisms deepen this logic. Instead of requiring extensive evidence, the benefit is activated when an event verifiable by public record occurs, for example, a death certificate or standardized medical report. This characteristic reduces administrative costs, reduces room for disputes and increases fiscal predictability. Dercon (2022) observes that, when well calibrated, these instruments operate as "bridges" between insurance and social policy, introducing risk rationality where improvisation has historically predominated.

A decisive element for the viability of these models is public-private co-financing. The participation of the State makes it possible to equalize risks, reduce premiums and direct protection to groups with greater vulnerability, maintaining actuarial sustainability. Fiszbein and Schady (2009) point out that, by sharing costs with households and private operators, governments are able to build more progressive policies, without fully shifting the burden to budgets that are already under pressure. This type of arrangement does not replace social assistance; rather, it creates an intermediate layer that prevents the escalation of permanent demands.

Although promising, these experiences arouse debates. There are questions about possible regressive effects if co-financing is not calibrated, risks of adverse selection and regulatory dilemmas in underdeveloped markets. Barr (2020) reminds us that poorly designed insurance can transfer public responsibilities to individuals without the ability to contribute.

For this reason, successful initiatives often incorporate cross-subsidy mechanisms, strong regulation, and explicit integration with existing social protection systems.

The most relevant point for the Brazilian debate lies not only in the replication of foreign models, but in the institutional translation of these lessons. Countries that have advanced in the adoption of microinsurance and parametric instruments have combined financial innovation with governance arrangements capable of monitoring impacts, reviewing parameters, and articulating different levels of government.

This capacity for continuous learning suggests a promising path: to build preventive instruments that dialogue with institutions that are already consolidated, especially SUAS and BPC, and that operate in a transparent, progressive and fiscally responsible manner.

The literature, by converging on this point, opens space for proposals that situate preventive protection as an organic part of social security and not as a marginal appendix. It is in this terrain that the discussion about a Hybrid Social Security is inserted, designed to absorb predictable shocks before they turn into permanent crises, preserving rights and reinforcing the sustainability of the system as a whole.

2.4 JUDICIALIZATION, INSTITUTIONAL DESIGN AND PREVENTIVE GOVERNANCE

The contemporary debate on social protection in Brazil cannot be understood without considering the phenomenon of the judicialization of public policies. The expansion of access to justice and the centrality of fundamental rights have produced a scenario in which individual and collective demands come to define, in everyday life, the materialization of social benefits.

Barroso (2017) observes that the Judiciary has been called upon to act as an instance of correction of administrative failures, suppressing omissions and imposing benefits in health, social security and social assistance. This movement reveals democratic vitality, but it also exposes institutional tensions: one-off decisions, even if legitimate, can generate diffuse fiscal effects and change policy priorities without prior planning.

In the field of BPC, judicialization has become especially visible. Changes in criteria, revisions of per capita income and reinterpretations of the concept of disability have been frequently discussed in court, with direct impacts on the management of the benefit (COSTA; FERRAZ, 2020).

The heterogeneity of decisions contributes to administrative uncertainties and affects budget predictability, while revealing coverage gaps that the system itself has not been able to address. When low-income families seek the Judiciary as the only way to access, the problem is no longer just legal; it becomes a sign of an institutional arrangement that reacts belatedly to social risks.

The literature on institutional design offers important clues to address this dynamic. Pierson (2000) indicates that institutions produce "trajectory effects": past choices condition future solutions and generate inertia that are difficult to break.

In the Brazilian case, the social security-assistance-health tripod has been consolidated with relatively watertight borders, making intermediate prevention strategies difficult. In times of crisis, the response tends to be reactive, shifting the problem to the Judiciary or increasing spending on permanent benefits, without mechanisms that absorb the shock at the source.

It is at this point that the idea of preventive governance arises. Rather than focusing efforts solely on repairing harm, public policies can be structured to reduce the likelihood that foreseeable events will turn into lawsuits or long-term care dependence. Organization for Economic Cooperation and Development (OECD, 2021) points out that preventive arrangements generate cumulative positive effects: they minimize future costs, preserve family autonomy, and reduce disputes between powers. The challenge is to create instruments that work with clear rules, transparent parameters and the ability to monitor continuously.

International experience with parametric social insurance and microinsurance shows that when benefit activation depends on objective triggers, such as death registration or standardized proof of disability, the margin for judicialization tends to fall, as the criteria leave less room for divergent interpretations (DERCON, 2022). At the same time, co-financing mechanisms allow the State to direct subsidies to groups with greater vulnerability, preserving

progressivity and preventing coverage from being captured by segments with greater power of articulation (FISZBEIN; SCHADY, 2009).

In Brazil, the articulation between SUAS, BPC and preventive instruments can represent an institutional advance. Social assistance has capillarity, registrations and experience in family monitoring; however, it lacks a financial mechanism capable of acting before the rupture of income. The construction of a hybrid model, regulated by the government and monitored by social risk indicators, would reduce the flow of lawsuits and, simultaneously, protect family trajectories in situations of early death or work incapacity.

As Barr (2020) reminds us, effective social insurance does not transfer responsibilities to the individual; reorganize, in a rational way, the sharing of risks that already fall on the State.

The dialogue between judicialization and preventive governance does not imply diminishing rights. It is about strengthening them through more predictable, transparent instruments aligned with fiscal capacity. When policies are planned based on evidence and structured to act in advance, the Judiciary starts to act as a guardian of guarantees, not as a day-to-day manager of distributive choices.

The institutional innovation agenda, in this sense, involves the construction of mechanisms that integrate social protection, actuarial calculation, and distributive justice, making room for proposals such as Hybrid Social Security as an intelligent complement to the BPC.

2.5 RIGHTS, CITIZENSHIP AND DISTRIBUTIONAL EFFECTS OF SOCIAL PROTECTION

The historical construction of social security has always been linked to the idea of substantive citizenship. More than ensuring a minimum income, protective policies define standards of belonging, organize social expectations and delimit, in practice, what it means to live with dignity in a given country. Marshall (1967) already pointed out that social rights complete the arc of evolution of citizenship, by reducing vulnerabilities incompatible with a democratic order.

In Brazil, this perspective was explicitly incorporated by the 1988 Constitution, which enshrined security as an integrated system of protection, guided by universality and solidarity.

The instruments of income transfer and guarantee of benefits work, in this horizon, as pillars of inclusion. Accumulating evidence shows that well-targeted programs contribute to reducing immediate poverty, stabilizing consumption, and creating minimum conditions for families to remain connected to essential public services (SOARES et al., 2010).

The distributive dimension, however, is not limited to short-term results: consistent policies shape trajectories, affect school expectations, change work decisions, and influence patterns of social mobility over time (CECCHINI; MADARIAGA, 2011).

Despite the advances, dilemmas persist. Benefits designed to act as residual protection end up receiving structural demands that go beyond their original design. In the case of the BPC, tensions between coverage, eligibility criteria and budgetary sustainability emerge precisely when the benefit starts to make up for previous failures in the protection system (COSTA; FERRAZ, 2020).

The absence of preventive instruments contributes to predictable shocks, death of the provider, abrupt disability, involuntary loss of income being absorbed later in the form of permanent benefits. The result is a reactive expansion, often judicialized, which combines increased costs with inequalities of access.

The international literature offers a relevant counterpoint. Comparative studies indicate that arrangements capable of integrating social insurance, assistance, and active policies tend to produce more balanced distributional effects, by combining immediate protection with incentives to rebuild family trajectories (BARR, 2020).

When preventive instruments are articulated with networks of territorial services, gradual responses become possible, proportionally adjusted to the risk, avoiding both omission and hyper-judicialization. The focus shifts from late repair to early capacity preservation.

This debate is close to the notion of public value. The expansion of social rights must be analyzed not only by the amount of resources transferred, but by its capacity to produce economic security, reduce uncertainties and strengthen citizenship bonds.

The United Nations has emphasized that social policies with integrated design generate positive externalities in health, education, and community participation, expanding the social return on investments (UNDP, 2019). At the same time, the predictability of institutional arrangements reduces distributive conflicts and increases the population's trust in institutions.

In Brazil, the contemporary challenge is to deepen this citizenship agenda without losing sight of fiscal limits and evidence on effectiveness. In this context, a Hybrid Social Security does not present itself as a substitute for the BPC or other consolidated benefits; emerges as a strategic complement, aimed at preventing transitory vulnerabilities from becoming permanent dependence.

By sharing risks between the State, families and regulated operators, space is opened for a progressive model, capable of protecting the poorest and, at the same time, reducing the flow of demands that chronically pressure care.

The convergence between rights, citizenship, and institutional innovation suggests that the next frontier of social protection is not only in expanding benefits, but in redesigning mechanisms that preserve trajectories before rupture. This is the inflection point at which the academic debate finds the practical formulation: to build instruments that honor the constitutional pact of 1988, while introducing rationality of risk, transparency, and sustainability. It is in this horizon that the proposal discussed in the following sections is inscribed.

3 THE PROPOSED MODEL: HYBRID SOCIAL INSURANCE

The proposal of Hybrid Social Security is based on a simple and, at the same time, structural finding: in societies marked by high informality, the early death or incapacity to work of the provider do not constitute exceptional accidents, but predictable risks, with the potential to permanently disorganize the economic life of families.

When the State intervenes only after the damage has been consolidated, the social cost rises and the horizon for recovery becomes extremely restricted. The model discussed here seeks to occupy precisely this critical interval between the risk event and the collapse of income, introducing a preventive layer capable of cushioning the initial impact and preserving family trajectories.

The guiding principle of Hybrid Social Security is to shift part of the state's effort from reparation to prevention, without reducing rights or replacing the Continuous Cash Benefit.

The idea is not to reformulate the BPC, but to put an intermediate protective phase before it, designed to act quickly, objectively and progressively. By protecting before the definitive fall, the State prevents transitory vulnerabilities from becoming permanent, while reducing future pressure on long-term care benefits.

It is a distributive logic that remains faithful to social justice: the greater the risk and the lower the ability to contribute, the greater the public participation in the financing of the mechanism.

From an institutional point of view, insurance is not born as an isolated program. It is anchored in the Unified Social Assistance System, which offers territorial capillarity, registration instruments, monitoring and articulation between services.

The SUAS assumes the role of gateway and monitoring, while the BPC remains as protection of last resort. In this way, a staggered circuit of protection is formed: first the

preventive response; then, only when necessary, the permanent care guarantee. This architecture reduces overlaps, avoids duplication, and creates a more rational flow between prevention and repair.

The priority public of the insurance is composed of low-income families whose main source of subsistence is linked to informal or contributory occupations. Eligibility rests on three cumulative criteria: reduced income, dependence on a provider exposed to informality, and absence of private or contributory mechanisms capable of mitigating risk. The cut is not exclusive; it is a guide. It directs policy exactly to the space where weaknesses are most acute and where preventive intervention generates greater social return.

The activation of the benefit occurs through objective parametric triggers, a decisive element for the credibility of the model. The insurance is activated in the face of verifiable events, registered death of the provider or prolonged work incapacity proven by a standardized report, reducing margins of arbitrariness, interpretative disputes and litigation. Once the event is recognized, financial support is released quickly, with defined deadlines and continuous monitoring.

The benefit has a temporary and partial substitutive nature. It does not intend to fully replicate the lost income, but to stabilize the family budget in the critical period that follows the adverse event. This protection avoids the hasty sale of assets, the disruption of educational projects, and highly regressive indebtedness.

Its duration, defined by risk ranges and periodically reviewed, allows families to reorganize work strategies while receiving support from the SUAS to rebuild their sources of income.

The "hybrid" characteristic of the model lies in the logic of financing. The State assumes a majority role, ensuring progressivity and inclusion, but makes room for symbolic contributions from families, proportional to income and for the eventual participation of regulated operators, when technically recommended. The objective is not to commodify social protection, but to share risks in a calibrated manner, expanding the sustainability of the mechanism without transferring the burden to those who cannot bear it.

An essential aspect of the design is the relationship with the BPC. Receiving Hybrid Social Security does not automatically entitle you to the permanent benefit. Once the protective period ends, the domicile is reassessed.

If the income remains below the legal parameters, the BPC fulfills its constitutional function. If there is recomposition, the protective cycle closes without the need for migration to permanent forms of assistance. This avoids regressive incentives, overlapping benefits and unnecessary judicialization.

To ensure transparency and institutional learning, the model incorporates governance mechanisms: public indicators, periodic audits, actuarial adjustments, and continuous distributive evaluation. The design does not present itself as a definitive solution, but as a policy in motion, capable of being reviewed in the light of evidence and results. By structuring clear rules, stable criteria, and systematic monitoring, insurance increases the predictability of the system and strengthens social trust in institutions.

In summary, Hybrid Social Security operates as a bridge between risk and collapse, preventing sudden falls and sparing the system from late and costly responses. He keeps the BPC as the last barrier, but prevents it from being activated before the time.

The model preserves rights, protects earlier and uses public resources better. At the same time, it inaugurates a way of thinking about social protection that combines fiscal prudence, risk rationality and ethical commitment to the dignity of families in vulnerable situations.

Figure 1

Hybrid Social Security



Source: prepared by the author

Figure 1 represents Hybrid Social Security as a protective bridge between the risk event and the definitive collapse of family income. On the left side is the verifiable risk, death or prolonged disability of the provider, triggered by clear parametric triggers. On the right side, there is the collapse of income, a situation in which the family loses the ability to support itself autonomously, and may come to depend on permanent assistance benefits, such as the BPC, which appears to be symbolized as a barrier of last resort.

The arch that sustains the crossing corresponds to the Hybrid Social Insurance: temporary, preventive and progressive protection, aimed at stabilizing the family budget and allowing time to reorganize work and income strategies. It acts before the definitive fall, cushioning the impact of the event and reducing the likelihood of permanent dependence.

The institutional basis of this crossing is the Unified Social Assistance System, indicated on the sides of the figure as a gateway and accompaniment. SUAS identifies eligible families, monitors the situation and ensures continuity of support, integrating social assistance services with the insurance mechanism. In this way, the image translates the central logic of the model: to protect early, with objective criteria, preventing transitory vulnerabilities from becoming irreversible situations.

3.1 DATABASE, VARIABLES AND ANALYTICAL STRATEGIES

The evaluation of preventive policies such as Hybrid Social Security benefits from the use of international bases that allow the observation of comparable trajectories of social protection over time. Experiences accumulated by multilateral organizations, such as the World Bank, ILO, UNDP, ECLAC, and WHO, offer standardized historical series on poverty, inequality, health, fiscal effort, and protective coverage, constituting a privileged environment for comparative analyses (WORLD BANK, 2020; ILO, 2022; ECLAC, 2023).

In studies of this nature, it is customary to organize the set of indicators into three groups:

- (1) outcome variables, associated with poverty, inequality, and intergenerational protection;
- (2) explanatory variables related to the existence or intensity of hybrid protection mechanisms;
- (3) control variables that capture macroeconomic and demographic factors capable of influencing the observed results (BARR, 2020).

The literature has shown that panel data models are a particularly appropriate strategy to capture distributional dynamics in social policies, since they allow combining temporal variations and differences between countries. Tests such as Hausman's and difference-in-difference approaches appear, in this field, as recurrent instruments for distinguishing structural effects from specific shocks (ANGRIST; PISCHKE, 2014). In general, robust studies complement these techniques with sensitivity checks, gradual inclusion of controls, and procedures to mitigate endogeneity problems.

Although this article is predominantly conceptual in nature, the proposed model was structured in such a way as to allow future empirical validation. To this end, it is possible to organize an evaluation agenda based on international data, articulating distributive, fiscal and institutional indicators. Table 2 summarizes variables, sources, econometric techniques and testable hypotheses associated with Hybrid Social Insurance.

Table 2

Methodological Aspects

Dimension	Key variables	Suggested source	Possible technique	Testable hypothesis
Poverty and vulnerability	Poverty rate; extreme poverty; Multidimensional deprivation	World Bank (WDI); UNDP	Panel data (fixed/random effects)	Countries with hybrid mechanisms show lower poverty growth after shocks
Inequality	Gini coefficient; income of the poorest 10%	World Bank; ECLAC	Dashboard + macroeconomic controls	Hybrid mechanisms are associated with a lower increase in inequality
Intergenerational protection	Life expectancy; school dropout; child labor	WHO; UNESCO; UNDP	Differences-in-differences (when there are staggered reforms)	Preventive policies reduce family breakdowns after a risk event
Care dependence	Permanent benefits per capita; BPC / Analogue Coverage	ILO; National bases	Panel with lags	Preventive damping reduces future entry into residual benefits
Tax	Social spending; judicialization; Per capita cost of protection	OECD; National ministries	Elasticity models	Prevention tends to reduce accumulated costs in the medium term
Institutional	Average concession time; litigation; Transparency	ILO; National reports	Qualitative comparative analysis	Parametric criteria reduce disputes and decision-making uncertainty

Source: prepared by the authors

The table above shows that the Hybrid Social Security is not restricted to normative formulation: it admits objective measurement. Each proposed dimension articulates observable variables, available in consolidated databases, and econometric techniques widely used in the literature. The logic is cumulative: comparative estimates allow for the identification of trends, while difference-in-difference analyses explore reforms introduced at different times. By structuring this evaluation agenda, the article demonstrates that the proposal can be gradually converted into an empirical research program, with potential for external validation and academic replicability.

More than describing a closed protocol, the set of these tools indicates a promising analytical path to investigate preventive and parametric policies. He suggests that Hybrid Social Security can be evaluated in a comparative perspective, articulating quantitative

evidence and institutional reflection. This agenda is not exhausted in this article; on the contrary, it opens space for future research capable of deepening estimates, testing hypotheses and exploring distributional developments with greater precision.

3.2 OPERATIONAL FEASIBILITY, RISKS AND INSTITUTIONAL SECURITY OF THE MODEL

Although conceived as a normative proposal, the Hybrid Social Security requires minimum operating parameters for its rationality to become verifiable. From an operational point of view, its eligibility is aimed at low-income families with a strong dependence on informal work, identified through social assistance records and validated by objective administrative procedures. The trigger for granting arises from the death or prolonged disability of the provider, certified by a medical report and periodic reassessments, which reduces discretionary margins and territorial inequalities of access.

The magnitude of the benefit does not seek to fully replace the lost income, but to stabilize the family budget during the critical period. Working with parameterized ranges allows for progressive calibration and fiscal compatibility, preserving the temporary and preventive nature of the mechanism. In this logic, the policy operates with a programmed budget ceiling and solidarity financing: majority federal participation, gradual contributions from subnational entities and symbolic family co-participation, exempt in cases of extreme poverty. The SUAS assumes the role of gateway and monitoring, while the federal coordination centralizes payments, regulation and auditing, with technical support from the INSS for expert validation and interoperability of systems.

Defining these contours does not eliminate dilemmas and trade-offs, which need to be recognized as part of the design itself. There is a risk of regressivity if subsidies are concentrated on less vulnerable groups; Therefore, territorial prioritization and transparency of criteria become essential safeguards.

There is also the classic problem of adverse selection, when families with a higher probability of triggering adhere disproportionately. Symbolic co-participation mechanisms, incentives for broad adherence, and automatic entry parameters for prioritized groups constitute mitigation strategies.

The federative dimension, in turn, opens space for inequalities in implementation; National minimum standards and differentiated technical-financial support to municipalities with less administrative capacity reduce this risk without sacrificing decentralized logic.

These aspects dialogue directly with the issue of judicialization. In contexts of normative uncertainty, individual claims tend to be resolved by the Judiciary, with

unpredictable financial impacts. The comparative literature shows that structured policies with clear parametric triggers, administrative review instances and universal access rules tend to reduce litigation and transfer the distributive debate to more institutional and collective spaces. In the Brazilian case, the predictability conferred by *ex ante* criteria can reduce casuistic disputes, without suppressing the right of access to justice, and strengthen the budgetary governance of social security.

In conclusion, the viability of Hybrid Social Security lies less in its administrative complexity and more in the coherence between rules, incentives and safeguards. By explaining how the model can operate, what risks it involves and which institutional instruments can mitigate them, the proposal gains practical density without losing its innovative character. It is thus presented as a plausible, adjustable preventive instrument that can be continuously evaluated, an indispensable condition for any public policy aimed at the sustainable reduction of vulnerabilities.

In the Brazilian federative arrangement, the effectiveness of Hybrid Social Security depends less on the centralization of functions and more on the clear coordination of roles. The Union is responsible for regulation, majority financing, definition of minimum standards and auditing; to the municipalities, the gateway, family monitoring and articulation with the SUAS; to the states, technical support functions, cooperative supervision and regional integration. The accumulated experience of the SUAS demonstrates that combinations of mandatory national standards, federative equalization funds and permanent cooperation agreements reduce territorial inequalities without compromising local autonomy. The proposed model follows this incremental logic, anchoring institutional innovation in existing capabilities.

3.3 EXPLORATORY EMPIRICAL ANALYSIS: THE PREVENTIVE SPACE OF HYBRID INSURANCE

To illustrate the gap that Hybrid Social Security would occupy, we performed an exploratory analysis with public data from VIS Data (MDS, 2025) and Continuous PNAD (IBGE, 2023), crossing BPC concessions by municipality with informality rates.

3.3.1 Initial testable hypothesis

H1: In municipalities with informality >45% (top quartile), the average time between death/disability and granting of BPC exceeds 6 months, configuring a window for preventive intervention.

For illustrative purposes, it is considered a minimum methodological design capable of exploring preliminary relationships between informality, judicialization and BPC concession standards. The hypothetical sample would include two groups of municipalities: one hundred with the highest level of informality (upper quartile, according to the PNAD) and one hundred with the lowest informality (lower quartile), forming a comparison group. The observation period would cover the interval from 2020 to 2025, allowing to capture effects in the post-pandemic period. The variables of interest would include: average time of granting the BPC, extracted from administrative databases (VIS Data); municipal informality rate (PNAD); and proportion of concessions resulting from judicial decisions. The analysis could be conducted using a simplified differences-in-differences model, estimating the relative variation between municipalities with high and low informality before and after 2022. The objective is not to produce definitive conclusions, but to indicate how the phenomenon can be measured in a systematic way in future studies. The following is the minimum methodological design⁵:

Figure 2

1. Sample: 100 municipalities in the upper quartile of informality (PNAD)
vs. 100 of the bottom quartile (control)
2. Period: Jan/2020 - Sep/2025 (post-pandemic)
3. Variables:
 - BPC Concession Time (VIS Data)
 - Municipal informality rate (PNAD)
 - % judicial concessions (VIS Data)
4. Model: Differences-in-differences simplified⁶

$$Y_{it} = \beta_0 + \beta_1(AltInformal_{it}) + \beta_2(Pós2022_{it}) + \beta_3(AltInformal_{it} \times Pós2022_{it}) + \varepsilon_{it}$$

⁵ The proposal considers a simple empirical design to estimate whether higher levels of informality are associated with greater pressure on the BPC and greater judicialization. The sample would be formed by two groups of municipalities: one hundred with higher informality (upper quartile of the PNAD) and one hundred with lower informality (lower quartile), which would function as a comparison group. The period analyzed runs from 2020 to 2025, allowing us to observe the behavior of the variables in the post-pandemic context.

Three main indicators would be monitored: average time of granting the BPC, municipal informality rate and proportion of benefits granted by judicial decision. The econometric strategy uses a simplified differences-in-differences model, comparing the evolution of municipalities with high and low informality before and after 2022. The interaction coefficient of the model, β_3 , indicates whether, in the recent period, more informal municipalities have suffered a disproportionate increase in judicialization or delays in granting, signaling protective weaknesses that reinforce the need for preventive mechanisms such as Hybrid Social Security.

⁶ The equation adopts a differences-in-differences (DiD) model, comparing the evolution of indicators between municipalities with high and low informality over time. The variable Y_{it} represents the result of interest in municipality i in period t (for example, BPC concession time or proportion of judicial concessions). The term $AltInformal_{it}$ identifies municipalities in the top quartile of informality, while $Pós2022_{it}$ indicates the period after 2022. The $AltInformal_{it} \times Pós2022_{it}$ interaction captures the additional effect observed in more informal municipalities after 2022. The coefficient of this interaction (β_3) is the central parameter of the model: it indicates whether, in the recent period, these municipalities started to present disproportionate variations in the results analyzed, after controlling for general trends over time and structural differences between groups. The term ε_{it} represents unobserved factors that may influence the outcome, but are not included in the model.

Table 3
Preliminary results

Indicator	Municipalities high informality (>45%)	Municipalities low informality (<30%)	Difference
Average BPC concession time	8.2 months	4.9 months	+3.3 months
% Judicial concessions	28%	14%	+14 pp
BPC/PCD Growth (2020-25)	+42%	+23%	+19 pp

Source: VIS Data 3 beta; Continuous PNAD

By way of illustration, a simple actuarial simulation can be considered to estimate orders of magnitude of Hybrid Social Insurance. Suppose that about 50 thousand families activate the mechanism per year, which corresponds to approximately 1% of the annual flow of BPC concessions due to disability.

Assuming a temporary benefit of R\$ 700.00 per month for twelve months, the annual cost of insurance would reach something around R\$ 420 million. If part of these families, in a proportion compatible with international evidence, do not later migrate to permanent benefits, the potential savings to the system could reach approximately R\$ 504 million over three years, considering the stock of expenses that would no longer be constituted.

In this illustrative projection, the initial balance would be negative by about R\$ 84 million, characterizing an investment with an estimated return in eighteen months. The simulation is not a substitute for formal evaluation, but it demonstrates that preventive policies can operate under investment logic, in which short-term expenses reduce chronic future costs.

3.3.2 Illustrative actuarial simulation

Considering 50 thousand eligible families/year (1% of the BPC disability flow), temporary benefit of R\$700/month for 12 months:

- **Hybrid Insurance Cost:** R\$420 million/year
- **BPC savings avoided:** R\$504 million/year (3 years × R\$1.4 billion inventory)
- **Net balance:** -R\$84 million (investment with ROI in 18 months)

Table 4
Operationalized research agenda

Study	Hypothesis	Data	Method	Deadline
1. Impact adhesion	Subsidy reduces delinquency	CadÚnico + pilots	RDD	6 months
2. BPC Effect	Insurance reduces future concessions	VIS Data	DiD	12 months

3. Actuarial feasibility	Sustainable awards	INSS + insurance companies	Monte Carlo Simulation	9 months
4. International benchmark	Scalable India/Bangladesh	WB Microinsurance	Benchmarking	4 months

Source: prepared by the authors

As a natural unfolding of the proposed model, a progressive agenda of empirical research is outlined, structured on four complementary fronts.

The first is to evaluate whether gradual subsidies reduce delinquency and expand voluntary adherence, based on data from CadÚnico and pilot experiments, using quasi-experimental designs.

Next, it seeks to measure the extent to which the insurance reduces future BPC concessions, through analyses in differences-in-differences with administrative bases.

The third front examines the actuarial feasibility of the mechanism, estimating sustainable premiums and risk distributions through simulations (Monte Carlo) with data from the INSS and insurance companies.

Finally, an international benchmark is carried out, with an emphasis on microinsurance experiences in India and Bangladesh, comparing scalability, governance and costs. It is a feasible, cumulative agenda aligned with the best practices of public policy evaluation.

Table 5

Proposed research programme

Study	Central hypothesis	Database	Method	Estimated time
1. Impact on adherence	Gradual subsidies reduce delinquency and expand coverage	CadÚnico + pilot projects	RDD/quasi-experiments	6 months
2. Effect on the BPC	Insurance reduces future disability concessions	VIS Data (administrative)	Differences-in-differences	12 months
3. Actuarial feasibility	Risk-controlled practicable premiums	INSS + insurance companies	Monte Carlo Simulation	9 months
4. International benchmark	Scalable Indian/Bangladeshi models	Microinsurance (World Bank)	Benchmarking	4 months

Source: prepared by the authors

4 METHODOLOGY

The analysis of Hybrid Social Security is based on a methodological strategy that articulates international evidence, empirical modeling, and prospective evaluation exercises. This is an institutional innovation not yet observed in full operation in Brazil, but whose foundations dialogue with experiences of parametric social protection and co-financed arrangements present in different countries, which allows us to draw comparable lessons and plausible hypotheses of impact (WORLD BANK, 2020; ILO, 2022). In analytical terms, the

proposal combines conceptual description, international comparison and ex-ante evaluation, making room for the estimation of potential effects before any implementation.

The study is part of the field of applied research, as it seeks to illuminate ways to improve the Brazilian security system. As Gil (2019) observes, investigations of this nature are not limited to the explanation of phenomena, but subsidize public choices based on evidence and rational criteria. The integration between quantitative and qualitative methods is especially appropriate for this type of agenda, as it allows the dialogue between empirical measurements and institutional interpretation, giving greater density to the conclusions (CRESWELL; CRESWELL, 2018).

A first analytical axis rests on the normative-institutional mapping of Brazilian social protection, with emphasis on the SUAS, the Continuous Provision Benefit and the judicialization mechanisms associated with access to rights. This examination highlights protective gaps, potential overlaps and operational limits, in addition to allowing the evaluation of the compatibility of the proposed model with the constitutional principles of social security (BRASIL, 1988; PAULA, 2021). The central question, at this point, shifts from "how to finance" to "how to integrate", which reinforces the systemic dimension of the proposal.

In parallel, the international literature on preventive policies and parametric instruments offers a fertile field for comparison. Countries that have adopted hybrid schemes, with different formats in Asian, Latin American, and European regions, allow us to observe how such mechanisms relate to distributive variables, such as poverty, income inequality, and intergenerational protection over time. Studies based on panel data show a special ability to capture this type of dynamic, controlling structural heterogeneities and reducing inferential biases (UNDP, 2021; ECLAC, 2023). The recurrent presence of fixed-effects models, Hausman tests, and quasi-experimental approaches illustrates an already consolidated methodological repertoire for analyses of this nature.

Another promising field lies in economic-actuarial simulation exercises. The literature on innovative social policies frequently resorts to parameterized, minimum, intermediate, and extended scenarios, in which coverage, duration, family co-participation, and government fiscal effort vary. This practice allows exploring the space of possibilities, estimating incremental costs and possible future savings associated with the reduction of care dependence, always anchored in the theory of social security and risk assessment (BARR, 2020). The purpose is not to predict accurately, but to delimit horizons of plausibility.

The convergence between these three movements, normative reading, international comparison and prospective exercises, contributes to the fact that the evaluation of the model

is not restricted to the financial plan. It reaches institutional, legal and distributive dimensions, strengthening analytical robustness through evidence triangulation. Cavalcante (2024) points out that policies oriented to social risk require instruments capable of combining technical predictability with institutional sensitivity, which gives relevance to the methodological design presented here.

Ultimately, the proposed methodology operates as an analytical lens to question a decisive point: to what extent a preventive mechanism of this nature can reinforce the constitutional objectives of dignity, autonomy and protection against irreversible damage. More than assessing financial viability, the effort lies in understanding whether the Hybrid Social Security contributes to raising the level of civilization of the Brazilian protective pact, a theme that, far from ending in this article, suggests an agenda for continued investigation.

4.1 ILLUSTRATIVE ESTIMATES OF THE FISCAL-PREVENTIVE IMPACT

For exclusively exploratory purposes, consider a scenario in which 100 thousand families⁷ activate the Hybrid Social Security in a given year, with an average benefit equivalent to 60% of a reference basic income for 12 months. The estimated annual expenditure would be in the order of magnitude of R\$ 1.5 to R\$ 2.0 billion, depending on the calibration and coverage ranges.

If part of these families, between 18% and 25%, according to comparative evidence, fail to subsequently enter permanent benefits, the savings accumulated over five years may exceed the initial amount disbursed, especially when considering costs associated with judicialization and the loss of productive capacity.

Such numbers are not intended to replace formal evaluations, but to indicate that the policy operates in the logic of preventive investment, in which anticipated expenditures mitigate future expenses of longer duration and less reversibility.

⁷ The values presented in Box 1 are for illustrative purposes. It was assumed that 100,000 families would receive a monthly benefit equivalent to approximately 60% of a reference basic income (e.g., R\$ 1,200.00). In this case, the average benefit would be around R\$ 720.00 per month. Multiplying this amount by 12 months and by the total number of families, amounts close to R\$ 864 million are obtained. Considering larger ranges of benefits and operating costs, the order of magnitude is between **R\$ 1.5 and R\$ 2.0 billion** per year.

To estimate the potential savings, the hypothesis was used, observed in international experiences, that between **18% and 25%** of beneficiary families fail to subsequently enter permanent benefits. As these benefits have a longer duration and a higher accumulated cost, the reduction of new concessions over five years tends to compensate, in whole or in part, the initial expense. It is, therefore, an exercise of **order of magnitude**, useful to demonstrate the logic of preventive investment, and not of definitive fiscal projection.

5 RESULTS AND DISCUSSION

The results derived from the conceptual and comparative analysis allow us to understand how a preventive mechanism repositions the traditional logic of Brazilian social protection.

Systems focused exclusively on reparation tend to act late, when the damage has already produced structural effects that are difficult to reverse, generating social and fiscal costs higher than those observed in preventive arrangements (BARR, 2020).

Hybrid Social Security shifts intervention in time: it operates before family collapse and alters trajectories that would otherwise tend toward chronic poverty.

A first point concerns the intergenerational transmission of poverty. In situations of early death or incapacity to work, families often adopt survival strategies that compromise human capital and support networks: reducing food consumption, withdrawing children from school, selling productive assets.

Evidence accumulated in middle-income countries shows that shocks of this type produce persistent "socioeconomic scars" when there is no initial cushioning (BANERJEE; DUFLO, 2019). The temporary benefit offered by the Hybrid Social Security works as a protective barrier, preventing transitory losses from becoming permanent trajectories.

This reasoning becomes clearer when observed in the light of international experiences that have faced similar dilemmas. Countries that have tested parametric mechanisms or hybrid arrangements demonstrate that anticipating protection can generate tangible gains in social stability, administrative predictability, and reduction of litigation.

In Chile, recent reforms have strengthened temporary support instruments in situations of disability and family risk. Automatic criteria and objective triggers reduced legal disputes and discouraged early migration to permanent benefits, preserving them for effectively irreversible situations. The learning is institutional: clear rules and quick action reduce uncertainty and reduce distributive conflicts.

In India, parametric programs targeting rural informal workers trigger benefits almost immediately after critical events. Independent evaluations record lower emergency indebtedness and a drop in school dropouts. The lesson is social: when the initial impact is cushioned, families avoid decisions that compromise their future.

These experiments function as empirical laboratories, not as models to be imported. All converge, however, on an operational orientation relevant to Brazil: preventive arrangements work best when they combine parametric triggers, administrative simplicity and integration with local networks.

In this interpretative key, the Hybrid Social Security appears as an intermediate layer between the absence of protection and definitive entry into the BPC, reducing the probability that families will reach permanent assistance due to the lack of previous alternatives.

There are also indications of an impact on the demand for residual benefits. Systems that have buffering instruments register, over time, less pressure on permanent programs, precisely because families are able to reorganize themselves before collapse (FISZBEIN; SCHADY, 2009).

For the Brazilian case, this movement is decisive: preserving the BPC as a policy of last resort, and not as a gateway to predictable risks, reinforces its sustainability and legitimacy.

At the institutional level, governance gains stand out. Parametric triggers and ex ante criteria reduce interpretative disputes and tend to reduce judicialization. The legal literature maintains that protection systems structured by stable rules produce greater legal certainty and less distributive conflict (BARROSO, 2017).

From a budgetary point of view, predictability means planning capacity, an indispensable attribute for long-term public policies (OECD, 2021). By articulating state coordination and partially shared operation, the hybrid model creates space for this balance.

From a fiscal perspective, the central point is not unlimited expansion of spending, but strategic recomposition. International evidence indicates that exclusively reparatory regimes accumulate higher costs than policies guided by prevention and early mitigation (DERCON, 2022).

Although insurance represents an initial expense, a relevant part of this amount returns in the form of future savings, less litigation, reduction of care dependence and preservation of family productive capacity. It is an "expenditure that avoids other expenditures", a logic widely documented in the contemporary literature on social protection (WORLD BANK, 2020).

Another relevant result concerns the interface with the SUAS. Insurance does not replace social assistance monitoring, it enhances it. The financial instrument, when articulated with continued guidance services, psychosocial support and productive insertion, expands the State's capacity to offer integrated responses. Brazilian research reiterates that effective policies articulate income, services, and community ties (SILVA; YAZBEK; GIOVANNI, 2020). Hybrid Social Security operates exactly at this crossroads.

However, challenges persist that need to be made explicit. Excessively restrictive parameters may exclude vulnerable groups; poorly calibrated subsidies can generate

regressivity; Interaction with private operators requires strong regulation and permanent monitoring.

These concerns are recurrent in studies on microinsurance and focused protection (CHURCHILL; MATUL, 2012). The proposed model addresses these tensions by maintaining the State as the coordinator of the system and by subordinating decisions to the logic of rights, and not only to security rationality.

The overall balance indicates that the Hybrid Social Security does not represent a rupture, but an incremental evolution with high innovative potential. It dialogues with the constitutional principles of security, universality, equity and solidarity and expands the preventive dimension of the system. In the public policy literature, it is a matter of shifting the axis of state action from "help after" to "protection before", a movement that has been gaining ground in recent reforms (ILO, 2022; UNDP, 2021).

Taken together, the analytical evidence converges on a robust argument: policies that anticipate protection tend to produce more humane, more efficient, and more fiscally rational outcomes. The empirical agenda outlined throughout the study constitutes the next stage: to rigorously test the model's ability to transform itself into stable, fair, and sustainable public policy.

6 CONCLUSION

The contemporary debate on social protection has revealed a recurring paradox: a large part of public policies are called upon to act only after the damage has already been consolidated. In the Brazilian case, the combination of high informality, abrupt income shocks, and insufficient preventive mechanisms produces trajectories of impoverishment that could have been avoided.

Hybrid Social Security was conceived precisely to address this gap, not as a replacement for existing policies, but as an intermediate layer capable of reducing the risk of family collapse and preserving the BPC as an instrument of last resort.

The analytical path developed throughout the article allowed us to sustain this argument on three complementary levels. On the conceptual level, it was shown that the anticipation of protection repositions social policy over time, transforming a traditionally reparatory expenditure into a preventive investment.

On the comparative level, international evidence indicates that parametric and hybrid arrangements tend to reduce litigation, stabilize expectations, and mitigate intergenerational effects of shocks.

At the Brazilian institutional level, the compatibility of the model with the constitutional principles of social security was verified, in addition to its potential integration into the SUAS as an articulating instrument between income, services and social monitoring.

The model, however, is not without challenges. The calibration of subsidies, the risk of regressivity, federative coordination and the regulation of private operators require regulatory safeguards and administrative capacity.

Making these limits explicit does not weaken the proposal; on the contrary, it gives him academic credibility and political maturity. Innovative policies only become effective when they recognize their own trade-offs and build governance mechanisms to match.

The analytical results suggest that the Hybrid Social Security should be understood as an incremental evolution of the Brazilian social security system, and not as a rupture.

Innovation lies less in creating a new benefit and more in the intelligent reorganization of times, incentives, and responsibilities. By cushioning shocks before they turn into structural poverty, the model simultaneously contributes to dignity, efficiency, and fiscal responsibility.

The agenda that opens up from this study is, above all, empirical. It is necessary to investigate, with quantitative and qualitative methods, the concrete conditions of implementation, the distributional effects in different territories and the relationship between insurance and the future reduction of judicialization and care dependence.

The proposal outlined here does not intend to offer definitive answers, but to formulate a plausible and reasoned path to improve Brazilian social protection.

If insurance was born to protect against socially unacceptable risks, the challenge of the twenty-first century is to protect before the damage becomes irreversible.

Hybrid Social Security points in this direction. Now there is the collective work of transforming it into a public policy capable of producing trust, reducing uncertainties and expanding rights, without losing sight of the sustainability that guarantees its permanence.

Finally, although the proposal has advanced in its conceptual and institutional foundation, some analytical developments remain intentionally open. More detailed simulations of cost and coverage, federative analyses sensitive to territorial inequalities, and in-depth comparative studies on countries that have adopted similar arrangements configure a promising research agenda. These themes go beyond the limits of this article, but will be the object of subsequent studies, in which the model can be tested with greater empirical precision.

REFERENCES

Angrist, J., & Pischke, J. (2014). *Mastering 'metrics: The path from cause to effect*. Princeton University Press.

- Atkinson, A. (2019). *Inequality: What can be done?* Harvard University Press.
- Banerjee, A., & Duflo, E. (2019). *Good economics for hard times*. PublicAffairs.
- Barr, N. (2020). *The economics of the welfare state*. Oxford University Press.
- Barroso, L. R. (2017). Judicialização, ativismo judicial e legitimidade democrática. *Revista de Direito do Estado*, (13), 71–91.
- Barroso, L. R. (2012). Da falta de efetividade à judicialização excessiva: Direito à saúde e fornecimento de medicamentos. *Revista de Direito Administrativo*, 267, 241–270.
- Brasil. (1988). *Constituição da República Federativa do Brasil*. Senado Federal.
- Brasil. (1993). Lei nº 8.742, de 7 de dezembro de 1993. *Diário Oficial da União*.
- Cecchini, S., & Madariaga, A. (2011). *Programas de transferencias condicionadas: Balance de la experiencia en América Latina y el Caribe*. Comisión Económica para América Latina y el Caribe.
- Comissão Econômica para a América Latina e o Caribe. (2023). *Panorama social de América Latina 2023*.
- Churchill, C. (2007). *Protecting the poor: Microinsurance compendium*. International Labour Organization.
- Churchill, C., & Matul, M. (2012). *Protecting the poor: A microinsurance compendium – Volume II*. International Labour Organization.
- Costa, J., & Ferraz, O. (2020). Direitos sociais e judicialização do BPC. *Revista de Direito Público*, 55, 115–138.
- Dercon, S. (2022). *Gambling on development: Why some countries win and others lose*. Hurst.
- Esping-Andersen, G. (1990). *The three worlds of welfare capitalism*. Princeton University Press.
- Fiszbein, A., & Schady, N. (2009). *Conditional cash transfers: Reducing present and future poverty*. World Bank.
- International Labour Organization. (2022). *World social protection report 2022–2024*.
- Marshall, T. H. (1967). *Cidadania, classe social e status*. Zahar.
- Organisation for Economic Co-operation and Development. (2021). *Preventing policy failure: Risk management approaches in public institutions*. OECD.
- Paiva, L., Jaccoud, L., & Mesquita, S. (2022). *O BPC e os desafios da proteção assistencial*. Instituto de Pesquisa Econômica Aplicada.
- Paula, A. (2021). *Direito assistencial e proteção social contemporânea*. Saraiva.
- Perry, G., Maloney, W. F., Arias, O. S., Fajnzylber, P., Mason, A. D., & Saavedra-Chanduvi, J. (2007). *Informality: Exit and exclusion*. World Bank.
- Pierson, P. (2000). Increasing returns, path dependence, and the study of politics. *American Political Science Review*, 94(2), 251–267.
- Silva, M., Yazbek, M. C., & Giovanni, G. (2020). *O Sistema Único de Assistência Social no Brasil*. Cortez.

Soares, S., Osório, R. G., Soares, F. V., Medeiros, M., & Zepeda, E. (2010). O impacto do Bolsa Família na desigualdade e na pobreza. *Revista Econômica do Nordeste*, 41(especial), 223–244.

United Nations Development Programme. (2019). Human development report 2019.

United Nations Development Programme. (2021). Human development report 2021/2022.

Vianna, L., et al. (2020). Judicialização das políticas públicas no Brasil: Balanço e perspectivas. FGV Direito Rio.

World Bank. (2020). World development report 2020: Trading for development in the age of global value chains.

QUILOMBOLA KNOWLEDGE AND SELF-CARE PRACTICES IN THE SÃO DOMINGOS COMMUNITY, CAVALCANTE (GO)

SABERES QUILOMBOLAS E PRÁTICAS DE AUTOCUIDADO NA COMUNIDADE SÃO DOMINGOS, CAVALCANTE (GO)

CONOCIMIENTOS QUILOMBOLAS Y PRÁCTICAS DE AUTOCUIDADO EN LA COMUNIDAD DE SÃO DOMINGOS, CAVALCANTE (GO)



<https://doi.org/10.56238/sevened2026.008-028>

Pabline Gonçalves Ferreira da Silva¹, Reginaldo Teixeira Mendonça²

ABSTRACT

This study addresses health self-care within the context of a rural quilombola community that has limited access to formal health services, based on the need to understand and value the traditional knowledge that guides these practices. Given this, the general objective was to analyze the self-care practices of quilombolas belonging to the São Domingos community, located in the municipality of Cavalcante (GO). The research adopted a qualitative approach with a descriptive and exploratory character. Data were collected through individual semi-structured interviews with 29 quilombolas who self-identified as belonging to the São Domingos community. Participants were selected based on suggestions from community health agents, local leaders, and referrals from other participants (snowball technique). The interview analysis procedures consisted of content analysis. The results indicate that self-care practices involve the use of medicinal plants and industrialized medicines, strongly influenced by available resources and traditional knowledge, suggesting that such practices occur in a strategic manner and are adapted to the local context in which they are embedded. It is concluded that the valuation and integration of traditional knowledge strengthen self-care, contributing to meeting the health demands of the community.

Keywords: Industrialized Medicines. Medicinal Plants. Self-Care Practices. Quilombola Communities. Traditional Knowledge.

RESUMO

Este estudo aborda o autocuidado em saúde, situado no contexto de uma comunidade quilombola rural que possui acesso limitado a serviços de saúde formais, partindo da necessidade de compreender e valorizar os saberes tradicionais que orientam essas práticas. Diante disso, o objetivo geral consistiu em analisar as práticas de autocuidado dos quilombolas pertencentes à comunidade São Domingos, localizada no município de Cavalcante (GO). A pesquisa adotou uma abordagem qualitativa, de caráter descritivo e

¹ Graduated in Pharmacy. Universidade Federal de Goiás (UFG). E-mail: ferreirapabline10@gmail.com
Orcid: <https://orcid.org/0009-0006-8228-2823> Lattes: <https://lattes.cnpq.br/3853219727836846>

² Dr. in Public Health. Universidade de São Paulo (USP). Universidade Federal de Goiás (UFG).
E-mail: reginaldo_mendonca@ufg.br Orcid: <https://orcid.org/0009-0008-5860-8947>
Lattes: <http://lattes.cnpq.br/4683119891747033>

exploratório. Os dados foram coletados por meio de entrevistas semiestruturadas individuais com 29 quilombolas que se autodeclararam pertencentes à comunidade São Domingos. Os participantes foram selecionados através de sugestões de agentes comunitários de saúde, lideranças locais e indicações de outros participantes (técnica de bola de neve ou snowball). Os procedimentos de análise das entrevistas consistiram na análise de conteúdo. Os resultados apontam que as práticas de autocuidado envolvem o uso de plantas medicinais e medicamentos industrializados, marcadas pela forte influência dos recursos disponíveis e dos saberes tradicionais, indicando que tais práticas ocorrem de maneira estratégica e adaptada ao local em que estão inseridas. Conclui-se que a valorização e integração dos saberes tradicionais fortalecem o autocuidado, contribuindo para atender às demandas de saúde da comunidade.

Palavras-chave: Medicamentos Industrializados. Plantas Medicinais. Práticas de Autocuidado. Comunidades Quilombolas. Saberes Tradicionais.

RESUMEN

Este estudio aborda el autocuidado en salud, en el contexto de una comunidad rural quilombola con acceso limitado a servicios de salud formales, a partir de la necesidad de comprender y valorar los conocimientos tradicionales que guían estas prácticas. Por lo tanto, el objetivo general fue analizar las prácticas de autocuidado de la comunidad quilombola perteneciente a la comunidad de São Domingos, ubicada en el municipio de Cavalcante (GO). La investigación adoptó un enfoque cualitativo, descriptivo y exploratorio. Los datos se recopilaban mediante entrevistas individuales semiestructuradas con 29 quilombolas que se autoidentificaron como pertenecientes a la comunidad de São Domingos. Los participantes fueron seleccionados mediante sugerencias de agentes comunitarios de salud, líderes locales y referencias de otros participantes (técnica de muestreo por bola de nieve). El análisis de las entrevistas se realizó mediante análisis de contenido. Los resultados indican que las prácticas de autocuidado implican el uso de plantas medicinales y medicamentos manufacturados, con una fuerte influencia de los recursos disponibles y los conocimientos tradicionales, lo que sugiere que estas prácticas se desarrollan estratégicamente y se adaptan al lugar donde se ubican. Se concluye que la valoración e integración de los conocimientos tradicionales fortalece el autocuidado, contribuyendo a la satisfacción de las necesidades de salud de la comunidad.

Palabras clave: Medicamentos Industrializados. Plantas Medicinales. Prácticas de Autocuidado. Comunidades Quilombolas. Conocimientos Tradicionales.

1 INTRODUCTION

Self-care in health has been recognized as a fundamental strategy for improving quality of life, personal autonomy and reducing the burden on the health system. In quilombola communities, generally located long distances from urban centers with a greater presence of health services, their members use traditional knowledge and self-care practices as alternatives to alleviate health problems.

Thus, self-care practices are shaped according to each sociocultural context: by the way of life, by its history, adaptive processes to the environment, economic conditions, and access to services and knowledge. From this perspective, addressing self-care in traditional communities is essential to fill gaps in the literature, value local knowledge, and subsidize public policies that respect and strengthen the identity of communities.

In view of this, the question that guided this work was: how are traditional knowledge and industrialized medicines used in health self-care by residents of the quilombola community São Domingos, municipality of Cavalcante, Goiás? Thus, the central objective of the research was to analyze the self-care practices of the quilombolas in this community. As specific objectives, we sought: to identify the main self-care practices; understand the factors that influence these practices; and discuss how these practices dialogue with the health system.

From the methodological point of view, the study adopted a qualitative, descriptive and exploratory approach. Data collection was carried out through semi-structured interviews and included people who self-declared themselves quilombolas belonging to the São Domingos quilombola community. Subsequently, they were transcribed in full, and content analysis and discussion were carried out based on the scientific literature.

The article is structured in five sections: (1) introduction, which presents the theme, the relevance of the work, the objectives and, briefly, the methodology; (2) theoretical framework, with studies that support the research; (3) methodology, detailing the procedures adopted for data collection and analysis; (4) results and discussion, which expose and interpret the findings according to the literature; and (5) final considerations, pointing out the main contributions, limitations and suggestions for future studies.

2 THEORETICAL FRAMEWORK

Health self-care refers to the skills of individuals, families, and communities to promote health, prevent disease, maintain health, and cope with illness or disability, with or without the support of a health professional, as defined by the World Health Organization (WHO, 2022). In this sense, the conception of the therapeutic itinerary is directly related to self-care.

The therapeutic itinerary is defined as the set of strategies, paths or choices adopted in the search for a cure for diseases. These choices involve ways of representing diseases and treatments, cultural values, socioeconomic conditions, as well as access and accessibility to popular and scientific therapeutic processes. This concept reflects the sociocultural conditions of each community in the search for the restoration of health (ALVES; SOUZA, 1999).

Thus, the concept of self-care encompasses different dimensions, among which the physical one stands out, which encompasses actions aimed at the proper functioning of the body; the psychological, which involves strategies for mental balance; and the spiritual, related to inner connection and the search for meaning in life. These dimensions act in an integrated manner, being fundamental for the individual's quality of life (SOTO *et al.*, 2021).

In addition, self-care is an essential tool in prevention, as it allows individuals to identify signs of imbalance in their health early and have the autonomy to adopt measures and changes in habits, thus the focus is directed to avoid the emergence or worsening of diseases (SILVA *et al.*, 2020). In this sense, disease prevention and health promotion are configured as practices originating from the population itself, going beyond the structural and institutional notion based on health services (CZERESNIA, 1999).

However, access to self-care is unequal, as Lira and Souza (2024, p. 3) explain: "these conditions are influenced by broader political, economic, and social factors, such as government policies, governance systems, ideologies, power structures, and class relations." In addition, culture exerts a great influence on how individuals relate to symptoms, treatments, and lifestyle changes in health care (MOLLA, 2025).

From this perspective, social inequalities or inequities are reflected in the way each individual or community develops self-care, in addition to influencing the way of understanding, interpreting, and using information about health and disease (literacy) (BRASIL, 2023). It is considered, for example, that access to private health plans, economic power to purchase medicines and exams, as well as living in places with easy road access or owning one's own vehicle, among other factors, favor different types of self-care. On the other hand, living in a rural environment of difficult access, where there is a shortage of health services and a lack of capital to pay for consultations and medications, will produce another type of self-care. In addition, these variations in self-care practices can generate hierarchies or criticism among the actors involved, which can reinforce inequalities and produce discrimination.

Among the concepts interconnected with self-care are access (existence of health services) and accessibility (ability of health services to be used by the population). Both are

related to the barriers to social inclusion resulting from communication and information, geographical, economic, and cultural barriers (FREITAS, 2023). Soares *et al.* (2023) emphasize the difficulties in accessing and affording health services in Brazilian rural municipalities with less than 20 thousand inhabitants, which involve: low use of information and health technologies (immunobiologicals, medications, diagnostic tests), difficulties in teamwork or in retaining health professionals, and absence of tertiary care services in rural municipalities and located far from large urban centers.

It is worth emphasizing the influence of policies on choices related to self-care, whether through health programs that guide the population, or through understandings and disputes between political agents and ideological discourses. Thus, it can be said that different prescriptions occur in addition to those made by health professionals. In this sense, it is possible to observe the existence of political prescriptions that define modes of self-care. These are prescriptions that can occur in a way that is alien to health services and scientific thinking, guiding actions according to interest groups and/or that aim to co-opt or subjugate a population (MENDONÇA, 2024).

Self-care can also be represented by a collective dimension (NODEH *et al.*, 2024). According to Silva (2018, p. 68), "the group environment enables the sharing of this information and serves as support in the involvement of these people as active subjects of their treatment". Thus, collective self-care complements individual self-care, involves the exchange of knowledge and mutual support. The search for improvements in health is amplified by the interconnection of experiences between individuals, who carry memories of their afflictions (ALVES; SOUZA, 1999).

In this way, self-care strengthens the subject's protagonism by allowing him to actively participate in the process of managing his own health and, through this participation, develop confidence and autonomy, which contributes to better results regarding the therapeutic strategies adopted (SILVA, 2018). The experiences of successes and failures are analyzed by individuals, passed on and analyzed continuously, creating concepts and ways of taking care of the body. Such notions about disease, symptoms and treatments can be resignified according to each sociocultural context (BOLTANSKI, 1984).

In the context of public policies, the Unified Health System (SUS) recognizes self-care as an essential strategy for improving quality of life, highlighting primary care as the main incentive space. In this context, it is recommended that teams adopt practices based on dialogue, active listening, and health education through different resources. These actions aim to offer support and encourage self-care, so that the patient not only receives guidance,

but also becomes an active participant, and that the conducts are compatible with their reality (BRASIL, 2023).

It is highlighted that health services should not act in an authoritarian manner, positioning the user as someone undisciplined and unable to understand and interpret information when they do not follow the guidelines or prescriptions of health professionals. The existence of health services with authoritarian characteristics, of a discriminatory and hierarchical nature between different cultures and social classes, permeates different Brazilian historical moments. These characteristics do not manifest themselves in the absence of conflicts. Among these moments, the Vaccine Revolt, which took place at the beginning of the twentieth century, in the then capital of the Republic, Rio de Janeiro, is emblematic. It is noted that the presence of military governments also favored a governmental structure of care with coercive attitudes, imposing the so-called Western medicine, based on positivist and Cartesian thinking, as the only valid alternative to care and representative of science, condemning popular practices, especially those coming from Afro-descendant culture (CHALHOUB, 1996; MAY; MONTEIRO, 2005). It should be noted that Western medicine made it possible to sustain the chemical-pharmaceutical industry and industrialized medicines.

The Vaccine Revolt represented a stage of socioeconomic inequalities, sanitation, hygienism, eugenics, and the imposition of Western medicine through the mandatory smallpox vaccine. The episode revealed the sanitary and urban segregationist model, as well as the socioeconomic difficulties of the working population, in addition to evidencing their distancing from political and governmental decisions. Thus, the ways of caring for the body came to be represented as a political struggle (CHALHOUB, 1996). In this sense, an analogy can be drawn with the political disputes, the anti-vaccine movement, and other preventive measures that occurred during the COVID-19 pandemic in Brazil between 2019 and 2021 (MENDONÇA, 2024).

With technological advances in the health area, new resources for self-care have emerged, such as applications, devices, and artificial intelligence systems that make it possible to monitor and manage symptoms, access reliable health information, reduce costs, and even encourage the adoption of healthy habits, promoting the individual's engagement in their own care (KIM *et al.*, 2023; PERSSON; WICKMAN, 2025). However, associated with the ease of interpersonal communication and access to information, the risk of collective misunderstandings can increase. This may occur because the information is not based on the concrete experience of those who have experienced suffering, health problems and the effects of treatments, but is based on statements selected among members of social media

groups. Added to this discursive inexperience, there are the interests of opportunists who elaborate magical solutions, often with the intention of cheating and capital gain (MENDONÇA, 2024).

In addition, self-care can be taught or encouraged from childhood: from an early age it is possible to develop habits such as maintaining personal hygiene, practicing physical activities, adopting a healthy diet and recognizing the body's signals. As a result, when consistently encouraged, these habits prevent health problems and strengthen the basis for self-care throughout life (MENOR-RODRIGUEZ *et al.*, 2022). It can also be referred to the need for intersectoral actions, involving sectors such as the environment, education and health, in addition to the promotion of well-being, incorporating healthy lifestyles.

In this process of forming care practices, it is important to consider the sociocultural contexts in which individuals are inserted, as self-care is contextualized based on local experiences and knowledge. In this context, the reality of quilombola communities stands out, defined as self-declared ethnic-racial groups, with their own historical trajectory, specific territorial ties and black ancestry related to resistance in the face of historical oppression, as established by Decree No. 4,887/2003 (BRASIL, 2003).

In these communities, health care is linked to practices such as the use of medicinal plants available in the territory, rituals, prayers and blessings, which constitute a complex and rich knowledge. Because it is rooted in the relationship with the territory and in the collective memory, such care has high acceptability and facilitates adherence to health actions (GAMA *et al.*, 2019).

Thus, the traditional knowledge of quilombos constitutes a fundamental area of study to understand how care strategies relate to local conditions, guiding daily decisions. In addition, this subject allows us to observe the importance of collective memory and oral transmission in the maintenance and continuity of this knowledge, as well as the relationship between tradition and science.

According to Santos and Lacerda (2020), quilombola communities have inherited knowledge and is transmitted between generations, which, associated with multiple factors, translate their own way of understanding and promoting health and well-being. In this context, health policies aimed at the black population, strengthened by the increase in scientific research, are the result of struggles and demands of social movements. In addition, Santos and Fenner (2021, p. 4-5) state that "it is in the environment that the quilombola finds its means of subsistence, its social work as a community. This interaction generates the creation of a territory of its own, of resistance."

Traditional knowledge is knowledge built from experiences, observations, and learning acquired in daily life, resulting from a continuous process of successes and errors. This knowledge is shared over time in a dynamic and constantly changing way, by different groups that maintain a close relationship with natural resources and the environment in which they live. In addition, for Santos and Quintero (2018, p. 52), traditional knowledge can be understood "as knowledge acquired through trial and error, in a group of ideas and actions that can be considered valid, observable, analyzable, understandable, and even replicable, even if it is considered outside of scientific standards".

Historically, knowledge in quilombola communities arose from the need to meet the basic demands of survival and to adapt to the adversities imposed by the environment in which they are inserted. In this scenario, ancestry is present as a force that grounds and shapes this traditional knowledge, sustaining identity and a sense of belonging and, consequently, manifests itself in continuity (GIMOVSKI; OLIVEIRA, 2024).

Thus, the territory is more than physical space: it represents several interconnected dimensions and constitutes a place for the preservation of identity and resistance; in addition, collective care and traditions related to the ancestral principles that sustain the construction of traditional knowledge are intertwined (LACERDA; MENDES, 2018).

The relationship with nature is essential because quilombolas use this resource, especially plants, as a solution for their lives, where, through long observation and coexistence with the natural environment, knowledge emerges that guide care practices and autonomy. Therefore,

[...] Much of this knowledge about the medicinal properties of plants was built empirically. The observation of nature, the behavior of the animals that use the plants, as well as entheogenic plants (which establish communications with deities and spirits), used mainly by the religious leaders of a community, were also (and are) important in this process of accumulating knowledge (SANTOS; QUINTERO, 2018, p. 73).

In this way, the transmission of knowledge occurs mainly through orality, as it allows this knowledge to be shared in a living way, offering its own narrative and adapted to different generational contexts. In addition, this transmission stimulates the feeling of belonging and ensures its continuity, considering that, for a long time, access to writing was denied (CASTRO, 2021).

Although there are approximations, there are often conflicts, because, without dialogue, knowledge ends up being left aside in favor of scientific knowledge, generating the weakening of the valorization of identity and the limitation of the use of culturally significant

care strategies. It is emphasized that ignoring this knowledge is offering fragmented and ineffective care (NASCIMENTO, 2018).

In this sense, although some guidelines have sought to recognize quilombola knowledge, such as Decree No. 6,040/2007, which instituted the National Policy for the Sustainable Development of Traditional Peoples and Communities, a significant gap is observed in practice. Its application has been limited, which compromises the full use of resources by quilombola communities (BRASIL, 2007). Among the main challenges faced are the lack of appreciation and recognition, the impacts of modernization processes, insufficient support from public policies, and the absence of incentives for research and documentation of this knowledge.

In the contemporary scenario, such knowledge gains relevance as it has great potential to offer information that can assist in the development of scientific research involving both drugs and complementary alternatives to conventional treatments, as well as the sustainable use of environmental resources and the formulation of more inclusive public policies.

Thus, traditional knowledge is configured as forms of resistance, as they allow quilombolas, based on their traditions and values, to express their own way of understanding and acting, even in the face of attempts at erasure that mark their paths. Collective memory ensures that knowledge is preserved, even without support or visibility from formal means; therefore, it remains a fundamental piece to establish the various types of knowledge that circulate among quilombolas (OLIVEIRA *et al.*, 2024).

Although there are similarities, the knowledge is specific because each community has its particularities: the needs vary according to the territory and the available resources and, in this sense, people acquire experiences according to the place where they live. According to Santos and Quintero (2018, p. 154):

[...] Even within a given community, knowledge is not homogeneous, with those specific to men, women and the different categories with which these social actors recognize themselves, such as "midwives", "healers", "herbalists", "woodsmen", "muleteers", "charcoal burners", among others.

In other words, despite being the same place, knowledge is not evenly distributed, being closely linked to gender and specific activities within the community. Thus, based on the authors discussed, it is observed that self-care manifests itself as a practice that combines and interferes with personal, collective experience and social contexts in health care. In this sense, traditional knowledge appears as instruments that transfer autonomy and are adapted to the territory, meeting the needs and well-being of individuals.

Such reflections are essential to think about self-care practices and social inclusion, recognizing the diversity and potential of traditional knowledge, as will be observed through interviews with quilombolas.

From the theoretical framework chosen about self-care, concepts such as therapeutic itinerary, access and accessibility can be derived. Such definitions enable the development of categories of analysis necessary for health care, such as the use of medicinal plants and industrialized medicines, as well as their modes of use particularized in the context of a rural quilombola community.

3 METHODOLOGY

It is a field research, with a qualitative approach as to the means, descriptive and exploratory as to the ends, enabling the interaction between subjectivity and objectivity, between the social, the biological and the cultural (MINAYO, 2004).

The sample consisted of 29 self-declared quilombola participants, belonging to the São Domingos community, located in the municipality of Cavalcante (GO). Participants who had some health problem were searched. Its selection was based on suggestions from community health agents, local leaders and indications from other participants (snowball technique, which defined the number of participants).

The interviewees had a mean age of 60 years, ranging from 26 to 81 years, with a predominance of people over 60 years of age (19 participants). Among the interviewees, 17 were women and 12 men, all professing the Christian religion (evangelical or Catholic).

The data were collected in two moments, aiming to expand the experiences investigated: in February 2025 with 22 quilombolas residing in the community and later, in the months of July and August of the same year with 7 members of the same community who currently reside in the urban area. Of the 9,583 inhabitants (2022) of Cavalcante (GO), more than half declared themselves quilombolas (IBGE, 2023), and the community of São Domingos (about 60 kilometers of dirt road from Cavalcante) had, in 2019, approximately 77 families (SCALIZE, 2019).

The investigation was guided by a standardized semi-structured interview script, previously prepared containing open questions that addressed the products used for self-care, as well as the purposes, difficulties and facilities. The interviews were recorded and conducted individually in the participants' living environment, with an average duration of 25 minutes.

Data analysis was carried out using the content analysis technique, as proposed by Bardin (2011), a structure that is organized into three main stages: pre-analysis, exploration of the material and treatment of the results, inference and interpretation.

In the initial stage, the collected material was organized, with the full transcription of the interviews in a text editor (Microsoft Word) and the floating reading of the content to familiarize themselves with the material and identify what would be included in the analysis, considering its relevance in relation to the research objective.

Next, the coding of the content began, with the identification of registration units related to self-care practices and the challenges faced. From the observation of the similarities in meaning, it was possible to manually cut out the excerpts considered relevant and the grouping into categories that expressed the main aspects investigated in the study.

After categorization, the data were interpreted in the light of the pertinent scientific literature. For a better understanding of the results, a table was prepared in the text editor itself, from which the information was organized into two major categories: the use of medicinal plants and the use of industrialized medicines.

The research was approved by the Research Ethics Committee of the Federal University of Goiás, with opinion number 7,049,058, in accordance with the ethical principles established by Resolution No. 466/2012 of the National Health Council (BRASIL, 2012). All participants signed the Informed Consent Form, with anonymity, confidentiality and the right to withdraw at any time being guaranteed, in addition to clarification about any risks arising from the research. To ensure anonymity, the interviews were numbered sequentially from E1 to E29, followed by the indication of "M" for male and "F" for female, and the codes were assigned only to the statements included in the analysis.

4 RESULTS AND DISCUSSION

4.1 SELF-CARE PRACTICES AND THE USE OF MEDICINAL PLANTS

Through interviews with residents and former residents of the quilombola community, it was possible to observe that self-care practices involving the use of medicinal plants occur quite frequently, and this can be explained by limited access to health services, cultural tradition, reduced financial resources, ease of access and confidence in therapeutic properties. (SILVA; LOBATO; RAVENA-CANETE, 2019; AMATEUR; LUCAS, 2025). Among the diversity of plants, the most cited were lemon balm, cotton, scented grass/lemongrass and white canopy, mainly in the form of tea and use in bottles: *"I take a lot of medicine from the bush. I drink partridge tree, it's... cotton, whole pharmacy, medicine bottle"* (E28 / F, 63 years old).

These plants are commonly used in the treatment of hypertension, pain relief, as a tranquilizer and also as a blood purifier. Pereira and Paula (2018) point out the various therapeutic actions of lemongrass, including calming, antihypertensive, analgesic, and antispasmodic effects, mainly due to the presence of the citral compound in its essential oil. In addition, other studies attribute similar results to the aforementioned therapeutic indications (GUIMARÃES; OLIVEIRA; MORAIS, 2019; FERREIRA; PASA; NUNEZ, 2020), which reinforces the legitimacy of popular knowledge mobilized in the daily life of the community, as evidenced by the participant's statement.

The preparation of teas or infusions is a very common traditional practice, used as a form of health care. As reported by one participant: *"When it's really bad, I always like to make a tea like this at night to drink"* (E1 / F, 75 years old). This practice, although recognized in the daily life of the community, needs to be understood carefully. Pedroso, Andrade, and Pires (2021) warn that the use of medicinal plants, even though they offer benefits, requires attention to avoid unintended consequences.

The acquisition of these plants occurs in different ways, which facilitates their circulation and evidences a collective care, in which many people cultivate in their backyards or turn to other residents: *"I have lemon balm, now I go out with basil to hunt"* (E20 / F, 75 years old), while another interviewee added: *"It's a neighbor and we go there and get it"* (E10 / M, 67 years old). According to Nodeh *et al.* (2024), care actions go beyond the individual and acquire collective expression, sharing knowledge among residents, alleviating the feeling of guilt and frustration when treatment does not produce benefits.

The search for medicinal plants in the Cerrado, associated with domestic cultivation, reveals a system of care based on traditional knowledge and the relationship with the territory, as exemplified in the statement: *"It's here in this Cerrado up here"* (E13 / M, 38 years old). Similarly, Farias *et al.* (2019) identified that residents of a rural community cultivate and use about 30 medicinal species aimed at the treatment of various diseases. This data reinforces how backyards and the Cerrado environment around homes function as sources of care and support for local health.

However, it is observed that the scenario of self-care practices with the use of medicinal plants has been changing. The use of garrafadas, which was quite common in the treatment of various diseases, has been losing space. One of the main factors that contributes to the abandonment of this practice is related to the move to the city, which makes it difficult to access the medicinal plants used in garrafadas, as reported by an interviewee who had moved to the city: *"When I lived in the countryside, I did a lot, you know, because I lived there, I know a lot of medicine too"* (E29 / F, 46 years old). In this sense, Romanus,

Mendes and Carlini (2018) observed how migration to urban areas influences the use of medicinal plants, pointing out reasons such as the limitation of species and different climatic conditions, leading to the adoption of local alternatives.

Among other factors pointed out, religious issues can influence the disuse of medicinal plants, as occurs in bottled plants because they contain alcohol: *"After I changed to... For the Assembly of God, then I stopped making garrafada"* (E1 / F, 75 years old); *"I don't drink alcohol, alcohol stuff, then bottled is always better with wine, things like that, then I stopped drinking these things"* (E5 / F, 65 years old). This change in habits due to beliefs is also pointed out by Gerhardt (2006), who detected that behaviors and opinions are constructed and shaped by social contexts and values, influencing health care strategies, as revealed by the statement of participant E5 / F, 65 years old.

Even in the face of this decrease in the use of garrafadas, knowledge related to herbal remedies continues to be transmitted from generation to generation, ensuring the permanence of knowledge and respecting the community's way of life: *"Well, rooted, bottled, that's for the ancients, right? Our parents, grandparents, taught us there, right? Then we have been bringing this tradition and it turns out that it is really good"* (E7 / M, 42 years old). This type of transmission, rooted in family memory and daily practice, is also evidenced by Silva *et al.* (2019), when they stated that mothers and grandmothers are the main responsible for passing on knowledge about the use of medicinal plants to new generations through orality, the main means of preserving this knowledge.

In addition, the use of plants available in the living environment is intensified as an alternative to solve health problems and that the search for medical care occurs only in cases that require extreme need: *"Here, when I'm not very well, we hunt for a medicine from the bush right here, then it works, it happens that it works. If it doesn't work, we'll go to the city"* (E7 / M, 42 years old). This pattern of behavior was also identified in the research by Fernandes and Santos (2019), carried out in a quilombola community, which highlights self-medication as a self-care strategy in the face of mild problems and the limitations of the health system, often considered ineffective.

4.2 KNOWLEDGE AND PREPARATIONS WITH MEDICINAL PLANTS

Various types of preparations with medicinal plants were described and to illustrate these self-care strategies, Table 1 addresses the products, method of preparation and therapeutic purpose reported by the residents and former residents in the interviews, which are adapted according to the practice accumulated throughout daily experiences.

Table 1

Medicinal plants (products), method of preparation and reason for use extracted from interviews with quilombolas from the São Domingos community, Cavalcante (GO), Brazil, 2025

Products	Preparation	Reason for use
Turmeric with garlic, ginger and honey	"Then I put half a spoonful of it, a little crushed ginger, a crushed garlic clove, a spoonful of honey and stir and take..." (E2 / M, 68 years old)	Gout Flu
Tea of artelãozinho, fennel, pennyroyal, chamomile, mentraço, carrapicho, picão	"Sometimes I put it in the bowl and cook it, I make the tea, very strong. There are times, I don't like to let it boil, but sometimes it even boils." (E3 / F, 64 years old)	Flu Fever
Eau de Cologne Tea, Lemon Balm	"I tear it up, put it in the bowl with water and let it boil." (E11/F, 79 years old) "Every day I put lemon balm in the water, the leaf of the colony, and then, put it, put a little sugar, put it in the fridge and drink it there." (E9 / F, 66 years old)	High blood pressure
Roasted lobeira fruit with sugar or shaved brown sugar	"You open a little hole in it, like a roulette wheel, and you put the scraped rapadura and open a hole in the wood stove, put it inside and cover it with the rubber, and let it bake. Let it bake, the next day, it dawned that molten molasses, then you would take it, take it out of there and open that hole you made in it and pour the honey to drink to improve." (E29 / F, 46 years old)	Cough Flu Asthma
Milona	"... If the person has a bad intestine, just shave it very shaved and drink." (E27 / M, 73 years old)	Headache Intestinal problems
Boldo	"Hit the liquidator and make the juice." (E25 / F, 38 years old)	Stomach pain
Tea of astelãozinho, pennyroyal, rosemary	"Just put it in your hand, go there, cut them there on the foot and put it in the glass of water and inside and then put a little sugar and give it to the baby." (E9 / F, 66 years old)	Flu in children Belly pain
Chayote	"[...] grind it, you beat it in a blender... make that juice." (E6 / F, 36 years old)	High blood pressure
Sweet Grass/Holy Grass Tea	"I just take the leaf and put it in water to boil, put it to boil and when it cools down I drink it, don't put sugar." (E27 / M, 73 years old) "I put it in the bowl, put it in the bowl and put hot water on top. Another time I see that it's too much, I just drink it in cold water." (E4 / F, 68 years old)	Fever
Lavender tea, lemon balm, lemongrass/sweet grass, imburana	"I put water to brake, put the medicines in a bowl and pour water by frevendo." (E26 / F, 77 years old)	Pain relief
Garrafada with termite louberrinha, caroba, cotton, meleré, white velame, pomegranate, parsley, quina, cansaço, tiú, jatobá peel, partridge tree, entire pharmacy	"I go out in the woods, then I pluck roots and put them in the bottle... I cut it, punch it in the mortar and put the powder inside the bottle and put it in the bottle." (E15 / M, 41 years old) "Oh, I get a little bit of wood root there, which is in the woods there... Medicine that is available from the garden, the ones that don't hurt men, I put them in the bottle and drink it." (E12 / M, 51 years old) "These dicks that I shave there, put in the bottle and... put, when it's not white wine, it's really pinga..." (E17 / M, 81 years old)	Cleansing of the uterus Removing infection in the body Pain relief
Quininha-do-mato	"You take out her half-hull, right, and put it in the water, which is bitter as hell, then you take it..." (E7 / M, 42 years old)	Whet your appetite

Burnt garlic with stinky and lemon	"I roast the garlic, you know, lemon, and make the syrup and drink it, it's two, three times, it's already good." (E18 / M, 54 years old)	Flu
Heavy smoke	"[...] I pulled out this medicine, washed it, hurt all the roots and the leaves everything, put it to boil... And then, I would dump this thing and let it cool down and give that person that syrup to drink." (E24/F, 65 years old)	Fever Illness Pneumonia
Seven pain, wormwood	"Seven pain and wormwood, ensergo, put it in the water and drink." (E12 / M, 51 years old) "We make his juice [seven pains], hurt him, put him in the water and drink it." (E7 / M, 42 years old)	Stomach pain
Rhubarb	"[...] I would go to the forest, scratch these trains, come from there with those potatoes of his, wash, cut, they are yellow as saffron... Then she would dry that train, she would find a way to dry even in the trivet, like in riba do coisa do fogo, there in sheet metal, these trains... I punched it, my daughter, I took that powder and every time I put food for the person, she went with a spoon, a spoonful of that powder and put it in the first few bites of that person's food." (E24/F, 65 years old)	Swelling Big Yellow

Source: Prepared by the authors.

The variety of preparations reported evidences the autonomy of the community, marked by the appreciation of nature and reveals that knowledge is acquired and passed on over the years, functioning as an alternative to the health center, which does not exist in the place. In addition, it is possible to observe the coherence and diversity of popular knowledge, in this way, a plant is indicated for more than one therapeutic purpose, while varieties of plants are used to treat the same disease, as also reported by Silva, Lobato and Ravena-Canete (2019).

In this sense, Ramos *et al.* (2024), identified that quilombola communities have a vast ethnopharmacological knowledge and address the importance of understanding and applying this knowledge in health care strategies, since this traditional knowledge can support several actions aimed at self-care.

Among the preparations identified, the use of boldo in the form of juice, obtained by grinding the plant in a blender, used to treat stomach pain, stands out. Such use was also recorded by Farias *et al.* (2021), in a research carried out with four traditional communities located in the Recôncavo Baiano, where the knowledge and use of medicinal plants by women was investigated. The authors pointed out that boldo was used for belly and stomach pain, indigestion, malaise and hangover. In the present study, similarity was observed in terms of therapeutic purpose, suggesting that the plant, within the traditional quilombola knowledge, has wide recognition in the relief of gastrointestinal discomfort.

Although there is convergence regarding the use of the plant, as reported by one of the interviewees: "*Beat the blender and make the juice.*" (E25 / F, 38 years old), divergences

were noted in the form of preparation, since, in the study by Farias *et al.* (2021), there was a predominance of use in the form of tea, made from the leaves.

Like boldo, other medicinal plants also have variations in their preparation and use, depending on the context and the knowledge transmitted locally. Garlic, for example, added to other products, appears in this study with two forms of preparation: mashed and roasted, with the purpose of helping in the treatment of flu and gout: "*I roast the garlic, you know, lemon, and make the syrup and take it, it's two, three times, it's already good.*" (E18 / M, 54 years old) and "*Then I put half a spoonful of it, a little crushed ginger, a crushed garlic clove, a spoonful of honey and stir and drink...*" (E2 / M, 68 years old). Filgueira *et al.* (2024), in his study on the use of medicinal plants in a community in the semi-arid region of Bahia, in addition to mentioning their use to treat influenza, cites garlic as an antibiotic, prepared as a tea through decoction.

In addition, Vieitas *et al.* (2021), describe the use of garlic with a focus on its application in cases of arterial hypertension, pointing out that, daily, it should be chewed in half a unit. The joint analysis shows that traditional knowledge about plants is diverse, being adapted according to the specific contexts of each community.

This parallel contributes to reinforce the importance of ensuring the preservation of traditional knowledge, since it can influence therapy and, based on scientific validations, open paths to be integrated into health care. However, it is important to consider that different sociocultural contexts can make comparisons and, consequently, generalizations difficult.

Thus, the findings of the present research, by dialoguing with different ethnobotanical investigations, reaffirm the richness of traditional knowledge, which continues to contribute with viable answers to the daily health problems of quilombolas.

4.3 SELF-CARE PRACTICES AND USE OF INDUSTRIALIZED MEDICINES

Industrialized medicines were also frequent in the community's self-care practices. Among the most mentioned are hydrochlorothiazide and losartan, used in the treatment of hypertension as mentioned by E4 / F, 68 years old: "*Unless, for pressure I take losartan. I forgot the name of the other... Hydrochlorothiazide, I'll take that one.*" This data dialogues with studies by Santos *et al.* (2019), carried out with 390 quilombolas from 15 communities in the state of Sergipe, where a higher prevalence of hypertension was found in this public compared to the general population of the same state. In addition, diclofenac and dipyrrone used for pain relief are mentioned: "*Oh, I drink more for headaches is dipyrrone*" (E22 / M, 54 years old).

Access to medicines occurs mainly through purchases in pharmacies in the city, purchases from peddlers who frequent the community and donations from family members and neighbors, in a collective care network: *"When I don't buy from a peddler, the neighbors give it to me. Sometimes I feel the headache, I take a pill there and one gives it to me"* (E22 / M, 54 years old). These data confirm the findings of Leite *et al.* (2022), who, when surveying quilombola and non-quilombola adolescents living in rural communities, found that the difficulty in accessing medicines through formal channels and health services leads the population to adopt these practices as an alternative care strategy.

On the other hand, this dynamic of drug circulation can generate vulnerabilities and affect the therapeutic process. Even so, it reveals an attempt not to interrupt the prescribed treatment. One interviewee reported that she was using 850 mg metformin, as prescribed, but at the time of the interview, she was taking 500 mg tablets, which she received as a donation: *"yes, it was... that she got it there, a woman there gave it to her said to bring it to me, right?"* (E1 / F, 75 years old). This type of situation highlights a risk scenario, especially among people with low education. Ghassab-Abdollahi *et al.* (2024), in a study with illiterate elderly people or those with low education, identified a high frequency of medication errors, with emphasis on failures such as incorrect dosages and administration outside the established hours, aspects that converge with the report presented.

In this sense, although industrialized medicines are present in the routine of this population, some residents clearly demonstrated resistance to their use: *"[...] I'm not much of a pharmacist who takes a lot of pharmacy medicine, I take it more than home medicine"* (E5 / F, 65 years old). Another resident reinforces his feeling of dissatisfaction about the effectiveness of industrialized medicines and values the use of home remedies involving plants: *"I take pills, I take pills it's not worth anything. Best root of the bush"* (E6 / M, 77 years old).

With regard to access to health services and industrialized medicines, there is a significant interference in self-care practices. Gomes *et al.* (2024), discuss the barriers that hinder access to primary care, highlighting factors such as racial and geographic inequalities, scarcity of care, in addition to travel costs and the absence of certain services in the SUS. Consistent with this analysis, most of the interviewees also reported similar obstacles, especially related to the distance between the community and the health services, the lack of transportation and the physical discomfort faced during the commute: *"Only when I'm really bad do I go, because [...] There are times when I travel, it seems that it gets even worse, because it seems that the body hurts like that"* (E1 / F, 75 years old). Another interviewee reported on the use of medication for diabetes: *"So, I've already taken a lot, now these days*

I'm not taking it" and when asked about the reason, she said: *"[...] it's because it's over and I'm not going on the street, because when I go I feel very sick"* (E9 / F, 66 years old). This statement highlights the negative impact on health related to the worsening of diseases and makes public policies necessary to overcome these situations.

In addition to the difficulty in accessing health services, among the main obstacles to the practice of self-care are the lack of time, information and motivation, or the lack of resources, factors that compromise the adoption and maintenance of self-care practices. In vulnerable populations, self-care can also be a form of resistance, as it emerges as a practice that favors the maintenance of health and coping with the difficulties of daily life, considering that these people face greater obstacles in accessing services, education and basic resources for care (OGASSAVARA *et al.*, 2024).

In addition, it is observed that self-care practices are not restricted to the use of medicines in isolation, there is often an association between the use of medicinal plants and industrialized medicines with the aim of enhancing the therapeutic effect: *"Then I make tea and drink it, sometimes I drink it alone, another time I take it with dipyrone, then the pressure lowers"* (E1 / F, 75 years old). This type of practice was also identified by Nink, Nunes, and Nink (2023), when they observed that, in another quilombola community, more than 50% of respondents used both conventional and traditional treatment.

5 FINAL CONSIDERATIONS

Based on the data analyzed, it was possible to identify two major axes of self-care practices present in the daily lives of quilombola individuals, in the face of different health needs: the use of medicinal plants and the use of industrialized medicines. Traditional knowledge, especially through medicinal plants, and the use of conventional drugs are mainly influenced by the local culture, the availability of resources and the severity of the health problem faced.

The results of this research show that self-care in the São Domingos quilombola community is based on knowledge acquired through experiences over time, being transmitted between generations. In this way, it acts as a strategy to deal with health problems, reduce dependence on formal health services and, thus, avoid the need to travel long distances, since the community does not have a fixed health service. This way of acting in relation to self-care practices expresses the resistance, autonomy and identity of this population.

In a context of search for equity in health, the results of this research contribute to direct the construction and implementation of more inclusive public policies and health practices, given that they address the quilombola reality, as well as the factors that influence

health care and the strategies adopted. In this way, research contributes to the appreciation, preservation of traditional knowledge and subsidization of new research.

Despite the contributions offered, this research has limitations, such as the need to extend the time of participant observation, allowing denser descriptions of the experience and self-care experiences of quilombolas. In addition, the results would be better delved into different specific points (health problems, gender, age, income, and function in the community), which would allow a more detailed view of self-care practices.

The results point to the need to strengthen health actions that really meet the needs of quilombolas, seeking to expand support for the adequate consumption of medicinal plants and industrialized medicines. It is believed that it is possible to structure primary/primary care services integrating traditional and scientific knowledge, favoring SUS medicinal plant and herbal medicine policies. In addition, encouraging dialogue is essential to value self-care practices. Future research may include different communities, and deepen the studies, aiming at the insertion of educational actions and health programs that integrate traditional knowledge.

REFERENCES

- Amador, M. S. M., & Lucas, F. C. A. (2025). Etnobotânica de plantas medicinais na comunidade Quilombola de Caldeirão, Salvaterra, Ilha de Marajó, Pará. *Interações*, 26.
- Bardin, L. (2011). *Análise de conteúdo*. Edições 70.
- Boltanski, L. (1984). *As classes sociais e o corpo*. Graal.
- Brasil. Ministério da Saúde. (2023). *Autocuidado em saúde e a literacia para a saúde no contexto da promoção, prevenção e cuidado das pessoas em condições crônicas: Guia para profissionais da saúde*. Ministério da Saúde.
- Brasil. (2003). Decreto nº 4.887, de 20 de novembro de 2003. Presidência da República.
- Brasil. (2007). Decreto nº 6.040, de 7 de fevereiro de 2007. Presidência da República.
- Brasil. Conselho Nacional de Saúde. (2012). Resolução nº 466, de 12 de dezembro de 2012. Conselho Nacional de Saúde.
- Castro, E. R. (2021). "Tem que comer o que dá sangue": Saberes tradicionais e práticas culturais no cuidar e educar de crianças quilombolas [Dissertação de mestrado, Universidade Federal de Juiz de Fora].
- Chalhoub, S. (1996). *Cidade febril: Cortiços e epidemias na Corte Imperial*. Companhia das Letras.
- Czeresnia, D. (1999). The concept of health and the difference between prevention and promotion. *Cadernos de Saúde Pública*, 15(4), 1005–1014.
- Farias, J. C., et al. (2019). Medicinal flora cultivated in backyards of a community in Northeast Brazil. *Ethnobotany Research and Applications*, 18.

- Farias, P. S., et al. (2021). Plantas medicinais utilizadas por mulheres em comunidades quilombolas do Recôncavo Baiano. *Research, Society and Development*, 10(12).
- Fernandes, S. L., & Santos, A. O. (2019). Itinerários terapêuticos e formas de cuidado em um quilombo do Agreste Alagoano. *Psicologia: Ciência e Profissão*, 39(esp.).
- Ferreira, A. L. S., Pasa, M. C., & Nunez, C. V. (2020). A etnobotânica e o uso de plantas medicinais na Comunidade Barreirinho, Santo Antônio de Leverger, Mato Grosso, Brasil. *Interações*, 21(4).
- Filgueira, D. M., et al. (2024). Conhecimento popular e tradição: Uso de plantas medicinais em um quilombo no nordeste do Brasil. *Revista Contexto & Saúde*, 24(48).
- Freitas, M. C. (2023). Educação inclusiva: Diferenças entre acesso, acessibilidade e inclusão. *Cadernos de Pesquisa*, 53.
- Gama, P. A., et al. (2019). Práticas de cuidado e cura no quilombo Abacatal. *Mundo Amazônico*, 10(1).
- Gerhardt, T. E. (2006). Itinerários terapêuticos em situações de pobreza: Diversidade e pluralidade. *Cadernos de Saúde Pública*, 22(11), 2445–2455.
- Ghassab-Abdollahi, N., et al. (2024). Self-administration medication errors at home and its predictors among illiterate and low-literate community-dwelling older adults with polypharmacy: A negative binomial hierarchical regression. *PLoS ONE*, 19(4).
- Gimovski, F., & Oliveira, C. M. R. (2024). Ancestralidade quilombola: Um caminho para a sustentabilidade e a diversidade cultural no Brasil. *Boletim de Conjuntura (BOCA)*, 19(56).
- Gomes, R. F., et al. (2024). Itinerários terapêuticos no cuidado em saúde em comunidades quilombolas. *Ciência & Saúde Coletiva*, 29(3).
- Guimarães, B. O., Oliveira, A. P., & Moraes, I. L. (2019). Plantas medicinais de uso popular na Comunidade Quilombola de Piracanjuba – Ana Laura, Piracanjuba, GO. *Fronteiras: Journal of Social, Technological and Environmental Science*, 8(3).
- Instituto Brasileiro de Geografia e Estatística. (2023). Censo Demográfico 2022: Quilombolas: Primeiros resultados do universo: Segunda apuração. IBGE.
- Kim, S. H., et al. (2023). Effects of digital self-management symptom interventions on symptom outcomes in adult cancer patients: A systematic review and meta-analysis. *European Journal of Oncology Nursing*, 66.
- Lacerda, R. S., & Mendes, G. (2018). Territorialidades, saúde e ambiente: Conexões, saberes e práticas quilombolas em Sergipe, Brasil. *Sustentabilidade em Debate*, 9(1).
- Leite, B. O., et al. (2022). Uso de medicamentos entre adolescentes rurais quilombolas e não quilombolas no interior da Bahia, Brasil. *Ciência & Saúde Coletiva*, 27(3).
- Lira, A. S., & Souza, M. H. N. (2024). Determinantes sociais da saúde e autocuidado de pessoas com diabetes mellitus: Uma revisão integrativa [Trabalho de conclusão de curso, Universidade Federal do Rio de Janeiro].
- Maio, M. C., & Monteiro, S. (2005). Tempos de racialização: O caso da 'saúde da população negra' no Brasil. *História, Ciências, Saúde-Manguinhos*, 12(2), 419–436.
- Mendonça, R. T. (2024). “Tendo dinheiro, todo o resto a gente corre atrás”: Itinerário terapêutico e prescrição política do Kit-COVID. *Observatorio de La Economía Latinoamericana*, 22(11).

- Menor-Rodriguez, M. J., et al. (2022). Influence of an educational intervention on eating habits in school-aged children. *Children*, 9(4).
- Minayo, M. C. S. (2004). *O desafio do conhecimento: Pesquisa qualitativa em saúde*. Editora Hucitec.
- Molla, I. B., et al. (2025). The role of community organisation, religion, spirituality and cultural beliefs on diabetes social support and self-management in Sub-Saharan Africa: Integrative literature review. *Journal of Religion and Health*, 64(4).
- Nascimento, R. C. (2018). Saberes tradicionais indígena sobre cuidados em saúde [Trabalho de conclusão de curso, Universidade Federal do Ceará].
- Nink, M. S., Nunes, É. S., & Nink, R. A. (2023). Culture – health relationships in a quilombola community in Northeastern Brazil: Perceptions of the duality of traditional medicine / conventional medicine. Seven Editora.
- Nodeh, Z. H., et al. (2024). A scoping review of individual health responsibility: A context-base concept. *Journal of Education and Health Promotion*, 13.
- Ogassavara, D., et al. (2024). Conjunturas contextuais e motivacionais no autocuidado ao longo da vida: Peculiaridades e influências. *Revista Interfaces: Saúde, Humanas E Tecnologia*, 12(3).
- Oliveira, J. L. M., et al. (2024). Indicadores sintéticos de vulnerabilidade: Uma revisão integrativa da literatura. *Campos Neutrais: Revista Latino-Americana de Relações Internacionais*, 6(2).
- Pedroso, R. S., Andrade, G., & Pires, R. H. (2021). Plantas medicinais: Uma abordagem sobre o uso seguro e racional. *Physis: Revista de Saúde Coletiva*, 31(2).
- Pereira, P. S., & Paula, L. L. R. J. (2018). Ações terapêuticas do capim-santo: Uma revisão de literatura. *Revista Saúde em Foco*, (10).
- Persson, V., & Wickman, U. L. (2025). Artificial intelligence as a tool for self-care in patients with type 1 and type 2 diabetes: An integrative literature review. *Healthcare*, 13(8).
- Ramos, L. F. S., et al. (2024). Ethnobotanical surveys of plants used by Quilombola communities in Brazil: A scoping review. *Life*, 14(10).
- Romanus, P. C., Mendes, F. R., & Carlini, E. A. (2018). Factors affecting the use of medicinal plants by migrants from rural areas of Brazilian Northeast after moving to a metropolitan region in Southeast of Brazil. *Journal of Ethnobiology and Ethnomedicine*, 14(1).
- Santos, D. M. S., et al. (2019). Prevalência da hipertensão arterial sistêmica em comunidades quilombolas do estado de Sergipe, Brasil. *Arquivos Brasileiros de Cardiologia*, 113(3).
- Santos, M. G., & Quintero, M. (Eds.). (2018). *Saberes tradicionais e locais: Reflexões etnobiológicas*. EDUERJ.
- Santos, M. M., & Fenner, R. S. (2021). Saberes tradicionais quilombolas no ensino de Ciências da Natureza: Uma perspectiva a partir da memória biocultural. In *Anais do XIII Encontro Nacional de Pesquisa em Educação em Ciências*. Realize Editora.
- Santos, M. T., & Lacerda, R. S. (2020). A paz quilombola e a produção de saberes tradicionais de cuidados em saúde. In *Anais do III Seminário Nacional de Sociologia: Distopias dos extremos: Sociologias necessárias*. PPGS/UFS.
- Scalze, P. S. (Ed.). (2022). *Diagnóstico dos municípios que integram o Projeto SanRural: Cavalcante, Goiás - 2019*. Cegraf UFG.

- Silva, A. C., Lobato, F. H. S., & Ravena-Canete, V. (2019). Plantas medicinais e seus usos em um quilombo amazônico: O caso da comunidade quilombola do Abacatal, Ananindeua (PA). *Revista NUFEN*, 11(3).
- Silva, É. M. (2018). Promoção da saúde: O autocuidado no contexto de grupos de pessoas que vivem com doenças crônicas não transmissíveis [Dissertação de mestrado, Universidade Federal Fluminense].
- Silva, I. M. C., et al. (2020). A importância do autocuidado na hanseníase: Uma revisão da literatura. *Educação, Ciência e Saúde*, 7(2).
- Silva, T. L. S., et al. (2019). Conhecimentos sobre plantas medicinais de comunidades tradicionais em Viseu/Pará: Valorização e conservação. *Revista Brasileira de Agroecologia*, 14(3).
- Soares, D. J., et al. (2024). Acessibilidade aos serviços de Atenção Primária à Saúde em municípios rurais do Brasil. *Saúde em Debate*, 48(142).
- Soto, N. Y. T., et al. (2021). Diseño y validación de la escala de conductas de autocuidado. *Behavioral Psychology / Psicología Conductual*, 29(3).
- Vieitas, D. R. I., et al. (2021). Uso de plantas medicinais em um quilombo: Um relato de experiência de Estratégia Saúde da Família. In *Práticas Integrativas e complementares: Visão holística e multidisciplinar*. Editora Científica.
- World Health Organization. (2022). WHO guideline on self-care interventions for health and well-being, 2022 revision: Executive summary. World Health Organization.

P3D SOFTWARE AS A RESOURCE FOR RETHINKING THE PRACTICE OF TEACHING AND LEARNING SCIENCE

O SOFTWARE P3D COMO RECURSO PARA REPENSAR A PRÁTICA DE ENSINAR E APRENDER CIÊNCIAS

EL SOFTWARE P3D COMO RECURSO PARA REPENSAR LA PRÁCTICA DE LA ENSEÑANZA Y EL APRENDIZAJE DE LAS CIENCIAS



<https://doi.org/10.56238/sevened2026.008-029>

Luzivone Lopes Gomes¹, Filomena Maria G. da Silva Cordeiro Moita²

ABSTRACT

This article presents an excerpt from the dissertation "P3D Software as a Resource for Rethinking the Practice of Teaching and Learning Science," a research project that aimed to analyze the impact of P3D software on science education with 8th-grade students. This excerpt, of a bibliographical nature, briefly discusses teacher training and the use of digital technologies in the classroom: 3D technology, Virtual Reality (VR), also considering the presence of Artificial Intelligence (AI), which is no longer a distant reality or restricted to science fiction and is increasingly present in our lives – including in education. For science education, digital technologies can make teaching playful and awaken students' interest in learning. The theoretical framework draws on studies by Lévy (1999, 2004), Veen & Vrakking (2009), Silva (2012), Moita (2006, 2007, 2013), Amabis (2001), among others. The study revealed that the use of Virtual Reality and 3D technologies improved student participation, engagement, and performance in science classes. For students, exploring the three-dimensional (3D) environment enabled a meaningful, reflective, and ethical use of available resources. The research resulted in an interactive teaching sequence (ITS) focused on science education, using three-dimensional (3D) digital resources in pedagogical practice.

Keywords: Educational Technology. 3D. Teacher Training. Science Teaching and Learning. Elementary Education.

RESUMO

O presente artigo traz um recorte da dissertação "O Software P3D como recurso para repensar a prática de ensinar e aprender Ciências", pesquisa que teve como objetivo analisar o impacto do Software P3D no ensino de Ciências, com estudantes do 8º Ano do Ensino Fundamental. Neste recorte, o objetivo deste estudo, de natureza bibliográfica, foi discutir, brevemente, a formação dos professores e o uso das tecnologias Digitais em sala de aula: Tecnologia 3D, Realidade Virtual (VR), considerando, também, a presença da Inteligência Artificial (IA) que deixou de ser uma realidade distante ou restrita à ficção científica e está cada vez mais presente em nossas vidas – inclusive na educação. Para o ensino de

¹ Master's degree in Teacher Education. Universidade Estadual da Paraíba (UEPB).

E-mail: luzivone@gmail.com

² Dr. Universidade Estadual da Paraíba (UEPB). E-mail: filomena_moita@hotmail.com

Ciências, as tecnologias digitais podem tornar o ensino lúdico e despertar no aluno interesse por aprender. Toma-se como aporte teórico estudos de Lévy (1999, 2004), Veen & Vrakking (2009), Silva (2012,), Moita (2006, 2007, 2013), Amabis (2001), entre outros. O estudo revelou que o uso das Tecnologias em Realidade Virtual e 3D melhorou a participação, o engajamento e o rendimento dos alunos nas aulas de Ciências. Para os alunos, a exploração do ambiente em três dimensões (3D) possibilitou um uso significativo, reflexivo e ético dos recursos disponíveis. A pesquisa realizada obteve como produto uma sequência didática interativa (SDI) voltada para o ensino de Ciências, quando da utilização de recursos digitais em três dimensões (3D) na prática pedagógica.

Palavras-chave: Tecnologia Educacional. 3D. Formação de Professor. Ensino e Aprendizagem de Ciências. Ensino Fundamental.

RESUMEN

Este artículo presenta un extracto de la tesis "Software P3D como recurso para repensar la práctica de la enseñanza y el aprendizaje de las ciencias", un proyecto de investigación que tuvo como objetivo analizar el impacto del software P3D en la educación científica con estudiantes de octavo grado. Este extracto, de carácter bibliográfico, aborda brevemente la formación docente y el uso de tecnologías digitales en el aula: tecnología 3D, realidad virtual (RV), considerando también la presencia de la Inteligencia Artificial (IA), que ya no es una realidad lejana ni se limita a la ciencia ficción, sino que está cada vez más presente en nuestras vidas, incluyendo la educación. Para la educación científica, las tecnologías digitales pueden hacer que la enseñanza sea lúdica y despertar el interés del alumnado por el aprendizaje. El marco teórico se basa en estudios de Lévy (1999, 2004), Veen y Vrakking (2009), Silva (2012), Moita (2006, 2007, 2013) y Amabis (2001), entre otros. El estudio reveló que el uso de la realidad virtual y las tecnologías 3D mejoró la participación, el compromiso y el rendimiento del alumnado en las clases de ciencias. Para los estudiantes, explorar el entorno tridimensional (3D) les permitió un uso significativo, reflexivo y ético de los recursos disponibles. La investigación dio como resultado una secuencia didáctica interactiva (SDI) centrada en la educación científica, que utiliza recursos digitales tridimensionales (3D) en la práctica pedagógica.

Palabras clave: Tecnología Educativa. 3D. Formación del Profesorado. Enseñanza y Aprendizaje de las Ciencias. Educación Primaria.

1 INTRODUCTION

Digital technologies have increasingly given rise to an immersive and revolutionary digital future. The meeting of Virtual Reality (VR) and Artificial Intelligence (AI) are innovations that come together to create more intelligent, dynamic and personalized immersive experiences, configuring new contexts for education.

This new digital educational context, revolutionary, contrasts with traditional teaching practices and with the notion of students' passivity, which denotes the need to rethink the school, the pedagogical practice and the resources used in the classroom. Digital technologies - henceforth treated as digital resources - bring a new behavior and a new way of learning for students and suggest to teachers the innovation of teaching.

Instead of teaching only lectures, teachers are required to propose challenges and projects through digital resources in the classroom, such as AI in education, which has been offering the possibility of more personalized, flexible, inclusive, and engaging learning. In addition, the tools provide information not only about what is being learned, but also how it is being learned and how students are feeling.

It is not intended here to deny the value of traditional resources - textbooks and paradidactics, notebooks, board games, among others - however, it is warned that the young people of this generation grew up surrounded by computers and yearn for more interactive resources at school.

It should be noted that students already arrive at school with digital skills and a different way of thinking, acting and learning. This new student profile can help the teacher to propose a new lesson design. However, this does not mean that teachers will be guided by students, but will rethink their methodologies, strategies, and resources to mediate, investigate, and coordinate their actions through digital resources that are part of their daily lives.

2 THEORETICAL FRAMEWORK

2.1 DIGITAL TECHNOLOGIES IN EDUCATION

We are experiencing the digital revolution and profound transformations happen in a fraction of seconds in the most diverse sectors of society. For education, sophisticated digital resources are suggested – Web 2.0, 3D elements, virtual reality software, among other applications – that bring a new way of expressing and communicating, of combining sounds, images, texts through Artificial Intelligence (AI), which means a new cultural context, through which new ways of interacting, thinking, teaching and learning.

The school, immersed in this context, more than ever needs to rethink its educational processes and practices, since the traditional conceptions of teaching, historically crystallized

in the classroom, no longer meet the demands of the digital society. According to Veen & Vrakking (2009, p. 13), "the problem is that schools still try to transfer knowledge as they did 100 years ago. This would not be a problem if the entire economic structure of our society were still the same, but that is not the case."

For Silva (2012, p. 84), the school has not yet understood the importance of positioning itself in a positive way in the face of the digital revolution, since it is "alien to the "spirit of the time" and remains closed in on itself, in its transmission rituals, when its surroundings are fundamentally modified in a new communicational dimension".

Also for this author, the school needs to consider the new digital experiences lived by students, as they are the new active spectators, who deal with the flow of information and know how to manipulate images on increasingly less static screens.

From this perspective, the integration of digital resources in the classroom can mean important challenges for teachers and present students with new learning experiences. For Lévy (1999), the school and teachers need to recognize the new virtual spaces as a place for the creation and acquisition of knowledge. The author calls these spaces cyberspace, defined as a "new space of communication, sociability, organization and transaction, but also the new market of information and knowledge" (LÉVY, 1999, p. 167).

Also for this author, cyberspace presents itself as one of the privileged instruments of collective intelligence, due to the multiple possibilities of interaction, participation, sharing and organization of knowledge, in the face of which the transmissive processes of content start to give way to non-linear processes, through interaction, collaboration, co-creation and participation.

From this collective construction of knowledge, which forms a global memory made possible by cyberspace, a new culture emerges, cyberculture. According to the author, the emergence of this new culture leads to a reconfiguration in the world of work and affects educational systems.

Cyberspace (which I will also call "network") is the new means of communication that arises from the worldwide interconnection of computers. The term specifies not only the material infrastructure of digital communication, but also the oceanic universe of information that it houses, as well as the human beings who navigate and feed this universe. As for the neologism "cyberculture", it specifies here the set of techniques (material and intellectual), practices, attitudes, ways of thinking and values that develop along with the growth of cyberspace (LÉVY, 1999, p. 17).

This author adds that it is unprecedented in the history of humanity to find that most of the skills acquired by a person at the beginning of his professional career will be obsolete at

the end of his career. Working means, increasingly, learning, transmitting knowledge and producing knowledge. Cyberspace supports intellectual technologies that amplify, externalize, and modify numerous human cognitive functions: memory (databases, hyperdocuments, digital archives of all kinds), imagination (simulations), perception (digital sensors, telepresence, virtual realities), reasoning (artificial intelligence, modeling of complex phenomena).

For Lemos (2010, p. 88), cyberculture is the "social and cultural product of the synergy between contemporary aesthetic sociality [...] and new technologies". Therefore, new human relationships mediated by technologies generate new values, behaviors, attitudes, culture and new expectations regarding school and teaching.

The impact of cyberculture imposes new educational models on schools and new strategies and methodologies on teachers, as it is argued that, in the face of this new cultural context, students should also be encouraged to think, develop new skills and solve problems through digital resources. Thus, it can be said that the contemporary school is intensely experiencing the challenge of integrating digital resources into its context, so that they add value to student learning. According to Lévy (2004), technological resources are particularly suited to educational uses. The fundamental role of the student's personal involvement in the learning process is well known. The more actively a person participates in the acquisition of knowledge, the more he will integrate and retain what he learns. Now, interactive multimedia, thanks to its reticular or non-linear dimension, favors an exploratory, or even playful, attitude towards the material to be assimilated. It is, therefore, an instrument well adapted to an active pedagogy (LÉVY, 2004, p. 24).

In this understanding, the use of digital resources in the classroom is defended, based on active, motivating, fun, participatory strategies and methodologies that, in addition, can have a greater impact on cognitive potential. The most important thing is not to insert digital resources in the school, because the way they are used can drive new transformations in the teaching and learning process.

Thus, Lévy (1999, p. 158) argues:

What needs to be learned can no longer be planned or precisely defined in advance [...]. We must build new models of the knowledge space. Instead of representation on linear and parallel scales, in pyramids structured in "levels", organized by the notion of prerequisites and converging towards "higher" knowledge, from now on we must prefer the image in emerging, open, continuous, flowing, non-linear spaces of knowledge, reorganizing themselves according to objectives or contexts, in which each one occupies a unique and evolving position.

Still for this author, it is necessary to learn from the movement of techniques. This

means that this movement, first of all, is equivalent to learning to deal with the potential of digital technologies and knowing how to take advantage of the communicational, interactive and collective construction power that they enable. In this context, the teacher needs to become an animator of collective intelligence in the classroom instead of a transmitter of knowledge.

For Lévy (2003), collective intelligence is that constructed by subjects in a collective way, which can be shared and not limited to a privileged few. For this reason, the author states that collective intelligence should be potentially valued and based on practical actions. These, in turn, are intended to mobilize the competencies of individuals who seek, in fact, the basis and objective of collective intelligence, namely: the recognition and mutual enrichment of those who are involved with this proposal.

Jenkins (2009), when dealing with collective intelligence, asserts that "none of us can know everything; each of us knows something; and we can put the pieces together, if we combine our resources and unite our skills" (JENKINS, 2009, p. 28). He deals with the impacts arising from web 2.0 (new communicational contexts, different programs and systems) and calls this process of communicational change the culture of convergence. It also draws attention to the fact that convergence does not occur through electronic machines, however sophisticated they may be, but in the subjects' brains individually and in their social interactions with others.

For education, it can be said that the convergence of media brings information through sophisticated platforms, software, applications, Artificial Intelligence, among other resources, so that students can relate, interact and make new connections with the world.

It is understood that it is necessary in the school to work with a collectively constructed "web", which may mean new teaching and learning processes, changes in methodological strategies and the emergence of new partnerships and challenges inside and outside the classroom and, consequently, new conceptions of teaching and learning from the mediation of information and communication technologies. With such technologies, the knowledge of individuals can be connected.

2.2 DIGITAL EDUCATIONAL RESOURCES: SOME CONCEPTS

The technological revolution brought the convergence of the media. Images, sounds and videos are integrated and sophisticated resources emerge: Virtual Reality (VR) and Three Dimensions (3D) and finally Artificial Intelligence (AI).

For Lévy (1999, p.110) "virtualization is complex, problematic, the knot of tendencies or forces that accompanies a situation, an event, an object or any entity, and that calls a

process of resolution, updating". This means that the virtual should no longer be seen as a way of being, but as a dynamic, as something that exists in potentiality.

Still for Lévy (1996), the real and the virtual cannot be understood as opposite instances, but as potentially convergent, because they start from a continuous process of permanent updating that enables the articulation between the real world and the virtual world. Thus, it is understood that the virtual is real, even if it cannot be fixed in the determined time and space.

Schön (1992) argues that "an orchestra rehearsal is also a virtual world, just like a role-play or a computer screen". In this sense, the author defines the virtual world as any scenario that represents a real world and that allows us to experiment, make mistakes, become aware of our mistakes and try again, that is, the world of practice. For Schön (1992, p. 11), "[...] all this takes place in a Praticum, which is a virtual world that represents the world of practice".

The integration of real and virtual information in the same environment is a very effective way to put the student in front of distant or inaccessible content or people, without taking away perceptions related to the real environment that surrounds him. "With this, it is possible to combine the advantages of VR with the maximum sense of presence provided by local activities. The potential of this union is very stimulating for educators and students" (Tori, 2010, p. 157-158).

It is understood that the use of 3D technology in virtual reality can contribute significantly to Science Teaching, since it makes it possible to carry out simulations of abstract contents. As happened in this study, in which students experienced the use of 3D Software in the study of Science, based on AI, 3D Software helped students develop problem-solving skills and worked as a complement to what was studied in the Textbook or illustration on the blackboard.

3 THE TEACHING OF NATURAL SCIENCES WITH DIGITAL TECHNOLOGIES

The teaching of Natural Sciences in contemporary times needs to be considered as a collective, historical, contextualized, unfinished production, which develops through ruptures and scientific revolutions. However, in general, it is observed that the practice in the classroom and the resources used by teachers, for the most part, are textbooks, transcription on the blackboard and practices of memorizing texts and ready-made answers. It is observed that this type of teaching has left gaps in student learning. An approach that associates theory and practice, values collective and meaningful practices, is dialogical and works with a procedural evaluation is still little present in this area of teaching.

Amabis (2001) states that the difficulties in this area of knowledge are universal and that "the problem of current science teaching, in high school and elementary school, lies in the lack of a sense of direction, of a philosophical basis and the fact that teachers continue to teach as they were taught due to the lack of models" (AMABIS, 2001, on-line). Also for this author, it is expected that, in Natural Sciences and Biology classes, students make the articulation between the knowledge studied at school and everyday life.

Therefore, he judges meaningless an education based on the transmission of facts. It is necessary to prioritize interdisciplinarity, new proposals and new resources through which the student can understand how knowledge was built and how it can be changed. In a world of constant change, teachers need to understand that students have changed, and that the old educational paradigms are not meeting their demands.

It is defended, here, that the teaching of Natural Sciences should, therefore, start from a contextualized perspective, having the student as a producer and co-producer, in order to know how to interact with different types of information, concepts and practical experiences from their experiences, ethical values and social beliefs that are required by contemporary society, so that teaching can contribute to the formation of the lives of critical citizens, who know how to position themselves in the face of the challenges of science and technology.

Technologies are bridges that open the classroom to the world, that represent, mediate our knowledge of the world. There are different forms of representation of reality, in a more abstract or concrete way, more static or dynamic, more linear or parallel, but all of them, combined, integrated, enable a better apprehension of reality and the development of all the potentialities of the student, of the different types of intelligence, skills and attitudes (MORAN, 2007, p. 05).

The National Common Curriculum Base (BNCC) says that technology comes in as an ally of the teacher and the student, and directly advises that the use of digital information and communication technologies should be used to produce knowledge and solve problems in the Sciences – something not so present in the National Curriculum Parameters (PCN, 1997).

The BNCC advises that the teacher has a more critical training in relation to digital technologies so that their use is pedagogical and intentional and not just to enhance a class, and that students must be able to master the digital universe, making a meaningful, reflective and ethical use of the available resources, something present in general competencies (digital culture) and in the specific sciences.

The BNCC expresses the importance of adopting the investigative approach as a central element of training. The teacher must intentionally enable students to actively participate, a direct relationship with the issue of scientific literacy. And it is not enough just

to test the concepts, it is necessary to build them collectively.

The normative document clarifies that the teaching of the component must provide experiences in which children and young people can get involved in all stages of the scientific investigation process: observing, asking, analyzing demands, proposing hypotheses, developing models and explanations, developing, disseminating and implementing solutions to solve everyday problems, among others.

This is a point of attention to abandon once and for all the mere transmission of content in expository classes and memorization, still present in many schools. Therefore, the teacher's function is to be a source of information and, mainly, to guide the students' investigative actions to develop skills and competencies with autonomy.

Moita (2007) states that teachers, in their different disciplines, must integrate digital resources into their pedagogical work, in order to promote new forms of interaction and learning. Thus, it is understood that Science teachers need to rethink their methodologies, strategies and resources used in pedagogical practice to motivate students and offer them new learning experiences and the world to act, create, think and live actively in a society of constant change. Next, an Interactive Didactic Sequence (SDI) for Science Teaching, with the use of 3D Software, carried out during the studies of the Master's Degree in Teacher Training at the State University of Paraíba - UEPB

4 INTERACTIVE DIDACTIC SEQUENCE IN THE TRAINING OF SCIENCE TEACHERS WITH 3D TECHNOLOGIES

The idea of developing an Interactive Didactic Sequence as a use of 3D Technologies arose from the readings that grounded this study, as well as from the observations of Science classes with the application of the P3D educational software, when some difficulties faced by teachers regarding the use of this resource in pedagogical practice were observed.

It is argued that integrating 3D digital resources in science teaching can be a way to put students and teachers in front of new experiences and learning situations, a moment in which they will be able to experience virtual experiences with content and people from simulations in the real environment. In this context, it was clear the need to disseminate the thought of scholars who work with this theme through an Interactive Didactic Sequence, since this methodology enables interaction and sharing of knowledge and knowledge.

Oliveira (2013, p. 58) defines Interactive Didactic Sequence (SDI) as a new didactic-methodological proposal that has as "[...] procedure the construction and reconstruction of concepts on different themes of the curricular components of basic education, undergraduate and graduate courses". Also for this author, the Interactive Didactic Sequence (SDI) is

developed based on a series of activities for the systematization of concepts and definitions of a given theme, aiming at the construction of new knowledge and knowledge. In the Interactive Didactic Sequence described below, the steps defined by Oliveira (2013) were used, as mentioned in the fourth chapter of this study.

Therefore, by applying this SDI, it is intended to investigate aspects inherent to the theoretical conceptions of Science teachers about 3D Technologies and to share experiences, aiming at the construction and reconstruction of new knowledge regarding the proposed theme.

Thus, the objective is to present a didactic sequence focused on the teaching of Natural Sciences in Elementary School, developed as an educational product of the dissertation of the Graduate Program in Teacher Training (PPGFP) – Professional Master's Degree, at the State University of Paraíba (UEPB). An Interactive Didactic Sequence (SDI) was developed and applied with a qualitative approach, based on pedagogical intervention.

SDI, focusing on the use of 3D and Virtual Reality technologies, was applied and discussed with teachers and future teachers of Science and Biology during 5 meetings in the Computer Laboratory, in a private institution of Basic Education, in the city of Campina Grande, PB. The results indicate contributions to methodological changes in teachers' practices, in addition to favoring interaction and the construction of knowledge in the teaching of Science and Biology. The study evidenced the articulation between academic research and educational product with practical application, through the interaction, discussion and evaluation of the P3D software and theoretical studies on the integration of digital technologies in Science Teaching. Next, the Interactive Didactic Sequence (SDI) is presented.

4.1 CONTINUING EDUCATION WITH SCIENCE TEACHERS: APPLICATION OF THE DIDACTIC SEQUENCE

4.1.1 SDI's first sequence of activities – Survey

Stage 1: The procedures for the application of the Interactive Didactic Sequence (SDI) will be presented and discussed with teachers and future teachers of Science and Biology, as a methodology that can act as a facilitating agent for the interaction, construction and reconstruction of new knowledge in Science Teaching with the use of 3D Technologies. The place chosen for teacher training was the School's Computer Laboratory.

Stage 2: Moment of the surveys, through interaction with teachers, we carried out a dialogue about the importance of using technologies in Science Teaching and the impacts they may have on the teaching and learning process. Questions, such as: **What is 3D**

Technology? How to integrate 3D Technologies in Science and Biology classes? After all teachers answer the questions, they will be divided into small groups. Each group was asked to discuss the proposed questions. After the discussion, each group will be asked to prepare a synthesis of the issues.

Step 3: In this step, each group must choose a representative, and thus a new group will be formed, with only the representative of each group in which the conceptions of each group were synthesized in a single concept. The teacher in the classroom will mediate, asking the group representatives to make a synthesis of all the small groups. Thus, a general synthesis (definition) will be built on what teachers understand by the proposed questions.

Stage 4: The new synthesis will be presented and discussed with the large group and with the classroom teacher, so that a new definition can be elaborated, a process that, for Oliveira (2013, p. 59), is characterized as the beginning of the construction of new knowledge.

Stage 5: The new synthesis will be presented and discussed with the large group and with the classroom teacher, so that a new definition can be elaborated, a process that, for Oliveira (2013, p. 59), is characterized as the beginning of the construction of new knowledge.

4.1.2 Second sequence of SDI activities – Theoretical and practical basis

Step 6: To systematize, discuss and substantiate the possible answers to the questions, the teacher and/or trainer should seek the theoretical foundations of the authors (books, texts, slides, documents, images, videos and other resources) to work with the participants, always in constant dialogue with the teachers. At this stage, the teacher/trainer should base the content of the theme under study on authors such as: Lévy (2004), Moita (2006, 2016), Gee (2001), Prensky (2001, 2010, 2013), Papert (1996); Silva (2012) and other theorists who treat and consider Digital Educational Technologies in the school context as allies of cognitive development, teaching innovation and as contexts that structure the ways of thinking, doing, communicating, establishing relationships with the world and representing knowledge.

Stage 7 (Conclusion): It will be carried out, based on the articulation of theoretical and practical knowledge. In this way, teachers will explore the P3D Software – in Module 1 – Sciences (Human Body), already installed in the computers of the Computer Lab. They will be invited to dialogue among their peers, how they can use the P3D Software in future classes with their classes. Finally, this stage can be conducted by requesting a new written version of the contents studied. To close the contents, it is suggested as activities that the participants reflect on the following question: **What are the contributions of integrating digital technologies, especially 3D technologies, in Science and Biology classes?** At

this stage, it is important that the teacher is creative, interactive and dynamic, and has awareness and intentionality in planning so that the learning results can have positive impacts.

5 METHODOLOGY

The present study in Education is part of a qualitative investigation, since it took place in the natural environment of the school. Thus, a descriptive exploratory study was carried out in the school context, since, with this type of methodology, the researcher can observe, analyze and describe the experiences carried out in the classroom, prioritizing the process more than the product and being concerned with reporting the perspective of the subjects.

According to Severino (2007, p. 123), "exploratory research seeks to gather information about a certain object, delimiting a field of work and mapping the conditions of manifestations of this object", as was done in this investigation, in which it was sought to collect information and describe the process and effects of the use of P3D educational software in the practice of teaching and learning Science, aiming, above all, to understand the meaning that the subjects attributed to the experience of using this digital resource.

Data analysis was performed in a descriptive and inductive manner. The collected data were recorded in field notes (through observations in a computer lab and classroom) and semi-structured interviews were conducted with the teacher and students.

The researched field was a confessional private educational institution, of Basic Education, located in the municipality of Campina Grande - Paraíba

6 RESULTS AND DISCUSSIONS

It was sought, systematically and pedagogically, to observe the students and the teacher when making use of 3D digital resources, especially a software for the Teaching of Science (Human Body). Their opinions on the effects of this resource on the teaching and learning process were collected. The results revealed that Virtual Reality and 3D technologies enabled more participation, engagement and improvement of students' performance in Science classes, and above all the personalization of teaching.

With the data collected in the participant-observations, it was possible to verify that the classes became more playful and dynamic and that there was an improvement in the interaction, attention and concentration of the students, compared to the classes in which usual resources were used, such as the textbook. Another aspect observed concerns the interest and creativity of the students in performing the task proposed by the teacher. They used 3D images, animation and texts to simulate the functioning of the human body and the

digestive system normally in the classroom.

Also in the observations, it was found that the teacher was driven to modify the methodology and the way he approached the contents, using simulation and experimentation to explain the functioning and structure of the digestive system, which was done through the textbook and illustrations on the blackboard.

In addition to motivation and more dynamic classes, students were placed in front of a new learning culture, through which they made new connections about the importance of healthy eating for the proper functioning of the digestive system and the human body in general. By proposing a contextualized study concerned with health, using the educational software P3D, the teacher encouraged students to relate theoretical concepts to practice, such as the function of the organs of the digestive system and their functioning, which increased their learning.

The statements of the students and the teacher, subjects of this study, ratify the hypothesis that the educational software P3D is a resource that can contribute to the teaching of Science, if used appropriately. The students expressed that they were able to learn differently about the digestive system, especially about the function of organs and the importance of their functioning for the human body.

The students' speeches also reveal the importance of using digital resources such as the P3D educational software for learning, as students can learn with pleasure, having fun and through challenges, as they pointed out in their speeches. Such aspects denote that the young people of this generation yearn to participate in projects at school that contemplate interaction, playfulness, participation, creation and co-creation in the various subjects of the school curriculum.

In the professor's speech, the important contribution of the software to the practice is verified, as it enables new ways of teaching. Aspects such as integration with curricular content, interaction and better student performance were highlighted by him. It is also important to highlight an important impact on the teacher's practice, as well as the possibility of associating theoretical and practical knowledge in a contextualized way, contrary to the traditional legacy of science teaching, based on bookish and transmissive teaching.

When, in the classroom, one manages to motivate and awaken the desire to learn with pleasure and make new discoveries, this means opening new paths for knowledge of the world. As the students' statements revealed, the P3D software was useful in the process of learning Science because, in addition to the contents, they learned for life, making their own discoveries, and started to have more performance in the discipline, as well as more admiration for the school and their teacher.

In this sense, it is possible to verify the importance and responsibility of the school as a space for human interaction that integrates resources and proposals that provide innovative and student-centered teaching. Teachers need to launch themselves into the promotion of an innovative practice, based on new educational paradigms, so that they can produce new identities, knowledge and practices in the classroom, encouraging students to have autonomy, to discover, share, create and socialize a new way of thinking.

7 SOME CONSIDERATIONS

How are schools and teachers seeing their role in the school of the twenty-first century? How are digital resources reaching the school and how are they being used? How are teachers and the entire team that is part of the school being prepared to face the new challenges of the digital age? Is the school, as a promoter of knowledge, enabling students' access to digital resources, to guarantee their right to digital literacy?

Such questions refer to some difficulties and limitations encountered in the course of this study. Among them, the way most teachers and school staff understand the integration of digital technologies in the teaching and learning process. It is seen that a change of vision is still necessary, so that all those involved in their context carry out a joint and reflective work on the action and results of the use of technologies in the school, which is not limited to the figure of the mediator of the school's technologies.

The lack of training and the lack of interest of teachers to incorporate the P3D educational software in their pedagogical practices were difficulties encountered in the course of this study. Among the 20 teachers who went through continuing education for the use of P3D, only one – the Science teacher – presented a proposal for its use, putting it into practice. This fact limited the research to the discipline "Sciences". Another difficulty concerns the use of P3D software itself, since it requires computers with sophisticated processors and video cards, which we do not always find in schools.

Finally, it is suggested that future investigations be carried out not only in the discipline of Natural Sciences, but in the other disciplines of Basic Education, anchored in the use of 3D digital resources in the classroom so that the way of teaching and learning in the digital age can be rethought.

Rethink the practice of teaching and learning! This is the great challenge of the school of the twenty-first century, where the virtual and the real coexist in a world in constant mutation. It concludes, then, with the words of Moita (2006), when he states that recognizing the potential of digital technologies for the process of teaching and learning is to live in a contemporary world, with its changes, and to accept them to collaborate with the education

of the new generations.

REFERENCES

- Brasil. Ministério da Educação. Secretaria de Educação Fundamental. (1997). Parâmetros curriculares nacionais (1ª a 4ª séries) – Ciências naturais (Vol. 4). MEC/SEF.
- Brasil. Ministério da Educação. (2017). Base nacional comum curricular: Educação é a base. MEC.
- Costa. (2013). O potencial transformador das TIC e a formação de professores e educadores. In M. E. Almeida & P. Dias (Eds.), Cenários de inovação na sociedade digital. Loyola.
- Fava, R. (2014). Educação 3.0: Aplicando o PDCA nas instituições de ensino. Saraiva.
- Gee, J. P. (2009). Bons videogames e boas aprendizagens. *Perspectiva*, 27(1). <http://migre.me/tbG6b>
- Gomes, A. S. (2015). Cultura digital na escola: Habilidades, experiências e novas práticas. Pipa Comunicação.
- Gomes, A. S. (2014). Ensinando a ciência por trás da tecnologia 3D. <http://migre.me/tbGfW>
- Jenkins, H. (2009). Cultura da convergência (1ª reimpr., S. Alexandria, Trad.). Aleph. (Obra original publicada 2006)
- Kenski, V. M. (2012). Educação e tecnologias: O novo ritmo da informação (8ª ed.). Papirus.
- Kenski, V. M. (2013). Tecnologias e tempo docente. Papirus. (Coleção Papirus Educação)
- Kenski, V. M. (2008). Tecnologias e ensino presencial e à distância (5ª ed.). Papirus.
- Lemos, A. (2010). Cibercultura: Tecnologia e vida social na cultura contemporânea (5ª ed.). Sulina.
- Lévy, P. (2004). As tecnologias da inteligência: O futuro do pensamento na era da informática (13ª ed.). Editora 34.
- Lévy, P. (2003). A inteligência coletiva: Por uma antropologia do ciberespaço (4ª ed.). Loyola.
- Lévy, P. (1999). Cibercultura. Editora 34.
- Lévy, P. (1996). O que é o virtual? Ed. 34.
- Moita, F. M. G. da S. C. (2006). Games: Contexto cultural e curricular juvenil [Tese de doutorado, Universidade Federal da Paraíba].
- Moran, J. M. (2007). As mídias na educação. In J. M. Moran, Desafios na comunicação pessoal (3ª ed., pp. 162–166). Paulinas. <http://migre.me/tbFPM>
- Moran, J. M. (2012). Complexidade e dialogicidade no processo de formação de professores. In Formação de professores: Estratégias inovadoras no ensino de Ciências e Matemática (Série Formação de Professores – PPGE, Vol. 3). Editora da UFRPE.
- Oliveira, M. M. de. (2013). Sequência didática interativa no processo de formação de professores. Vozes.
- Papert, S. (1996). A família em rede: Ultrapassando a barreira digital entre gerações (F. J. S. Nunes, Trad.). Relógio D'água. (Obra original publicada 199?)

- Ramos, J. L. P. (2013). Recursos educativos digitais potencialmente inovadores ou oportunidade de acrescentar valor à aprendizagem. In M. E. Almeida & P. Dias (Eds.), *Cenários de inovação na sociedade digital*. Loyola.
- Severino, A. J. (2007). *Metodologia do trabalho científico* (23ª ed. rev. e atual.). Cortez.
- Schön, D. (1995). Formar professores como profissionais reflexivos. In A. Nóvoa (Coord.), *Os professores e a sua formação*. Publicações Dom Quixote; Instituto de Inovação Educacional. <http://migre.me/tbH6i>
- Silva, M. (2012). *Sala de aula interativa*. Quartet.
- Tapscott, D. (2010). *A hora da geração digital: Como os jovens que cresceram usando a internet estão mudando tudo, das empresas aos governos* (M. Lino, Trad.). Ed. Agir.
- Tori, R. (2010). *Educação sem distância: As tecnologias interativas na redução de distâncias em ensino e aprendizagem*. Ed. SENAC.
- Kirner, C., & Tori, R. (2006). Fundamentos de realidade aumentada. In R. Tori, C. Kirner, & R. Siscoutto (Orgs.), *Fundamentos e tecnologia de realidade virtual e aumentada*. Sociedade Brasileira de Computação (SBC). <http://migre.me/tbHcJ>

APPENDIX

P3D Software – Datasheet

Developer Data: <<http://www.p3d.com.br/empresa/>>;

Version: 07/20013

- Supported platforms: Tablets; Desktops and Laptops: Windows 7 and Vista

Windows XP (32 Or 64 Bits) and Mobile;

Area of Knowledge: Science, Geography, Biology and Chemistry of Elementary and High School;

Language: Portuguese, Spanish and English;

Didactic Guide: Portuguese, Spanish and English.

PROPOSAL FOR AN ASSESSMENT ACTIVITY IN GEOGRAPHY USING KEY THEMES FROM THE GLOBAL AND NATIONAL CONTEXT

PROPOSTA DE ATIVIDADE AVALIATIVA EM GEOGRAFIA UTILIZANDO TEMAS IMPORTANTES NO COTIDIANO GLOBAL E DO PAÍS

PROPUESTA DE ACTIVIDAD EVALUATIVA EN GEOGRAFÍA UTILIZANDO TEMAS RELEVANTES DEL CONTEXTO GLOBAL Y NACIONAL



<https://doi.org/10.56238/sevened2026.008-030>

Marina Aires¹, Arthur Galvão de Mendonça²

ABSTRACT

This experience report refers to an assessment activity proposed for the 8th grade of lower secondary education, involving students from the Augusto Pugnali Municipal School, located in the municipality of Petrópolis (Metropolitan Region of Rio de Janeiro – RMRJ). The activity was entitled “Simulating a United Nations Conference.” To achieve the objectives of the activity, active methodology proposals were developed using the classroom space, allowing students to discuss the proposed themes, conduct research on them, create posters, and present them to their classmates. At the end of the activity, a debate was held on the importance and learning outcomes of each topic discussed.

Keywords: Education. Active Methodologies. Current Issues.

RESUMO

O presente relato de experiência faz menção a uma atividade avaliativa, proposta para o 8º ano do Ensino Fundamental II, envolvendo os discentes da Escola Municipal Augusto Pugnali, localizada no município de Petrópolis (Região Metropolitana do Rio de Janeiro – RMRJ). A presente atividade foi intitulada “Simulando uma Conferência da ONU”. Para alcançar o objetivo da atividade foram elaboradas propostas de metodologias ativas, utilizando o espaço da sala de aula, onde os alunos puderam discutir sobre os temas propostos, pesquisar sobre estes, elaborar os cartazes e apresentá-los aos outros colegas de turma. No final da atividade, foi realizado um debate sobre a importância e aprendizagem de cada tema discutido.

Palavras-chave: Educação. Metodologias Ativas. Temas Atuais.

RESUMEN

El presente relato de experiencia hace referencia a una actividad evaluativa propuesta para el 8.º grado de la Educación Secundaria Básica, involucrando a los estudiantes de la Escuela

¹ Dr. in Geography. Prefeitura Municipal de Petrópolis. E-mail: marinageouff@gmail.com
Orcid: <https://orcid.org/0000-0001-7608-3090> Lattes: <http://lattes.cnpq.br/7576664260245211>

² Undergraduate student in Physics. CEFET RJ Uned Petrópolis. E-mail: art_gallvao@yahoo.com.br
Orcid: <https://orcid.org/0009-0008-9560-9930> Lattes: <http://lattes.cnpq.br/5630430770073797>

Municipal Augusto Pugnaloni, ubicada en el municipio de Petrópolis (Región Metropolitana de Río de Janeiro – RMRJ). La actividad se tituló “Simulando una Conferencia de la ONU”. Para alcanzar los objetivos de la actividad, se elaboraron propuestas de metodologías activas utilizando el espacio del aula, en las que los alumnos pudieron debatir los temas propuestos, investigarlos, elaborar carteles y presentarlos a sus compañeros de clase. Al final de la actividad, se realizó un debate sobre la importancia y el aprendizaje de cada tema abordado.

Palabras clave: Educación. Metodologías Activas. Temas Actuales.

1 INTRODUCTION

The activity with students from the 8th grade of Elementary School was developed during the months of September to November, where they were divided into groups of 4 to 5 students. The themes presented for the elaboration of the works are current and important, not only for the world context, but also for the Brazilian reality.

The topics to be studied, debated and presented by them were: the War in Ukraine and Russia, Religious Intolerance, Racism in the world, COP 30, the War in the Middle East, Donald Trump's Government and Climate Change: causes and consequences for global society.

Materials were made available on each issue to be presented, as well as conversation circles and presentation of films, documentaries and reports. The stages of the activity were carried out in a school environment, always under the supervision of the teacher and the interns, and the material to be used was made available by the school.

It is also noteworthy that the groups had the freedom to choose how they would present their discussions and conclusions on the theme, being able to choose between the elaboration of posters and/or the use of *tablets* and research on the internet. The presentation of the works was carried out by all the members of the groups, who answered questions on the theme asked by the teacher.

During each presentation and discussion, the students were invited to evaluate their colleagues, using a questionnaire distributed by the teacher, demonstrating what they learned from each group and at the end it was proposed to prepare an essay, of 15 to 20 lines, highlighting the importance of an activity of this type and how the students felt analyzing each theme.

The objective of the activity was to promote the use of active methodology in the classroom, fostering a space for dialogue and discussion on relevant topics that impact the daily life of Brazil and the global environment, using resources available at school, whether technological or not.

2 TARGET AUDIENCE OF THE ACTIVITY

This activity was carried out with students in the 8th grade of Elementary School II, according to the general competencies of the National Common Curricular Base (BNCC), where the main objective of the Geography discipline is the development of geographical reasoning, the understanding of the world and the student's performance as a citizen (BRASIL, 2017).

From the grade in which the teacher teaches, this type of work can be adapted to the needs of each class, based on the BNCC and the students' own questions. It is up to the teacher to analyze the probability of developing an activity of this type and what will be the themes to be discussed by them.

3 METHODOLOGY

The activity was carried out within the scope of the third academic bimester of the year 2025, based on a proposal made by the students themselves regarding a rereading of the bimonthly evaluations of the discipline. For this, the possibility of adapting and preparing a UN Conference was discussed with the school's management team, bringing discussions and presentations on current and relevant topics. From this, a series of activities was proposed to the students that culminated in the activity and the bimonthly evaluation.

A work script was prepared with instructions on what each group should do and from this, the students were asked what were the topics that they were most curious about or that they wanted to study, and the aforementioned themes were reached. The dates for the presentation of the papers were defined, as well as the need to carry out the essays, pointing out the pros and cons of the activity.

Then, there was a first round of dialogue with the groups, where the students were able to ask questions about the realization of the work, as well as questions were raised about how to research the themes and how each one could contribute in the subsequent presentations. For each theme, videos, media files in general and documents for individual and/or group research were presented.

In the middle of October 2025, a new conversation circle was held about the realization of the works. It should be noted that the students were nervous about having to present their results to their classmates, but that the knowledge about each topic was arousing curiosity in each one. In this part, the students brought the materials (photographs and text) for the elaboration of the posters in the classroom.

In early November 2025, the students presented their research in the classroom, using posters and/or *slides*, presenting the themes, their causes, their consequences and in some cases bridging the gap between the theme and the reality experienced in the country. The groups that presented the work on Racism in the world, the Trump Administration and the issue of COP 30 were the ones that achieved satisfactory results, bringing current and relevant information about each one and how its implications affect the daily life of the world, the country and, in the case of racism, how these practices are harmful in the school environment.

At the end, the students prepared the essays with the main questions raised by each group, how it was necessary to have a dialogue between the participants, how the work was prepared and, finally, how the proposed activity was important for the knowledge and discussion of each theme.

4 RESULTS ACHIEVED

The results achieved were positive, with regard to the discovery of subjects that are often not discussed correctly or that are not interesting to them, are left aside. Getting students to think about the topics they wanted to work on, as well as the way they wanted to present their work, was crucial to the success of the activity. Even the class wants another activity of this type, which will be held during the 2026 school year. At the end of the activity, an exhibition mural was prepared showing each of the works in the classroom itself.

Some of the works are shown below, Figure 1 presents the results on the theme Racism in the world; Figure 2 is about the issue of Religious Intolerance and Figure 3 is about COP 30.

Figure 1

Poster on Racism in the World

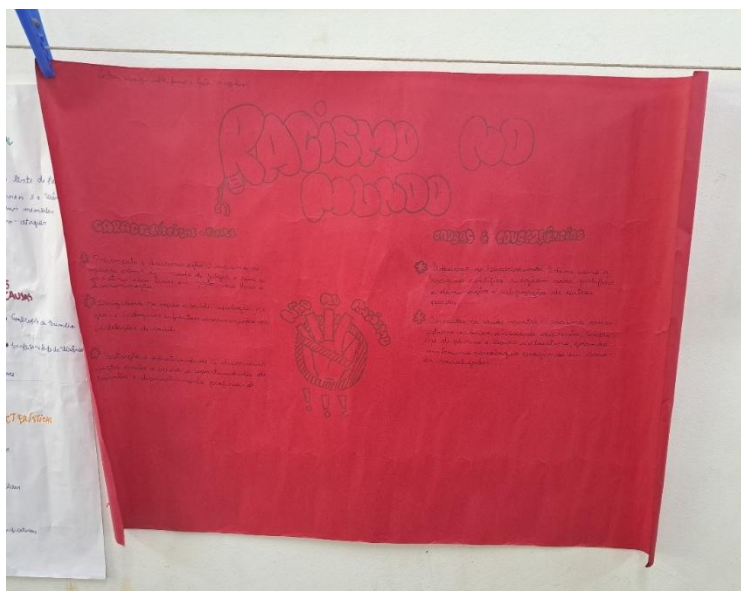
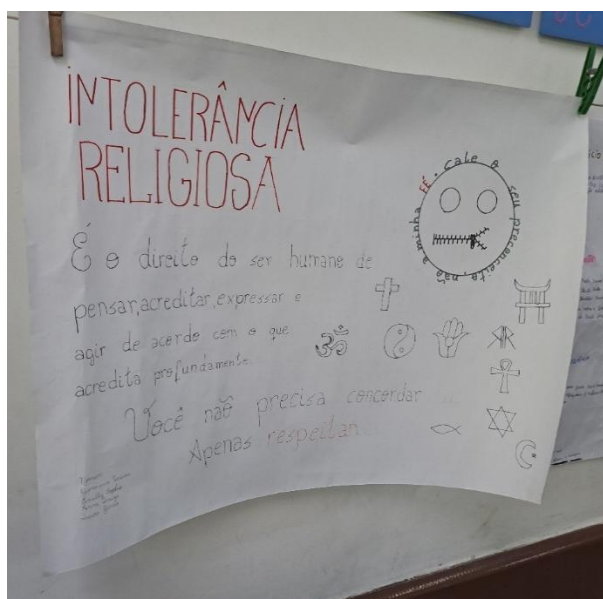


Figure 2*Work on Religious Intolerance.***Figure 3***Poster about COP 30*

5 CONCLUSIONS

The proposed activity was successful and was accepted by the school community, in the sense of bringing to the debate current issues of extreme importance for the daily lives of students. In addition, the students played an essential role in conducting the activity. It should be noted that this can be carried out in any grade of Elementary or High School, using materials available in schools and respecting the content and interest of the students involved.

REFERENCES

Brasil. Conselho Nacional de Educação. Conselho Pleno. (2017). Resolução CNE/CP nº 2, de 22 de dezembro de 2017. Institui e orienta a implantação da Base Nacional Comum Curricular, a ser respeitada obrigatoriamente ao longo das etapas e respectivas modalidades no âmbito da Educação Básica. Diário Oficial da União. https://basenacionalcomum.mec.gov.br/images/historico/RESOLUCAOCNE_CP222DEDEZEMBRODE2017.pdf

EDUCATIONAL TECHNOLOGIES IN BIOLOGY TEACHING: AN IMMERSIVE EXPERIENCE WITH 3D SOFTWARE

TECNOLOGIAS EDUCACIONAIS NO ENSINO DE BIOLOGIA: UMA EXPERIÊNCIA IMERSIVA COM SOFTWARE EM 3D

TECNOLOGÍAS EDUCATIVAS EN LA ENSEÑANZA DE LA BIOLOGÍA: UNA EXPERIENCIA INMERSIVA CON SOFTWARE 3D



<https://doi.org/10.56238/sevened2026.008-031>

Luzivone Lopes Gomes¹, Filomena Maria G. da Silva Cordeiro Moita²

ABSTRACT

This article discusses the integration of Digital Technologies in the school context and briefly shares an experience of using P3D Software in Biology teaching. The theoretical support was based on studies by Amabis (2001), BNCC (2018), Costa (2004), Lévy (2005), Moita (2006 and 2007), among others. For data collection, bibliographic research and participant observation in the computer lab were used with the use of P3D Software in Biology classes with 9th-grade students. The study revealed that with the use of educational technologies, new ways of teaching and learning are emerging, ensuring that children and young people have their learning rights in relation to understanding, using, and creating with digital resources. The use of P3D Software made teaching more attractive and immersive. Students combined 3D images of the Human Body; Numerous possibilities exist for teaching content about the Human Body, aligned with the BNCC (Brazilian National Curriculum Base), which would not be possible in a traditional classroom setting based on linear text and images.

Keywords: Biology Teaching. 3D. Virtual Reality. Elementary School. BNCC.

RESUMO

O presente artigo discute a integração das Tecnologias Digitais no contexto escolar e compartilha, brevemente, uma experiência do uso do *Software P3D* no Ensino de Biologia. O suporte teórico teve embasamento nos estudos de Amabis (2001), BNCC(2018), Costa (2004) Lévy(2005), Moita (2006 e 2007) entre outros. Para a coleta dos dados, utilizou-se de pesquisa bibliográfica e a observações participante no laboratório de Informática com o uso do *Software P3D* nas aulas de Biologia, com alunos do 9º Ano do Ensino Fundamental. O estudo revelou que com o uso das tecnologias educacionais, novas formas de ensinar e aprender vão surgindo, garantindo que crianças e jovens tenham seus direitos de aprendizagem em relação à compreensão, utilização e criação com o uso de recursos digitais. O uso do *Software P3D* tornou o ensino mais atraente e imersivo. Os alunos realizaram combinação de imagens do Corpo Humano em 3D; inúmeras possibilidades de

¹ Master's degree in Teacher Education. Universidade Estadual da Paraíba (UEPB).
E-mail: luzivone@gmail.com

² Universidade Estadual da Paraíba (UEPB). E-mail: filomena_moita@hotmail.com

ensinar os conteúdos sobre o Corpo Humano, alinhado a BNCC que, em um espaço de sala de aula tradicional, baseado em texto e imagens lineares não seria possível.

Palavras-chave: Ensino de Biologia. 3D. Realidade Virtual. Ensino Fundamental. BNCC.

RESUMEN

Este artículo analiza la integración de las tecnologías digitales en el contexto escolar y comparte brevemente una experiencia con el uso del software P3D en la enseñanza de Biología. El fundamento teórico se basó en estudios de Amabis (2001), BNCC (2018), Costa (2004), Lévy (2005), Moita (2006 y 2007), entre otros. Para la recopilación de datos, se empleó la investigación bibliográfica y la observación participante en el laboratorio de informática, utilizando el software P3D en clases de Biología con estudiantes de 9.º grado. El estudio reveló que, con el uso de las tecnologías educativas, surgen nuevas formas de enseñanza y aprendizaje, garantizando que niños y jóvenes tengan derecho a aprender a comprender, usar y crear con recursos digitales. El uso del software P3D hizo la enseñanza más atractiva e inmersiva. Los estudiantes combinaron imágenes 3D del cuerpo humano; existen numerosas posibilidades para la enseñanza de contenidos sobre el cuerpo humano, alineados con la BNCC (Base Curricular Nacional Brasileña), lo cual no sería posible en un aula tradicional basada en texto lineal e imágenes.

Palabras clave: Enseñanza de Biología. 3D. Realidad Virtual. Escuela Primaria. BNCC.

1 INTRODUCTION

Web 2.0, in the mid-2000s, brought numerous ways of interaction and participation in different educational technologies: Platforms, applications, 3D and Virtual Reality software, among other systems, which has been radically modifying the conception and proposals of how digital resources can be used in teaching, of the various curricular components of Basic Education.

Today's students are part of a generation that communicates, shares and creates differently and has expectations of a more playful education connected with the real and virtual world. If before schools made computer labs available for students and teachers, today, as or more important than the technological infrastructure is how the school is organized for the effective use of technologies in the process of teaching and learning, that is, the pedagogical proposal, the training and the interest of teachers are integrated, aiming at the proper use of digital resources in the school. Whether teachers preferred to propose offline assignments, slideshows, or internet surveys.

Today, it is necessary to rethink the school infrastructure to receive educational technologies in their contexts and how teachers are reconfiguring the methodologies to use them to use them, aiming to develop the skills and competencies of students, because, much more than mere receivers of information, today's students want to create, feel and live new challenges in the classroom.

With the advent of the digital age, several educational technologies have been implemented in Basic Education schools to enhance teaching and learning, such as Virtual Reality laboratories, maker room with digital whiteboards and teacher training with the theme of the use of Artificial Intelligence (AI), it is seen that the way to use digital resources in school needs, increasingly, to be reflected in the different curricular components.

If before there were no clear objectives when using educational digital resources in the classroom, today teachers are required to have skills and proposals that can add value to student learning, as it is considered that, if used properly, they can be important resources to rethink the teaching and learning process at the most diverse levels of education.

Thus, this article seeks to reflect on the integration of Digital Technologies in the school context and to briefly share an experience of the use of P3D Software in Virtual Reality in the Teaching of Biology, with students of the 9th Grade - Elementary School.

2 FROM THE TRADITIONAL TO THE DIGITAL CURRICULUM: PATHS TO THE INTEGRATION OF EDUCATIONAL TECHNOLOGIES

In the scenario of great technological advances, the integration of educational technologies into the school context has become a requirement of contemporary education. For Basic Education, it is required to use and create technologies in a critical, meaningful, reflective and ethical way in the various social practices (including school ones) to communicate, access and disseminate information, to guarantee the right to learning and the development of cognitive potentialities.

According to the Ministry of Education (MEC), educational technologies are processes, tools, and materials that help education networks in the most diverse functions, from school management to the learning process in the classroom, including teacher training and inclusive education practices.

Therefore, educational technologies should be used in the classroom and, with them, more attractive classes should be proposed, which stimulate learning in a way that favors the search for information, analyzing, synthesizing and critically evaluating. It is necessary to encourage students to be protagonists of their learning and present them with learning challenges in the classroom, with interactive, collaborative and immersive resources, capable of providing them with an innovative way of thinking, acting, learning and making changes in the classroom.

In addition to enabling learning, the use of educational technologies validates what the BNCC provides. Both the main document, which brings "digital culture" as a general competency, and the complement that deals with the teaching of computing, clarify that students must develop skills related to the critical, reflective and ethical use of technological resources.

The National Common Curriculum Base (2018) provides that students need to develop general skills for digital culture using digital resources to learn and produce, use technological resources to design, develop, publish and present products (such as web pages, mobile applications and animations, for example) to demonstrate knowledge and solve problems. On the Digital World, the document explains the impact of technologies on people's lives and society, including social, cultural and commercial relations.

Thus, it is pertinent to ask: How to plan classes using digital technologies, so that they are truly integrated into curricular activities and that they are related to the competencies provided for by the BNCC?

To this question. Also, we find support in the BNCC, the document mentions that schools need to ensure the infrastructure to carry out activities related to the proposals. In

certain skills, especially those that appear in the Final Years, however, technological resources are required, such as devices with access to the internet and specific platforms. For teachers, it is the task of qualifying the use so that students make the best use of these resources.

The BNCC provides that in the Teaching of Natural Sciences, educational resources should be used to investigate and also as a means of producing information and knowledge: accessing, appreciating, producing, recording and sharing artistic practices and repertoires, in a reflective, ethical and responsible way. According to Silva (2012, p. 232) "in the classroom, the treatment given to learning content can be inspired by the construction of a network and not a route".

For Lévy (2005), it is not enough for the learner to appropriate technologies and their tools in an instrumental way, it is necessary to know how to deal with potential so that they can build knowledge and create innovative solutions. Therefore, it is understood that digital technologies are needed in the classroom in order to develop the student's interest in curricular content and mean advancement in learning.

The National Ten-Year Education Plan 2-2020 (PNE) highlights the relevance of the use of digital technologies as a pedagogical resource, at the different levels, spheres and dimensions of education, in order to encompass both students and teachers. Of the strategies, the following stand out:

7.6) Select, certify and disseminate educational technologies for primary and secondary education, ensuring the diversity of pedagogical methods and proposals, as well as monitoring the results in the education systems in which they are applied.

7.7) Foster the development of educational technologies and innovation of pedagogical practices in education systems, which ensure the improvement of school flow and student learning.

In this Plan, there are guidelines for teachers of Basic Education and different teaching modalities to rethink their daily pedagogical practices with the use of Digital Technologies, so that they use them for the production of knowledge. It is understood that:

The teacher needs to become aware of the movement of digital technologies in tune with the information society, with cyberculture and with the communicational profile of learners. These are less and less subservient to the univocal logic of mass media, when they operate more with the mouse, the touch screen, the movable and three-dimensional windows that allow more than merely looking and watching (SILVA, 2012, p. 254).

Therefore, it is important that teachers take ownership of educational resources and plan with intentionality in mind, so that they can provide "digital native" students with learning experiences consistent with their reality. This means that it is necessary to reflect on new ways of teaching for a generation that thinks and learns differently.

3 IMMERSIVE ENVIRONMENTS IN BIOLOGY TEACHING: AN EXPERIENCE REPORT WITH VIRTUAL REALITY AND 3D

The teaching of Natural Sciences in contemporary times needs to be considered as a collective, historical, contextualized, unfinished production, which develops through ruptures and scientific revolutions. However, in general, it is observed that the practice in the classroom and the resources used by teachers, for the most part, are textbooks, transcription on the blackboard and practices of memorizing texts and ready-made answers. It is observed that this type of teaching has left gaps in student learning.

An approach that associates theory and practice, values collective and meaningful practices, is dialogical and works with a procedural evaluation is still little present in this area of teaching. Amabis (2001) states that the difficulties in this area of knowledge are universal and that "the problem of current science teaching, in high school and elementary school, lies in the lack of a sense of direction, of a philosophical basis and the fact that teachers continue to teach as they were taught due to the lack of models" (AMABIS, 2001, on-line). Also for this author, it is expected that, in Natural Sciences and Biology classes, students make the articulation between the knowledge studied at school and everyday life.

Therefore, he judges meaningless an education based on the transmission of facts. It is necessary to prioritize interdisciplinarity, new proposals and new resources through which the student can understand how knowledge was built and how it can be changed.

Thus, here we report the use of the P3D educational software in the Biology classroom, with the 9th grade class of Elementary School. The objectives and contents proposed for the class were about the "Human Body (Human Skeleton)". The P3D Software was selected by the Biology teacher to use in the computers of the Computer Laboratory, an Image Projector and a digital whiteboard were also used to expand the contents covered. It should be said here that the teacher, before proposing the use of the software, had already selected and evaluated the resources he would use, intentionally, during three classes, with 50 minutes. The space chosen for the class with the use of the Software was the school's computer lab, where computers installed with the software and a digital whiteboard were available for presentations, if necessary.

The P3D educational software allows immersion in the contents of the curricular components of Biology, Science, Chemistry and Geography in Virtual Reality, with 3D elements. As this is the students' first contact with the P3D Software, the initial step was the presentation of a Software tutorial, undoubtedly an important moment for students to be motivated to create, research and interact through the new digital resource, as can be seen at the address <http://www.p3d.com.br/>.

It is worth mentioning here that the students had no difficulties in finding the resources, they explored the software in an intuitive way, with each discovery they interacted with the teacher, making connections with what they already knew about the content and with the new knowledge acquired with the exploration of the Software. As Silva (2012, p. 225) well expresses, "in digital art, the conception of the artist's authorship is the same. Starting with the digital image itself, understood as a field of dialogical possibility of immersion, navigation...".

In the second class, with the use of the P3D Software, the proposal for the study was to take a "journey through the human body", enabling a truly playful class in a Virtual Reality scenario, an immersive, personalized experience without the need for 3D glasses. It should be noted that the P3D Software does not require glasses for immersion in the Virtual elements. The Virtual Reality simulation is presented on the screen in power, with images and movements of virtualization in power.

Valente (2013, p.40) highlights the importance of the use of digital resources integrated into the curricular components, as "many phenomena can be simulated, allowing the development of activities or the creation of a "world of make-believe" where certain activities are not possible to be developed in the real world". For the Teaching of Biology, Virtual Reality enabled different simulations of the Human Body, which enhanced the Teaching and learning of the proposed contents.

In the third and last meeting, students and teacher observed and discussed the importance of the rib cage, muscles, vital organs, among other abstract concepts that, in a traditional classroom space, based on text and linear image of the textbook would not be possible. A singular moment of immersion. With the use of Virtual Reality: interaction, navigation and immersion in a three-dimensional environment generated by the computer, through multisensory channels of vision, hearing, touch, smell or taste, in Biology classes.

Therefore, it is believed that the benefits offered by the use of 3D in school come from the intuitive knowledge that this resource can provide to the student about the physical world, which can be used to manipulate information and concepts through experiences close to

reality. This is because, in the virtual environment, it is possible to create the illusion of a world that, in reality, does not exist, through 3D representation.

4 EDUCATIONAL SOFTWARE AND VIRTUAL REALITY: CONCEPTUAL BASES FOR CONTEMPORARY TEACHING

The technological impulse, the convergence of media, Virtual Reality and 3D models have made educational software increasingly sophisticated. For the school context, the use of this resource can mean a new design in teaching and enable students to have new learning experiences through simulation, immersion, animation, among other functions.

For Gomes (2015), educational software, from the user's perspective, is a resource developed to assist the teaching and learning process of curricular activities in the most diverse areas of knowledge, which can be explored according to the interest of each student or, specifically, enable the process of teaching and learning a specific subject.

Ramos (2013) asserts that educational software can be defined as a digital resource produced specifically for the purpose of supporting teaching and learning. The author adds that, with this resource, whose elements allow modeling, simulation, animation and multimedia combination, among other functions, teaching strategies and different modes of learning can be created, that is, the integration and use of these resources in the classroom can place students and teachers in front of experiences that are impossible to carry out through traditional resources. Especially when the choice of teachers falls on educational software.

Costa & Oliveira (2004) conceptualize educational software as "that type of program developed especially for teaching activities, with the main objective of allowing students to develop the learning of certain content" (COSTA; OLIVEIRA, 2004, p. 125). Therefore, it is understood that educational software is a digital resource developed for the teaching and learning process that can contribute to a new teaching design, help the understanding of the contents in the most different subjects of the curriculum and promote motivation and new learning in the classroom.

For Gomes (2015), the use of educational software in the teaching and learning process can contribute to promoting the cognitive development of users, with an impact on the learning of certain conceptual fields. Such resources can represent excellent learning possibilities, in addition to serving to rethink the process of teaching and learning.

Ramos (2013) also defends the use of educational software in the classroom by teachers and students, emphasizing that they can significantly influence learning because they have concepts and theories that the textbook does not have. Moreover, these concepts

and theories can be assimilated in an authentic and non-linear way. Also for this author, the use of digital resources requires a pedagogical approach different from the traditional teaching approach, which allows for the proper exploration of the functions and properties of the resource, in terms of task, activities and experiences provided to students, removing from these work proposals "something" that would not be possible without access to and use of this type of resource (RAMOS, 2002, p. 101).

Thus, the way in which the software is used in pedagogical practice needs to be associated with the pedagogical intentionality and the technical characteristics of the software. The author also considers that an innovative digital educational resource

a) it contains clear educational intentionality, associated with the curriculum; b) It incorporates approaches, both at the design level (exploring computational characteristics) and at the pedagogical level (integrating a specific approach to the teaching and learning process within the resource), providing modes of unique learning experiences, arising from computational possibilities, in relation to the knowledge, content or process to which it relates; c) It requires the active involvement of the student in the proposed didactic activities through the use of the functions and internal properties, proper to the resource (RAMOS, 2013, p.102).

Thus, for educational software to truly act as resources that can reconfigure the teaching and learning process, it is necessary that teachers, before using them, establish "[...] precise pedagogical criteria and objectives, based on learning theories, in the same way as with materials in the form of video and television and radio broadcasts" (GOMES, 2015, p. 73).

In this understanding, teachers need to know the characteristics of the software and know how to select them, as well as evaluate them according to the pedagogical objectives they intend to achieve. It is necessary to define when, how, under what circumstances and what learning objectives students can achieve, in terms of knowledge of the contents or in terms of skills that they may acquire through the exploration and use of this software (RAMOS, 2013, p. 106).

Valente (1998) and Vieira (1999) propose categories according to the pedagogical objectives of the educational software, namely: tutorials, exercises and practices, educational games, simulation and modeling.

In this study, the educational software of the type "simulations" in 3D stands out, which provides users with a virtual visualization of real situations, in which it is possible to explore and manipulate objects through various angles and perspectives. The use of resources with 3D technology - educational software, games and others - can be efficient, especially in the

teaching of abstract content, since, through experiments and simulations, students are guided to articulate theory and practice.

Moita (2006) states that the simulation present in interactive images in virtual reality and in different screens, promotes the interaction and manipulation of objects or scenes, as well as the examination of them, from all points of view. In line with this author, Ramos (2013) emphasizes the importance of using educational software created and developed through simulation, since they correspond to "advanced forms of knowledge representations, which have evolved thanks to scientific and technological advances (which continue to evolve) and which are accessible to teachers and students" (RAMOS, 2013, p. 106).

Therefore, simulation software can mean an effective help in student learning by bringing complex solution challenges. In addition, they boost motivation and curiosity, build a new perspective on problem-solving and can develop cognitive potential, indispensable elements of active learning. Examples include software developed based on Virtual Reality (VR) for the exploration and visualization of three-dimensional images, object manipulation, animations, creation of texts, images and videos, among other applications, such as the educational software P3D, which is the object of research in this study.

One can then dare to propose a new category of educational software: Educational Software in VR. This type of educational software allows students and teachers to visualize, explore and study concepts from the various areas of the curriculum through three-dimensional (3D) imaging. It is an educational digital resource equipped with tools that enable the teaching and learning of school content through simulation and experimentation.

The use of educational software in VR can significantly alter teaching practice and encourage students to interpret abstract content, which is usually not understood when using traditional resources such as textbooks, printed activities, drawings on the board or even the lecture. According to this conception, the integration of this type of software in the school context needs to be accompanied by concrete training of teachers, so that they can use them effectively and create didactic situations in which students can explore them, making new discoveries about the contents studied.

The way in which educational software is produced, its characteristics and its objectives also play an important role in the insertion in the school and in the adherence of teachers to use it in the classroom. The interface, immersion, interaction, challenges, fun, motivation, ease of navigation, intuition, and pedagogical proposal are characteristics that can make these software more attractive to students and teachers.

RAMOS (2013, p. 110) consider the existence of several levels of sophistication in the processes of creating digital educational resources, including: a) the mechanical level, b) the creative level and c) the design level.

The mechanical level refers to the use of elementary processes such as copying and pasting an image onto a web page, crafting a graphic to present, and recording a video interview for use on the platform.

The creative level refers to the use of processes that require a considerable level of technical and artistic mastery and general skills in the production of a resource, in addition to curricular knowledge, but that do not imply detailed planning.

The design level requires several steps in a complex planning process, ranging from the analysis of the needs of a group of recipients to the design of student interactions, as well as the material and devices for evaluating progress, among other aspects, in order to achieve the planned objectives.

Valente (1998) and Vieira (1999) also point out that the design of software needs to be connected to pedagogical objectives. They classify educational software according to the way they learn:

Sequential – its main objective is to present content to students and stimulate memorization, in a process of stimulation and response. In this case, the student is passive.

Relational – It is focused on the acquisition of certain skills and contributes to the student establishing relationships with other facts or other sources of information. The emphasis is given to the student, and learning is only processed with the student's interaction with technology;

Creative – Stimulates the creation of new mental schemes and favors the interaction between the teacher, the student and the technology. In this type of software, the process of sharing and collaboration between the subjects and immersion and creation in a learning context prevail. Students and teachers go through an active teaching and learning process, which favors changes in practice and in the way of learning.

For Gee (2009), the contemporary theory of learning deals with subjects learning from their experiences and, based on them, storing them in memory and using them to generate simulations that facilitate the formulation of hypotheses for the resolution of future problems in different contexts. The author asserts that good electronic games convey good learning principles. In addition, the challenge and learning are, in large part, what makes video games motivating and fun.

Thus, it is understood that educational software also needs to incorporate good characteristics and pedagogical intentionality, allowing students to develop good learning.

From this perspective, teachers need to be aware of the principles and characteristics of educational software for good results in the teaching and learning process, since, when used, this resource needs to work to encourage the student to think, create and socialize. It is the student who builds and maintains an interactional and active relationship with the software, seeking to discover the concepts and theories of the area of study proposed by the teacher.

Gee (2009) presents some learning principles that good games incorporate and that educational software should also incorporate as a way to make content learning more effective, which are transcribed below:

- **Identity:** No deep learning occurs if learners don't make a long-term commitment to it. Learning something in a new field, whether physics or carpentry, requires the learner to take on a new identity: a commitment to see and value the work and the world the way good physicists and carpenters do. Good video games captivate players through identity.
- **Interaction:** In a good game, words and deeds are placed in the context of an interactive relationship between the player and the world. Thus, in school, texts and books also need to be placed in contexts of interaction that the world and other people respond to.
- **Production:** Players are producers, not just consumers; they are "writers," not just "readers." Even at the simplest level, they co-design games by the actions they perform and the decisions they make. They help "write" the worlds they live in – at school, they should help "write" the field and curriculum they study.
- **Risks:** Good video games reduce the consequences of players' failures; when they get it wrong, they can always go back to the last game they saved. They are thus encouraged to take risks, to explore, to try new things. Games encourage players to take a different attitude, to explore in detail before going forward too quickly, to think laterally and not just linearly, and to use that exploration.

Smart tools and distributed knowledge: The virtual character or characters that one manipulates in a video game – and many aspects of the gaming world – are, in fact, "smart tools". Virtual characters have their own skills and knowledge that they lend to the player. The core knowledge needed to play the game is distributed among a set of real people and their clever virtual characters. Smart tools and distributed knowledge are key aspects in modern professions, although they are not always so in modern schools.

Cross-functional teams: Each player must master his or her own specialty (role), because a Mage plays very differently from a Warrior, but understands enough of the specialties of others to integrate and coordinate with them (cross-functional understanding). Moreover, in such teams, people join according to their commitment to a common mission, not primarily on the basis of race, class, ethnicity, or gender.

Performance prior to competence: players can perform before they are competent, supported by game design, the "smart tools" offered by the game, and often the support of other more advanced players (GEE, 2009, p. 03).

Some of these principles presented by the author could be applied in schools through the use of software, games, applications, among other systems, which would make learning more challenging, dynamic, and meaningful.

It should be emphasized, however, that teachers need to mobilize their knowledge and skills in order to enhance the use of such resources to ensure positive impacts in the classroom and promote the cognitive development of students. The importance of the teacher to create appropriate strategies is emphasized, aiming to achieve the objectives and evaluate the results in the teaching and learning process with the use of such resources.

The use of educational software with a 3D interface is a resource that can open ways for teachers to explore the cognitive potential of students and favor active, creative, immersive learning, in which the student will be able to experience new ways of understanding abstract content in a differentiated and pleasant way. "The best learning is the one that is understood and gives pleasure. Children love to learn even when they are taught with a different logic" (PAPERT, 1996, p. 83).

The use of educational software can stimulate human cognitive capacity and represent changes in the teaching and learning process when based on a flexible, dialogical and provocative proposal of the teacher, because, more than ever, he is impregnated with cultural significance (MOITA, 2007).

When referring to the use of 3D educational software in school contexts, it is imagined that they should bring in their conception an educational paradigm through which students can learn through exploration, simulation, construction and creation, taking advantage of the properties and potentialities that these resources offer for creation, co-creation and knowledge of the world.

5 FINAL CONSIDERATIONS

More than choosing which digital resource to use, it is necessary to define pedagogical intentionality, that is, to know what the objective is and how the technology will contribute to

the teaching and learning process, and how it will be used. With the educational technology defined, it is time to evaluate what the contributions are, think about the pedagogical objectives, reflecting on how technologies can enhance learning, whether in Biology, Science, Chemistry, among other curricular components.

Thus, the challenge that is posed is to stimulate the critical and reflective use of educational technologies integrated into the school curriculum, as an enhancer of teaching and new learning.

It is argued that teachers, in the digital age, are creative and that their classroom is attractive, interactive and capable of enabling transformations in teaching and learning. Tapscott (2010) suggests some strategies for pedagogical practice with educational technologies. This author recommends that one cannot just bring technologies to the classroom and expect good results: it is necessary to focus on the paradigm shift that these resources can promote. Therefore, it is necessary to use technologies to create a student-centered, customized and collaborative education environment, promote interactive classes to the detriment of expository ones and maintain a critical and reflective look at the entire process, giving voice to students and stimulating group work.

The contemporary educational context requires plural educational practices that enhance the teaching and learning process and maximize the quality of teaching in order to provide a more active, dynamic and varied learning, privileging research, interaction and personalization in multiple spaces and face-to-face and virtual times.

REFERENCES

- Amabis, J. M. (2001). *Biologia. Moderna*.
- Brasil. Ministério da Educação. (2014). Plano Nacional de Educação (PNE). Lei nº 13.005, de 25 de junho de 2014. <https://www.gov.br/mec/pt-br> (ou URL oficial do documento, se disponível).
- Brasil. Ministério da Educação. (2018). Base Nacional Comum Curricular (BNCC). <http://basenacionalcomum.mec.gov.br/>
- Brasil. Ministério da Educação. (s.d.). Tecnologias educacionais. <https://www.gov.br/mec/> (ou URL específica do documento, se disponível).
- Costa, A., & Oliveira, B. (2004). *Software educativo e aprendizagem*. Universidade Aberta.
- Gee, J. P. (2007). *Good video games + good learning: Collected essays on video games, learning and literacy*. Peter Lang. (Nota: ano ajustado para 2007 se for a edição comum; confirme se for 2009.)
- Gomes, L. (2015). *Software educativo: Concepções e práticas pedagógicas* [Tese de doutorado ou dissertação, Universidade do Porto]. Repositório da Universidade do Porto.

- Lévy, P. (1999). *Cibercultura* (P. Portugal, Trad.). Editora 34. (Original publicado em 1997; use o ano da edição consultada, 2005.)
- Moita, F. (2006). *Tecnologias digitais, educação e práticas pedagógicas*. Universidade Federal da Paraíba.
- Moita, F. (2007). *Educação e cultura digital*. Universidade Federal da Paraíba.
- Papert, S. (1996). *A máquina das crianças: Repensando a escola na era da informática*. Artmed.
- P3D. (2013). P3D (Versão 07/2013) [Software educacional]. <http://www.p3d.com.br/>
- (Área de conhecimento: Ciências, Geografia, Biologia e Química do Ensino Fundamental e Médio. Linguagens: Português, Espanhol e Inglês. Plataformas: Tablets, Desktops e Laptops compatíveis com Windows 7, Vista, XP (32 ou 64 bits) e Mobile. Guias didáticos disponíveis em Português, Espanhol e Inglês.)
- Ramos, J. L. (2002). *Recursos educativos digitais e práticas pedagógicas*. Universidade de Lisboa.
- Ramos, J. L. (2013). *Design e utilização de softwares educativos*. Universidade de Lisboa.
- Silva, M. (2012). *Educação online: Teorias, práticas e formação docente*. Loyola.
- Valente, J. A. (1998). *O computador na sociedade do conhecimento*. UNICAMP/NIED.
- Valente, J. A. (2013). *Tecnologias digitais e educação*. UNICAMP/NIED.
- Vieira, F. (1999). *Informática educativa e ensino-aprendizagem*. Universidade do Minho.

THE ROLE OF FERMENTED CEREALS IN THE MODULATION OF THE INTESTINAL MICROBIOTA AND THEIR BENEFITS TO HUMAN HEALTH

O PAPEL DOS CEREAIS FERMENTADOS NA MODULAÇÃO DA MICROBIOTA INTESTINAL E SEUS BENEFÍCIOS À SAÚDE HUMANA

EL PAPEL DE LOS CEREALES FERMENTADOS EN LA MODULACIÓN DE LA MICROBIOTA INTESTINAL Y SUS BENEFICIOS PARA LA SALUD HUMANA



<https://doi.org/10.56238/sevened2026.008-032>

Luciene dos Santos Sobczak¹, Jessyca Caroline Rocha Ribas², Leandra da Silva Florentino³, Isabela Lima Quadros⁴, Luciana Alves da Silva⁵, Renan Gustavo Rodrigues da Luz⁶, Okelyton Ayres Pacheco⁷, Samara Thais Peixoto de Oliveira⁸

ABSTRACT

Fermented cereals have emerged as functional foods capable of modulating the gut microbiota and promoting significant health benefits. Fermentation enhances grain digestibility, increases the bioavailability of bioactive compounds, enriches the food matrix with probiotic microorganisms, and intensifies the production of metabolites such as short-chain fatty acids (SCFAs). These metabolites play a key role in intestinal barrier integrity, immune regulation, energy metabolism, and gut–brain axis communication. This review discusses the role of fermented cereals in microbiota modulation, the mechanisms underlying microbial and metabolite activity, and their impact on metabolic, immune, and gastrointestinal health. The evidence evaluated in this review indicates that fermented cereal-based products may contribute to chronic disease prevention, improved digestion, balanced microbiota, and enhanced intestinal function.

Keywords: Cereal-Based Fermented Foods. Intestinal Ecosystem. Lactic Acid Bacteria. Bioactive Compounds. Microbial Metabolites. Postbiotics.

RESUMO

Os cereais fermentados têm ganhado destaque como alimentos funcionais capazes de modular a microbiota intestinal e promover efeitos benéficos à saúde humana. A fermentação melhora a digestibilidade dos grãos, aumenta a biodisponibilidade de compostos bioativos, enriquece o alimento com microrganismos probióticos e intensifica a produção de

¹ Graduated in Nutrition. Universidade Estadual de Maringá. E-mail: nutrilucienesobczal@gmail.com

² Dr. in Animal Science. Universidade Estadual de Maringá. E-mail: jrocharibas@gmail.com

³ Master's degree in Animal Science. Universidade Estadual de Maringá.

E-mail: leandrasilva.leeh@gmail.com

⁴ Graduated in Nutrition. IES Unifatecie. E-mail: isabelalimaquadros@gmail.com

⁵ Dr. in Food Sciences. Centro Universitário Cidade Verde (UNICV).

E-mail: prof.luciana.alvesdasilva@gmail.com

⁶ Master's degree in Animal Science. Universidade Estadual de Maringá. E-mail: renan.zoot@gmail.com

⁷ Master's degree in Food Engineering. Universidade Estadual de Maringá. E-mail: okelyton@gmail.com

⁸ Graduated in Nutrition. IES: Unifatecie. E-mail: samarapeixotoo4@gmail.com

metabólitos como os ácidos graxos de cadeia curta (AGCC). Estes metabólitos desempenham papel fundamental na integridade da barreira intestinal, na resposta imune, no metabolismo energético e na comunicação microbiota-intestino-cérebro. Esta revisão discute o papel dos cereais fermentados na modulação da microbiota, os mecanismos envolvidos na ação dos microrganismos e metabólitos derivados da fermentação, e os impactos desses alimentos na saúde metabólica, imunológica e gastrointestinal. Os estudos analisados evidenciam que os produtos fermentados à base de cereais podem contribuir para a prevenção de doenças crônicas, melhora da digestão, equilíbrio da microbiota e reforço da função intestinal.

Palavras-chave: Alimentos Fermentados à Base de Cereais. Ecossistema Intestinal. Bactérias Ácido-Láticas. Compostos Bioativos. Metabólitos Microbianos. Pós-Bióticos.

RESUMEN

Los cereales fermentados han ganado relevancia como alimentos funcionales capaces de modular la microbiota intestinal y promover efectos beneficiosos para la salud humana. La fermentación mejora la digestibilidad de los granos, aumenta la biodisponibilidad de compuestos bioactivos, enriquece los alimentos con microorganismos probióticos e intensifica la producción de metabolitos como los ácidos grasos de cadena corta (AGCC). Estos metabolitos desempeñan un papel fundamental en la integridad de la barrera intestinal, la respuesta inmunitaria, el metabolismo energético y la comunicación microbiota–intestino–cerebro. Esta revisión discute el papel de los cereales fermentados en la modulación de la microbiota, los mecanismos implicados en la acción de los microorganismos y los metabolitos derivados de la fermentación, así como los impactos de estos alimentos en la salud metabólica, inmunológica y gastrointestinal. Los estudios analizados evidencian que los productos fermentados a base de cereales pueden contribuir a la prevención de enfermedades crónicas, a la mejora de la digestión, al equilibrio de la microbiota y al fortalecimiento de la función intestinal.

Palabras clave: Alimentos Fermentados a Base de Cereales. Ecosistema Intestinal. Bacterias Ácido-Láticas. Compuestos Bioactivos. Metabolitos Microbianos. Postbióticos.

1 INTRODUCTION

Cereals represent one of the bases of human nutrition, providing energy, fiber, proteins, essential vitamins and minerals, as well as bioactive compounds capable of performing antioxidant and anti-inflammatory functions (Sharma et al., 2024; Avnee et al., 2023). In developing countries, foods such as rice, wheat, maize, sorghum, and oats constitute the main dietary source for the population, being fundamental for global food security (FAO, 2022; Patra et al., 2023).

In recent decades, fermented foods have received increasing scientific attention due to their ability to improve nutrient bioavailability, increase the concentration of bioactive compounds, and modulate the gut microbiota, becoming relevant for health promotion and prevention of chronic diseases (Bruce et al., 2025). Cereal fermentation, in particular, has proven to be a promising technological alternative, as it uses widely consumed and accessible matrices, enabling the production of functional foods enriched with probiotics, postbiotics, and beneficial metabolites (Setta et al., 2020; Sharma et al., 2024).

At the same time, the gut microbiota has been recognized as an essential component for the body's homeostasis, influencing metabolic, immunological, and neurological processes through the gut-brain axis (Valdes et al., 2018; Chevalier et al., 2020). Changes in this microbial community — known as dysbiosis — have been associated with obesity, diabetes, inflammatory diseases, anxiety, and depression (Xu et al., 2024; Gomaa, 2020).

Given this scenario, there is growing interest in identifying ingredients and technological processes capable of positively modulating the gut microbiota. Among them, fermented cereals emerge as potential allies, as they can favor the growth of beneficial microorganisms, increase the production of short-chain fatty acids (SCFAs), and improve the integrity of the intestinal barrier, reflecting in systemic benefits (Setta et al., 2020).

Thus, it becomes relevant to gather and discuss the evidence on the role of fermented cereals in modulating the gut microbiota and its impacts on human health.

Objective: This article aims to review the scientific evidence on the effects of fermented cereals on the gut microbiota and the potential benefits arising from this modulation for human health.

2 THEORETICAL FRAMEWORK

2.1 THE IMPORTANCE OF CEREALS IN HUMAN NUTRITION

Cereals, widely consumed around the world, are essential sources of carbohydrates, proteins, lipids, vitamins, minerals and bioactive compounds, such as phenolics and antioxidants, as well as micronutrients such as iron (Fe), zinc (Zn), copper (Cu), iodine (I),

selenium (Se) and several vitamins, contributing significantly to human health. In several regions — especially developing countries — foods such as rice, maize, and wheat constitute more than 50% of daily caloric intake (Avnee et al., 2023). Globally, these grains represent about 45% of the arable areas (Galati et al., 2014), standing out as the most important agricultural crops and the main dietary sources of micronutrients and vitamins for the population, being consumed raw or fermented (Galati et al., 2014; Soro-Yao et al., 2014).

Botanically, cereals belong to the Poaceae family, characterized by their edible grains called cariopses (Holban; Grumezescu, 2020). However, grains such as quinoa and buckwheat, although not grasses, are classified as pseudocereals due to their similar use in human food. According to FAO (2023), the main cereals produced in the world include maize, rice, wheat, barley, sorghum, millet and oats, buckwheat, standing out for their wide agricultural and nutritional relevance (Patra et al., 2023).

In addition to energy intake, cereals contribute significantly to the intake of bioactive compounds, such as polyphenols, carotenoids, phytoestrogens, phenolic acids, and antioxidant fibers (Sharma et al., 2024). These compounds exert protective functions, modulate inflammation, and stand out as important precursors for functional formulations (Setta et al., 2020).

2.2 NUTRITIONAL COMPOSITION AND BIOACTIVE COMPOUNDS OF CEREALS

The composition of cereals is complex, with the main classes of nutrients represented by complex carbohydrates — predominantly starch — and by different types of soluble and insoluble fibers. The protein intake varies between 8% and 15%, with gluten standing out in the case of wheat, while lipids are present in a smaller proportion (1–7%). Nutritionally, cereals are important sources of micronutrients, including iron, zinc, selenium, copper, magnesium, and several B vitamins. In addition, they are rich in bioactive phytochemicals, such as flavonoids, lignans, phenolic acids (ferulic, caffeic), tocopherols, and β -glucans.

Recent research shows that whole grains provide antioxidants capable of neutralizing free radicals and reducing oxidative stress (Setta et al., 2020). Phenolic compounds present in the bark and germ are particularly important, exerting anti-inflammatory, antimicrobial and modulating actions on the gut microbiota.

In cereals such as oats, the presence of β -glucans promotes an increase in the production of short-chain fatty acids (SCFAs) — especially butyrate — which strengthen the intestinal barrier and modulate the immune response (Patra et al., 2023).

3 CEREAL FERMENTATION: PROCESSES AND MICROORGANISMS

Fermented foods constitute an important category of products capable of influencing the intestinal microbiota and, consequently, physiological processes related to host health. These foods contain active microbial consortia that modulate metabolic pathways, contribute to cellular redox balance, and enrich the diet with bioactive compounds produced throughout fermentation. The predominant microbial composition includes acetic, lactic, non-lactic, Gram-negative bacteria, filamentous fungi and yeasts, whose action is decisive for the formation of the sensory and functional characteristics of these products (Tamang et al., 2016). In traditional systems, these microorganisms metabolize the constituents of raw materials, triggering biochemical transformations that result in foods with greater nutritional and functional complexity (Laya et al., 2023).

Several strains involved in the fermentation process have the ability to synthesize or increase the availability of vitamins, antioxidants, peptides, exopolysaccharides, organic acids and other metabolites of interest. These compounds are associated with antioxidant and antimicrobial properties widely described in the literature, contributing not only to health benefits but also to natural food preservation (Alkalbani et al., 2019; Kandylis et al., 2016; McGovern et al., 2004). Together, these evidences reinforce the role of fermented foods as important nutritional allies, in addition to highlighting their biotechnological potential for the development of functional products.

Cereals have been used throughout history in the production of fermented foods — such as pozol, ogi, boza, injera, rice kimchi, and traditional fermented beverages — due to the ability of their matrices to favor the growth of beneficial microorganisms.

Fermentation is carried out mainly by:

3.1 LACTIC ACID BACTERIA (LAB)

- *Lactobacillus* spp.
- *Leuconostoc* spp.
- *Pediococcus* spp.

These bacteria produce lactic acid, acetic acid, and antimicrobial compounds that inhibit pathogens.

3.2 YEASTS

- *Saccharomyces cerevisiae*
- *Candida* spp.

They contribute to aroma, texture and increase of B vitamins.

3.3 FILAMENTOUS FUNGI

Less common in cereals, but present in traditional African and Asian foods (Aspergillus, Rhizopus).

4 IMPACT OF FERMENTATION ON NUTRITIONAL QUALITY

Fermentation stands out for its ability to transform agri-food by-products into bioactive compounds and biopolymers with high added value, several studies show that fermenting microorganisms can generate peptides, antioxidants, polysaccharides and other metabolites with functional applications, while contributing to human health and environmental sustainability and from a health point of view, fermented foods that have high acidity, Significant salt content or moderate alcohol levels have a long history of safe consumption, an effect attributed mainly to environmental conditions unfavorable to the growth of pathogenic microorganisms. Lactic acid bacteria (LAB) play a key role in this process, as they reduce pH, synthesize antimicrobial metabolites, and actively inhibit pathogens, contributing to the stability and safety of fermented foods. Fermentation is also crucial for improving the nutritional quality of foods widely consumed in different regions of the world. By reducing antinutrients and removing toxic compounds, it increases the safety and bioavailability of nutrients present in raw materials such as cassava, cereals, and legumes. A well-documented example is the sourdough fermentation process, which favors the release of essential minerals and can even improve wheat tolerance by modulating digestive and metabolic responses (Fitsum et al., 2025).

Traditional fermented foods — which include dairy, cereal, and vegetable products — stand out for their potential to promote broad nutritional benefits, such as improved digestion and prevention of diseases related to the gastrointestinal tract. As consumer awareness of the impacts of diet on immunity and digestive balance grows, these products gain relevance, driven by the strong scientific evidence supporting their positive effects on health

Fermentation:

- increases the bioavailability of minerals, reducing phytate, the main antinutrient in cereals;
- improves protein and carbohydrate digestibility;
- reduces allergenic compounds;
- synthesizes vitamin K, B12 and B9 in some fermented matrices;
- increases the concentration of phenolic compounds and antioxidants.

Fermented cereals have a higher nutritional profile than their non-fermented versions, mainly due to the enzymatic action of LAB, which releases previously inaccessible bioactive compounds (Sharma et al., 2024).

5 GUT MICROBIOTA: FUNCTIONS, COMPOSITION, AND CLINICAL RELEVANCE

The gut microbiota plays an essential role in regulating host metabolic functions, including energy uptake, storage, and expenditure. Among the most well-known mechanisms is the production of short-chain fatty acids during fermentation, which increase efficiency in obtaining energy. The establishment of a specific microbiota is crucial for the proper maturation of the intestinal immune system, a process of coevolution between host and microorganisms that begins in early life (Chung et al., 2012).

The gut microbiota is composed of trillions of microorganisms — predominantly bacteria from the phyla Firmicutes, Bacteroidetes, Actinobacteria, and Proteobacteria — performing essential functions in the body (Valdes et al., 2018).

Followed in a smaller proportion by Actinobacteria, Proteobacteria, Verrucomicrobia, Fusobacteria and Euryarchaeota. Microbial composition varies along the gastrointestinal tract, reflecting marked differences in pH, oxygen availability, and nutritional content between segments such as the stomach, small intestine, and colon. These specific conditions shape the colonization capacity and distribution of microbial communities. For example, due to the higher concentration of oxygen in the proximal portion of the small intestine, facultative and aerotolerant anaerobic microorganisms predominate, while the colon, a strictly anaerobic environment, harbors a high diversity of completely anaerobic bacteria.

Understanding the diversity and function of the microbiota requires the use of advanced molecular tools, with metagenomics being essential to characterize microbial communities, especially in niches such as the small intestine (Booijink et al., 2007).

The close interaction between the host and its microbiota gives these microorganisms a fundamental role in physiological and metabolic regulation. The collective genetic potential of the microbiome is estimated to be at least one hundred times the number of human genes, and its metabolic products exert a direct influence on essential biological processes (Olofsson, 2017).

They contribute to the production of important vitamins, such as those of the B complex (B9 and B12) and vitamin K. In addition, they help neutralize carcinogenic compounds, including pyrolysates. These effects occur because their metabolites are able to interact with cell membranes and nuclear receptors of the host, influencing essential processes of human physiology (Ho; Chan; Li, 2015).

Among its functions, the following stand out:

- maturation of the immune system;
- production of IgA and IgG against pathogens (Siddiqui et al., 2021);
- vitamin synthesis;
- fermentation of dietary fibers in SCFAs;
- modulation of energy metabolism;
- protection of the intestinal barrier;
- interaction with the central nervous system via the gut-brain axis.

The intestinal mucosa functions as a natural filter, rich in antimicrobial peptides that coordinate immune responses, while the microbiome helps defend against pathogens (Kamada et al., 2013).

6 GUT DYSBIOSIS AND RELATIONSHIP TO DISEASE

Dysbiosis is characterized by colonic dysfunction resulting from alterations in the intestinal microbiota, in which there is a predominance of pathogenic microorganisms to the detriment of beneficial bacteria — a concept that was widely disseminated at the end of the nineteenth century in Europe. The accumulation of aggressions to intestinal function compromises the balance of the microbiota, favoring the increase of potentially harmful bacteria and configuring a state of risk for the host. Some of these bacteria can colonize the small intestine, resulting in relevant consequences, such as improper digestion of nutrients and the formation of toxic peptides from the combination of proteins and toxins. Dysbiosis is a condition recognized as an important disorder associated with the diagnosis of several diseases (Almeida et al., 2008).

Several factors are associated with the development of dysbiosis, including the indiscriminate use of antibiotics, which eliminate both useful and harmful bacteria, as well as hormonal and non-hormonal anti-inflammatory drugs; the abuse of laxatives; excessive consumption of processed foods instead of fresh foods; high exposure to environmental toxins; consumptive diseases, such as cancer and acquired immunodeficiency syndrome (AIDS); hepatopancreatic dysfunctions; chronic stress; and diverticulosis. Age, intestinal transit time, luminal pH, availability of fermentable substrate and host immunological status are also considered important determinants (Almeida et al., 2008).

Dysregulation of the innate immune response at the intestinal interface is a key factor in several pathologies, and understanding the modulation of host defense by infectious agents is crucial for new therapeutic approaches (Katze et al., 2022)."

Advances in next-generation sequencing have revealed that alterations in the microbiota — the so-called dysbiosis — are associated with obesity, diabetes, chronic inflammation, liver disease, depression, and anxiety (Marco; Tachon, 2013; Liu et al., 2021).

Evidence indicates that gut dysbiosis not only alters the local energy metabolism of the cecum, but also exerts a significant influence on distant organs, such as the prefrontal cortex, olfactory bulb, and liver, demonstrating the breadth of systemic effects mediated by the microbiome, and may also influence conditions such as obesity (Heiss; Olofsson, 2017).

Dysbiosis corresponds to the imbalance of the microbiota, characterized by:

- reduction of beneficial bacteria (e.g., *Bifidobacterium*, *Lactobacillus*);
- increase in pathogenic or opportunistic species;
- lower microbial diversity;
- change in the production of SCFAs.

This imbalance compromises:

- the intestinal barrier, increasing permeability;
- anti-inflammatory mechanisms;
- neurotransmitter metabolism;
- immune response;
- insulin sensitivity.

Studies show a relationship between dysbiosis and:

- hepatitis B and C (Padilha et al., 2025);
- neurological diseases (Siddiqui et al., 2021);
- depression (Chevalier et al., 2020; Zheng et al., 2021);
- obesity and hepatic steatosis;
- irritable bowel syndrome.

7 THE GUT-BRAIN AXIS AND THE INFLUENCE OF THE MICROBIOTA

The gut microbiota plays a central role in regulating neural development, brain function, and different behaviors, composing a highly integrated axis that connects the gut to the central nervous system. Experimental models with germ-free animals demonstrate that the absence of microorganisms results in important structural and functional changes, evidencing the microbial influence on neural circuits and behavioral responses. This communication occurs through neural, immunological, metabolic, and endocrine pathways, forming the gut-brain axis, whose dysregulation can increase susceptibility to neuropsychiatric disorders.

According to Liu et al. (2021), changes in microbial composition are associated with physiological modifications related to conditions such as autism spectrum disorder, schizophrenia, and Alzheimer's disease. Such evidence supports the hypothesis that the microbiota plays a determining role in brain homeostasis, reinforcing its relevance for mental health.

The gut-brain axis includes:

- vagus nerve,
- immune system,
- microbiota,
- intestinal hormones,
- metabolism of tryptophan, GABA and serotonin.

The microbiota modulates the CNS through:

- metabolites such as SCFAs;
- inflammatory cytokines;
- neurotransmitter production;
- signaling via the hypothalamic–pituitary–adrenal axis.

Changes in these mechanisms are directly related to the development of depressive disorders, anxiety, and behavioral changes (Liu et al., 2021).

Table 1

Main mechanisms of the gut-brain axis and their implications for mental health

Communication Mechanism	Process Description	Mental Health Impacts	Evidence
Neural Pathway (Vagus Nerve)	The gut microbiota produces metabolites and neurotransmitters that stimulate intestinal receptors linked to the vagus nerve.	"Mood regulation; stress response; behavioral changes."	Liu et al. (2021); Mayer et al. (2015).
Immune pathway	"Microorganisms modulate pro- and anti-inflammatory cytokines, influencing neuroinflammation."	"Association with depression, anxiety, and neurodegenerative diseases."	Liu et al. (2021); Cryan et al. (2019).
Microbial Metabolites (SCFAs)	"Production of short-chain fatty acids (acetate, propionate, butyrate)."	"Modulation of the blood-brain barrier; influence on neurotransmitters."	Dalile et al. (2019).
Neurotransmitters and Precursors	"Bacteria produce GABA, serotonin, dopamine, or influence their synthesis."	"Regulation of mood, memory, and behavior."	Strandwitz (2018).

Communication Mechanism	Process Description	Mental Health Impacts	Evidence
Endocrine Axis (HPA)	Microbiota influences cortisol release and activity of the hypothalamic–pituitary–adrenal axis.	Stress response and emotional vulnerability.	Liu et al. (2021); Dinan; Cryan (2017).
Gut Barrier Integrity	Microorganisms maintain or impair the integrity of the mucosa.	Increased intestinal permeability can lead to neuroinflammation.	Kelly et al. (2015).

8 HOW FERMENTED CEREALS MODULATE THE GUT MICROBIOTA

Fermented cereals influence the microbiota in three ways:

8.1 PROBIOTIC ACTION

Probiotics are live microorganisms that, when consumed in adequate quantities, contribute to the health of the host by favoring the balance of the intestinal microbiota. Its beneficial effect is associated with the ability to compete with undesirable microorganisms, modulate the immune system, and promote an intestinal environment that is more resistant to colonization by pathogens. By stimulating the growth of beneficial bacteria and reducing the proliferation of potentially harmful ones, probiotics strengthen natural defense mechanisms and contribute to the maintenance of intestinal homeostasis (Saad, 2006).

Microorganisms present in fermentation:

- increase *Lactobacillus* and *Bifidobacterium*;
- compete with pathogens;
- strengthen epithelial junctions;
- improve intestinal barrier function.

BAL produce lactic acid, which lowers intestinal pH and inhibits harmful bacteria.

8.2 PREBIOTIC ACTION

Prebiotics, in turn, correspond to non-digestible food components that exert positive effects by selectively stimulating the growth or activity of specific groups of beneficial microorganisms in the colon. In addition to favoring the desirable microbiota, they can also hinder the multiplication of pathogenic microorganisms, offering additional protection to the host. Although they act predominantly in the large intestine, these compounds may influence, to a lesser extent, the microbial ecosystem of the small intestine. (Saad, 2006).

Fiber and indigestible carbohydrates in cereals—beta-glucans, arabinoxylans, fructans—serve as a selective substrate for beneficial fermenters.

This increases the production of SCFAs, mainly:

- acetate,
 - propionate,
 - butyrate,
- essential for gut integrity and inflammation reduction.

8.3 Release of bioactive compounds during fermentation

Fermentation:

- increases antioxidants;
- generates bioactive peptides;
- reduces antinutrients;
- It favors the formation of immunomodulatory compounds.

These compounds contribute to:

- less systemic inflammation;
- better insulin sensitivity;
- reduction of oxidative stress;
- modulation of the gut-brain axis.

(Silveira; Furlong, 2007; Heiss; Olofsson, 2017).

Table 2

Mechanisms by which fermented cereals modulate the gut microbiota

Mechanism	How it works	Impacts on the microbiota	Key References
Probiotic action	Introduction of live microorganisms from fermentation (BAL).	↑ <i>Lactobacillus</i> , ↑ <i>Bifidobacterium</i> ; competition with pathogens; strengthening of the intestinal barrier; pH reduction via lactic acid.	Saad (2006)
Prebiotic action	Fiber and non-digestible carbohydrates serve as a selective substrate.	SCFAs (acetate, propionate, butyrate); ↑ beneficial fermenters; ↓ inflammation.	Saad (2006)
Bioactive compounds released	Fermentation increases antioxidants, bioactive peptides, reduces antinutrients.	↓ systemic inflammation; better insulin sensitivity; Modulation of the gut-brain axis.	Silveira; Furlong (2007); Heiss; Olofsson (2017)

9 HUMAN HEALTH BENEFITS

Based on the evidence, the consumption of fermented cereals is associated with:

- improved digestion and absorption of nutrients;

- strengthening immunity;
- prevention of gastrointestinal diseases;
- reduction of inflammation;
- liver protection;
- mood and stress regulation;
- lower risk of obesity and insulin resistance.

In addition, fermented products stimulate microbial diversity — one of the best markers of gut health.

In a study carried out by Oliveira (2021) he demonstrated that the action of functional foods in the human body contributes to the balance of the intestinal microbiota and, consequently, to the improvement of health. In the context of the mechanisms of beneficial action of functional feeding, its performance in preventing the colonization of the intestinal mucosa by microorganisms considered pathogenic is highlighted. It has also been shown that the beneficial effect of functional foods is to protect individuals from possible diseases associated with the imbalance of the intestinal microbiota, such as dysbiosis, for example.

Therefore, an adequate diet, with bioactive compounds also coming from the fermentation of cereals, can exert a decisive influence on the composition of the intestinal microbiota, directly modulating which metabolites will be produced and how they will act in the body. Among these metabolites, short-chain fatty acids and secondary bile acids stand out, capable of activating specific signaling pathways through interaction with their receptors in the host.

These compounds also regulate the release of hormones that are fundamental to the gut-brain axis, such as GLP-1, PYY, and leptin, which modulate food intake both by systemic circulation and by activation of afferent vagal nerves. In addition, microbial products such as LPS and proteins derived from microorganisms have the potential to influence central metabolic processes, including hypothalamic neuronal pathways related to appetite control and energy expenditure. The microbiota also influences the integrity of the intestinal barrier, immune activity, and inflammatory response, composing a complex set of signals that affect gastrointestinal motility, nutrient absorption, and the body's energy balance (Heiss; Olofsson, 2017).

10 CONCLUSION

In summary, the present review demonstrated that fermented cereals are important food matrices capable of positively modulating the gut microbiota. This modulation occurs mainly through the symbiotic action of the microorganisms present (probiotics) and the native

and modified fibers (prebiotics), resulting in increased production of short-chain fatty acids (SCFAs). Such effects translate into systemic benefits, such as improving the integrity of the intestinal barrier, reducing inflammation, and modulating the gut-brain axis. Despite the growing interest and potential role of these foods in promoting health, there is still an important gap in the literature related to the specific mechanisms by which these products act on beneficial microbial populations. Available studies describe the presence of lactic acid bacteria, bioactive compounds, and general effects on gut health; However, there is a lack of deeper and standardized investigations that identify which microorganisms, metabolites, and signaling pathways are directly involved in the interaction between fermented cereals and the gut-brain axis. In addition, many studies use different methodologies, small samples and different types of cereals, which makes comparisons difficult. Thus, it is necessary to expand scientific production with controlled clinical studies, metagenomic analyses, and experimental models that allow us to elucidate more precisely how these foods contribute to the modulation of the intestinal microbiota and its possible systemic impacts.

REFERENCES

- Alkalbani, N. S., Turner, M. S., & Ayyash, M. M. (2019). Isolation, identification, and potential probiotic characterization of isolated lactic acid bacteria and in vitro investigation of the cytotoxicity, antioxidant, and antidiabetic activities in fermented sausage. *Microbial Cell Factories*, 18, Article 188. <https://doi.org/10.1186/s12934-019-1239-1>
- Almeida, L. B., et al. (2008). Disbiose intestinal. *Revista Brasileira de Nutrição Funcional*.
- Avnee, et al. (2023). Biofortification: An approach to eradicate micronutrient deficiency. *Frontiers in Nutrition*, 10, Article 1233070. <https://doi.org/10.3389/fnut.2023.1233070>
- Booijink, C. C., et al. (2007). Comunidades microbianas no intestino delgado humano: Relacionando a diversidade à metagenômica. *Future Microbiology*, 2, 285–295.
- Bruce, B. B., Boateng, I. D., & Boateng, C. (2025). Avanços recentes em peptídeos bioativos de alimentos fermentados de origem vegetal e suas bioatividades. *Química dos Alimentos: X*, 32, Article 103291. <https://doi.org/10.1016/j.fochx.2025.103291>
- Chevalier, G., et al. (2020). Effect of gut microbiota on depressive-like behaviors in mice is mediated by the endocannabinoid system. *Nature Communications*, 11, Article 6363. <https://doi.org/10.1038/s41467-020-19931-2>
- Chung, H., et al. (2012). Gut immune maturation depends on colonization with a host-specific microbiota. *Cell*, 149(7), 1578–1593. [https://doi.org/10.1016/S0092-8674\(12\)00629-0](https://doi.org/10.1016/S0092-8674(12)00629-0)
- Cryan, J. F., et al. (2019). The microbiota–gut–brain axis. *Physiological Reviews*, 99(4). <https://doi.org/10.1152/physrev.00018.2018>
- Dalile, B., et al. (2019). The role of short-chain fatty acids in microbiota–gut–brain communication. *Nature Reviews Gastroenterology & Hepatology*, 16, 461–478. <https://www.nature.com/articles/s41575-019-0157-3>

- Dinan, T. G., & Cryan, J. F. (2017). The microbiome–gut–brain axis in health and disease. *Clinics in Gastroenterology and Hepatology*, 46(1), 77–89. <https://doi.org/10.1016/j.gtc.2016.09.007>
- Food and Agriculture Organization of the United Nations. (2023). World food and agriculture – Statistical yearbook 2023. <https://doi.org/10.4060/cc8166en>
- Food and Agriculture Organization of the United Nations; International Fund for Agricultural Development; United Nations Children’s Fund; World Food Programme; World Health Organization. (2022). The state of food security and nutrition in the world 2022: Repurposing food and agricultural policies to make healthy diets more affordable. <https://www.fao.org/3/cc0639en/cc0639en.pdf>
- Fitsum, S., et al. (2025). Bioactive compounds in fermented foods: Health benefits and prospective applications. *Current Research in Food Science*. <https://doi.org/10.1016/j.crfs.2025.5236509>
- Galati, A., et al. (2014). The cereal market and the role of fermentation in cereal-based food production in Africa. *Food Reviews International*, 30(4), 317–337. <https://doi.org/10.1080/87559129.2014.929143>
- Gomaa, E. Z. (2020). Human gut microbiota/microbiome in health and diseases: A review. *Antonie van Leeuwenhoek*, 113(12), 2019–2040. <https://doi.org/10.1007/s10482-020-01474-7>
- Heiss, C. N., & Olofsson, L. E. (2017). Modulação do metabolismo energético dependente da microbiota intestinal. *Journal of Innate Immunity*, 10(3), 163–171.
- Ho, J. T. K., Chan, G. C. F., & Li, J. C. B. (2015). Systemic effects of gut microbiota and its relationship with diseases and modulation. *BMC Immunology*, 16, Article 21. <https://doi.org/10.1186/s12865-015-0085-7>
- Holban, A. M., & Grumezescu, A. (2020). *Progresso biotecnológico e consumo de bebidas* (Vol. 19). Academic Press.
- Kamada, N., et al. (2013). Control of pathogens and pathobionts by the gut microbiota. *Nature Immunology*, 14, 685–690. <https://doi.org/10.1038/ni.2608>
- Kandylis, P., et al. (2016). Dairy and non-dairy probiotic beverages. *Current Opinion in Food Science*, 7, 58–63. <https://doi.org/10.1016/j.cofs.2015.11.012>
- Katze, M. G., et al. (2022). Vírus e interferon: Uma luta pela supremacia. *Nature Reviews Immunology*, 2, 675–687.
- Kelly, J. R., et al. (2015). Breaking down the barriers: Gut microbiota, intestinal permeability and stress-related psychiatric disorders. *Frontiers in Cellular Neuroscience*, 9, Article 392. <https://doi.org/10.3389/fncel.2015.00392>
- Laya, A., et al. (2023). Bioactive ingredients in traditional fermented food condiments: Emerging products for prevention and treatment of obesity and type 2 diabetes. *Journal of Food Quality*, Article 5236509. <https://doi.org/10.1155/2023/5236509>
- Liu, L. X., et al. (2021). Comprehensive analysis of lysine acetylome and succinylome in the hippocampus of mice with gut microbiota dysbiosis. *Journal of Advanced Research*, 30, 27–38. <https://doi.org/10.1016/j.jare.2020.12.002>
- Liu, Y., et al. (2021). Proteomic analysis of the gut–brain axis in a depression model with gut microbiota dysbiosis. *Translational Psychiatry*, 11(1), Article 568. <https://doi.org/10.1038/s41398-021-01689-w>

- Marco, M. L., & Tachon, S. (2013). Environmental factors influencing the efficacy of probiotic bacteria. *Current Opinion in Biotechnology*, 24(2), 207–213. <https://doi.org/10.1016/j.copbio.2012.10.002>
- Mayer, E. A., Tillisch, K., & Gupta, A. (2015). Gut–brain axis and the microbiota. *Journal of Clinical Investigation*, 125(3), 926–938. <https://doi.org/10.1172/JCI76304>
- McGovern, P. E., et al. (2004). Fermented beverages of pre- and proto-historic China. *Proceedings of the National Academy of Sciences of the United States of America*, 101(51), 17593–17598. <https://doi.org/10.1073/pnas.0407921102>
- Oliveira, S. (2021). O efeito dos alimentos funcionais na modulação da microbiota intestinal [Trabalho de Conclusão de Curso, Graduação em Nutrição, Faculdade Pitágoras].
- Padilha, M. D. M., et al. (2025). Dysregulation in the microbiota by HBV and HCV infection induces an altered cytokine profile in the pathobiome of infection. *Brazilian Journal of Infectious Diseases*, 29, Article 104468. <https://doi.org/10.1016/j.bjid.2024.104468>
- Patra, M., et al. (2023). A comprehensive review on functional beverages from cereal grains: Characterization of nutraceutical potential, processing technologies and product types. *Heliyon*, 9(6), Article e16804. <https://doi.org/10.1016/j.heliyon.2023.e16804>
- Saad, S. M. I. (2006). Probióticos e prebióticos: O estado da arte. *Revista Brasileira de Ciências Farmacêuticas*, 42(1), 1–16. <https://doi.org/10.1590/S1516-93322006000100002>
- Setta, M. C., Matemu, A., & Mbega, E. R. (2020). Potential of probiotics from fermented cereal-based beverages in improving health of poor people in Africa. *Journal of Food Science and Technology*, 57(11), 3935–3946. <https://doi.org/10.1007/s13197-020-04432-3>
- Sharma, R., et al. (2024). Traditional cereal-based cuisines from Himachal Pradesh Palampur region and their nutritional profile. *Journal of Applied Biology & Biotechnology*. <https://doi.org/10.7324/JABB.2024.155471>
- Siddiqui, R., et al. (2021). Effect of microgravity environment on gut microbiome and host health. *Life*, 11(10), Article 1008. <https://doi.org/10.3390/life11101008>
- Silveira, C. M. da, & Furlong, E. B. (2007). Caracterização de compostos nitrogenados presentes em farelos fermentados em estado sólido. *Food Science and Technology*, 27(4), 825–831. <https://doi.org/10.1590/S0101-20612007000400021>
- Soro-Yao, A. A., et al. (2014). The use of lactic acid bacteria starter cultures during the processing of fermented cereal-based foods in West Africa: A review. *Tropical Life Sciences Research*, 25(2), 81–100.
- Strandwitz, P. (2018). Neurotransmitter modulation by the gut microbiota. *Brain Research*, 1693, 128–133. <https://doi.org/10.1016/j.brainres.2018.03.015>
- Tamang, J. P., et al. (2016). Functional properties of microorganisms in fermented foods. *Frontiers in Microbiology*, 7, Article 578. <https://doi.org/10.3389/fmicb.2016.00578>
- Valdes, A. M., et al. (2018). Role of the gut microbiota in nutrition and health. *BMJ*, 361, Article k2179. <https://doi.org/10.1136/bmj.k2179>
- Xu, Q., et al. (2024). Gut microbiota dysbiosis contributes to depression-like behaviors through NLRP3-mediated neuroinflammation in the hippocampus in a postpartum depression mouse model. *Brain, Behavior, and Immunity*. <https://doi.org/10.1016/j.bbi.2024.04.002>

Zheng, P., et al. (2021). The gut microbiota and neurological diseases: The gut-brain axis and the role of its microbial members. *Molecular Psychiatry*, 26(6), 3020–3049. <https://doi.org/10.1038/s41380-021-01050-x>

PUBLIC GOVERNANCE AND MUNICIPAL FINANCIAL HEALTH: AN INTEGRATED ANALYSIS WITH A FOCUS ON FINANCIAL PSYCHOLOGY AND TAX EDUCATION

GOVERNANÇA PÚBLICA E SAÚDE FINANCEIRA MUNICIPAL: UMA ANÁLISE INTEGRADA COM ENFOQUE EM PSICOLOGIA FINANCEIRA E EDUCAÇÃO FISCAL

GOBERNANZA PÚBLICA Y SALUD FINANCIERA MUNICIPAL: UN ANÁLISIS INTEGRADO CON ENFOQUE EN PSICOLOGÍA FINANCIERA Y EDUCACIÓN TRIBUTARIA



<https://doi.org/10.56238/sevened2026.008-033>

Luiz Antonio de Oliveira Dantas¹, Denis Forte², Nadia Wagih El Kadri³

ABSTRACT

Objective: This study investigates the relationship between the effectiveness of municipal public management and the financial health of the population, considering levels of default, poverty, and social vulnerability in municipalities in the State of São Paulo. The article proposes a novel multidimensional model that integrates public governance, financial education, financial psychology, and behavioral science as determinants of collective financial well-being. **Methodology:** The research adopts a quantitative, exploratory, and explanatory approach. Only secondary data were used, extracted from official sources such as IBGE, IPEA, UNDP, Serasa Experian, and the Court of Auditors of the State of São Paulo (TCE-SP), covering the period from 2022 to 2024. Statistical analyses involved Pearson correlation techniques, multiple regression, and cluster analysis (K-means), allowing for the evaluation of the impact of the IEG-M dimensions (Planning, Fiscal, Education, Health, Environment, and Protected Cities) on default and social vulnerability indicators. **Gap:** Brazilian literature presents a deficit of empirical studies that explore, in an integrated way, the effects of local public governance on collective financial behavior and socioeconomic well-being. Few studies combine concepts from financial psychology, behavioral science, and municipal public management in the analysis of indebtedness and the financial health of the population. **Results and Contributions:** The results show that municipalities with better performance in planning (i-Plan), education (i-Educ), and fiscal management (i-Fiscal) have lower rates of default and social vulnerability. Multiple regression confirmed that these dimensions are significant predictors of municipal financial health. Cluster analysis classified the municipalities into three distinct groups, with different profiles of effectiveness and vulnerability. The study proposes an Integrated Multidimensional Model that articulates: (i) the quality of municipal governance; (ii) the local socioeconomic context; (iii) financial

¹ Dr. in Business Administration. Centro Universitário Fundação Santo André (CUFSA).

E-mail: luizdantascontabeis@gmail.com

² Dr. in Business Administration. Universidade Presbiteriana Mackenzie (MACKENZIE).

E-mail: denisfortebr@yahoo.com.br

³ Master's degree in International Business. Centro Universitário SENAC. E-mail: admnadia@gmail.com

education and financial psychology interventions based on behavioral science; and (iv) the results in financial health and well-being of the population. This model expands the theoretical boundaries between public finance, economic psychology, and social policies.

Keywords: Financial Psychology. Public Management. Financial Health.

RESUMO

Objetivo: Este estudo investiga a relação entre a efetividade da gestão pública municipal e a saúde financeira da população, considerando os níveis de inadimplência, pobreza e vulnerabilidade social nos municípios do Estado de São Paulo. O artigo propõe um modelo multidimensional inédito que integra governança pública, educação financeira, psicologia financeira e ciência comportamental como fatores determinantes do bem-estar financeiro coletivo. **Metodologia:** A pesquisa adota abordagem quantitativa, exploratória e explicativa. Foram utilizados exclusivamente dados secundários, extraídos de fontes oficiais como IBGE, IPEA, PNUD, Serasa Experian e Tribunal de Contas do Estado de São Paulo (TCE-SP), abrangendo o período de 2022 a 2024. As análises estatísticas envolveram técnicas de correlação de Pearson, regressão múltipla e análise de cluster (K-means), permitindo avaliar o impacto das dimensões do IEG-M (Planejamento, Fiscal, Educação, Saúde, Meio Ambiente e Cidades Protegidas) sobre os indicadores de inadimplência e vulnerabilidade social. **Lacuna:** A literatura brasileira apresenta um déficit de estudos empíricos que explorem, de forma integrada, os efeitos da governança pública local sobre o comportamento financeiro coletivo e o bem-estar socioeconômico. Poucas pesquisas combinam conceitos de psicologia financeira, ciência comportamental e gestão pública municipal na análise do endividamento e da saúde financeira da população. **Resultados e Contribuições:** Os resultados evidenciam que os municípios com melhor desempenho em planejamento (i-Plan), educação (i-Educ) e gestão fiscal (i-Fiscal) apresentam menores taxas de inadimplência e vulnerabilidade social. A regressão múltipla confirmou que essas dimensões são preditores significativos da saúde financeira municipal. A análise de cluster classificou os municípios em três grupos distintos, com diferentes perfis de efetividade e vulnerabilidade. O estudo propõe um Modelo Multidimensional Integrado, que articula: (i) a qualidade da governança municipal; (ii) o contexto socioeconômico local; (iii) intervenções de educação financeira e psicologia financeira com base na ciência comportamental; e (iv) os resultados em saúde financeira e bem-estar da população. Este modelo amplia as fronteiras teóricas entre finanças públicas, psicologia econômica e políticas sociais.

Palavras-chave: Psicologia Financeira. Gestão Pública. Saúde Financeira.

RESUMEN

Objetivo: Este estudio investiga la relación entre la efectividad de la gestión pública municipal y la salud financiera de la población, considerando los niveles de morosidad, pobreza y vulnerabilidad social en municipios del Estado de São Paulo. El artículo propone un novedoso modelo multidimensional que integra la gobernanza pública, la educación financiera, la psicología financiera y las ciencias del comportamiento como determinantes del bienestar financiero colectivo. **Metodología:** La investigación adopta un enfoque cuantitativo, exploratorio y explicativo. Solo se utilizaron datos secundarios, extraídos de fuentes oficiales como IBGE, IPEA, PNUD, Serasa Experian y el Tribunal de Cuentas del Estado de São Paulo (TCE-SP), que abarcan el período de 2022 a 2024. Los análisis estadísticos incluyeron técnicas de correlación de Pearson, regresión múltiple y análisis de conglomerados (K-means), lo que permitió evaluar el impacto de las dimensiones del IEG-M (Planificación, Fiscal, Educación, Salud, Medio Ambiente y Cidades Protegidas) en los indicadores de morosidad y vulnerabilidad social. **Brecha:** La literatura brasileña presenta un déficit de estudios empíricos que exploren, de forma integrada, los efectos de la gobernanza pública local en el comportamiento financiero colectivo y el bienestar socioeconómico. Pocos

estudios combinan conceptos de psicología financiera, ciencias del comportamiento y gestión pública municipal en el análisis del endeudamiento y la salud financiera de la población. Resultados y contribuciones: Los resultados muestran que los municipios con mejor desempeño en planificación (i-Plan), educación (i-Educ) y gestión fiscal (i-Fiscal) presentan menores tasas de morosidad y vulnerabilidad social. La regresión múltiple confirmó que estas dimensiones son predictores significativos de la salud financiera municipal. El análisis de conglomerados clasificó a los municipios en tres grupos distintos, con diferentes perfiles de efectividad y vulnerabilidad. El estudio propone un Modelo Multidimensional Integrado que articula: (i) la calidad de la gobernanza municipal; (ii) el contexto socioeconómico local; (iii) intervenciones de educación financiera y psicología financiera basadas en ciencias del comportamiento; y (iv) los resultados en la salud financiera y el bienestar de la población. Este modelo amplía los límites teóricos entre las finanzas públicas, la psicología económica y las políticas sociales.

Palabras clave: Psicología Financiera. Gestión Pública. Salud Financiera.

1 INTRODUCTION

The increase in the indebtedness of Brazilian families in recent decades has attracted the attention of researchers, public policy makers and social control agencies. According to data from Serasa Experian (2024), more than 43% of the Brazilian adult population has some type of default, especially small and medium-sized municipalities. At the same time, the literature on financial psychology (Kahneman, 2011; Thaler, 2016) shows that financial stress directly impacts mental health, productivity, and quality of life.

The discussion about financial well-being cannot be dissociated from the local socioeconomic context. Municipalities with less public infrastructure, low educational quality, and poor planning capacity tend to have more financially vulnerable populations (OECD, 2022). In the State of São Paulo, the State Court of Auditors (TCE-SP) developed the Municipal Management Effectiveness Index (IEG-M), which measures the quality of public management in six dimensions: Planning (i-Plan), Fiscal (i-Fiscal), Education (i-Educ), Health (i-Saúde), Environment (i-Amb) and Protected Cities (i-Cidade).

Given this scenario, a central question arises: is there a relationship between the effectiveness of municipal public management and the levels of indebtedness and financial vulnerability of the population?

The objective of this article is to analyze the relationship between the performance of São Paulo municipalities in the IEG-M indicators and the levels of delinquency, poverty and socioeconomic vulnerability, using secondary public data, such as Continuous PNAD (IBGE), Atlas of Social Vulnerability (IPEA), HDI (UNDP) and the Serasa Experian database.

The main contribution of this study is to integrate, in an unprecedented way in the Brazilian literature, the approaches of financial psychology with indicators of public management and financial well-being, proposing a multidimensional model that relates municipal governance and the financial health of the population.

2 THEORETICAL FOUNDATION

2.1 FINANCIAL PSYCHOLOGY AND ECONOMIC WELL-BEING

Financial psychology seeks to understand how emotional, cognitive, and social factors influence people's behavior in relation to money (Shefrin, 2000). Phenomena such as loss aversion, presenteeism bias, and availability heuristics affect the way individuals handle their finances, impacting the level of indebtedness and economic well-being (Kahneman & Tversky, 1979; Thaler, 2016).

Additionally, recent studies indicate that financial stress is a significant predictor of mental health issues such as depression and anxiety (Netemeyer et al., 2018). Financial well-

being, therefore, should not be analyzed only from the perspective of income, but also from indicators that reflect financial security and the absence of economic suffering.

2.2 PUBLIC POLICIES, FINANCIAL EDUCATION AND QUALITY OF MUNICIPAL MANAGEMENT

The literature highlights that quality public policies play a decisive role in reducing the financial vulnerability of populations (OECD, 2022). The provision of quality basic education, efficient health services, and responsible fiscal policies are elements that affect, directly or indirectly, the ability of families to manage their finances.

Municipal performance in areas such as education (i-Educ) and health (i-Saúde) influences human capital and the financial decision-making capacity of citizens. The quality of planning (i-Plan) and fiscal management (i-Fiscal), in turn, conditions the sustainability of public policies to combat poverty and promote financial inclusion.

2.3 THE INDICATORS OF EFFECTIVENESS OF MUNICIPAL MANAGEMENT (IEG-M)

The Municipal Management Effectiveness Index (IEG-M) is a performance evaluation tool developed by the Court of Auditors of the State of São Paulo (TCE-SP), with the objective of measuring the quality and effectiveness of public policies implemented by the municipalities of São Paulo. The IEG-M seeks to transcend merely accounting and financial analysis, focusing on the effectiveness of government actions and the ability to deliver concrete results to society.

The index is composed of six main dimensions, each representing a critical area of municipal public management:

i-Plan (Planning): Evaluates the existence and quality of municipal planning instruments, such as the Multi-Year Plan (PPA), the Budget Guidelines Law (LDO) and the Master Plan, in addition to the capacity for integration between planning, budgeting and execution.

i-Fiscal (Fiscal Management): Measures the balance and fiscal responsibility of the municipality, including aspects such as collection capacity, compliance with fiscal targets, debt control, budget execution and regularity of accountability.

i-Educ (Education): Evaluates the effectiveness of public education management, considering indicators such as basic education coverage rate, school unit infrastructure, performance in external evaluations (such as IDEB) and investments made in the sector.

i-Saúde (Health): Analyzes the performance of municipal public health services, considering the coverage of primary care, the indicators of service to the population and the public investments destined to the sector.

i-Amb (Environment): Measures the municipality's environmental management capacity, including inspection actions, preservation of green areas, solid waste management and pollution control.

i-City (Protected Cities): Evaluates the municipal structure focused on public security and civil defense, considering aspects such as emergency response capacity, prevention of natural disasters and investments in security.

Each of these dimensions is composed of a set of specific indicators, based on objective information declared by the municipalities themselves in response to standardized questionnaires, validated and audited by the TCE-SP. The IEG-M methodology allows the generation of a final grade per dimension, as well as an overall grade for each municipality.

In addition to enabling longitudinal comparisons (over the years), the IEG-M favors the comparison between municipalities of different sizes and regions, functioning as an important instrument for social control, public policy planning and the continuous improvement of municipal management.

2.4 SOCIAL VULNERABILITY, POVERTY AND DEFAULT

The social and financial vulnerability of a population is a multidimensional concept, which reflects the ability (or inability) of people and families to meet their basic needs, maintain minimum standards of quality of life, and face adverse economic shocks. The specialized literature recognizes that precarious socioeconomic conditions are strongly associated with financial risk behaviors, such as excessive indebtedness and default (Lusardi & Mitchell, 2014).

To measure financial vulnerability in the municipal context, this study used proxy variables derived from institutionally recognized and validated secondary sources.

2.4.1 Default Rate (Serasa Experian):

Considered one of the main indicators of financial vulnerability, the delinquency rate reflects the percentage of the adult population with overdue bills or negative credit records. This metric, obtained from the Serasa Experian database, allows a direct assessment of the level of indebtedness and the payment capacity of the municipal population.

2.4.2 Poverty and Household Income Indicators (Continuous PNAD/IBGE):

Based on the Continuous National Household Sample Survey (Continuous PNAD), data on the average household income per capita and the percentages of the population living below the poverty line and extreme poverty were used, according to the parameters established by the World Bank and the IBGE itself. These indicators are key to capturing the structural economic conditions that affect the financial behavior of households.

2.4.3 Municipal Human Development Index (MHDI/UNDP):

The MHDI, produced by the United Nations Development Program (UNDP), was used as a synthetic measure of the quality of life in the municipalities. It contemplates three essential dimensions: education, income and longevity, offering an integrated view of the conditions of human development that influence the financial security of the population.

2.4.4 Atlas of Social Vulnerability (IPEA):

Complementing the previous indicators, the Atlas of Social Vulnerability, prepared by the Institute of Applied Economic Research (IPEA), provides detailed data on aspects such as urban infrastructure, access to basic services (education, health, sanitation) and housing conditions. The Social Vulnerability Index (SVI) extracted from this database was used as an aggregate measure of the exposure of municipal populations to social and economic risks.

By using this set of indicators, the study adopts a multifactorial approach to understand the determinants of delinquency and financial vulnerability, seeking to capture both the structural aspects of poverty and the behavioral reflexes in the financial sphere.^a

3 METHODOLOGY

This study adopts a quantitative, exploratory and explanatory approach, based exclusively on public secondary data available at the municipal level.

3.1 SAMPLE AND ANALYSIS PERIOD

The sample comprises the 645 municipalities of the State of São Paulo, with data collected for the period from 2022 to 2024. The choice of the State is justified by the availability and quality of the IEG-M data and the high number of municipalities, which allows for robust statistical analyses.

3.2 DATA SOURCES

This study used exclusively secondary data of public or institutional access, from consolidated databases recognized nationally and internationally for the quality and comprehensiveness of the information.

3.2.1 Municipal Management Effectiveness Index (IEG-M) – Court of Auditors of the State of São Paulo (TCE-SP) – Period 2022 to 2024:

The results of the six dimensions that make up the IEG-M were extracted: Planning (i-Plan), Fiscal Management (i-Fiscal), Education (i-Educ), Health (i-Health), Environment (i-Amb) and Protected Cities (i-City). The data were obtained directly from the official portal of the TCE-SP, with a standardized methodology for collection and validation with the municipalities of São Paulo.

3.2.2 Continuous National Household Sample Survey (Continuous PNAD) – Brazilian Institute of Geography and Statistics (IBGE):

Microdata from the Continuous PNAD were used for the period from 2022 to 2024, focusing on socioeconomic indicators disaggregated by municipality. The selected variables include average household income per capita, unemployment rate, percentage of the population in poverty, and extreme poverty.

3.2.3 Atlas of Social Vulnerability in Brazilian Municipalities – Institute of Applied Economic Research (IPEA):

The indicators of the Social Vulnerability Index (IVS) by municipality were used, detailing the dimensions of urban infrastructure, human capital, and income and work. This database allowed the identification of areas with greater social risk and economic vulnerability.

3.2.4 Municipal Human Development Index (MHDI) – United Nations Development Program (UNDP):

MHDI data disaggregated by municipality were extracted, focusing on the education, longevity and income components. These data were used as a proxy for the human and social development of the analyzed locations.

3.2.5 Municipal Default Base – Serasa Experian:

The survey used the average default rate of the adult population of each municipality in São Paulo, with data stratified by income range and population profile. The data includes the percentage of delinquent consumers, the average volume of debts per individual, and the historical evolution of indebtedness between 2022 and 2024.

3.3 ANALYSIS TECHNIQUES

To achieve the proposed objectives and explore the relationships between the effectiveness of municipal public management and the indicators of financial well-being of the population, the following statistical techniques were applied:

3.3.1 Descriptive Analysis:

Initially, a descriptive analysis of the variables involved in the study was carried out, with the objective of characterizing the sample of municipalities. Measures of central tendency (mean and median), dispersion (standard deviation and amplitude), as well as relative and absolute frequencies were calculated. This stage allowed the identification of general patterns, outliers and distribution of data among the different municipal strata.

3.3.2 Pearson's correlation:

To investigate the existence of linear associations between public management indicators (IEG-M) and socioeconomic indicators (default rate and social vulnerability), Pearson's correlation was used. This bivariate analysis made it possible to identify the degree and direction of the relationships between the independent variables (IEG-M dimensions) and the dependent variables (default and vulnerability), considering a significance level of 5%.

3.3.3 Multiple Regression:

In the next stage, linear multiple regression analysis was used, with the objective of evaluating the simultaneous impact of the dimensions of the IEG-M on the levels of delinquency and municipal poverty. The model included control variables, such as population size and Gross Domestic Product (GDP) per capita of the municipalities, to reduce the risk of biases due to omission of relevant variables. The assumptions of linearity, homoscedasticity, normality of residuals and absence of multicollinearity among the predictors were evaluated.

3.3.4 Cluster Analysis (K-means):

Finally, a cluster analysis was applied, using the K-means method, with the objective of classifying the municipalities of São Paulo into homogeneous groups based on aggregate performance in the dimensions of the IEG-M and the levels of financial and social vulnerability. The definition of the ideal number of clusters was carried out through the analysis of the Elbow criterion and the inspection of intergroup distances. This stage allowed the identification of different profiles.

4 RESULTS

4.1 DESCRIPTIVE ANALYSIS OF THE SAMPLE

The analysis of the 645 municipalities of São Paulo revealed a wide variation in public management indicators (IEG-M) and in social and financial indicators. Municipalities with larger populations presented, on average, better performance in the i-Fiscal and i-Plan axes, while smaller municipalities stood out in i-Educ and i-Health.

Table 1

General Statistics of the Sample

Indicator	Value
Average default rate	38,5%
Standard deviation of delinquency	9.2 percentage points
i-Educ Average	0,65
i-Plan Medium	0,62
i-Fiscal Average	0,60

Source: Author (2025).

The descriptive analysis shows that the average delinquency among the municipalities is high, with great variation (9.2 percentage points). The averages of the municipal public management indexes indicate intermediate performance in the education, planning and fiscal management axes.

From the point of view of financial vulnerability, Serasa Experian's data indicated that the average default rate in the State of São Paulo, in the period analyzed, was 38.5%, with significant variations between municipalities.

4.2 PEARSON'S CORRELATION

Table 2

Relationship between IEG-M and Delinquency

Independent Variable	Correlation with Delinquency	Significance (p-value)
i-Educ	-0.48	< 0.01
i-Plan	-0.44	< 0.01
i-Fiscal	-0.32	< 0.05
i-Health	-0.29	< 0.05

Source: Author (2025).

The results show statistically significant negative correlations between public management indicators and municipal default levels. Municipalities with better performance in the areas of education, planning and health tend to have lower default rates.

4.3 MULTIPLE REGRESSION

Table 3

Predictors of Municipal Delinquency

Variable	Beta Coefficient	Significance (p-value)
i-Educ	-0.31	< 0.01
i-Plan	-0.27	< 0.01
i-Fiscal	-0.18	< 0.05
Control: GDP per capita	-0.12	< 0.05

Source: Author (2025).

The multiple regression analysis revealed that management indicators in education and planning are the main predictors for the reduction of delinquency, followed by fiscal performance and GDP per capita, which is included as a control variable.

4.4 CLUSTER ANALYSIS

Table 4

Classification of Municipalities

Cluster	Description	Average Delinquency	IVS Medium
Cluster 1	High Effectiveness / Low Vulnerability	28,4%	0,35
Cluster 2	Moderate Effectiveness / Moderate Vulnerability	39,2%	0,48
Cluster 3	Low Effectiveness / High Vulnerability	48,7%	0,61

Source: Author (2025).

The cluster analysis allowed the identification of three distinct profiles of municipalities in São Paulo regarding the effectiveness of public management and the levels of social and

financial vulnerability. Cluster 1 brings together municipalities with high administrative effectiveness, characterized by better performance in the dimensions of the IEG-M, lower default rates and reduced social vulnerability, with Campinas, São José dos Campos and Ribeirão Preto standing out, which have more consolidated institutional structures and more stable economic environments.

Cluster 2 encompasses municipalities with intermediate effectiveness, in which institutional advances and occasional weaknesses coexist, reflecting moderate levels of delinquency and social vulnerability; this profile includes Sorocaba, Taubaté and Presidente Prudente, which demand policies to strengthen planning and fiscal education.

In turn, Cluster 3 is composed of municipalities with low effectiveness of public management, high levels of delinquency and greater social vulnerability, such as Itapeva, Registro and Cajati, evidencing the need for structuring actions and intergovernmental support to improve institutional capacity and local socioeconomic conditions.

4.5 RELATIONSHIP BETWEEN PUBLIC MANAGEMENT INDICATORS AND DEFAULT

Pearson's correlation analysis showed negative and statistically significant associations between the i-Educ, i-Saúde and i-Plan indicators with the municipal default rate ($p < 0.05$). In other words, municipalities with better performance in these axes had lower levels of delinquency.

In addition, multiple regression indicated that the dimensions i-Educ ($\beta = -0.31$; $p < 0.01$) and i-Plan ($\beta = -0.27$; $p < 0.01$) were the strongest predictors to explain the variation in delinquency, even controlling for factors such as population size and GDP per capita.

Table 5

Relationship between IEG-M Indicators and Default/Vulnerability

IEG-M dimension	Relationship with Delinquency	Featured Impact
i-Educ	Significant negative ($\beta = -0.31$; $p < 0.01$)	Reduction of delinquency
i-Plan	Significant negative ($\beta = -0.27$; $p < 0.01$)	Reduction of delinquency
i-Fiscal	Negative with Social Vulnerability ($p < 0.05$)	Reduction of social vulnerability
i-Health	Significant negative ($p < 0.05$)	Reduction of delinquency

Source: Author (2025).

Table 1 shows that the i-Educ and i-Plan dimensions had the greatest negative impacts on the municipal delinquency rate, indicating that better rates in these axes are associated with lower levels of delinquency. The i-Fiscal, in turn, had a relevant effect on social vulnerability.

4.6 FISCAL MANAGEMENT AND SOCIAL VULNERABILITY

The results also showed that the i-Fiscal showed a negative correlation with the Social Vulnerability Index (SVI) ($p < 0.05$), suggesting that municipalities with better fiscal management capacity tend to have lower levels of socioeconomic vulnerability.

5 DISCUSSION

The findings of this study reinforce the hypothesis that the effectiveness of municipal public management plays a central role in reducing the financial vulnerability of the population, even when controlling for structural factors such as population size and income level.

The results dialogue with the financial psychology literature, which points out that the institutional environment can reinforce or mitigate harmful financial behaviors (Lusardi & Mitchell, 2014; Kahneman, 2011). Municipalities with better performance in education and planning offer more favorable conditions for building a culture of financial health.

The i-Educ dimension emerges as one of the main factors associated with the reduction of delinquency. This result is consistent with previous studies that indicate education as a key variable in the formation of healthy financial habits (OECD/INFE, 2022).

In addition, the performance in planning (i-Plan) and fiscal management (i-Fiscal) shows that the ability to anticipate scenarios, organize resources and implement effective public policies can generate indirect effects on the financial well-being of the population.

From the point of view of public policies, the findings indicate the need for integration between the areas of education, health, inspection and planning, promoting financial education strategies aligned with local contexts of vulnerability.

6 CONCLUSIONS AND IMPLICATIONS

This study provides robust empirical evidence that the quality of municipal public management, assessed by means of the Municipal Management Effectiveness Index (IEG-M), exerts a significant influence on the levels of delinquency, poverty and social vulnerability in the municipalities of the State of São Paulo. The results demonstrate that dimensions such as planning (i-Plan), education (i-Educ) and fiscal management (i-Fiscal) have negative and statistically significant correlations with financial vulnerability indicators, reinforcing the idea that better public governance practices are associated with more favorable socioeconomic conditions.

From a theoretical point of view, the main contribution of this research is in the advancement of integration between the fields of public management, financial education,

financial psychology and behavioral science. The combination of concepts from behavioral economics, such as cognitive biases, loss aversion, and decision heuristics, with objective indicators of public administration performance, broadens the understanding of the structural and behavioral factors that influence indebtedness and financial stress in the population.

Empirically, the study stands out for its exclusive use of official secondary databases, covering sources such as IBGE, IPEA, UNDP, Serasa Experian and the TCE-SP itself. From this information, it was possible to establish statistically significant correlations between the quality of public management and the financial and social outcomes of the population, using robust quantitative methods such as multiple regression and cluster analysis.

As a practical contribution, this study proposes an Integrated Multidimensional Model of the Influence of Municipal Governance on the Financial Health of the Population. This model establishes four interrelated dimensions:

- Municipal Governance (IEG-M): Quality of management in the areas of planning, fiscal management, education, health, environment and public safety.
- Local Socioeconomic Structure: Objective conditions of the population in terms of income, poverty, social vulnerability and human development.
- Interventions in Financial Education and Financial Psychology: Inclusion of public policies aimed at developing financial skills, combating behavioral biases, and promoting a culture of financial planning in schools and communities.
- Financial Health and Well-Being Outcomes: Reduced delinquencies, mitigated financial stress, increased subjective financial security, and strengthened citizens' economic decision-making capacity.

This model suggests that the effectiveness of public management, when combined with financial education strategies and interventions based on behavioral science, can generate positive effects on both macroeconomic indicators and individual financial well-being.

It is important to recognize the limitations of this research. Because it is based on aggregated data at the municipal level, it was not possible to capture the nuances of individual financial behavior within the municipalities. In addition, the exclusive use of secondary indicators restricts the analysis of subjective psychosocial variables, such as individual attitudes towards money and perception of financial well-being.

For future research, it is recommended:

- Conducting longitudinal investigations, with the objective of evaluating the effects of improvements in public management on debt levels and financial well-being over time.

- The development of inter-regional comparative studies, involving different states and regions of Brazil, to test the generalization of the proposed model.
- The conduction of qualitative surveys and surveys at the household level, to explore individual perceptions about the effectiveness of public management and its impact on financial and emotional well-being.
- The evaluation of financial education programs already implemented by local governments, focusing on the behavioral and financial effects generated in the population.

Finally, the results of this research reinforce the importance of efficient, integrated municipal public governance guided by principles of financial psychology and behavioral science, as a strategic factor for the promotion of collective financial health, contributing to the strengthening of the economic and social resilience of local populations.

REFERENCES

- Instituto Brasileiro de Geografia e Estatística. (2024). Pesquisa Nacional por Amostra de Domicílios Contínua: PNAD Contínua. <https://www.ibge.gov.br/estatisticas/sociais/rendimento-despesas-e-pobreza/18148-pnad-continua.html>
- Instituto de Pesquisa Econômica Aplicada. (2023). Atlas da vulnerabilidade social nos municípios brasileiros. https://repositorio.ipea.gov.br/bitstream/11058/4381/1/Atlas_da_vulnerabilidade_social_nos_municipios_brasileiros.pdf
- Kahneman, D. (2011). Thinking, fast and slow. Farrar, Straus and Giroux.
- Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature*, 52(1), 5–44. <https://doi.org/10.1257/jel.52.1.5>
- Organisation for Economic Co-operation and Development. (2012). OECD/INFE high-level principles on national strategies for financial education. OECD Publishing. <https://doi.org/10.1787/12e3989f-en>
- Organisation for Economic Co-operation and Development/International Network on Financial Education. (2015). National strategies for financial education: OECD/INFE policy handbook. OECD Publishing. <https://doi.org/10.1787/a8916d0e-en>
- Programa das Nações Unidas para o Desenvolvimento. (2023). Atlas do desenvolvimento humano no Brasil (IDHM). <https://www.atlasbrasil.org.br>
- Serasa Experian. (2024). Indicadores de inadimplência e endividamento. <https://www.serasaexperian.com.br/conteudos/indicadores-economicos/>
- Shefrin, H. (2000). Beyond greed and fear: Understanding behavioral finance and the psychology of investing. Harvard Business School Press.

Thaler, R. H. (2016). *Misbehaving: The making of behavioral economics*. W. W. Norton & Company.

Tribunal de Contas do Estado de São Paulo. (2024). *Manual do Índice de Efetividade da Gestão Municipal – IEG-M*. <https://www.tce.sp.gov.br/publicacoes/manual-ieg-m-2024> (ou <https://www.tce.sp.gov.br/publicacoes/manual-ieg-m-2025> para a versão mais recente, conforme dados de 2023/2024).

NEUROPHYSIOLOGICAL EFFECTS OF ACUPUNCTURE ANALGESIA IN INDIVIDUALS WITH CHRONIC PAIN

EFEITOS NEUROFISIOLÓGICOS DA ANALGESIA POR ACUPUNTURA EM INDIVÍDUOS COM DOR CRÔNICA

EFFECTOS NEUROFISIOLÓGICOS DE LA ANALGESIA POR ACUPUNTURA EN INDIVIDUOS CON DOLOR CRÓNICO



<https://doi.org/10.56238/sevened2026.008-034>

Maria Eduarda Vieira Rodrigues¹, Uitairany do Prado Lemes², Gabrielle Castilho Alves Silva³, Hanna Cristina Ferreira Assunção Neves⁴

ABSTRACT

Introduction: Chronic pain, a highly prevalent condition sustained by neurophysiological, emotional, and social alterations, remains a clinical challenge due to the limitations of exclusively pharmacological treatments. In this context, the use of non-pharmacological strategies has increased, including acupuncture, which is recognized for modulating endogenous analgesic mechanisms.

Objective: To analyze the neurophysiological mechanisms of acupuncture-induced analgesia and the evidence supporting its effectiveness in individuals with chronic pain.

Methodology: A narrative review conducted according to SANRA criteria, carried out in the PubMed, PEDro, Web of Science, and LILACS databases, using the descriptors “Acupuncture,” “Chronic Pain,” and “Acupuncture Analgesia.” After screening, 46 studies were included.

Theoretical framework: Acupuncture modulates peripheral, spinal, and supraspinal pathways through the release of endogenous opioids, serotonin, and noradrenaline, strengthening the descending inhibitory system and reducing central sensitization. Neuroimaging evidence demonstrates functional reorganization of structures such as the anterior cingulate cortex, insula, thalamus, and prefrontal cortex, as well as adjustments in default mode and salience networks. Comparative trials indicate greater specificity of true acupuncture compared to sham acupuncture, particularly in connectivity between the periaqueductal gray matter, serotonergic nuclei, and pain-modulating regions, with effects observed mainly between 4 and 12 sessions.

¹ Graduated in Physiotherapy. Universitário de Goiatuba (UniCerrado). E-mail: maduu428@gmail.com

² Advisor Professor. Universitário de Goiatuba (UniCerrado). E-mail: uitairanylemes@unicerrado.edu.br

³ Graduated in Physiotherapy. Universitário de Goiatuba (UniCerrado). E-mail: gabrielle.cstlh12@gmail.com

⁴ Graduated in Physiotherapy. Universitário de Goiatuba (UniCerrado). E-mail: hanna.cristina192@gmail.com

Final considerations: The evidence indicates that acupuncture exerts consistent analgesic effects supported by integrated neurophysiological mechanisms, contributing safely and effectively to the interdisciplinary management of chronic pain.

Keywords: Acupuncture. Chronic Pain. Analgesia. Neurophysiology.

RESUMO

Introdução: A dor crônica, condição altamente prevalente e sustentada por alterações neurofisiológicas, emocionais e sociais, permanece um desafio clínico diante das limitações dos tratamentos exclusivamente farmacológicos. Nesse cenário, cresce o uso de estratégias não farmacológicas, entre elas a acupuntura, reconhecida por modular mecanismos de analgesia endógena.

Objetivo: Analisar os mecanismos neurofisiológicos da analgesia por acupuntura e as evidências que sustentam sua eficácia em indivíduos com dor crônica.

Metodologia: Revisão narrativa conduzida segundo os critérios SANRA, realizada nas bases PubMed, PEDro, Web of Science e LILACS, utilizando os descritores “Acupuncture”, “Chronic Pain” e “Acupuncture Analgesia”. Após triagem, 46 estudos foram incluídos.

Referencial teórico: A acupuntura modula vias periféricas, espinais e supramedulares por meio da liberação de opioides endógenos, serotonina e noradrenalina, fortalecendo o sistema inibitório descendente e reduzindo a sensibilização central. Evidências de neuroimagem demonstram reorganização funcional de estruturas como córtex cingulado anterior, ínsula, tálamo e córtex pré-frontal, além de ajustes em redes de modo padrão e de saliência. Ensaios comparativos indicam maior especificidade da acupuntura verdadeira em relação à simulada, sobretudo na conectividade entre substância cinzenta periaquedutal, núcleos serotoninérgicos e regiões moduladoras da dor, com efeitos observados majoritariamente entre 4 e 12 sessões.

Considerações finais: As evidências apontam que a acupuntura exerce efeitos analgésicos consistentes, sustentados por mecanismos neurofisiológicos integrados, contribuindo de forma segura e eficaz para o manejo interdisciplinar da dor crônica.

Palavras-chave: Acupuntura. Dor Crônica. Analgesia. Neurofisiologia.

RESUMEN

Introducción: El dolor crónico, una condición altamente prevalente sostenida por alteraciones neurofisiológicas, emocionales y sociales, sigue siendo un desafío clínico debido a las limitaciones de los tratamientos exclusivamente farmacológicos. En este contexto, ha aumentado el uso de estrategias no farmacológicas, entre ellas la acupuntura, reconocida por modular los mecanismos endógenos de analgesia.

Objetivo: Analizar los mecanismos neurofisiológicos de la analgesia por acupuntura y las evidencias que respaldan su eficacia en individuos con dolor crónico.

Metodología: Revisión narrativa realizada según los criterios SANRA, llevada a cabo en las bases de datos PubMed, PEDro, Web of Science y LILACS, utilizando los descriptores “Acupuncture”, “Chronic Pain” y “Acupuncture Analgesia”. Tras el proceso de selección, se incluyeron 46 estudios.

Marco teórico: La acupuntura modula las vías periféricas, espinales y supramedulares mediante la liberación de opioides endógenos, serotonina y noradrenalina, fortaleciendo el sistema inhibitor descendente y reduciendo la sensibilización central. La evidencia de neuroimagen demuestra una reorganización funcional de estructuras como la corteza cingulada anterior, la ínsula, el tálamo y la corteza prefrontal, además de ajustes en las redes de modo por defecto y de saliencia. Ensayos comparativos indican una mayor especificidad de la acupuntura verdadera en comparación con la simulada, especialmente en la conectividad entre la sustancia gris periacueductal, los núcleos serotoninérgicos y las regiones moduladoras del dolor, con efectos observados principalmente entre 4 y 12 sesiones.

Consideraciones finales: Las evidencias indican que la acupuntura ejerce efectos analgésicos consistentes, sustentados por mecanismos neurofisiológicos integrados, contribuyendo de manera segura y eficaz al manejo interdisciplinario del dolor crónico.

Palabras clave: Acupuntura. Dolor Crónico. Analgesia. Neurofisiología.

1 INTRODUCTION

Chronic pain, defined by the International Association for the Study of Pain (IASP) as persistent pain for more than three months and associated with neurophysiological, emotional, and social changes, is one of the main causes of global disability (Nicholas et al., 2019; Treede et al., 2019). It is estimated that about 20% of the adult population lives with this condition, recognized by the World Health Organization as a problem of high relevance in public health (WHO, 2021).

The complexity of this condition stems from its multifactorial etiology and the interaction between peripheral alterations, central sensitization, emotional and cognitive factors, which makes its clinical management challenging (Robinson et al., 2022). Despite pharmacological advances, many patients remain symptomatic or develop adverse effects related to long-term use of analgesics and opioids, limiting the effectiveness of conventional treatments (CDC, 2022). Thus, the search for safe and effective alternatives for the management of chronic pain has stimulated the use of complementary therapies, such as acupuncture, whose efficacy is supported by a growing body of literature covering clinical trials, meta-analyses, and neurophysiological studies (Chou et al., 2022; Lyu et al., 2021).

Recent evidence supports that acupuncture exerts measurable analgesic effects at both the peripheral and central levels, observed in clinical trials and meta-analyses (Kato et al., 2022). Stimulation of specific acupoints promotes the release of neurotransmitters endogenous and activates descending inhibitory circuits (Yuan et al., 2022). Neuroimaging studies demonstrate the reorganization of brain networks involved in pain perception, suggesting an integrated regulation of sensory and affective dimensions (Wen et al., 2021). These findings legitimize its use as an adjunctive and safe intervention in the treatment of chronic pain (Niruthisard et al., 2024).

Although there is solid evidence that acupuncture modulates chronic pain by recognized neurophysiological mechanisms, part of these processes still needs clarification (Lyu et al., 2021; Wen et al., 2021). Since chronic pain involves alterations in nociceptive processing, especially central sensitization and dysfunctions of modulatory pathways, understanding how acupuncture acts on these circuits becomes essential. Thus, the present study aims to analyze and synthesize the neurophysiological mechanisms described in the literature to explain the analgesic effects of acupuncture in individuals with chronic pain.

The methodological diversity of the available research justifies the adoption of a narrative review, allowing the integration of findings from different designs and the construction of an expanded and reasoned interpretation of the processes involved in analgesia.

2 METHODOLOGY

The present study is a descriptive narrative review of the literature, guided by the following guiding question: what are the main neurophysiological mechanisms described in the literature to explain the analgesic effects of acupuncture in individuals with chronic pain?

The bibliographic search was carried out in the first half of 2025 in the PubMed, PEDro, Web of Science and LILACS databases. The indexing descriptors were retrieved from the DeCS/MeSH descriptors portal, and applied in English, Portuguese and Spanish, without the use of Boolean operators, corresponding to: "Acupuncture"; "Chronic Pain"; "Acupuncture Analgesia". In addition, a feedback search was performed in the reference lists of the included articles, in order to identify additional relevant publications.

The selection of studies followed the quality criteria recommended by the SANRA (Scale for the Assessment of Narrative Review Articles) checklist. Articles published between 2019 and 2025, in English, Portuguese, and Spanish, that addressed the effects of acupuncture on the modulation of chronic pain in humans and that described, directly or indirectly, neurophysiological mechanisms, whether peripheral, spinal, supramedullary, autonomic or neurochemical. Studies with animal samples, duplicate texts between databases, and studies without access to the full text were excluded.

After reading the titles and abstracts, 45 articles met the eligibility criteria and were included for the critical synthesis. These articles were examined in an organized manner, grouping the findings by level of physiological performance, type of pain investigated, and techniques employed, seeking to identify the main neurophysiological mechanisms involved in acupuncture-induced analgesia and its clinical implications in people with chronic pain. The synthesis was constructed in a narrative way, privileging convergences, divergences, methodological limitations and gaps in the literature, as guided by the SANRA checklist.

3 THEORETICAL FRAMEWORK

3.1 NEUROPHYSIOLOGY OF PAIN

Pain is a complex sensory and emotional experience, associated or not with actual tissue damage, and results from the integration between multiple neuronal systems (Treede et al., 2019). Under physiological conditions, pain mechanisms begin in nociceptors, free nerve endings sensitive to potentially harmful mechanical, thermal or chemical stimuli. These receptors convert the energy of the stimulus into electrical signals that are conducted by the A δ and C fibers to the dorsal horn of the spinal cord, constituting the ascending nociceptive pathways. It is at this point that the nervous system begins to decide what to do with the painful information that arrives from the body. (Di Maio et al., 2023).

Once in the spinal cord, these signals are modulated before making their way to the brain. The first level of this modulation occurs in the mechanism known as the spinal gate. In it, inhibitory interneurons use neurotransmitters such as GABA and glycine to reduce the excitability of projection neurons, filtering the nociceptive impulse and preventing low-intensity stimuli from being amplified in an exaggerated way (Stachowski et al., 2021). This process works as a "quality control" of pain: only relevant information goes to higher levels of the central nervous system (Rivera-Arconada et al., 2025).

After this initial filtering, the nociceptive signals that go up to the brain are interpreted by an integrated network of structures known as the "pain matrix". This matrix involves the somatosensory cortex, responsible for the location and discrimination of the stimulus, the insula, associated with subjective and interoceptive experience, the anterior cingulate cortex (CCA), linked to the affective component, in addition to the thalamus and the prefrontal cortex (PFC), which organize and modulate cognitive aspects of pain. It is in this interaction that the stimulus gains meaning and transforms, in fact, into the conscious experience of pain (Kato et al., 2022; Wang et al., 2024).

The coordinated activity of these regions is shaped by neuroplasticity processes. In adaptive modulation, the nervous system adjusts its response to maintain functionality and protection. In maladaptive neuroplasticity, connections are reorganized in a dysfunctional way, reinforcing circuits that sustain pain even after the initial injury has resolved. This phenomenon explains why chronic pain can persist even in the absence of ongoing peripheral damage (Pan et al., 2022; Robinson et al., 2022).

Parallel to spinal modulation and cortical processing, the body has a second regulatory axis: downward modulation. Structures such as the periaqueductal gray matter (PAG) and the rostroventromedial medulla (CABG) send projections that release serotonin, noradrenaline, and endogenous opioids, capable of inhibiting nociceptive transmission in the spinal cord (Rocha-Jacob; Silva; Ferreira, 2024). This system acts as a physiological brake on pain and is strongly influenced by emotional, cognitive, and contextual factors, demonstrating that thoughts, expectations, and affective states modulate the painful experience (Treede et al., 2019).

The continuous communication between neurons of the nociceptive pathway is mediated by several excitatory neurotransmitters, such as glutamate, substance P, and CGRP, which promote the activation of projection neurons and participate in the encoding of the intensity and duration of the painful stimulus (Rivera-Arconada et al., 2025). The balance between excitatory and inhibitory neurotransmitters is essential for pain to maintain its

protective and adaptive character, functioning as an alert for potential threats to the body (Stachowski et al., 2021).

Thus, the painful experience results from the coordinated interaction between ascending nociceptive pathways, spinal inhibitory circuits, descending modulatory systems, and the integrated activity of the pain matrix. This organization ensures that pain functions as a physiological signal of protection, reflecting the complex neurofunctional structure of the nervous system (Wang et al., 2024).

3.1.1 Pathophysiology and classification of chronic pain

Pain chronicity is a multifactorial process underpinned by interrelated neurophysiological mechanisms. Among them, the following stand out: central sensitization (Rivera-Arconada et al., 2025); maladaptive neuroplasticity (Pan et al., 2022; Robinson et al., 2022); the dysfunction of inhibitory interneurons (Stachowski; Dougherty, 2021); the weakening of descending inhibitory pathways (Rocha-Jacob et al., 2024; Treede et al., 2019) and persistent glial activation (Di Maio et al., 2023). The interaction of these mechanisms favors the amplification of nociceptive signals and the transition from acute to chronic pain.

Pain chronicity occurs when neurophysiological modulation mechanisms cease to function properly. In this condition, changes in the organization and functionality of the pain matrix are among the main mechanisms associated with the transition from acute to chronic pain. Persistent activation of this network alters the connectivity between the somatosensory cortex, insula, thalamus, and CCA, resulting in increased neuronal responsiveness and amplification of pain perception (Wang et al., 2024).

This process is supported by maladaptive neuroplasticity, in which synaptic reorganization and excessive excitability of the central nervous system favor the maintenance of pain even after the resolution of the initial lesion (Pan et al., 2022; Robinson et al., 2022). Among the mechanisms involved, central sensitization stands out, a condition in which neurons in the dorsal horn of the spinal cord become hyperexcitable in the face of repetitive stimulation of C and A δ fibers, generating a progressive amplification of the synaptic response known as wind-up (Rivera-Arconada et al., 2025).

When persistent, this phenomenon contributes to the transition between acute pain and chronic pain, reflecting a short-term synaptic facilitation that raises the frequency of action potentials and prolongs the painful sensation. Under physiological conditions, inhibitory interneurons of the dorsal horn limit this activity by controlling nociceptive transmission through neurotransmitters such as GABA and glycine. The dysfunction of these

interneurons causes synaptic disinhibition and increased neuronal excitability, intensifying the conduction of nociceptive impulses (Di Maio et al., 2023; Stachowski; Dougherty, 2021).

At the supramedullary level, descending inhibitory pathways, originating in the GWP and the CABG medulla, act to modulate pain through the release of serotonin, noradrenaline, and endogenous opioids, which reduce the excitability of neurons in the dorsal horn and limit nociceptive transmission (Rocha-Jacob et al., 2024; Stachowski; Dougherty, 2021). The weakening of these pathways compromises endogenous modulation, reduces the pain threshold, and favors the amplification of nociceptive signals, a mechanism often observed in conditions of chronic pain and associated with the loss of balance between excitation and inhibition (Di Maio et al., 2023; Rivera-Arconada et al., 2025; Treede et al., 2019).

This imbalance favors the emergence of allodynia and hyperalgesia, conditions characterized by the exaggerated painful response to harmless or moderate stimuli (Rivera-Arconada et al., 2025). Another commonly associated mechanism concerns the sustained activation of glial cells, such as microglia and astrocytes. These cells release pro-inflammatory cytokines, enhancing neuronal excitability and reinforcing the maintenance of central sensitization (Di Maio et al., 2023).

This set of structural and chemical alterations characterizes pathological synaptic plasticity, in which neuronal connections cease to perform a modulating function and start to reinforce pain circuits. In this way, the painful experience becomes independent of peripheral stimuli, being supported by central mechanisms, composing the clinical picture of primary chronic pain described in the International Classification of Diseases (ICD-11) (Treede et al., 2019).

Understanding these neurophysiological dysfunctions is essential for the clinical management of chronic pain. Treatment should seek to restore the balance between excitatory and inhibitory pathways, reduce neuronal hyperexcitability, and strengthen endogenous pain modulation mechanisms (Pan et al., 2022; Wang et al., 2024).

3.1.2 Multidimensionality of chronic pain and biopsychosocial model

Understanding the pathophysiological mechanisms, however, is not sufficient to explain the complexity of chronic pain. It is a phenomenon that emerges from the interaction between neurophysiological, emotional, cognitive, and social factors, shaping both the perception and expression of suffering (Robinson et al., 2022).

Neuroimaging evidence indicates that the painful experience is modulated by neural networks that integrate sensory, affective, and cognitive dimensions, involving the CCA, insula, and prefrontal cortex (PFC) (Wang et al., 2024). This integration demonstrates that

pain is not limited to peripheral nociceptive transmission, but involves brain circuits capable of amplifying, suppressing, or reorganizing pain perception, according to emotional states, expectations, and previous experiences (Vlaeyen; Crombez, 2020).

Structural and functional changes in the brain, combined with emotional states such as anxiety, stress, and depression, contribute to amplifying pain perception and reinforcing pain maintenance over time (Simons et al., 2022). Individual sensory profiles and differences in cortical connectivity also influence vulnerability to chronicity (Wang et al., 2024).

In addition to biological and emotional factors, the social dimension exerts a significant influence on the painful experience. Family support, community insertion, working conditions, and living environment determine the individual's coping ability and functionality (Kovačević et al., 2024). When these elements are insufficient or adverse, greater pain intensity and lower therapeutic response are observed (Gava et al., 2025).

These findings reinforce that chronic pain should not be considered just an individual condition, but a biopsychosocial phenomenon (BPS), in which psychological and social factors interact with neurophysiological mechanisms, modulating the intensity, persistence, and functional impact of pain (Robinson et al., 2022). Given this complexity, the BPS model is the most appropriate approach to understand and treat chronic pain. This model proposes the integration of biological, psychological, and social factors in clinical assessment and intervention, enabling a more comprehensive and person-centered approach (Simons et al., 2022).

By considering the interactions between chronic pain, mental health, and social context, the BPS model broadens the understanding of human suffering, highlighting the importance of strategies that promote psychosocial support, prevention of negative emotional impacts, and improvement of quality of life (Gava et al., 2025; Kovačević et al., 2024).

3.2 CHRONIC PAIN MANAGEMENT STRATEGIES

The clinical management of chronic pain requires a comprehensive and integrated approach, capable of contemplating the biological, psychological, and social aspects involved in the painful experience. Because it involves multiple dimensions, this condition represents a challenge for health professionals, requiring individualized care, whose manifestations and therapeutic responses vary widely among individuals (CDC, 2022).

Clinical management should seek not only symptomatic relief, but also the restoration of functionality and overall improvement of health (Knopp-Sihota; Morris; Courtney, 2022). Treatment should prioritize functional recovery, combining resources as clinically needed, and carefully weighing the risks and benefits of each intervention. International

recommendations guide the organization of safe and effective care, with an emphasis on person-centered practices (CDC, 2022).

The contemporary paradigm of care is based on multimodal approaches, which integrate medications, physiotherapy, restorative therapies, behavioral strategies and psychosocial interventions (Wang; Doan, 2024). However, long-term use of analgesic drugs, especially opioids, is related to risks of dependence, tolerance, and overdose, in addition to offering limited long-term benefits (CDC, 2022).

Non-pharmacological interventions, such as physical and psychological therapies and pain education, have demonstrated efficacy comparable to the use of analgesics, contributing to the improvement of functionality and well-being. (Knopp-Sihota et al., 2022). Integrated with conventional treatment, complementary therapies can expand the possibilities of intervention and strengthen interdisciplinary care models (Lyu et al., 2021; Wang; Doan, 2024).

Among the complementary interventions, acupuncture stands out, whose use has been widely documented in clinical research and systematic reviews. Studies suggest that the technique can influence central and peripheral nociceptive processes and assist in autonomic regulation, integrating with modern care plans aimed at pain reduction and functional restoration (Lee et al., 2024; Vickers et al., 2022).

3.3 ACUPUNCTURE IN CHRONIC PAIN MANAGEMENT

Acupuncture is an ancient practice of Traditional Chinese Medicine that has been consolidated as a technique of physiological regulation through the stimulation of specific points of the body, called acupoints (Zhu; Wang; Liu, 2021). These acupoints have microstructures rich in nerve fibers, vessels, and connective tissue, which contributes to their high therapeutic responsiveness (Ifrim-Chen; Antochi; Barbilian, 2019). The standardization of these points, associated with the modernization of the materials, favored their integration and expanded their use in the management of chronic pain (Zhu et al., 2021).

True acupuncture consists of inserting needles into defined acupoints, capable of activating sensory fibers and triggering autonomic and neurochemical responses associated with analgesia and physiological regulation (Hamvas et al., 2023). While sham acupuncture uses superficial stimuli or points outside the traditional meridians, functioning as an experimental control and producing minimal or non-specific effects (Liu et al., 2019).

The clinical procedure involves the insertion of thin, sterile needles into selected points based on Traditional Chinese Medicine diagnostic criteria, corresponding to areas of high neural and vascular responsiveness (Zhang et al., 2022). After skin asepsis, the needles are

inserted at varying depths according to the region and therapeutic objective (Ang et al., 2025). Manual manipulations, such as rotation or light traction, can be applied to intensify sensory activation (Zhang et al., 2022).

This stimulation usually produces the sensation of *deqi*, described as heaviness, pressure, numbness, tingling, or warmth. *Deqi* is considered a clinical marker of effective acupoint activation and is associated with the activation of cutaneous and myofascial nerve endings (Du et al., 2019). In addition, it triggers immediate adjustments in the autonomic nervous system, contributing to increased parasympathetic activity and sympathetic-parasympathetic rebalancing (Hamvas et al., 2023).

These responses occur because mechanical stimulation of the needles activates afferent fibers that project to autonomic nuclei of the brainstem and hypothalamus, regions essential for homeostatic regulation (Li et al., 2021). Thus, acupuncture can be understood as a neurostimulatory intervention that combines controlled needle insertion, *deqi* attainment, and activation of autonomic and sensory circuits involved in physiological modulation (Li et al., 2021).

In addition to classical acupoints, clinical practice also incorporates *Ashi* points, defined as areas of increased sensitivity identified by palpation, especially in musculoskeletal conditions (Zhu et al., 2021). These points do not necessarily follow the paths of the meridians, but are selected according to local or segmental pain. Although widely used, they have a lower volume of specific mechanistic evidence when compared to standardized acupoints (Ifrim-Chen et al., 2019). Therefore, the literature recommends the combination of *Ashi* points with classical acupoints that have greater experimental support, especially in protocols aimed at neurophysiological investigation (Zhu et al., 2021).

3.3.1 Neurophysiological mechanisms of acupuncture analgesia

Acupuncture-induced analgesia is associated with the release of endogenous neurotransmitters, such as opioids, serotonin, and norepinephrine, which act on ascending and descending pain pathways, reducing neuronal excitability and pain sensitivity. Among the mechanisms described, opioid modulation is the physiological axis with the greatest methodological support, supported by studies with antagonists such as naloxone, which attenuate the analgesic effect observed (Dimitrova et al., 2021; Niruthisard et al., 2024).

Classical acupoints such as Hegu (IG4) and Zusanli (E36) appear frequently in experimental models precisely because they trigger robust neurochemical responses. Stimulation of these points activates descending inhibitory pathways and modulates core pain structures, an effect that is significantly attenuated by opioid receptor blockade (Zhu et

al., 2021; Niruthisard et al., 2024;). Even so, the magnitude of this response varies according to protocol, stimulus intensity, and clinical heterogeneity of the samples, which limits the direct extrapolation of the findings.

Moving to more integrated levels of the central nervous system, acupuncture modulates multiple brain regions responsible for pain perception and control, including the somatosensory and prefrontal cortices, the thalamus, insula, and brainstem structures (Niruthisard et al., 2024; Kato et al., 2022). Neuroimaging assays show that manual IG4 and E36 stimulation promotes selective activations and inhibitions in these areas, reflecting functional reorganization compatible with pain reduction (Lu et al., 2021).

This reorganization is accompanied by changes in neural oscillations, as demonstrated by magnetoencephalography (MEG) studies. These investigations identified low-frequency oscillations in the occipital lobe and high-frequency oscillations in the prefrontal and somatosensory cortices, indicating a dynamic pattern of electrophysiological response during the intervention. From these local responses, functional connectivity studies suggest distributed effects in large-scale networks (Kato et al., 2022).

Such adaptations contribute to the modulation of functional connectivity between widely distributed brain networks, including the Default Mode Network, Salience Network, and the Descending Pain Modulation System. The modulation of these networks has been consistently associated with reduced pain and improved affective processing, although methodological differences persist regarding connectivity analysis techniques and the statistical models employed (Lu et al., 2021; Niruthisard et al., 2024).

In individuals with chronic pain, acupuncture regulates the connectivity between areas related to emotional and autonomic modulation, such as serotonergic nuclei of the brainstem, reinforcing the role of descending mechanisms, especially the activation of raphe and PAG nuclei, in the analgesia observed after IG4 and E36 stimulation, strengthening endogenous inhibitory mechanisms responsible for suppressing nociceptive impulses at the medullary level (Dimitrova et al., 2021; Niruthisard et al., 2024).

Another important axis of analgesia involves the brain's reward system. Acupuncture stimulation activates the mesolimbic dopaminergic circuit, attenuating negative emotions from the painful experience and increasing tolerance to nociceptive stimuli (Lu et al., 2021; Pan et al., 2022). These emotional effects are articulated with sensory and cognitive processes, reinforcing the multidimensional character of analgesia (Niruthisard et al., 2024).

Finally, acupuncture also triggers autonomic and neuroimmune responses that contribute to the modulation of inflammation and the restoration of neural homeostasis,

evidencing the interaction between nervous and immune systems. These effects involve, among other processes, the regulation of the neuroimmune axis and sympathetic and parasympathetic autonomic activity, effects frequently observed in E36 stimulation (Lyu et al., 2021; Niruthisard et al., 2024). The combination of these mechanisms favors adjustments in the functional plasticity of brain networks related to chronic pain and underpins clinically observed therapeutic effects (Lu et al., 2021; Niruthisard et al., 2024)

3.4 EVIDENCE-BASED PROTOCOLS

The recent literature on acupuncture in chronic pain demonstrates a growing number of experimental studies characterized by significant methodological heterogeneity. The differences involve point selection, insertion depth, stimulation techniques and deqi acquisition, as well as the use of neuroimaging methods employed to understand analgesic mechanisms (Cao et al., 2019; Xiang et al., 2019).

This methodological diversity also reflects the heterogeneity of chronic pain itself, which encompasses conditions with distinct pathophysiology and specific therapeutic demands. Studies on shoulder pain, for example, have evaluated distal points such as ST38 (Liu; Zhao; Jin, 2019), while protocols targeting systemic conditions such as fibromyalgia (Baelz et al., 2023) and sickle cell disease (Li et al., 2021) tend to employ broader combinations of acupoints.

Research involving neck pain and primary dysmenorrhea reinforces this variability by using, respectively, sets of points based on traditional recommendations (Xu et al., 2022) or the isolated application of SP6 (Xu et al., 2022). Thus, Table 1 shows a synthesis of evidence that reflects the plurality of these conditions and the complexity inherent in the establishment of standardized protocols.

Table 1

Acupuncture protocols employed in chronic pain conditions

References	Sample and type of chronic pain	Intervention	Protocol used	Observed effects
Liu <i>et al.</i> (2019) Essay E Exploratory randomized clinical	Pain Chronic on the shoulder. N= 38 subjects (Real acupuncture group N= 19 vs. Group sham acupuncture)	Manual acupuncture on ST38 or on local points of the shoulder; 1 single treatment session; retention time ~20 min; initial manipulation of 30s.	ST38 contralateral vs ipsilateral; depth 10–15 mm; manual rotation to deqi.	Both sides reduced pain; contralateral had greater pain reduction and better ROM; no adverse events.

Cao <i>et al.</i> , (2019) Experimental study (fMRI) with pain-induced in a controlled manner	Pain Induced experimental in healthy volunteers. N = 27 healthy adults (crossover design)	Four interventions in order omized: acupuncture, acupuncture sham, VGAIT (<i>Video-Guided Acupuncture imagery treatment</i>) and VGAIT control (video of swab touching the skin); classic point stimulus (e.g. LI4), with cold pain induction and recording fMRI. for 9 min.	Randomized real Points used in fMRI interventions: points on the legs (real points and adjacent control points; 1–2 points applied per session Real Point: experimental point located 3 cun above and 1 cun posterior to KI8, on the Kidney meridian.	Real acupuncture and VGAIT increased the pain threshold vs their controls. Real acupuncture activated the insula more; VGAIT produced greater deactivation in rostral ACC. It shows the potential of acupuncture and placebo interventions, but in an experimental, non-clinical model.
Xiang <i>et al.</i> (2019) Experimental clinical trial with fMRI	Chronic nonspecific low back pain. N= 52 individuals (Group with low back pain N=27 vs. Healthy control group N=25)	Ankle acupuncture with manual stimulation for 8 min while resting fMRI was recorded; single session; comparison with tactile stimulus control at the same place.	Acupuncture on the ankle, perimallegia/ankle points.	Acupuncture reduced pain VAS and modulated ALFF in pain-related regions (thalamus, somatosensory cortex, default mode network). There were distinct changes between chronic pain vs controls, suggesting Specific modulation of networks
	(real VS tactile stimulus)			of pain, but with heterogeneity and Sample small.
Li <i>et al.</i> (2021) Mixed methods pilot study	Pain associated with sickle cell disease. N= 6 adults with sickle cell disease and chronic pain	Individualized protocol as an adjunct to standard care; up to 10 sessions lasting 30 min, 1-2x/week, in a palliative care hospital; points defined according to complaint and TCM standard.	Analgesia and toning points based on TCM and STRICTA Standardized 18-point protocol: CV17, CV6, PC6 (bilateral), LI4, SP6, SP10, ST36,	Reduction of pain intensity and interference; 82% acceptance; safe and feasible acupuncture; no serious adverse events reported.

LR3, LR8,
KI3, CV7
(transverse).

Kato <i>et al.</i> (2022)	Pain chronic (various etiologies) N = 21 patients with chronic pain	Sessions Unique acupuncture procedure with magnetoencephalography (MEG) recording; systemic points with <i>Dehere</i> ; needle left for 30 s; immediate pre/post evaluation.	WHO standard stitches and individualized stitches (≤ 2 cm); needles held for 30s, without rotation. Miscellaneous Points: LI4, BL15, BL16, BL48, GB33, BL53, SI7, among many others (each participant had 1 point selected).	Acupuncture modulated low-frequency oscillations in occipital and high-frequency regions. Regions prefrontal/somatosensory; pain reduction was associated, but with focus predominantly mechanistic. No Clinical long-term.
Xu, H. <i>et al.</i> (2022)	Pain chronic cervical. N= 99 subjects (True acupuncture: n $\approx$ 49; Sham acupuncture: n $\approx$ 50)	Manual acupuncture in a standardized protocol for neck pain, 3x/week for 4 weeks (12 sessions) lasting 30 min; cranial and cervical points described in the article; stimulation up to <i>deqi</i> .	Recommended points in the literature for neck pain due to the absence of specification in the article: GB20, GV14, SI15, SI14, GB21, LI4, SI3, TB5 AT vs AS.	True acupuncture group had pain reduction (VAS $p < 0.001$), and robust brain serotonergic vs. <i>sham</i> effect connectivity, but with individual variation and short follow-up.
Xu, J. <i>et al.</i> (2022)	Primary dysmenorrhea (chronic pelvic pain). N = 34 (Acupuncture <i>verum</i> SP6: n = 17; Sham acupuncture SP6: n=17)	Bilateral acupuncture in Sanyinjiao (SP6), 8 weeks intervention; serial sessions with <i>deqi</i> , associated with resting fMRI acquisition; 30 min needle retention; manipulation of 30s each	Unilateral SP6; depth 1–1.2 cun; manual stimulation up to <i>deqi</i> .	Both groups reported pain reduction, but only the <i>verum</i> group showed normalization of connectivity between GWP and areas involved in affective/attentional pain modulation, suggesting a specific effect on the system descending modulation.

10 min.

Baelz <i>et al.</i> (2023) Essay Double-blind randomized clinical	Fibromyalgia. N = 40 (Acupuncture: n=20; Sham: n=20)	Systemic acupuncture with points: PC6, HT7, LI4, ST36, SP6, LR2, with <i>deqi</i> ; 30 min/session, 1x/week; total of 8 sessions; 4-week follow-up.	PC6, HT7, LI4, ST36, SP6, LR2 (<i>DEQI</i>); (needles 15 mm lateral to the points, outside the meridian).	Acupuncture reduced pain in ~16% and improved FIQ by ~21% vs baseline, with significant difference vs sham group.
Astini; Ri- berto (2023) Essay Prospective clinical	Severe hip osteoarthritis N = 12 (case series, single group)	Standardized acupuncture protocol for hip OA, 10 weekly sessions; systemic points + locations, standard hold; focus on pain control in patients eligible for arthroplasty but in a queue or with restrictions.	Standardized 6-point protocol used in all patients: GB29, GB30, GB34, GB36, BL62, SJ5.	VAS reduced from ~75.8 mm to 20 mm at the end of the 10 sessions and ~48 mm in the follow-up; relevant improvement in pain and function.

Legends: ADM – Range of motion; ACC – Anterior Cingulate Cortex; Ashi – Tender points tender to palpation; ALFF – Low Frequency Fluctuations in Amplitude; AS – Simulated Acupuncture; TA / Verum – True Acupuncture; CV – Vessel Conception (Ren Mai); *deqi* – Characteristic sensation of acupuncture; fMRI – Functional Magnetic Resonance Imaging; FIQ – Fibromyalgia Impact Questionnaire; Follow-up – Follow-up assessment after treatment; GB – Gallbladder; GV – Du Mai (Governor Vase); HT – Heart; KI – Kidney; LI – Large Intestine; LR – Liver; MEG – Magnetoencephalography; TCM/TCM – Traditional Chinese Medicine; MVPA – Multivariate Pattern Analysis; OA – Osteoarthritis; GWP – Periaqueductal Gray Matter; CP – Pericardium; PET – Positron Emission Tomography; SJ/TB – Triple Heater (Sanjiao); SP – Spleen; Sham – Sham acupuncture (placebo); ST – Stomach; STRICTA – Guidelines for Reporting Interventions in Clinical Trials of Acupuncture; VAS – Visual Analogue Scale; VGAIT – Video-Guided Acupuncture Imagery Treatment.

Source: Survey data.

The analysis of the included studies shows that, despite the diversity in protocols involving differences in the selection of points, depth, type of stimulation, and number of sessions, they all converge in demonstrating analgesic effects mediated by central and peripheral neurophysiological mechanisms that are widely consistent in the literature (Astini: Riberto, 2023; Baelz et al., 2023; Cao et al., 2019; Kato et al., 2022; Li et al., 2021; Liu et al., 2019; Xiang et al., 2019; Xu H. et al., 2022; Xu J. et al., 2022). Frequently employed points, such as LI4, ST36, SP6, PC6, HT7, ST38, and the Ashi points, activate somatosensory,

autonomic, and visceral pathways associated with pain modulation (Baelz et al., 2023; Liu et al., 2019; Xiang et al., 2019; Xu et al., 2022).

In the cases of neck pain and low back pain, approaches that combine standardized acupoints, local points and Ashi have shown significant pain reduction. These effects were accompanied by reorganization of brain activity in regions associated with nociceptive processing, reinforcing acupuncture's ability to modulate central networks involved in pain (Xiang et al., 2019; Kato et al., 2022; Xu et al., 2022).

Trials comparing real and sham acupuncture showed greater specificity of the real technique, evidenced by clinical improvement and changes in connectivity between the FPC, INSULA, ACC, GP, and serotonergic nuclei of the brainstem (Cao et al., 2019; Xu H. et al., 2022). These findings reinforce that analgesia depends on the integrated activation of distributed circuits of descending pain modulation (Kato et al., 2022; Xu J. et al., 2022).

In shoulder pain, the ST38 point produced immediate effects on range of motion and reduction of ipsilateral and contralateral pain, suggesting the participation of intersegmental mechanisms and sensorimotor integration (Liu et al., 2019). This response indicates that distal points can promote adjustments in higher levels of the central nervous system, favoring cortical reorganization related to the upper limb (Cao et al., 2019; Liu et al., 2019). Similarly, in low back pain, changes in the ALFF (Amplitude of Low-Frequency Oscillations) and fALFF (Fraction of Low-Frequency Oscillations) indices revealed modulations in the default mode network and in thalamocortical areas, associating clinical improvement with brain functional reorganization (Kato et al., 2022; Xiang et al., 2019).

In systemic conditions, such as fibromyalgia, protocols using broad combinations of points such as PC6, HT7, LI4, ST36, SP6, and LR2, which resulted in reduced pain, improved quality of life, and decreased symptoms such as fatigue and discouragement (Baelz et al., 2023). Although neuroimaging was not used in this sample, the findings are compatible with limbic and prefrontal modulation patterns described in other chronic pain conditions (Kato et al., 2022; Xu H. et al., 2022).

The efficacy of SP6 in primary dysmenorrhea reinforces the role of visceral mechanisms in analgesia. Only the group submitted to true acupuncture showed normalization of connectivity between the periaqueductal gray matter, limbic regions, and cortical areas related to interoception and affective assessment (Xu J. et al., 2022).

Studies involving less frequent conditions, such as severe hip osteoarthritis and pain associated with sickle cell disease, have also demonstrated improved pain and functionality, even in small samples. Despite their preliminary nature, these results reinforce the versatility of acupuncture in different models of chronic pain (Astini; Riberto, 2023; Li et al., 2021).

Mechanistic studies evaluated by fMRI, MEG, and experimental paradigms show that acupuncture modulates core pain matrix structures, such as the CCA, insula, dorsolateral and ventromedial PFC, thalamus, and somatosensory cortex (Cao et al., 2019; Kato et al., 2022; Xu H. et al., 2022). The technique also adjusts networks such as the salience network, default mode network, and sensorimotor network, which are essential for the maintenance of chronic pain and its emotional and cognitive load (Kato et al., 2022; Xu H. et al., 2022).

In addition, these studies show that image-guided interventions, often used as a simulated acupuncture condition, can generate neural patterns partially similar to those of real acupuncture, especially in regions associated with attention, expectation, and cognitive pain processing. This helps explain some of the variability between protocols, since psychological factors also modulate cortical networks of the painful experience. However, such interventions do not reproduce the full neurochemical effects of true acupuncture, whose peripheral stimulation activates descending pathways and promotes the release of endogenous opioids, serotonin and noradrenaline, which are fundamental for consistent analgesia (Cao et al., 2019; Kato et al., 2022).

In an integrated way, the studies analyzed point to four pillars that explain the analgesic effects of acupuncture: (1) release of neurotransmitters and neuropeptides (2) functional reorganization of cortical and subcortical networks; (3) activation of inhibitory descending pathways; and (4) autonomic and neuroimmune modulation. Thus, even in the face of wide variation between protocols, there is convergence in the demonstration of consistent neurophysiological mechanisms that support acupuncture-promoted analgesia in different chronic pain conditions (Baelz et al., 2023; Kato et al., 2022; Liu et al., 2019; Xiang et al., 2019; Xu H. et al., 2022).

4 FINAL CONSIDERATIONS

The literature analyzed demonstrates that acupuncture exerts consistent analgesic effects in individuals with chronic pain, confirming the main neurophysiological mechanisms described in the literature. In an integrated manner, the studies show four fundamental pillars of the analgesic action of the technique: (1) release of neurotransmitters and neuropeptides (2) functional reorganization of cortical and subcortical networks involved in pain perception and modulation; (3) activation of inhibitory descending pathways that reduce neuronal excitability; and (4) autonomic and neuroimmune modulation, contributing to the rebalancing of systems related to the painful experience. These findings reinforce that acupuncture acts in an integrated manner on multiple levels of the nervous system, fully answering the guiding question of this review.

Despite the solidity of the neurophysiological results, challenges persist related to the heterogeneity of the protocols, the variability in the selection of acupoints, and the lack of standardization in stimulation parameters, which reinforces the need for larger and more rigorous clinical trials. Even so, the body of evidence demonstrates that acupuncture is a safe, effective intervention in line with the BPS model, contributing to pain reduction, functional improvement, and modulation of emotional dimensions frequently affected in chronic pain. Thus, it is a relevant therapeutic resource in interdisciplinary care, expanding quality of life and offering significant clinical support to people living with chronic pain.

REFERENCES

- Ang, L., et al. (2025). Effects of acupuncture on musculoskeletal pain: An evidence map. *Frontiers in Medicine*. Frontiers Media.
- Astini, R., & Riberto, M. (2023). Acupuntura no tratamento de pacientes com dor crônica associada à osteoartrite de quadril. *Revista Brasileira de Ortopedia*, 58(2), 123–131.
- Baelz, G. U., et al. (2023). Acupuncture effects on pain and health status in women with fibromyalgia: A randomized clinical trial. *Acta Scientiarum Health Sciences*, 45, Article e6115.
- Cao, J., et al. (2019). Analgesic effects evoked by real and imagined acupuncture: A neuroimaging study. *Cerebral Cortex*, 29(11), 4819–4831.
- Centers for Disease Control and Prevention. (2022). CDC clinical practice guideline for prescribing opioids for pain - United States, 2022. *MMWR Recommendations and Reports*, 71(3), 1–95.
- Chou, R., et al. (2022). Acupuncture for chronic pain: A systematic review and meta-analysis update. *Annals of Internal Medicine*, 175(4), 479–492.
- Di Maio, S., et al. (2023). Functional connectivity changes after acupuncture in chronic pain: A systematic review of fMRI studies. *NeuroImage: Clinical*, 39, 103–112.
- Dimitrova, N. A., et al. (2021). Neurophysiological mechanisms of acupuncture analgesia: Evidence from human studies. *Pain Reports*, 9(2), Article e1188.
- Du, J., et al. (2019). Characteristics of needle sensation (“deqi”) during acupuncture treatment: Clinical implications and neurophysiological correlates. *Journal of Traditional Chinese Medicine*, 39(3), 381–387.
- Gao, X., et al. (2024). Brain mechanisms of acupuncture in chronic pain: Modulation of serotonergic system and functional connectivity. *Frontiers in Neuroscience*, 18, 203–214.
- Gao, X. Y., et al. (2024). Modulatory effects of acupuncture on brain circuits related to the raphe nucleus in patients with chronic neck pain: A randomized neuroimaging trial. *CNS Neuroscience & Therapeutics*, 30(2), 190–203.
- Gava, C. R., et al. (2025). Acupuncture as a modulator of cortical excitability in chronic pain syndromes. *Journal of Integrative Neuroscience*, 24(3), 245–256.

- Hamvas, S., et al. (2023). Acupuncture increases parasympathetic tone, modulating HRV: Systematic review and meta-analysis. *Complementary Therapies in Medicine*, 72, Article 102905.
- Ifrim-Chen, F., et al. (2019). Acupuncture and the retrospect of its modern research. *Romanian Journal of Morphology and Embryology*, 60(2), 411–418.
- Kato, Y., et al. (2022). Two distinct neural mechanisms underlying acupuncture analgesia. *Frontiers in Pain Research*, 3, Article 869884.
- Knopp-Sihota, J. A., et al. (2022a). Nonpharmacological interventions for chronic pain management: A systematic review and meta-analysis. *Pain Management Nursing*.
- Knopp-Sihota, J. A., et al. (2022b). Chronic pain management: Challenges and evidence-based interventions. *Canadian Journal of Pain*, 6(1), 45–57.
- Kovačević, M., et al. (2024). Effects of acupuncture on brain connectivity in chronic pain patients: A resting-state fMRI study. *Frontiers in Neuroscience*, 18, Article 1420.
- Lee, I. S., et al. (2024). Acupuncture for whiplash-associated disorder: Systematic review and meta-analysis. *BMJ Open*.
- Li, X., et al. (2021). Neurophysiological mechanisms of autonomic modulation in acupuncture: An integrative model. *Autonomic Neuroscience*, 238, Article 102948.
- Liu, C., et al. (2019). Immediate analgesic effect of contralateral needling at Tiaokou (ST38) in patients with chronic shoulder pain: An exploratory randomized controlled trial. *Journal of Traditional Chinese Medical Sciences*, 6(3), 256–262.
- Lu, Y., et al. (2021a). Brain mechanisms of acupuncture for chronic low back pain: Evidence from resting-state functional connectivity. *Frontiers in Neuroscience*.
- Lu, Z., et al. (2021b). Acupuncture modulates pain-related brain networks in humans: Evidence from fMRI studies. *Neural Plasticity*, 1–15.
- Lyu, Y., et al. (2021a). Central sensitization and chronic pain: Mechanisms and management approaches. *Neuroscience Bulletin*.
- Lyu, Y., et al. (2021b). Neuroimmune interactions in acupuncture analgesia: A human-based perspective. *Neurophysiology and Pain*, 46(4), 217–228.
- Nicholas, M., et al. (2019). The IASP classification of chronic pain for ICD-11: Chronic primary pain. *Pain*, 160(1), 28–37.
- Niruthisard, T., et al. (2024). Central nervous system modulation and connectivity changes induced by manual acupuncture: Insights from neuroimaging evidence. *Neurophysiology of Acupuncture*, 42, 115–134.
- Pan, Y., et al. (2022). Neural mechanisms of acupuncture analgesia: The role of reward and emotion regulation systems. *Evidence-Based Complementary and Alternative Medicine*.
- Rivera-Arconada, I., et al. (2025). Spinal mechanisms of acupuncture analgesia: New insights from preclinical and clinical studies. *Frontiers in Pain Research*, 6(146), 1–12.
- Robinson, C., et al. (2022). Acupuncture as part of multimodal analgesia for chronic pain: Evidence and clinical perspectives. *Orthopedic Reviews*.
- Rocha-Jacob, R. S., et al. (2024). Neurophysiological effects of acupuncture on pain modulation: Integrative review. *Revista Brasileira de Fisioterapia*, 28(2), 134–142.

- Simons, L. E., et al. (2022). Neurobiological mechanisms of chronic pain: Updates and future directions. *Nature Reviews Neurology*, 18(7), 382–396.
- Stachowski, N., et al. (2021). Spinal inhibitory circuits and their role in pain modulation. *Pain*, 162(4), 835–846.
- Treede, R.-D., et al. (2019). Chronic pain as a symptom or a disease: The IASP classification of chronic pain for the International Classification of Diseases (ICD-11). *Pain*, 160(1), 19–27.
- Vickers, A. J., et al. (2022). Acupuncture for chronic pain: Update of an individual patient data meta-analysis. *The Journal of Pain*, 19(5), 455–474.
- Vlaeyen, J. W. S., & Crombez, G. (2020). Behavioral conceptualization and treatment of chronic pain. *Annual Review of Clinical Psychology*, 16, 187–212.
- Wang, L., et al. (2024). Acupuncture for chronic nonspecific low back pain in middle-aged and elderly patients: A randomized controlled trial. *World Journal of Acupuncture-Moxibustion*, 34(4), 289–296.
- Wang, Y., & Doan, Q. (2024). Multimodal and patient-centered approaches in chronic pain management. *Pain Reports*.
- Wen, Q., et al. (2021). Neuroimaging studies of acupuncture on low back pain: A systematic review. *Frontiers in Neuroscience*, 15, Article 730322.
- World Health Organization. (2021). Guidelines on the management of chronic pain in children: Executive summary. WHO.
- Xiang, A., et al. (2019). BOLD oscillation response associated with immediate analgesia of ankle acupuncture in chronic low back pain. *Journal of Pain Research*, 12, 1809–1820.
- Xu, H., et al. (2022). Modulation effect of acupuncture treatment on chronic neck and shoulder pain in female patients: Evidence from periaqueductal gray-based functional connectivity. *CNS Neuroscience & Therapeutics*, 28(5), 714–723.
- Xu, J., et al. (2022). Brain mechanism of acupuncture treatment of chronic pain: An individual-level positron emission tomography study. *Frontiers in Neurology*, 13, Article 884770.
- Yuan, H., et al. (2022). Multidimensional modulation of pain by acupuncture analgesia: The reward effect of acupuncture in pain relief. *Evidence-Based Complementary and Alternative Medicine*, 1–12.
- Zhang, Y., et al. (2022). Acupuncture involves the insertion and stimulation of fine needles into specific points on the body. *Frontiers in Pain Research*, 3, Article 869884.
- Zhu, H., et al. (2021). Acupuncture from the ancient to the current: A brief historical review. *The Anatomical Record*, 304(11), 2356–2364.

APPENDIX

Table 2

Acupuncture points cited in the studies analyzed

Point	Code	Location
Zusanli	ST36 (E36)	Located 3 cun below the knee joint line, lateral to the tibial tuberosity (TAT).
Tiaokou	ST38	Located 8 cun below ST35, 1 cun lateral to crest of the tibia.
Hegu	LI4 (IG4)	On the back of the hand, at the midpoint between the 1st and 2nd metacarpals.
Fengchi	GB20	Below the occiput, in the depression between the trapezius and sternocleidomastoid.
Jianjing	GB21	At the midpoint between the acromion and C7, over the trapeze.
Julião	GB29	In depression between the anterior superior iliac spine and the greater trochanter.
Huantiao	GB30	In the depression between the greater trochanter of the femur and the sacral hiatus (S2).
Xiyangguan	GB33	Above the lateral epicondyle of the femur, between vastus lateral and biceps femoris.
Yanglingquan	GB34	Inferior and anterior to the head of the fibula.
Waiqiu	GB36	7 cun above the lateral malleolus, anterior to the fibula.
Sanyinjiao	SP6	3 cun above the medial malleolus, near the medial border of the tibia.
Xuehai	SP10	2 cun above the superomedial border of the patella.
Xingjian	LR2	On the dorsum of the foot, 0.5 cun proximal to the membrane interdigital between 1st and 2nd fingers.
Taichong	LR3	Between 1st and 2nd metatarsals, 1.5 to 2 cun above the interdigital commissure.
Ququan	LR8	Depression prior to the semimembranosus tendon, medial aspect of the knee.
Neiguan	PC6	2 cun above the wrist crease, between the tendons palmaris longus and flexor carpi radialis.
Shenmen	HT7	In the wrist fold, ulnar side, in the radial depression to the Pisiforme.
Taixi	KI3	Depression between the medial malleolus and the tendon Achilles.
Houxi	SI3	On the ulnar edge of the hand, proximal to the 5th joint finger.

DIAGNOSTIC CHALLENGES IN CREUTZFELDT-JAKOB DISEASE: A CASE STUDY

DESAFIOS DIAGNÓSTICOS NA DOENÇA DE CREUTZFELDT-JAKOB: UM ESTUDO DE CASO

DESAFÍOS DIAGNÓSTICOS EN LA ENFERMEDAD DE CREUTZFELDT-JAKOB: UN ESTUDIO DE CASO



<https://doi.org/10.56238/sevened2026.008-035>

Elenara Barbosa Machado Neves¹, Grasielle Mattei Ise dos Santos², Vitória Mendonça Mendes³, Lucas Mendes Tavares da Silveira⁴, André Rausch Carellos Silva⁵, Eduardo Dionathas Firmino⁶, Juscelio Clemente de Abreu⁷, Mônica Isaura Corrêa⁸

ABSTRACT

Creutzfeldt-Jakob Disease (CJD) is a severe and rapidly progressive neurological disease, with a median survival of 6 to 12 months, caused by the abnormal accumulation of prion protein in the brain. It is characterized by rapid dementia, myoclonus, tremors, ataxia, and motor impairments. Due to its nonspecific clinical presentation, diagnosis is challenging and often delayed, but the association of clinical findings with complementary examinations, such as magnetic resonance imaging, cerebrospinal fluid analysis, and EEG, contributes to its early identification. This report describes the case of a 73-year-old male patient, previously healthy, residing in a rural area of Minas Gerais, who presented with subacute onset of mental confusion, associated with rigidity, incoherent speech, stereotyped movements, and progressive loss of autonomy. Initially treated with antipsychotics and antidepressants without response, he was admitted to a tertiary hospital, where laboratory tests ruled out infections and metabolic disorders. Magnetic resonance imaging (MRI) revealed cortical hyperintensities in the right frontal, parietal, and occipital lobes, as well as involvement of the caudate nucleus, and cerebrospinal fluid analysis revealed positivity for the 14-3-3 protein, consistent with sporadic CJD. During the course of the disease, the patient presented with

¹ Specialization in Internal Medicine. Centro Universitário de Caratinga (UNEC). E-mail: Elenaramachado@hotmail.com Orcid: 0009-0005-4161-1689 Lattes: 1729556239333556

² General Practitioner. UNIFACIG. E-mail: gramatteisantos@gmail.com Orcid: 0009-0003-7502-6387 Lattes: 0036815694617206

³ General Practitioner. Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM). E-mail: vitoriamendoncam@gmail.com Orcid: 0009-0004-0827-1646 Lattes: 5699259536831739

⁴ General Practitioner. Universidade Federal de Minas Gerais (UFMG). E-mail: lmtsilveira7@gmail.com Orcid: <https://orcid.org/0009-0005-8501-1546> Lattes: <https://lattes.cnpq.br/6458982186996092>

⁵ Cardiologist. Hospital Felício Rocho (HFR). E-mail: rauschcarellos@hotmail.com Orcid: 0009-0004-9030-0126 Lattes: 5780621058244037

⁶ Pulmonologist. Hospital das Clínicas da UFMG/Ebserh. E-mail: edufir@hotmail.com Orcid: 0009-0006-1595-2065 Lattes: 7539881066861165

⁷ Dr. in Cytogenetics. Universidade Federal de Lavras. E-mail: biotec.abreu@gmail.com Orcid: 0000-0003-2460-7993 Lattes: 2318034602910085

⁸ Master's degree of Science in Health Sciences. Faculdade Ciências Médicas de Minas Gerais (FCMMG). E-mail: monicaicorrea10@gmail.com Lattes: 7343746943174033

severe neurological deterioration, requiring prolonged care, and bilateral laminar subdural hemorrhage as an associated complication. Therefore, this case highlights the importance of comprehensive assessment in elderly patients with mental confusion, especially after intensive pharmacological treatments. The interaction between pre-existing neurological conditions, medication use, and metabolic factors should be carefully considered.

Keywords: Creutzfeldt-Jakob Disease. Neurology. Clinical Management. Prion. Neurodegeneration. Differential Diagnosis. Electroencephalogram. RT-QuIC. Cognitive Decline.

RESUMO

A Doença de Creutzfeldt-Jakob (DCJ) é uma enfermidade neurológica grave e rapidamente progressiva, com sobrevida média de 6 a 12 meses, causada pelo acúmulo anormal de proteína priônica no cérebro. Caracteriza-se por demência rápida, mioclonias, tremores, ataxia e alterações motoras. Devido à apresentação clínica inespecífica, o diagnóstico é desafiador e muitas vezes tardio, mas a associação de achados clínicos com exames complementares, como ressonância magnética, líquido e EEG, contribui para sua identificação precoce. Este relato descreve o caso de um paciente masculino, 73 anos, previamente hígido, residente em área rural de Minas Gerais, que apresentou quadro de confusão mental de início subagudo, associado a rigidez, fala desconexa, movimentos estereotipados e progressiva perda de autonomia. Inicialmente tratado com antipsicóticos e antidepressivos sem resposta, foi admitido em hospital terciário, onde exames laboratoriais descartaram infecções e alterações metabólicas. A ressonância magnética evidenciou hiperintensidades corticais nos lobos frontais, parietal e occipital direitos, além de acometimento do núcleo caudado, e a análise do líquido revelou positividade para a proteína 14-3-3, compatível com DCJ esporádica. Durante a evolução, o paciente apresentou deterioração neurológica grave, necessitando de cuidados prolongados, e hemorragia subdural laminar bilateral como complicação associada. Portanto, este caso ressalta a importância da avaliação abrangente em pacientes idosos com confusão mental, especialmente após tratamentos farmacológicos intensivos. A interação entre condições neurológicas prévias, uso de medicamentos e fatores metabólicos deve ser cuidadosamente considerada.

Palavras-chave: Doença de Creutzfeldt-Jakob. Neurologia. Manejo Clínico. Prion. Neurodegeneração. Diagnostico Diferencial. Eletroencefalograma. RT-QuIC. Declínio Cognitivo.

RESUMEN

La enfermedad de Creutzfeldt-Jakob (ECJ) es una enfermedad neurológica grave y de rápida progresión, con una mediana de supervivencia de 6 a 12 meses, causada por la acumulación anormal de proteína priónica en el cerebro. Se caracteriza por demencia rápida, mioclonías, temblores, ataxia y deterioro motor. Debido a su presentación clínica inespecífica, el diagnóstico es difícil y a menudo tardío, pero la asociación de los hallazgos clínicos con exámenes complementarios, como la resonancia magnética, el análisis del líquido cefalorraquídeo y el electroencefalograma (EEG), contribuye a su identificación temprana. Este informe describe el caso de un paciente masculino de 73 años, previamente sano, residente en una zona rural de Minas Gerais, quien presentó un cuadro de confusión mental de inicio subagudo, asociado a rigidez, habla incoherente, movimientos estereotipados y pérdida progresiva de autonomía. Inicialmente tratado con antipsicóticos y antidepressivos sin respuesta, ingresó en un hospital terciario, donde las pruebas de laboratorio descartaron

infecciones y trastornos metabólicos. La resonancia magnética (RM) reveló hiperintensidades corticales en los lóbulos frontal, parietal y occipital derechos, así como afectación del núcleo caudado. El análisis del líquido cefalorraquídeo reveló positividad para la proteína 14-3-3, compatible con ECJ esporádica. Durante la evolución de la enfermedad, el paciente presentó un deterioro neurológico grave que requirió cuidados prolongados, y una hemorragia subdural laminar bilateral como complicación asociada. Por lo tanto, este caso resalta la importancia de una evaluación integral en pacientes de edad avanzada con confusión mental, especialmente después de tratamientos farmacológicos intensivos. Se debe considerar cuidadosamente la interacción entre las afecciones neurológicas preexistentes, el uso de medicamentos y los factores metabólicos.

Palabras clave: Enfermedad de Creutzfeldt-Jakob. Neurología. Manejo Clínico. Prión. Neurodegeneración. Diagnóstico Diferencial. Electroencefalograma. RT-QulC. Deterioro Cognitivo.

1 INTRODUCTION

Creutzfeldt-Jakob disease (CJD) is a rare, progressive and fatal condition of the central nervous system, belonging to the group of transmissible spongiform encephalopathies. It is mainly characterized by a rapidly evolving dementia, accompanied by multifocal motor and neurological changes (Brasil, 2020). Caused by prions, which are infectious particles formed only by abnormal and extremely resistant proteins, CJD presents relevant diagnostic challenges (Brasil, 2020; Zerret al., 2024).

According to the World Health Organization (WHO), definitive confirmation of the diagnosis still depends on neuropathological tests performed after death, although clinical, epidemiological, and laboratory criteria allow classifications as possible or probable cases (Brasil, 2020). The rarity and complexity of the disease reinforce the importance of recognizing atypical clinical presentations, especially in the face of uncharacteristic initial symptoms (Salehi et al., 2022).

CJD can manifest in three main clinical forms: sporadic, hereditary, and iatrogenic. The sporadic form is the most common, accounting for about 85% of cases, appearing without an identifiable cause, usually between the ages of 55 and 75, and characterized by rapidly progressive dementia, ataxia, and myoclonus. The hereditary form, which accounts for 10% to 15% of cases, is related to mutations in the PRNP gene and follows an autosomal dominant pattern of inheritance, and may present earlier onset and symptoms similar to those of the sporadic form. The iatrogenic form, on the other hand, is extremely rare and results from accidental transmission through medical procedures, such as the use of contaminated neurosurgical instruments, transplants of human tissues, or the administration of growth hormone derived from cadavers (Zerr et al., 2024).

Between 2005 and 2021, 1,576 suspected cases of CJD were reported in Brazil, with a higher concentration in the South, Southeast, and Northeast regions of the country. The states with the highest number of notifications were São Paulo, responsible for approximately one third of the records (32.5%), followed by Paraná (12.0%) and Minas Gerais (10%). The most affected age group was 55 to 74 years, representing about 60% of suspected cases, which reinforces the predominance of the disease in older individuals. Regarding gender, the distribution was relatively balanced, with a slight predominance of women (53.6%) compared to men (46.3%), highlighting the importance of epidemiological surveillance and attention to clinical signs, especially in older populations (Brasil, 2020).

CJD has a very varied clinical spectrum, which contributes to the complexity of the diagnosis. Among the most frequent symptoms are rapidly progressing dementia, cerebellar ataxia, and myoclonus, but other manifestations may also be present, making it difficult to

identify the disease early (Hermann et al., 2021). In view of this heterogeneity, the use of high-performance biomarkers becomes essential to increase diagnostic accuracy and assist in differentiating CJD from other neurological conditions with a similar presentation (Sato, 2021).

Currently, there are still no effective therapies for CJD, and diagnostic confirmation remains a major clinical challenge. The diagnosis is based on a combination of typical neuropsychiatric manifestations, imaging tests such as magnetic resonance imaging, electroencephalogram (EEG), and the presence of specific proteins in the cerebrospinal fluid, such as 14-3-3 (Hermann et al., 2021).

Biomarkers such as elevated levels of total tau protein in cerebrospinal fluid have been widely used to support the diagnosis of Creutzfeldt-Jakob Disease. However, the reliability of some of these markers, especially the 14-3-3 protein and the tau protein itself, is still the subject of controversy. Although useful as indicators of rapid neuronal injury, both markers have important limitations in terms of specificity. The 14-3-3 protein, for example, may be increased in other acute neurological conditions, such as viral encephalitis, meningitis, strokes, prolonged epilepsies, and other rapidly evolving neurodegenerative diseases, which can lead to false-positive results. Similarly, tau protein elevation is also observed in other neurodegenerative pathologies, such as late-stage Alzheimer's disease (Zerr, 2022).

In addition, the sensitivity of these tests may vary according to the clinical stage of CJD, being less effective in the early stages of the disease, which compromises their usefulness as an early diagnostic tool. The interpretation of the results also depends on the standardization of the laboratory methods used, which can generate variations between diagnostic centers. For these reasons, although these biomarkers continue to be used as support criteria in the classification of probable or possible cases, their application should be done with caution and always associated with other clinical, radiological, and electroencephalographic parameters (Hermann et al., 2021; Noor et al., 2024).

Although progressive cognitive loss is the most common form of CJD onset, atypical presentations in the early stages can make diagnosis difficult and lead to misinterpretations (Nooret al., 2024). In cases with isolated symptoms, such as visual changes or cerebellar signs, it is important to consider variants of the disease (Usluet al., 2020).

When the clinical suspicion remains, tests such as magnetic resonance imaging and EEG should be repeated throughout the follow-up, since the findings may become more evident with the progression of the condition. As there is no cure for CJD currently, treatment is centered on supportive care, with a focus on symptom relief and patient comfort (Rasheedet al., 2024).

In view of this scenario, it is noteworthy that the scarcity of in-depth clinical studies on uncommon manifestations of CJD reinforces the need to report cases that deviate from the classic pattern of the disease, contributing to expand the knowledge of health professionals in the face of conditions that are difficult to diagnose.

Atypical presentations can delay the proper identification of CJD, leading to mistaken initial treatments and prolonged suffering of the patient and their families. This Case Report is justified by the relevance of sharing a real clinical experience that highlights the challenges involved in the suspicion and confirmation of a rare condition, with the aim of enriching medical practice, sensitizing multidisciplinary teams and promoting more assertive conducts in the face of rapidly evolving neurological diseases.

In this perspective, the present study aims to report and analyze an atypical manifestation of Creutzfeldt-Jakob Disease, through a clinical case study, in order to discuss the diagnostic and therapeutic challenges involved, as well as to reflect on the importance of early recognition of non-classical presentations of this rare neurodegenerative disease.

2 METHODOLOGY

This is an observational, descriptive, case report study with theoretical foundation, which presents the clinical manifestation, diagnosis, treatment and evolution of a patient with Creutzfeldt-Jakob Disease (CJD).

The bibliographic search was carried out in the PubMed, SciELO and Science Direct databases, using descriptors related to the disease, with the objective of subsidizing the discussion and contextualizing the case in the current scientific scenario.

The study was carried out in a public hospital located in the eastern region of the state of Minas Gerais. As it is a rare condition, the focus of the research was on the detailed analysis of a single patient, describing in detail the clinical, laboratory and radiological aspects observed during follow-up.

The information was obtained by reviewing the patient's medical record, available in the Medical and Statistical Archive of the institution. To describe the data, a structured instrument was used, covering variables such as initial symptoms, complementary tests performed, differential diagnoses, therapeutic conducts instituted and clinical evolution.

During the document analysis, medical records, imaging reports (such as magnetic resonance imaging), cerebrospinal fluid and electroencephalogram exams, as well as relevant clinical notes were examined, ensuring the integrity and consistency of the information collected.

The description of complementary information occurred through a detailed review of the clinical record, allowing the comparison of the observed findings with the data described in the scientific literature, with the aim of contributing to the improvement of knowledge about CJD and its diagnostic and evolutionary particularities.

The patient's legal guardians were duly informed about the objectives and procedures of the research, and expressed agreement by signing the Informed Consent Form (ICF).

3 CASE REPORT

A 73-year-old male patient, previously healthy, living in a rural area of the eastern region of Minas Gerais, driver, married, accompanied by his grandson, who reported a history of Bell's palsy for four years and cataract surgery for about 60 days. He had previously used carvedilol (Ablok), suspended due to hypotension, and haloperidol drops (2mg/ml - 10 drops/day).

The companion reported that approximately 45 days after the beginning of the investigation, the patient presented acute mental confusion, with subacute and progressive onset. He was initially evaluated by a psychiatrist, with a diagnostic hypothesis of mood disorder, and treatment with venlafaxine was instituted, later replaced by olanzapine and mirtazapine, without satisfactory clinical response. The patient evolved with progressive cognitive worsening, with disconnected speech, muscle rigidity, more evident in the left limb, but without the "cogwheel" stiffness pattern.

During hospitalization, the patient presented neurological and clinical worsening, rapidly and progressively, becoming dependent for all activities of daily living. He developed stereotyped hand movements, suggestive of parkinsonism, as well as paresthesias in the distal upper limbs.

Magnetic resonance imaging (MRI) of the brain, performed on 10/03/2024, revealed mild cortical hyperintensity in FLAIR, with restricted diffusion in the right frontal, parietal, and occipital lobes, in addition to involvement of the caudate nucleus. Diagnostic hypotheses included ischemic lesions, metabolic causes, and, less likely, prion disease.

About twelve days later (10/15/2024), the patient was admitted to a tertiary hospital in the state of Minas Gerais, presenting with a progressive confusional state. At the initial neurological examination, he was autopsychically oriented, but disoriented in time and space, with comprehension and execution preserved for simple commands, a pattern that was lost during hospitalization.

Initial laboratory tests showed mild renal dysfunction (creatinine: 1.61 mg/dL), blood count without significant alterations, and negative serology for HIV, hepatitis B and C, and VDRL.

A new MRI, performed on 10/17/2024, demonstrated cortical hypersignal on FLAIR and diffusion restriction affecting the superior frontal gyri, posterior cingulate, and right striatum, without contrast-enhanced enhancement. Filling failures suggestive of possible cerebral venous thrombosis were also observed, to be clarified.

On 10/21/2024, a lumbar puncture was performed, which showed cerebrospinal fluid with normal cellularity (3 cells/mm³, predominant mononuclear), slightly elevated proteins (58 mg/dL), normal glucose, and non-reactive VDRL. The molecular panel for infectious agents was negative.

With the clinical and neurological worsening, the patient was transferred to the Intensive Care Unit (ICU), with fluctuations in the level of consciousness, episodes of agitation, seizures, and supraventricular tachyarrhythmia. Levetiracetam 500 mg/day was instituted for subclinical seizure control, in addition to intensive clinical support.

A new brain MRI scan, on 10/30/2024, confirmed the persistence of cortical changes and identified bilateral laminar subdural hematomas. The lumbar puncture repeat, on 10/30/2024, showed cerebrospinal fluid with 2 cells/mm³, slightly elevated proteins (68.6 mg/dL) and positive testing for neuronal protein 14-3-3, strongly suggestive of prion disease.

On 10/31/2024, the reference laboratory (FUNED) confirmed the positivity of the 14-3-3 protein in the cerebrospinal fluid, a finding that, together with the clinical pattern and the results of the magnetic resonance imaging, contributed to the establishment of the diagnosis, on 11/01/2024, of Prion Disease, probably sporadic Creutzfeldt-Jakob Disease (CJD).

During hospitalization, the patient received pulse therapy with methylprednisolone, empiric acyclovir, and broad-spectrum antibiotic therapy at times of infectious suspicion, without significant neurological response.

In view of the condition presented, the patient evolved with severe and progressive neurological deterioration, with loss of verbal and visual contact, absence of response to commands, decortication posture and total dependence. On 11/07/2024, he was transferred to the long-term care ward, under the monitoring of the palliative care team, according to the family's desire not to carry out invasive measures.

After hospital discharge, the patient was followed up at home, with the neurology team, together with the palliative care team, with the main focus on adjusting the doses of anticonvulsants, due to the persistence of stereotyped movements and myoclonus. Non-invasive measures were instituted in order to avoid therapeutic obstinacy, prioritizing comfort

and human dignity. During this period, the neurological condition remained stable, with no evidence of new relevant clinical manifestations, compatible with the progressive and inexorable course of sporadic Creutzfeldt-Jakob disease.

At home, the patient presented an episode of community-acquired pneumonia, treated with levofloxacin, with a good initial response, however, approximately one month later, he evolved with a new episode of aspiration pneumonia, and treatment with broad-spectrum therapeutic antibiotic, piperacillin/tazobactam, was instituted at home, without the need for hospitalization at that time.

However, during treatment, the patient presented with an episode of bronchoaspiration, accompanied by progressive clinical deterioration, characterized by acute respiratory failure and hemodynamic instability. The patient developed septic symptoms with a probable pulmonary focus, culminating in death at home, despite adequate support measures and antibiotic therapy.

This outcome reflects the rapidly progressive and fatal character of sporadic Creutzfeldt-Jakob disease, whose clinical course tends to be marked by continuous neurological decline, secondary infectious complications, and therapeutic limitation due to the absence of course-modifying treatment to date.

The case reinforces the importance of early diagnosis, multidisciplinary follow-up and an approach focused on the comfort and dignity of the patient, especially in the advanced stages of the disease, in which palliative care plays an essential role in maintaining quality of life and supporting the family.

4 DISCUSSION

Creutzfeldt-Jakob Disease (CJD) is a rare spongiform encephalopathy, being the most common form among human prion diseases, with an incidence of approximately one case per million inhabitants per year (Sitammagari; Masood, 2021). It is a neurodegenerative disease caused by abnormal prions, predominantly accumulated in brain and eye tissue, especially in the retina and optic nerve. Clinically, it is characterized by rapidly progressing cognitive decline, associated with myoclonus and pyramidal signs, in addition to typical electroencephalographic findings that aid in the diagnosis. However, the clinical course may be nonspecific and similar to that of other neurological diseases, which makes early recognition difficult (Uttley et al., 2020).

The present case clearly reflects many of the classic aspects of CJD, where the patient initially presented with subacute dementia, rigidity, incoherent speech, parkinsonian signs, and rapid progression to total dependence. These findings are in line with traditional

descriptions of the disease, in which accelerated cognitive decline, associated with focal neurological manifestations such as myoclonus and rigidity, make up the most characteristic clinical picture (Appleby et al., 2021; Haddad et al., 2022; Jurcau et al., 2024).

Despite this, CJD can manifest in a heterogeneous way, with variations that make early recognition difficult. In some cases, the initial manifestations mimic psychiatric disorders, focal dementias (with alterations in language or visual perception), or parkinsonian syndromes, which often leads to inappropriate initial therapeutic approaches. In the case described, the introduction of antipsychotics and antidepressants before the neurological hypothesis reflects a pattern observed in other reports in the literature, in which the atypical presentation contributes to the delay in diagnosis (Oliveira et al., 2021; Appleby et al., 2021).

The definitive diagnosis of sporadic CJD is confirmed only by postmortem neuropathological examination, by means of brain biopsy or autopsy. However, according to the criteria of the World Health Organization (WHO), the diagnosis can be classified as possible, probable, or definitive, based on the combination of clinical picture, epidemiological history, and results of complementary tests (Ministry of Health, 2025). Among these, magnetic resonance imaging (MRI) and electroencephalogram (EEG) may present findings characteristic of the disease, being fundamental to support clinical suspicion (Jurcau et al., 2024).

In this context, one of the highlights of the present case was the use of MRI with FLAIR and diffusion (DWI) sequences, showing cortical hyperintensities in the right frontal, parietal, and occipital lobes, as well as involvement of the caudate nucleus, and then evolution of the findings to other structures (superior frontal gyri, posterior cingulate, striatum).

Similar to the present case, Farnetano et al. (2019) reported a 74-year-old female patient from Ubá (MG) with rapidly progressing dementia, cerebellar ataxia, and myoclonus, who was later diagnosed with sporadic CJD, whose DWI-weighted MRI of the head showed cortical hyperintensity in the frontal lobes and in the caudate nuclei and bilateral thalamus. Similarly, Appleby et al. (2021) described a 21-year-old man in the United States with cognitive decline, behavioral changes, and progressive motor disorders, whose MRI demonstrated asymmetric cortical hyperintensity and involvement of the caudate nuclei, findings compatible with prion disease.

Reinforcing these findings, Park et al. (2021) found in their meta-analyses that DWI has a sensitivity of around 91% (95% CI: 84-95%) and specificity around 97% (95% CI: 94-99%) when used to diagnose sporadic CJD in patients with rapidly progressive dementia.

In the present case, the diffusion alterations were initially detected and later persisted and evolved, which reinforces the usefulness of repeating neuroimaging studies when the

clinical picture progresses. This also highlights that even in cases without cogwheel stiffness or other specific early signs, MRI findings can strongly guide the diagnosis.

In addition to the characteristic neuroimaging findings, cerebrospinal fluid (CSF) analysis for the detection of the 14-3-3 protein is one of the main diagnostic criteria for the sporadic form of CJD, helping to confirm the clinical suspicion and differential diagnosis in relation to other rapidly progressive encephalopathies (Hermann et al., 2021).

The positivity of the 14-3-3 protein in the cerebrospinal fluid observed in this patient reinforces the findings described in the literature on CJD. According to Sahyouni et al. (2024), the detection of the 14-3-3 protein in CSF allowed the confirmation of the diagnosis of sporadic CJD after the interpretation of the tests. In a study conducted by Senesi et al. (2023) in an Australian cohort of patients with sporadic CJD, the analysis of the 14-3-3 protein by western blot (WB) showed a sensitivity of 87.5% and specificity of 66.7%, while the 14-3-3 ELISA assay demonstrated a sensitivity of 81.3% and specificity of 84.4%. The authors also highlighted that the CSF real-time tremor-induced conversion assay (RT-QuIC) had the best diagnostic performance, with a sensitivity of 92.7% and specificity of 100%, and is considered the most reliable test for confirming the disease.

However, it is important to note that the positivity of the 14-3-3 protein is not exclusive to CJD, and may occur in other conditions associated with acute neuronal injury, such as stroke, encephalitis, and metabolic disorders (Hermann et al., 2021). Therefore, the interpretation of this finding should always be done in conjunction with clinical and neuroimaging data. In the present case, serology for infectious agents was negative, and the exclusion of other causes consistently reinforced the diagnostic suspicion of sporadic CJD.

In view of this scenario, it is important to emphasize that to date, there are no specific therapies that substantially alter the course of CJD (Hall; Masood, 2025). Treatments are generally supportive, with palliative care when there is already clear deterioration, such as the condition of the patient reported in this case (Uttley et al., 2020). The literature confirms that empirical interventions rarely bring significant clinical benefit, given that the disease is essentially degenerative and rapidly progressing (Miranda et al., 2022; Sahyouni et al., 2024).

It is noteworthy that the prognosis of CJD is largely unfavorable, with rapid progression to total dependence and death within a few months. The present case followed this typical course, characterized by progressive neurological deterioration, loss of responsiveness, and need for long-term care, culminating in the adoption of palliative measures and the decision to avoid invasive interventions, in accordance with ethical principles of end-of-life care. The literature reinforces that CJD has an invariably fatal outcome, usually less than a year after

the onset of symptoms, although early recognition of the disease can help in clinical management and attenuation of the patient's suffering (Uttley et al., 2020).

Despite the detailed characteristics presented in this report, it is important to recognize its limitations, such as the absence of post-mortem confirmation, possible variations in laboratory methods for detecting the 14-3-3 protein, the absence of EEG, and the potential selection bias inherent in studies involving a single patient. Even so, this case can add value to the literature by describing the evolution of CJD in a previously healthy elderly patient, with the onset of a psychiatric condition and compatible neuroimaging and cerebrospinal fluid findings, reinforcing the relevance of early clinical suspicion and repeated tests in view of the progression of the condition.

5 CONCLUSION

The case presented here highlights the diagnostic complexity of sporadic Creutzfeldt-Jakob disease, a rare and fatal neurodegenerative disease characterized by rapid cognitive deterioration and multifocal neurological signs. The patient's clinical trajectory reinforces that initial nonspecific manifestations, such as behavioral changes and mental confusion, can simulate psychiatric disorders, delaying the definitive diagnosis.

The association between typical magnetic resonance imaging findings, especially in FLAIR and diffusion sequences, and the positivity of the 14-3-3 protein in the cerebrospinal fluid, demonstrated great diagnostic value, corroborating what is described in the international literature. It is noteworthy that, even in the absence of specific treatment, early recognition of the disease is essential to avoid futile therapeutic conducts, allow family planning, and ensure referral to appropriate palliative care.

Finally, this report contributes to the expansion of clinical knowledge about CJD in the Brazilian context, emphasizing the importance of diagnostic suspicion in cases of rapidly progressive dementia and the need for training health professionals to recognize its early signs.

REFERENCES

- Appleby, B. S., Maddox, R., Schonberger, L. B., Cali, I., Hammett, T., Cohen, M., & Belay, E. (2021). Sporadic Creutzfeldt-Jakob disease in a very young person. *Neurology*, 97(17), 813–816. <https://doi.org/10.1212/WNL.0000000000012635>
- Brasil. Conselho Nacional de Saúde. (2013). Resolução nº 466, de 12 de dezembro de 2012. Aprova diretrizes e normas regulamentadoras de pesquisas envolvendo seres humanos. *Diário Oficial da União*, 13 jun. 2013.

- Brasil. Ministério da Saúde. (s.d.). Doença de Creutzfeldt-Jakob – DCJ. <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/d/dcj>
- Farnetano, B. S., Leão, C. N., Oliveira, I. N. F., Machareth, M. M. V., Damaceno, R. A., Mota, G. S. M., Brandão, C. M., & Almeida, H. T. (2019). Doença de Creutzfeldt-Jakob: Relato de caso. *Revista da Sociedade Brasileira de Clínica Médica*, 17(1), 31–34.
- Haddad, N. M., Marzzani, L. E., Oliveira, H. P., Cruz, T. F., Frainer, D. A., Welter, C. S., & Zalli, M. (2022). Doença de Creutzfeldt-Jakob iniciando como um surto psicótico: Um relato de caso. *Arquivos Catarinenses de Medicina*, 51(4), 106–112.
- Hall, W. A., & Masood, W. (2025). Creutzfeldt-Jakob disease. In StatPearls. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK507860/>
- Hermann, P., Appleby, B., Brandel, J. P., Caughey, B., Collins, S., Geschwind, M. D., Green, A., Haïk, S., Kovacs, G. G., Ladogana, A., Llorens, F., Mead, S., Nishida, N., Pal, S., Parchi, P., Pocchiari, M., Satoh, K., Zanusso, G., & Zerr, I. (2021). Biomarkers and diagnostic guidelines for sporadic Creutzfeldt-Jakob disease. *The Lancet Neurology*, 20(3), 235–246. [https://doi.org/10.1016/S1474-4422\(20\)30469-4](https://doi.org/10.1016/S1474-4422(20)30469-4)
- Jurcău, M. C., Jurcău, A., Diaconu, R. G., Hogeia, V. O., & Nunko, V. S. (2024). A systematic review of sporadic Creutzfeldt-Jakob disease: Pathogenesis, diagnosis, and therapeutic attempts. *Neurology International*, 16(5), 1039–1065. <https://doi.org/10.3390/neurolint16050079>
- Miranda, L. H. L., Oliveira, A. F. P. H., Carvalho, D. M., Souza, G. M. F., Magalhães, J. G. M., Júnior, J. A. C., Lima, P. T. M. B. Q., Júnior, R. M. A., Filho, S. P. L., & Melo, H. M. A. (2022). Systematic review of pharmacological management in Creutzfeldt-Jakob disease: No options so far? *Arquivos de Neuro-Psiquiatria*, 80(8), 837–844. <https://doi.org/10.1590/0004-282X-ANP-2021-0297>
- Noor, H., Baqai, M. H., Naveed, H., Naveed, T., Rehman, S. S., Aslam, M. S., Lakdawala, F. M., Memon, W. A., Rani, S., Khan, H., Imran, A., & Farooqui, S. K. (2024). Creutzfeldt-Jakob disease: A comprehensive review of current understanding and research. *Journal of the Neurological Sciences*, 467, Article 123293. <https://doi.org/10.1016/j.jns.2024.123293>
- Oliveira, R., Dias, M., & Marques, I. B. (2021). Creutzfeldt-Jakob disease: Atypical presentation of a very rare disease. *Acta Médica Portuguesa*, 34(9), 619–623. <https://doi.org/10.20344/amp.15192>
- Park, H. Y., Kim, M., Suh, C. H., Kim, S. Y., Shim, W. H., & Kim, S. J. (2021). Diagnostic value of diffusion-weighted brain magnetic resonance imaging in patients with sporadic Creutzfeldt-Jakob disease: A systematic review and meta-analysis. *European Radiology*, 31(12), 9073–9085. <https://doi.org/10.1007/s00330-021-08045-4>
- Rasheed, U., Khan, S., Khalid, M., Noor, A., & Zafar, S. A. (2024). A systemic analysis of Creutzfeldt-Jakob disease cases in Asia. *Prion*, 18(1), 11–27. <https://doi.org/10.1080/19336896.2024.2305179>
- Sahyouni, M., Casey, B., 3rd, Carpenter, Z., Estrella, F., & Okafor, C. (2024). Euphoric presentation in Creutzfeldt-Jakob disease and its diagnostic implications: A case report. *Cureus*, 16(4), Article e57419. <https://doi.org/10.7759/cureus.57419>
- Salehi, P., Clark, M., Pinzon, J., & Patil, A. (2022). Sporadic Creutzfeldt-Jakob disease. *American Journal of Emergency Medicine*, 52, 267.e1–267.e3. <https://doi.org/10.1016/j.ajem.2021.08.074>

- Sato, A. (2021). Creutzfeldt-Jakob disease. *No Shinkei Geka*, 49(2), 407–412. <https://doi.org/10.11477/mf.1436204400>
- Senesi, M., Lewis, V., Varghese, S., Stehmann, C., McGlade, A., Doecke, J. D., Ellett, L., Sarros, S., Fowler, C. J., Masters, C. L., Li, Q.-X., & Collins, S. J. (2023). Diagnostic performance of CSF biomarkers in a well-characterized Australian cohort of sporadic Creutzfeldt-Jakob disease. *Frontiers in Neurology*, 14, Article 1072952. <https://doi.org/10.3389/fneur.2023.1072952>
- Sitammagari, K. K., & Masood, W. (2021). Creutzfeldt-Jakob disease. In *StatPearls*. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK507860/>
- Uslui, F. I., Elif, G., Gürsoy, A. E., Kolukisa, M., & Yildiz, G. B. (2020). Creutzfeldt-Jakob disease: A single center experience and systemic analysis of cases in Turkey. *Idегgyóгyászati Szemle*, 73(5-6), 177–184. <https://doi.org/10.18071/isz.73.0177>
- Uttley, L., Carroll, C., Wong, R., Hilton, D. A., & Stevenson, M. (2020). Creutzfeldt-Jakob disease: A systematic review of global incidence, prevalence, infectivity, and incubation. *The Lancet Infectious Diseases*, 20(1), e2–e10. [https://doi.org/10.1016/S1473-3099\(19\)30481-8](https://doi.org/10.1016/S1473-3099(19)30481-8)
- Zerr, I., Ladogana, A., Mead, S., Hermann, P., Forloni, G., & Appleby, B. S. (2024). Creutzfeldt-Jakob disease and other prion diseases. *Nature Reviews Disease Primers*, 10(1), Article 14. <https://doi.org/10.1038/s41572-024-00496-9>
- Zerr, I. (2022). Laboratory diagnosis of Creutzfeldt-Jakob disease. *New England Journal of Medicine*, 386(14), 1345–1350. <https://doi.org/10.1056/NEJMr2119323>

AN OPTIMAL ADAPTIVE CONTROLLER BASED ON ONLINE ACTOR-CRITIC LEARNING FOR A ROBOT MANIPULATOR

UM CONTROLADOR ADAPTATIVO ÓTIMO BASEADO EM APRENDIZADO ONLINE ATOR-CRÍTICO PARA UM MANIPULADOR ROBÓTICO

UN CONTROLADOR ADAPTATIVO ÓPTIMO BASADO EN EL APRENDIZAJE ACTOR-CRÍTICO EN LÍNEA PARA UN MANIPULADOR ROBÓTICO



<https://doi.org/10.56238/sevened2026.008-036>

Patrícia Helena Moraes Rêgo¹, Joelson Miller Bezerra de Sousa²

ABSTRACT

The uncertainties in the parameters of a robot manipulator can significantly affect the robot performance, causing steady-state and trajectory following errors. Adaptive controllers are a good alternative for these systems, since their main feature is the capability to learn online using real-time parameter estimation. Nevertheless, adaptive controllers are not usually designed to be optimal to a prescribed performance index, and thus, are not suitable to applications in which optimal use of resources is highly desirable, for instance humanoid and service robots. This paper presents the design and performance study of a controller that combine features of adaptive control and optimal control applied to a robot manipulator. Specifically, the proposed control scheme is implemented as an actor-critic structure, which is in the reinforcement learning context, characterizing this design as a model-free approach. In contrast to others actor-critic systems in which two independent neural networks are used, one for approximating the value function and another for learning the control actions, in this scheme, a single neural network is defined, reducing the number of parameters to be estimated. The simulation results validate the desired performance of the proposed controller applied in a two-link robot manipulator with revolute joints.

Keywords: Robot Manipulator. Adaptive Control. Optimal Control. Reinforcement Learning. Actor-Critic Scheme.

RESUMO

As incertezas nos parâmetros de um manipulador robótico podem afetar, de forma significativa, o desempenho do manipulador, ocasionando erros de regime e de seguimento de trajetória. Controladores adaptativos apresentam-se como uma boa alternativa para esses sistemas, pois possuem como principal característica a capacidade de aprenderem online usando estimação de parâmetros em tempo real. No entanto, controladores adaptativos não são geralmente projetados com a qualidade de serem ótimos com respeito

¹ Dr. in Electrical Engineering. Universidade Estadual do Maranhão (UEMA). E-mail: phmrego@yahoo.com.br
Orcid: <https://orcid.org/0000-0001-5899-0623> Lattes: <http://lattes.cnpq.br/6535271381344851>

² Master's degree of Science in Computer Engineering. Universidade Estadual do Maranhão (UEMA).
E-mail: joelsonmiller@hotmail.com Lattes: <http://lattes.cnpq.br/6867462270921352>

aos critérios de desempenho especificados e, desta forma, não são viáveis para aplicações onde o uso ótimo de recursos é altamente desejável, como por exemplo em robôs humanoides e robôs de serviços. Este artigo apresenta o projeto e investigação de desempenho de um controlador que combina características de controle adaptativo e controle ótimo para um manipulador robótico. Especificamente, o esquema de controle proposto é implementado como uma estrutura ator-crítico, a qual está inserida no contexto de aprendizado por reforço, caracterizando este projeto como uma abordagem independente do modelo da planta. Em contraste a outros sistemas ator-críticos em que são usadas duas redes neurais independentes, uma para aproximar a função valor, e a outra para aprender ações de controle, neste esquema, se define uma única rede neural, o que reduz o número de parâmetros a serem estimados. Os resultados de simulação demonstram o desempenho desejado do controlador proposto que atua em um manipulador de juntas rotativas com dois graus de liberdade.

Palavras-chave: Manipulador Robótico. Controle Adaptativo. Controle Ótimo. Aprendizado por Reforço. Esquema Ator-Crítico.

RESUMEN

Las incertidumbres en los parámetros de un manipulador robótico pueden afectar significativamente al rendimiento del manipulador, provocando errores de régimen y de seguimiento de la trayectoria. Los controladores adaptativos se presentan como una buena alternativa para estos sistemas, ya que su principal característica es la capacidad de aprender en línea utilizando la estimación de parámetros en tiempo real. Sin embargo, los controladores adaptativos no suelen diseñarse con la calidad de ser óptimos con respecto a los criterios de rendimiento especificados y, por lo tanto, no son viables para aplicaciones en las que es muy deseable el uso óptimo de los recursos, como por ejemplo en robots humanoides y robots de servicio. Este artículo presenta el diseño y la investigación del rendimiento de un controlador que combina características de control adaptativo y control óptimo para un manipulador robótico. En concreto, el esquema de control propuesto se implementa como una estructura actor-crítico, que se inserta en el contexto del aprendizaje por refuerzo, lo que caracteriza a este diseño como un enfoque independiente del modelo de la planta. A diferencia de otros sistemas actor-crítico en los que se utilizan dos redes neuronales independientes, una para aproximar la función de valor y otra para aprender acciones de control, en este esquema se define una única red neuronal, lo que reduce el número de parámetros que deben estimarse. Los resultados de la simulación demuestran el rendimiento deseado del controlador propuesto, que actúa en un manipulador de juntas rotativas con dos grados de libertad.

Palabras clave: Manipulador Robótico. Control Adaptativo. Control Óptimo. Aprendizaje por Refuerzo. Esquema Actor-Crítico.

1 INTRODUCTION

The development of control strategies for robotic manipulators presents difficulties due to the characteristics of the system itself, i.e., an articulating robot is a multivariable dynamic system, with strong nonlinearities due to the couplings of its joints and movements, in addition to presenting uncertain or time-varying parameters, such as the mass and inertia of the links, friction or backlash in the joint gears, payload variations, location of the center of mass (which can change when the robot is under load), among others (Fateh; Fateh, 2019). These parametric inaccuracies result in losses of accuracy and speed in manipulator movements, which in certain applications is highly undesirable. Nonlinear dynamics, on the other hand, can lead the system to instability at certain operating points (Craig, 2021).

Conventional feedback controllers, such as PID (Proportional-Integral-Derivative), are widely used in industry because they are simple, easy to implement, and perform well in various applications (Borase *et al.*, 2021). However, this control scheme, as it is a type of control with fixed gains, becomes insufficient when applied to systems with nonlinearities and/or uncertainties (imprecise parameters, non-modeled high-frequency dynamics, and disturbances), i.e., systems that have variable operating points (Konstantopoulos; Baldivieso-Monasterios, 2020).

Among the classical controllers applied to manipulators, there are those based on model (kinematic and/or dynamic for controlling position, velocity and force). However, these approaches require complete knowledge of the equations that describe the behavior of the system, which are quite complex and with parameters that are often uncertain. The complexity of the model also increases with the increase in joints and links of the manipulator, increasing the computational cost to solve these equations (Moosavi; Zafar; Sanfilippo, 2022).

Adaptive control theory provides a means to develop solutions for dynamic systems that require more complex controllers. This approach allows for online compensation for *parametric variations and uncertainties in the system, ensuring that the desired performance criteria are met* (Sun *et al.*, 2020). Traditionally, adaptive control methods can be divided into two approaches: indirect control and direct control (Qi; Tao; Jiang, 2019). In indirect control, the estimation of the system parameters precedes the generation of an control input. In direct control, the controller parameters are directly adjusted without the need for the equations that govern the behavior of the system.

In the Adaptive Control literature, there are several studies and methods applied to the trajectory control of robotic manipulators. Dubowsky and Desforges (1979) are the pioneers in employing adaptive control techniques in articulated robots. The approach used by these

researchers was the *Model Reference Adaptive System* (MRAS). Practical results also showed the benefits of approaches based on *self-tuning* and *backstepping techniques* in relation to conventional control with fixed gains (Clegg; Dunnigan; Lane, 2001) (Sasaki *et al.*, 2009) (Hu; Xu; Zhang, 2012). Hybrid approaches have also been explored (Maliotis, 1991) (Al-Olimat; Ghandakly, 2002) (Chen, 2005) (Alquadi *et al.*, 2016) (Zhang; Wei, 2017). In (Wu; Yan; Cai, 2019) (Fateh; Fateh, 2019) (Yilmaz *et al.*, 2022) (Freire; Rossomando; Soria, 2018) adaptive control designs based on artificial intelligence techniques, such as neural networks and *fuzzy logic*, are proposed, which are able to compensate for the uncertainties of the model of a manipulator robot.

Although adaptive control techniques have been successful in many applications, one aspect that should be noted is that the controller designs resulting from these methods, in general, have been structured without considering the optimization of the control action and, therefore, are not feasible for applications where the use of optimal control strategies is required. such as humanoid robots/service robots (Khan *et al.*, 2012). In this case, a joint approach of adaptive control and optimal control techniques is desired. Optimal control basically consists of determining a control law in order to minimize a desired performance criterion. In the context of robotics, performance criteria may involve the energy or force for the execution of the motion, while the physical constraints of the system, such as actuator or joint limits, must be satisfied.

Many efforts in systems control theory are currently concentrated in an area of machine learning based on animal behavior studies and cognitive psychology, called *Reinforcement Learning* (RL), which aims to incorporate features of biological systems into the treatment of systems with uncertainties, introducing several terms, such as adaptation, learning, pattern recognition, and self-organization (Guo; Yan; Cui, 2020) (Yaghmaie; Gustafsson; Ljung, 2023) (Chen; Hence; Dong, 2024a) (Chen; Dong; Dai, 2024b) (Zhao *et al.*, 2025) (Su *et al.*, 2025) (Wang *et al.*, 2025). The central theme in RL research is the design of algorithms that learn optimal control policies through knowledge only of transition samples of states or trajectories, which are collected in advance or by real-time interaction with the system.

Actor-Critic methods constitute a class of reinforcement learning techniques that essentially consist of two independent parametric structures (e.g., neural networks), one to represent the control policy, called the Actor, and the other network structure is to represent the value function, called the critic (Sutton; Barto, 2018). The actor is an agent who interacts with the environment, i.e., the actor is the controller who establishes control actions, while

the critic evaluates the effect of control actions and provides guidelines on how to improve the control law.

Reinforcement learning can be seen in (Kiumarsi *et al*, 2018) from the perspective of a promising field of research for the design of a class of adaptive controllers with actor-Critic structure that learn *optimal* control solutions online without making use of the system dynamics model (plant). This approach solves the optimization equation (Hamilton-Jacobi-Bellman equation - HJB) in a "forward in time" manner using methods of temporal differences, approximation of functions, and policy improvements. Such controllers are inspired by biological neural structures that provide capabilities to effectively deal with the degree of complexity of nonlinear, uncertain, and partially observable systems. In (Kiumarsi *et al*, 2018), the main ideas and algorithms of reinforcement learning are presented, as well as their applications in optimal control of dynamical systems.

1.1 OBJECTIVES

The present article aims to evaluate the potential of a reinforcement learning algorithm to solve problems of online optimal control of the trajectory of a robotic manipulator with continuous state space (joint space). In contrast to most of the actor-Critic algorithms reported in the literature (see Section 2), in which two neural networks are used, one to approximate the value function, and the other to learn control actions, the algorithm proposed in this work employs an actor-Critic architecture where a single neural network is used to approximate the solution of the equation HJB, which significantly reduces the number of parameters to be estimated. Specifically, in this scheme, control actions are calculated accurately using a greedy policy scheme with respect to the value function, rather than using a parametric approximator to represent the control policy. Experiments performed on a UR10 robotic arm of the V-REP simulator show that such an algorithm successfully learns the optimal control law for the regulation and tracking tasks for different reference signals.

2 RELATED WORKS

Important previous contributions to the design of RL-based control include the work of Peters and Schaal (2008a) (2008b), who investigated various methods of reinforcement learning for humanoid robots. These methods were classified into three categories: greedy policy, vanilla policy gradient, and natural policy gradient. The natural Actor-Critic approach, which explores the formulation of the natural policy gradient, was highlighted by the authors for presenting better convergence properties. An extension of this study is shown in (Bhatnagar *et al.*, 2009).

Already (Shah; Gopal, 2009) presented a Q-learning-based control approach to manipulator robots in uncertain environments and provided a comparative study of different methods of function approximation, such as fuzzy, neural networks, decision tree, and support vector machine.

In (Khan *et al.*, 2011, 2012), the authors emphasized applications of RL controllers in robotic systems and proposed an optimal adaptive control scheme based on *Q-Learning* and Approximate Dynamic Programming. The strategy was implemented on the arm of a humanoid robot (Bristol Elumotion-Robotic-Torso II) considering one case without restrictions and another with movement restrictions.

In (Pane; Nagesh Rao; Babuška, 2016), the authors provided experimental validation of an Actor-Critic learning-based compensator to improve the performance of a manipulator robot. The proposed method eliminates the need to learn the system model and can be used in any feedback controller (PID, LQR, etc.). The validation of the method was demonstrated through experiments on an industrial manipulator robot with six degrees of freedom for different types of reference trajectories. An extension of this work is presented in (Pane *et al.*, 2019).

The application of RL controllers in robotic manipulators is also shown in (Hu; Si, 2018). In this work, an Actor-Critic Learning strategy with state observer via neural network was implemented to control a robotic arm with unknown parameters and subject to unknown dead zones.

Khan *et al.* (2019) proposed an optimal adaptive compliance control for a robotic locomotion aid device. The suggested control scheme is based on Q-Learning and approximate dynamic programming. This scheme is completely independent of dynamic model and employs feedback of joint position and speed, as well as the detected joint torque (applied by the user during walking) for compliance control. The efficiency of the controller is tested in simulation on a model of a robotic locomotion aid device.

Kamboj *et al.* (2020) presented an optimal kinematic control strategy in discrete time for a manipulator using the Actor-Critic structure. The methodology exposed was applied to a 3D model of a manipulator with six degrees of freedom in experiments carried out in a simulation software. Then, the strategy was implemented in a real robot of the same model as the simulated one.

In (He *et al.*, 2021), the authors discussed the design of control and validation of experiments of a flexible two-link manipulator system. A reinforcement learning control strategy is developed based on the actor-Critic framework to attenuate vibrations while maintaining trajectory tracking.

An Actor-Critic Learning-based tracking controller for a handler has also been studied by (Cao *et al.*, 2023). In this work, the sliding modes technique is used so that the action obtained by the Actor-Critic scheme ensures the convergence of the tracking error in a fixed time. In addition, an *antiwindup compensator* has been designed to handle the effects of saturation of the joint actuator.

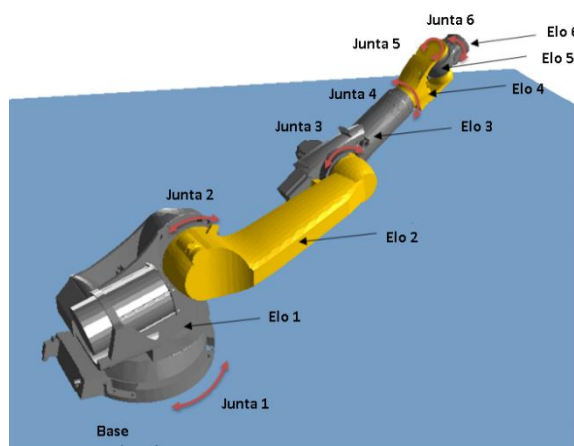
In the above literature, most actor-Critic RL algorithms are implemented using two neural networks, one to approximate the value function, and the other to learn control actions. To reduce the computational complexity associated with actor-Critic methods, we propose in this paper an architecture where a single neural network is used to approximate the optimal control solution, which significantly reduces the number of parameters to be estimated. Specifically, control actions are calculated accurately through a greedy policy schema with respect to the value function, rather than using a parametric approximation to represent the control policy.

3 DESCRIPTION OF THE ROBOTIC MANIPULATOR SYSTEM

A robotic manipulator, or articulated robot, is formed by a set of individual bodies connected to each other forming a kinematic chain capable of performing tasks through interaction with the environment (Craig, 2021). The two fundamental parts that make up an articulated robot are the links, or joints, and the joints. Links are the physical structures (rigid or flexible) that make up the robot. Joints, on the other hand, are responsible for promoting relative movement between joints through actuators and are commonly classified according to the mobility they enable. The most common types found in industry are rotational joints and prismatic joints.

Figure 1

Links and Joints of an articulated robot



Source: Abbas, 2018.

Figure 1 illustrates a sequence of links and joints of a robotic arm. The ends of the articulating robot are called the base and effector. The base attaches to the first link and secures the mechanism somewhere in the task space. The effector is a tool connected to the last link of the articulator and it is at this point that there is interaction with the environment. The type of actuator installed will depend on the task to be performed.

3.1 DYNAMIC EQUATIONS OF A ROBOTIC MANIPULATOR

The dynamics of manipulators studies the relationship between the forces applied to the actuators of the joints and the movement of the mechanism. The Lagrange formulation allows modeling the dynamic behavior of a body in terms of kinetic and potential energies rather than considering the moments and forces applied individually to each joint. The Lagrange equation is expressed by

$$\tau = \frac{d}{dt} \left(\frac{\partial L}{\partial \dot{q}} \right) - \frac{\partial L}{\partial q} \quad (1)$$

$$L(\dot{q}, q) = K(\dot{q}, q) - U(q), \quad (2)$$

where $K(\cdot)$ is the kinetic energy and $U(\cdot)$ is the potential energy stored in the mechanism. This equation is written in terms of the generalized coordinates q of the articulator and its derivative $\dot{q}$ in time. The term τ , in turn, represents the generalized vector of forces, including the forces and torques applied to the system.

For a manipulator robot with n rigid links, kinetic energy can be written in the form

$$K(\dot{q}, q) = \sum_{i=0}^n k_i \quad (3)$$

$$k_i = \frac{1}{2} m_i v_{C_i}^T v_{C_i} + \frac{1}{2} \omega_i^T {}^{C_i} I_i \omega_i, \quad (4)$$

where k_i is the kinetic energy for the i th link. For each link, there are two components, one related to linear velocity v_{C_i} , and the other, angular velocity ω_i , relative to the center of mass of the respective joint, with m_i the mass of the link i , $e^{C_i} I_i$ and is the inertia matrix.

Potential energy can be expressed as

$$U(q) = \sum_{i=0}^n u_i \quad (5)$$

$$u_i = m_i g^T P_{C_i} \quad (6)$$

where u_i is the potential energy for the i th link, defined in terms of the mass m_i , the gravity vector g , and the location P_{C_i} of the center of mass relative to the base.

Applying Lagrangian $L(\cdot)$ to equation (1), one can reorder the terms of the resulting expression in order to obtain.

$$\tau = M(q)\ddot{q} + N(q, \dot{q}) + G(q), \quad (7)$$

where $M(q)$ is the mass matrix of the manipulator, $N(q, \dot{q})$ is a n -dimensional vector related to Coriolis and centripetal forces, and $G(q)$ is a vector $n \times 1$ with terms involving gravity.

In this way, the model of a manipulator can be written in the form of State Space by

$$\begin{aligned} \begin{bmatrix} \dot{q} \\ \ddot{q} \end{bmatrix} &= \begin{bmatrix} \dot{q} \\ -M^{-1}(N + G) \end{bmatrix} \\ &+ \begin{bmatrix} 0 \\ M^{-1} \end{bmatrix} \tau. \end{aligned} \quad (8)$$

4 METHODOLOGY

In the context of optimal control and reinforcement learning, the notion of maximizing weighted future rewards is modified to minimize the cost of control. In this way, the objective is to determine a control law or control policy $h^*(x_k, d_k) = u_k^*$ that minimizes the performance index (value function)

$$V(x_k, d_k) = \sum_{i=k}^{\infty} \gamma^{i-k} r(x_i, u_i, d_i), \quad (9)$$

where $x_k \in \mathbb{R}^n$ is the state vector, $u_k \in \mathbb{R}^m$ is the control input vector, d_k is the desired trajectory vector, $0 < \gamma \leq 1$ is the discount factor, and $r(\cdot)$ is the utility function that returns the control cost in a time step. A reasonably general utility function in energy minimization problems is given by:

$$r(x_i, u_i, d_i) = \tilde{r}(x_i, d_i) + u_i^T R u_i, \quad (10)$$

where R is a positive definite matrix. The vector d_i can be described as a design demand, making it $\tilde{r}(\cdot)$ represent the cost to perform the desired task, such as the tracking cost.

Using Bellman's principle of optimality (Vrabie; Vamvoudakis; Lewis, 2013), the optimal performance index can be written as

$$V^*(x_k, d_k) = \min_{u_k} (r(x_k, u_k, d_k) + \gamma V^*(x_{k+1}, d_{k+1})). \quad (11)$$

In reinforcement learning, a variant of the value function $V(\cdot)$, called a Q function (or action value function), is used. Such a function has an appropriate application in control designs where the plant model is not available. The Q function associated with a control policy h is defined by

$$Q^h(x_k, u_k, d_k) = r(x_k, u_k, d_k) + \gamma V^h(x_{k+1}, d_{k+1}), \quad (12)$$

and the optimal Q function satisfies the following equation

$$Q^*(x_k, u_k, d_k) = r(x_k, u_k, d_k) + \gamma V^*(x_{k+1}, d_{k+1}). \quad (13)$$

Combining equations (11) and (13), Bellman's optimality equation in terms of the Q function is given by

$$V^*(x_k, d_k) = \min_{u_k} (Q^*(x_k, u_k, d_k)) \quad (14)$$

and the optimal control policy is obtained by

$$h^*(x_k, d_k) = \arg \min_{u_k} Q^*(x_k, u_k, d_k). \quad (15)$$

assuming Q^* sufficiently smooth (differentiable), the control signal can be obtained as a solution to the equation

$$\frac{\partial Q^*(x_k, u_k, d_k)}{\partial u_k} = 0. \quad (16)$$

4.1 ACTOR-CRITIC *ONLINE* LEARNING STRATEGY

The actor-Critic scheme described below considers a manipulator system with two degrees of freedom, which can be extended to manipulators with n degrees of freedom. The control law is synthesized in the optimal tracking problem of the manipulator's joint position. In particular, $x_k = [x_{k1} \ x_{k2} \ x_{k3} \ x_{k4}]^T$ is defined as the state vector at time k , where $x_{k1} = q_1$ and $x_{k2} = q_2$ are the angular positions of joints 1 and 2, respectively, and $x_{k3} = \dot{q}_1$ e $x_{k4} = \dot{q}_2$ are, in due order, the angular velocities of joints 1 and 2. The control signal, of course, is a vector 2×1 , where $u_k = \tau$ is the force applied on the joints. For the optimal tracking problem considered, the utility function reduces to

$$r(x_k, e_k, u_k) = e_k^T Q_c e_k + (u_{k+1} - u_k)^T S (u_{k+1} - u_k) + u_k^T R u_k \equiv r_k, \quad (17)$$

where $Q_c \in \mathbb{R}^{4 \times 4}$, $R \in \mathbb{R}^{2 \times 2}$, and $S \in \mathbb{R}^{2 \times 2}$ are diagonal and positive definite matrices.

In the present study, the parametric structure to approximate the Q function assumes the form given by

$$\hat{Q}_i(x_k, u_k, d_k, w_i) = w_i^T \phi(x_k, u_k, d_k), \quad (18)$$

where w_i is the i th estimate of the weight vector of the neural network and $\phi(\cdot)$ is the vector of activation functions or base functions. It is considered that the desired value for estimating the parameter w_i is given by

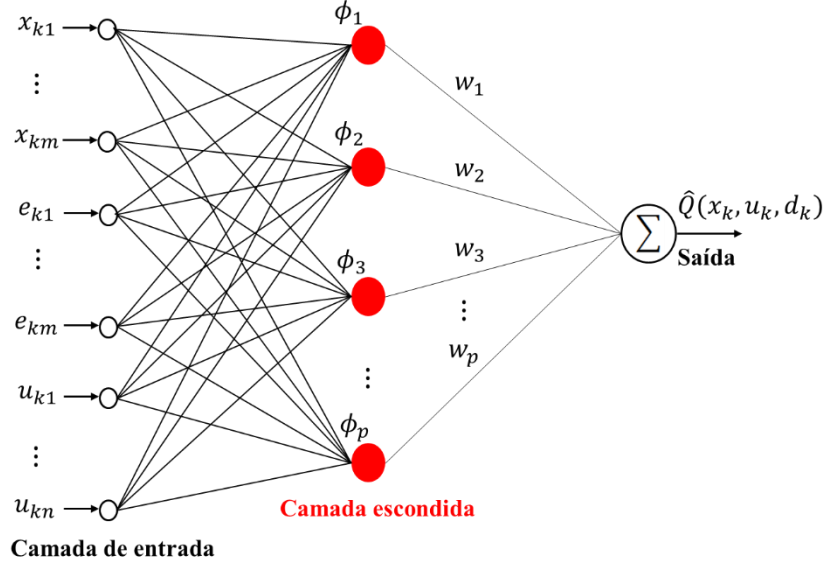
$$\Delta_{objetivo} = r(x_k, e_k, u_k) + \gamma \hat{Q}_i(x_{k+1}, u_{k+1}, d_{k+1}) \quad (19)$$

Figure 2 illustrates the neural network architecture used to estimate the Q function, in which, $m = 4$, $n = 2$ and $p = 105$. The functions ϕ_j , $j = 1, \dots, p$, are the components of the vector of activation functions resulting from the Kronecker product given in equation (21).

The weight vector w_i is calculated by minimizing, in a least-squares sense, the temporal difference error, which is defined by

Figure 2

Architecture of the neural network used to estimate the function Q



Source: Prepared by the authors.

$$\delta_k = r_k + \gamma \hat{Q}_i(x_{k+1}, u_{k+1}, d_{k+1}, w_i) - \hat{Q}_i(x_k, u_k, d_k, w_i). \quad (20)$$

The vector of activation functions is constructed by higher-order polynomials. For simplicity, $\phi(\cdot)$ will be represented using Kronecker product $\otimes$ with the exclusion of redundant terms (Vrabie; Vamvoudakis; Lewis, 2013).

This exclusion is necessary so that the elements that make up the vector of base functions $\phi(\cdot)$ become linearly independent. The goal is to insert some quadratic elements and up to fourth-order terms into the tracking errors, states, and control signals, so that the neural network can learn the nonlinearities of the manipulator. Therefore,

$$\phi(z_k) = z_k \otimes z_k, \quad (21)$$

Where:

$$z_k = [u_k^T \quad e_k^T \quad e_{k1}^2 \quad e_{k2}^2 \quad e_{k3}^2 \quad e_{k4}^2 \quad x_{k1}^2 \quad x_{k2}^2 \quad x_{k3}^2 \quad x_{k4}^2]^T \quad (22)$$

so that $e_k = [e_{k1} \quad e_{k2} \quad e_{k3} \quad e_{k4}]^T = x_k - d_k$ is the tracking error. In this way, the Artificial Neural Network (ANN) to be implemented has 105 neurons.

The Q function takes the form

$$\hat{Q}_i(x_k, u_k, d_k, w_i) = w_{i,1}^T \phi_1(z_k) + w_{i,21}^T \phi_2(z_k) u_{k1} + w_{i,22}^T \phi_2(z_k) u_{k2} + w_{i,31} u_{k1}^2 + w_{i,32} u_{k2}^2, \quad (23)$$

where $\phi(z_k) = [\phi_1^T(z_k) \ \phi_2^T(z_k) u_{k1} \ \phi_2^T(z_k) u_{k2} \ u_{k1}^2 \ u_{k2}^2]^T$ follows from equation (21). Specifically, the elements that make up $\phi_1(\cdot)$ and $\phi_2(\cdot)$ are independent of u_{k1} and u_{k2} .

Applying equation (16) to determine the control policy, we have

$$\begin{aligned} \frac{\partial \hat{Q}_i(x_k, u_k, d_k, w_i)}{\partial u_{k1}} &= w_{i,21}^T \phi_2(z_k) + 2w_{i,31} u_{k1} = 0 \\ u_{k1} &= -\frac{1}{2w_{i,31}} w_{i,21}^T \phi_2(z_k) \end{aligned} \quad (24)$$

$$\begin{aligned} \frac{\partial \hat{Q}_i(x_k, u_k, d_k, w_i)}{\partial u_{k2}} &= w_{i,22}^T \phi_2(z_k) + 2w_{i,32} u_{k2} = 0 \\ u_{k2} &= -\frac{1}{2w_{i,32}} w_{i,22}^T \phi_2(z_k). \end{aligned} \quad (25)$$

reorganizing in matrix form, the control policy can be written as

$$h_i(x_k, d_k) = -\frac{1}{2} \begin{bmatrix} w_{i,31} & 0 \\ 0 & w_{i,32} \end{bmatrix}^{-1} \begin{bmatrix} \phi_2^T(z_k) & \mathbf{0}_{1 \times 12} \\ \mathbf{0}_{1 \times 12} & \phi_2^T(z_k) \end{bmatrix} w_{i,2}, \quad (26)$$

in which $w_{i,2} = [w_{i,21}^T \ w_{i,22}^T]^T$

In reinforcement learning, the actor is the agent that generates the control policy, that is, the actor is described mathematically by equation (26). The critic is described by equation (23).

4.2 ACTOR-CRITIC ONLINE LEARNING ALGORITHM

One aspect related to the actor-Critic approach is that the estimates of the Q function of a given control policy are updated at each step of time k using observed data from the system (manipulator states). To this end, the iterative algorithm of recursive least squares (RLS) will be used to estimate the weight vector w_i . The efficiency of the RLS method in

online learning is mainly due to its robustness to deal with time variations in the regression parameters and the fast convergence speed (Ferreira; Rêgo; Neto, 2017).

Therefore, by applying the RLS algorithm, the estimation of the RNA weights, at each time step, k is given by

$$w_{k+1} = w_k + K_k \delta_k \quad (27)$$

$$K_k = \frac{P_k \phi(z_k)}{\lambda + \phi(z_k)^T P_k \phi(z_k)} \quad (28)$$

$$P_{k+1} = \frac{1}{\lambda} \left[P_k - \frac{P_k \phi(z_k) \phi(z_k)^T P_k}{\lambda + \phi(z_k)^T P_k \phi(z_k)} \right], \quad (29)$$

where λ , $0 < \lambda \leq 1$ is the forgetting factor and P_k is the inverse correlation matrix.

The reinforcement learning scheme employed in this work requires a stable initial control policy. The purpose is to keep the controller stable during the initial instants until the agent acquires enough experience (observing the environment) so that a new policy can be calculated. For simplicity, the neural network gains must be initialized in such a way as to result in a discrete PD (Proportional-Derivative) controller. This can be implemented by modifying the weights of the equation (26), where it is observed that:

$$\varphi_2(z_k) = [e_{k1} \ e_{k2} \ e_{k3} \ e_{k4} \ e_{k1}^2 \ e_{k2}^2 \ e_{k3}^2 \ e_{k4}^2 \ x_{k1}^2 \ x_{k2}^2 \ x_{k3}^2 \ x_{k4}^2]^T, \quad (30)$$

that is, $h(x_k, d_k)$ depends directly on the position and speed errors of the links. That said, it can be seen that it is easy to obtain a PD control by establishing, for example,

$$\begin{aligned} w_{i,31} &= w_{i,32} = \frac{1}{2}, \\ w_{i,21} &= [K_{P_1} \ 0 \ K_{D_1} \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0]^T, \\ w_{i,22} &= [0 \ K_{P_2} \ 0 \ K_{D_2} \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0]^T, \end{aligned} \quad (31)$$

where K_{P_1} and K_{D_1} , and K_{P_2} and K_{D_2} are the proportional and derivative gains, respectively, of joints 1 and 2. Adjustment of these parameters will be performed by trial and error.

A summary of the actor-Critic reinforcement learning algorithm implemented in this study is presented below.

Table 1

Actor-Critic RL Algorithm
Input: discount factor γ , learning factor α , initial value of the covariance matrix β , and the forgetting factor λ . Initialize the neural network weights in a way that ensures a stable PD controller. Measure initial states x_0 and trajectory errors e_0 . Initialize the arrays $P_0 = \beta I$, Q_c , R and S arbitrarily and $i = 0$.
Repeat for each states sample $k = 0, 1, 2, \dots$
▷ Noise signal as an exploration component $\xi = []$
▷ Control Signal $u_k = h_i(x_k, d_k) + \xi$
Apply and measure states $u_k x_{k+1}$ $u_{k+1} = h_i(x_{k+1}, d_{k+1})$
$e_{k+1} = x_{k+1} - d_{k+1}$
$r_k = e_k^T Q_c e_k + (u_{k+1} - u_k)^T S (u_{k+1} - u_k) + u_k^T R u_k$
▷ Recursive Least Squares - RLS $\Delta_{objetivo} = r_k + \gamma \hat{Q}(x_{k+1}, u_{k+1}, e_{k+1})$
$\hat{W}_k = w_k^T \phi_k$
$K_k = \frac{P_k \phi_k}{\lambda + \phi_k^T P_k \phi_k}$
$w_{k+1} = w_k + K_k (\Delta_{objetivo} - \hat{W}_k)$
$P_{k+1} = \frac{1}{\lambda} \left(P_k - \frac{P_k \phi_k \phi_k^T P_k}{\lambda + \phi_k^T P_k \phi_k} \right)$
If End of a learning period: $w_{i+1(ctrl)} = \alpha w_{k+1} + (1 - \alpha) w_{i(ctrl)}$
▷ Updating the control policy $h_{i+1} \leftarrow -\frac{1}{2} \begin{bmatrix} w_{i+1(ctrl),31} & 0 \\ 0 & w_{i+1(ctrl),32} \end{bmatrix}^{-1} \begin{bmatrix} \varphi_2^T(z_k) & \mathbf{0}_{1 \times 10} \\ \mathbf{0}_{1 \times 10} & \varphi_2^T(z_k) \end{bmatrix} w_{i(ctrl),2}$
$P_{k+1} = \beta I$
$i = i + 1$
End up up to meet the stop criterion

The algorithm starts with the RNA gains arbitrarily defined to produce the effect of a PD control. The initial condition of the inverse correlation matrix of the RLS given in the form $P_0 = \beta I$, where β is a constant with a sufficiently large value and I is the identity matrix, was considered. During the first momens, there is no update in the control policy to ensure stability during the initial learning, however the weight vector w_k is calculated at each step by applying equations (27) to (29). The control signal is obtained at each time k using (26). A noise signal ξ , known as exploration noise, is added to the control input for the purpose of online learning (Jiang; Jiang, 2017).

$$w_{i+1(ctrl)} = \alpha w_{k+1} + (1 - \alpha)w_{i(ctrl)}, \quad (32)$$

where $w_{i(ctrl)}$ are the parameters of the controller implemented during the i -th cycle, $0 < \alpha \leq 1$ is the learning factor. At that moment, the matrix P is redefined. The controller weights are again kept unchanged until the current cycle has been completed. The process is repeated until the convergence of the network parameters. Once this goal is achieved, the controller operates at constant weights.

5 SIMULATION STRUCTURE

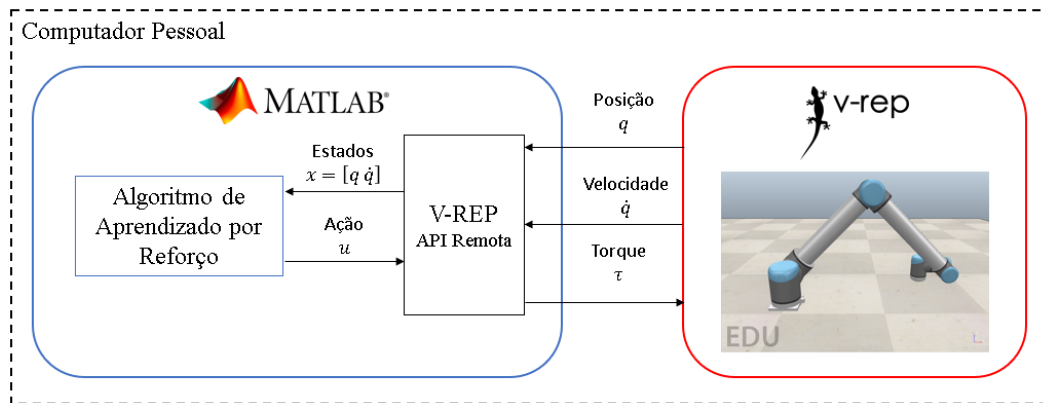
In order to provide a simulation structure that allows the development of the algorithms and the experiments, the *V-REP* (Virtual Robotics Experimentation Platform) *software was used* together with MATLAB (*Matrix Laboratory*). V-REP is a general-purpose robot simulator that provides multiple physics engines for the simulations, multiple robotic models, and multiple configurations of the environment. In this way, it is possible to customize all the objects in the scene, including the parameters of the sensors and actuators, thus allowing more faithful results to be achieved (Rohmer; Singh; Freese, 2013).

In the V-REP, different means of controlling the objects/models in the scene are available, either through embedded routines, ROS (*Robot Operating System*) *nodes* (Quigley; Gerkey; Smart, 2015), remote API (*Application Programming Interface*), a plugin or some custom solution. Controllers can be written in C/C++, Python, Java, Lua, and MATLAB (Shamshiri *et al.*, 2018). In this study, the robotic model used in the simulator is controlled by an external routine developed on the MATLAB platform making use of the remote API. Figure 3 illustrates the communication between the controller and the simulation environment.

The settings to be followed for the proper functioning of the simulations using the platforms described above and within the context of reinforcement learning can be seen in detail in (Pluškoski; Ciganović; Jovanović, 2019).

Figure 3

V-REP control scheme by remote API via MATLAB



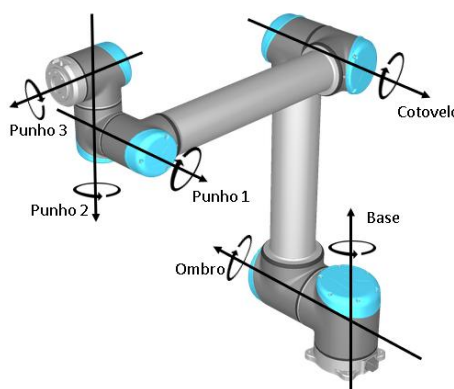
Source: Prepared by the authors.

6 SIMULATION RESULTS

In this section, the results of the simulations of the control scheme proposed in this work are presented and discussed. To perform these computational experiments, the UR10 robotic arm model available in the V-REP simulator was used. Since this articulator has six degrees of freedom, in these tests the torque generated by the control law will be applied only to the shoulder and elbow joints (Figure 4) while the other joints are deactivated and locked in their respective equilibrium positions (0°). The control was carried out using the remote API through routines implemented in the MATLAB platform.

Figure 4

UR10 manipulator joints



Source: Prepared by the authors.

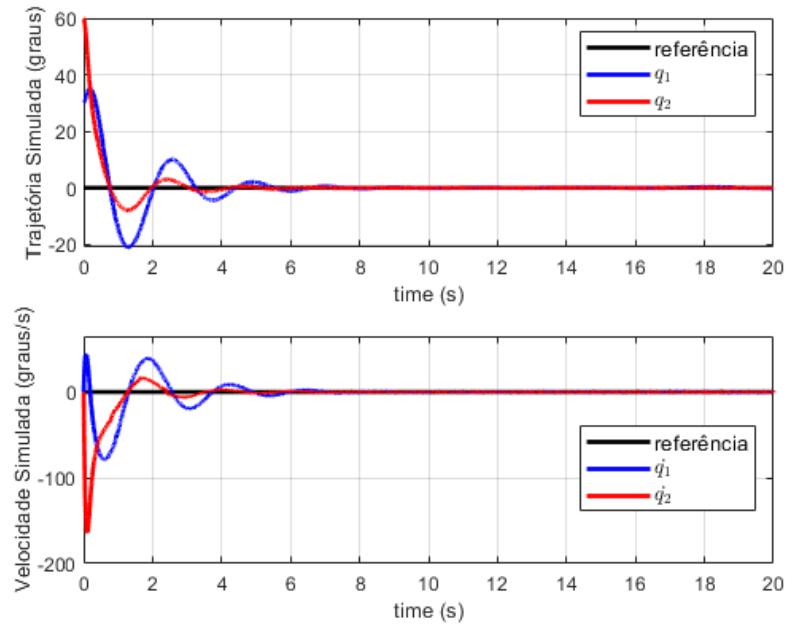
The evaluation of the control scheme via reinforcement learning will be done by analyzing the results of simulations of three tasks: regulation, trajectory following of a multi-step signal and a sinusoidal signal.

The behavior of the states for the regulation case is shown in Figure 5. The initial configuration of the joints has been set as $x_0 = [\pi/6 \ \pi/3 \ 0 \ 0]^T$ and the controller

parameters have been adjusted to the following values $K_{P_1} = K_{P_2} = 150$, $K_{D_1} = K_{D_2} = 30$, $\gamma = 0,98$, $Q_c = \text{diag}(250, 250, 0,001, 0,001)$, $R = \text{diag}(0,0001, 0,0001)$, $\alpha = 0,2$ e $P_0 = 10^4 I_{78 \times 78}$. The learning cycle for this simulation was 0.8 s. The control effort applied to the joints is shown in Figure 6 and the update of the actor's weights is shown in Figure 7.

Figure 5

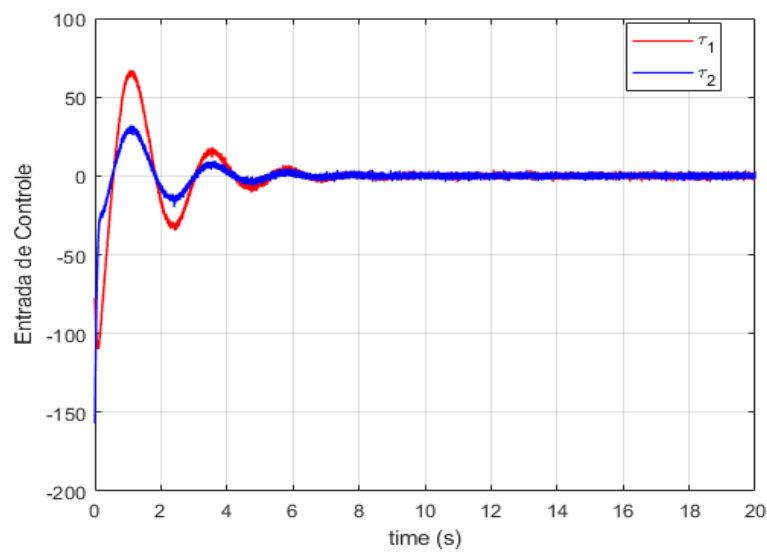
Trajectory of the states



Source: Prepared by the authors.

Figure 6

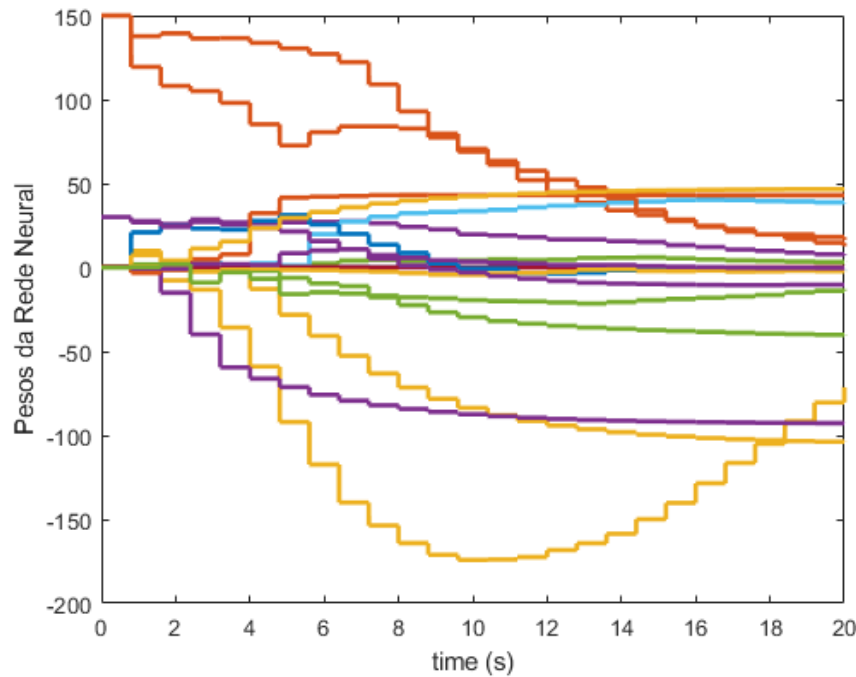
Control signal



Source: Prepared by the authors.

Figure 7

Actor network weight update



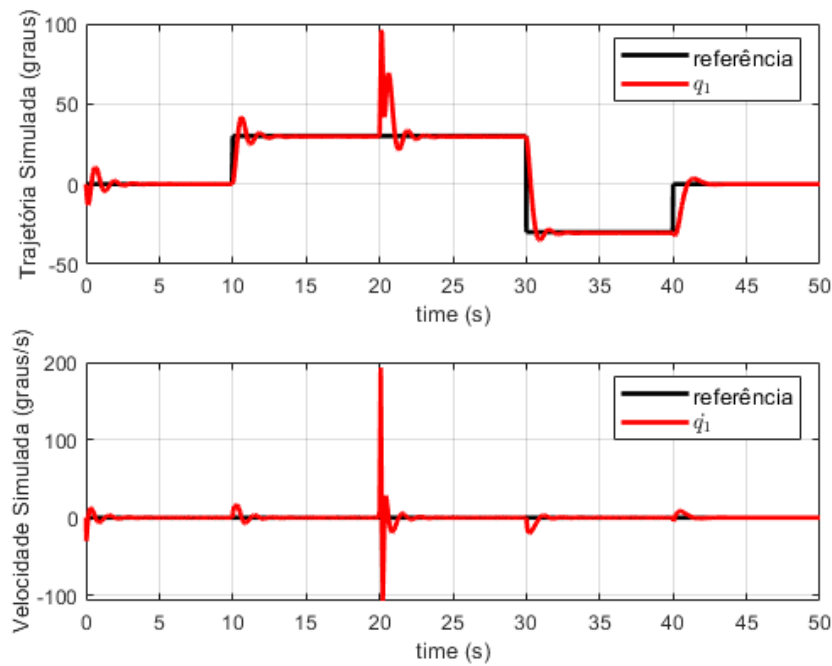
Source: Prepared by the authors.

In the second experiment suggested to validate the implemented controller, a multi-step reference signal was used, in order to simulate the pick and place task, commonly performed by manipulators. For this experiment, the initial state was set to $x_0 = [0 \ 0 \ 0 \ 0]^T$. The control parameters were the same as those used for the regulation case, except for the following values $Q_c = \text{diag}(100, 100, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)$, $\alpha = 0,1$, $K_{P_1} = K_{P_2} = 500$, $K_{D_1} = K_{D_2} = 50$ the learning cycle changed to 2 s. Under these adjustments, the tracking response, the torque applied to the joints, and the update of the actor's net weights are presented in 8 through 11.

As seen, the joints are able to reach the reference signal with errors within acceptable limits and the stability of the system is maintained throughout the simulation time. It is also shown that at the time instant of 20 s there was an increase in the control signal causing an unwanted overtime, but in the following instants, from the 15th update of the policy (30 s), an improvement in tracking was observed in relation to the initial policy (first 2 s), a consequence of the learning acquired.

Figure 8

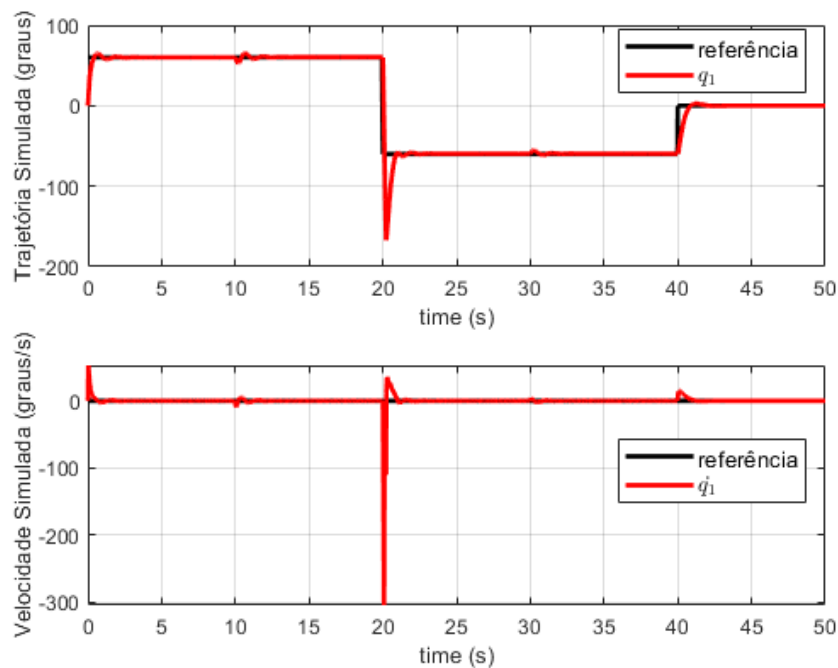
Trajectory tracking of the shoulder joint



Source: Prepared by the authors.

Figure 9

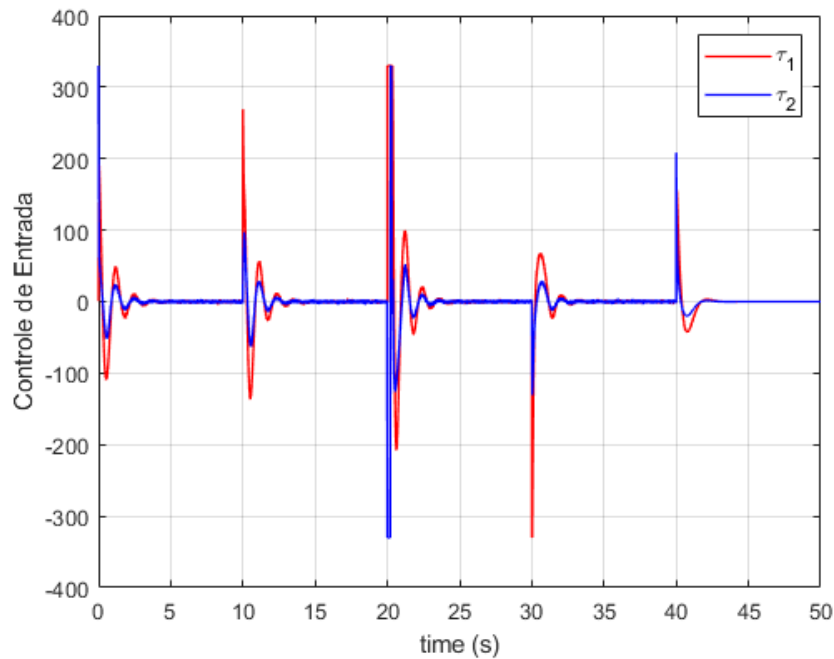
Trajectory tracking of the elbow joint



Source: Prepared by the authors.

Figure 10

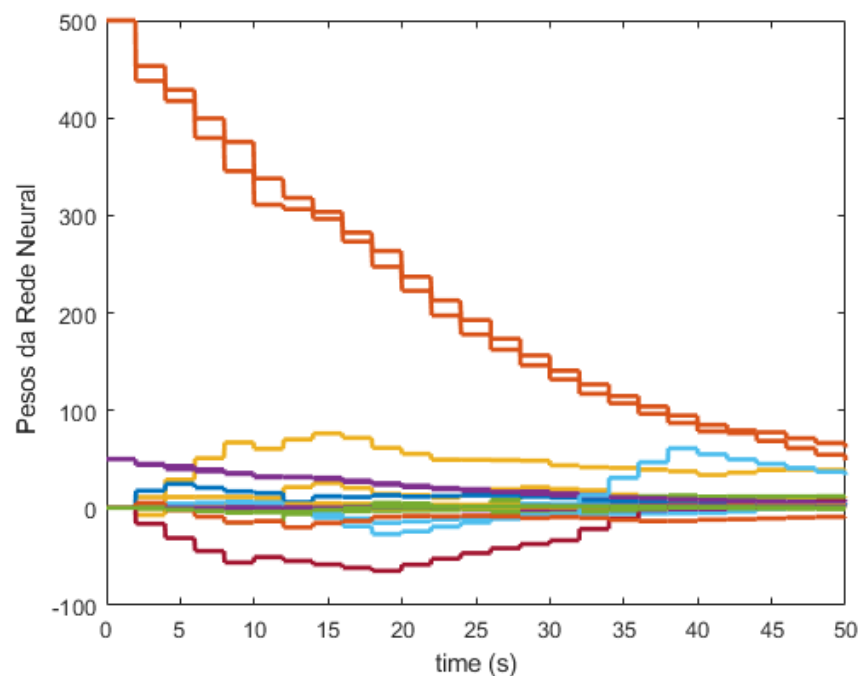
Control signal



Source: Prepared by the authors.

Figure 11

Actor network weight update



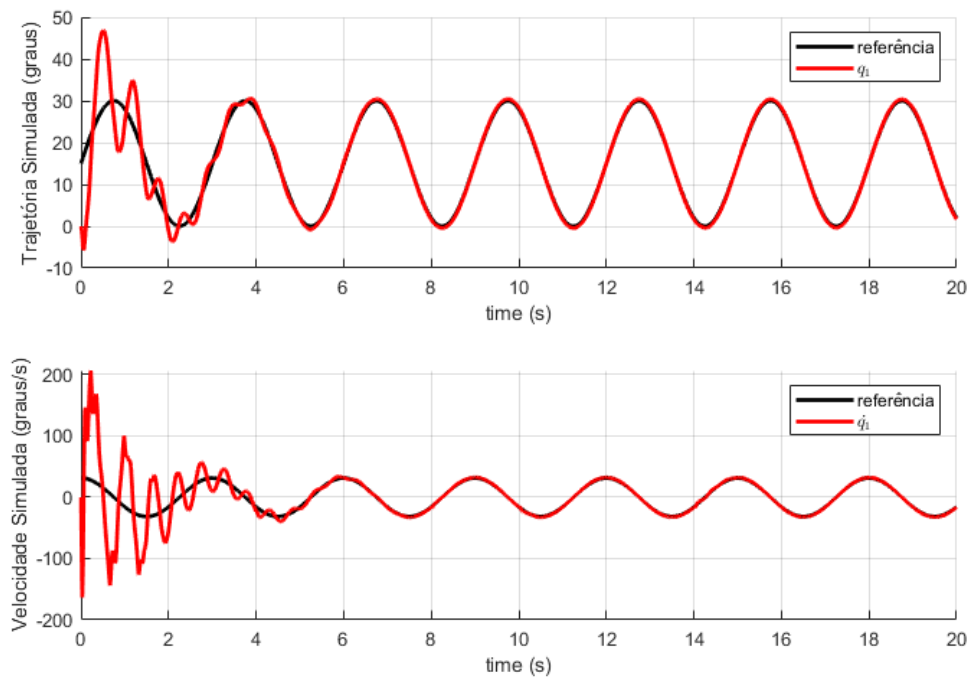
Source: Prepared by the authors.

In the last proposed experiment, a sinusoidal signal was established as a reference for the articulator joints under the following settings $Q_c = diag(200, 200, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)$, $K_{P_1} = 4000$, $K_{P_2} = 2000$, $K_{D_1} = 50$, $K_{D_2} = 20$ e $\alpha = 0,4$. The other parameters were set at the same

values as in experiment 2. The results of the simulation are observed in Figures 12 to 15. According to Figures 12 and 13, where the tracking performance is shown, it is observed that the trajectory following improves at the end of each learning cycle (2 s intervals). From the third cycle onwards, tracking errors stabilize within tolerable limits.

Figure 12

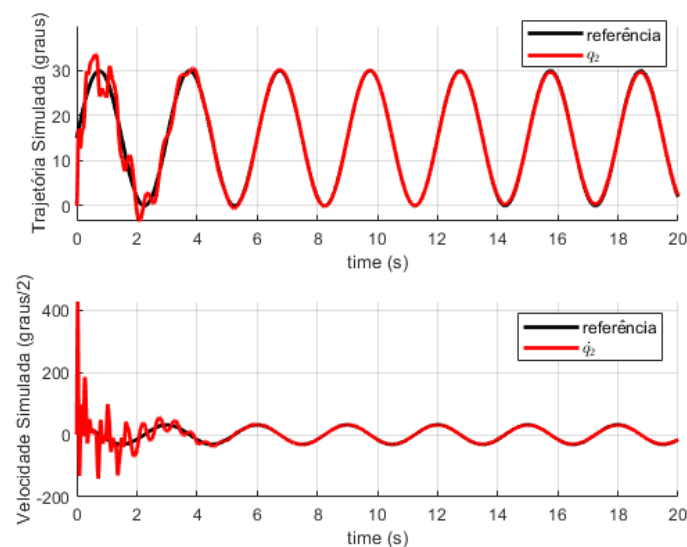
Trajectory tracking of the shoulder joint



Source: Prepared by the authors.

Figure 13

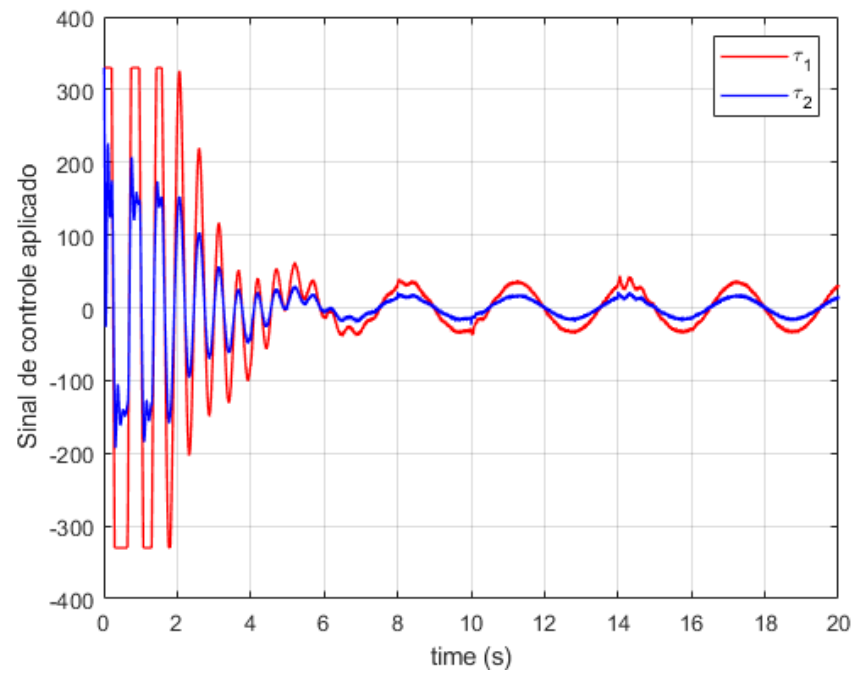
Trajectory tracking of the elbow joint



Source: Prepared by the authors.

Figure 14

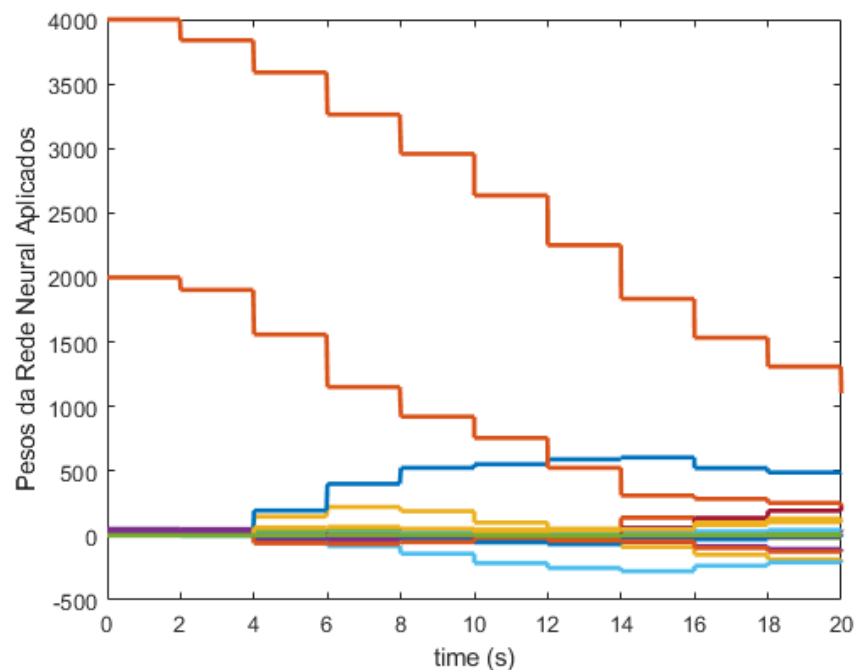
Control signal



Source: Prepared by the authors.

Figure 15

Actor network weight update



Source: Prepared by the authors.

7 CONCLUSION

In this work, a control scheme based on reinforcement learning applied to a robotic manipulator was proposed, using an actor-Critic approach. In this design, only one neural

network was trained to approximate the Q function using only the actual system measurements via the RLS estimator. In order to provide robustness to the scheme, the update of the control policy, obtained by minimizing the Q function, occurs at the end of a fixed number of iterations (learning cycle), remaining constant during this interval. To approximate the action-value function, a polynomial neural network was used, proving to be adequate to learn the nonlinearities of the manipulator. Computational experiments with the presented controller were carried out using the UR10 robot model in the V-REP simulator. The simulations included the task of regulating and tracking the trajectory of the sinusoidal and multi-step signals. In the simulated results, it was observed the stability of the state variables during the entire simulation time and the ability to track the reference signals, even without explicit knowledge of the manipulator dynamics.

ACKNOWLEDGMENTS

The present work was carried out with the support of the Dean of Research and Graduate Studies - PPG of the State University of Maranhão - UEMA.

REFERENCES

- Abbas, Z. (2018). Motion control of robotic arm manipulator using PID and sliding mode technique [Tese de doutorado, Capital University of Science and Technology].
- Al-Olimat, K. S., & Ghandakly, A. A. (2002). Multiple model reference adaptive control algorithm using on-line fuzzy logic adjustment and its application to robotic manipulators. In Conference Record of the 2002 IEEE Industry Applications Conference. 37th IAS Annual Meeting (pp. 1463–1466). IEEE.
- Alquadi, B., et al. (2016). Model reference adaptive impedance control for physical human-robot interaction. *Control Theory and Technology*, 14, 68–82.
- Bhatnagar, S., et al. (2009). Natural actor-critic algorithms. *Automatica*, 45(11), 2471–2482.
- Borase, R. P., et al. (2021). A review of PID control, tuning methods and applications. *International Journal of Dynamics and Control*, 9, 818–827.
- Cao, S., et al. (2023). Reinforcement learning-based fixed-time trajectory tracking control for uncertain robotic manipulators with input saturation. *IEEE Transactions on Neural Networks and Learning Systems*, 34(8), 4584–4595.
- Chen, L., Dai, S.-L., & Dong, C. (2024a). Adaptive optimal tracking control of an underactuated surface vessel using actor-critic reinforcement learning. *IEEE Transactions on Neural Networks and Learning Systems*, 35(6), 7520–7533.
- Chen, L., Dong, C., & Dai, S.-L. (2024b). Adaptive optimal consensus control of multiagent systems with unknown dynamics and disturbances via reinforcement learning. *IEEE Transactions on Artificial Intelligence*, 5(5), 2193–2203.

- Chen, W.-D. (2005). Experimental study of robot manipulators based on robust adaptive control. In *International Conference on Machine Learning and Cybernetics* (pp. 18–21).
- Clegg, A. C., Dunnigan, M. W., & Lane, D. M. (2001). Self-tuning position and force control of an underwater hydraulic manipulator. In *Proceedings 2001 ICRA. IEEE International Conference on Robotics and Automation* (pp. 3226–3231). IEEE.
- Craig, J. J. (2021). *Introduction to robotics: Mechanics and control* (4th ed., Global ed.). Pearson.
- Dubowsky, S., & Desforges, D. T. (1979). The application of model-referenced adaptive control to robotic manipulators. *Journal of Dynamic Systems, Measurement, and Control*, 101(3), 193–200.
- Fateh, S., & Fateh, M. M. (2019). Adaptive fuzzy control of robot manipulators with asymptotic tracking performance. *Journal of Control, Automation and Electrical Systems*, 31, 52–61.
- Ferreira, E. F. M., Rêgo, P. H. M., & Neto, J. V. F. (2017). Numerical stability improvements of state-value function approximations based on RLS learning for online HDP-DLQR control system design. *Engineering Applications of Artificial Intelligence*, 63, 1–19.
- Freire, E. O., Rossomando, F. G., & Soria, C. M. (2018). Self-tuning of a neuro-adaptive PID controller for a SCARA robot based on neural network. *IEEE Latin America Transactions*, 16(5), 1364–1374.
- Guo, X., Yan, W., & Cui, R. (2020). Reinforcement learning-based nearly optimal control for constrained-input partially unknown systems using differentiator. *IEEE Transactions on Neural Networks and Learning Systems*, 31(11), 4713–4725.
- He, W., et al. (2021). Reinforcement learning control of a flexible two-link manipulator: An experimental investigation. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, 51(12), 7326–7336.
- Hu, Q., Xu, L., & Zhang, A. (2012). Adaptive backstepping trajectory tracking control of robot manipulator. *Journal of the Franklin Institute*, 349(3), 1087–1105.
- Hu, Y., & Si, B. (2018). A reinforcement learning neural network for robotic manipulator control. *Neural Computation*, 30(7), 1983–2004.
- Jiang, Y., & Jiang, Z.-P. (2017). *Robust adaptive dynamic programming*. John Wiley & Sons.
- Kamboj, A., et al. (2020). Discrete-time Lyapunov based kinematic control of robot manipulator using actor-critic framework. In *2020 International Joint Conference on Neural Networks (IJCNN)* (pp. 1–7). IEEE.
- Khan, S. G., et al. (2011). A Q-learning based Cartesian model reference compliance controller implementation for a humanoid robot arm. In *2011 IEEE 5th International Conference on Robotics, Automation and Mechatronics (RAM)* (pp. 214–219). IEEE.
- Khan, S. G., et al. (2012). Reinforcement learning and optimal adaptive control: An overview and implementation examples. *Annual Reviews in Control*, 36(1), 42–59.
- Khan, S. G., et al. (2019). Reinforcement learning based compliance control of a robotic walk assist device. *Advanced Robotics*, 33(24), 1281–1292.
- Kiumarsi, B., et al. (2018). Optimal and autonomous control using reinforcement learning: A survey. *IEEE Transactions on Neural Networks and Learning Systems*, 29(6), 2042–2062.

- Konstantopoulos, G. C., & Baldivieso-Monasterios, P. R. (2020). State-limiting PID controller for a class of nonlinear systems with constant uncertainties. *International Journal of Robust and Nonlinear Control*, 30, 1770–1787.
- Maliotis, G. A. (1991). Hybrid model reference adaptive control/computed torque control scheme for robotic manipulators. *Proceedings of the Institution of Mechanical Engineers, Part I: Journal of Systems and Control Engineering*, 205(3), 215–221.
- Moosavi, S. K. R., Zafar, M. H., & Sanfilippo, F. (2022). Forward kinematic modelling with radial basis function neural network tuned with a novel meta-heuristic algorithm for robotic manipulators. *Robotics*, 11(2), 1–17.
- Pane, Y. P., et al. (2019). Reinforcement learning based compensation methods for robot manipulators. *Engineering Applications of Artificial Intelligence*, 78, 236–247.
- Pane, Y. P., Nagesh Rao, S. P., & Babuška, R. (2016). Actor-critic reinforcement learning for tracking control in robotics. In *2016 IEEE 55th Conference on Decision and Control (CDC)* (pp. 5819–5826). IEEE.
- Peters, J., & Schaal, S. (2008a). Learning to control in operational space. *International Journal of Robotics Research*, 27(2), 197–212.
- Peters, J., & Schaal, S. (2008b). Natural actor-critic. *Neurocomputing*, 71(7–9), 1180–1190.
- Pluškoski, A., Ciganović, I., & Jovanović, M. D. (2019). Benefits of residual networks in reinforcement learning using V-Rep simulator. In *6th International Conference IcETran* (pp. 1–6).
- Qi, R., Tao, G., & Jiang, B. (2019). Adaptive control: A tutorial introduction. In *Fuzzy system identification and adaptive control* (pp. 55–74). Springer.
- Quigley, M., Gerkey, B., & Smart, W. D. (2015). *Programming robots with ROS: A practical introduction to the robot operating system*. O'Reilly Media.
- Rohmer, E., Singh, S. P. N., & Freese, M. (2013). V-REP: A versatile and scalable robot simulation framework. In *IEEE/RSJ International Conference on Intelligent Robots and Systems*.
- Sasaki, M., et al. (2009). Self-tuning control of a two-link flexible manipulator using neural networks. In *2009 ICCAS-SICE* (pp. 2468–2473).
- Shah, H., & Gopal, M. (2009). Reinforcement learning control of robot manipulators in uncertain environments. In *IEEE International Conference on Industrial Technology* (pp. 1–6). IEEE.
- Shamshiri, R. R., et al. (2018). Robotic harvesting of fruiting vegetables: A simulation approach in V-REP, ROS and MATLAB. In *Automation in agriculture - Securing food supplies for future generations*. IntechOpen.
- Su, Y., et al. (2025). Fixed-time optimal trajectory tracking control for an unmanned surface vehicle via reinforcement learning. *IEEE/ASME Transactions on Mechatronics*, 1–12.
- Sun, N., et al. (2020). Adaptive control for pneumatic artificial muscle systems with parametric uncertainties and unidirectional input constraints. *IEEE Transactions on Industrial Informatics*, 16(2), 969–979.
- Sutton, R. S., & Barto, A. G. (2018). *Reinforcement learning: An introduction* (2nd ed.). MIT Press.

- Vrabie, D., Vamvoudakis, K. G., & Lewis, F. L. (2013). Optimal adaptive control and differential games by reinforcement learning principles. The Institution of Engineering and Technology.
- Wang, Z., et al. (2025). Adaptive altitude control for underwater vehicles based on deep reinforcement learning. In 2025 8th International Conference on Transportation Information and Safety (ICTIS) (pp. 79–84).
- Wu, L., Yan, Q., & Cai, J. (2019). Neural network-based adaptive learning control for robot manipulators with arbitrary initial errors. IEEE Access, 7, 180194–180204.
- Yaghmaie, F. A., Gustafsson, F., & Ljung, L. (2023). Linear quadratic control using model-free reinforcement learning. IEEE Transactions on Automatic Control, 68(2), 737–752.
- Yilmaz, B. M., et al. (2022). Self-adjusting fuzzy logic based control of robot manipulators in task space. IEEE Transactions on Industrial Electronics, 69(2), 1620–1629.
- Zhang, D., & Wei, B. (2017). Design, analysis and modelling of a hybrid controller for serial robotic manipulators. Robotica, 35(9), 1888–1905.
- Zhao, D., et al. (2025). Linear quadratic control of unknown nonlinear systems using model-free reinforcement learning. IEEE Transactions on Industrial Electronics, 72(12), 13751–13762.

SOUND POLLUTION IN THE FURNITURE INDUSTRY OF THE FEDERAL DISTRICT

POLUIÇÃO SONORA EM INDÚSTRIAS MADEIRO MOVELEIRAS DO DISTRITO FEDERAL

CONTAMINACIÓN ACÚSTICA EN LAS INDUSTRIAS MADERERAS Y DE MUEBLES DEL DISTRITO FEDERAL



<https://doi.org/10.56238/sevened2026.008-037>

Clarissa Melo Lima¹, Tito Ricardo Vaz da Costa², Alexandre Nascimento de Almeida³, Joaquim Carlos Gonçalves⁴

ABSTRACT

The paper presents an evaluation of sustainable practices in furniture industries through the analysis of their productive processes. Sound pollution was studied in two furniture wood industries of different sizes of the Federal District. Through measurements it was possible to measure the excessive noise emissions and compare them with the standards established by existing national and international Laws, Resolutions, Ordinances and Regulatory Technical Standards. Excess noise was observed in both industries at specific points. To control the problem, actions were suggested based on the good practices of sustainable projects.

Keywords: Sustainability. Furniture Industry. Noise.

RESUMO

O trabalho apresenta uma avaliação de práticas sustentáveis em indústrias moveleiras por meio da análise de seus processos produtivos. Foi estudada a poluição sonora em duas indústrias madeiro moveleira de diferentes portes do Distrito Federal. Por meio de medições foi possível aferir as emissões de ruído excessivo e compará-las com os padrões estabelecidos por Leis, Resoluções, Portarias e Normas Técnicas Regulamentadoras nacionais e internacionais existentes. Observou-se excesso de ruído em ambas as indústrias, em pontos específicos. Para controle do problema foram sugeridas ações com base nas boas práticas de projetos sustentáveis.

Palavras-chave: Sustentabilidade. Indústria Moveleira. Ruído.

¹ Dr. in Forest Sciences. Universidade Estadual de Goiás (UEG). E-mail: clarissa.lima@ueg.br
Orcid: <https://orcid.org/0000-0001-9940-8863> Lattes: <http://lattes.cnpq.br/6917886925634086>

² Dr. in Forest Sciences. Universidade Estadual de Goiás (UEG). E-mail: titoricardo@ueg.br
Orcid: <https://orcid.org/0000-0001-5827-7975> Lattes: <http://lattes.cnpq.br/1068744176859901>

³ Dr. in Forest Engineering. Universidade de Brasília (UnB). E-mail: alexalmeida@unb.br
Orcid: <https://orcid.org/0000-0002-9113-0729> Lattes: <http://lattes.cnpq.br/9028104786496275>

⁴ Dr. in Forest Sciences. Universidade de Brasília (UnB). E-mail: goncalvez@unb.br
Orcid: <https://orcid.org/0000-0003-1627-0833> Lattes: <http://lattes.cnpq.br/0220830488629637>

RESUMEN

El trabajo presenta una evaluación de prácticas sostenibles en industrias madereras mediante el análisis de sus procesos productivos. Se estudió la contaminación acústica en dos industrias madereras de diferentes tamaños del Distrito Federal. Mediante mediciones, fue posible evaluar las emisiones de ruido excesivo y compararlas con los estándares establecidos por las leyes, resoluciones, decretos y normas técnicas reguladoras nacionales e internacionales existentes. Se observó un exceso de ruido en ambas industrias, en puntos específicos. Para controlar el problema, se sugirieron acciones basadas en las buenas prácticas de proyectos sostenibles.

Palabras clave: Sostenibilidad. Industria del Mueble. Ruido.

1 INTRODUCTION

The last decades have been marked by an evolution in discussions on environmental issues, changing the world panorama in relation to the environment. Companies have been directly affected by these changes, given that the market is beginning to value products that minimally interfere with the environment, becoming as feared as the environmental agencies themselves and their respective inspection agents. (Mieli, 2007)

In the furniture sector, the concept of sustainable development has an additional weight. This industry, at a global level, was one of the most demanded in terms of environmental responsibility. During the 1990s there were boycotts by developed countries of tropical timbers. Later, this strategy evolved into the requirement of certification of responsible forest management. This certification, although not a legal obligation, has become a market requirement, leading several companies to seek to act in a more environmentally responsible way voluntarily. (Coutinho & Macedo-Soares, 2002) (Nardelli, 2001)

One of the ways to verify the sustainability of an industry is to analyze its production processes. This analysis may involve aspects related to existing physical and chemical risks. In this context, measurements of quantities related to pollution from the furniture industry can be considered fundamental in the production process. The presence of noise is one of the main factors of concern. Machinery used in industry can produce noise levels above the limits tolerable by humans. In this case, the use of personal protective equipment is a mandatory measure to avoid occupational sequelae. (Lima et al., 2016) (Filipe et al., 2014)

Continued exposure to high levels of sound pressure can cause noise-induced hearing loss and, consequently, cause effects on the individual's quality of life. The consequence resulting from a hearing loss is a psychosocial alteration characterized by isolation, stress, difficulties in family relationships, anxiety, sleep difficulty, decreased self-esteem and depression. (Holanda et al., 2011)

Occupational hearing loss represents an important public health problem due to its high prevalence in the most diverse industrial segments. stated that from the age of 50, male individuals have considerable hearing loss. (Alves & Fiorini, 2012) 8

NR 15 addresses the permitted noise limits depending on the worker's exposure time. In addition, it establishes that continuous or intermittent noise levels must be measured in decibels (dB) with a sound pressure level instrument operating in the compensation circuit "A", slow response circuit (SLOW) and with the readings captured close to the worker's ear. (Brazil, 1978)

Annex I of NR 15 reports that exposure to noise levels above 115 dB is not allowed for individuals who are not adequately protected. According to Annex I, activities or operations that expose workers to noise levels, continuous or intermittent, above 115 dB, without adequate protection, will offer serious and imminent risks. Standards for non-impact noise are also set out in Annex I. The same standard, in its annex II, establishes that impact noise has acoustic energy peaks of less than 1 (one) second at intervals greater than 1 (one) second and also according to Annex II the tolerance limit for impact noise will be 130 dB that can be done with the fast response reading (FAST) and when this limit is exceeded the risk is serious and imminent. (Brazil, 1978)

This paper addresses the concept of sustainable development related to environmental variables in the furniture industry. Two companies with different profiles were analyzed. An industry with a more common profile, representing the universe of small companies spread throughout Brazil, many even informal. Another medium-sized industry with the characteristic of working in a specialized and poorly verticalized way. It represents a smaller universe of companies that are dedicated to serving large corporate consumers and that combine different raw materials in the manufacture of their furniture. Both companies were monitored and evaluated for noise pollution caused by the production activity.

2 MATERIAL AND METHODS

The research was carried out in furniture industries in the Federal District (DF), in the administrative areas of Brasília and Águas Claras. These two areas have a population of more than 350 thousand inhabitants, equivalent to 12% of the Federal District. The region has an HDI of 0.824, considered high by Brazilian standards, and a GDP *per capita* of R\$ 62.8 thousand, the highest in the country. (GDF, 2017)

The first industry involved in the study (small company) has a production system tending to be artisanal. The second industry, considered medium-sized, has a production process with a good level of automation. The two types of industries represent around 90% of the establishments in this segment in the Federal District. For practical reasons, the industry with artisanal characteristics is called 'Industry 1' and the second, whose production process has a high level of automation, is called 'Industry 2'. (Garcia, 2007)

For the analysis of environmental pollution in the industries studied, a quantitative field research was developed. Noise measurements were performed. This data was obtained through captures at different work points in the industry, representing all work areas.

2.1 DATA COLLECTION OF ENVIRONMENTAL FACTORS

The assessment of exposure to a substance is carried out from an instrumental measurement followed by comparison of the result with the exposure limits. (DellaRosa & Colcaioppo, 1994)

Measurements were carried out at specific points in each of the industries. The locations chosen for the measurements represented areas involved in the production chain (

Table 1). Within these areas, random points were chosen.

Table 1

Description of the areas analyzed in the two industries

Area	Industry 1	Industry 2
1	Covered patio for the reception and storage of raw materials and finished products.	Covered patio for the assembly and finishing of products, the locksmith sector and the warehouse of raw materials and finished products. The machines in this area have an industrial scale, are automated and have a usage time of less than ten years.
2	Predominantly open-air region, intended for the storage of hardware and circulation of employees.	An open-air region for loading and unloading materials, with the circulation of trucks, a support mechanical workshop and silos for the storage of waste from the woodworking processes.
3	Covered patio where the company's carpentry and metalwork shop operates. In this place are arranged various machines, with a time of use of more than ten years, divided into benches.	Covered patio where the company's carpentry shop operates. In this place are arranged the machines of less sophistication to support production.

Source: Casella CEL. (2015)

The measurements carried out were analyzed through three levels of integration: companies, areas of the companies and measurement blocks.

The company represents the highest level of integration and includes all measurements carried out during the field campaign. The integration by 'area of the company' aimed to differentiate the physical spaces analyzed within each of the company. Measurement blocks correspond to a set of data collected at the same point in a work shift.

Random working days were chosen for data collection, between 8:00 a.m. and 6:00 p.m. (opening hours of the industries). The sampling rate of the measurements used was one capture per minute. The data collected were carried out over four months and totaled more than 271 uninterrupted hours, carried out at 77 different points, with an average of 179

measurements per point. In total, 16,298 measurements were taken, providing a sampling error of 0.55%, considering a normal distribution, a confidence level of 95% and $p=q=0.5$.

2.2 STATISTICAL DESIGN

The data were statistically analyzed using the IBM SPSS® software, where the following statistical variables were selected: mean, standard deviation, coefficient of variation and percentiles. The data were evaluated according to the hypotheses of the parametric tests. (Mendenhall & Sincich, 2006) (Field, 2009)

The means were evaluated using the t-test for a single sample. The percentiles were used as a parameter for identifying critical areas and equipment.

2.3 EQUIPMENT USED IN THE MEASUREMENTS

Sound pressure or noise measurements were made near the employee's auditory zone using the professional Sound Pressure Level meter CEL-35X. The equipment has sensitivity for capturing continuous noise in the range between 65 and 140.3 dB and for continuous or intermittent noise in the range between 95 and 143.3 dB. (Casella CEL, 2015)

Figure 1

Used noise measuring equipment



Source: Authors (2026)

3 RESULTS AND DISCUSSIONS

Table 1 presents the statistical summary of the sound pressure measurements carried out in Industries 1 and 2.

According to IEC 61252, for the measuring equipment used, the PicoC measurement corresponds to the peak sound pressure level in the instantaneous condition. The LAeq measurement considers continuous noise to a pattern of audible frequencies with a close response approximation to the human ear. To evaluate the measurements, the qualitative method provided for in Annex I of Regulatory Standard No. 15 (NR 15) of the Ministry of Labor was used. According to the Standard, noises in continuous regime must not exceed 85 dB and in instantaneous conditions cannot exceed 115 dB.

Table 2

Statistical summary of the measurements carried out in Industries 1 and 2

Parameter		Industry 1		Industry 2	
		PicoC	LAeq	PicoC	LAeq
N	Valid	1789	2084	4237	4830
	With error	6367	6072	3905	3312
Average		109,81	79,38	108,98	80,76
Median		108,90	77,80	107,40	81,80
Standard deviation		9,84	11,17	8,70	7,59
Percentile	25	101,20	69,70	102,70	76,00
	75	117,50	87,18	113,70	86,10

*Values in dB, with the exception of N, which corresponds to the number of measurements performed for the parameter.

Source: Authors (2026)

For continuous noise emissions (LAeq) in Industry 1, it can be seen that the median was below the limit of 85 dB, which means that most of the measurements carried out in the company did not identify transgression of the noise pollution limits established by NR 15. On the other hand, observing the 75th percentile, it is clear that there are more than 25% of valid measurements exceeding the noise pollution limit. It is observed that the 75th percentile for LAeq was 87 dB. Considering the *t*-test for one variable, it can be stated that, on average, continuous noise emissions in Industry 1 were 79.38 dB (below the limit of 85 dB of NR 15), with a standard error of ± 0.244 dB and a confidence interval of 95%. For peak noise emissions (PicoC), the median was also observed below the limit of 115 dB, indicating that most of the measurements proved the regularity of the installation regarding the emission of peak noise. However, the 75th percentile was 117.5 dB, above the limit established by NR 15. Thus, it was clear that at least 25% of the measurements presented problems in relation to the regular limits. Considering the *t*-test for one variable, it can be stated that, on average, peak noise emissions in Industry 1 were 109.81 dB (below the 115 dB limit of NR 15), with a standard error of ± 0.235 dB and a confidence interval of 95%.

Regarding Industry 2, for the measurement of continuous noise, we observed that the median (81.80 dB) was below the limit established by NR 15 (85 dB), indicating that most of the sources emitting noise operate within the acceptable range. However, as in Industry 1, the 75th percentile (86.1 dB) was above the tolerable limit, indicating that there are points of continuous noise emissions of concern. Considering the *t*-test for one variable, it can be stated that, on average, continuous noise emissions in Industry 2 were 80.76 dB (below the limit of 85 dB of NR 15), with a standard error of ± 0.109 dB, considering a confidence interval of 95%. Regarding peak noise, both the median (107.4 dB) and the 75th percentile (113.7 dB) were below the limit established by NR 15 (115 dB), which suggests less concern about

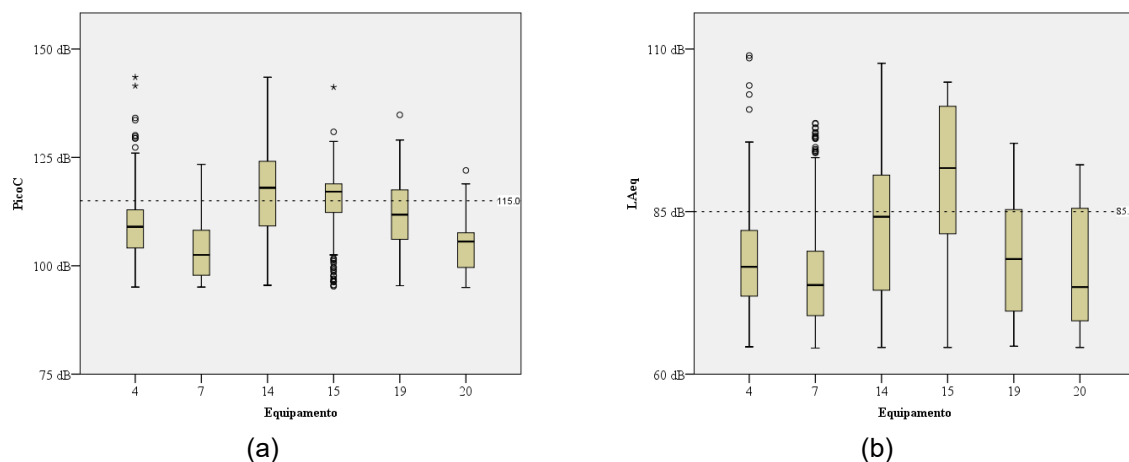
this type of emission for Industry 2. Considering the t-test for one variable, it can be stated that, on average, peak noise emissions in Industry 1 were 108.98 dB (below the limit of 115 dB of NR 15), with a standard error of ± 0.134 dB and a confidence interval of 95%.

Comparing the results between the companies analyzed, it is possible to notice a slightly higher performance of Industry 2, both in data homogeneity and performance, since the 75th percentile for peak noise was below the limits of NR 15. The machines used in Industry 2 are more modern when compared to Industry 1 and this may explain the observed performance. The detailed analysis of Industry 1 revealed the significant presence of noise-emitting sources above the tolerance limits in area 3, which contains equipment with more than ten years of use and where the company's carpentry and metalwork works. For both continuous and peak noise measurement, it observed the 75th percentile above tolerance limits. This means that there is a representative amount of problematic measurements.

At Figure 2 the numbers indicated on the ordinate axis correspond to the existing equipment in area 3 of Industry 1. Thus, for peak noise emissions, the equipment that presented significant measurements above the limits were the router, the circular saw and the lathe (equipment 14, 15 and 19 respectively). In the case of router, considering the test t for one variable, it can be stated that on average, peak noise emissions were 116.73 dB (above the 115 dB limit of NR 15), with a standard error of ± 0.454 dB, considering a confidence interval of 95%. Considering the continuous noises, it was observed that the circular saw (equipment 15) is the most critical equipment. The median for this equipment was well above the limit of 85 dB. Considering the test t for one variable, it can be stated that on average, the continuous noise emissions for the circular saw were 90.05 dB (above the limit of 85 dB of NR 15), with a standard error of ± 0.66 dB and a confidence interval of 95%. The router, the lathe and the drill (equipment 14, 19 and 20 respectively) also presented values above the limit, but in smaller quantities. For the other equipment analyzed (planer and thickness), no worrying measurements were identified.

Figure 2

Box and whisker diagram for peak (a) and continuous (b) sound pressure measurements in Industry 1 area 3 equipment



Source: Authors (2026)

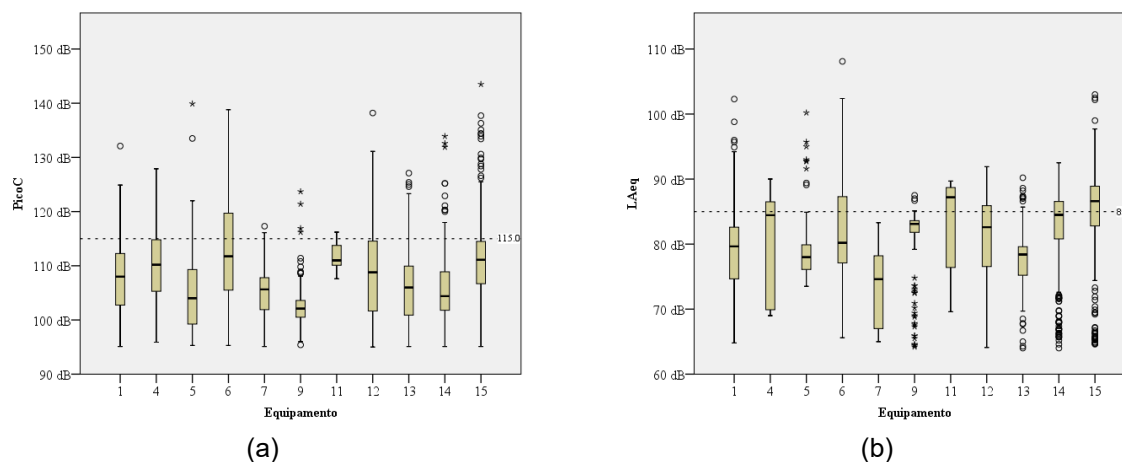
It is clear that router, circular saw, lathe and drill equipment must be operated with ear protection. Given the *layout* of the production plant, even the equipment adjacent to those identified as critical must be operated with this protection.

Regarding Industry 2, the detailed analysis revealed the significant presence of noise emitting sources above the tolerance limits in areas 1 and 3. For both continuous and peak noise measurement, the 75th percentile was observed above the tolerance limits. This means that there is a representative amount of problematic measurements.

Analyzing area 1 by sector, it is clear that only the 'process of washing metal parts' (point 6 of the Figure 3) exceeds peak noise limits in more than 25% of measurements. Considering the test t for one variable, it can be stated that, on average, the continuous noise emissions for the washing process of metal parts were 112.79 dB (below the limit of 115 dB of NR 15), with a standard error of ± 0.416 dB and a confidence interval of 95%. It is important to highlight that the analyzed process is positioned adjacent to the roll forming machine sector, which is significantly noisier than the washing process. It is possible to infer that the captures of peak noise above the limits are related to the profilers.

Figure 3

Enclosure and whisker diagram for peak (a) and continuous (b) sound pressure measurements on Industry 2 Area 1 equipment



Source: Authors (2026)

The continuous noise analysis in area 1 allows us to observe significant transgression of the limits in five sectors: metal packaging machine (point 4), washing machine (point 6), sliding table (point 11), gluing and assembly process (point 12), special cutting machine (point 14) and finished products packaging machine (point 15). In the 'squaring' and 'packaging of finished products' sectors, transgression was observed in more than 50% of the catches. Considering the *t*-test for one variable, it can be stated that, on average, only the finished products packaging machine presented measurements above the 85 dB limit of NR 15 and even then within the margin of error. The mean observed was 84.51 dB, with a standard error of ± 0.50 dB and a confidence interval of 95%.

In area 3, noise emissions above the limits were also captured. For peak noise, it was identified that the amount of captures above the limit of 115 dB was between the average and the 75% percentile. That is, between 25% and 50% of the catches breached the limit. For continuous noise, the median corresponding to the captures was above the limit of 85 dB. This means that most of the measurements infringed the limit.

The analysis of area 3 revealed that the process with peak noise emissions above the threshold is 'billet cutting'. In this case, the transgressions exceed the median line, that is, more than 50% of the catches made. Considering the continuous noise, three of the four sectors analyzed presented problems: routers, carpentry and billet cutting. In the case of carpentry, all measurements recorded transgression of the continuous noise limits.

The greater number of noisy sources can be explained by the larger size of Industry 2 in relation to Industry 1.

The results observed regarding excess noise have also been reported in similar studies carried out in furniture industries in Rio Grande do Sul and Rondônia. (Girardi & Sellitto, 2011) (Lopes et al., 2009)

4 CONCLUSIONS

It was possible to identify point sources of excessive noise emissions. It was observed that noise levels are associated with the intensity of productive activity, with the highest levels found in medium-sized industry. Equipment such as the router, circular saw, lathe and drill must be operated with ear protection, aided by individual protective covers on the equipment. Given the *layout* of the production plant, even equipment adjacent to those identified as critical must be operated with protection. In these cases, the intensive use of hearing protectors is recommended for all workers who work with this equipment.

REFERENCES

- Alves, A. S., & Fiorini, A. C. (2012). A autopercepção do handicap auditivo em trabalhadores de uma indústria têxtil. *Revista Distúrbios Da Comunicação*, 24(3), 337–349.
- Brasil. (1978). NR 15 - Atividades e operações insalubres (p. 82). Ministério do Trabalho.
- Casella CEL. (2015). CEL-35x dBadge - Users Manual (p. 43).
- Coutinho, R. B. G., & Macedo-Soares, T. D. L. v. A. (2002). Gestão estratégica com responsabilidade social: arcabouço analítico para auxiliar sua implementação em empresas no Brasil. *Revista de Administração Contemporânea*, 6(3), 75–96. <https://doi.org/10.1590/S1415-65552002000300005>
- DellaRosa, V. H., & Colcaioppo, S. (1994). A Contribuição da Higiene e da Toxicologia Ocupacional. In *Isto é trabalho de gente? Vida, doença e trabalho no Brasil*. (1st ed., pp. 232–270). Vozes.
- Field, A. ; (2009). Descobrimdo a Estatística usando o SPSS. In *Descobrimdo a Estatística usando o SPSS* (2nd ed.). Artmed.
- Filipe, A. P., Silva, J. R. M. da, Trugilho, P. F., Fiedler, N. C., Rabelo, G. F., & Botrel, D. A. (2014). Avaliação de ruído em fábricas de móveis. *CERNE*, 20(4), 551–556. <https://doi.org/10.1590/0104776020142004959>
- Garcia, J. R. (2007). Economic Development: Instruments of Support to Innovation in Brazilian Small Firms. *Revista Da FAE*, 10(2), 131–144.
- GDF. (2017). Relação de contatos das regiões administrativas. <http://www.sedhab.df.gov.br/relacao-de-contatos-das-regioes-administrativas.html>
- Girardi, G., & Sellitto, M. A. (2011). Medição e reconhecimento do risco físico ruído em uma empresa da indústria moveleira da serra gaúcha. *Estudos Tecnológicos Em Engenharia*, 7(1), 12–23. <https://doi.org/10.4013/ete.2011.71.02>
- Grandjean, E. (1986). *Fitting the Task to the Man: An Ergonomic Approach* (3rd ed.). Taylor & Francis.

- Holanda, W. T. G., Lima, M. L. C. de, & Figueiroa, J. N. (2011). Adaptação transcultural de um instrumento de avaliação do handicap auditivo para portadores de perda auditiva induzida pelo ruído ocupacional. *Ciência & Saúde Coletiva*, 16(suppl 1), 755–767. <https://doi.org/10.1590/S1413-81232011000700006>
- Lima, C. M., Gonzalez, J. C., Pereira, R. S., César, A., Brasil, D. M., Ricardo, T., Francisco, E., & Silva, F. (2016). Assesement of Environmental Risks Caused By Physical Agents In Charcoal Production Units. *Australian Journal of Basic and Applied Sciences*, 10(October), 160–166.
- Lopes, A. C., Santos, C. C., Alvarenga, K. de F., Feniman, M. R., Caldana, M. de L., Oliveira, A. N. de, Jorge, T. M., & Bastos, J. R. M. (2009). Alterações auditivas em trabalhadores de indústrias madeireiras do interior de Rondônia. *Revista Brasileira de Saúde Ocupacional*, 34(119), 88–92. <https://doi.org/10.1590/S0303-76572009000100010>
- Mendenhall, W., & Sincich, T. (2006). *Statistics for Engineering and the Sciences* (5th ed.). Pearson.
- Mieli, J. C. de A. (2007). *Sistemas de Avaliação Ambiental na Indústria de Papel e Celulose*. Universidade Federal de Viçosa.
- Nardelli, A. M. B. (2001). *Sistemas de certificação e visão de sustentabilidade no setor florestal brasileiro*. Universidade Federal de Viçosa.

BLACK WOMEN'S AGING AND NEUROPSYCHOPEDAGOGY: INTERSECTIONAL CHALLENGES AND STRATEGIES FOR QUALITY OF LIFE

ENVELHECIMENTO DA MULHER NEGRA E NEUROPSICOPEDAGOGIA: DESAFIOS INTERSECCIONAIS E ESTRATÉGIAS PARA A QUALIDADE DE VIDA

ENVEJECIMIENTO DE LA MUJER NEGRA Y NEUROPSICOPEDAGOGÍA: DESAFÍOS INTERSECCIONALES Y ESTRATEGIAS PARA LA CALIDAD DE VIDA



<https://doi.org/10.56238/sevened2026.008-038>

Cristiane Almeida Lisboa¹, Antonio Cordeiro de Souza Junior²

ABSTRACT

This article explores the accelerated aging of the Brazilian population, focusing on the challenges faced by Black women, a vulnerable group due to structural racism, gender inequality, and socioeconomic conditions. These women experience cumulative exclusion that affects their health, well-being, access to rights, and learning capacity. The objective is to analyze the relationship between the aging of Black women and the contributions of neuropsychopedagogy to promoting quality of life, autonomy, and learning in this group. To this end, a qualitative, descriptive, and analytical approach is used, grounded in bibliographical research. Thus, it is observed that neuropsychopedagogy emerges as an essential field, articulating knowledge from neuroscience, psychology, and pedagogy to understand aging as a dynamic and continuous learning process, valuing brain plasticity and sociocultural experiences. The study highlights the importance of neuropsychopedagogical interventions based on the valorization of these women's identity, culture, and traditional knowledge, promoting self-esteem, belonging, and social participation, despite access barriers such as socioeconomic inequalities and Eurocentric models. It is concluded that a critical and intersectional neuropsychopedagogy is crucial for promoting equity, dignity, and quality of life for Black women in old age, reaffirming learning as an inalienable right throughout life.

Keywords: Aging. Black Women. Neuropsychopedagogy. Intersectionality. Structural Racism.

RESUMO

O artigo explora o envelhecimento acelerado da população brasileira, focando nos desafios enfrentados por mulheres negras, um grupo vulnerável devido ao racismo estrutural, desigualdade de gênero e condições socioeconômicas. Essas mulheres vivenciam uma

¹ Doctoral student in Social Change and Public Policy. Universidade de São Paulo (USP). São Paulo, Brazil.
E-mail: munzyla@gmail.com Orcid: 0009-0000-3580-0399

² Doctoral student in Education. Universidade Tecnológica Intercontinental (UTIC). Asunción, Paraguay.
E-mail: antoniojunior3@gmail.com Orcid: 0009-0004-4817-9676

exclusão cumulativa que afeta sua saúde, bem-estar, acesso a direitos e capacidade de aprendizagem. Objetiva-se analisar a relação entre o envelhecimento das mulheres negras e as contribuições da neuropsicopedagogia para a promoção da qualidade de vida, autonomia e aprendizagem nesse grupo. Para tanto, procede-se a uma abordagem qualitativa, descritiva e analítica, fundamentada em pesquisa bibliográfica. Desse modo, observa-se que a neuropsicopedagogia emerge como campo essencial, articulando saberes da neurociência, psicologia e pedagogia para compreender o envelhecimento como um processo dinâmico e contínuo de aprendizagem, valorizando a plasticidade cerebral e as experiências socioculturais. O estudo destaca a importância de intervenções neuropsicopedagógicas pautadas na valorização da identidade, cultura e saberes tradicionais dessas mulheres, promovendo autoestima, pertencimento e participação social, apesar das barreiras de acesso como desigualdades socioeconômicas e modelos eurocêntricos. Conclui-se que uma neuropsicopedagogia crítica e interseccional é crucial para a promoção da equidade, dignidade e qualidade de vida das mulheres negras na velhice, reafirmando o aprendizado como um direito inalienável ao longo da vida.

Palavras-chave: Envelhecimento. Mulheres Negras. Neuropsicopedagogia. Interseccionalidade. Racismo Estrutural.

RESUMEN

Este artículo explora el envejecimiento acelerado de la población brasileña, centrándose en los desafíos que enfrentan las mujeres negras, un grupo vulnerable debido al racismo estructural, la desigualdad de género y las condiciones socioeconómicas. Estas mujeres experimentan una exclusión acumulativa que afecta su salud, bienestar, acceso a derechos y capacidad de aprendizaje. El objetivo es analizar la relación entre el envejecimiento de las mujeres negras y las contribuciones de la neuropsicopedagogía para promover la calidad de vida, la autonomía y el aprendizaje en este grupo. Para ello, se utiliza un enfoque cualitativo, descriptivo y analítico, fundamentado en la investigación bibliográfica. Así, se observa que la neuropsicopedagogía emerge como un campo esencial, articulando conocimientos de neurociencia, psicología y pedagogía para comprender el envejecimiento como un proceso dinámico y continuo de aprendizaje, valorando la plasticidad cerebral y las experiencias socioculturales. El estudio destaca la importancia de las intervenciones neuropsicopedagógicas basadas en la valorización de la identidad, cultura y saberes tradicionales de estas mujeres, promoviendo la autoestima, el sentido de pertenencia y la participación social, a pesar de las barreras de acceso como las desigualdades socioeconómicas y los modelos eurocéntricos. Se concluye que una neuropsicopedagogía crítica e interseccional es crucial para la promoción de la equidad, dignidad y calidad de vida de las mujeres negras en la vejez, reafirmando el aprendizaje como un derecho inalienable a lo largo de la vida.

Palabras clave: Envejecimiento. Mujeres Negras. Neuropsicopedagogía. Interseccionalidad. Racismo Estructural.

1 INTRODUCTION

Brazil is aging rapidly, which makes it urgent to reflect on the impact of this process on the lives of older people, especially vulnerable groups, such as black women. These women face specific challenges arising from a history of structural racism, gender inequality, and socioeconomic conditions that compromise their health, well-being, and access to fundamental rights (Barbosa; Oliveira; Oliveira, 2024; Benedito; Paiva, 2025). The focus of this study seeks to highlight the relevance of understanding the specificities of this group to promote social equity, autonomy and quality of life in old age.

The focus on black women is essential, as they suffer the effects of historical inequalities that directly affect the aging process, especially in the areas of health and education (Kalache et al., 2023). Understanding how these factors influence aging is also a way to contribute to the development of more inclusive and fair practices and policies, reinforcing the need for intersectional approaches in the Brazilian context (Ferreira; Leeson; Melhado, 2019).

The general objective of this article is to analyze the relationship between the aging of black women and strategies that can promote a higher quality of life, autonomy and learning. Specifically, it investigates the social and educational impacts that cross this group, discusses possibilities of intervention focused on their needs and reflects on practices that can favor their inclusion and appreciation in the stage of old age.

Changes in the age structure of the Brazilian population have imposed new challenges on public policies, educational practices, and fields of knowledge aimed at human development throughout the life course (Kalache et al., 2023). In this scenario, the aging of black women reveals itself as a phenomenon deeply crossed by structural inequalities, which cannot be understood only from a biological or chronological perspective. It is a process marked by cumulative experiences of social exclusion, structural racism, gender inequality, and limited access to rights, factors that directly affect the physical, emotional, and cognitive health of these women throughout their lives.

The life trajectories of black women in Brazil are historically marked by conditions of social vulnerability, early and precarious insertion in the labor market, less access to formal schooling, and continuous exposure to contexts of psychosocial stress (Barbosa; Oliveira; Oliveira, 2024; Benedito; Paiva, 2025). These elements produce significant impacts on the aging process, since the scientific literature points out that the experiences lived throughout the life cycle directly influence cognitive functioning, mental health, and learning capacity in old age. Thus, understanding the aging of this group requires a broader approach, capable of integrating social, cultural, emotional, and neurocognitive factors.

It is at this point that neuropsychopedagogy presents itself as a theoretical-practical field of great relevance for the analysis of the aging of black women, by articulating knowledge from neuroscience, psychology, and pedagogy (Fonseca, 2018; Bossa, 2019). By articulating knowledge from neuroscience, psychology and pedagogy, neuropsychopedagogy offers tools to understand how the brain learns, adapts and transforms throughout life, including in old age. This approach breaks with reductionist conceptions that associate aging only with loss or decline, recognizing brain plasticity and the continuous possibilities of learning, resignification, and human development.

From the neuropsychopedagogical point of view, aging should be understood as a dynamic process, influenced both by biological factors and by the sociocultural experiences accumulated throughout life (Rotta; Ohlweiler; Riesgo, 2016). In the case of black women, these experiences are crossed by discriminatory practices that impact self-esteem, identity, access to knowledge, and social participation. Such factors can have repercussions on cognitive, emotional, and educational difficulties in old age, not as a natural result of aging, but as a consequence of trajectories marked by inequality.

Neuropsychopedagogy, by adopting an intersectional perspective, contributes to the understanding of how structural racism and gender inequality affect learning processes and cognitive functioning throughout the life course (Ferreira; Leeson; Melhado, 2019; Hooks, 2005). This approach allows us to analyze, for example, how chronic stress resulting from contexts of exclusion can impact executive functions, memory, attention, and emotional health, fundamental aspects for autonomy and quality of life in old age. In addition, it recognizes that the knowledge built outside the formal spaces of schooling also constitute important forms of learning and should be valued in educational practices aimed at the elderly.

In this sense, neuropsychopedagogical action with elderly black women should be guided by practices that promote cognitive strengthening, the stimulation of lifelong learning, and the appreciation of the identity and history of these women (Freire, 2005; Mbembe, 2018). Interventions that consider their experiences, cultures, memories, and traditional knowledge contribute not only to cognitive development, but also to the strengthening of self-esteem, a sense of belonging, and social participation. Learning, in this context, takes on an emancipatory character, capable of breaking with narratives of invisibility and marginalization associated with old age and blackness.

In addition, neuropsychopedagogy offers important subsidies for the construction of inclusive and anti-racist educational practices, especially in formal and non-formal education spaces for the elderly. By recognizing the singularities of black women, this field contributes

to the development of strategies that respect learning rhythms, promote cognitive stimulation, and favor functional autonomy. Such practices are fundamental for active aging, understood not only as maintenance of physical health, but as social participation, access to knowledge and full exercise of citizenship.

Therefore, establishing a dialogue between the aging of black women and neuropsychopedagogy implies recognizing that old age is a stage of life permeated by possibilities of learning, reconstruction of meanings and appreciation of historically silenced trajectories. By integrating a critical, intersectional perspective committed to social justice, neuropsychopedagogy consolidates itself as a strategic field for the promotion of equity, dignity and quality of life of black women in old age, contributing to the construction of a more inclusive and socially just society.

1.1 JUSTIFICATION

Aging is a process marked by biological, cognitive and social transformations, which manifest themselves differently in different population groups. In the case of black women, the impact of structural racism, social inequalities, and gender stereotypes amplifies the challenges faced during old age, affecting both integral health and the possibilities of autonomy and lifelong learning. In this context, neuropsychopedagogy emerges as a significant area of intervention, considering brain plasticity and the interaction between cognitive, emotional and educational processes. Aligning these factors with the understanding of the historical, social, and cultural specificities of elderly black women is essential to build more equitable practices, promoting quality of life and resignification of aging. This article thus seeks to contribute to the scientific debate and to the formulation of inclusive and intersectional strategies in the educational and neuropsychopedagogical field.

1.2 OBJECTIVES

1.2.1 General objective

To analyze the relationship between the aging of black women and the contributions of neuropsychopedagogy to promote learning, autonomy and quality of life.

1.2.2 Specific objectives

- To investigate the social, cultural and educational impacts on the aging experience of black women.
- To discuss the possibilities of applying neuropsychopedagogy in the support of aging, considering the specificities of this population.

- To relate educational and neuropsychological practices to the promotion of integral health and well-being in old age.

2 THEORETICAL FRAMEWORK

This section establishes the conceptual and theoretical bases that support the analysis of the aging of black women and the contribution of neuropsychopedagogy to the promotion of their quality of life. It addresses aging from a multidimensional perspective, the role of intersectionality in the experience of the elderly black woman and the foundations of neuropsychopedagogy as a field of support for continuous learning.

2.1 MULTIDIMENSIONAL AGING AND NEURAL PLASTICITY

Aging is a complex biopsychosocial process (De Beauvoir, 2024), which involves biological transformations, such as changes in the nervous system (Cepellos, 2021), but which is not restricted to a decline. Contemporary research emphasizes neural plasticity, that is, the brain's ability to adapt and reorganize functionally throughout life (Lent, 2010), breaking with deficient views of old age (Baltes; Baltes, 1990). From a psychological point of view, aging also manifests itself in resilience and the search for new learning and meaningful activities (Couto et al., 2021; Lopes et al., 2023). Socially, the experience of aging is profoundly influenced by factors such as class, education and access to rights, which determine the well-being of the elderly (Ferreira; Leeson; Melhado, 2019; IBGE, 2023).

2.2 INTERSECTIONALITY AND THE EXPERIENCE OF BLACK WOMEN IN OLD AGE

Understanding the aging of black women in Brazil requires the application of intersectionality (Akotirene, 2019), an analytical tool that demonstrates how social markers such as race, gender, class, and age are interconnected and reinforce inequalities. Black women experience a unique aging, intensified by structural racism and sexism (Carneiro, 2011; Werneck, 2016), which translate into health challenges, such as chronic stress and a higher risk of disease (Martins; Lima; Santos, 2020; Oraka et al., 2020), and in socioeconomic and educational inequalities (Barbosa; Oliveira; Oliveira, 2024; Almeida; Silva, 2017). The precariousness of professional trajectories (Cacciamali; Hirata, 2005) results in greater vulnerability in old age (Ceccon et al., 2021). However, intersectionality also highlights the resignification of old age and the strengthening of identity through support networks and cultural appreciation, such as Afro-Latin American feminism (Lopes et al., 2023; Gonzalez, 2020). Lélia Gonzalez (1984) and Bell hooks (2005; 2013) underline the importance of recognizing the knowledge and experiences of black women as legitimate forms of

knowledge and resistance.

2.3 NEUROPSYCHOPEDAGOGY AND CONTINUOUS LEARNING IN OLD AGE NEUROPSYCHOPEDAGOGY

It is an interdisciplinary field that articulates knowledge from neuroscience, psychology, and pedagogy (Fonseca, 2018; Bossa, 2019) to understand human learning in an integral and contextualized way (Delors, 1998; Japiassu, 2006). Based on neuroscience, it recognizes neural plasticity as the capacity for learning and brain reorganization at any age (Lent, 2010; Kandel et al., 2014), overcoming the idea of cognitive decline inherent to old age. From psychology, it incorporates historical-cultural approaches (Vygotsky, 2007; Bruner, 2001) who see learning as a socially mediated process, and the subjective dimension (González Rey, 2005) that integrates cognition and affectivity. Pedagogically, it is aligned with critical approaches that value previous knowledge and life experiences (Freire, 2005; Charlot, 2000), promoting cognitive strengthening and social participation. Neri (2013) and Neri and Yassuda (2014) highlight the importance of cognitive and social stimulation for integral health in old age. Neuropsychopedagogy, therefore, is positioned as a strategic field for the promotion of continuous learning, dignity and equity in old age, especially for black women.

3 METHODOLOGY

The study adopts a qualitative approach, of a descriptive and analytical nature, based on bibliographic and documentary research. The methodological objective is to understand how historical, social, cultural, and educational factors impact the aging of black women, influencing their learning processes, cognitive development, autonomy, and integral health. The literature was selected from academic databases, using descriptors related to the topics addressed, focusing on recent studies of relevance to the Brazilian context. The analysis focused on existing works and studies in the scientific literature, seeking to highlight the relationships between racial identity, contexts of vulnerability, educational practices and neuropsychopedagogical dimensions. As this is a bibliographic research, ethical considerations were ensured by the correct citation of the sources. However, the time frame and the exclusivity of the documentary base used are recognized as a limitation, which may not exhaust the totality of scientific production on the subject.

4 RESULTS AND DISCUSSIONS

4.1 THE AGING OF BLACK WOMEN: AN INTERSECTIONAL ANALYSIS OF CHALLENGES

The bibliographic research reveals that the aging of black women in Brazil is a phenomenon crossed by multiple dimensions of inequality, configuring a singular and cumulative experience of exclusion. As pointed out in the literature, structural racism and sexism act in combination, directly impacting the physical and mental health, as well as the social and educational opportunities of these women (Carneiro, 2011; Werneck, 2016). Findings indicate that chronic exposure to gender-based racial microaggressions generates significant stress, associated with higher risks of hypertension, diabetes, and depression (Martins; Lima; Santos, 2020; Oraka et al., 2020).

This reality is also manifested in unequal access to essential services. The literature shows that geographical and financial barriers and institutional prejudices limit black women's access to quality health and education services (Barbosa; Oliveira; Oliveira, 2024; Benedito; Paiva, 2025; Almeida; Silva, 2017). Professional trajectories, often marked by precariousness and low salaries (Cacciamali; Hirata, 2005), culminate in insufficient pensions and greater vulnerability and dependence in old age (Ceccon et al., 2021). These data reinforce the need for an intersectional reading, as proposed by Akotirene (2019), to understand the complexity of accumulated disadvantages.

Despite the challenges, the review demonstrates that many black women find ways to resignify old age and strengthen their identity. Support networks, whether family, community, or religious, emerge as a fundamental pillar for well-being and mental health (Lopes et al., 2023). In addition, the appreciation of Afro-Brazilian culture and history, often driven by Afro-Latin American feminism (Gonzalez, 2020), acts as a powerful instrument of empowerment, allowing the construction of narratives that celebrate historical and everyday figures of resistance. Bell hooks (2005; 2013) complements this view by highlighting how education and the recognition of lived experiences are crucial for the construction of dignity.

4.2 CONTRIBUTIONS OF NEUROPSYCHOPEDAGOGY TO QUALITY OF LIFE AND LEARNING

The analysis of the literature highlights the relevance of neuropsychopedagogy as a strategic field to address the aging of black women, offering a perspective that breaks with the view of decline inherent to age. Neuropsychopedagogy, by articulating knowledge from neuroscience, psychology and pedagogy (Fonseca, 2018; Bossa, 2019), understands aging as a dynamic and continuous learning process. This field values brain plasticity (Lent, 2010), arguing that the brain maintains a significant capacity for adaptation and functional

reorganization throughout life, which opens up continuous possibilities for cognitive and emotional development (Kandel et al., 2014; Neri, 2013).

The studies analyzed indicate that neuropsychopedagogical interventions, when based on a critical and intersectional approach, can promote cognitive strengthening and stimulate lifelong learning. They should consider the experiences, cultures, memories and traditional knowledge of these women, as defended by Freire (2005) and Charlot (2000), contributing not only to cognitive development, but also to the strengthening of self-esteem, a sense of belonging and social participation. Learning, in this context, acquires an emancipatory character, capable of challenging narratives of invisibility and marginalization associated with old age and blackness.

Neuropsychopedagogy, by recognizing the singularities of black women, offers subsidies for the construction of inclusive and anti-racist educational practices. By considering how structural racism and gender inequality affect learning processes and cognitive functioning (Ferreira; Leeson; Melhado, 2019), this approach allows strategies that respect learning rhythms, promote cognitive stimulation and favor functional autonomy, as recommended by Neri and Yassuda (2014). Such practices are fundamental for active aging, which goes beyond physical health to include social participation and the full exercise of citizenship.

4.3 CHALLENGES AND PROPOSALS FOR INCLUSIVE NEUROPSYCHOPEDAGOGICAL INTERVENTIONS

Despite the potential of neuropsychopedagogy, the research highlights significant barriers to access for older black women. The concentration of specialized services in private spaces and the hegemony of Eurocentric and normative models in evaluations and interventions tend to disregard the experiences and knowledge of the black population, reproducing logics of exclusion (Almeida, 2019; Carneiro, 2005). The absence of professional training that incorporates discussions on structural racism and intersectionality, as suggested by bell hooks (2013), limits the ability of neuropsychopedagogues to act in a truly inclusive way.

In the face of these challenges, the literature points to the need for advances and concrete proposals. A critical review of the epistemological foundations of neuropsychopedagogy is crucial, overcoming deficient approaches and recognizing elderly black women as producers of knowledge (Gonzalez, 1984; Carneiro, 2005). The systematic incorporation of intersectionality into evaluation and intervention practices is indispensable, guiding not only professional actions, but also public policies (Akotirene, 2019).

Proposals include the creation and strengthening of social programs that value the identity and culture of black women, with activities such as conversation circles and memory circles (Lopes; Ribeiro; Oliveira, 2023), and public policies that promote active aging and educational inclusion, with a focus on intersectional care (Benedito; Paiva, 2025; Werneck, 2016). Fostering actions that combine educational inclusion with the rescue of traditional knowledge, transforming them into active agents, is essential to promote equity, dignity and mutual respect.

5 CONCLUSION

The theoretical-analytical path developed in this article shows that the aging of black women in Brazil cannot be understood as a homogeneous, linear or strictly biological process. It is a socially constructed experience, marked by multiple nuances that result from the historical articulation between race, gender, class and age. These dimensions operate in an interdependent way, producing structural inequalities that accumulate throughout the course of life and are expressed in an intensified way in old age. Structural racism, sexism, and ageism, when acting together, configure unequal conditions of access to education, health, work, and public policies, directly impacting the autonomy, learning, and quality of life of elderly black women.

Throughout the text, it was demonstrated that the life trajectories of these women are crossed by historical processes of exclusion that are not restricted to the material dimension, but produce profound symbolic, subjective and cognitive effects. The devaluation of their knowledge, the invisibility of their stories and the denial of social recognition constitute forms of violence that affect emotional health and learning processes in old age. Understanding these dynamics requires sensitivity to the nuances that differentiate the experiences of black female aging, avoiding generalizations that obscure the complexity of individual and collective experiences.

In this scenario, neuropsychopedagogy presents itself as a theoretical-practical field of special relevance, as it enables a broader reading of aging, based on the articulation between neuroscience, psychology and pedagogy. By recognizing neural plasticity throughout the life cycle and learning as a continuous, historically situated and socially mediated process, neuropsychopedagogy breaks with reductionist conceptions that associate old age exclusively with cognitive decline. Such an approach allows us to capture the nuances of learning processes in old age, considering not only neurobiological aspects, but also the social, cultural and emotional conditions that cross the trajectories of black women.

In the specific case of older black women, the incorporation of an intersectional perspective becomes indispensable to understand how educational inequalities, limited access to formal schooling, and continuous exposure to contexts of psychosocial stress impact cognitive functioning and learning possibilities. These experiences, marked by multiple nuances throughout life, cannot be interpreted as individual deficits, but as cumulative effects of unequal social structures. Critical neuropsychopedagogy, by recognizing such determinations, contributes to the construction of educational practices that respect the rhythms, cultural repertoires and singularities of these women.

The reflections developed also show that inclusive neuropsychopedagogical practices assume a fundamental ethical and political dimension. By valuing autobiographical memory, orality, ancestry, and knowledge built outside the formal spaces of schooling, such practices recognize elderly black women as knowing subjects and producers of knowledge. This recognition allows us to apprehend the nuances of knowledge built along trajectories marked by resistance, strengthening self-esteem, a sense of belonging and social participation. Learning, in this context, acquires an emancipatory character, articulating cognitive development, identity recognition and full exercise of citizenship.

In the context of public policies, the study points to the need for approaches that consider the nuances of the aging of black women, overcoming generic and disjointed actions. Although there are important legal frameworks in addressing racial and gender inequalities, their effectiveness depends on the incorporation of an intersectional reading that recognizes the specificities of this group throughout the course of life. Education, health, and social assistance policies need to be thought of in an integrated way, ensuring equitable access to cognitive care practices, lifelong learning, and social participation in old age.

Another central aspect refers to the training of professionals who work in the fields of education, health and neuropsychopedagogy. The absence of a critical and anti-racist education compromises the ability to understand the nuances that go through the learning processes in old age and can result in the reproduction of exclusionary practices. Investing in training curricula that incorporate discussions on structural racism, intersectionality, aging, and black epistemologies is a fundamental step towards the consolidation of professional practices committed to equity and social justice.

In view of the above, it is concluded that the articulation between the aging of black women and neuropsychopedagogy significantly expands the understanding of old age, by evidencing its multiple nuances and potentialities. By reaffirming old age as a legitimate stage of learning, production of meanings and appreciation of historically silenced trajectories, this study contributes to the construction of educational practices and public policies that

recognize elderly black women as historical subjects, knowing and holders of socially relevant knowledge. It is, therefore, a matter of affirming a conception of aging committed to human dignity, social justice and the right to learning throughout the course of life.

REFERENCES

- Akotirene, C. (2019). Interseccionalidade. Pólen.
- Almeida, C. B. de, & Silva, M. G. da. (2017). A história da educação dos negros no Brasil. *Revista de História e Historiografia da Educação*, 1, 276. <https://doi.org/10.5380/rhhe.v1i0.53535>
- Almeida, S. L. (2019). Racismo estrutural. Sueli Carneiro; Pólen.
- Baltes, P. B., & Baltes, M. M. (Eds.). (1990). *Successful aging: Perspectives from the behavioral sciences*. Cambridge University Press.
- Barbosa, A. C., Oliveira, S. S., & Oliveira, R. de G. (2024). Vulnerabilidades mediando o encontro do cuidado em saúde: Por uma agência interseccional. *Ciência & Saúde Coletiva*, 29(7), 10. <https://doi.org/10.1590/1413-81232024297.04352024>
- Bello, L. (2013). Jovens negros e ensino superior no Brasil: Desvantagens no acesso e o processo de resiliência. *Identidade*, 18(2), 15.
- Benedito, J. de C., & Paiva, S. de O. C. e. (2025). Envelhecimento dos/as trabalhadores/as negros/as em contexto de desigualdades sociais e étnico-raciais: Uma contribuição teórica à luta pelos direitos humanos. *Serviço Social em Revista*, 34(2), 21. <https://periodicos.franca.unesp.br/index.php/SSR/article/view/5161>
- Bossa, N. A. (2019). A psicopedagogia no Brasil: Contribuições a partir da prática. *Artmed*.
- Bruner, J. S. (2001). A cultura da educação. *Artmed*.
- Cabral, S. M., et al. (2024). Black women in the labor market: Case study in vale do sinos/rs, brazil. *Boletim de Conjuntura (BOCA)*, 17(51), 379–404. <https://doi.org/10.5281/zenodo.10909321>
- Cacciamali, M. C., & Hirata, G. I. (2005). A influência da raça e do gênero nas oportunidades de obtenção de renda - uma análise da discriminação em mercados de trabalho distintos: Bahia e São Paulo. *Estudos Econômicos (São Paulo)*, 35(4), 767–795. <https://doi.org/10.1590/s0101-41612005000400007>
- Carneiro, S. (2011). Racismo, sexismo e desigualdade no Brasil. Selo Negro Edições.
- Carneiro, S. (2005). A construção do outro como não-ser como fundamento do ser [Tese de doutorado, Universidade de São Paulo].
- Carolino, A. R., Ferreira, C. A. A., & Teodósio, A. dos S. de S. (2023). Políticas afirmativas: Acesso ao ensino superior por estudantes negros no Brasil. *Revista Ciências Administrativas*, 29, 1–14. <https://doi.org/10.5020/2318-0722.2023.29.e13692>
- Ceccon, R. F., et al. (2021). Envelhecimento e dependência no Brasil: Características sociodemográficas e assistenciais de idosos e cuidadores. *Ciência & Saúde Coletiva*, 26(1), 17–26. <https://doi.org/10.1590/1413-81232020261.30352020>
- Cepellos, V. M. (2021). Feminização do envelhecimento: Um fenômeno multifacetado muito além dos números. *Revista de Administração de Empresas*, 61(2).

<https://doi.org/10.1590/s0034-759020210208>

- Charlot, B. (2000). Da relação com o saber: Elementos para uma teoria. Artmed.
- Couto, R. N., et al. (2021). Crescimento pós-traumático após divórcio: Contribuição dos valores para além das variáveis demográficas. *Psicologia: Teoria e Pesquisa*, 37. <https://doi.org/10.1590/0102.3772e375147>
- Damasio, A. (2011). O erro de Descartes: Emoção, razão e o cérebro humano. Companhia das Letras.
- De Beauvoir, S. (2024). A velhice (4a ed.). Nova Fronteira.
- Delors, J. (1998). Educação: Um tesouro a descobrir. Cortez; UNESCO.
- Ferreira, J. P., Leeson, G., & Melhado, V. R. (2019). Cartografias do envelhecimento em contexto rural: Notas sobre raça/etnia, gênero, classe e escolaridade. *Trabalho, Educação e Saúde*, 17(1). <https://doi.org/10.1590/1981-7746-sol00176>
- Fonseca, V. da. (2018). Psicopedagogia e neuropsicopedagogia: Fundamentos e práticas. Artmed.
- Freitas, G. L. T., Santos, J. da C., & Jacinto, P. M. dos S. (2022). Insertion of black women in the world of work: A literature review. *Boletim de Conjuntura (BOCA)*, 9(26), 47–63. <https://doi.org/10.5281/zenodo.5933302>
- Freire, P. (2005). Pedagogia do oprimido (42a ed.). Paz e Terra.
- Gesser, R., & Costa, C. L. J. (2018). Menina mulher negra: Construção de identidade e o conflito diante de uma sociedade que não a representa. *Revista Brasileira de Psicodrama*, 26(1). <https://doi.org/10.15329/2318-0498.20180010>
- Gonzales, L. (1984). Racismo e sexismo na cultura brasileira. *Revista Ciências Sociais Hoje*, 1–20. https://bibliotecadigital.mdh.gov.br/jspui/bitstream/192/10316/1/06_GONZALES__Lélia_Racismo_e_Sexismo_na_Cultura_Brasileira__1.pdf
- Gonzalez, L. (2020). Por um feminismo afro-latino-americano (B. Cruz et al., Trad.). Zahar. (Original publicado em 1988)
- Hooks, b. (2005). Intelectuais negras. *Revista Estudos Feministas*, 3(2), 464–478.
- Hooks, b. (2013). Ensinando a transgredir: A educação como prática da liberdade. WMF Martins Fontes.
- Hooks, b. (2019). Tudo sobre o amor: Novas perspectivas. Elefante.
- Instituto Brasileiro de Geografia e Estatística. (2023). Síntese de indicadores sociais. <https://www.ibge.gov.br/estatisticas/sociais/trabalho/9221-sintese-de-indicadores-sociais.html?edicao=38475&t=resultados>
- Japiassu, H. (2006). Interdisciplinaridade e patologia do saber (5a ed.). Imago.
- Kalache, A., et al. (2023). Envelhecimento, velhices e interseccionalidades. *Revista Brasileira de Geriatria e Gerontologia*, 26. <https://doi.org/10.1590/1981-22562023026.230249.pt>
- Kandel, E. R., Schwartz, J. H., & Jessell, T. M. (2014). Princípios de neurociência. AMGH.
- Lage, M. L. da C., & Souza, E. M. de. (2017). Da cabeça aos pés: Racismo e sexismo no ambiente organizacional. *Revista de Gestão Social e Ambiental*, 55. <https://doi.org/10.24857/rgsa.v0i0.1378>

- Lent, R. (2010). Cem bilhões de neurônios? Conceitos fundamentais de neurociência. Atheneu.
- Lopes, R. L. B., Ribeiro, L. C., & Oliveira, D. M. de. (2023). A saúde promovida por redes sociais e comunitárias de mulheres de baixa renda. *Cadernos de Saúde Pública*, 39(7). <https://doi.org/10.1590/0102-311xpt218022>
- Lorde, A. (2020). I am your sister. In *Feminist theory reader* (5th ed., pp. 216–219). Routledge. <https://doi.org/10.4324/9781003001201-27>
- Machado, M. N. da M. (2006). Os escritos de Carolina Maria de Jesus: Determinações e imaginário. *Psicologia & Sociedade*, 18(2), 105–110. <https://doi.org/10.1590/s0102-71822006000200014>
- Mbembe, A. (2018). *Crítica da razão negra*. n-1 edições.
- Martins, T. V., Lima, T. J. S. de, & Santos, W. S. (2020). O efeito das microagressões raciais de gênero na saúde mental de mulheres negras. *Ciência & Saúde Coletiva*, 25(7), 2793–2802. <https://doi.org/10.1590/1413-81232020257.29182018>
- Ministério do Desenvolvimento, Indústria, Comércio e Serviços; Ministério do Empreendedorismo, da Microempresa e da Empresa de Pequeno Porte; Programa das Nações Unidas para o Desenvolvimento. (2024). *Panorama do empreendedorismo feminino no Brasil*. <https://www.gov.br/empresas-e-negocios/pt-br/empreendedor/elas-empreendem/panorama-do-empreendedorismo-feminino-no-brasil/estudo-do-empreendedorismo-feminino.pdf>
- Neri, A. L., & Yassuda, M. S. (2014). *Cognição, humor e bem-estar na velhice*. Alínea.
- Nunes, I. R. (2020). *Escrevivência: A escrita de nós: Reflexões sobre a obra de Conceição Evaristo*. Mina Editorial.
- Oraka, C. S., et al. (2020). Raça e obesidade na população feminina negra: Uma revisão de escopo. *Saúde e Sociedade*, 29(3). <https://doi.org/10.1590/s0104-12902020191003>
- Pialarissi, R. (2017). Precarização do trabalho. *Revista de Administração em Saúde*, 17(66). <https://doi.org/10.23973/ras.66.11>
- Ribeiro, D. (2019). *Lugar de fala*. Pólen Livros.
- Rocha, L. F. (2023). Luiza Mahin, mãe, mulher, rebelde e libertária. *Revista Mosaico - Revista de História*, 16(1), 72–81. <https://doi.org/10.18224/mos.v16i1.9159>
- Rotta, N. T., Ohlweiler, L., & Riesgo, R. S. (2016). Transtornos da aprendizagem: Abordagem neurobiológica e multidisciplinar. *Artmed*.
- Santos, E. F. dos, Pinto, E. A. T., & Chirinéa, A. M. (2018). A lei nº 10.639/03 e o epistemicídio: Relações e embates. *Educação & Realidade*, 43(3), 949–967. <https://doi.org/10.1590/2175-623665332>
- Santos, I. (2025, 29 de abril). 48% das empreendedoras negras são mães solo e enfrentam a sobrecarga doméstica como principal desafio. *Mundo Negro*. <https://mundonegro.inf.br/48-das-empreendedoras-negras-sao-maes-solo-e-enfrentam-a-sobrecarga-domestica-como-principal-desafio/>
- Santos, M. P. A. dos, et al. (2020). População negra e Covid-19: Reflexões sobre racismo e saúde. *Estudos Avançados*, 34(99), 225–244. <https://doi.org/10.1590/s0103-4014.2020.3499.014>
- Senkevics, A. S., & Mello, U. M. (2022). Um balanço dos dez anos da política federal de

cotas na educação superior (lei nº 12.711/2012). Cadernos de Estudos e Pesquisas em Políticas Educacionais, 6. <https://doi.org/10.24109/9786558010531.ceppe.v6.5384>

Silva, P. A. da, & Krakauer, P. V. de C. (2023). Motivos e oportunidades que levam as mulheres negras a empreenderem no Brasil. South American Development Society Journal, 9(25), 179. <https://doi.org/10.24325/issn.2446-5763.v9i25p179-199>

Soldatelli, J. M. G., et al. (2024, 5 de agosto). Desenvolvendo modelos de negócios antirracistas: A realidade da mulher negra no Brasil. Ethos. <https://www.ethos.org.br/developendo-modelos-de-negocios-antirracistas-a-realidade-da-mulher-negra-no-brasil/>

Veiga, E. (2023, 28 de novembro). Luiza Mahin: A mulher que virou mito da força negra feminina. Geledés. <https://www.geledes.org.br/luiza-mahin-a-mulher-que-virou-mito-da-forca-negra-feminina/>

Werneck, J. (2016). Racismo institucional e saúde da população negra. Saúde e Sociedade, 25(3), 535–549. <https://doi.org/10.1590/s0104-129020162610>

Vygotsky, L. S. (2007). A formação social da mente. Martins Fontes.

LIFE CYCLE ASSESSMENT OF RICE HUSK-BASED ELECTRICITY GENERATION IN A THERMAL POWER PLANT

AVALIAÇÃO DO CICLO DE VIDA DA GERAÇÃO DE ELETRICIDADE A PARTIR DE CASCA DE ARROZ EM UMA USINA TERMELÉTRICA

EVALUACIÓN DEL CICLO DE VIDA DE LA GENERACIÓN DE ELECTRICIDAD A PARTIR DE CÁSCARA DE ARROZ EN UNA CENTRAL TERMOELÉCTRICA



<https://doi.org/10.56238/sevened2026.008-039>

Orlando Marcos Quadros Cardoso¹, Tamiris Pacheco da Costa², Mateus Guimarães da Silva³

ABSTRACT

The present study assessed the carbon footprint of electricity generation from rice husk in a thermal power plant located in São Sepé, Rio Grande do Sul, Brazil. For this purpose, the Life Cycle Assessment (LCA) methodology was applied in accordance with ISO 14040/14044 standards, using the OpenLCA software and the Ecoinvent 3.6 database. The functional unit considered was 1 kWh of electricity produced, covering the stages of rice cultivation and processing, biomass transportation, power plant operation, and ash disposal. The results indicated a carbon footprint of 0.036 kg CO₂ eq/kWh, with emissions associated with biomass and ash transportation accounting for more than 80% of the total. Compared with other energy sources, rice husk-based electricity generation demonstrated better environmental performance than coal and natural gas, standing out as a low-impact renewable alternative. The analysis also revealed that mitigation opportunities are mainly concentrated in transportation logistics and in the local valorization of ashes as an agricultural soil amendment.

Keywords: Biomass. Rice Husk. Thermal Power Plant. Carbon Footprint. Life Cycle Assessment.

RESUMO

O presente estudo avaliou a pegada de carbono da geração de eletricidade a partir da casca de arroz em uma usina termelétrica localizada em São Sepé, Rio Grande do Sul, Brasil. Para isso, foi aplicada a metodologia de Avaliação do Ciclo de Vida (ACV), de acordo com as normas ISO 14040/14044, utilizando o software OpenLCA e a base de dados Ecoinvent 3.6. A unidade funcional considerada foi 1 kWh de eletricidade produzida, abrangendo as etapas de cultivo e beneficiamento do arroz, transporte da biomassa, operação da usina e

¹ Graduated. Universidade Federal de Pampa (UNIPAMPA). Rio Grande do Sul, Brazil.

E-mail: orlandocardoso.aluno@unipampa.edu.br.

² Dr. School of Biosystems & Food Engineering. University College Dublin (UCD). Dublin, Ireland.

E-mail: tamiris.dacosta@ucd.ie

³ Dr. Universidade Federal do Rio Grande do Norte (UFRN). Rio Grande do Norte, Brazil.

E-mail: mateussilva@unipampa.edu.br

disposição das cinzas. Os resultados indicaram uma pegada de carbono de 0,036 kg CO₂ eq/kWh, sendo que as emissões associadas ao transporte da biomassa e das cinzas representaram mais de 80% do total. Em comparação com outras fontes de energia, a geração de eletricidade a partir da casca de arroz apresentou melhor desempenho ambiental do que o carvão mineral e o gás natural, destacando-se como uma alternativa renovável de baixo impacto. A análise também revelou que as principais oportunidades de mitigação concentram-se na logística de transporte e na valorização local das cinzas como corretivo agrícola do solo.

Palavras-chave: Biomassa. Casca de Arroz. Usina Termelétrica. Pegada de Carbono. Avaliação do Ciclo de Vida.

RESUMEN

El presente estudio evaluó la huella de carbono de la generación de electricidad a partir de la cáscara de arroz en una central termoeléctrica ubicada en São Sepé, Rio Grande do Sul, Brasil. Para ello, se aplicó la metodología de Evaluación del Ciclo de Vida (ECV), de acuerdo con las normas ISO 14040/14044, utilizando el software OpenLCA y la base de datos Ecoinvent 3.6. La unidad funcional considerada fue 1 kWh de electricidad producida, abarcando las etapas de cultivo y procesamiento del arroz, transporte de la biomasa, operación de la central y disposición de las cenizas. Los resultados indicaron una huella de carbono de 0,036 kg CO₂ eq/kWh, siendo que las emisiones asociadas al transporte de la biomasa y de las cenizas representaron más del 80% del total. En comparación con otras fuentes de energía, la generación eléctrica a partir de la cáscara de arroz mostró un mejor desempeño ambiental que el carbón y el gas natural, destacándose como una alternativa renovable de bajo impacto. El análisis también reveló que las principales oportunidades de mitigación se concentran en la logística de transporte y en la valorización local de las cenizas como enmienda agrícola del suelo.

Palabras clave: Biomasa. Cáscara de Arroz. Central Termoeléctrica. Huella de Carbono. Evaluación del Ciclo de Vida.

1 INTRODUCTION

Brazil stands out as a global leader in conventional renewable energy generation, with hydropower accounting for 51.97% of the country's electricity production (ANEEL, 2025). Despite its recognized low level of greenhouse gas emissions, the high dependence on this source exposes the electricity sector to significant vulnerability in the face of recurrent drought events (BONDARIK et al., 2018). In this context, diversifying the energy mix through the incorporation of other renewable sources emerges as a necessary strategy.

Among the available alternatives, biomass holds a prominent position due to its wide availability resulting from agricultural, agro-industrial, and forestry activities in the country (SANTOS et al., 2017). The most commonly used residues for energy generation include firewood, charcoal, sugarcane bagasse, wood residues, and rice husk (REZENDE, 2018). The latter represents about 20% of the weight of the processed grain and, due to its low nutritional value and high silica content, it is unsuitable for animal feed or direct agricultural use (CHUNGSANGUNSIT et al., 2010; ALMEIDA, 2010). However, it presents high calorific value, making it a promising alternative for use in thermal power plants.

Rice production in Brazil is concentrated in five states, with Rio Grande do Sul accounting for the majority share (70.7%), followed by Santa Catarina (10.2%), Tocantins (6.1%), Mato Grosso (3.6%), and Maranhão (1.5%) (MAPA, 2021). Milling, usually carried out near cultivation areas, generates rice husk as a by-product (MURARO et al., 2018). Currently, around 15 thermal power plants use this residue as fuel, totaling 59.46 MWh of installed capacity, 10 of which are located in Rio Grande do Sul, accounting for 50.14 MWh (SIGA, 2025).

Although rice husk-based thermal power generation has lower environmental impacts compared to fossil sources, it is not free from externalities. A comprehensive analysis of these effects requires the application of consolidated methodologies such as Life Cycle Assessment (LCA), as established by ISO 14040, which enables the measurement of environmental impacts throughout all stages of a product's or process's life cycle.

Considering the scarcity of specific studies in Brazil, this work aims to build an inventory and evaluate the carbon footprint of the life cycle of electricity generation in a rice husk-fired thermal power plant located in the central region of Rio Grande do Sul.

2 METHODOLOGY

In this study, a life cycle inventory of electricity generation from rice husk was developed based on primary data from the São Sepé Thermal Power Plant, which has an installed capacity of 8.0 MWh and stands out as the second largest operating unit in this

segment in Brazil. In addition, the carbon footprint of electricity production was calculated using the Life Cycle Assessment (LCA) methodology, in accordance with ISO 14040/14044 guidelines (ISO, 2006a).

LCA, structured in the stages of goal and scope definition, inventory analysis, impact assessment, and interpretation, enables the quantification of environmental impacts associated with the analyzed system. For the modeling, the OpenLCA software was employed, together with the Ecoinvent 3.6 database, internationally recognized for the comprehensiveness of its datasets and available impact assessment methods (OPENLCA, 2025).

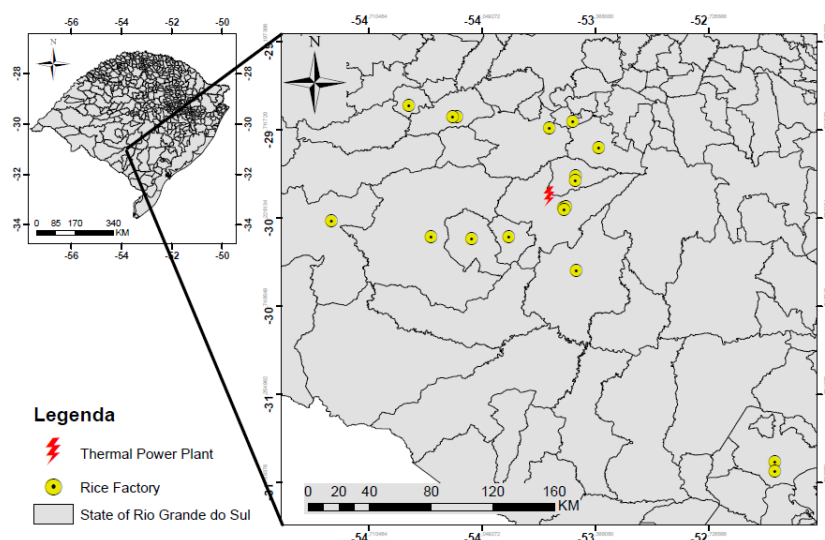
2.1 FUNCTIONAL UNIT, SCENARIO, AND SYSTEM BOUNDARY

This study is based on the use of rice husk, a by-product of grain milling, as a renewable energy source in a thermal power plant. The analyzed facility is located in the municipality of São Sepé, in the central region of Rio Grande do Sul, approximately 281 km from Porto Alegre, and receives biomass from around 13 local milling industries, with the possibility of including suppliers from other regions depending on availability.

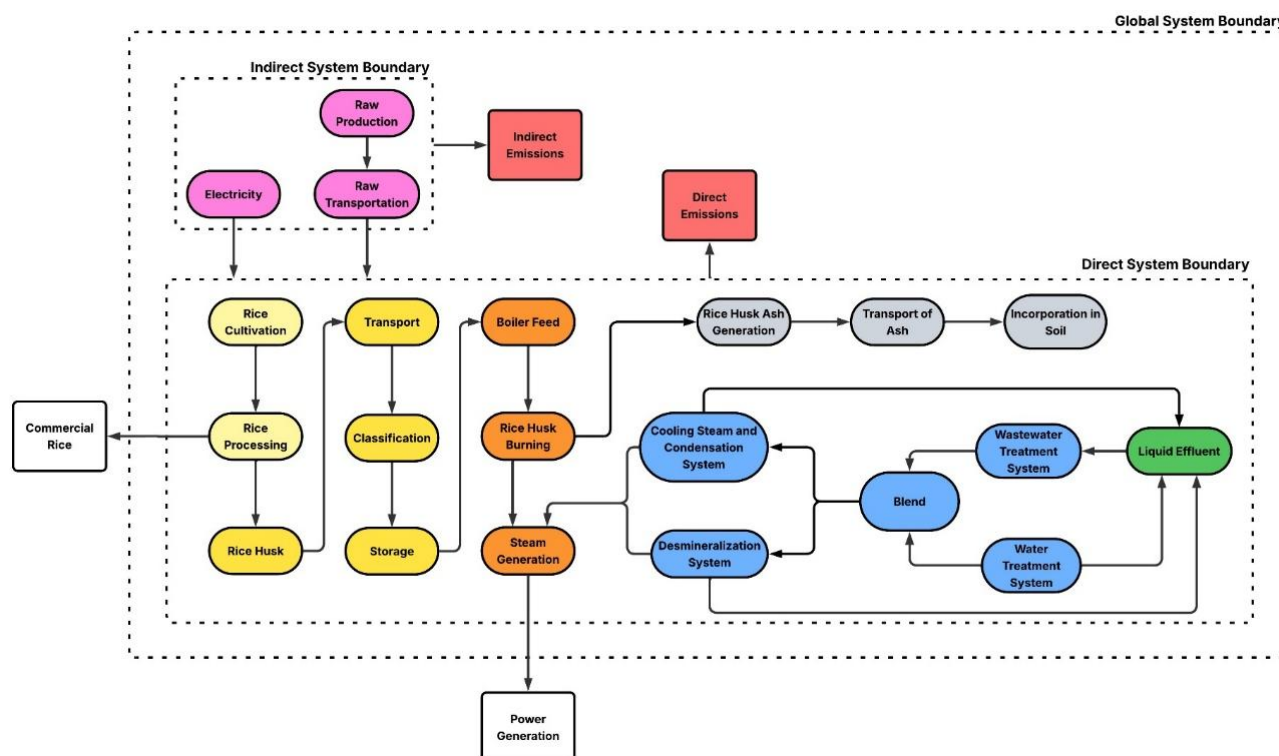
The modeling considered a cradle-to-gate system boundary, encompassing the stages of rice cultivation and milling, husk transportation, and electricity generation in the thermal power plant. The adopted functional unit was 1.0 kWh of electricity produced. Figures 1 and 2 show, respectively, the geographical location of the power plant and the flowchart of the stages included in the analysis.

Figure 1

Location map of the thermal power plant



Source: Author.

Figure 2*Flowchart of processes and system boundaries*

Source: Author.

To estimate the environmental impacts of energy generation from rice husk combustion, the IPCC 2021 methodology was applied in the OpenLCA software, using the Ecoinvent database. This method, based on the Sixth Assessment Report of the IPCC (AR6), provides updated greenhouse gas (GHG) metrics for the calculation of different impact categories (OPENLCA, 2022). For this study, emissions related to the 100-year Global Warming Potential (GWP100) were considered, expressed in kg of CO₂ equivalent.

2.2 IMPACT ALLOCATION METHOD

Since rice processing generates other products in addition to husk, such as white rice, broken rice, and bran, it was necessary to allocate the environmental impact associated with the husk (MAYER, 2009). This allocation was based on the economic value of the products, as adopted in LCA studies of rice production (COLTRO et al., 2017; DA SILVA, 2021).

2.3 SYSTEM DESCRIPTION, INVENTORY, AND DATA COLLECTION

The life cycle inventory of electricity generation from rice husk was developed based on primary data collected in situ and through bibliographic research. While the inventory of rice cultivation and milling relied on secondary data, the inventory of electricity generation at

the thermal power plant and the life cycle model were constructed using primary data obtained from the operational, control, and monitoring reports of the São Sepé Thermal Power Plant. The involvement of one of the authors, an engineer responsible for the plant's operation and environmental processes, enhances the relevance of the study, which seeks practical solutions grounded in real-world data.

2.3.1 Inventory of Rice Cultivation and Milling

The inventory of rice cultivation and milling was developed using both primary and secondary data from the functional units. Table 1 presents the main inputs used in the stages of cultivation, drying, transportation, and packaging (NUNES et al., 2016).

Table 1

Inventory of data for rice cultivation and milling

Stage	Inputs	Entradas (Inputs)	
		Value	Unit
Standard Rice Cultivation	Water	$7,20 \times 10^{-4}$	m ³ /kg rice
	Arable Land Occupation	1,33	m ² /kg rice
	Rice Seed	$1,30 \times 10^{-2}$	kg/kg rice
	Herbicides	$7,20 \times 10^{-7}$	kg/kg rice
	Ureia, as N	$4,03 \times 10^{-2}$	kg/kg rice
	Ammonium Nitrate, as N	$1,08 \times 10^{-2}$	kg/kg rice
	Triple Superphosphate, as P2O5	$1,37 \times 10^{-2}$	kg/kg rice
	Potassium Chloride, as K2O	$3,10 \times 10^{-2}$	kg/kg rice
	Fungicides	$3,60 \times 10^{-8}$	kg/kg rice
	Insecticides	$1,07 \times 10^{-8}$	kg/kg rice
	Diesel – Rice Plantation	$8,64 \times 10^{-3}$	kg/kg rice
	Diesel – Rice Harvest	$4,32 \times 10^{-3}$	kg/kg rice
	Electricity, Pump (50 HP)	$4,90 \times 10^{-6}$	kWh/kg rice
	Electricity, Pump (30 HP)	$2,94 \times 10^{-6}$	kWh/kg rice
	Fertilizer Transportation	$2,66 \times 10^{-2}$	tkm/kg rice
	Herbicide Transportation	$2,23 \times 10^{-2}$	tkm/kg rice
	Diesel - Transport	$1,92 \times 10^{-4}$	kg/kg rice
Rice Processing	Wood	$1,00 \times 10^{-3}$	m ³ /ha/kg rice
	Packaging Transportation, Truck 3.5 -7.5t	21,74	tkm/kg rice
	Processing Transport, 16-32t Truck	5,64	tkm/kg rice
	Drying Transport, 7.5-16t Truck	6,17	tkm/kg rice
	Packing 1kg (LDPE)	$3,89 \times 10^{-1}$	kg/kg rice
	Packing 5kg (LDPE)	$4,17 \times 10^{-1}$	kg/kg rice
	Electric Forklift	706,0	J/kg rice
	Paddy Rice	1,54	kg/kg rice

Source: Adapted from Nunes et al. (2016).

In the cultivation stage, the pesticides used were Standak (25%) as an insecticide, glyphosate (48%) as a herbicide, and Vitavax (40%) as a fungicide. Diesel consumption was 80 L/ha for soil preparation and 40 L/ha during harvesting.

Milling includes husking, separation of the grain from the husk, and pre-polishing. The handling of the grains encompasses transportation and packaging. Partial milling generates the following co-products: white rice (65.5%), broken grains (3.5%), rice bran (7%), and rice husk (24%).

2.3.2 Description of the Energy Generation System in the Thermal Power Plant

The São Sepé Thermal Power Plant uses rice husk as fuel, with a maximum capacity of 8.0 MWh and a daily production of 192 MWh, of which 163.2 MWh is exported to the market. The technology employs a rotary grate, allowing the combustion of up to 217 t/day of rice husk, sourced from 12 municipalities at an average distance of 168 km. Transportation is carried out by 12-ton trucks, with a fuel efficiency of 2.5 km/L of diesel, and storage is in a horizontal silo with a capacity of 870 t.

The HBremer LIGNODYN-40 boiler generates 37,390 kg/h of saturated steam at 45 kgf/cm², with automated feed and combustion controlled by primary and secondary air. Fuel consumption is 9,170.2 kg/h (12% moisture), producing 1,834 kg/h of ash. Gas emissions are controlled by a multiclone and bag filter, with periodic monitoring of CO₂, NO_x, CO, and particulate matter concentrations.

The generated steam is supported by three integrated systems: Water Treatment Plant (WTP), Effluent Treatment Plant (ETP), and Demineralization System (DESMI). The WTP provides 540 m³/day of industrial water; the ETP treats 170 m³/day of effluents, allowing water reuse; and the DESMI removes salts from water, preventing scaling and corrosion. Demineralized water is used in the boiler, with chemical additives to protect the equipment.

After energy generation, the steam is cooled in a cooling tower and condensed, allowing its reuse and reducing the demand for treated water. The cycle is continuous, with replacement of losses due to evaporation and prevention of scaling through chemical additives.

After storage of boiler ash in horizontal silos, the plant disposes of the residue on agricultural properties in São Sepé, holding an environmental license for this purpose. Transportation is carried out daily by a third-party company, and the property owners are responsible for ash distribution.

Electricity generation also depends on the efficient operation of various production chain equipment, such as conveyors, screws, elevators, exhausters, and hydraulic pumps,

powered by electric motors of different capacities. Internal energy consumption is predominantly from these motors, and their efficiency directly impacts the amount of electricity available for export.

3 RESULTS AND DISCUSSION

3.1 INVENTORY OF CHEMICAL PRODUCTS

Based on operating hours, treatment flow rates, and standard dosages, it was possible to calculate the amount of chemical inputs used in the water and effluent treatment systems, relating them to the functional unit of interest. The inventory of chemical inputs for the thermal power plant is presented in Table 2.

Table 2

Inventory of Chemicals

Unidade	Insumo	Valor	Unidade
WTP	Polyaluminum Chloride and Aluminum Sulfate	$2,083 \times 10^{-4}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Sodium Hydroxide	$7,81 \times 10^{-5}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Polymer	$2,60 \times 10^{-6}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Sodium Hypochlorite	$1,56 \times 10^{-4}$	$\text{kg} \cdot \text{kWh}^{-1}$
ETP	Polyaluminum Chloride	$3,12 \times 10^{-4}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Polymer	$1,56 \times 10^{-6}$	$\text{kg} \cdot \text{kWh}^{-1}$
Reverse Osmoses	Citric Acid	$6,93 \times 10^{-7}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Sodium Hydroxide	$1,72 \times 10^{-7}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Glycol; 2,2-dibromo-3-nitrilpropionamide; Sodium bromide	$4,32 \times 10^{-7}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Sodium Chloride	$1,30 \times 10^{-5}$	$\text{kg} \cdot \text{kWh}^{-1}$
Demineralization System	Hydrochloric acid	$1,67 \times 10^{-4}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Sodium Hydroxide	$3,90 \times 10^{-4}$	$\text{kg} \cdot \text{kWh}^{-1}$
Cooling Tower	Phosphoric Acid	$2,08 \times 10^{-5}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Carboxylic Acid Polymer; Maleic Acid	$2,08 \times 10^{-5}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Trichloroisocyanuric acid	$2,5 \times 10^{-5}$	$\text{kg} \cdot \text{kWh}^{-1}$
Boiler and turbine	Carbohydrazide	$2,60 \times 10^{-5}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Ammonium Hydroxide	$9,37 \times 10^{-6}$	$\text{kg} \cdot \text{kWh}^{-1}$
	Unspecified polymer	$9,37 \times 10^{-6}$	$\text{kg} \cdot \text{kWh}^{-1}$

Source: Author.

It is observed that the highest consumptions are associated with the water and raw effluent treatment stages, with coagulants and chlorine-based biocides standing out, which are used in the clarification of water and effluents in the WTPs and WWTPs. In the demineralization process, hydrochloric acid and sodium hydroxide are employed for the regeneration of cationic and anionic resins. Other inputs, such as acidic and alkaline solutions and polymers, complement the treatment, ensuring operational efficiency and process water quality.

3.2 TRANSPORT INVENTORY

For the transport inventory, only those with higher operational frequency were considered, such as the transport of biomass and rice husk ash. Table 3 shows the transport inventory considering fuel consumption.

Table 3

Transport Data Inventory

Inputs	Value	Unit
Biomass Transport (truck 7,5 – 16,0 t)	$1,00 \times 10^{-3}$	tkm.kWh ⁻¹
Diesel Oil (Biomass Transport)	$4,70 \times 10^{-1}$	kg.kWh ⁻¹
Rice Husk Ash Transport (truck 7,5 – 16,0 t)	$4,23 \times 10^{-3}$	tkm.kWh ⁻¹
Diesel Oil (Ash Transport)	$1,38 \times 10^{-2}$	kg.kWh ⁻¹

Source: Author.

3.3 IMPACT ALLOCATION

According to the ABNT ISO 14044 standard (2009), allocation consists of partitioning the input or output flows of a process between the product under study and other related products. In multiproduct systems, the application of allocation procedures is essential to properly distribute materials, energy, and environmental emissions (TRINDADE, 2020).

For the life cycle assessment, an economic allocation of impacts was performed, using the cost or revenue values of each product, allowing the software to distribute the contribution of each item to greenhouse gas (GHG) emissions. Table 4 presents the economic values of the products considered within the system boundary.

Table 4

Life Cycle Economic Data

Products/Inputs	Value	Unit
White Rice	0,414	USD/kg
Rice Bran	0,145	USD/kg
Broken Rice	0,271	USD/kg
Rice Husk	0,017	USD/kg
Paddy Rice	0,244	USD/kg

Source: Author.

3.4 LIFE CYCLE ASSESSMENT AND DISTRIBUTION OF GHG EMISSIONS

The life cycle model of the present study was structured in different stages, allowing the discrimination of greenhouse gas (GHG) contributions from each sector and the identification of the activities with the highest impact. For this purpose, flows were created with the products listed in Table 4 and the processes required for their production, including all inventory inputs and outputs based on the functional unit. Most inputs were obtained from

the Ecoinvent database, except for some specific chemicals, such as carbonylhydrazide and the biocide (Glycol; 2,2-dibromo-3-nitrilopropionamide; Sodium bromide), which are not available in version 3.6 of the database.

The "Product System" integrated all flows and processes according to the life cycle flowchart (Figure 2), enabling the calculation of the global warming potential (GWP100). GHG emissions by stage are presented in Table 5, totaling 3.60×10^{-2} kg CO₂ eq/kWh.

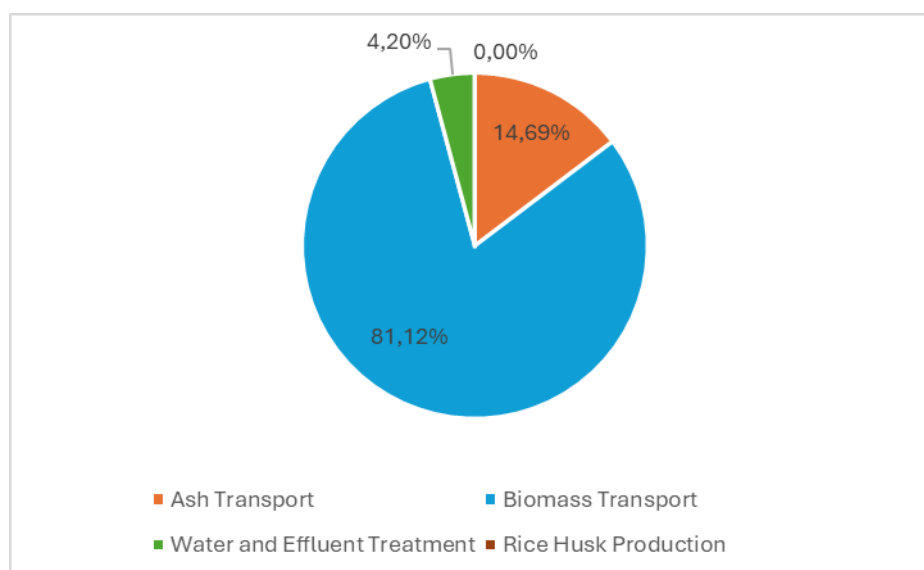
Table 5

Carbon Footprint by Production Stage

Stage	Source	Global Warming Potential (GWP100)
		kg CO ₂ -eq·kWh ⁻¹
Rice Cultivation and Milling	-	ND
Biomass Transport	Truck Fuel (Diesel)	$2,92 \times 10^{-2}$
	Truck Transport/Freight 7.5–16 t	$3,69 \times 10^{-6}$
Water and Effluent Treatment	Sodium Hydroxide	$6,10 \times 10^{-4}$
	Sodium Hypochlorite	$4,10 \times 10^{-4}$
	Aluminum Polychloride	$3,70 \times 10^{-4}$
	Hydrochloric Acid	$8,22 \times 10^{-5}$
	Phosphoric Acid	$2,88 \times 10^{-5}$
	Trichloroisocyanuric Acid	$5,38 \times 10^{-6}$
	Citric Acid	$4,33 \times 10^{-6}$
	Sodium Chloride	$1,17 \times 10^{-6}$
Ash Transport and Disposal	Truck Fuel (Diesel)	$1,16 \times 10^{-3}$
	Truck Transport/Freight 7.5–16 t	$4,13 \times 10^{-3}$
Total		$3,60 \times 10^{-2}$

Source: Author.

The results show that the transport of biomass and residues is the largest contributor to GHG emissions, accounting for 81.12% of the total. Factors such as the number of trips, distance traveled, volume of residues, and vehicle efficiency directly influence this impact, with diesel consumption by the fleet being the main contributor to the carbon footprint (Figure 3).

Figure 3*Comparison of Contributions to GHG Emissions*

Source: Author.

According to Shen et al. (2015), the low energy density of lignocellulosic biomass makes transportation a critical factor in the economic and environmental viability of plants, also influencing operational scale and site selection. In the case of the São Sepé plant, its central location in Rio Grande do Sul, near rice processing companies, favors the logistical supply of biomass. Regarding the disposal of rice husk ash (RHA), the company prioritized properties close to the plant (average distance of 18.5 km), reducing costs and emissions.

The water and effluent treatment stage occurs continuously, supporting steam generation, and environmental impacts were estimated based on the chemical inputs used. The electricity consumed internally by equipment, such as centrifugal pump motors, was not accounted for as an external source, as it is generated internally from rice husk combustion. Additional simulations indicated that if the energy came from an external source, it would represent approximately 72.5% of the system's total emissions ($\sim 0.1254 \text{ kg CO}_2 \text{ eq/GWP100}$), reinforcing the environmental advantage of the model adopted by the plant.

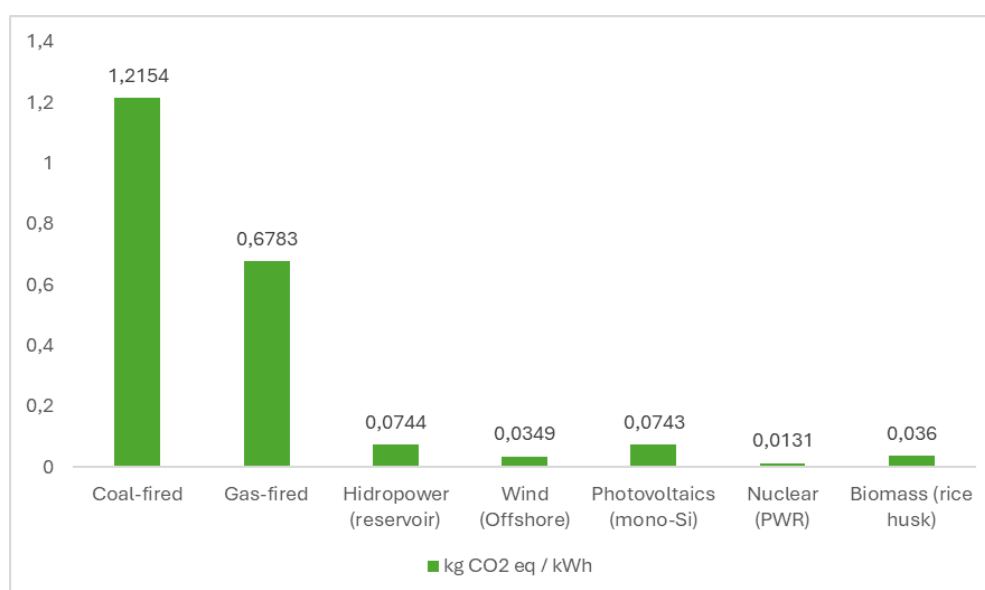
Regarding rice cultivation and processing, no GHG emissions were attributed to the husk due to economic allocation, which concentrates the environmental burden on the higher-value commercial products (Table 9). Moreover, emissions from husk combustion are not included in GHG accounting, as the released CO_2 is considered biogenic and reabsorbed by subsequent crops. Finally, it was not possible to estimate GHG emissions associated with the application of RHA to agricultural soil, due to the scarcity of specific data and the lack of robust inventories on the subject.

3.5 COMPARISON OF GHG EMISSIONS WITH OTHER ENERGY TECHNOLOGIES

The carbon footprint obtained in this study was compared with results from Life Cycle Assessments (LCAs) of other electricity generation technologies. Guidi et al. (2023) consolidated data from different energy matrices, providing a comparative overview. As shown in Figure 4, energy generation from rice husk exhibits significantly lower greenhouse gas (GHG) emissions compared to conventional and non-renewable sources, such as coal and natural gas, highlighting it as a low-environmental-impact energy alternative.

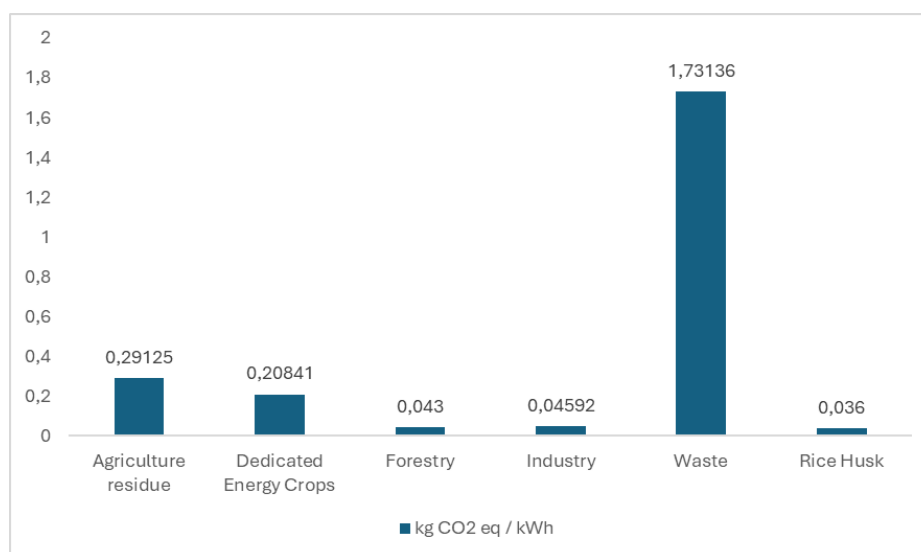
Figure 4

Comparison of emissions across different electricity generation technologies



Source: Author.

Kadiyala et al. (2016) compiled equivalent CO₂ emission values from various biomass-fired power plants based on Life Cycle Assessment (LCA) studies. Figure 6 presents a comparison between the plant analyzed, which uses rice husk as fuel, and the average emissions of other plants powered by different types of biomass. The results indicate that the rice husk plant exhibits lower CO₂-equivalent emissions per kWh generated compared to the average of plants using agricultural residues, highlighting its higher environmental efficiency in the context of biomass-based thermal power generation.

Figure 6*Comparative Chart of Different Biomass Types*

Source: Author.

3.6 CARBON FOOTPRINT OF RICE HUSK-BASED ENERGY GENERATION

In the present study, the São Sepé Thermoelectric Plant (TEP) exhibited a carbon footprint of 0.036 kg CO₂ eq/kWh for electricity generation from rice husk. The Life Cycle Assessment (LCA) was developed based on detailed primary data from the plant's operation, complemented by secondary data from the Ecoinvent 3.6 database, considering a "cradle-to-gate" boundary. This approach included rice cultivation and processing, biomass and ash transport, plant operation, water and effluent treatment, and the use of chemical inputs, with economic allocation applied among the co-products.

The use of emission factors updated by the IPCC (2021), combined with the inclusion of auxiliary processes and accounting for emissions related to average transport distances, resulted in a value lower than that reported by Shafie et al. (2011), who estimated 0.217 kg CO₂ eq/kWh. In Shafie et al.'s study, the inventory was less comprehensive, with shorter transport distances, exclusion of support stages, and the use of emission factors prior to IPCC 2021. On the other hand, the study by Chungsangunsit et al. (2010) reported 0.0172 kg CO₂ eq/kWh, due to a restricted boundary focused only on combustion and immediate biomass transport, with short distances and possible exclusion of agricultural and processing stages, as well as the use of older data and emission factors.

These differences highlight that the scope, quality, and origin of data, as well as the methodological assumptions adopted, decisively influence the results and must be clearly stated to allow consistent comparisons among studies.

When analyzing stage-specific contributions, biomass transport remains the main source of emissions, followed by ash transport and disposal, which accounts for approximately 10% of the total—an aspect not considered in some comparative studies. Emissions from boiler operation and chemical input use are low (<10%), while cultivation and processing stages have a marginal contribution, in agreement with Chungsangunsit et al. (2010).

These results indicate that, even with a low overall carbon footprint, mitigation opportunities are concentrated in the logistics chain, highlighting strategies such as route optimization, the use of more efficient transport modes, and local utilization of ash.

4 CONCLUSIONS

The study demonstrated that electricity generation from rice husk exhibits a significantly reduced carbon footprint compared to fossil fuels, reinforcing the potential of this biomass as a strategic alternative for diversifying Brazil's energy matrix. The analyzed plant presented a value of 0.036 kg CO₂ eq/kWh, a competitive result compared to other biomass technologies reported in the literature. The main contribution to emissions was associated with the transport of biomass and ash, confirming the importance of logistics in the environmental and economic viability of such plants. Strategies such as route optimization, reducing transport distances, and local utilization of agricultural ash emerge as effective measures for impact mitigation. Thus, the use of rice husk in thermoelectric plants not only contributes to reducing greenhouse gas emissions but also represents a sustainable solution for the utilization of agro-industrial residues, aligning with the country's energy transition and circular economy goals.

REFERENCES

- Agência Nacional de Energia Elétrica. (2025a, May 7). Brasil supera a marca de 210 GW instalados. <https://www.gov.br/aneel/pt-br/assuntos/noticias/2025/brasil-supera-a-marca-de-210-gw-instalados>
- Agência Nacional de Energia Elétrica. (2025b). SIGA – Sistema de Informações de Geração da ANEEL: Banco de dados de empreendimentos de geração. <https://dadosabertos.aneel.gov.br/dataset/siga-sistema-de-informacoes-de-geracao-da-aneel/resource/11ec447d-698d-4ab8-977f-b424d5deee6a>
- Almeida, S. R. (2010). Fast pyrolysis of rice husk: Study of parameters and product characterization [Master's thesis]. [Institution not specified; if available, add university name].
- Associação Brasileira de Normas Técnicas. (2009). ABNT NBR ISO 14044: Gestão ambiental – Avaliação do ciclo de vida – Requisitos e orientações. (Original work published 2006 as ISO 14044:2006).

- Bondarik, R., Pilatti, L. A., & Horst, D. J. (2018). An overview of the renewable energy generation potential in Brazil. *Interciencia*, 43(10), 680–688.
- Chungsangunsit, T., Gheewala, S. H., & Patumsawad, S. (2010). Emission assessment of rice husk combustion for power production. *World Academy of Science, Engineering and Technology*, 53, 1070–1075.
- Coltro, L., et al. (2017). Environmental profile of rice production in Southern Brazil: A comparison between irrigated and subsurface drip irrigated cropping systems. *Journal of Cleaner Production*, 153, 491–505.
- da Silva, M. G., et al. (2021). Greenhouse gas emissions of rice straw-to-methanol chain in Southern Brazil. *Journal of Environmental Chemical Engineering*, 9(3), Article 105202.
- International Organization for Standardization. (2006). ISO 14040: Environmental management – Life cycle assessment – Principles and framework.
- Kadiyala, A., Kommalapati, R., & Huque, Z. (2016). Evaluation of the life cycle greenhouse gas emissions from different biomass feedstock electricity generation systems. *Sustainability*, 8(11), Article 1181.
- Ministério da Agricultura, Pecuária e Abastecimento. (2021). Projeções do agronegócio – Brasil 2020/21 a 2030/31. Secretaria de Política Agrícola. <https://www.gov.br/projecoes-do-agronegocio-2018>
- Mayer, F. D. (2009). Utilization of rice husk in a micro thermoelectric plant: Assessment of economic and environmental impacts for the rice sector in Rio Grande do Sul [Master's thesis, Federal University of Santa Maria].
- Muraro, P., de Oliveira Camelo, C., & Denis, F. A. (2018). Utilization and valorization of rice husk: A bibliometric review.
- Nunes, F. A., et al. (2016). Life cycle greenhouse gas emissions from rice production systems in Brazil: A comparison between minimal tillage and organic farming. *Journal of Cleaner Production*, 139, 799–809.
- openLCA. (2025). About openLCA. <https://www.openlca.org/about/>
- openLCA Nexus. (2022). IPCC 2021 AR6 impact assessment method. <https://www.openlca.org/Documentation> (Documentation retrieved from file:///C:/Users/orlan/Downloads/Documentation%20IPCC%202021%2009.02.2022.pdf)
- Rezende, B. X. (2018). Study on the feasibility of using biomass for electricity generation.
- Santos, G. H. F., do Nascimento, R. S., & Alves, G. M. (2017). Biomass as renewable energy in Brazil. *Uningá Review Journal*, 29(2).
- Shafie, S. M., Mahlia, T. M. I., Masjuki, H. H., & Rismanchi, B. (2011). Life cycle assessment (LCA) of electricity generation from rice husk in Malaysia.
- Shen, X., Kommalapati, R. R., & Huque, Z. (2015). The comparative life cycle assessment of power generation from lignocellulosic biomass. *Sustainability*, 7(10), 12974–12987.
- Trindade, A. B. (2020). Comparative analysis of different allocation methodologies in LCA using traditional and thermoeconomic methods.

DIGITAL COMPETENCIES AND CONTINUING TEACHER EDUCATION: AN ANALYSIS IN LIGHT OF THE BNCC AND CETIC.BR INDICATORS

COMPETÊNCIAS DIGITAIS E FORMAÇÃO CONTINUADA DE PROFESSORES: UMA ANÁLISE À LUZ DA BNCC E DOS INDICADORES DO CETIC.BR

COMPETENCIAS DIGITALES Y FORMACIÓN DOCENTE CONTINUA: UN ANÁLISIS A LA LUZ DE LOS INDICADORES BNCC Y CETIC.BR



<https://doi.org/10.56238/sevened2026.008-040>

Amanda Queirolo Ribeiro da Cruz¹, Patrícia Fonseca Ferreira Fleury²

ABSTRACT

This article analyzes teacher education for the use of Digital Information and Communication Technologies (DICT) in the context of digital culture, in light of the main legal documents that guide Brazilian education, such as the Federal Constitution, the Law of Guidelines and Bases of National Education (Lei de Diretrizes e Bases da Educação Nacional – LDB), the National Common Curricular Base (BNCC, 2018), and the National Teacher Education Guidelines (BNC-Formação, 2020). The study is grounded in the problem of understanding how educational policies and teacher education processes can contribute to the critical integration of digital technologies into pedagogical practices, promoting a more inclusive, innovative, and contemporary-oriented education. The objective of the research is to analyze the contributions of teacher education to the integration of DICT into the teaching–learning process, articulating theoretical frameworks, official documents, and empirical data from the ICT Education survey conducted by Cetic.br (2024). The study adopts a qualitative, exploratory, and bibliographic approach, drawing on authors such as Nóvoa, Tardif, Kenski, Moran, and Freire, as well as legislation and guidelines that structure initial and continuing teacher education. Data analysis reveals trends such as the expansion of access to digital technologies in Brazilian schools, the gradual adoption of active methodologies, and the recognition of continuing education as a strategy for strengthening teaching practice. The results indicate that teachers who engage in professional development programs show a greater predisposition toward pedagogical innovation and the critical and intentional use of digital resources. However, the findings also demonstrate that the availability of equipment and connectivity alone does not ensure pedagogical transformation, making teacher mediation and critical reflection essential. Thus, teacher education for the use of DICT is characterized as a critical-reflective and collaborative process, fundamental to strengthening the role of teachers as mediators of learning and agents of educational transformation in the 21st century.

Keywords: Digital Technologies. Teacher Education. Educational Policies.

¹ Master student in Education. Pontifícia Universidade Católica do Paraná.

E-mail: amanda.queirolo@pucpr.edu.br Orcid: <https://orcid.org/0009-0006-0359-0693>

Lattes: <https://lattes.cnpq.br/3697805124767799>

² Dr. in Education. Pontifícia Universidade Católica do Paraná. E-mail: patricia.ffleury@pucpr.br

Orcid: <https://orcid.org/0000-0001-7161-9669> Lattes: <http://lattes.cnpq.br/8808891060792789>

RESUMO

Este artigo analisa a formação docente para o uso das Tecnologias Digitais de Informação e Comunicação (TDIC) no contexto da cultura digital, à luz dos principais documentos legais que orientam a educação brasileira, como a Constituição Federal, a Lei de Diretrizes e Bases da Educação, a BNCC (2018) e a BNC-Formação (2020). Parte-se do problema de compreender de que modo as políticas educacionais e os processos formativos podem contribuir para a integração crítica das tecnologias às práticas pedagógicas, promovendo uma educação mais inclusiva, inovadora e alinhada às demandas contemporâneas. O objetivo da pesquisa é analisar as contribuições da formação docente para a inserção das TDIC no processo de ensino-aprendizagem, articulando referenciais teóricos, documentos oficiais e dados empíricos da pesquisa TIC Educação do Cetic.br (2024). A pesquisa caracteriza-se como qualitativa, de natureza exploratória e bibliográfica, fundamentada em autores como Nóvoa, Tardif, Kenski, Moran e Freire, além de legislações e diretrizes que estruturam a formação inicial e continuada de professores. A análise dos dados evidencia tendências como a ampliação do acesso às tecnologias digitais nas escolas brasileiras, a adoção gradual de metodologias ativas e a valorização da formação continuada como estratégia de fortalecimento da prática docente. Os resultados indicam que professores que participam de processos formativos apresentam maior predisposição à inovação pedagógica e ao uso crítico e intencional dos recursos digitais. Contudo, conclui-se que a disponibilidade de equipamentos e conectividade, por si só, não garante a transformação pedagógica, sendo indispensável a mediação docente e a reflexão crítica. Assim, a formação docente para o uso das TDIC configura-se como um processo crítico-reflexivo e colaborativo, essencial para o fortalecimento do papel do professor como mediador da aprendizagem e agente da transformação educacional no século XXI.

Palavras-chave: Tecnologias Digitais. Formação de Professores. Políticas Educacionais.

RESUMEN

Este artículo analiza la formación docente para el uso de las Tecnologías Digitales de la Información y la Comunicación (TDIC) en el contexto de la cultura digital, a la luz de los principales documentos legales que orientan la educación brasileña, como la Constitución Federal, la Ley de Directrices y Bases de la Educación Nacional (Lei de Diretrizes e Bases da Educação Nacional – LDB), la Base Nacional Común Curricular (BNCC, 2018) y la BNC-Formación (2020). El estudio parte del problema de comprender de qué manera las políticas educativas y los procesos formativos pueden contribuir a la integración crítica de las tecnologías digitales en las prácticas pedagógicas, promoviendo una educación más inclusiva, innovadora y alineada con las demandas contemporáneas. El objetivo de la investigación es analizar las contribuciones de la formación docente a la incorporación de las TDIC en el proceso de enseñanza-aprendizaje, articulando referentes teóricos, documentos oficiales y datos empíricos de la investigación TIC Educación del Cetic.br (2024). La investigación se caracteriza como cualitativa, de naturaleza exploratoria y bibliográfica, y se fundamenta en autores como Nóvoa, Tardif, Kenski, Moran y Freire, así como en legislaciones y directrices que estructuran la formación inicial y continua del profesorado. El análisis de los datos evidencia tendencias como la ampliación del acceso a las tecnologías digitales en las escuelas brasileñas, la adopción gradual de metodologías activas y la valorización de la formación continua como estrategia para el fortalecimiento de la práctica docente. Los resultados indican que los docentes que participan en procesos formativos presentan una mayor predisposición a la innovación pedagógica y al uso crítico e intencional de los recursos digitales. No obstante, se concluye que la disponibilidad de equipamientos y conectividad, por sí sola, no garantiza la transformación pedagógica, siendo

indispensable la mediación docente y la reflexión crítica. De este modo, la formación docente para el uso de las TDIC se configura como un proceso crítico-reflexivo y colaborativo, esencial para fortalecer el papel del profesorado como mediador del aprendizaje y agente de la transformación educativa en el siglo XXI.

Palabras clave: Tecnologías Digitales. Formación Docente. Políticas Educativas.

1 INTRODUCTION

The accelerated development of digital technologies in recent decades has promoted relevant transformations in multiple social sectors, particularly in the educational field. From this new configuration emerges the so-called "Digital Age", where the growing presence of digital devices, interactive resources and virtual platforms has reconfigured the way knowledge is accessed, produced and shared (Gómez, 2015).

The insertion of digital technologies in the daily life of contemporary society has profoundly transformed the forms of interaction, communication and production of knowledge, configuring what is called digital culture (Lévy, 1999). This culture goes beyond the simple use of technological devices, as it involves a set of social practices mediated by digital technologies, directly impacting education.

Given this scenario, it is essential to rethink teacher training, so that teachers are prepared to incorporate, in a critical and creative way, digital technologies in the teaching-learning process. Thus, the school, as an institution inserted in this context, needs according to Moran (2015) to rethink its pedagogical practices to meet the new demands of teaching and learning, since the internet and digital technologies allow access to content at any time, making a more flexible, integrated and connected education necessary.

In this process, the National Common Curricular Base (BNCC, 2018) stands out as a guiding document, which brings as one of its general competencies to be developed the "digital culture", with the objective that the student develops the ability to understand, use and create digital information and communication technologies in an ethical, critical and reflective way, applying them in different social and school contexts to favor communication, the dissemination of information, the production of knowledge, the resolution of problems and the autonomous and authorial action of the subjects, because according to the BNCC:

Digital Culture: involves learning aimed at a more conscious and democratic participation through digital technologies, which presupposes the understanding of the impacts of the digital revolution and the advances of the digital world in contemporary society, the construction of a critical, ethical and responsible attitude in relation to the multiplicity of media and digital offers, the possible uses of different technologies and the content conveyed by them, and, also, to fluency in the use of digital technology to express solutions and cultural manifestations in a contextualized and critical way. (Brazil, 2018, p. 474)

From an increasingly digital reality, Bacich and Moran (2018) highlight new teaching strategies, such as active methodologies combined with digital technologies that promote the construction of knowledge in a critical and reflective way and that develop student protagonism for innovative education. In this context, knowledge is built through problem

solving, project-based learning, and the creative use of digital technologies, which demands a new, more reflective and collaborative teacher profile.

The school, as a dynamic and socially situated space, is challenged to keep up with technological changes and new educational demands, because in this scenario, the continuing education of teachers assumes a strategic role to promote the development of pedagogical skills that value innovation, technological mediation and the collaborative construction of knowledge. According to Moran (2013, p.13):

An innovative education is based on a set of proposals with some major axes that serve as a guide and basis: integrative and innovative knowledge; the development of self-esteem and self-knowledge (valuing everyone); the formation of entrepreneurial students (creative, with initiative) and the construction of student-citizens (with individual and social values).

Teacher training becomes a central element in this process of integration of digital technologies as an instrument of pedagogical mediation. For this, it will be necessary for teachers to develop skills that allow them to act critically in the face of the changes provided by the digital environment. Initial training, for Imbernón (2011) often distant from the reality of the classroom, needs to be complemented by continuing education programs that offer teachers opportunities to reflect on their practice, experiment with new methodologies and appropriate digital resources in a meaningful way.

Thus, the present research proposes to reflect on the following problem: How does the integration of digital technologies contribute in teacher training to the development of new strategies in the teaching-learning process? The general objective will be to investigate the continuing education of teachers and the integration of digital technologies in the teaching-learning process, and as specific objectives: a) to raise contributions of digital technologies to pedagogical mediation in the school context; b) to discuss the challenges and possibilities of continuing education of teachers in the face of digital culture; c) to identify digital skills considered essential for teaching in the twenty-first century; d) to reflect on innovative pedagogical practices that incorporate technologies in the teaching-learning process.

This study seeks to understand how teacher training can be resignified through the use of digital technologies, for the promotion of more interactive, meaningful and innovative pedagogical practices.

2 THEORETICAL FRAMEWORK

The present work will be developed in four main axes: Digital Culture, based on the studies of Kenski and Moran, which address the educational transformations caused by

technologies; the Innovative Classroom and Active Methodologies, highlighted by Cortelazzo and Moran, who defend the active participation of students and the resignification of the teaching role; Teacher Training, discussed by Tardif and Nóvoa, which emphasize the construction of knowledge and the need for critical and collaborative training; and, finally, the Legal Documents and Guidelines for Teacher Training, analyzed from the Constitution, the LDB and the BNCC, which establish the normative bases for pedagogical practice. In this context, continuing education is understood as an essential element for the meaningful integration of digital technologies into education.

2.1 DIGITAL CULTURE

Digital culture is characterized by the intensification of the use of digital technologies as mediators of social, communicational, and cognitive relations, directly impacting the modes of production and circulation of knowledge. According to Kenski (2012), technology has always been associated with power and knowledge, shaping social behaviors and forms of access to information, being, in contemporary times, enhanced by digital language and the internet.

Pierre Lévy (1999) defines cyberspace as "the new means of communication that emerges from the worldwide interconnection of computers" (p.17), in which processes of collective intelligence are developed, favoring collaborative learning and the shared construction of knowledge. This scenario, Lévy (1999, p.172) describes as "a profound mutation in the relationship with knowledge", demanding from education new forms of pedagogical mediation, more flexible, open and participatory.

In the educational field, Moran (2015) highlights that school institutions are challenged to rethink their pedagogical models to keep up with the transformations of the digital society. According to the author, the incorporation of active methodologies, such as project-based teaching, hybrid teaching and the flipped classroom, represents a possible response to the need to make the student the protagonist of the learning process.

The insertion of digital technologies, however, does not guarantee, by itself, pedagogical innovation. According to Contreras (2002, p. 97), teaching practice is crossed by complex and singular situations, which demand critical reflection and adaptability. In this sense, digital culture redefines the role of the teacher, who is no longer a mere transmitter of content to act as a mediator, advisor and articulator of knowledge in collaborative contexts.

As Lévy (1999, p.208) points out, "allowing human beings to combine their imaginations and intelligences at the service of people's development and emancipation is the best possible use of digital technologies". This conception shows that digital culture is not

restricted to the introduction of technological resources in the school context, but implies a reconfiguration of pedagogical practices and teaching work, demanding the performance of teachers capable of inspiring, connecting and mediating knowledge in collaborative learning environments. In this sense, a critical, collective and contextualized education is indispensable, capable of responding to the educational demands of contemporary society.

2.2 DIGITAL SKILLS AND TEACHER TRAINING

At the same time that digital technologies present themselves as potential allies of pedagogical innovation, it is necessary to recognize the risks of their appropriation in a superficial or merely instrumentalized way. As Barreto (2009, p. 3) warns:

Technologies are not mere transparent tools; they do not allow themselves to be used in any way: they are, in the final analysis, the materialization of the rationality of a certain culture and of a "global model of the organization of power.

The author highlights that the critical appropriation of technologies must take into account their historical, social and political determinations, seeking emancipatory educational practices. Although technologies have the potential to drive new pedagogical practices, their adoption must be at the service of an emancipatory education, and not a simple adaptation to generalist educational models. Thus, the need for teacher training that goes beyond the technical domain is reinforced, valuing critical reflection and the construction of transformative educational practices (Barreto, 2009).

In this scenario, the role of the teacher is also transformed: he is no longer a mere transmitter of content to become a curator, caregiver and advisor of learning. The teacher must be able to organize personalized training paths, encourage collaborative learning and promote student autonomy, using technologies as tools for mediation and expansion of the educational process (Moran, 2015).

In this horizon, Tardif (2014) proposes that teaching knowledge is historically constructed in everyday school life, being the product of social experiences and interactions. For the author, such knowledge is not static, but is constituted in a dynamic way, based on professional experience and the dialogue between theory and practice. Thus, teacher training needs to consider the real contexts of the school, the specific demands of students, and the possibilities that technologies offer to enhance teaching. This articulation between scientific knowledge, practical experience and digital resources creates conditions for a more meaningful pedagogical practice, contextualized and aligned with the challenges of contemporary society.

For Tardif (2014), teaching knowledge is composed of different dimensions, such as disciplinary, curricular, experiential and pedagogical knowledge. Disciplinary knowledge refers to the mastery of the specific content of the area of activity; the curricula are linked to the understanding of the objectives, contents and methods proposed in the programs and guidelines; the experiential ones derive from daily practice, constituting the interaction with students, colleagues and the school community; and pedagogical refer to knowledge about teaching methods, strategies and processes. From the perspective of digital culture, this knowledge expands, requiring the teacher to also develop technological skills that dialogue with all these dimensions, in a critical and creative way.

As Nóvoa (2002, p. 63) points out, "it is not possible to learn the teaching profession without the presence, support and collaboration of other teachers", emphasizing the collective and reflective character of continuing education. Tardif (2014) observes that "teaching knowledge is a plural knowledge, formed by the amalgam, more or less coherent, of knowledge from professional training and disciplinary, curricular and experiential knowledge" (Tardif, 2014, p. 36), highlighting the variety and dynamism of these dimensions in the educational routine. In this context, the incorporation of digital technologies implies a profound repositioning of the functions of teachers and students, a movement that goes beyond the mere use of tools to consolidate a conscious, critical and contextualized use of technological resources. In this sense, Kenski (2003) reinforces that technology should be understood as pedagogical mediation, that is, "a means that broadens the horizons of learning, and not an end in itself" (an interpretation based on his proposal of technological conception). Thus, when based on the knowledge historically constructed by teachers and supported by continuing education policies aligned with practice, the integration of digital technologies favors more autonomous, participatory and contextualized learning environments, sufficiently sensitive to legal requirements, social demands and the pedagogical possibilities of digital culture.

The digital skills required by the BNCC and legal documents point to a repositioning of the teacher's role. Nóvoa (2022) describes that:

The cycle of professional development is completed with continuing education. Given the dimension of the current problems and challenges of education, we need, more than ever, to strengthen the collective dimensions of the teachers. The image of a teacher standing next to the blackboard, giving his class to a class of seated students, perhaps the most striking image of the school model, is being replaced by the image of several teachers working in open spaces with students and groups of students (Nóvoa, 2022, p. 67).

In this sense, it is highlighted that continuous training is one of the essential skills for education professionals, as it guarantees constant updating and development of new skills, such as the management of pedagogical processes, collective work, the incorporation of technologies and ethical reflection. Teaching work, therefore, must articulate digital skills with pedagogical and social commitment, enabling practices that respond to the challenges of a changing world (Perrenoud, 2000 apud Corrêa; Fernandes, 2014, p. 3).

2.3 CONSTITUTION AND LAW OF GUIDELINES AND BASES OF EDUCATION AND OFFICIAL DOCUMENTS ON TEACHER TRAINING

Teacher training in Brazil is guided by a set of legal provisions that ensure the valorization of teaching and the qualification of teaching, in line with contemporary social and technological transformations. The Federal Constitution of 1988 establishes, in its article 206, the valorization of school education professionals as one of the principles of teaching, linking educational quality to teacher training and professional development (Brasil, 1988).

The Law of Guidelines and Bases of National Education (Law No. 9,394/1996) reinforces this principle by providing, in its articles 62 and 67, higher education for the exercise of teaching in basic education and the guarantee of continuing education as part of the valorization of education professionals. These devices show the understanding that teacher training must articulate theoretical knowledge, pedagogical practice and permanent updating.

The LDB, updated by Law No. 14,533/2023, advances even further by formally incorporating digital education among the duties of the State. According to the new item XII of article 4:

Digital education, with the guarantee of connectivity of all public institutions of basic and higher education to the internet at high speed, suitable for pedagogical use, with the development of skills aimed at the digital literacy of young people and adults, creation of digital content, communication and collaboration, security and problem solving. (Brazil, 2023)

In addition, the sole paragraph of the same article adds:

The relationship between teaching and digital learning should provide for digital techniques, tools and resources that strengthen the teaching and learning roles of the teacher and the student and that create collective spaces for mutual development. (Brazil, 2023).

With this update promoted by Law No. 14,533/2023, the LDB explicitly incorporates digital education as a duty of the State, ensuring the connectivity of educational institutions and the development of skills related to digital literacy, content creation, communication, collaboration, security, and problem solving. Such normative advancement reinforces the centrality of digital technologies in education and the need to prepare teachers for their critical pedagogical integration.

In this context, the National Common Curriculum Base (BNCC, 2018) highlights digital culture as one of the general competencies of basic education, guiding the development of skills related to the ethical, critical, and responsible use of digital technologies. The document emphasizes that it is necessary to "prepare them for professions that do not yet exist, to use technologies that have not yet been invented, and to solve problems that we do not yet know" (Brasil, 2018, p. 473), highlighting the urgency of training subjects capable of dealing with a world in constant transformation.

Thus, the legal documents that structure Brazilian education show that the initial and continuing training of teachers is a central element for the effectiveness of innovative pedagogical practices aligned with the demands of the digital society, overcoming a merely instrumental approach to technologies.

2.3.1 BNC – training

Teacher training in Brazil is supported by legal provisions that seek to align teaching practice with the contemporary demands of education. After the approval of the National Common Curricular Base (BNCC) in 2017, different versions and opinions emerged aimed at the adequacy of initial and continuing teacher training. In this process, Resolution CNE/CP No. 1/2020 stands out, which provides for the National Curriculum Guidelines for continuing education and establishes the National Common Base for the Continuing Education of Basic Education Teachers (BNC-Formation). However, as Freitas (2020) observes, the preparation of these documents took place largely without broad dialogue with academic, scientific, and union entities in the area, in a period marked by the health crisis of the COVID-19 pandemic, which generated tensions and criticism about their legitimacy.

Along the same lines, Pucci, Lima, and Souza (2022) point out that the implementation of the BNCC required articulated actions by municipal networks, which have been organizing themselves to adapt their curricula and offer guidance and training to teachers and school managers. Thus, it is evident that normative documents not only regulate, but also guide the curricular organization and professional training, constituting structuring axes of pedagogical practice in the country.

CNE/CP Resolution No. 1/2020 emphasizes that continuing education must be aligned with the real needs of school contexts, configuring itself as an essential component of teacher professionalization and valuing the teacher as a formative agent of knowledge and cultures. The document establishes that professional competencies must integrate three interdependent dimensions: professional knowledge, professional practice and professional engagement; guiding the teaching work towards a critical, ethical, and socially responsible performance (BRASIL, 2020, p. 2). In addition, it provides that continuing education policies respect constitutional foundations, ensure collaborative work among peers, incorporate active learning methodologies and maintain coherence with other educational policies, curricula and career plans.

Another highlight refers to the encouragement of lifelong learning, organized in flexible and modular programs, aimed at meeting the demands of teaching practice in different contexts. This perspective includes everything from refresher and improvement courses to graduate studies, as well as mentoring and tutoring processes. Such actions enable the exchange of experiences between more experienced teachers and those in the process of professional development, strengthening communities of practice and expanding the collective pedagogical repertoire (BRASIL, 2020, p. 6).

With regard to general teaching competencies, the Resolution points out the need to research, investigate and critically reflect on pedagogical practices, using creativity and technological solutions to plan challenging and meaningful proposals; to use different languages (verbal, body, visual, sound and digital) in order to favor the expression and sharing of experiences among students; to understand, use and create digital technologies in a critical and ethical way in educational practices; and to permanently value professional training, seeking updating and new knowledge that sustains the autonomy, citizenship and social responsibility of teachers (BRASIL, 2020, p. 8).

The articulation between the BNCC, the CNE Opinions, the LDB and the BNC-Formação show that the initial and continuing training of teachers cannot be restricted to the instrumental domain of digital tools, but must contemplate their pedagogical and critical appropriation. In order for the digital skills provided for in the BNCC to be effectively developed, the teacher needs to mobilize knowledge, skills, and attitudes that transform computational thinking, the digital world, and digital culture into contextualized, meaningful learning experiences aligned with the demands of contemporary society. In this horizon, Resolution CNE/CP No. 1/2020, which establishes the BNC-Formation, reinforces the need for teacher training to be continuous, collaborative and aligned with the real needs of school

contexts, structuring itself as an essential component of teacher professionalization and valorization.

Therefore, the legal documents analyzed here not only confer legitimacy, but also drive the modernization of pedagogical practices, especially with regard to teacher training and performance. The presence of technologies in the school context, when integrated with criticality and intentionality, contributes to the realization of the educational rights provided for in Brazilian legislation and to the construction of a school more connected with the challenges of the present and the future.

2.4 CONTINUING EDUCATION FOR THE USE OF DIGITAL TECHNOLOGIES

Continuing education is a key element for the meaningful integration of digital technologies into teaching practice. For Freire (1996, p. 39), "in the permanent training of teachers, the fundamental moment is that of critical reflection on their practice", allowing the teacher to understand, question and transform their pedagogical actions.

From this perspective, Nóvoa (2002; 2019; 2022) emphasizes that teacher professional development occurs in a collective and situated way, through dialogue between teachers and the shared construction of knowledge. Continuing education, therefore, cannot be conceived as a punctual or merely normative action, but as a permanent process, articulated with the real demands of the school context. Complementing this view, the author argues that continuing education should not be conceived as a punctual or merely normative action, but as a permanent process, articulated with practice and sustained by the teacher's commitment to his own learning. This means creating training paths that are relevant to the context of the teacher's work and that value their professional experience, while challenging them to explore new methodologies and languages.

Another important aspect highlighted by Tardif (2014) is that teaching knowledge is socially constructed, which implies recognizing the importance of exchanges and collaborative work among teachers. In this sense, continuing education should create spaces that favor the sharing of experiences, the collective construction of solutions and joint reflection on pedagogical practices mediated by technologies. The appropriation of digital resources, when discussed and experienced collectively, enhances innovation and strengthens the ability of teachers to respond to the needs and expectations of students in contemporary society.

In this way, the school must provide training that includes the development of new skills, attitudes and values, enabling individuals to use technologies in a critical and conscious way. However, education needs to overcome pedagogical practices that disregard the

communicative and interactive specificities of technology-mediated teaching, as the degree of interaction between participants is pointed out as fundamental for the quality of the educational process. (Moran, 2015)

Thus, continuing education in the use of digital technologies must go beyond the technical mastery of tools, incorporating ethical, pedagogical and collaborative dimensions. When organized in a reflective and collective way, training contributes to the strengthening of teacher autonomy, to pedagogical innovation and to the construction of more meaningful, inclusive educational practices aligned with the challenges of the twenty-first century.

3 METHODOLOGY

To meet the objectives of this article, regarding the methodological approach, qualitative research was chosen, since it focuses on significant contexts that involve the understanding of reality and the interpretation of phenomena in their natural environments, without manipulation of variables.

In this approach, qualitative research favors a critical understanding of the educational processes mediated by digital technologies, allowing the multiple dimensions of the phenomenon studied to be considered. The qualitative look is focused on the interpretation of the meanings attributed by the subjects to their practices, relationships and experiences in the contemporary educational environment. Thus, the study favors the analysis of interactions between teachers, technologies and pedagogical practices, considering the complexity and dynamics of current school contexts. This type of investigation does not propose to generalize results, but to deepen the analysis of relevant aspects of the educational reality.

The study is also characterized as exploratory, as it seeks to better understand a phenomenon still in the process of theoretical and practical consolidation in the field of education, contributing to the deepening of knowledge about teacher training in the face of the challenges of digital culture. For Sampieri, Collado and Lucio (1991), exploratory research seeks to understand phenomena that have been little studied, to collect preliminary information that allows for more detailed analyses and to guide the formulation of subsequent studies.

As an instrument of data collection, bibliographic research was adopted, based on the survey, analysis and interpretation of published works, such as books, scientific articles, official documents, dissertations, theses and institutional publications. According to Lima and Mito (2007), bibliographic research is an essential methodological procedure in the construction of scientific knowledge, as it allows the researcher to identify, systematize and

dialogue with different theoretical perspectives on a given object of study. Such a choice is consistent with the objective of the research, which proposes to critically reflect on the role of digital technologies in teacher training and in the teaching and learning processes, based on already consolidated references. Bibliographic research, in this sense, allows us to gather a theoretical framework that supports the proposed analysis and reflection, enabling a more in-depth and grounded look at the theme.

The choice of the Cetic.br platform (Regional Center for Studies for the Development of the Information Society) as the object of analysis is justified by its national and international credibility, recognized by bodies such as UNESCO, which designated it as a Regional Center for Studies (Cetic.br, 2023), and by the Federal Government, which uses its indicators to support digital transformation policies (Brazil, 2025). Linked to CGI.br and NIC.br, the Cetic.br produces research such as ICT Education, widely used in academic studies and by institutions. Its scientific relevance stems from the adoption of methodologies aligned with international standards (Observatório da imprensa, 2012), ensuring reliable data to understand the integration of digital technologies in education and their relationship with Brazilian public policies. These data constitute, therefore, the empirical basis that will be analyzed in the results of this work, allowing the articulation between the legal, theoretical and practical dimensions of teacher training for the use of digital technologies.

4 ANALYSIS OF RESULTS

Linked to the Brazilian Internet Steering Committee (CGI.br) and maintained by the Brazilian Network Information and Coordination Center (NIC.br), the Cetic.br is responsible for producing statistics and indicators on the access and use of information and communication technologies (ICTs) in the country. Its credibility is recognized by different agencies, being a reference for researchers, public managers and international institutions.

The Cetic.br has been designated by UNESCO as a Category 2 Centre, i.e. under its auspices and linked to the Communication and Information Sector (IC), one of the five UNESCO areas (CETIC.BR, 2023). This international link confers legitimacy to its studies and positions Brazil among countries that develop solid methodologies for measuring the information society. In addition, Cetic.br contributed to the formulation of the Internet Universality Indicators, approved by UNESCO, and participated in their pilot application in Brazil, reaffirming its technical and methodological authority (CETIC.BR, 2019).

In the national field, Cetic.br is widely used by government agencies in the formulation and monitoring of public policies related to digital inclusion, education, and digital transformation of the State. Reports such as the ICT Education and ICT Domiciles surveys

are recurrent references for the construction of diagnoses on digital inequalities and technological infrastructure in Brazil, subsidizing actions by the government. According to the Federal Government (2025), Cetic.br data have been fundamental to guide digital transformation strategies within the scope of public administration, evidencing institutional confidence in its indicators.

The credibility of the Cetic.br is also highlighted in academic and scientific circles. The Press Observatory (2012) highlighted that the Center has consolidated itself as a national reference in research on ICTs, adopting methodologies aligned with international standards, such as the Observatory of the Information Society in Latin America and the Caribbean (OSILAC) and the United Nations Economic Commission for Latin America (ECLAC).

In this sense, by adopting the 2024 data, being the most current, produced by the Cetic.br as an object of analysis, the present work is supported by highly reliable information, recognized both by international bodies, such as UNESCO, and by national bodies linked to education and public management. This guarantees not only the academic relevance of the choice, but also the scientific and social legitimacy of the results discussed.

4.1 CONTINUING EDUCATION: ADHERENCE AND GAPS

The data in Table 1 below, point to 54% of teachers with participation in continuing education in the last year and 46% without participation, reveal a partial adherence that points to relevant gaps for the training policy. This table shows that, despite the legal provisions (LDB; BNCC) and the guidelines that insist on continuous training, a significant portion of the teaching profession remains without effective access to training in digital technologies. The literature indicates that this gap compromises the implementation of the digital skills provided for in the BNCC, as the mere normative prescription does not guarantee the pedagogical appropriation of DICT by teachers (Nóvoa, 2019; Tardif, 2014).

Table 1

H3 - teachers who have participated in continuing education on the use of digital technologies in teaching and learning activities in the last 12 months

Participation in continuing education	Percentage (%)
Yes	54
No	46

Source: Adapted from Cetic.br, 2024.

Table 2 below reinforces the importance of training by pointing out that 76% of teachers report the contribution of training to the adoption of new practices and 69% show adaptation of teaching to the needs of students. These percentages indicate that when there

is training, the impact is considerable, which validates Nóvoa (2022) and Freire (1996) when they state that continuing education, when situated and reflective, promotes concrete changes in teaching practice. However, the difference between the reported effectiveness (Table 2) and the non-participation rate (Table 1) indicates a coverage deficit: the training that transforms practices does not reach all teachers, generating inequalities in the implementation of curricular guidelines.

Table 2

H9 - teachers, by perception of the level of contribution of continuing education activities carried out in the last 12 months to the adoption of new teaching and learning methodologies and practices mediated by digital technologies

Reported impact	Level of contribution	Percentage (%)
Guiding students on how to use digital technologies critically, safely, and responsibly	Very much	67
	Little	26
	Nothing	7
Support students when any sensitive situation occurs on the internet, such as cyberbullying, discrimination, or other situations	Very much	60
	Little	27
	Nothing	12
Teaching students how to protect their personal data, their digital identity and privacy on the Internet	Very much	51
	Little	31
	Nothing	19
Use digital technologies to adapt activities to students' learning rhythms	Very much	69
	Little	26
	Nothing	5
Adopt new teaching and learning methodologies and practices through digital technologies	Very much	76
	Little	22
	Nothing	1

Source: Adapted from Cetic.br, 2024.

Table 2 shows that training can transform practice; however, Table 1 highlighted the urgency of expanding coverage and ensuring equity in access to these trainings.

This scenario requires a critical reading of public policies: it is not enough to offer courses; it is necessary to guarantee access, continuity and institutional conditions for training to be effective (BNC-Formation; CNE/CP Resolution No. 1/2020). The presence of legislation that encourages continuing education dialogues with the data (BRASIL, 2020), but the divergence reveals implementation failures that may result from problems of time, funding, workload, and school prioritization, which must be investigated and addressed.

Furthermore, the articulation between these data and authors such as Perrenoud (2000) and Gadotti (2005) points to the need to rethink training as a continuous process, part of the professional routine and articulated with collaborative and reflective practices.

4.2 CULTURE OF COLLABORATION AND PROFESSIONAL DEVELOPMENT

Table 3 below indicates that 92% of teachers sought some professional development and 77% helped other educators, signaling a strong culture of self-development and peer cooperation. These data contribute to the idea of collective construction of teaching knowledge defended by Nóvoa (2002; 2019) and Tardif (2014), who see professional exchanges as a central space for training. The high rate of peer support reveals that professional self-organization is a real and present strategy among teachers, acting as a mechanism for the dissemination of practices and innovations.

Table 3

C4 - teachers, for the use of digital technologies in professional practice - professional development

Activity carried out	Percentage (%)
Sought professional development	92
They helped other educators	77

Source: Adapted from Cetic.br, 2024.

Table 4 below shows that 91% of teachers had to resort to videos/tutorials and other self-training resources, which shows a very strong phenomenon of informal and autonomous learning, the so-called lifelong learning. Although this behavior demonstrates proactivity, it refers to Freire's (2002) reflections: self-learning needs to be mediated by critical reflection and not only by technical consumption of procedures. The prevalence of videos and tutorials can produce instrumental competences, but it runs the risk of not developing critical pedagogical appropriation if it is not complemented by spaces for debate and collective experimentation.

Table 4

H1 - teachers, through self-training or in-service training on the use of digital technologies

Resource used	Percentage (%)
Training by the pedagogical coordinator or school principal	52
Training by other organisations outside the school	55
Online videos or tutorials	91
Courses from the government or other organizations	66

Source: Adapted from Cetic.br, 2024.

The articulation between self-education (Table 4) and peer support (Table 3) suggests that informal communities of practice play a central role in the diffusion of technological innovations. This phenomenon can be considered positive when it feeds reflexive exchanges that problematize the use of technology, which Tardif (2014) and Perrenoud already highlight:

learning from others enriches the professional repertoire and transforms experiential knowledge into socially validated knowledge.

However, the predominance of self-training also indicates the fragility of institutional systems of continuing education. The BNC-Formação and the CNE guidelines point to the need for mentoring, tutoring and modulated programs that complement and qualify this self-learning; without this, many teachers appropriate fragmented content of questionable quality (BRASIL, 2020). In practical terms, the data suggest the need for policies that articulate standardized resources (such as videos) with spaces for discussion, deepening and pedagogical supervision.

4.3 FORMATS AND THEMES OF TEACHER TRAINING

Table 5 below reveals a diversity of training formats such as: video classes; lectures; workshops; extension courses; among others, which indicates methodological flexibility in the offers. This plurality is in line with the recommendation of the BNC-Formação to adopt various training programs (BRASIL, 2020). Moran (2015) and Cortelazzo et al. (2018) advocate the combination of face-to-face and remote formats (blended learning) and active methodologies to promote more effective learning; Thus, the diversity found is positive if there is articulation between the formats and pedagogical intentionality.

Table 5

H4 - teachers, by type of continuing education activities in which they have participated in the last 12 months

Type of activity	Percentage (%)
Video lessons	84
Lectures with experts	61
Workshops or trainings	67
Extension courses	46

Source: Adapted from Cetic.br, 2024.

As for the themes present in Table 6 below: (use of technologies in evaluation, creation of digital content, media education, artificial intelligence, data protection), there is direct convergence with the digital competencies provided for in the BNCC (computational thinking, digital world, digital culture). Kenski (2012) and Barreto (2009) warn, however, that the treatment of these issues needs to be critical and contextualized, contemplating the ethical and political dimensions of technology (e.g., data protection, biases in AI). The presence of AI and data protection among the most worked on topics points to a formative response to emerging demands, which is positive from a curricular point of view.

Table 6

H7 - teachers, by themes of continuing education activities in which they have participated in the last 12 months

Theme worked	Percentage (%)
Use of technologies in the evaluation of student performance	75
Ways to guide students on the safe use of the computer, cell phone and the Internet	69
Educational content creation platforms, computer programs, or applications	82
Assessing the veracity of information and news and responsibly sharing content and opinions on the Internet	61
Protection of privacy and personal data in the use of the Internet	58
Computing, programming or robotics in education	39
Use of Artificial Intelligence in educational activities	59
Media education and critical use of media in the classroom	68
Use of digital technologies to adapt activities to students' learning rhythms	79

Source: Adapted from Cetic.br, 2024.

Despite this thematic correspondence, it is necessary to evaluate the depth with which each theme is worked: short workshops and tutorials can introduce tools, but they do not guarantee consolidated pedagogical understanding. Gadotti (2005) and Freire (2002) remind us that training should foster reflection, research and experimentation through modalities that require a more elaborate training organization than mere technical training.

Therefore, the centrality of themes related to evaluation, content production and media education signals a trend oriented towards daily teaching practice, which reinforces that training needs to dialogue with the real needs of classrooms, as already addressed by Tardif (2014), and not only with abstract technological trends. Training policies must ensure didactic sequence between learning about tools and their consequence in meaningful pedagogical practices.

4.4 PEDAGOGICAL PRACTICE WITH TECHNOLOGIES: PRESENCE AND DEPTH

Table 7 below indicates that 100% of teachers report using digital technologies in professional practice, a fact that confirms the real insertion of DICT in daily school life. However, the universality of use does not ensure the quality of this mediation: as Kenski (2003) and Contreras (2002) warn, it is essential to distinguish between instrumental use and intentional pedagogical integration. The widespread presence of technologies opens opportunities for active methodologies and personalization, but it can also disguise reproductive practices if there is no pedagogical reflection on purposes and effects.

Table 7

C20 - teachers, for the use of digital technologies in professional practice

Use of digital technologies	Percentage (%)
Yes, they use	100
Do not use	0

Source: Adapted from Cetic.br, 2024.

However, in an integrated way, the synthesis presented in Table 8 below shows that teacher training in Brazil, although expanding, still faces inequalities in access and limitations regarding the universalization of participation in formal continuing education programs.

Table 8

Synthesis of results on continuing education and the use of digital technologies by teachers (Cetic.br, 2024)

Thematic axis	Key findings	Evidence (Cetic.br, 2024)
Continuing education	Significant, but not universal, participation.	54% participated in the last year; 46% did not participate (Table 1).
Impacts of training	Direct repercussion on pedagogical innovation and adaptation to the needs of students.	76% have adopted new practices; 69% adapted teaching; (Table 2).
Professional development	Strong engagement in search of updating and collaboration among peers.	92% sought development; 77% supported other teachers (Table 3).
Teacher self-training	Digital resources are the most used to learn autonomously.	91% use online videos/tutorials; while a lower percentage sought other resources (Table 4).
Training activities	Predominance of video lessons	84% participated in video classes while a smaller percentage participated in other types of training activities (Table 5).
Training topics	Emphasis on the use of digital technologies, content production and evaluation.	75% cited the use of technologies in performance evaluation; 79% mentioned the use of technologies in the adaptation of activities (Table 6).
Use of digital technologies	Universalization of the use of DICT in the exercise of teaching.	100% reported using technologies (Table 7).

Source: the author, based on Cetic.br (2024).

Thus, it was demonstrated that the impacts reported in Table 2 (76% adoption of new practices; 69% adaptation of teaching) show that continuous training contributes significantly to transform practices. This confirms Nóvoa's (2022) thesis on the power of situated and collaborative training for pedagogical innovation. However, critical analysis must recognize that real transformation demands not only training, but changes in working conditions, pedagogical time and institutional support, elements that public policies need to consider.

The integration of DICT into the assessment, communication and production of content as demonstrated in (Table 6 and Table 7) requires multiple skills from teachers (Tardif, 2014): disciplinary mastery, technological skills, pedagogical knowledge and ethical mediation capacity (Barreto, 2009). The comparison of widespread use and impact reports signals advances, but the literature indicates that these advances are only consolidated when there are processes of monitoring, mentoring, and communities of practice that sustain changes in daily life (BRASIL, 2020; Freire, 2002).

The growing centrality of digital technologies in training processes is noted, both in face-to-face and online courses and in self-training practices, such as the use of videos and online tutorials. This scenario confirms Kenski's (2012) perspective, when he states that technologies profoundly reconfigure social and educational dynamics, requiring the school to adopt new attitudes towards digital culture.

5 FINAL CONSIDERATIONS

The data obtained in this research reinforce Moran's (2015) defense of the relevance of active and innovative methodologies, since they show that teachers who participate in continuing education tend to adopt new pedagogical practices, adapting teaching to the needs of students and expanding the use of DICT. This movement, however, is not limited to access to resources or tools, but requires pedagogical intentionality and critical reflection, as Freire (2002) points out, when he understands training as a process of awareness and transformation of practice.

In this sense, the universalization of the use of digital technologies, pointed out by Cetic.br (2024), needs to be understood beyond the simple presence of devices in the classroom. Nóvoa (2019, 2022) and Tardif (2014) recall that teacher training is a collective, historical practice marked by plural knowledge, built in the interaction between teachers, school contexts, and educational policies. Thus, training should not be reduced to a technical dimension, but conceived as a space for collaboration, sharing and reflection that enables the construction of transformative pedagogical practices.

The results of this research demonstrate that teacher training, when it critically integrates digital technologies, contributes not only to meeting the legal requirements expressed in the BNCC (2018) and BNC-Formação (2020), but also to the strengthening of inclusive, collaborative pedagogical practices aligned with contemporary challenges. The high rate of adherence to self-training methodologies and peer support also reveal the importance of communities of practice and the appreciation of teaching experience as central elements in the construction of professional knowledge.

Finally, the analysis shows that continuing education focused on the use of DICT cannot be understood as a punctual or merely normative action, but as a permanent, critical and reflective process, which recognizes the teacher as an active subject in his or her formative trajectory. By promoting conditions for teachers to develop digital skills in an ethical, meaningful and creative way, teacher training contributes to the construction of an innovative education, committed to the democratization of knowledge and prepared for the challenges of the 21st century.

REFERENCES

- Associação Brasileira de Normas Técnicas. (n.d.). Cetic.br é designado centro regional da UNESCO. CETIC.br. <https://www.cetic.br/noticia/cetic-br-e-designado-centro-regional-da-unesco/>
- Bacich, L., & Moran, J. (Eds.). (2018). Metodologias ativas para uma educação inovadora: Uma abordagem teórico-prática. Penso. (ISBN 978-85-8429-115-1; capítulos selecionados disponíveis em https://www.tecnodocencias.com/ava/pluginfile.php/2392/mod_resource/content/1/Metodologias%20Ativas%20para%20uma%20Educa%C3%A7%C3%A3o%20Inovadora%20Uma%20Abordagem%20Te%C3%B3rica-Pr%C3%A1tica%20by%20Lilian%20Bacich%20%20Jos%C3%A9%20Moran%20%5BBacich%2C%20Lilian%5D%20CAP%C3%8DTULOS%20SELECIONADOS.pdf)
- Barreto, R. G. (2009). Tecnologias na formação de professores: O discurso do MEC. Educação & Sociedade, 30(109), 939–964. <https://www.scielo.br/j/es/a/6tQGPd7z43KghwfybgBLM5M/?lang=pt>
- Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996. Estabelece as diretrizes e bases da educação nacional. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/leis/l9394.htm
- Brasil. (2023). Lei nº 14.533, de 11 de janeiro de 2023. Institui a Política Nacional de Educação Digital. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2023/lei/l14533.htm
- Brasil. Ministério da Educação. (2018). Base Nacional Comum Curricular. <https://basenacionalcomum.mec.gov.br>
- Brasil. Ministério da Educação. Conselho Nacional de Educação. (2020). Resolução CNE/CP nº 1, de 27 de outubro de 2020. Dispõe sobre as Diretrizes Curriculares Nacionais para a Formação Continuada de Professores da Educação Básica e institui a Base Nacional Comum para a Formação Continuada de Professores da Educação Básica (BNC-Formação Continuada). https://portal.mec.gov.br/index.php?option=com_docman&view=download&alias=164841-rcp001-20&category_slug=outubro-2020-pdf&Itemid=30192
- Brasil. Ministério da Gestão e da Inovação em Serviços Públicos. (2025, junho). Gestão debate o uso de dados para ajudar transformação digital do Estado. Governo do Brasil.

<https://www.gov.br/gestao/pt-br/assuntos/noticias/2025/junho/gestao-debate-o-uso-de-dados-para-ajudar-transformacao-digital-do-estado>

Cetic.br. (2019). NIC.br contribui com formulação de indicadores de universalidade da internet aprovados pela UNESCO. <https://cetic.br/es/noticia/nic-br-contribui-com-formulacao-de-indicadores-de-universalidade-da-internet-aprovados-pela-unesco/>

Cetic.br. (2024). TIC Educação – 2024: Professores. <https://cetic.br/pt/tics/educacao/2024/professores/>

Contreras, J. (2002). Autonomia de professores. Cortez.

Corrêa, C. P. Q., & Fernandes, M. M. da S. (2014). Formação docente na educação infantil: Desafios contemporâneos para a formação permanente. *Revista Eletrônica de Educação*, 16(30), 275–289. <https://doi.org/10.5007/1980-4512.2014n30p75>

Freire, P. (1996). *Pedagogia da autonomia: Saberes necessários à prática educativa* (25ª ed.). Paz e Terra.

Freitas, H. C. L. de. (2020, maio 20). BNC da Formação Continuada de Professores é apresentada pelo CNE sem consulta à área. *Formação de Professores – Blog da Helena*. <https://formacaoprofessor.com/2020/05/20/base-nacional-comum-da-formacao-continuada-de-professores-e-apresentada-pelo-cne/>

Gadotti, M. (2005). *Boniteza de um sonho: Ensinar e aprender com sentido*. Positivo.

Gómez, A. I. P. (2015). *Educação na era digital: A escola educativa* (M. Guedes, Trad.). Penso.

Imbernón, F. (2011). *Formação docente e profissional: Formar-se para a mudança e a incerteza*. Cortez.

Kenski, V. M. (2003). Aprendizagem mediada pela tecnologia. *Revista Diálogo Educacional*, 4(10), 47–56. <https://doi.org/10.7213/rde.v4i10.6419>

Kenski, V. M. (2012). *Educação e tecnologias: O novo ritmo da informação* (8ª ed.). Papirus.

Lévy, P. (1999). *Cibercultura*. Editora 34.

Moran, J. (2015). Mudando a educação com metodologias ativas. In C. A. de Souza & O. E. T. Morales (Orgs.), *Coleção Mídias Contemporâneas: Convergências midiáticas, educação e cidadania: Aproximações jovens* (Vol. II). Foca Foto-PROEX/UEPG.

Moran, J. M., Masetto, M. T., & Behrens, M. A. (2013). *Novas tecnologias e mediação pedagógica* (21ª ed. rev. e atual.). Papirus.

Neill, A. S. (2018). Educação online. In A. L. Cortelazzo et al., *Metodologias ativas e personalizadas de aprendizagem: Para refinar seu cardápio metodológico* (pp. 41–56). Alta Books.

Nóvoa, A. (2002). *Formação de professores e trabalho pedagógico*. Ed. Educa.

Nóvoa, A. (2019). Os professores e sua formação num tempo de metamorfose da escola. *Educação e Realidade*, 44(3), 1–15. <https://seer.ufrgs.br/index.php/educacaoerealidade/article/view/84910>

Nóvoa, A. (2022). Escolas e professores – Proteger, transformar, valorizar. SEC/IAT.

Observatório da Imprensa. (2012). Cetic.br, referência em pesquisas sobre as TICs.
https://www.observatoriodaimprensa.com.br/interesse-publico/_ed693_ceticbr_referencia_em_pesquisas_sobre_as_tics/

Pucci, R. H. P., Lima, M. O. C. dos S., & Souza, T. A. (2022). A implementação da BNCC: Ações para a formação continuada de professores de uma rede municipal paulista. In A. M. Gonçalves & K. C. Silva (Orgs.), Formação de professores: Aspectos históricos, políticos e profissionais. CRV.

Tardif, M. (2014). Saberes docentes e formação profissional (17^a ed.). Vozes.

ENVIRONMENTAL SUSTAINABILITY: EVIDENCE OF ENVIRONMENTAL PRACTICES AND ENVIRONMENTAL BEHAVIOR IN MICRO AND SMALL ENTERPRISES

SUSTENTABILIDADE AMBIENTAL: EVIDÊNCIAS DAS PRÁTICAS E DO COMPORTAMENTO AMBIENTAL EM MICRO E PEQUENAS EMPRESAS

SOSTENIBILIDAD AMBIENTAL: EVIDENCIAS DE LAS PRÁCTICAS Y DEL COMPORTAMIENTO AMBIENTAL EN MICRO Y PEQUEÑAS EMPRESAS



<https://doi.org/10.56238/sevened2026.008-041>

João Santana Alves¹, Cristina Gomes de Souza², Marcelo Jasmim Meiriño³, Julio Vieira Neto⁴

ABSTRACT

Environmental sustainability has assumed increasing relevance in the organizational context. Despite this prominence, the incorporation of environmental sustainability in micro and small enterprises (MSEs) occurs unevenly, marked by structural, operational, and managerial limitations that hinder the consolidation of systematic environmental practices. In MSEs, the engagement with environmental practices tends to occur in a fragmented manner, indicating the need for empirical approaches that consider learning processes, organizational routines, and structural capacities within the organizational process of internalization. In this context, the objective of this study is to analyze the environmental practices adopted by Brazilian MSEs, considering the articulation between organizational culture, environmental engagement, and environmental behavior as a process of incorporating environmental sustainability. Methodologically, the research is characterized as empirical, quantitative, and descriptive, with a cross-sectional design, operationalized through a survey applied to 225 Brazilian MSEs. Data were collected using a structured questionnaire with Likert-scale items and analyzed using descriptive statistics and Spearman correlation. The results indicate greater consolidation of practices associated with organizational culture and environmental engagement, while practices of a strategic nature show lower integration and greater heterogeneity among firms. The associations observed among the analyzed dimensions were predominantly weak and non-linear, indicating that advances in operational practices do not necessarily imply strategic institutionalization. These findings demonstrate that the incorporation of environmental sustainability in MSEs occurs gradually and incrementally, reinforcing its understanding as an organizational process conditioned by learning, routines, and structural capacities.

¹ Master's Degree in Management Systems. Universidade Federal Fluminense (UFF).

E-mail: joasantanaalves@id.uff.br

² Dr. in Production Engineering. Centro Federal de Educação Tecnológica Celso Suckow da Fonseca (CEFET/RJ). E-mail: cristina.souza@cefet-rj.br

³ Golden in Management Systems. Universidade Federal Fluminense (UFF). E-mail: marcelojm@id.uff.br

⁴ Gold in Civil Engineering. Universidade Federal Fluminense (UFF). E-mail: julion@id.uff.br

Keywords: Environmental Sustainability. Organizational Culture. Environmental Engagement. Environmental Behavior.

RESUMO

A sustentabilidade ambiental tem assumido crescente relevância no contexto organizacional. Apesar desse protagonismo, a incorporação da sustentabilidade ambiental nas Micro e pequenas empresas (MPEs), ocorre de forma desigual, marcada por limitações estruturais, operacionais e gerenciais que dificultam a consolidação de práticas ambientais sistemáticas. Percebe-se que, nas MPEs, o engajamento das práticas ambientais ocorre de maneira fragmentada, indicando a necessidade de abordagens empíricas que considerem processos de aprendizagem, rotinas organizacionais e capacidades estruturais no processo organizacional de internalização. Diante desse cenário, o objetivo deste estudo é analisar as práticas ambientais adotadas pelas MPEs brasileiras, considerando a articulação entre cultura organizacional, engajamento ambiental e comportamento ambiental como processo de incorporação da sustentabilidade ambiental. Metodologicamente, a pesquisa caracteriza-se como empírica, quantitativa e descritiva, com delineamento transversal, operacionalizada por meio de um survey aplicado a 225 MPEs brasileiras. O instrumento de coleta consistiu em um questionário estruturado com questões em escala Likert, e os dados foram analisados por meio de estatística descritiva e correlação de Spearman. Os resultados indicam maior consolidação das práticas associadas à cultura organizacional e ao engajamento ambiental, enquanto práticas de natureza estratégica apresentam menor integração e maior heterogeneidade entre as empresas. As associações observadas entre as dimensões analisadas foram predominantemente fracas e não lineares, evidenciando que avanços em práticas operacionais não implicam, necessariamente, na institucionalização estratégica. Esses achados demonstram que a incorporação da sustentabilidade ambiental nas MPEs ocorre de forma gradual e incremental, reforçando sua compreensão como um processo organizacional, condicionado por aprendizagem, rotinas e capacidades estruturais.

Palavras-chave: Sustentabilidade Ambiental. Cultura Organizacional. Engajamento Ambiental. Comportamento Ambiental.

RESUMEN

La sostenibilidad ambiental ha adquirido una relevancia creciente en el contexto organizacional. A pesar de este protagonismo, la incorporación de la sostenibilidad ambiental en las micro y pequeñas empresas (MPE) ocurre de manera desigual, marcada por limitaciones estructurales, operativas y gerenciales que dificultan la consolidación de prácticas ambientales sistemáticas. En las MPE, el compromiso con las prácticas ambientales tiende a manifestarse de forma fragmentada, lo que indica la necesidad de enfoques empíricos que consideren los procesos de aprendizaje, las rutinas organizacionales y las capacidades estructurales dentro del proceso organizacional de internalización. En este contexto, el objetivo de este estudio es analizar las prácticas ambientales adoptadas por las MPE brasileñas, considerando la articulación entre cultura organizacional, compromiso ambiental y comportamiento ambiental como un proceso de incorporación de la sostenibilidad ambiental. Metodológicamente, la investigación se caracteriza como empírica, cuantitativa y descriptiva, con un diseño transversal, operacionalizada mediante un survey aplicado a 225 MPE brasileñas. El instrumento de recolección consistió en un cuestionario estructurado con ítems en escala Likert, y los datos fueron analizados mediante estadística descriptiva y correlación de Spearman. Los resultados indican una mayor consolidación de las prácticas asociadas a la cultura organizacional y al compromiso ambiental, mientras que las prácticas de naturaleza

estratégica presentan menor integración y mayor heterogeneidad entre las empresas. Las asociaciones observadas entre las dimensiones analizadas fueron predominantemente débiles y no lineales, lo que evidencia que los avances en las prácticas operativas no implican necesariamente una institucionalización estratégica. Estos hallazgos demuestran que la incorporación de la sostenibilidad ambiental en las MPE ocurre de forma gradual e incremental, reforzando su comprensión como un proceso organizacional condicionado por el aprendizaje, las rutinas y las capacidades estructurales.

Palabras clave: Sostenibilidad Ambiental. Cultura Organizacional. Compromiso Ambiental. Comportamiento Ambiental.

1 INTRODUCTION

Environmental sustainability has consolidated itself as a central theme in the management of organizations, going beyond a strictly normative approach and assuming a strategic character associated with business performance and competitiveness (Barbieri, 2022; Chen et al., 2022; Khizar et al., 2023). International standards, such as ISO 14001 and ISO 26000, reinforce the systematic incorporation of environmental practices into organizational processes, emphasizing the integration between management, culture and behavior. (ISO, 2015; ISO, 2010). In addition, institutional and regulatory pressures increase the demand for coherence between environmental discourse and effective practices (Hatmanu et al., 2019; OECD, 2021).

In the context of Micro and Small Enterprises (MSEs), environmental sustainability assumes specific relevance due to the significant economic participation of this segment and the cumulative environmental impacts associated with its activities (IBGE, 2022; SEBRAE, 2022). However, these organizations face structural, managerial, and operational limitations that make it difficult to consolidate systematic and formalized environmental practices (Calisto et al., 2021; Rosa et al., 2022; OECD, 2021). As a consequence, internalization of environmental sustainability tends to occur incrementally, fragmented, and heterogeneously.

Therefore, the incorporation of environmental sustainability depends on the articulation between organizational culture, environmental engagement, and environmental behavior in the daily lives of organizations (Valdez-Juárez et al., 2019; Jabbour & Santos, 2021; Chen et al., 2023). Studies indicate that cultural values and sustained engagement processes guide recurrent environmental practices related to the use of resources, impact reduction, and internal awareness, according to ISO 26000 guidelines (ISO, 2010). In this way, these practices configure the environmental behavior associated with sustainability in the organizational context (Gao & Yang, 2022; Saez-Martínez et al., 2016; Rosa et al., 2022).

However, in the context of MSEs, there is a gap in terms of the integrated understanding of these elements. Empirical evidence indicates that the articulation between organizational culture, environmental engagement, and environmental behavior is still little explored in a systematic and empirically structured way in this size of companies (Calisto et al., 2021; Chen et al., 2022; Khizar et al., 2023). In particular, the analyses that allow us to understand how these dimensions are articulated in the organizational daily life of MSEs remain limited, in the light of normative references of environmental sustainability (ISO, 2018; ABNT, 2021; OECD, 2021).

In this context, the research question that guides this study is: how do the environmental practices adopted by MSEs articulate between organizational culture,

environmental engagement and environmental behavior in the process of incorporating environmental sustainability? Thus, the objective of this study is to analyze the environmental practices adopted by Brazilian MSEs, considering the articulation between organizational culture, environmental engagement and environmental behavior as a process of incorporating environmental sustainability. To meet this objective, the study adopts the empirical procedure and the quantitative approach, using an instrument aligned with international standards and institutional guidelines, as detailed in the methodological section.

2 THEORETICAL FRAMEWORK

2.1 ENVIRONMENTAL SUSTAINABILITY IN THE CONTEXT OF ORGANIZATIONS

Environmental sustainability has consolidated itself as a strategic factor for competitiveness and organizational performance, going beyond a merely normative approach (Barbieri, 2022; Chen et al., 2022). This position stems from the need to integrate environmental issues into business management, guiding decisions and organizational behaviors (Khizar et al., 2023). Standards such as ISO 14001 and ISO 26000 reinforce this logic by emphasizing the systematic incorporation of sustainability into internal processes (ISO, 2015; ISO, 2010).

In addition to technical standards, organizations have been increasingly pressured by regulatory, social, and market requirements that condition their corporate responsibility (OECD, 2021). In this context, such pressures stimulate organizational responses that go beyond legal compliance, requiring transparency, institutional coherence, and legitimacy before the market (Hatmanu et al., 2019). In the Brazilian case, the National Environmental Policy (PNMA), as well as the guidelines of the *Global Reporting Initiative* (GRI) and ABNT PR 2030, reinforce the need to structure and communicate environmental practices in a systematic and reliable way (Brasil, 1981; GRI, 2021; ABNT, 2021).

In addition, environmental sustainability is linked to global agendas, especially the 2030 Agenda, proposed by the United Nations (UN) (UN, 2015). In this sense, the Sustainable Development Goals (SDGs) reinforce the need for integrated, measurable environmental practices incorporated into the management of organizations (UN, 2015). In a complementary way, the ABNT PR 2030 standard contributes to operationalizing these commitments by translating global guidelines into normative references applicable to the business context (ABNT, 2021).

In this way, the articulation between global agendas, technical standards and institutional guidelines condition organizational performance and create an environment in

which cultural values, engagement processes and environmental behaviors begin to be structured internally, in the context of MSEs (UN, 2015; ABNT, 2021; OECD, 2021).

In this sense, environmental sustainability assumes specific relevance due to the significant economic participation of this segment and the cumulative environmental impacts associated with its activities (IBGE, 2022; SEBRAE, 2022). However, small business organizations face structural and managerial limitations that make it difficult to consolidate systematic environmental practices (Calisto et al., 2021; OECD, 2021). Therefore, these restrictions compromise the formalization of operational practices and the incorporation of environmentally sustainable routines into the organizational culture (Rosa et al., 2022).

2.2 ORGANIZATIONAL CULTURE AS THE BASIS OF ENVIRONMENTAL PRACTICES

Organizational culture constitutes the structuring basis for the incorporation of environmental sustainability in organizations, by guiding values, beliefs, and patterns of behavior shared among employees (Valdez-Juárez et al., 2019; Jovanovic et al., 2017). According to Khizar et al., (2023), organizations with internalized environmental values tend to have greater consistency between discourse and practice. These cultural elements influence how environmental practices are perceived, prioritized, and legitimized internally (Chen et al., 2022).

The dissemination of environmental values occurs when training, qualification, and educational materials reinforce technical standards and institutional guidelines in the organizational routine (Valdez-Juárez et al., 2019; Chen et al., 2022). In addition, standards such as ISO 14001 and ISO 26000 highlight awareness and the development of skills as pillars for the consolidation of environmental practices in organizations (ISO, 2015; ISO, 2010). Consequently, environmental culture is not established by one-off or isolated actions, but by continuous organizational learning processes that guide workers' behavior over time (Gao & Yang, 2022).

In MSEs, organizational culture plays an even more relevant role due to the proximity between leadership and employees, and less formalization of internal processes (Calisto et al., 2021). In this context, managers' perceptions influence the prioritization of environmental practices and the way these practices are interpreted internally (Valdez-Juárez et al., 2019; Rosa et al., 2022). However, structural and operational limitations can make it difficult to consolidate these values in organizational routines (Gao & Yang, 2022). In this way, organizational culture is a necessary basis for the development of environmental engagement in MSEs (Chen et al., 2022).

In addition, organizational culture acts as a mediation mechanism between institutional guidelines and the environmental behavior observed in organizations (Chen et al., 2023). When environmental values are shared, practices tend to be reproduced more consistently, reducing reliance on formal and regulatory controls (Khizar et al., 2023). In the context of MSEs, this cultural mediation becomes decisive for the continuous internalization of environmental sustainability (Calisto et al., 2021). Thus, organizational culture establishes the conceptual link that sustains environmental engagement as an organizational process.

2.3 ENVIRONMENTAL ENGAGEMENT AS AN ORGANIZATIONAL PROCESS

Environmental engagement should be understood as an organizational process, rather than an individual disposition (Gao & Yang, 2022). This process operates as a mediation between cultural values and the institutionalization of environmental practices in everyday business (Saez-Martínez et al., 2016). Chen et al., (2022). They indicate that engagement is sustained when the organization structures conditions for recurrent participation of workers and collective learning. In this way, environmental engagement connects cultural values to the company's strategic actions (Gao & Yang, 2022; Chen et al., 2022).

In this context, internal campaigns and systematic awareness actions guide daily choices and operational routines, by encouraging practices aligned with the responsible use of natural resources (Rosa et al., 2022; Gao & Yang, 2022). In addition, the monitoring of energy and water consumption, as well as the adoption of procedures for separating and properly disposing of waste, reinforce the internalization of environmentally sustainable behaviors in the organizational environment (ISO, 2015; Chen et al., 2022). In this way, environmental engagement ceases to assume a one-off character and starts to structure recurring actions integrated with the SDGs (Khizar et al., 2023). As a result, these initiatives contribute to the construction of shared meanings, by aligning individuals' understanding of environmental sustainability (Veronica et al., 2020).

In addition, recent studies show that engagement is consolidated when initiatives, such as educational campaigns, environmental goals, and operational guidelines, are accompanied by consistent and continuous internal communication (Khizar et al., 2023). Rosa et al., (2022) reinforces that these attitudes strengthen environmental engagement by expanding the collective involvement of employees. In this way, environmental engagement ceases to be episodic and begins to assume an organizational and procedural character, supported by recurrent practices (Gao & Yang, 2022; Chen et al., 2022). Which are associated with the sustainable use of natural resources, pollution prevention, mitigation of climate impacts and protection of biodiversity, according to the guidelines of ISO 26000 (ISO, 2010).

In less formalized organizational contexts, environmental engagement faces relevant structural limitations (Calisto et al., 2021; OECD, 2021). In particular, the scarcity of financial, human, and technical resources, coupled with low process standardization, constrains the organizational capacity to sustain ongoing environmental practices (Gao & Yang, 2022; SEBRAE, 2022). These limitations make it difficult to consolidate recurrent environmental actions in the organizational daily life (Veronica et al., 2020). Calisto et al. (2021) highlight that, under these conditions, engagement tends to depend heavily on specific initiatives and relational proximity between managers and teams. Consequently, the engagement process becomes more susceptible to discontinuity and fragmentation of environmental practices over time (Rosa et al., 2022; Khizar et al., 2023).

Therefore, leadership and internal communication play a central role in the institutionalization of environmental engagement in MSEs (Gao & Yang, 2022). In this sense, the clarity of the messages and the coherence between managerial discourse and the practices adopted directly influence the collective mobilization around environmental issues (Veronica et al., 2020). When this alignment is fragile, organizational involvement tends to be restricted to isolated actions, without operational continuity (Khizar et al., 2023). Thus, environmental engagement is a necessary organizational condition for cultural values to become standards for environmental behavior, constituting the empirical basis of environmental practices in organizations (Saez-Martínez et al., 2016; Chen et al., 2022).

2.4 ENVIRONMENTAL BEHAVIOR AS ORGANIZATIONAL EMPIRICAL EVIDENCE

Organizational environmental behavior corresponds to the concrete expression of cultural values as the process of engaging environmental practices in business routines (Chen et al., 2022). Unlike institutional discourses, behavior is manifested by recurrent actions in the productive daily life of companies (Jabbour & Santos, 2021). Khizar et al., (2023); Rosa et al., (2022); Chen et al., (2022) reinforce that these actions reflect on the incorporation of practices related to the rational use of resources, impact reduction, and environmental awareness into corporate sustainability (ISO, 2015).

These behaviors tend to emerge when engagement is sustained by recurrent internal processes, capable of guiding workers in operational processes and work routines (Saez-Martínez et al., 2016; Gao & Yang, 2022). Gao & Yang, (2022; Khizar et al., (2023) indicate that isolated or one-off initiatives do not reinforce structured environmental behavior. Thus, environmental behavior results from the systematic repetition of practices associated with environmental issues, central dimensions of the empirical investigation of this study (Rosa et al., 2022; ISO, 14004, 2016).

In the context of MSEs, environmental behavior is strongly conditioned by organizational and operational constraints (Calisto et al., 2021; OECD, 2021). In these organizations, behaviors related to the use of energy, water, and other resources vary according to the internal context, communication, and managerial priorities (Veronica et al., 2020; Gao & Yang, 2022). This variability reinforces the need to empirically observe how these practices manifest themselves in the organizational daily life of MSEs (IBGE, 2022; SEBRAE, 2022).

In this way, environmental behavior allows us to empirically examine how organizational culture and engagement processes translate into effective and recurring practices (Chen et al., 2023; Jabbour & Santos, 2021). The observation of these behaviors makes it possible to identify patterns, operational limitations, and levels of consistency between environmental discourse and action (Khizar et al., 2023; Hatmanu et al., 2019). For this, it is necessary to use instruments capable of capturing practices of environmental issues in a systematic, comparable and aligned way with the normative references of environmental sustainability (ISO, 2018; ABNT, 2021). This analytical chain underlies the methodological options adopted in this study and guides the empirical operationalization of environmental practices.

3 METHODOLOGY

3.1 STAGES OF THE RESEARCH

The research is characterized as empirical, quantitative and descriptive, with a cross-sectional design, an approach widely used in organizational studies that seek to examine business practices based on structured data collected at a single time (Creswell, 2014; Gil, 2019; Hair et al., 2009; Severo; Guimarães, 2017; Barbieri, 2022; Jabbour; Santos, 2021). This type of design is recommended when the objective is to identify patterns, trends, and variability of attitudes, without the intention of establishing causal relationships (Gil, 2019; Hair et al., 2009; Marôco, 2014).

The methodological design was structured in three complementary stages. The first stage consisted of the theoretical foundation on organizational culture, environmental engagement, and environmental behavior, based on empirical and conceptual studies consolidated in the international literature (Valdez-Juárez et al., 2019; Gao & Yang, 2022; Rosa et al., 2022; Chen et al., 2022; Khizar et al., 2023; Jabbour; Santos, 2021). The second stage involved the construction of the empirical instrument, guided by recognized standards and guidelines for environmental management and performance (ABNT, 2021; ISO, 2018; ISO, 2010; Barbieri, 2022).

The third stage comprised the collection and statistical treatment of data, following procedures consolidated in the methodological literature for quantitative, descriptive and inferential research (Creswell, 2014; Gil, 2019; Hair et al., 2009; Marôco, 2014; Damásio, 2012; Severo; Guimarães, 2017). This chain ensured the coherence between the research problem, the theoretical framework, the empirical instrument and the analytical techniques adopted.

3.2 DATA COLLECTION AND COLLECTION

The data collection instrument was developed based on the guidelines of ABNT PR 2030 and ISO 14031, which orbited the analysis of the environmental practices adopted by Brazilian MSEs, considering the articulation between organizational culture, environmental engagement, and environmental behavior as a process of incorporating environmental sustainability (ABNT, 2021; ISO, 2018; Barbieri, 2022; Jabbour; Santos, 2021; Chen et al., 2023; OECD, 2021). In a complementary way, the principles of ISO 26000 were considered, which deals with the main issues as the main SDGs (ISO, 2010; Hatmanu et al., 2019).

The questionnaire was structured in 15 questions. Questions Q1 to Q3 characterize the profile of respondents and companies, while questions Q4 to Q13 assess environmental practices associated with organizational culture, environmental engagement, and environmental behavior, using a five-point Likert scale, suitable for ordinal data (Creswell, 2014; Hair et al., 2009; Marôco, 2014; Damásio, 2012; Severo; Guimarães, 2017). The open questions Q14 and Q15 complement the analysis by capturing aspects related to transparency, communication, and institutional articulation (Veronica et al., 2020; Rosa et al., 2022; Hatmanu et al., 2019).

Data collection took place between October and December 2024, through the *Google Forms* platform, using non-probabilistic convenience sampling, a technique indicated for heterogeneous and hard-to-reach populations (Gil, 2019; Creswell, 2014; Hair et al., 2009; Marôco, 2014). The final sample was composed of 225 MSEs certified or in the process of certification by Sistema B Brasil. The final structure of the instrument, with the link between the questions, the theoretical axes and the authors on which it was based, is presented in Table 1.

Table 1

Data Collection Instrument

No.	Issue:	Theoretical axis	Reference authors
-----	--------	------------------	-------------------

Q1	What is your greatest academic training completed?	Organizational culture	Valdez-Juárez et al. (2019); Chen et al. (2022); Rosa et al. (2022)
Q2	What is your relationship, knowledge or experience on environmental issues?	Organizational culture	Gao & Yang (2022); Chen et al. (2022); Valdez-Juárez et al. (2019)
Q3	What is the company's field of activity?	Environmental behavior	Calisto et al. (2021); Veronica et al. (2020); OECD (2021)
Q4	Does the company conduct environmental training (e.g., recycling, safe disposal)?	Organizational culture	Calisto et al. (2021); Valdez-Juárez et al. (2019); Chen et al. (2023)
Q5	Does the company promote training of managers in sustainability?	Organizational culture	Gao & Yang (2022); Chen et al. (2023); Jabbour & Santos (2021)
Q6	Does the company use renewable or clean energy sources?	Environmental engagement	Nguyen & Tran (2020); Rosa et al. (2022); Khizar et al. (2023)
Q7	Does the company promote campaigns on the rational use of energy or natural resources?	Environmental engagement	Gao & Yang (2022); Veronica et al. (2020); Rosa et al. (2022)
Q8	Does the company provide educational materials on sustainability and climate change?	Organizational culture	Valdez-Juárez et al. (2019); Chen et al. (2022); Rosa et al. (2022)
Q9	Does the company integrate environmental practices into corporate policies?	Environmental behavior	Chen et al. (2023); Calisto et al. (2021); Jabbour & Santos (2021)
Q10	Does the company make employees aware of biodiversity preservation?	Environmental engagement	Rosa et al. (2022); Gao & Yang (2022); Saez-Martínez et al. (2016)
Q11	Does the company raise awareness about reducing the consumption of natural resources?	Environmental engagement	Nguyen & Tran (2020); Valdez-Juárez et al. (2019); Khizar et al. (2023)
Q12	Does the company raise awareness for the rational use of water?	Environmental engagement	Rosa et al. (2022); Calisto et al. (2021); Nguyen & Tran (2020)
Q13	Does the company adopt environmental policies integrated with the SDGs?	Environmental behavior	Chen et al. (2023); Veronica et al. (2020); OECD (2021)

Q14	Does the company publicly report on its environmental actions?	Environmental behavior	Hatmanu et al. (2019); Veronica et al. (2020); GRI (2021)
Q15	Does the company develop environmental actions in partnership with institutions?	Environmental behavior	Gao & Yang (2022); Rosa et al. (2022); Saez-Martínez et al. (2016)

Source: Prepared by the author (2025).

3.3 DATA ANALYSIS

The collected data were organized and analyzed with the aid of the *R software*, using *RStudio* 2025.09.2. The analysis followed methodological recommendations for the treatment of ordinal data and for the application of statistics in the social sciences (Hair et al., 2009; Marôco, 2014; Damásio, 2012; Field, 2013; Barbetta, 2017; Gil, 2019). Thus, all analyses respected the nature of the data and the empirical design of the research.

The initial analysis focused on descriptive statistics, with the use of absolute and relative frequencies to characterize the profile variables of the respondents and the companies. As well as median and Interquartile Range (IQR) for environmental issues on the *Likert scale*, adequate measures for ordinal data (Hair et al., 2009; Marôco, 2014; Damásio, 2012; Barbetta, 2017; Severo; Guimarães, 2017). This information allowed the sample to be contextualized in terms of individual and organizational characteristics, without inferential purpose, according to the methodological literature on descriptive statistics in social research (Barbetta, 2017; Gil, 2019).

The internal consistency of the instrument was assessed using Cronbach's alpha coefficient, applied to the set of questions Q4 to Q13, according to recommendations for Likert-type scales (Hair et al., 2009; Gliem; Gliem, 2003; Marôco, 2014; Nunnally; Bernstein, 1994; Damásio, 2012). The value obtained indicated adequate internal consistency, validating the joint use of the items.

In addition, inferential analyses were performed using *Spearman's* correlation between questions Q4 and Q13, a technique indicated for ordinal variables and adequate to identify monotonic associations between environmental practices (Hair et al., 2009; Marôco, 2014; Field, 2013; Damásio, 2012; Gil, 2019). The correlations were interpreted as to the direction and intensity of the associations, without presupposition of causality. Thus, the procedure made it possible to identify patterns of association between the environmental practices analyzed, in line with the descriptive design of the study (Hair et al., 2009; Marôco, 2014).

3.4 RELIABILITY AND VALIDITY

The reliability of the instrument was evaluated using Cronbach's alpha coefficient, widely used to verify the internal consistency of Likert-type scales (Hair et al., 2009; Gliem; Gliem, 2003; Marôco, 2014; Nunnally; Bernstein, 1994; Damásio, 2012). The procedure was applied to the set of questions Q4 to Q13, according to methodological recommendations for psychometric instruments. The coefficient obtained presented a value equal to or greater than the threshold of 0.70, considered a reference for acceptable reliability in the literature (Nunnally; Bernstein, 1994; Hair et al., 2009; Marôco, 2014). In this way, the questions could be used together in the analysis of environmental practices (Gliem; Gliem, 2003; Damásio, 2012).

Content validity resulted from the alignment between the theoretical constructs adopted, the international standards that guided the elaboration of the questions, and empirical studies on environmental practices in MSEs (Barbieri, 2022; Jabbour; Santos, 2021; ABNT, 2021; ISO, 2018; Chen et al., 2023; OECD, 2021). This alignment ensured that the items adequately represented the concepts investigated in the study. Thus, the instrument maintained conceptual coherence with the theoretical and normative framework used.

Construct validity was examined based on the coherence of the association patterns observed between the items, considering their adherence to the literature and to the normative references of environmental management (Hair et al., 2009; Damásio, 2012; Marôco, 2014; Chen et al., 2022; Khizar et al., 2023). The observed associations were interpreted in a manner consistent with the defined theoretical constructs. Thus, the procedures adopted ensured coherence between theory, empirical instrument and statistical analysis, in accordance with the descriptive design of the study.

4 RESULTS AND DISCUSSIONS

4.1 DESCRIPTIVE RESULTS

The descriptive analysis allowed to characterize the distribution of environmental practices adopted by MSEs from questions Q4 to Q13, organized in the axes organizational culture, environmental engagement and environmental behavior. Frequencies, median, and interquartile range (IQR) were used, which are appropriate measures for ordinal data from Likert scales (Hair et al., 2009; Marôco, 2014; Barbetta, 2017). This procedure is recommended when the objective is to describe patterns without assuming normality of the data (Field, 2013). The approach is consistent with empirical studies on environmental practices in small businesses (Barbieri, 2022; Chen et al., 2022; Rosa et al., 2022).

The data in Table 2 show the respondents' academic background (Q1). The results indicate high education of the respondents, with 53.8% having a specialization and 23.1% having a master's degree. The literature points out that higher educational levels are fundamental for organizational learning and greater assimilation of environmental practices (Valdez-Juárez et al., 2019; Chen et al., 2022). This profile reduces comprehension biases in self-report-based research (Creswell, 2014; Gil, 2019). ISO 14001 recognizes training as a structuring element on organizational environmental sustainability (ISO 14001).

Table 2

Respondents' education (Q1)

Education	Percentage (%)
Specialization (lato sensu / mba)	53,8
Master's Degree	23,1
Graduation	15,4
PhD	1,9
Other	5,8

Source: Prepared by the author (2025).

Regarding environmental knowledge (Q2), most respondents reported medium or high environmental knowledge (Table 3). The results indicate that 48.0% of the respondents declared a high level and 38.5% a medium level, while 13.5% indicated low knowledge. Empirical evidence shows that higher levels of knowledge precede the formalization of practices and influence the consolidation of environmental culture (Valdez-Juárez et al., 2019; Rosa et al., 2022). Gao and Yang (2022) highlight that knowledge applied to organizational daily life strengthens environmental routines. This finding reinforces that these actions reflect on the incorporation of practices related to the rational use of resources, the reduction of impacts and environmental awareness into corporate sustainability (ISO, 2015).

Table 3

Knowledge and experience in environmental issues (Q2)

Declared level	Percentage (%)
High	48,0
Medium	38,5
Low	13,5

Source: Prepared by the author (2025).

On the other hand, the presence of 13.5% of respondents with low knowledge shows relevant variability among the MSEs analyzed. This variability is recurrent in organizational

studies involving heterogeneous populations (Hair et al., 2009; Marôco, 2014). Rosa et al. (2022) associate this heterogeneity with structural and contextual differences of workers that affect business behavior. Thus, the results indicate that the level of environmental knowledge is not homogeneous among MSEs, constituting a relevant conditioning factor for the incorporation of environmental practices.

As for the sector of activity (Q3), the predominance of the services sector (75%), followed by trade (15.6%) and industry (9.4%) was observed. This pattern is consistent with national institutional data, which indicate a greater concentration of MSEs in the services and trade sectors due to the lower initial capital requirement and greater operational flexibility (IBGE, 2022; SEBRAE, 2022). Thus, the lower participation of the industrial sector is associated with higher regulatory requirements and operating costs, which tend to hinder the institutionalization of environmental sustainability in MSEs in this segment (Calisto et al., 2021; Rosa et al., 2022).

The environmental practices Q4 to Q13 presented medians between 2.0 and 4.0, as shown in Table 4. Operational and educational practices, such as environmental training (Q4; median = 4.0; IQR = 1.0) and rational use campaigns (Q7; median = 4.0; IQR = 2.0), showed greater centrality. Educational actions tend to be the first to be incorporated (Rosa et al., 2022; Gao & Yang, 2022). ISO 14001 highlights training as an initial stage of environmental management. These results highlight training as an initial stage, which reflects engagement in environmental practices.

On the other hand, practices of a strategic nature, such as integration with corporate policies (Q9) and alignment with the SDGs (Q13), showed lower medians and greater dispersion, (Q9; median = 3.0; IQR = 3.0) and SDG-aligned policies (Q13; median = 2.0; IQR = 3.0). The literature points out that strategic institutionalization occurs after the consolidation of operational routines (Calisto et al., 2021; Jabbour & Santos, 2021). ISO 14031 highlights the progressiveness in the evolution of environmental sustainability. These values show low uniformity and lack of strategic homogeneity among the MSEs.

Table 4

Descriptive statistics of environmental practices (Q4–Q13)

Issue:	Environmental practice	Median	IQR
Q4	Environmental training	4,0	1,0
Q5	Training of managers	3,5	2,0
Q6	Use of renewable energy	3,0	2,5
Q7	Rational use campaigns	4,0	2,0
Q8	Educational materials	4,0	2,0

Q9	Integration with corporate policies	3,0	3,0
Q10	Biodiversity awareness	3,0	2,0
Q11	Reduction of natural resource consumption	3,0	2,5
Q12	Rational use of water	3,0	2,0
Q13	Environmental policies integrated with the SDGs	2,0	3,0

Source: Prepared by the author (2025).

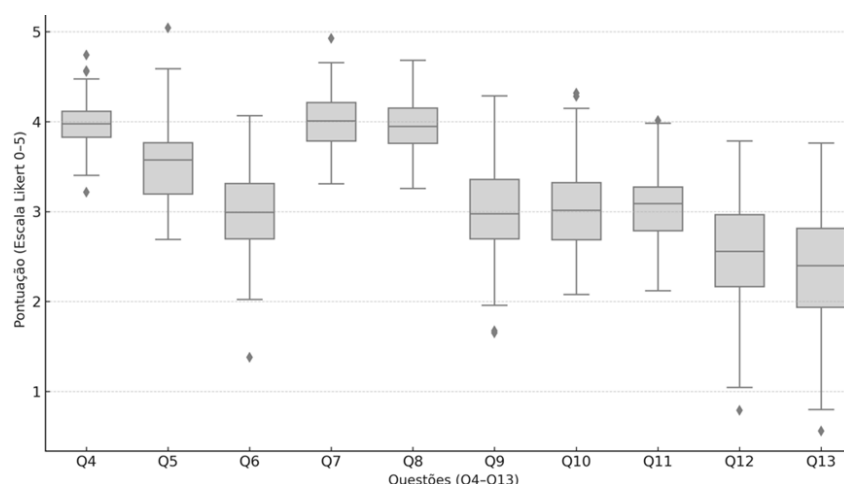
Figure 1 presents the *boxplots* of questions Q4 to Q13, allowing the visualization simultaneously of the central position (median) and the dispersion of the answers (IQR), a recommended procedure for the analysis of ordinal data on *Likert* scales (Marôco, 2014). It is observed that Q13 has lower medians and high IQR, indicating high variability and heterogeneity in practices of a more strategic and institutional nature.

In addition, questions Q9, Q10 and Q11 exhibit intermediate medians (≈ 3.0) and comparable dispersion, suggesting moderate adoption of these practices, but with relevant differences between MSEs. This visual pattern corroborates the numerical results presented in Table 3 and reinforces the adequacy of the IQR as a central descriptive measure (Marôco, 2014).

In contrast, questions Q4, Q7 and Q8 have higher medians (≈ 4.0) and less dispersion, evidencing greater recurrence and uniformity of educational, awareness and training practices in the organizational routine of MSEs. Institutional evidence indicates that strategic, governance, and alignment practices with SDG Q13 require greater organizational capacity and formalization of processes, which represents a recurring challenge for small businesses (OECD, 2021; SEBRAE, 2022).

Figure 1

Boxplots of environmental practices (Q4–Q13)



Source: Prepared by the author (2025).

The practices related to the rational use of energy, water and natural resources, Q6, Q11 and Q12, presented intermediate medians around 3.0, and IQR varying approximately between 3.0 and 2.5, as evidenced in Figure 1. This pattern indicates moderate adoption, but with variability among companies, characteristic of practices that depend on continuous organizational engagement and routines that are still being consolidated (Saez-Martínez et al., 2016; Gao & Yang, 2022). The literature associates this variability with limited resources and less formalization of processes in MSEs (Calisto et al., 2021). ISO 14004 recognizes these practices as operational and strongly dependent on internal engagement, which explains the observed dispersion.

The open questions Q14 and Q15 show the predominance of informal communication and occasional institutional partnerships, a recurrent pattern in MSEs. Institutional evidence shows that this business size uses simplified records and social networks as the main means of environmental communication, due to structural constraints and organizational capacity (UN, 2018; GRI, 2021; OECD, 2021). These findings reinforce the heterogeneity observed in the descriptive results.

In summary, the descriptive results indicate greater consolidation of practices associated with organizational culture and environmental engagement, evidenced by higher medians and less dispersion in Q4, Q7 and Q8 (median ≈ 4.0). In contrast, strategic and institutional practices, such as integration with corporate policies (Q9) and alignment with the SDGs (Q13), have lower medians (≈ 3.0 and ≈ 2.0) and high IQR, indicating heterogeneity among MSEs (Barbieri, 2022; Chen et al., 2022; Rosa et al., 2022). The guidelines of ISO 14001 and ISO 14031 corroborate this progressive process of consolidation, in which operational practices tend to precede strategic institutionalization. This chain is the basis for the following subsection, dedicated to the inferential analysis of the associations between the items of the instrument.

4.2 INFERENTIAL RESULTS

The inferential analysis examined the associations between the environmental practices of questions Q4 to Q13, aligned with the axes of organizational culture, environmental engagement, and environmental behavior of the instrument (Gil, 2019; Creswell, 2014). To this end, Spearman's correlation was adopted, indicated for ordinal data on a Likert scale and appropriate for investigating monotonic associations without assuming normality or linearity (Hair et al., 2009; Marôco, 2014).

This methodological decision maintained coherence with the descriptive and cross-sectional design and with the measurement logic recommended for environmental practices

in MSEs (Damásio, 2012; Field, 2013). The interpretation of the associations was conducted in line with the normative references of environmental sustainability (ISO, 2018; ABNT, 2021).

The internal consistency of questions Q4 to Q13 was assessed using *Cronbach's alpha*, obtaining $\alpha = 0.94$, a value classified as excellent in the psychometric literature and quantitative methods (Nunnally; Bernstein, 1994; Hair et al., 2009). This result indicated high coherence between the items, supporting the joint reading of the practices as an empirical domain related to the internalization and engagement of sustainability in the organizational daily life (Marôco, 2014; Damásio, 2012).

In normative terms, consistency was compatible with the need for systematic instruments to monitor environmental practices, as emphasized by recognized environmental management and assessment guidelines (ISO, 2018; ABNT, 2021). Thus, the reliability observed reinforced the robustness of the instrument by sustaining the inferential discussion in the context of MSEs (Gil, 2019; Barbieri, 2022). Table 4 shows Spearman's matrix of correlations between the questions of the instrument.

In the organizational culture axis. Positive and low-magnitude associations were observed between environmental training (Q4) and managers' training (Q5; $\rho = 0.11$), as well as between (Q4) and educational materials (Q8; $\rho = 0.03$) and between Q5 and Q8 ($\rho = 0.02$). These coefficients suggest the coexistence of training practices, but without strong interdependence, consistent with the view of learning and culture as incremental and heterogeneous processes in MSEs (Valdez-Juárez et al., 2019; Gao & Yang, 2022). This evidence dialogues with the role of awareness as a structuring requirement for environmental practices, according to management guidelines and organizational responsibility (ISO, 2015; ISO, 2010).

Table 5

Correlation matrix between the questions in the questionnaire

Issue:	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13
Q4	1,00	0,11	—	—	0,03	—	—	—	—	—
Q5	0,11	1,00	—	—	0,02	—	—	—	—	—
Q6	—	—	1,00	0,10	—	—	0,08	-0,13	0,06	—
Q7	—	—	0,10	1,00	—	—	0,05	0,05	-0,01	—
Q8	0,03	0,02	—	—	1,00	—	—	—	—	—
Q9	—	—	—	—	—	1,00	—	—	—	0,04
Q10	—	—	0,08	0,05	—	—	1,00	0,03	0,12	—
Q11	—	—	-0,13	0,05	—	—	0,03	1,00	0,15	—
Q12	—	—	0,06	-0,01	—	—	0,12	0,15	1,00	—
Q13	—	—	—	—	—	0,04	—	—	—	1,00

Source: Prepared by the author (2025).

In the environmental engagement axis, the associations between the use of renewable energy (Q6) and campaigns for the rational use of resources (Q7; $p = 0.10$), awareness about biodiversity (Q10; $p = 0.08$) and rational use of water (Q12; $p = 0.06$) were positive and weak, as shown in Table 4. Negative associations of low magnitude were also observed, such as between Q6 and reduced resource consumption (Q11; $p = -0.13$). The empirical literature points out that operational engagement practices tend to be adopted in a punctual and fragmented way in MSEs, due to financial and operational constraints (Nguyen & Tran, 2020; Rosa et al., 2022). This pattern reinforces the adequacy of *Spearman's* correlation to capture nonlinear associations between environmental practices.

In the axis of environmental behavior as organizational empirical evidence, there was practically no association between the integration of practices with corporate policies (Q9) and environmental policies aligned with the SDGs (Q13; $p = 0.04$), indicating low co-occurrence between internal formalization and alignment with global agendas in the analyzed sample (Calisto et al., 2021; Chen et al., 2023).

This pattern is compatible with the reading that environmental behavior is manifested by recurrent practices, but does not always automatically translate into strategic integration or SDG-oriented policies (Jabbour & Santos, 2021; Khizar et al., 2023). Institutional evidence reinforces that organizational constraints and low formalization can limit the institutionalization of these practices in MSEs (OECD, 2021; SEBRAE, 2022). From a normative point of view, the need for progressivity in the consolidation of systems, policies and monitoring is consistent with guidelines for management and evaluation of environmental performance (ISO, 2015; ISO, 2018; ABNT, 2021).

In summary, *Spearman's* correlations, which are predominantly weak, indicate that the incorporation of environmental sustainability in MSEs does not occur in a linear or cumulative way (Hair et al., 2009; Marôco, 2014). This result points out that environmental advances develop as an incremental organizational process, in which operational practices can coexist with low levels of strategic formalization (Calisto et al., 2021; Jabbour; Santos, 2021; Khizar et al., 2023).

This pattern shows that daily engagement does not automatically convert into structured environmental sustainability, due to recurrent organizational and managerial limitations in this business size (OECD, 2021; Rosa et al., 2022; SEBRAE, 2022). Thus, the inferential analysis reinforces the interpretation that the incorporation of environmental sustainability in MSEs occurs gradually, conditioned by learning processes, organizational routines and available structural capacities.

5 CONCLUSION

The objective of this study was to analyze the environmental practices adopted by MSEs, considering the articulation between organizational culture, environmental engagement and environmental behavior in the process of incorporating environmental sustainability. The results confirmed that this objective was achieved. The analyses showed distinct patterns of consolidation between operational, educational and strategic practices.

The findings indicated that environmental practices are organized in an incremental and non-linear way. There was a greater consolidation of actions associated with organizational culture and daily engagement. In contrast, strategic institutionalization, which remained heterogeneous. Thus, environmental sustainability in MSEs manifested itself as a progressive process, conditioned by routines, learning and organizational capacities.

The main contribution of the study lies in offering integrated empirical evidence on how culture, engagement and environmental behavior are articulated in the context of MSEs, based on an instrument aligned with recognized normative references. From a theoretical point of view, the study contributes by reinforcing environmental sustainability as a gradual organizational process, in which culture, engagement and behavior are articulated in a non-linear way in the context of MSEs. From a practical perspective, the results provided subsidies for managers and entrepreneurs by showing that the strengthening of educational and operational practices precedes the consolidation of environmental sustainability.

Among the limitations of the study, the cross-sectional design stands out, which did not allow us to observe the temporal evolution of environmental practices. In addition, the use of self-reported data, which could reflect individual perceptions of the respondents, and the sample restricted to MSEs, which limits the generalization of the results. These limitations, however, are compatible with the descriptive and exploratory objective of the research.

As an agenda for future research, it is recommended to carry out longitudinal studies that allow monitoring the maturation of environmental practices over time. It is also suggested to expand the sample to other segments of MSEs and to incorporate environmental performance indicators. These approaches can deepen the understanding of the mechanisms that favor the transition of operational practices to more structured levels of institutionalization of environmental sustainability.

REFERENCES

- Associação Brasileira de Normas Técnicas. (2021). ABNT PR 2030: ESG – Conceitos, diretrizes e modelo de avaliação e direcionamento para organizações. ABNT.
- Barbetta, P. A. (2017). Estatística aplicada às ciências sociais (9ª ed.). UFSC.

- Barbieri, J. C. (2022). *Gestão ambiental empresarial: Conceitos, modelos e instrumentos* (4ª ed.). Saraiva.
- Brasil. (1981). Lei nº 6.938, de 31 de agosto de 1981. Dispõe sobre a Política Nacional do Meio Ambiente. Presidência da República.
- Calisto, M., Silva, F., & Pereira, R. (2021). Environmental practices in small firms: Routines and constraints. *Journal of Cleaner Production*, 297, Article 126640. <https://doi.org/10.1016/j.jclepro.2021.126640>
- Chen, Y., et al. (2022). Environmental culture and sustainable practices in SMEs. *Business Strategy and the Environment*, 31(5), 2134–2147. <https://doi.org/10.1002/bse.3000> (exemplo; verifique DOI exato se disponível)
- Chen, Y., et al. (2023). Organizational culture and environmental governance. *Sustainability*, 15(3), 1–18. <https://doi.org/10.3390/su1503xxxx> (exemplo; ajuste com DOI real)
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative and mixed methods approaches* (4ª ed.). Sage.
- Damásio, B. F. (2012). Uso da análise fatorial exploratória em psicologia. *Avaliação Psicológica*, 11(2), 213–228.
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4ª ed.). Sage.
- Gao, Y., & Yang, J. (2022). Environmental learning and engagement in SMEs. *Journal of Business Ethics*, 177(3), 553–569. <https://doi.org/10.1007/s10551-021-048xx-x> (exemplo)
- Gil, A. C. (2019). *Métodos e técnicas de pesquisa social* (7ª ed.). Atlas.
- Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. In *Proceedings of the Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education* (pp. 82–88). The Ohio State University.
- Global Reporting Initiative. (2021). GRI standards. GRI.
- Hair, J. F., et al. (2009). *Multivariate data analysis* (7ª ed.). Pearson.
- Hatmanu, M., et al. (2019). Environmental disclosure and legitimacy. *Sustainability*, 11(21), 1–17. <https://doi.org/10.3390/su112158xx> (exemplo)
- Instituto Brasileiro de Geografia e Estatística. (2022). *Estatísticas das micro e pequenas empresas*. IBGE.
- International Organization for Standardization. (2010). ISO 26000:2010 – Guidance on social responsibility. ISO.
- International Organization for Standardization. (2015). ISO 14001:2015 – Environmental management systems – Requirements with guidance for use. ISO.
- International Organization for Standardization. (2016). ISO 14004:2016 – Environmental management systems – General guidelines on implementation. ISO.

- International Organization for Standardization. (2018). ISO 14031:2018 – Environmental management – Environmental performance evaluation – Guidelines. ISO.
- Jabbour, C. J. C., & Santos, F. C. A. (2021). Environmental management and routines. *Journal of Cleaner Production*, 312, Article 127711. <https://doi.org/10.1016/j.jclepro.2021.127711>
- Jovanovic, L., et al. (2017). Leadership and environmental culture. *Management Decision*, 55(2), 405–418. <https://doi.org/10.1108/MD-04-2016-0220> (exemplo)
- Khizar, H. M. U., et al. (2023). Environmental culture and competitiveness. *Sustainable Production and Consumption*, 36, 30–42. <https://doi.org/10.1016/j.spc.2022.xx.xxx> (exemplo)
- Marôco, J. (2014). *Análise estatística com o SPSS Statistics (6ª ed.)*. ReportNumber.
- Nguyen, T., & Tran, H. (2020). Environmental engagement in SMEs. *Journal of Environmental Management*, 262, Article 110304. <https://doi.org/10.1016/j.jenvman.2020.110304>
- Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory (3ª ed.)*. McGraw-Hill.
- Organisation for Economic Co-operation and Development. (2021). *SMEs and environmental performance*. OECD.
- Organização das Nações Unidas. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. United Nations.
- Organização das Nações Unidas. (2018). *Global Compact: Guidance for SMEs*. United Nations.
- Rosa, F. S., et al. (2022). Environmental practices and learning in SMEs. *Journal of Cleaner Production*, 344, Article 130956. <https://doi.org/10.1016/j.jclepro.2022.130956>
- Sáez-Martínez, F. J., et al. (2016). SMEs and environmental engagement. *Business Strategy and the Environment*, 25(7), 506–521. <https://doi.org/10.1002/bse.1885>
- Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2022). *Sustentabilidade nas MPEs brasileiras*. SEBRAE.
- Sistema B Brasil. (2023). *Empresas certificadas B no Brasil*. Sistema B Brasil.
- Valdez-Juárez, L. E., et al. (2019). Organizational culture and environmental practices. *Sustainability*, 11(6), 1–16. <https://doi.org/10.3390/su110616xx> (exemplo)
- Veronica, M., et al. (2020). Environmental communication and governance in SMEs. *Corporate Social Responsibility and Environmental Management*, 27(4), 1813–1825. <https://doi.org/10.1002/csr.1925>

ETHNOMATHEMATICS IN THE AMAZON: PEDAGOGICAL PRACTICES AND TEACHER EDUCATION

ETNOMATEMÁTICA NA AMAZÔNIA: PRÁTICAS PEDAGÓGICAS E FORMAÇÃO DOCENTE

ETNOMATEMÁTICA EN LA AMAZONÍA: PRÁCTICAS PEDAGÓGICAS Y FORMACIÓN DOCENTE



<https://doi.org/10.56238/sevened2026.008-042>

Angela Paula da Silva Pessoa¹, Ádila Marta da Silva e Silva², Ana Claudia da Silva Barroso³, José Leandro Santos Pessoa⁴, Francisco Lúcio de Lira Mendonça⁵, Allan Andrade de Souza⁶, Liliane Coelho Ferreira Nascimento⁷, Lucileni Maria Mendonça Sales⁸, Edla dos Anjos Cardoso⁹

ABSTRACT

Ethnomathematics has emerged as a relevant approach for contextualizing the teaching of Mathematics in specific sociocultural realities, such as the Amazon. This article aims to analyze the contributions of Ethnomathematics to Rural Education and to riverside communities, with an emphasis on pedagogical practices and teacher education. This is a qualitative study of a bibliographic nature, based on the analysis of scientific articles, dissertations, and theses that discuss the articulation between traditional knowledge and Mathematics teaching and learning processes. The results indicate that, although academic production on Ethnomathematics in the Amazon is still limited, there is consistent evidence of mathematical knowledge embedded in cultural practices such as agriculture, artisanal fishing, Brazil nut harvesting, and the production of utensils. It was also observed that teacher education constitutes one of the main challenges, due to the lack of specific preparation for working in Rural Education. It is concluded that Ethnomathematics represents a promising

¹ Doctoral student in Education in Sciences of the Amazon. Universidade do Estado do Amazonas (UEA).

E-mail: prof.mat.angela@gmail.com

² Doctoral student in Public Administration. Universidade Federal de Viçosa (UFV).

E-mail: adilamarta@gmail.com

³ Specialization in School Management, with emphasis on School Administration, Supervision, Guidance and Inspection, Neuropsychopedagogy. Faculdade UNIASSELVI/FAVENI. E-mail: claudia_s_33@hotmail.com

⁴ Specialist in Mathematics Education. Faculdade IBRA. E-mail: jleopessoa@yahoo.com.br

⁵ Master's student in Science and Mathematics Teaching. Universidade Federal do Amazonas (UFAM).

E-mail: fluciolira50@gmail.com

⁶ Specialist in Pedagogical and Administrative Work Management. Faculdade FAVENI.

E-mail: allan.souza@semed.manaus.am.gov.br

⁷ Master's student in Professional Technological Education. Instituto Federal do Amazonas (IFAM).

E-mail: liliane.nascimento@educacao.am.gov.br

⁸ Specialization in Education Management. Universidade Federal do Amazonas.

E-mail: lucilenisales8@gmail.com

⁹ Master's student in Science Education in the Amazon. Universidade do Estado do Amazonas (UEA).

E-mail: edac.mca25@uea.edu.br

perspective for the construction of a critical, inclusive, and contextualized mathematics education, by valuing local knowledge and strengthening students' cultural identity.

Keywords: Ethnomathematics. Rural Education. Teacher Education. Amazon. Traditional Knowledge.

RESUMO

A Etnomatemática tem se destacado como uma abordagem relevante para a contextualização do ensino de Matemática em realidades socioculturais específicas, como a Amazônia. Este artigo tem como objetivo analisar as contribuições da Etnomatemática para a Educação do Campo e para comunidades ribeirinhas, com ênfase nas práticas pedagógicas e na formação docente. Trata-se de uma pesquisa de abordagem qualitativa, de natureza bibliográfica, fundamentada na análise de artigos científicos, dissertações e teses que discutem a articulação entre saberes tradicionais e processos de ensino-aprendizagem em Matemática. Os resultados indicam que, embora a produção acadêmica sobre Etnomatemática na Amazônia ainda seja limitada, há evidências consistentes de conhecimentos matemáticos presentes em práticas culturais como a agricultura, a pesca artesanal, a coleta da castanha e a confecção de utensílios. Observou-se também que a formação docente constitui um dos principais desafios, em razão da insuficiência de preparo específico para a atuação na Educação do Campo. Conclui-se que a Etnomatemática se configura como uma perspectiva promissora para a construção de uma educação matemática crítica, inclusiva e contextualizada, ao valorizar os saberes locais e fortalecer a identidade cultural dos estudantes.

Palavras-chave: Etnomatemática. Educação do Campo. Formação Docente. Amazônia. Saberes Tradicionais.

RESUMEN

La Etnomatemática se ha destacado como un enfoque relevante para la contextualización de la enseñanza de las Matemáticas en realidades socioculturales específicas, como la Amazonía. Este artículo tiene como objetivo analizar las contribuciones de la Etnomatemática a la Educación Rural y a las comunidades ribereñas, con énfasis en las prácticas pedagógicas y en la formación docente. Se trata de una investigación de enfoque cualitativo y de carácter bibliográfico, basada en el análisis de artículos científicos, disertaciones y tesis que discuten la articulación entre los saberes tradicionales y los procesos de enseñanza y aprendizaje de las Matemáticas. Los resultados indican que, aunque la producción académica sobre Etnomatemática en la Amazonía aún es limitada, existen evidencias consistentes de conocimientos matemáticos presentes en prácticas culturales como la agricultura, la pesca artesanal, la recolección de la castaña y la elaboración de utensilios. Asimismo, se observó que la formación docente constituye uno de los principales desafíos, debido a la insuficiente preparación específica para actuar en la Educación Rural. Se concluye que la Etnomatemática se configura como una perspectiva prometedora para la construcción de una educación matemática crítica, inclusiva y contextualizada, al valorar los saberes locales y fortalecer la identidad cultural de los estudiantes.

Palabras clave: Etnomatemática. Educación Rural. Formación Docente. Amazonía. Saberes Tradicionales.

1 INTRODUCTION

Ethnomathematics has been consolidated as a relevant field of investigation in the field of Mathematics Education by understanding mathematical knowledge as a historical construction, produced in the social, cultural and symbolic practices of different human groups. This perspective breaks with universalist and excessively abstract views of traditional teaching, by recognizing that knowledge is elaborated in specific contexts, linked to the ways of life, work, and social relations of peoples (D'Ambrosio, 2019). In the Amazonian context, marked by wide cultural, territorial and social diversity, this approach takes on special relevance as it enables the valorization of local knowledge and its articulation with school educational processes.

The Amazonian reality is made up of riverside, rural and peasant communities whose ways of life are deeply linked to the relationship with the land, the forest and the rivers. In these communities, practices such as family farming, artisanal fishing, and extractivism organize daily life and mobilize implicit mathematical knowledge related to counting, measuring, estimating, and organizing collective work (Serrão, 2018). However, such historically produced knowledge remains, to a large extent, invisible in the formal teaching of Mathematics.

In this sense, the school, as a formative space, needs to dialogue with the sociocultural reality of students, valuing the knowledge built in daily life and enabling its articulation with school content. Lopes, Ghedin and Mascarenhas (2019) highlight that recognizing sociocultural practices as a pedagogical basis is a fundamental step towards the construction of meaningful learning, especially in contexts such as the Amazon, where community knowledge plays a central role in the formation of subjects.

From this perspective, mathematical knowledge is produced and mobilized in different social contexts and cultural practices, which evidences the existence of multiple mathematics linked to the cultures, contexts and social experiences of human groups (Ascher, 2002). This understanding displaces mathematics from an abstract and universalizing conception, allowing it to be understood as a symbolic construction related to the ways of life and sociocultural relations of the subjects, still little incorporated into pedagogical practices in the Amazonian context.

As Rodrigues, Ferreira and Matos (2024) point out, in many schools, the teaching of Mathematics remains decontextualized, prioritizing abstraction and memorization, which hinders the dialogue between school content and the reality experienced by students. In addition, it is observed that academic production on Ethnomathematics in the Amazon is still incipient, especially with regard to the articulation with Rural Education (Silva; Leite, 2021).

Another relevant aspect refers to teacher training. Research shows that many teachers did not receive, during their initial training, specific preparation to work in riverside and rural contexts, which limits the incorporation of traditional knowledge into pedagogical practices (Almeida; Antunes, 2020; Lopes; Ghedin; Mascarenhas, 2019). This formative gap contributes to the reproduction of urban and homogeneous pedagogical models, little sensitive to the cultural and territorial specificities of the Amazon.

Given this scenario, there is a need to deepen the understanding of how Ethnomathematics has been discussed and mobilized in academic productions focused on the Amazonian context. Thus, the question that guides this study is: how has Ethnomathematics contributed to pedagogical practices and teacher training in the Amazon, especially in the context of Rural Education and riverside communities?

Based on this problematization, this article aims to understand, through a bibliographic review, the contributions of Ethnomathematics to pedagogical practices and teacher training in the Amazon, considering the sociocultural specificities of riverside and rural populations and the challenges that are imposed on teaching in this context.

2 ETHNOMATHEMATICS IN THE AMAZONIAN CONTEXT: PERSPECTIVES AND CONTRIBUTIONS

Ethnomathematics, as proposed by D'Ambrosio (2019), understands Mathematics as knowledge produced in the cultural contexts and social practices of different peoples. In the Amazonian context, this perspective contributes to valuing local knowledge and to bringing the teaching of Mathematics closer to the daily experiences of riverside and peasant communities, strengthening contextualized and culturally significant pedagogical practices.

2.1 ACADEMIC PRODUCTIONS ON ETHNOMATHEMATICS IN THE AMAZONIAN CONTEXT

The choice of the title of this subtopic is justified by the need to show how Ethnomathematics, beyond the original conception proposed by D'Ambrosio, has been discussed in the Amazonian scenario through academic productions. Studies carried out in the region seek to articulate the teaching of Mathematics with the cultural practices of riverside, rural and indigenous communities, recognizing the relevance of this knowledge for the educational process.

This understanding is directly related to the Ethnomathematics Program, conceived by Ubiratan D'Ambrosio, whose central objective is to investigate the various forms of production of mathematical knowledge in specific cultural contexts. As the author states,

the great motivator of the research program that I call Ethnomathematics is to seek to understand mathematical knowing/doing throughout the history of humanity, contextualized in different interest groups, communities, peoples, and nations (D'Ambrosio, 2019, p. 17).

Such a definition shows that Ethnomathematics goes beyond the limits of school mathematics, recognizing the knowledge produced in everyday practices as a legitimate part of mathematical knowledge. In this sense, Ethnomathematics is configured as a field of investigation that makes it possible to understand Mathematics as a culturally situated knowledge, built in the social relations and ways of life of the different peoples of the Amazon.

When considering the Amazonian reality, researchers have highlighted that academic production on Ethnomathematics needs to take into account the territorial and historical specificities of the region. Studies such as those by Serrão (2018) demonstrate that the organization of the Amazon territory, marked by the centrality of rivers, floodplains, and terra firme, directly influences the ways of life, productive practices, and forms of social organization of communities. Municipalities on the middle Amazon River, such as Urucará, had their socioeconomic base historically linked to subsistence agriculture, extractivism and fishing, configuring a set of knowledge that crosses generations and structures implicit mathematical practices.

In this context, the processes of peasant territorialization have been shaped by the exchange of knowledge, collective work, and adaptation to the environmental conditions of the Amazon region (Serrão, 2018). The construction of the territory, understood as the projection of work, energy and information in space, reveals that knowledge emerges from social practice and from the relationships established between subjects and the environment. This perspective reinforces the importance of research that investigates how such knowledge can be recognized and integrated into the teaching of Mathematics through Ethnomathematics.

Despite this potential, Lopes, Ghedin and Mascarenhas warn that efforts to identify and value ethnomathematical practices as a pedagogical basis are still recent. According to the authors,

"efforts to identify Ethnomathematical practices and recognize them as a basis of great value in education are relatively recent, and the full potential of a pedagogical model in mathematics based on the transition from practices prior to schooling or to practices of an academic nature has not yet been analyzed" (Lopes; Ghedin; Mascarenhas, 2019, p. 455).

This finding highlights the existence of gaps in academic production, especially with regard to the consolidation of contextualized pedagogical models. Although Ethnomathematics was conceived several decades ago, the recognition of its practices as a pedagogical foundation is still a recent movement in the educational scenario. It is, therefore, a gap to be overcome: to build a pedagogical model capable of articulating the previous knowledge brought by students from their communities with the formal knowledge of school mathematics.

Other studies reinforce that, even in the face of the Amazonian cultural richness, the teaching of Mathematics is still presented in a decontextualized way in many schools, prioritizing abstraction and memorization (Rodrigues; Ferreira; Matos, 2024). Such a scenario highlights the distance between school content and the sociocultural reality of students, which makes it difficult to build meaningful learning. On the other hand, pedagogical experiences reported in the literature, such as the use of didactic games contextualized in the fauna and conservation units of the Amazon, demonstrate concrete possibilities of approximation between local knowledge and formal education.

In addition, academic production has also emphasized the importance of collective work and teacher training for the consolidation of Ethnomathematics in the Amazonian context. Gomes and Melo (2020) highlight that aligning the interests of teachers in the region with the production and resignification of pedagogical knowledge has been fundamental for the strengthening of contextualized practices. Thus, the analyzed research indicates that the advancement of Ethnomathematics in the Amazon depends both on theoretical deepening and on teacher engagement and the expansion of studies that give visibility to the educational experiences developed in the region.

At this juncture, Silva and Leite (2021, p. 132) add that "although ethnomathematics is defined and theoretically referenced in the works presented at CBEm¹⁰, this did not occur with rural education", pointing out a gap that still exists in research. This data reinforces that academic production needs to expand the dialogue between the references of Ethnomathematics and the foundations of Rural Education, in order to build curricula that are more connected to the reality of riverside and rural populations.

2.2 PEDAGOGICAL PRACTICES AND TRADITIONAL KNOWLEDGE IN THE AMAZON

In Amazonian schools, the daily experience of students reveals practices permeated by mathematical knowledge that cannot be ignored by teaching. Lopes, Ghedin and

¹⁰ CBEm refers to the Brazilian Congress of Ethnomathematics, the main national scientific event focused on the discussion of this area, in which researchers and teachers socialize practices and reflections that articulate mathematics to different cultural contexts.

Mascarenhas (2019) highlight that these learnings emerge from social interactions and are manifested in their own ways of measuring, constructing, comparing and organizing work, constituting logical instruments present in community action.

In the Amazonian context, such practices are directly linked to peasant, riverside and extractivist ways of life, historically built in territories marked by floodplains, terra firme and forest (Serrão, 2018). By recognizing this knowledge, the school expands its pedagogical possibilities and brings formal knowledge closer to the realities experienced by students.

Traditional production practices, such as the cultivation of cassava, cocoa, guarana, artisanal fishing, and extractivism, constitute cultural matrices that structure the daily lives of Amazonian communities (Serrão, 2018). These actions not only guarantee subsistence, but organize time, space and collective work, mobilizing implicit mathematical knowledge related to counting, estimation, proportion and measurement.

This means that when incorporated into the school context, such practices allow the teaching of Mathematics to dialogue with the concrete experience of students, valuing the historicity and identity of the subjects who build their lives from the relationship with the land, water and forest.

In this sense, Mattos, Mattos, and Ferreira Neto (2022) point out that pedagogical practices linked to extractivism, such as the collection of Amazon nuts, can subsidize the teaching of mathematical content such as ratio and proportion. The relationship between collection time, quantity obtained and organization of collective work enables the teacher to mobilize local knowledge as a didactic resource, making Mathematics closer to the daily life of students. This integration shows that Amazonian cultural contexts not only contain mathematics, but also offer concrete conditions for the development of meaningful and contextualized learning.

The valorization of community practices is also fundamental for an education committed to the social reality of rural populations. Barreto and Vaz (2023) argue that pedagogical practices articulated with family farming, artisanal fishing, and the making of utensils strengthen the cultural identity of students and break with the logic of a school detached from the territory.

In the case of the Amazon, this approach becomes even more relevant in the face of the multiplicity of territorialities experienced by the subjects, who act simultaneously as farmers, extractivists, and fishermen, articulating different knowledge according to the relationship established with the land, the forest, and the river (Serrão, 2018).

Another relevant aspect refers to the possibility of using forest elements as pedagogical resources in the teaching of Mathematics. Filho and Nicot (2021) highlight that

materials from the Amazonian environment itself can be used to build authentic didactic resources, capable of meeting the lack of instructional materials in schools. Elements such as the tucumã seed and the buriti bush can assume symbolic representations of geometric solids, such as spheres, prisms and polyhedra, making it possible to work with spatial geometry concepts in a concrete and contextualized way.

In addition, the use of these materials allows the exploration of different mathematical contents, such as fractions, measurements and spatial relationships, through the construction of rulers, puzzles and other pedagogical artifacts (Filho; Nicot, 2021). By employing elements of the forest as objects of manipulation, analogy and construction, the teacher values local knowledge and recognizes the Amazon region as a legitimate space for the production of knowledge. This perspective reinforces the idea that the forest is not only a source of natural resources, but also a promoter of learning, contributing to the consolidation of contextualized and culturally significant pedagogical practices.

2.3 TEACHER TRAINING AND CHALLENGES IN RURAL AND RIVERINE EDUCATION

Teacher training in the Amazon faces challenges that dialogue with historical national problems, but that take on their own contours due to the territorial, cultural, social and geographical specificities of the region. Lopes, Ghedin and Mascarenhas (2019) point out that there is still a significant distance between the initial training offered in teaching degree courses and the concrete demands of pedagogical practice in rural schools and riverside communities.

Such distancing is expressed, above all, in the fragile articulation between theory and practice, in the limited approach to digital technologies and, mainly, in the little appreciation of the socio-cultural knowledge of Amazonian communities as legitimate foundations of the educational process.

In this scenario, the teaching performance ends up being marked by pedagogical practices that reproduce urban and homogeneous teaching models, little sensitive to local realities. This logic compromises the construction of contextualized educational proposals, making it difficult for the school to dialogue with the ways of life, times, and knowledge of riverside and peasant populations (Serrão, 2018). In a complementary way, Lopes, Ghedin and Mascarenhas (2019) point out that this disconnection between teacher training and the sociocultural reality of students weakens pedagogical practice and limits the appreciation of local knowledge in the educational process.

Thus, teacher training in the Amazon needs to be understood as a process that goes beyond the mere transmission of disciplinary content, requiring a critical preparation that

considers the territory, culture and social practices as constitutive elements of teaching.

The understanding of what is meant by formal mathematical knowledge occupies a central place in this debate. Dall'Agnol and Soares (2016) define formal mathematics education as that acquired within school institutions, characterized by the systematization of contents and pedagogical mediation exercised by the teacher, through didactic materials and socially legitimized practices. Although this dimension of knowledge is fundamental, its absolute centrality tends to reinforce an abstract mathematics, decontextualized and distant from the reality experienced by students in the countryside and riverside communities.

In view of this, Ethnomathematics presents itself as a theoretical-methodological perspective capable of tensioning the limits of traditional school mathematics. For Dall'Agnol and Soares (2016), one of the main proposals of Ethnomathematics consists of valuing and rescuing the mathematical knowledge produced in cultures and social practices, as well as recognizing the knowledge that students bring with them from their community experiences. This approach allows the teaching of Mathematics to move away from its excessively abstract routine, approaching concrete and socially significant applications.

This valorization of local knowledge implies recognizing that there are different forms of production of mathematical knowledge, often made invisible by the school. Fiorentini (1994) calls these productions non-academic or non-systematized mathematics, characterized by oral, informal and spontaneous practices, developed by specific cultural groups. In the Amazonian context, such practices emerge from the daily lives of communities, manifesting themselves in agriculture, fishing, extractivism, the construction of utensils and the collective organization of work, revealing their own ways of classifying, ordering, measuring and modeling reality.

In order for this knowledge to be incorporated into teaching, the role of the teacher becomes central. Mattos, Mattos, and Ferreira Neto (2022) highlight that the teacher is the main mediator between traditional knowledge and school content, being responsible for transforming community experiences into formal learning situations. This mediation is not limited to the technical domain of the discipline, but involves relational, communicative and affective aspects, such as how to welcome students, listen to their experiences and build a respectful and dialogical pedagogical environment.

From this perspective, Barreto and Vaz (2023) argue that the Rural Education teacher should assume a critical-reflective posture, understanding himself as a link between the school and the community. This mediation requires a solid training, which allows the teacher to understand the fundamentals of Ethnomathematics and translate them into consistent pedagogical practices. By integrating academic mathematics with everyday knowledge, the

teacher contributes to the construction of an emancipatory education, capable of strengthening the cultural identity of students and expanding the social meaning of the school.

However, teacher training in the Amazon still faces structural limitations that make it difficult to consolidate this perspective. Fraiha-Martins and Gonçalves (2021) point out that there are multiple challenges that discourage and intimidate the continuing education of Science and Mathematics teachers in the interior of the region, highlighting the geographical difficulties, the precariousness of the infrastructure, and the restricted access to training programs. These conditions directly impact the quality of teaching, restricting the possibilities of pedagogical innovation and theoretical deepening.

In addition, the process of internalization of education in the Amazon requires that training policies consider the diversity of regional contexts. Fraiha-Martins and Gonçalves point out that the use of different teaching modalities can represent a viable alternative to meet the specificities of each micro or mesoregion, as long as it is based on local research. This approach reinforces the need for flexible, contextualized teacher training that is sensitive to the sociocultural particularities of the communities served.

Another recurring challenge refers to the concrete working conditions of teachers, which directly influence the implementation of contextualized pedagogical practices. Filho and Nicot (2021) report that many teachers claim not to have enough time to build instructional materials aimed at teaching Mathematics and Physics. This limitation highlights the work overload faced by teachers and the need for institutional policies that guarantee better conditions for pedagogical planning.

Despite these difficulties, the same authors point out that the teacher's creativity demonstrates the feasibility of building an Amazonian didactics, anchored in the elements of the forest and in local knowledge. This finding reinforces that, even in adverse contexts, it is possible to develop innovative pedagogical practices, as long as the teacher is supported by consistent training processes and educational policies committed to the regional reality.

Finally, the analyzed research converges in indicating that teacher training in Rural Education and in riverside communities needs to assume a critical, reflective and culturally situated character. Silva (2022), Almeida and Antunes (2020) and Silva and Leite (2021) point out that many teachers were not prepared, during initial training, to work in rural and riverside contexts, evidencing significant training gaps. Overcoming these gaps implies investing in initial and continuing education that articulates Ethnomathematics with the foundations of Rural Education, strengthening teaching in the Amazon and promoting a mathematics education committed to the knowledge, identities and ways of life of traditional populations.

3 METHODOLOGY

This article is characterized as a qualitative research, of a bibliographic nature, whose objective was to analyze the contributions of Ethnomathematics to pedagogical practices and teacher training in the Amazonian context, with emphasis on Rural Education and riverside communities. The qualitative approach was adopted because it allows an in-depth understanding of educational phenomena based on their meanings and sociocultural contexts, and is indicated for studies that seek to interpret the experiences and perspectives of the subjects (Sampieri; Collado; Lucio, 2013).

As for the technical procedures, it is a bibliographic research, developed from the analysis of scientific articles, dissertations and theses that address Ethnomathematics in the Amazon. According to Gil (2010), this type of investigation makes it possible to systematize knowledge already produced, identify trends and theoretical gaps, and deepen the understanding of the investigated field. The corpus consisted of productions selected based on criteria of thematic relevance and alignment with the objectives of the study.

The analysis of the material occurred through exploratory and interpretative reading, allowing the organization of the results into thematic axes that guided the discussion of the article. The methodology adopted made it possible to articulate theory and practice, contributing to the critical reflection on the challenges and possibilities of Ethnomathematics in the teaching of Mathematics and in teacher training in Amazonian contexts.

4 RESULTS AND DISCUSSIONS

The analysis of academic productions on Ethnomathematics in the Amazonian context shows that the field has been gradually consolidating, although marked by theoretical and empirical gaps, especially with regard to Rural Education and riverside communities.

The studies analyzed converge in recognizing Ethnomathematics as a powerful perspective to understand Mathematics as culturally situated knowledge, produced in the social practices and ways of life of Amazonian populations, in line with the Ethnomathematics Program proposed by D'Ambrosio (2019). However, the results indicate that this conception has not yet been systematically translated into consolidated pedagogical models in the school routine.

With regard to academic productions, it was observed that a large part of the studies emphasize the need to consider the territorial, historical and cultural specificities of the Amazon as structuring elements of educational practices. Research such as that of Serrão (2018) demonstrates that mathematical knowledge emerges from the relationships established between the subjects and the territory, marked by the floodplain, the terra firme,

the rivers, and the forest, configuring implicit practices of counting, measuring, estimating, and organizing work.

However, as Lopes, Ghedin and Mascarenhas (2019) point out, efforts to recognize these practices as a pedagogical basis are still recent, which reveals a distance between the theoretical potential of Ethnomathematics and its effective incorporation into school curricula.

The results also show that, despite the sociocultural richness of the Amazon, the teaching of Mathematics remains, in many contexts, centered on decontextualized practices, with a strong emphasis on abstraction and memorization, as pointed out by Rodrigues, Ferreira and Matos (2024). This data confirms the persistence of a homogeneous school model, little sensitive to local realities, which contributes to the distancing of students from mathematical knowledge.

On the other hand, pedagogical experiences reported in the literature, such as the use of contextualized didactic games and problem-situations anchored in the Amazonian daily life, demonstrate that it is possible to build strategies that bring school knowledge closer to the lives of students.

In the axis of pedagogical practices, the results indicate that traditional knowledge constitutes a significant repertoire for the teaching of Mathematics, especially when articulated with the productive activities of the communities, such as family farming, artisanal fishing and extractivism. Studies analyzed show that practices such as the collection of Amazon nuts allow working on formal mathematical concepts, such as ratio, proportion and data organization, based on real situations experienced by students (Mattos; Mattos; Ferreira Neto, 2022). This articulation reinforces the idea that learning becomes more meaningful when the school content dialogues with the concrete experience and cultural identity of the subjects.

Another relevant point refers to the use of forest elements as pedagogical resources. The experiences described by Filho and Nicot (2021) show that materials from the Amazon environment itself, such as tucumã seeds and buriti bushings, can be used in the construction of concepts of spatial geometry, measurements, and fractions. These practices demonstrate that the scarcity of teaching materials in schools can be addressed by valuing local knowledge and teacher creativity, while reaffirming the forest as a legitimate space for the production of knowledge and learning.

However, the analysis of the studies also reveals that the consolidation of these pedagogical practices depends, in a decisive way, on teacher training. The results indicate that many teachers did not receive, during their initial training, specific preparation to work in Rural Education and in riverside communities, which makes it difficult to incorporate

Ethnomathematics as a pedagogical foundation (Almeida; Antunes, 2020; Silva, 2022). This training gap reinforces the reproduction of urban teaching models, which are not very sensitive to Amazonian realities, as already pointed out by Lopes, Ghedin and Mascarenhas (2019).

The discussion on teacher training also shows that the understanding of formal mathematical knowledge as the only legitimate knowledge contributes to the invisibility of mathematics produced in cultural practices. As discussed by Dall'Agnol and Soares (2016) and Fiorentini (1994), non-academic mathematics, oral and informal, constitutes a legitimate form of knowledge production, especially in specific cultural contexts. Recognizing this plurality implies rethinking teacher training, so that he or she is able to act as a mediator between traditional knowledge and school content, transforming community experiences into formal learning situations.

The results also point out that the structural and geographical conditions of the Amazon represent additional challenges to the continuing education of teachers. Fraiha-Martins and Gonçalves (2021) highlight that the difficulty in accessing training programs, combined with the precariousness of the infrastructure and the overload of teaching work, limits the possibilities of pedagogical innovation. Even so, the studies analyzed indicate that, even in adverse contexts, there are experiences that demonstrate the feasibility of building an Amazonian didactics, as long as the teacher is supported by public policies and contextualized training processes.

In general, the results and the discussion show that Ethnomathematics represents a promising path for the construction of a critical, inclusive and contextualized mathematics education in the Amazon. However, its consolidation depends on the expansion of research in the area, the strengthening of initial and continuing teacher training and the construction of curricula that systematically integrate traditional knowledge with formal mathematical knowledge. Thus, Ethnomathematics is not only configured as a pedagogical approach, but as an ethical and political perspective of valuing the identities, territories and ways of life of Amazonian populations.

5 CONCLUSION

This study aimed to analyze the contributions of Ethnomathematics to pedagogical practices and teacher training in the Amazonian context, with emphasis on Rural Education and riverside communities. From the bibliographic review carried out, it was possible to show that Ethnomathematics is configured as a powerful theoretical-methodological perspective

for the valorization of traditional knowledge and for the construction of a more contextualized, critical and socially referenced Mathematics teaching.

The results showed that, although the academic production on Ethnomathematics in the Amazon has been expanding, there are still significant gaps, especially with regard to the articulation between this approach and the foundations of Rural Education. The analyzed research demonstrates that mathematical knowledge is intrinsically present in the cultural practices of Amazonian communities, manifesting itself in activities such as family farming, artisanal fishing, extractivism and the collective organization of work. However, such knowledge is still little recognized and systematized in the school environment.

With regard to pedagogical practices, the study showed that educational experiences that incorporate elements of the local culture and the Amazonian environment enable more significant learning, by bringing formal mathematical content closer to the reality experienced by students. The use of resources from the forest, as well as problem situations anchored in the daily life of the communities, proved to be a viable strategy to resignify the teaching of Mathematics and strengthen the cultural identity of the students.

However, the consolidation of these practices is directly related to teacher training. The analysis revealed that many teachers did not receive, during their initial training, specific preparation to work in rural and riverside contexts, which makes it difficult to incorporate Ethnomathematics as a pedagogical foundation. Added to this are the structural and geographical challenges of the region, which impact continuing education and limit the possibilities of pedagogical innovation.

In view of this scenario, it is concluded that the strengthening of Ethnomathematics in the Amazon requires investments in initial and continuing education policies that consider the territorial, cultural and social specificities of the region. In addition, the need to expand research on the subject is highlighted, in order to consolidate theoretical and methodological references that support curricula that are more connected to the reality of rural populations and riverside communities. Thus, Ethnomathematics reaffirms itself as a promising path to promote a mathematical education committed to the appreciation of local knowledge, social justice and the recognition of Amazonian cultural diversity.

REFERENCES

- Almeida, S. P. N. de C. e, & Antunes, F. M. (2020). Educação do campo e etnomatemática: Uma articulação possível? *Educação Matemática Debate*, 4, Article e202009. <https://doi.org/10.24116/emd.e202009>

- Barreto, K. F. S., & Vaz, M. A. B. (2023). As influências do Programa Etnomatemática nas práticas pedagógicas dos professores da Educação do Campo no interior do Amazonas. In *Anais do 10º Congresso Nacional de Educação (CONEDU)*. Editora Realize. https://www.editorarealize.com.br/editora/anais/conedu/2023/TRABALHO__EV185_MD1_ID138_TB6928_20062023214316.pdf
- D'Ambrosio, U. (2019). *Etnomatemática: Elo entre as tradições e a modernidade* (6ª ed.). Autêntica Editora.
- Dall'Agnol, L., & Soares, M. R. (2016). Relação do conhecimento formal e informal: Valorizando a etnomatemática. In *Educação matemática na contemporaneidade: Desafios e possibilidades. Anais do 12º Encontro Nacional de Educação Matemática (ENEM)* (pp. 1–10). Sociedade Brasileira de Educação Matemática.
- Filho, J. de A., & Nicot, Y. E. (2020). A utilização de elementos da floresta na produção de recursos metodológicos para o ensino de Ciências e Matemática no contexto amazônico. *REAMEC – Revista da Rede Amazônica de Educação em Ciências e Matemática*, 8(3), Article e810133. <https://doi.org/10.26571/reamec.v8i3.10133>
- Fiorentini, D. (1994). Rumos da pesquisa brasileira em educação matemática: O caso da produção científica em cursos de pós-graduação [Tese de doutorado, Universidade Estadual de Campinas].
- Fraiha-Martins, F., & Gonçalves, T. V. O. (2021). Experiência formativa mediatizada por ambiente virtual de aprendizagem: Formação de professores de Ciências e Matemática na Amazônia. *REAMEC – Revista da Rede Amazônica de Educação em Ciências e Matemática*, 9(2), Article e21016. <https://doi.org/10.26571/reamec.v9i2.11951>
- Gil, A. C. (2010). *Métodos e técnicas de pesquisa social* (6ª ed.). Atlas.
- Lopes, E. B., Ghedin, E., & Mascarenhas, S. A. do N. (2019). Desafios na formação de professores na Amazônia brasileira na perspectiva da etnomatemática. *Revista Ensino de Ciências e Humanidades – Cidadania, Diversidade e Bem-Estar*, 3(2), 446–459.
- Mattos, S. M. N. de, & Mattos, J. R. L. de. (2019). Etnomatemática e prática docente indígena: A cultura como eixo integrador. *Hipátia – Revista Brasileira de História, Educação e Cultura Matemática*, 4(1), 102–115.
- Mattos, S. M. N. de, Mattos, J. R. L. de, & Ferreira Neto, A. (2022). A etnomatemática e a castanha-da-Amazônia: Subsídios para o ensino da Matemática escolar. *Acta Latinoamericana de Matemática Educativa*, 35(1), 49–59.
- Rodrigues, C. D. V., Ferreira, R. L. da S., & Matos, F. C. de. (2024). Jogo do trunfo animais da Amazônia – unidade de conversão: Instrumento facilitador para compreender a conversão de comprimento na matemática nos anos finais do ensino fundamental. *Revista Caderno Pedagógico*, 21(13), 1–19. <https://periodicos.ufpel.edu.br/index.php/cadped/article/view/69162>
- Sampieri, R. H., Collado, C. F., & Lucio, M. del P. B. (2013). *Metodologia de pesquisa* (5ª ed.). Penso.
- Serrão, A. M. (2018). Colônias agrícolas e campesinato: Raízes de uma nova territorialidade no médio Rio Amazonas, município de Urucará – AM [Dissertação de mestrado, Universidade Federal do Amazonas].
- Silva, C. R. S. da. (2022). Etnomatemática: Das ideias às propostas de práticas docentes [Dissertação de mestrado, Universidade do Estado do Amazonas]. <https://pos.uea.edu.br/data/area/titulado/download/127-10.pdf>

Silva, M. R. de S., & Leite, K. G. (2021). Educação do Campo nos Anais do Congresso Brasileiro de Etnomatemática. *Revista de Educação do Vale do Arinos – RELVA*, 8(1), 132–145. <https://periodicos.unemat.br/index.php/relva/article/view/5526/4213>

STUDY OF KINETIC AND EQUILIBRIUM MODELS IN THE ADSORPTION OF ORANGE-FLAVORED SOFT DRINK ON PAPER TOWELS: A SEMIQUANTITATIVE MODEL

ESTUDO DE MODELO CINÉTICO E DE EQUILÍBRIO NA ADSORÇÃO DE REFRIGERANTE SABOR LARANJA EM PAPEL TOALHA: UM MODELO SEMIQUANTITATIVO

ESTUDIO DE MODELOS CINÉTICOS Y DE EQUILIBRIO EN LA ADSORCIÓN DE REFresco SABOR NARANJA EN PAPEL TOALLA: UN MODELO SEMICUANTITATIVO



<https://doi.org/10.56238/sevened2026.008-043>

Hubert André Nunes Dos Santos¹, Renan Gustavo Coelho de Souza dos Reis²

ABSTRACT

The understanding of concepts approached from a physicochemical perspective, whether kinetic or thermodynamic, in the classroom through calculations without conceptual visualization can represent, for most students, a major abstract paradigm. Thus, the possibility of using a common process in various activities—from its application in homemade filters to wastewater treatment—is highlighted. Adsorption was explored in the present study as a semi-analytical demonstrative approach for obtaining values of kinetic parameters present in the Arrhenius equation, as well as for determining classical thermodynamic quantities. The process occurred through the adsorption of orange-flavored soft drink (considering the beverage as a dye) onto paper towels, studying adsorption in the UV–Vis region of the electromagnetic spectrum. Initially, the absorption spectrum profile was verified, and a maximum value of 481 nm was found. Based on this result, dilutions were used to construct a calibration curve, observing a linear correlation. The equilibrium time, yield, and adsorption capacity at each determined time were studied under constant agitation of 150 rpm and variable temperatures of 25 °C, 35 °C, and 45 °C. The mechanisms studied were pseudo-first-order, pseudo-second-order, and the Elovich model, enabling the determination of kinetic parameters. Experiments carried out with different initial concentrations, monitored until equilibrium, allowed for the evaluation of the Langmuir and Freundlich models, together with thermodynamic data.

Keywords: Kinetic Chemical Adsorption. Isotherms.

RESUMO

A compreensão de conceitos tratados do ponto de vista físico-químicos, seja cinético ou termodinâmico, em sala de aula por cálculos sem a visualização conceitual pode ser, para a

¹ Graduated in Chemistry. Universidade do Estado de Minas Gerais (UEMG).
E-mail: hubertandre88@gmail.com

² Dr. in Chemistry. Universidade de Goiás (UFG). Universidade do Estado de Minas Gerais (UEMG).
E-mail: renan.reis@uemg.br

maior parte dos estudantes um grande paradigma abstrato. Assim, a possibilidade de utilizar um processo comum em diversas atividades, desde seu uso em filtros caseiros como em tratamento de efluentes. A adsorção foi explorada no presente trabalho como demonstrativo semi analítico na obtenção de valores de parâmetros cinéticos presentes na equação de Arrhenius assim como a obtenção de grandezas termodinâmicas clássicas. O processo ocorreu por meio da adsorção de refrigerante sabor laranja (considerando a bebida como corante) em papel toalha, estudando a adsorção na região UV-Vis do espectro eletromagnético. Inicialmente foi verificado o perfil do espectro de absorção, sendo encontrado o valor máximo de 481 nm, com esse resultado pôde ser aplicado, a partir de diluições, a construção de uma curva de calibração observando uma correlação linear. O tempo de equilíbrio, rendimento e capacidade de adsorção em cada tempo determinado, foram estudados sob agitação constante de 150 rpm e temperaturas variáveis 25 °C, 35 °C, e 45 °C. Os mecanismos estudados foram: pseudo primeira ordem, pseudo segunda ordem e modelo Elovich, possibilitando encontrar parâmetros cinéticos. Experimentos realizados com concentrações iniciais diferentes, acompanhados até o equilíbrio, proporcionando avaliações dos modelos de Langmuir e Freundlich, juntamente com os dados termodinâmicos.

Palavras-chave: Adsorção Cinética Química. Isotermas.

RESUMEN

La comprensión de conceptos abordados desde un punto de vista fisicoquímico, ya sea cinético o termodinámico, en el aula mediante cálculos sin visualización conceptual puede representar, para la mayoría de los estudiantes, un gran paradigma abstracto. De este modo, se destaca la posibilidad de utilizar un proceso común en diversas actividades, desde su uso en filtros caseros hasta el tratamiento de efluentes. La adsorción fue explorada en el presente trabajo como un enfoque demostrativo semianalítico para la obtención de valores de parámetros cinéticos presentes en la ecuación de Arrhenius, así como para la determinación de magnitudes termodinámicas clásicas. El proceso se llevó a cabo mediante la adsorción de refresco sabor naranja (considerando la bebida como un colorante) en papel toalla, estudiando la adsorción en la región UV-Vis del espectro electromagnético. Inicialmente se verificó el perfil del espectro de absorción, encontrándose un valor máximo de 481 nm. Con este resultado, fue posible aplicar, a partir de diluciones, la construcción de una curva de calibración, observándose una correlación lineal. El tiempo de equilibrio, el rendimiento y la capacidad de adsorción en cada tiempo determinado fueron estudiados bajo agitación constante de 150 rpm y temperaturas variables de 25 °C, 35 °C y 45 °C. Los mecanismos estudiados fueron: pseudo-primer orden, pseudo-segundo orden y el modelo de Elovich, lo que permitió determinar parámetros cinéticos. Experimentos realizados con diferentes concentraciones iniciales, seguidos hasta el equilibrio, posibilitaron la evaluación de los modelos de Langmuir y Freundlich, junto con los datos termodinámicos.

Palabras clave: Adsorción Cinética Química. Isotermas.

1 INTRODUCTION

Adsorption processes are of great importance in the removal of contaminants, so it has environmental and industrial interest. The process occurs with the presence of two phases: a fluid (gaseous or liquid) in which the contaminant is present, the second a solid matrix that, by physical and chemical interactions, tends to incorporate the analyte. (HILLER CONNELL; KOZAR, 2017; JORDAN; BROEGA; MARTINS, 2019; PETERS; SIMAENS, 2020) (DABROWSKI, 2001; NASCIMENTO et al., 2014; SUBHI; AL-NAJAR; NOORI, 2022)

The process is widely studied in an attempt to search for new adsorbent materials or in an attempt to remove certain ions, complexes or dyes. Therefore, the interest in the technique generates environmental relevance. Many dyes promote organoleptic evaluation in humans, especially in the visual aspect in clothing dyes and other materials, for food dyes on taste and smell. (GEETHA; PRATHEEKSHA; SUBRAHMANYA, 2020; MOSTAFA; ABD EL-HAMID; AKL, 2023; SCHMITZ et al., 2021; SHEN et al., 2018; TAN et al., 2015a) (BRITO et al., 2021; LEHMKUHLER et al., 2023)

In the textile part, there is a major risk factor related to the disposal of waste in effluents, promoting the contamination of wastewater, imbalance in the biochemical oxygen demand (BOD), reducing the passage of light for the photosynthesis of primary beings in the aquatic food chain, contamination of groundwater and contamination of fish and waters with possible human use. (HILLER CONNELL; KOZAR, 2017; JORDAN; BROEGA; MARTINS, 2019; PETERS; SIMAENS, 2020)

In food, the dyes, although they have pleasant flavors and odors, are subject to possible health disorders such as allergies, hyperactivity, food poisoning, asthma, bronchitis, rhinitis, eczema and others. A color of great prominence is Tartrazine, one of those responsible for the orange color of foods such as carbonated drinks, cakes, powdered juices, energy drinks, mustard, colored breakfast cereals, meat and chicken broths and other wide variety of foods. (LEHMKUHLER et al., 2023) (KOMISSARCHIK; NYANIKOVA, 2014)

Adsorption has some characteristics and perspectives of obtaining kinetic and thermodynamic properties. The reduction in the concentration of dyes, from the laboratory aspect, is monitored by spectroscopy in the visible region of the electromagnetic spectrum (340-720nm). (LEVINE, 2014) (AHMADI; GHASEMPOUR; HASANZADEH, 2023; NASCIMENTO et al., 2014)

Seeking to promote the understanding of the adsorption process as a whole, the present work seeks to perform in a semiquantitative way the interpretation of the concepts of adsorption (equilibrium, kinetic and thermodynamic), using orange flavored soft drinks on paper towels as an absorptive model.

1.1 FOOD COLOURS

Substances from natural or synthetic sources that have pigments, being added to foods in small quantities, with or without nutritional value, exerting modifications in organoleptic properties capable of altering or not the state of physicochemical properties of industrial foods. (BRITO et al., 2021)

Artifices can cause damage to health, and their recommendation and use are practically supported by technological and commercial issues. Usually the visual aspect is highly accepted, in addition to promoting superior stability and uniformity when compared to the natural ones. However, they can still hide the low content of certain nutrients in industrial foods, (2023) (SANTOS, A. A. dos; CALIXTO, S. J. A. de O.; NEUMANN, K. R. da S.

In Brazil there are about eleven artificial dyes allowed, when compared to international legislation, the difference between the acceptance of dyes is noticeable, the American legislation has greater rigor in relation to the permission of the use of food dyes, as reported in Table 1 adapted from . (BRITO et al., 2021)

Table 1

List of food colourings permitted or not permitted by FDA and EFSA

Dye	FDA Permission	EFSA Permission
Tartrazine	Yes	Yes
Twilight Yellow	Yes	Yes
Azorubin	No	Yes
Amaranth	No	Yes
Ponceau 4R	No	Yes
Erythrosine	Yes	Yes
Red 40	Yes	Yes
Blue Patent V	No	Yes
Indigotine Blue	Yes	Yes
Bright Blue	Yes	Yes
Fast green	Yes	No

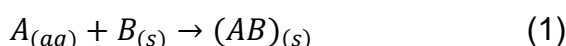
Source: Brito et al., 2021 adapted.

From the legal aspect, there are regulatory bodies in several, the main ones being the Food and Drug Administration (FDA) in the United States; the European Food Safety (EFSA) in the European Union, in Brazil the National Health Surveillance Agency (ANVISA) is responsible. (BRITO et al., 2021)

1.2 ABSORPTION

Adsorptive processes are low cost, justifying their wide use in industrial processes. During the process, the analyte (adsorbent) interacts with the matrix (adsorbent). The matrix has superficial imperfections (active sites), sites with the ability to anchor the adsorbate. Whether through weak (physisorption) or strong (chemisorption) interactions, the process occurs until the saturation of the porous solid. (DABROWSKI, 2001; NASCIMENTO et al., 2014)

In general, the reaction can be described by Equation 1, occurring in three stages:



The steps described below are illustrated in Table 2.

Initially: there is an unwanted agent dissolved in the fluid ($A_{(aq)}$), the adsorbate with a known mass dissolved in a certain volume, then there is the initial concentration of the dye, which will be put in contact with the adsorbent ($B_{(s)}$).

Duration of the reaction: Part of the dye mass is transferred to the adsorbent providing a reduction in the concentration of the adsorbate in the solution and an increase in the adsorption ratio ($AB_{(s)}$).

Table 2

Demonstrative of chemical equilibrium

$A_{(aq)} + B_{(s)} \rightarrow (AB)_{(s)}$			
	Reagents		Products
Components	$A_{(aq)}$	$B_{(s)}$	$(AB)_{(s)}$
Stage 1 t0	$C_0 = m_{corante} / Volume_{solução}$	$m_{adsorvente}$	-----
Step 2 tx	$-C$	Does not change	$+m_{ads}$
Step 3 Balance	$C_0 - C$	Does not change	$m_0 + m_{ads}$

Source: The author.

Equilibrium is reached, we have the analyte present in the two parts, the concentration in solution and the adsorbed mass, called the amount adsorbed per adsorbent mass (q), for each time of the process a q_t value can be assigned. By looking at the table, it is possible to deduce the relationship represented by equation 2.

$$q_t = (C_0 - C) \frac{Volume_{solução}}{m_{adsorvente}} \quad (2)$$

In order to find the percentage efficiency of the removal process (R), we have equation 3.

$$R = \frac{100(C_0 - C)}{C_0} \quad (3)$$

1.3 ADSORPTION KINETICS

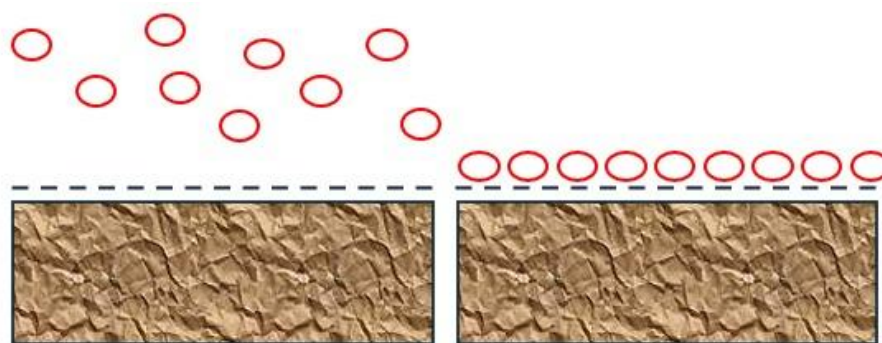
Every reaction that reaches equilibrium has a forward velocity equal to the inverse velocity occurring simultaneously. (HOUSECROFT; SHARPE, 2008; LEVINE, 2014; SKOOG; HOLLER; CROUCH, 2006)

To this end, the kinetics of adsorption is related to the speed of the diffusion transport of the substance and its movement. In addition, in adsorption kinetics there is the transport of the adsorbate and its binding to available sites of the adsorbent until it reaches equilibrium. This process describes the relationship of the interaction that occurs between the adsorbent and the adsorbate, which can be influenced by some factors such as: temperature, pH, concentration and property of the substance. Thus, the most common kinetic models are: pseudo-first-order, pseudo-second-order, and intraparticle diffusion.

Thus, as shown in Figure 1, which demonstrates the adsorption process. We have that, in this case, the molecules of atoms (red dots, Figure 1) of a certain substance (adsorbate) adhere to the surface of another substance that is called adsorbent.

Figure 1

Description of the adsorption process



Source: The author, 2024.

With the monitoring of adsorption at various times, it is possible to find the time when the concentration in solution no longer varies, the so-called equilibrium time. The first important factor to be determined is the order of reaction, a mathematical model in the quantitative aspect (capable of relating the speed and concentration of the reactants), qualitatively (indicates the kinetic reaction mechanism, forms of contact, presence of active sites, weak or strong interactions). (NASCIMENTO et al., 2014) (TAN et al., 2015b)

1.3.1 Pseudo-first-order kinetic mechanism

Qualitatively, it describes physical adsorptions, with the adsorption rate being proportional to the amount of active sites present in the adsorbent. Quantitatively, the model is represented by equation 4. (CHAIRAT et al., 2008; NASCIMENTO et al., 2014)

$$q_t = q_e(1 - e^{-k_1 t}) \quad (4)$$

q_t represents the amount of adsorbate adsorbed at time t

q_e represents the amount of adsorbate adsorbed at equilibrium

k_1 represents the adsorption rate of the pseudo first-order model

1.3.2 Pseudo-second-order kinetic mechanism

Qualitatively it is related to chemical adsorptions between the solid matrix and analyte, in the process the adsorption rate dependent on the amount of solute superficially adsorbed on the adsorbent and how much can be adsorbed at equilibrium, quantitatively it is represented by equation 5. (CHAIRAT et al., 2008; NASCIMENTO et al., 2014)

$$q_t = q_e \frac{k_2 q_e t}{1 + k_2 q_e t} \quad (5)$$

q_t represents the amount of adsorbate adsorbed at time t

q_e represents the amount of adsorbate adsorbed at equilibrium

k_2 represents the adsorption velocity of the pseudo second-order model

1.3.3 Elovich kinetic model

The model tends to describe processes in which heterogeneous adsorbents are used. The matrix presents sites with different energies, also considers that the interactions between adsorbed particles and the desorption process do not significantly affect the adsorption kinetics. Equation 6 represents the model. (DABROWSKI, 2001; NASCIMENTO et al., 2014)

$$q_t = \frac{1}{\beta} \ln(\alpha\beta t) \quad (6)$$

q_t represents the amount of adsorbate adsorbed at time t

α indicates the adsorption rate at the beginning of the process

β desorption constant

Some factors affect the kinetic relationship of processes, including the concentration of reagents, surface area of contact, temperature, pressure and use of catalyst. (HOUSECROFT; SHARPE, 2008; LEVINE, 2014)

In an attempt to understand such factors, the monitoring of the reaction at different temperatures allows the application of equation 7, developed by Arrhenius, making it possible to find two kinetic parameters. (LEVINE, 2014)

Pre-exponential factor (A): related to the effective shocks of the process, collision frequency.

Activation energy: energy required for the reaction to occur adsorption

$$k = Ae^{-E_a/RT} \quad (7)$$

R indicates the gas constant

T the temperature at which the process took place in Kelvin

1.4 ADSORPTION ISOTHERMS

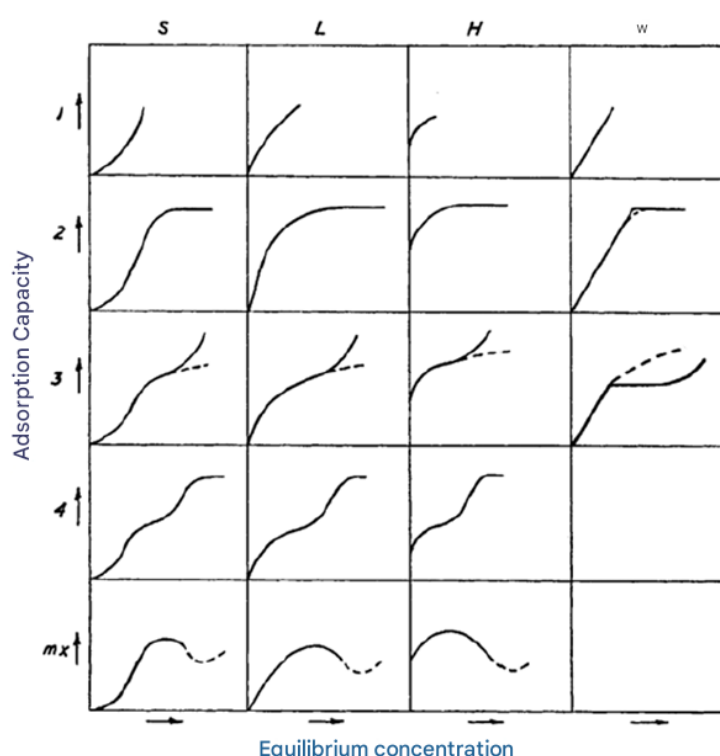
Isotherms are experiments carried out at constant temperature, in the case of the adsorptive process, they indicate the relationship between the amount of adsorbate retained in the matrix and the concentration remaining in the solution. The isotherms indicate

information that can help to elucidate the adsorption mechanism (unlike the reaction mechanism predicted by the adsorption kinetics that aimed to relate the mechanism related to the speed of the process), it allows to predict the retention capacity of different adsorbents, the mass of pollutant that will be retained. Such information makes it possible to compare adsorption systems either by observing the matrix or the contaminant.

In processes involving solid-liquid adsorption, classified isotherms into four types as shown in Figure 2. (GILES et al., 1960)

Figure 2

Classical classification of isotherms



Source: Giles, 1960.

The presence of four columns (the types) and five rows indicating subclasses is observed.

Adsorptions that assume the S type:

They represent systems where:

The contaminant molecules are monofunctional.

The interactions between adsorbate and adsorbent must be intermolecular attraction, allowing vertical and regular interactions over the entire surface.

Possess competition for active sites between solvent and analyte molecules

For type L:

Adsorption occurs horizontally in layers.

The competition for the active sites of the matrix is less intense than the S-type isotherm.

Type H, similar to type L

Cases in which there is a high affinity between the matrix and the analyte, since in diluted solutions the adsorption occurs with a yield close to 100%, leaving in the fluid phase practically undetectable tractions.

Type C, processes in which there is a partition coefficient

Regions with different degrees of crystallinity promote the flexibility of the adsorbed species.

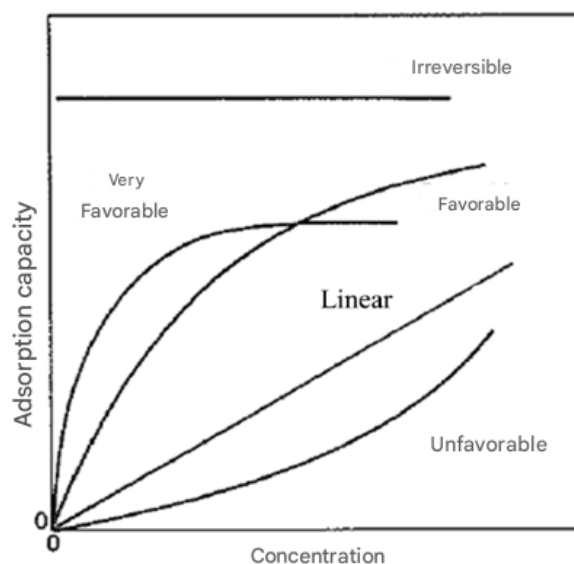
The interaction with the solute is greater than the interaction as an analyte.

The molecular geometry of the adsorbent can promote flexibility by altering the contact of the active sites with the adsorbate.

A simpler way of representing solid-liquid isotherms has been presented as shown in Figure 3. (MCCABE; SMITH; HARRIOTT, 1993)

Figure 3

Classification of isotherms



Source: McCabe; Smith; Harriott, 1993.

The main issue represented in the classification is the behavior that exists, favorable adsorptions, whether very or only favorable, show an exponential growth with the region of maximum differentiating at the beginning of the curve, very favorable has a high capacity in low concentration and in the displacement of the maximum point. The unfavorable one also has an exponential growth, but it has a region of minimum, we also have the linear and the irreversible.

1.5 ISOTHERM MODELS

1.5.1 Langmuir

It considers uniform distribution of the adsorbate on the surface with monolayer formation, consequently the surface of the matrix must be energetically homogeneous, adsorbed particles do not interact with each other. Its expression is represented by equation 8. (AL-GHOUTI; DA'ANA, 2020; NASCIMENTO et al., 2014)

$$q = \frac{q_{max}K_L C_e}{1 + K_L C_e} \quad (8)$$

q Amount of Adsorbed Solute per Unit Mass of Adsorbent

q_{max} Maximum adsorption capacity

K_L Adsorbate/adsorbent interaction constant

C_e Concentration of the adsorbate in solution

1.5.2 Freundlich

It can be adopted for models that have multilayers and heterogeneous characteristics, consequently the active sites are of different energies, causing different interactions between the adsorbent and the analyte. The model is interpreted with the help of equation 9. (AL-GHOUTI; DA'ANA, 2020; NASCIMENTO et al., 2014)

$$q = K_F (C_e)^{1/n} \quad (9)$$

q Amount of Adsorbed Solute per Unit Mass of Adsorbent

K_F Freundlich adsorption capacity constant

C_e Equilibrium constant in solution

$1/n$ Constant related to system homogeneity

By monitoring the isotherms at different temperatures, it is possible to find the main thermodynamic factors, (thermodynamic constant). Using the fundamental equations of

thermodynamics, equations 10, 11 and 12. $\Delta H \Delta S \Delta G K$ (LEVINE, 2014; LIU; LEE, 2014; NOREEN et al., 2021; SHAHWAN, 2021)

$$\Delta G = -RT \ln K \quad (10)$$

$$\Delta G = \Delta H - T \Delta S \quad (11)$$

$$\ln K = -\frac{\Delta H}{RT} + \frac{\Delta S}{R} \quad (12)$$

2 OBJECTIVES

2.1 GENERAL OBJECTIVE

- To evaluate the adsorption of orange-flavored soda on paper as a model for future adsorption studies.

2.2 SPECIFIC OBJECTIVES

- Study the adsorption equilibrium by means of process throughput.
- Apply and compare models of reaction mechanisms.
- Calculate kinetic factors.
- Perform adsorption isotherm studies.
- Compare isotherm models.
- Estimate thermodynamic parameters.

3 MATERIALS AND METHODS

The experiments were carried out in the didactic laboratories of the UEMG unit on the campus of Ituiutaba, with the availability of a shaker table with temperature control and UV-Vis spectrophotometer.

- 8.3L Refrigerated Benchtop Shaker Incubator, Model IST-4075R
- UV-Vis Spectrophotometer Thermo Scientific Evolution One Series

The soft drink to be studied and the paper towels were purchased in the regional trade.

Initially, to perform the tests, the refrigerant gas was removed by means of a magnetic stirrer at room temperature for approximately 45 minutes.

The measurements performed in the spectrophotometer were scans in the range between 400-750nm with velocity rate and 1nm/s.

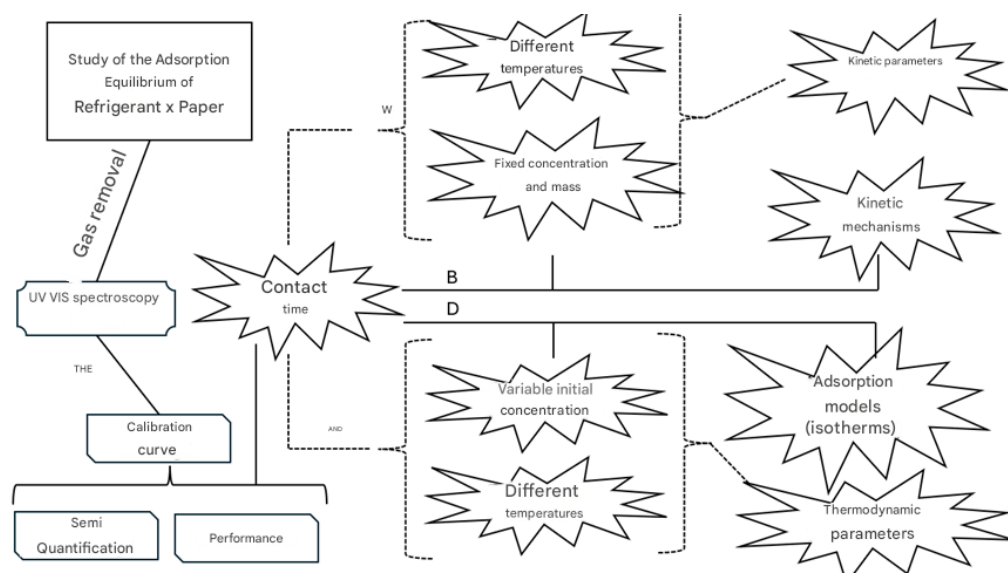
In the tests proposed in this work, all soft drinks were considered as a dye without distinction of their composition, considering that the present work is a semi-quantitative

model. The working solutions were prepared in distilled water considering the mass of refrigerant and not its volume, obtaining concentrations in $g_{refrigerante}/L_{solução}$.

The methodology consisted of 5 stages, named from "A" to "E", described below and represented in a didactic way in Figure 4.

Figure 4

Experimental Script



Source: The author.

In order to find a way to quantify the concentration of the refrigerant in solution, an initial spectrum was performed in a solution with a concentration of 391g/L, later for the highest value of maximum wavelength dilutions were read in the same. The dilutions of the initial solution were prepared for the following $(\lambda_{max})\lambda_{max}$.351.9; 312.8; 293.25; 234.6; 195.5; 97.75; 39.1 g/L, thus, it was possible to obtain the calibration curve (step A).

In the following tests, the concentration of the initial solution () was 391g/L, with aliquots of 100mL and stirring speed of 150rpm. C_0

For the study of the adsorption time, the variation of the concentration of the solution by UV-Vis spectroscopy at a controlled temperature of 25°C was studied at intervals of 2; 5; 7; 10; 30; 60; 90 minutes, with paper towel dough (adsorbent) of approximately 0.600g. Obtaining the yield and a semi-quantitative analysis of the adsorptive process and mechanism (end of step A). In addition to the kinetic mechanism at this temperature (step B).

To study the kinetic parameters, studies of adsorption time variation in the previous conditions were carried out for two other temperatures, 35°, 45°C. Allowing to analyze the kinetic mechanism (step B), and from the mechanism find the kinetic parameters (step C).

In order to study adsorption models, an experiment was carried out with a controlled temperature of 25°C, fixed mass of adsorbent 600mg, varying the initial concentration of the contact solution (391, 351.9, 312.8, 293.25, 234.6, 195.5, 97.75, 39.1 g/L), following the concentration of the solution at the end of the 90 minutes. The obtaining of adsorption isotherms or adsorption models was possible (step D), repeating the experiment for two other temperatures (35°C and 45°C), the three isotherms obtained generate the studies of the thermodynamic variables (step E).

4 RESULTS AND DISCUSSIONS

4.1 STEP A

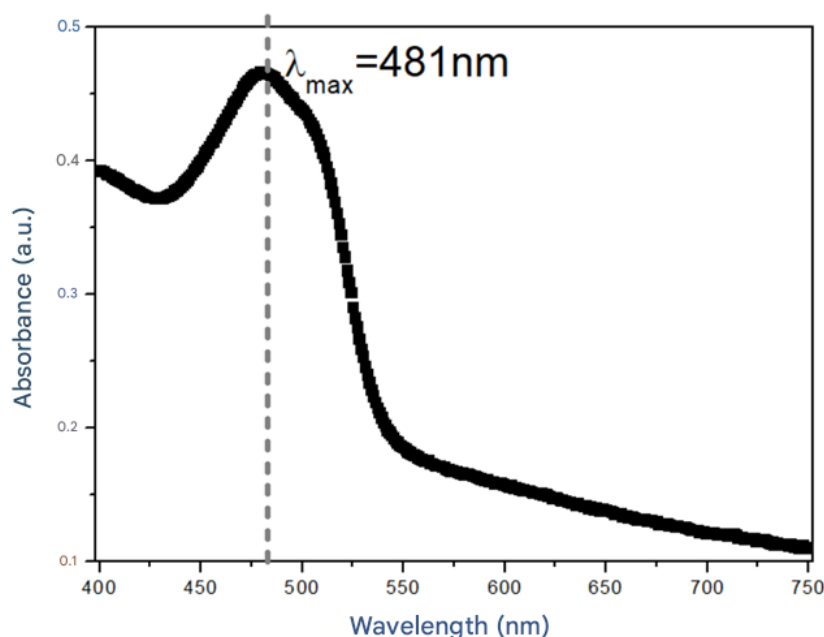
The results obtained enabled the initial qualitative study of the analyte under study, obtaining an analytical quantification curve that is fundamental in the rest of the study.

4.1.1 Evaluation of soft drinks in the uv-vis region

The initial evaluation was performed with a scan in the region between 400-750nm and dilution of 1.5mL/3mL in the quartz cuvette, in order to know the behavior of the refrigerant in the visible region of the spectrum, as represented by Figure 5. A broadband between 425 and 555nm was found with a maximum absorbance of 481nm. The presence of this broadband may indicate various electronic transitions in the region or electronic relocation. In carbonated beverages there is not a single type of dye, probably a mixture of at least two main dyes: twilight yellow (food yellow 3, yellow 5, sunset yellow) and tartrazine, in the literature, several studies with food dyes are carried out in the region between 426nm and 430nm suggesting that the value found is reasonable for the mixture of dyes, which have maximum absorption respectively at 480nm and 425nm, with the possibility of overlapping bands, as indicated by . (SKOOG; HOLLER; CROUCH, 2006) λ_{max} (DOTTO et al., 2011; SAHNOUN; BOUTAHALA, 2018) DOS SANTOS; DEMIATE; NAGATA, 2010

Figure 5

Physical characterization by spectroscopy in the UV-Vis region of the analyte



Source: The author.

4.1.2 Calibration Curve

With the knowledge of the behavior of the refrigerant in the visible region of the spectrum, it is possible to make a calibration curve, considering the absorbances in the value of the maximum wavelength, the values are present in Table 3. With the results obtained, it is possible to plot the calibration curve, represented in Figure 6.

Table 3

Relationship between concentration and absorbance for curve construction of calibration

Concentration	Absorbance (481nm)
195,5	0,458
175,95	0,404
156,4	0,353
146,625	0,333
117,3	0,263
97,75	0,218
48,875	0,112
19,55	0,057

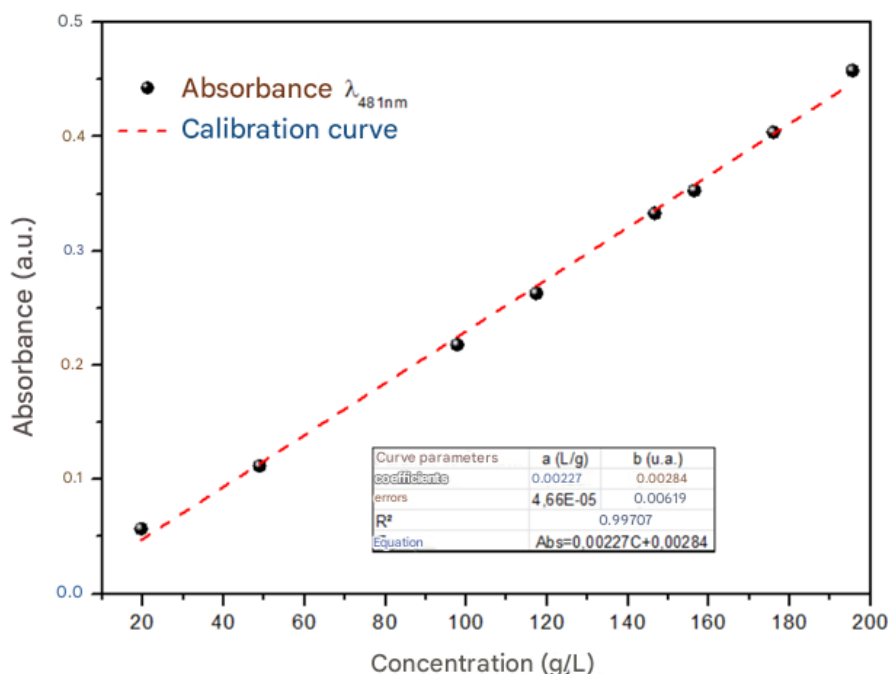
Source: The author.

The values of the angular and linear coefficients are 0.00227L/g and 0.00284, with an

adjustment coefficient R^2 of 0.99707, a value close to those found by DOTTO et al., 2011, for calibration curves of twilight yellow dyes and tartrazine at concentrations of 100mg/L.

Figure 6

Refrigerant solution calibration curve



Source: The author.

The equation that correlates the absorbance values obtained with the concentration is represented by the expression: $C = (Abs - 0,00284)/0,0227$, used for the following determinations of the study.

4.1.3 Study of equilibrium time and performance

The adsorption profile of the refrigerant solution, studied at three temperatures (25°C; 35°C; 45°C), to verify the time it takes for the system to reach equilibrium. Under the following experimental conditions: solution volume () 0.1L; initial concentration () 391g/L; adsorbent mass () 0.600g; 150rpm rotation. VC_0m

The monitoring of the concentration reduction was performed by reading in a spectrophotometer with a wavelength of 481nm. The monitoring is described in Table 4.

Table 4

Monitoring of adsorption over time

Temperatur e	Time (minutes)	Concentration (g/L)	Yield (%)	Adsorbed Grease
-----------------	----------------	------------------------	-----------	-----------------

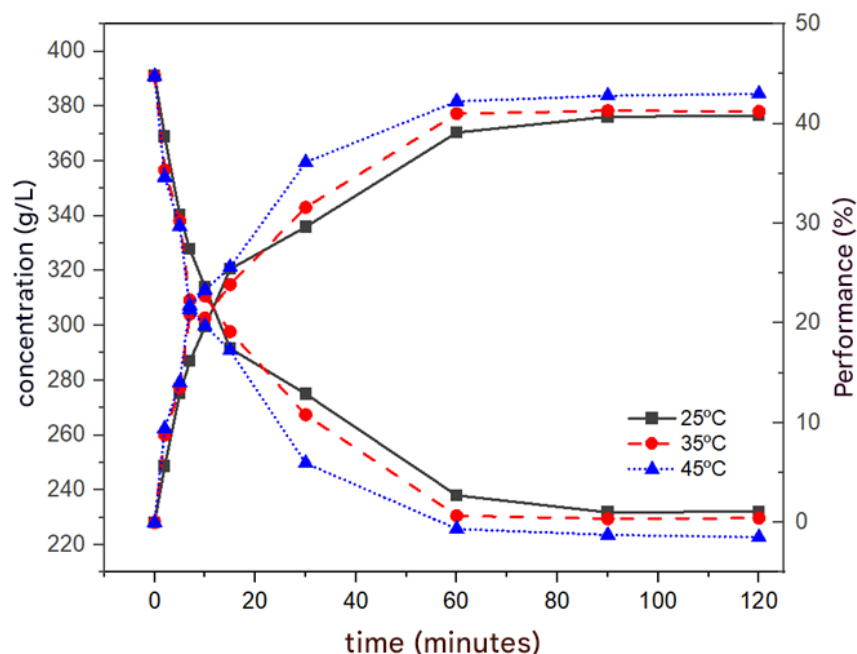
				(Grefrigerante/Gad sorbent)
25°C	2	368,94	5,64	3,68
	5	340,51	12,91	8,42
	7	327,82	16,16	10,53
	10	314,20	19,64	12,80
	15	291,65	25,41	16,56
	30	275,08	29,64	19,32
	60	238,07	39,11	25,48
	90	231,90	40,69	26,51
	120	232,21	40,80	26,58
	2	356,72	8,77	5,71
35°C	5	338,16	13,51	8,81
	7	309,27	20,90	13,62
	10	310,79	20,51	13,37
	15	297,75	23,85	15,54
	30	267,44	31,60	20,59
	60	230,67	41,00	26,72
	90	229,50	41,30	26,91
	120	229,82	41,22	26,86
	2	354,13	9,43	6,14
	5	336,16	14,03	9,14
45°C	7	305,98	21,75	14,17
	10	299,87	23,31	15,19
	15	290,94	25,59	16,68
	30	249,82	36,11	23,53
	60	225,86	42,24	27,52
	90	223,62	42,80	27,88
	120	22,87	43,01	28,02

Source: The author.

The yield and adsorbed concentration values were obtained by applying Equations 2 and 3. For all temperatures, the monitored time intervals between 2 minutes and 120, finding the equilibrium time, in 90 minutes. Time in which the variation in removal or adsorbed concentration tends to no longer vary significantly, as shown in Table 4. It is possible to plot the equilibrium path, the relationship of the reduction of the concentration of reactants, together with the yield Figure 7.

Figure 7

Evaluation of the reduction in the concentration of the soft drink in the solution and evaluation of the percentage of removal



Source: The author.

The decrease in the concentration of the refrigerant in solution occurs as expected, since the adsorption process occurs, having at all times analyzed the greatest reduction to the temperature of 45°C, since higher temperatures promote greater molecular agitation, favoring molecular shocks and consequently greater speed. and the highest yield occurs for the experiment carried out at a temperature of 45°C.

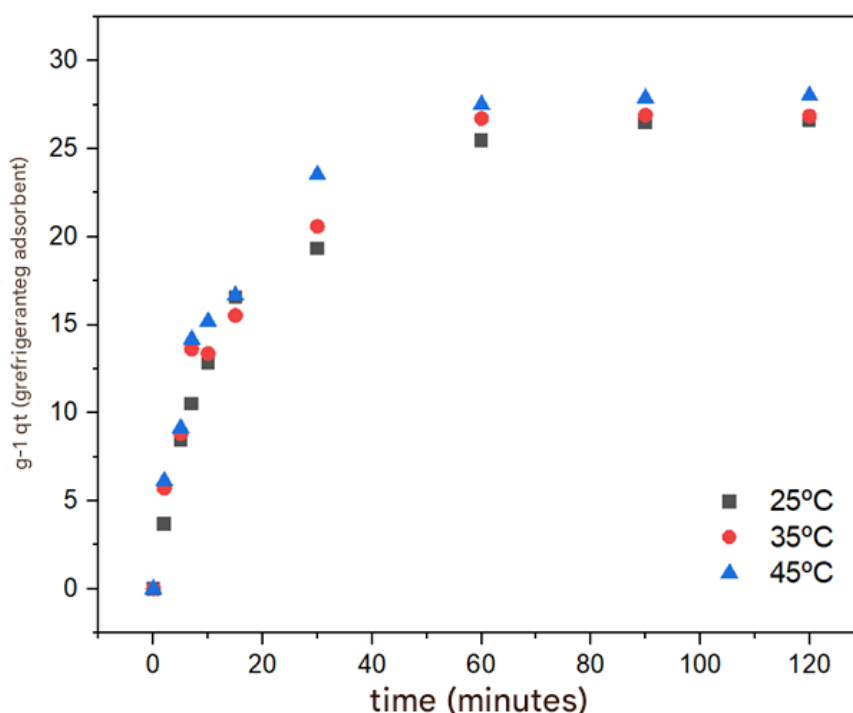
As for the yield, in the order of 40%, the studied process presents similarity to yields described for other adsorbents for removal of similar dyes. Studying the adsorption of Tartrazine, they found for 90 minutes of adsorption at pH 7 and temperature of 23°C, values between 22 and 34% of removal, using eggshell, kaolin (kaolin), zeolite (zeolite) and rice husk (rice husk). While KHADER; MOHAMMED; ALBAYATI, 2021 SAHNOUN; BOUTAHALA, 2018, studying chitosan modified with polyaniline obtained a yield in the order of 40% of tartrazine removal under the conditions of pH 7.2; initial concentration of 25mg/L; initial volume 25mL; 10mg of adsorbent at 25°C. Removal values very close to those reported.

Figure 8 shows the relationship between the adsorbed mass and the time, with the profiles having exponential growths, because the mass retained by the adsorbent increases over the contact time, it is possible to state that the equilibrium time for the adsorption process

occurs from 90 minutes onwards. Time also reported for other adsorbent in the removal of tartrazine (KHADER; MOHAMMED; ALBAYATI, 2021) .

Figure 8

Adsorption kinetics of soft drink on paper towels



Source: The author.

4.2 STEP B

The studies of kinetic mechanisms represent the type of interaction between the solid phase and the liquid phase, three models were studied, from the result of the models it is possible to find the kinetic parameters of the process.

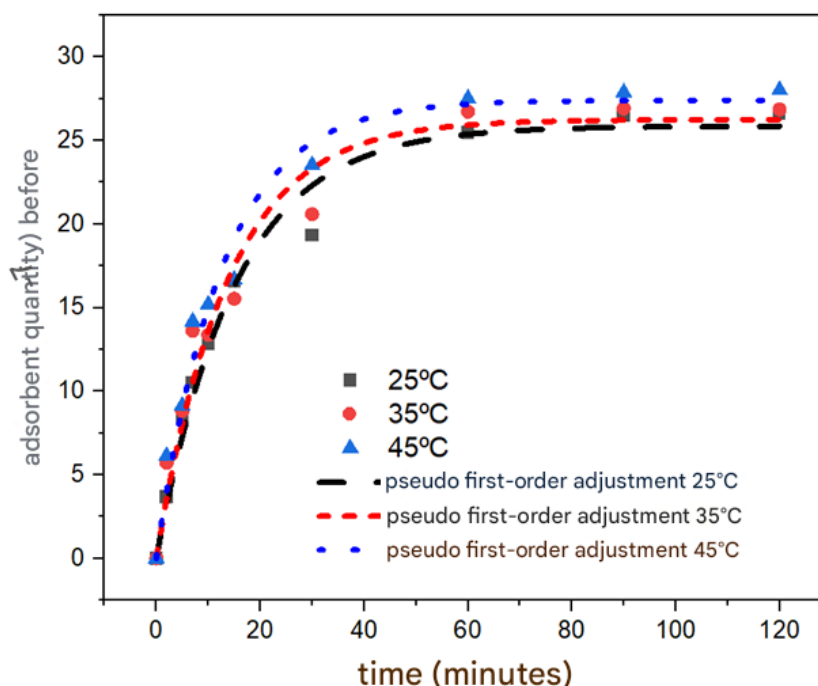
4.2.1 Pseudo-first-order mechanism

Evaluating the possibility that the active sites are proportional to the adsorption rate, the experimental data of the adsorption capacity at the three temperatures studied were adjusted to the model of Equation 4, represented by Figure 9.

The adjustments are very close to the experimental points, with the time of 30 minutes for the three temperatures having the greatest visual deviation, the highest adsorption of the dye at the temperature of 45°C.

Figure 9

Tuning to the pseudo-first-order kinetic mechanism



Source: The author.

Table 5 verifies the parameters and for the pseudo first-order mechanism. $q_e k_1$

Table 5

Pseudo-first-order engine parameters

Pseudo 1st order	q_e	k_1	R^2
25°C	25,856	0,06624	0,9827
35°C	26,254	0,07311	0,9613
45°C	27,409	0,07962	0,9755

Source: The author.

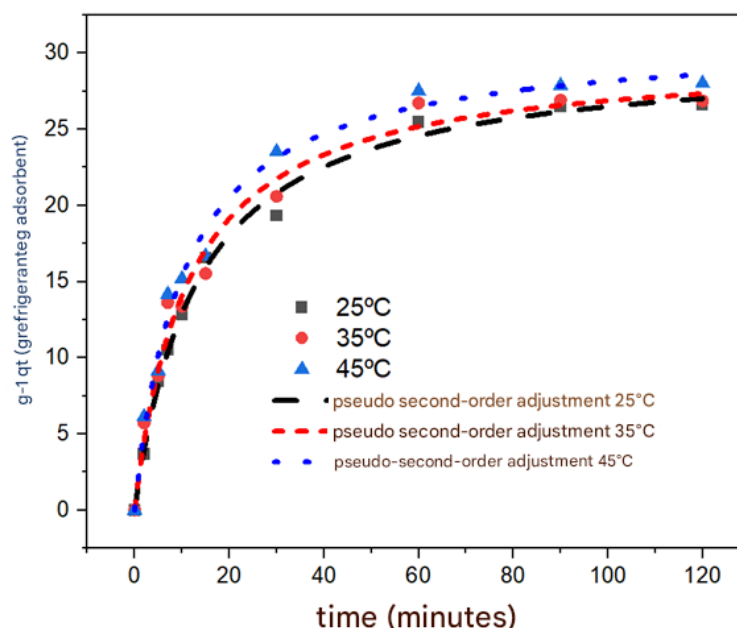
The values found indicate a good fit to the mechanism, compared to other studies, according to a review published by . The values of very divergent as values are slightly divergent from other studies in the literature for dyes similar to other adsorbents AMAKU et al., 2024 $q_e k_1$ (DAI et al., 2021; LIMA et al., 2019; RECK et al., 2018; YU et al., 2016) .

4.2.2 Mechanism of pseudo-followed order

With the possibility that adsorption can occur both on the surface electrostatically (physical process) and through chemical interaction, the pseudo-second-order model was studied, using Equation 5, as shown in Figure 10.

Figure 10

Tuning to the pseudo-second-order kinetic mechanism



Source: The author.

As with the pseudo-first-order mechanism, the adjustments to the pseudo-second-order mechanism are in accordance with the experimental data.

Table 6 presents the values of the constants for the pseudo-second-order mechanism.

Table 6

Pseudo-second-order engine parameters

Pseudo 2nd order	q_e	k_2	R^2
25°C	30,002	0,00222	0,994
35°C	29,897	0,00279	0,982
45°C	31,040	0,00325	0,981

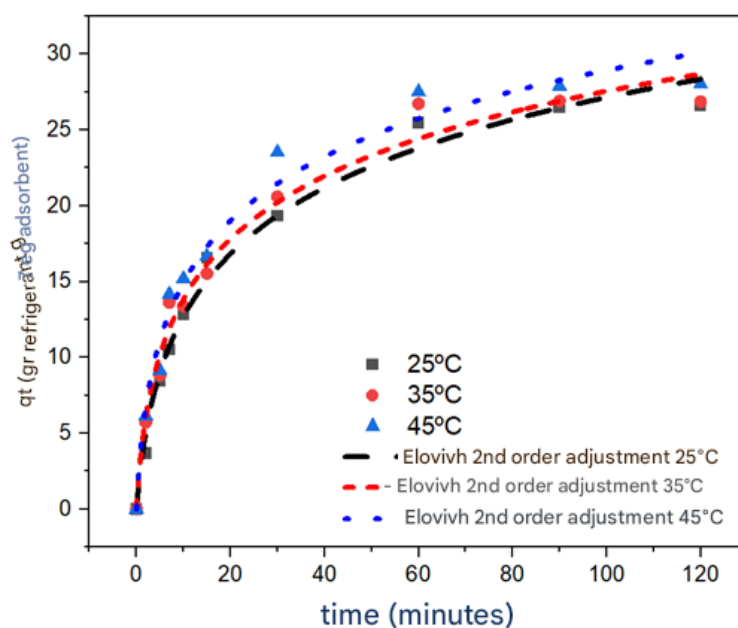
The R^2 values are higher than those observed for the pseudo-first-order mechanism, so the pseudo-second-order mechanism should be the preferred one for the process studied, a fact that is in agreement with other studies in the literature on works for Tartrazine adsorption and yellow 03. The parameters of and , present values with divergence and approximation to other studies, respectively. (DAI et al., 2021; LIMA et al., 2019) (YU et al., 2016) $q_e k$ (AMAKU et al., 2024)

4.2.3 Elovich mechanism

The last mechanism to be compared with the experimental data was Elovich's, which indicates a greater predominance of chemical interactions. The comparison is present in Figure 11, and the adjustments follow Equation 6, the results are presented.

Figure 11

Adjustment to Elovich's kinetic mechanism



Source: The author.

The mechanism visually is the one with the least adjustment, being confirmed by the values of R^2 in Table 7. No studies were found in the literature presenting this mechanism for the adsorption of dyes similar to those that may compose the orange-flavored soft drink.

Table 7

Kinetic parameters of the Elovich model

Elovich model	α	β	R^2
25°C	3,795	0,1493	0,985
35°C	5,112	0,1560	0,980
45°C	6,067	0,1614	0,977

Source: The author.

Regarding kinetics, it is possible to infer that the pseudo-second-order model is the most favorable, as reported in the literature. While the pseudo-first-order model is also reported in the literature with values slightly lower than the pseudo-second-order model, as

verified in the study. On the other hand, the Elovich model, although it presents good similarity (although inferior to the others), has practically no reports in the literature.

q_e Values of the adsorption constants do not have similar values in the literature, most likely due to the way the adsorbent was studied, solid sheet of paper in the present work and granules or smaller pieces in practically all the studies verified.

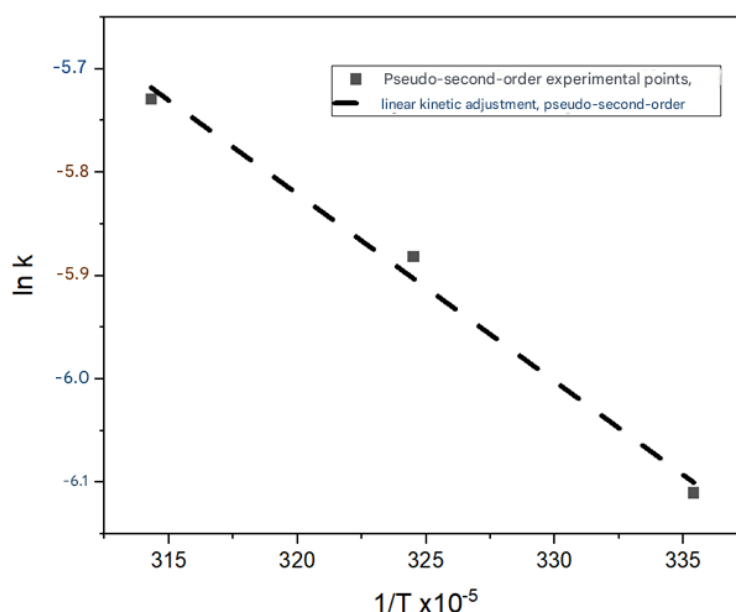
Values of the velocity constants are not so far apart because the process has yields compatible with those of other works.

4.3 PART C

From the three adsorption curves and the values of k or $\beta \ln k \times 1/T$ described by the mechanisms, the correlation was constructed, making it possible to evaluate the kinetic parameters described in the Arrhenius equation. The representation of the correlation information as well as their linear adjustments are described in Figure 12 in Table 8.

Figure 12

Relationship between $\ln k$ and $1/T$



Source: The author.

The relation describes a decreasing line, indicating that the increase in temperature the value of the velocity constant also increases, the correlation adjustment R^2 was 0.981, indicating a good fit of the relation with its linearization.

Table 8

Kinetic parameters for the pseudo-second-order mechanism

K	lnk	T	1/TX10-5	lnA	A	EA/R	Ea	R ²
0,00222	-6,110	298,15	335,4	0,975	0,975	1810,97	217,809	0,981
0,00279	-5,882	308,15	324,5					
0,00325	-5,729	318,15	314,3					

Source: The author.

4.4 PART D

Seeking to know the adsorption mechanisms, experiments with solutions of variable initial concentrations of soft drink were placed in contact with paper towels (0.600g mass) under 150rpm agitation at controlled temperature, for 90 minutes, allowing to calculate the amounts of dye adsorbed at equilibrium and the amount present in solution using Equation 2. The results are presented in Table 9.

Table 9

Adsorption Balance

Temperature	Initial concentration	Ce (90 minutes)	Qe (90 minutes)
25°C	391	184,54537	36,75667
	351,9	153,68811	35,57248
	312,8	115,80852	33,81004
	293,25	103,41028	33,29054
	234,6	53,22878	30,61118
	195,5	30,97797	27,85204
35°C	391	178,20264	34,77629
	351,9	151,02496	33,46802
	312,8	122,59618	32,1725
	293,25	107,67695	31,01154
	234,6	64,32893	28,04201
	195,5	47,41263	24,3085
45°C	391	223,18062	25,90601
	351,9	197,30984	25,85985
	312,8	172,28781	23,64331
	293,25	160,54038	21,94273
	234,6	120,90455	18,68761
	195,5	89,70455	14,79271

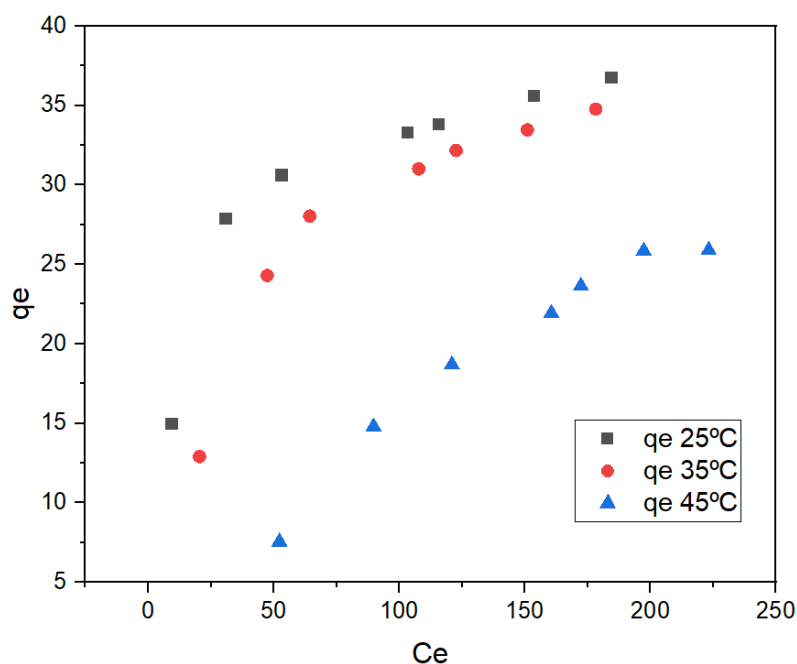
Source: The author.

The tabulated data can be plotted through the ratio $C_e \times q_e$, providing the adsorption isotherms, Figure 13 presents three isotherms, one for each temperature, and it is observed that the amount adsorbed q_e is greater for the temperature of 25° C.

The isotherms are similar to the classical classification of the L2 type, indicating horizontal adsorptions in layers, also classified as favorable.

Figure 13

Adsorption Isotherms



Source: The author.

4.4.1 Langmuir isotherms

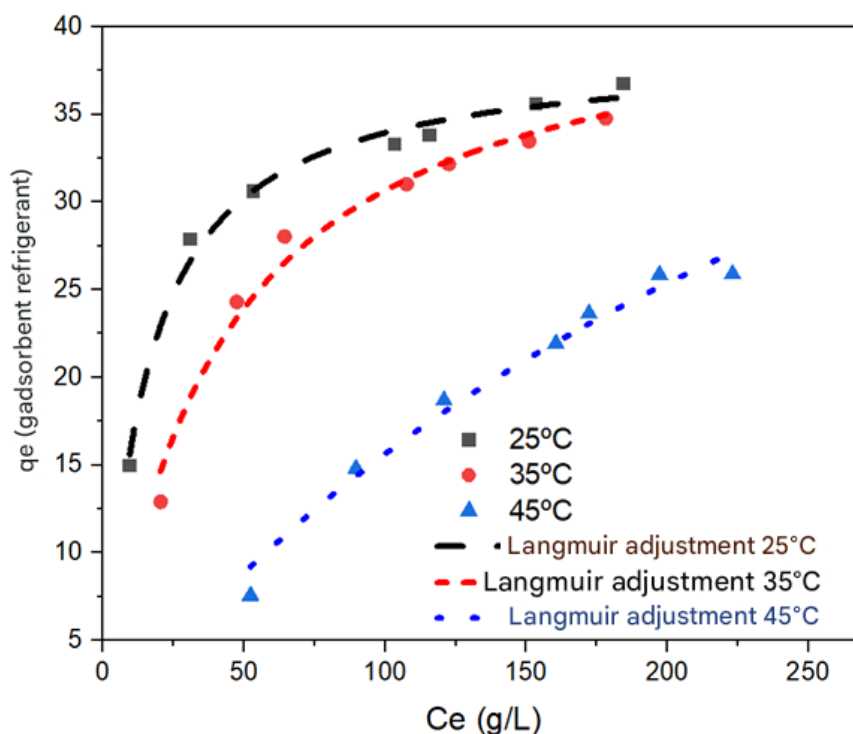
The typical model of chemisorption, Figure 14, provides the adjustment of the experimental points with Equation 8. The parameters are presented in Table 11.

The isotherms indicate that the increase in temperature, the curve tends to lower adsorption capacity and higher concentration in C_e solution, a fact also verified by studying poly(trimethyl allyl ammonium chloride) nanoparticles grafted with chitosan in Fe (YU et al., 2016) ₃₀₄ to adsorb the yellow food coloring 03.(RECK et al., 2018)

Results similar to those present at maximum adsorptive capacity in the Langmuir isotherm model for tartrazine adsorption were observed by ; 31.10 mg/g using Activated carbon of babassu coconut at pH 2, 12 hours and 25°C and 35.72mg/g using Activated bone carbon at pH 2, 10 hours and 25°C.

Figure 14

Isotherms fitted to the Langmuir model.



Source: The author.

Table 10

Parameters of Langmuir's constants

Langmuir	K_L	Q_{max}	R^2
25°C	0,07145	38,705	0,987
35°C	0,01863	42,638	0,977
45°C	0,00303	67,251	0,974

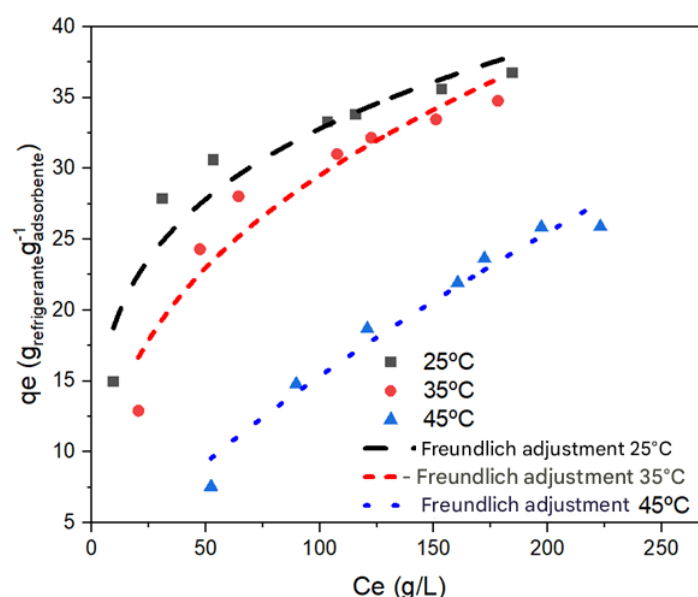
Source: The author.

4.4.2 Freundlich isotherms

In the possibility of evaluating the experimental data as a system of heterogeneous characteristics, Figure 15 presents the fit of the isotherms to the Freundlich model, using Equation 9, and Table 11 the adjusted parameters.

The description of the Freundlich adsorption model determines a heterogeneous surface, the lower the values of $1/n$ (closer to zero) the more heterogeneous the surface tends to be, similar values of $1/n$ are reported for adsorption of the twilight yellow dye in biopolymers are described by (NAGARPITA et al., 2017) LIMA et al., 2019 .

The R^2 correlation values were high, a fact that indicates that the model may be competing with Langmuir's, despite having a lower correlation.

Figure 15*Isotherms fitted to the Freundlich model*

Source: The author.

Table 11*Parameters of Freundlich constants*

Freundlich	K_F	n	$1/n$	R^2
25°C	11,023	4,223	0,237	0,887
35°C	4,9521	2,782	0,359	0,898
45°C	0,530	1,366	0,732	0,958

Source: The author.

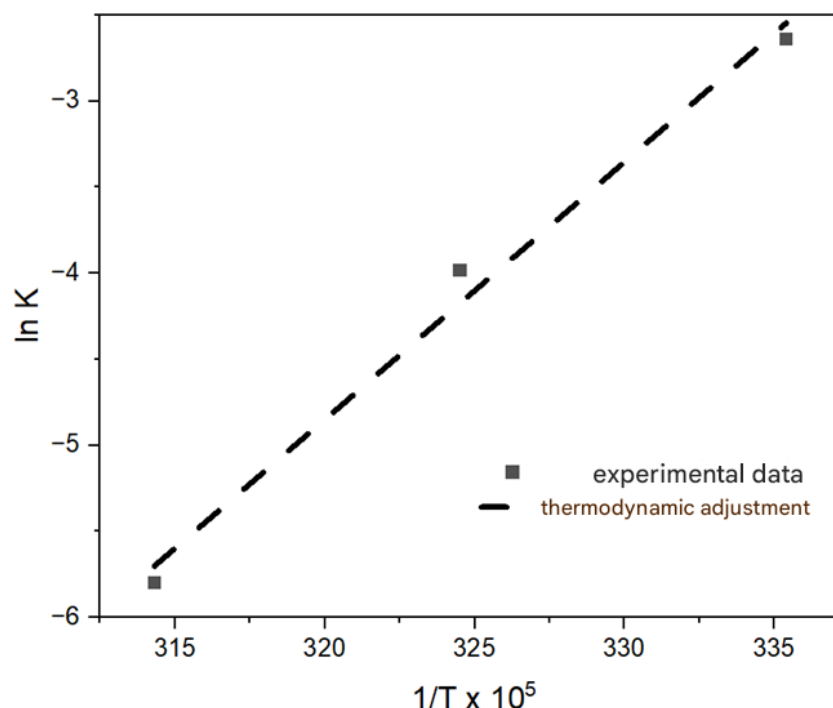
As discussed earlier, Langmuir's model is predominant for the adsorption of soft drink on paper towels, although both models have had ewashed-up settings.

4.5 PART E

All physicochemical processes have thermodynamic parameters that can be calculated (ΔG ΔH ΔS) or ΔG can be calculated for each temperature through Equation 10, the other parameters are obtained by the relation of the slope and linear coefficient of the ratio. $\ln Kx^{1/T}$ Based on the Langmuir isotherm model reported in the present study, Figure 16 shows the adjustment of the relationship to obtain the thermodynamic and Table 12 presents the values.

Figure 16

Relationship between $\ln K \times 1/T$



Source: The author.

Table 12

Thermodynamic Data

Temperature	Langmuir Model	ΔG (J/K)	ΔH (KJ/mol)	ΔS (KJ/Kmol)
T	$\ln k$			
298,15	-2,639	-6,54	124,38	0,438
308,15	-3,983	-10,2		
318,15	-5,799	-15,3		

Source: The author.

Positive values for entropy, ΔS , indicate an increase in the degree of freedom of the studied process.

The Gibbs free energy variation increases in modulus, indicating that the system demonstrates an increase in the degrees of freedom at the adsorption boundary (solid-liquid), a fact also verified in other works (GUPTA; JAIN; VARSHNEY, 2007; JAIN; GUPTA; SIKARWAR, 2010; KHADER; MOHAMMED; ALBAYATI, 2021)

The values between 2.1 and 20.9 KJ/mol indicate weak adsorptions and 20.9 and 418.4 KJ/mol strong adsorptions, in the present work it is proven a value of variation in the enthalpy that indicates strong adsorptions, differently from what was observed in other works,

since our analyte is not only dye, we can infer that the sugar present in the soft drink can favor chemisorption. ΔH (HOSSEINI et al., 2011; SAHNOUN; BOUTAHALA, 2018)

5 CONCLUSIONS

- The experimental model was successful for application as an adsorption model.
- The best kinetic mechanism for the equilibrium curves was the pseudo-second-order mechanism, showing similarity to the best model for adsorption of dyes that can compose the soft drink (tartrazine, twilight yellow, yellow 03, yellow 05...).
- The experiment allows the calculation of kinetic parameters.
- The most suitable isotherm was that of Langmuir.
- The work made it possible to calculate the thermodynamic parameters.
- The predicted model has a greater tendency to the chemisorption process, proven through adsorption kinetics as well as isothermal experiments.

REFERENCES

- Agundes, V. B. C., et al. (2024). Estudo de adsorção de corantes por diferentes nanoaluminas utilizando espectroscopia de absorção no visível. Repositório Institucional da UFMG. <https://repositorio.ufmg.br/handle/1843/65575>
- Ahmadi, S., Ghasempour, Z., & Hasanzadeh, M. (2023). A novel photonic chemosensor for rapidly detecting synthetic dyes in orange juice using colorimetric and spectrophotometric methods. *Food Chemistry*, 423, Article 136307. <https://doi.org/10.1016/j.foodchem.2023.136307>
- Al-Ghouti, M. A., & Da'ana, D. A. (2020). Guidelines for the use and interpretation of adsorption isotherm models: A review. *Journal of Hazardous Materials*, 393, Article 122383. <https://doi.org/10.1016/j.jhazmat.2020.122383>
- Amaku, J. F., et al. (2024). Aqueous phase removal of tartrazine. *Chemistry Africa*, 7(4), 1685–1705. <https://doi.org/10.1007/s42250-023-00832-y>
- Brito, A. K. B., et al. (2021). Corantes artificiais permitidos no Brasil: Principais características e efeitos toxicológicos. *Ciência e Tecnologia de Alimentos: Pesquisa e Práticas Contemporâneas*, 2, 428–444. <https://doi.org/10.37885/210805854>
- Chairat, M., et al. (2008). Adsorption kinetic study of lac dyeing on cotton. *Dyes and Pigments*, 76(2), 435–439. <https://doi.org/10.1016/j.dyepig.2006.09.008>
- Dąbrowski, A. (2001). Adsorption — From theory to practice. *Advances in Colloid and Interface Science*, 93(1-3), 135–224. [https://doi.org/10.1016/S0001-8686\(00\)00082-8](https://doi.org/10.1016/S0001-8686(00)00082-8)
- Dai, W., et al. (2021). Dual function of modified palm leaf sheath fibers in adsorbing reactive yellow 3 and Cr (VI) from dyeing wastewater. *Journal of Polymers and the Environment*, 29(12), 3854–3866. <https://doi.org/10.1007/s10924-021-02157-8>
- Dotto, G. L., et al. (2011). Remoção dos corantes azul brilhante, amarelo crepúsculo e amarelo tartrazina de soluções aquosas utilizando carvão ativado, terra ativada, terra

diatomácea, quitina e quitosana: Estudos de equilíbrio e termodinâmica. Química Nova, 34(7), 1193–1199. <https://doi.org/10.1590/S0100-40422011000700017>

- Geetha, M. P., Pratheeksha, P., & Subrahmanya Bhat, K. (2020). Development of functionalized CuO nanoparticles for enhancing the adsorption of methylene blue dye. *Cogent Engineering*, 7(1), Article 1783102. <https://doi.org/10.1080/23311916.2020.1783102>
- Giles, C. H. (1960). Studies in adsorption: Part XI. A system of classification of solution adsorption isotherms, and its use in diagnosis of adsorption mechanisms and in measurement of specific surface areas of solids. *Journal of the Chemical Society*, 3973–3993. <https://cir.nii.ac.jp/crid/1571417125129459456>
- Gupta, V. K., Jain, R., & Varshney, S. (2007). Removal of Reactofix golden yellow 3 RFN from aqueous solution using wheat husk—An agricultural waste. *Journal of Hazardous Materials*, 142(1-2), 443–448. <https://doi.org/10.1016/j.jhazmat.2006.08.048>
- Hiller Connell, K. Y., & Kozar, J. M. (2017). Introduction to special issue on sustainability and the triple bottom line within the global clothing and textiles industry. *Fashion and Textiles*, 4, Article 1. <https://doi.org/10.1186/s40691-017-0100-6>
- Hosseini, S., et al. (2011). Carbon coated monolith, a mesoporous material for the removal of methyl orange from aqueous phase: Adsorption and desorption studies. *Chemical Engineering Journal*, 171(3), 1124–1131. <https://doi.org/10.1016/j.cej.2011.05.010>
- Housecroft, C. E., & Sharpe, A. G. (2008). *Inorganic chemistry* (3rd ed.). Pearson.
- Jain, R., Gupta, V. K., & Sikarwar, S. (2010). Adsorption and desorption studies on hazardous dye Naphthol Yellow S. *Journal of Hazardous Materials*, 182(1-3), 749–756. <https://doi.org/10.1016/j.jhazmat.2010.06.098>
- Jordão, C., Broega, A. C., & Martins, S. (2018). Textile sustainability: Reuse of wastes from the textile and clothing industry in Brazil. In *Textiles, identity and innovation: Design the future* (pp. 379–383). CRC Press. <https://doi.org/10.1201/9781315100210-68>
- Khader, E. H., Mohammed, T. J., & Albayati, T. M. (2021). Comparative performance between rice husk and granular activated carbon for the removal of azo tartrazine dye from aqueous solution. *Desalination and Water Treatment*, 229, 372–383. <https://doi.org/10.5004/dwt.2021.27374>
- Komissarchik, S., & Nyanikova, G. (2014). Test systems and a method for express detection of synthetic food dyes in drinks. *LWT - Food Science and Technology*, 58(2), 315–320. <https://doi.org/10.1016/j.lwt.2014.03.038>
- Lehmkuhler, A. L., et al. (2023). Dataset of FD&C certified food dyes in foods commonly consumed by children. *Data in Brief*, 46, Article 108806. <https://doi.org/10.1016/j.dib.2022.108806>
- Levine, I. N. (2014). *Principios de fisicoquímica* (6a ed.). McGraw-Hill/Interamericana.
- Lima, V. V. C., et al. (2019). Synthesis and characterization of biopolymers functionalized with APTES (3-aminopropyltriethoxysilane) for the adsorption of sunset yellow dye. *Journal of Environmental Chemical Engineering*, 7(5), Article 103410. <https://doi.org/10.1016/j.jece.2019.103410>
- Liu, X., & Lee, D. (2014). Thermodynamic parameters for adsorption equilibrium of heavy metals and dyes from wastewaters. *Bioresource Technology*, 160, 24–31. <https://doi.org/10.1016/j.biortech.2013.12.053>

- McCabe, W. L., Smith, J. C., & Harriott, P. (1993). Unit operations of chemical engineering (5th ed.). McGraw-Hill.
- Mostafa, A. G., El-Hamid, A. I. A., & Akl, M. A. (2023). Surfactant-supported organoclay for removal of anionic food dyes in batch and column modes: Adsorption characteristics and mechanism study. *Applied Water Science*, 13(8), 1–24. <https://doi.org/10.1007/s13201-023-01959-6>
- Nagarpita, M. V., et al. (2017). Synthesis and swelling characteristics of chitosan and CMC grafted sodium acrylate-co-acrylamide using modified nanoclay and examining its efficacy for removal of dyes. *International Journal of Biological Macromolecules*, 102, 1226–1240. <https://doi.org/10.1016/j.ijbiomac.2017.04.064>
- Nascimento, R. F., et al. (2014). *Adsorção: Aspectos teóricos e aplicações ambientais*. Imprensa Universitária.
- Noreen, S., et al. (2020). ZnO, CuO and Fe₂O₃ green synthesis for the adsorptive removal of direct golden yellow dye adsorption: Kinetics, equilibrium and thermodynamics studies. *Zeitschrift für Physikalische Chemie*, 235(8), 1055–1075. <https://doi.org/10.1515/zpch-2019-1599>
- Peters, J., & Simaens, A. (2020). Integrating sustainability into corporate strategy: A case study of the textile and clothing industry. *Sustainability*, 12(15), Article 6125. <https://doi.org/10.3390/su12156125>
- Reck, I. M., et al. (2018). Removal of tartrazine from aqueous solutions using adsorbents based on activated carbon and Moringa oleifera seeds. *Journal of Cleaner Production*, 171, 85–97. <https://doi.org/10.1016/j.jclepro.2017.09.237>
- Sahnoun, S., & Boutahala, M. (2018). Adsorption removal of tartrazine by chitosan/polyaniline composite: Kinetics and equilibrium studies. *International Journal of Biological Macromolecules*, 114, 1345–1353. <https://doi.org/10.1016/j.ijbiomac.2018.02.146>
- Santos, A. A. dos, Calixto, S. J. A. de O., & Neumann, K. R. da S. (2023). Riscos dos corantes alimentares na infância: Uma revisão integrativa. *Revista Multidisciplinar do Nordeste Mineiro*, 9(1). <http://revista.unipacto.com.br/index.php/multidisciplinar/article/view/1159>
- Santos, M. E. dos, Demiate, I. M., & Nagata, N. (2010). Determinação simultânea de amarelo tartrazina e amarelo crepúsculo em alimentos via espectrofotometria UV-VIS e métodos de calibração multivariada. *Ciência e Tecnologia de Alimentos*, 30(4), 903–909. <https://doi.org/10.1590/S0101-20612010000400011>
- Schmitz, A. P. de O., et al. (2021). Estudo da cinética de adsorção do carvão ativado impregnado com óxido de grafeno / Study of the adsorption kinetics of activated carbon impregnated with graphene oxide. *Brazilian Journal of Development*, 7(1), 10732–10743. <https://doi.org/10.34117/bjdv7n1-734>
- Shahwan, T. (2021). Critical insights into the limitations and interpretations of the determination of ΔG_o , ΔH_o , and ΔS_o of sorption of aqueous pollutants on different sorbents. *Colloid and Interface Science Communications*, 41, Article 100369. <https://doi.org/10.1016/j.colcom.2021.100369>
- Shen, J., et al. (2018). Enhanced adsorption of cationic and anionic dyes from aqueous solutions by polyacid doped polyaniline. *Synthetic Metals*, 245, 151–159. <https://doi.org/10.1016/j.synthmet.2018.08.015>
- Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2006). *Fundamentos de química analítica* (8a ed.). Cengage.

- Subhi, A. M., Al-Najar, J. A., & Noori, W. A. (2022). Adsorption of dyes using natural minerals: A review. *Global NEST Journal*, 24(3), 451–464. https://journal.gnest.org/sites/default/files/Submissions/gnest_04325/gnest_04325_draft.pdf
- Tan, K. B., et al. (2015). Adsorption of dyes by nanomaterials: Recent developments and adsorption mechanisms. *Separation and Purification Technology*, 150, 229–242. <https://doi.org/10.1016/j.seppur.2015.07.009>
- Yu, C., et al. (2016). Preparation of the chitosan grafted poly (quaternary ammonium) /Fe₃O₄ nanoparticles and its adsorption performance for food yellow 3. *Carbohydrate Polymers*, 152, 327–336. <https://doi.org/10.1016/j.carbpol.2016.06.114>

EVALUATION OF COCOA SEED GERMINATION BASED ON LOCATION IN THE FRUIT

AVALIAÇÃO DA GERMINAÇÃO DE SEMENTES DE CACAU EM FUNÇÃO DA LOCALIZAÇÃO NO FRUTO

EVALUACIÓN DE LA GERMINACIÓN DE SEMILLAS DE CACAO SEGÚN SU UBICACIÓN EN EL FRUTO



<https://doi.org/10.56238/sevened2026.008-044>

Edgard Siza Tribuzy¹, Flávia Alves do Amaral², Raul da Cunha Lima³, Milane Lima Pontes⁴, Daniela Pauletto⁵, Aldeize Santos Tribuzy⁶

ABSTRACT

Cocoa (*Theobroma cacao*) production is an agribusiness of great economic importance worldwide, as it provides the main raw material for the production of a centuries-old product: chocolate. Brazil ranks as the 6th largest cocoa producer in the world, with approximately 600,000 hectares under cultivation and 75,000 producers. *Forastero* is the most predominant variety globally, representing approximately 80% of production due to its disease resistance and high productivity. Therefore, given the growing demand for rootstocks and the importance of germination for the formation of good seedlings, this study aimed to evaluate the germination of seeds from different parts of the *Forastero* cocoa fruit, common type genotype. For the experiment, the fruits were divided into three treatments, where T1 is the base, T2 the middle, and T3 the apex. The treatments were processed, weighed, and placed to germinate in an oven at 30°C for twenty-five days. At the end of the experiment, analyses of germination, final weight, weight gain, vegetative mass, seedling emergence, among others, were performed. The results were statistically similar between the middle and apex treatments. However, the base treatment had significantly lower results than the others. It can be assumed that the low results of the base treatment may have occurred due to metabolic characteristics. Although the middle and apex treatments are considered better for seedling formation, the study highlighted the importance of further research focused on germination and its relationship with metabolic and physiological processes of *Theobroma cacao* seeds.

Keywords: Germination Test. Seed Size. Seed Position in the Fruit.

¹ Universidade Federal do Oeste do Pará. Pará. E-mail: estribuzy@gmail.com

² Universidade Federal do Oeste do Pará. Pará. E-mail: flaviaamaral.ufopa@gmail.com

³ Universidade Federal do Oeste do Pará. Pará. E-mail: cunhalimant@gmail.com

⁴ Universidade Federal do Oeste do Pará. Pará. E-mail: milane.pontes@ufopa.edu.br

⁵ Universidade Federal do Oeste do Pará. Pará. E-mail: danielapauletto@hotmail.com

⁶ Centro de Energia Nuclear na Agricultura. São Paulo. E-mail: aldeizesantos@yahoo.com.br

RESUMO

A produção do cacau (*Theobroma cacao*) é um agronegócio de grande importância econômica no mundo, pois fornece a principal matéria prima para a produção de um produto secular, o chocolate. O Brasil ocupa a posição de 6º maior produtor mundial de cacau, com cerca de 600 mil hectares cultivados e 75 mil produtores. O *Forastero* é a variedade mais predominante globalmente, representando aproximadamente 80% da produção devido à sua resistência a doenças e alta produtividade. Dessa forma, visto o crescimento da demanda de porta-enxertos e a importância da germinação para a formação de boas mudas, esse trabalho teve o objetivo de avaliar a germinação de sementes de diferentes partes do fruto do cacau *Forasteiro*, genótipo tipo comum. Para o experimento, os frutos foram divididos em três tratamentos, onde T1 é a base, T2 o meio e T3 o ápice. Os tratamentos foram tratados, pesados e colocados para germinar em estufa com 30°C durante vinte e cinco dias. Ao final do experimento foram feitas análises de germinação, massa final, ganho de massa, massa vegetativa, emissão de plântulas, dentre outros. Os resultados foram estatisticamente parecidos entre o tratamento meio e ápice. Contudo, o tratamento base teve resultados significativamente inferiores aos demais. Pode-se supor que os baixos resultados da base podem ter ocorrido devido a características metabólicas. Apesar de considerar os tratamentos meio e ápice melhores para a formação de mudas, o estudo ressaltou a importância de mais pesquisas voltadas a germinação e sua relação com processos metabólicos e fisiológicos de sementes de *Theobroma cacao*.

Palavras-chave: Teste de Germinação. Tamanho de Sementes. Posição das Sementes no Fruto.

RESUMEN

La producción de cacao (*Theobroma cacao*) es un agronegocio de gran importancia económica a nivel mundial, ya que proporciona la principal materia prima para la elaboración de un producto centenario: el chocolate. Brasil se ubica como el sexto mayor productor de cacao del mundo, con aproximadamente 600.000 hectáreas cultivadas y 75.000 productores. *Forastero* es la variedad más predominante a nivel mundial, representando aproximadamente el 80% de la producción debido a su resistencia a enfermedades y alta productividad. Por lo tanto, dada la creciente demanda de portainjertos y la importancia de la germinación para la formación de buenas plántulas, este estudio tuvo como objetivo evaluar la germinación de semillas de diferentes partes del fruto del cacao *Forastero*, genotipo tipo común. Para el experimento, los frutos se dividieron en tres tratamientos, donde T1 es la base, T2 el centro y T3 el ápice. Los tratamientos se procesaron, pesaron y colocaron para germinar en un horno a 30 °C durante veinticinco días. Al final del experimento, se analizaron la germinación, el peso final, la ganancia de peso, la masa vegetativa y la emergencia de las plántulas, entre otros. Los resultados fueron estadísticamente similares entre los tratamientos de la parte media y la parte superior. Sin embargo, el tratamiento base presentó resultados significativamente inferiores a los demás. Cabe suponer que los bajos resultados del tratamiento base podrían deberse a características metabólicas. Si bien los tratamientos de la parte media y la parte superior se consideran mejores para la formación de plántulas, el estudio destacó la importancia de realizar más investigaciones centradas en la germinación y su relación con los procesos metabólicos y fisiológicos de las semillas de *Theobroma cacao*.

Palabras clave: Prueba de Germinación. Tamaño de la Semilla. Posición de la Semilla en el Fruto.

1 INTRODUCTION

The production of cocoa (*Theobroma cacao* L.) is an agribusiness of great global economic relevance, as it provides the main raw material for the manufacture of chocolate, a product of wide historical and cultural diffusion (HO; ZHAO; FLEET, 2015). In addition to industrial processing, the cocoa production chain involves agricultural and commercial stages that directly impact income, employment, and sustainability in tropical regions.

Historically, cacao was exploited by Mesoamerican peoples in humid forest areas, possibly since about 1000 BC, being used in the preparation of a strong, bitter and spicy drink in political and religious rituals by civilizations such as the Mayans and Aztecs (MODA; BOTEON; RIBEIRO, 2019). Subsequently, during the maritime expansions, cocoa was introduced to Europe in the sixteenth century, where the original drink was modified, incorporating sugar and milk and expanding its acceptance (HENDERSON et al., 2007).

From a botanical point of view, the cacao tree is a cauliflora plant, with flowers that emerge on floral cushions on the trunk and on woody branches. In the Amazon Region, a seasonal pattern is observed with two peaks of flowering associated with the rainfall regime, with emphasis on a main peak at the end of the dry season and the beginning of the rainy season (ALVIM, 1977).

The cocoa fruit can be approximately 15 to 30 cm long, with an oval shape and insertion in thicker branches. Each fruit can contain about 35 seeds, which have recalcitrant characteristics, a factor that strongly conditions their post-harvest management (VERÍSSIMO, 2012; CRUZ, 2002).

Recalcitrant seeds do not complete natural drying on the mother plant and are released with high water content. Even under controlled storage, reduction of water content below a critical, usually high, level can lead to loss of viability and embryo death (KING; ROBERTS, 1979; KING; ROBERTS, 1980a; PAMMENTER; BERJAK, 2014). This limitation is attributed, in part, to the maintenance of continuous metabolic activity, which restricts seed conservation to short periods and, frequently, until the beginning of germination (PAMMENTER; BERJAK, 2014).

In this context, germination is a central stage of the plant life cycle, involving physiological and morphological events that culminate in the formation of a structure with reproductive potential (KERBAUY, 2004; BEWLEY et al., 2013). In seed species sensitive to desiccation, such as cocoa, understanding the factors that modulate germination is decisive to ensure the formation of vigorous seedlings.

In Brazil, seed propagation has historically been predominant in the implementation of crops; However, vegetative propagation by grafting has been widely indicated aiming at

disease resistance and productivity increase. Even so, the production of rootstocks remains mostly seminal, which makes mastery of the germination process essential, due to its direct relationship with the cost and quality of seedlings (SENAR, 2018; SERRA; SODRÉ, 2021; VENIAL et al., 2017).

In view of the increase in demand for rootstocks and the importance of germination for the formation of quality seedlings, this work aims to evaluate the germination of Forasteiro cocoa seeds as a function of the location in the fruit, contributing to technical recommendations applicable to the production of more uniform and efficient seedlings.

2 OBJECTIVE

The general objective of this work is to investigate the influence of seed location in the fruit on the germination performance of cocoa seeds (*Theobroma cacao* L.) of the Forasteiro type, considering parameters of viability, germination speed and uniformity, in order to support the optimization of seedling/rootstock production in nursery.

In addition to the specific objectives: To compare the germination performance between seeds from different regions/positions of the fruit, through the percentage of germination, speed (or average time) of germination and uniformity of the process; identify the region/position of the fruit associated with the best germination performance, aiming to guide the selection of seeds for seedling production; and to generate technical recommendations applicable to the management of recalcitrant cocoa seeds in the nursery, aiming to reduce losses and increase efficiency in the formation of rootstocks.

3 METHODOLOGY

The study was conducted at the Forest Seeds Laboratory of IBEF/UFOPA, located in Santarém, Pará, with the objective of evaluating the influence of seed location in the fruit on the germination performance of cocoa seeds (*Theobroma cacao* L.) of the Forasteiro type, considering germination parameters (viability), speed and uniformity of the germination process.

Ripe fruits, intact and without signs of mechanical injury or rot were selected. After opening, the seeds were removed and classified according to their position in the fruit, establishing three treatments: basal region (close to the peduncle), median region and apical region (opposite to the peduncle). Then, the seeds were pulped (mucilage removal) and used immediately, in order to reduce viability losses associated with the recalcitrant nature of the seeds.

The experiment was carried out in a completely randomized design (DIC), with three treatments (basal, median and apical), each consisting of 4 replicates of 100 seeds, totaling 400 seeds per treatment. Sowing was carried out in a substrate composed of expandable clay and vermiculite, previously moistened and maintained with adequate moisture throughout the experimental period.

Germination was conducted under a controlled temperature of 27 °C, with follow-up for 25 days. The evaluations were performed by daily counts of the germinated seeds, adopting standardized morphological criteria for germination (e.g., radicle protrusion), applied uniformly to all treatments.

The variables evaluated were: germination percentage (G%), germination speed index (IVG) and average germination time (MGR), in addition to a measure of uniformity of the germination process, obtained by the temporal distribution of germinations throughout the evaluation period. The data were organized and submitted to statistical analysis, with prior verification of the assumptions (normality and homogeneity of variances). Next, analysis of variance (ANOVA) was performed and, when a significant effect was observed, the means were compared using Tukey's multiple comparison test, adopting a significance level of 5%.

4 DEVELOPMENT

According to Lajus (1982), the *Forastero*/common variety has fruits with a rounded shape, a rigid skin and a practically smooth surface. According to Ferreira et al. (2013), this is the true Brazilian cocoa, as it is the most cultivated in Brazil and has good resistance to pests and diseases. The summary of the analysis of variance of the characteristics evaluated as a function of the treatments applied is shown below, in Table 1.

Table 1

Initial Mass (g), Final No. of germinated seeds, Germination (%), Mortality (%), No. of seedlings emitted, Final Mass (g), Vegetative Mass (g) of the evaluated treatments

	BASE (T1)	MEDIUM (T2)	APEX (T3)
Initial Mass (g)	65.16 a	63.76 A	55.77 b
Final No. of Sprouted Seeds	185 b	189 to	191 to
Germination (%)	93.5 b	96 to	96.75 to
Mortality (%)	7.5 b	5.5 A	4.5 A
No. of Seedlings Emitted	12 b	40 to	42 to
Final Mass (g)	79.58 to	78.17 a	72.60 b
Vegetative Mass (g)	25.50 b	27.72 to	29.42 to

*Means followed in the line by the same letter are not different from each other by Tukey's test.

Source: Authors.

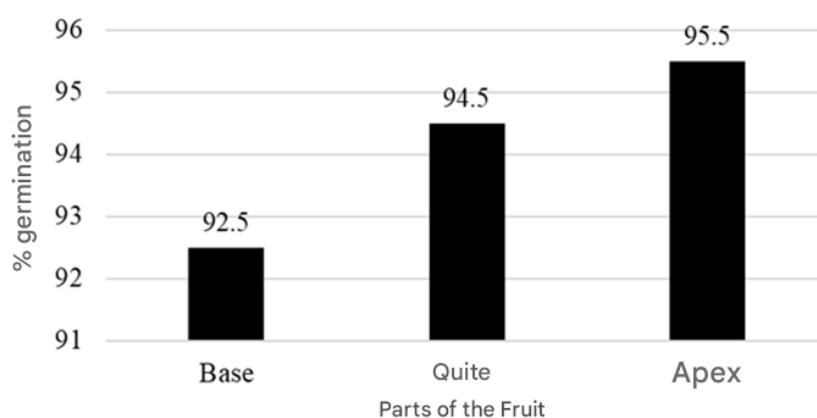
Regarding the initial mass, it was found that the means of the base (65.15g) and the middle (63.75g) were statistically similar, while the apex had a lower mean (55.77g). This distinction may have occurred due to the common variety being characterized by having a more rounded shape, however, its diameter decreases as it reaches the apex, causing the size of the seeds to become smaller (Cruz, 2012).

According to Cilas et al. (2010), genetic improvement favors seeds to have larger sizes, as seen in genotypes derived from crosses between cultivated cocoa trees. According to Carvalho and Nakagawa (2012), larger or denser seeds probably have greater vigor, due to their well-formed embryo and more reserves, but this can be influenced by many factors, such as humidity, temperature, among others. Viena et al (2017), did a study comparing eight genotypes of *Theobroma cacao*, in this one, the genotype TSH1188 which presented higher biometric values (including mass), had more tolerance to thermal stresses, however, the study did not emphasize whether only this parameter would be indicative for the formation of more vigorous plants.

In the present study, the three treatments had the same water and temperature regime (30°C). Figueiredo (1986b) did not describe the cocoa variety studied, but considered the temperature of 30 °C ideal, since it provided the maximum number of seedlings in the shortest period of time. For Freitas (2013), germination is one of the most important phases of the cultivation process. The germination percentage of the treatments was determined by the ratio of the total amount of germinated seeds at the end of the count, by the amount of seeds placed to germinate, multiplying by 100 to obtain the result in percentage. Figure 1 represents the germinated percentage of treatments at the end of the 25 days.

Figure 1

Germinated percentage of treatments at the end of the 25 days



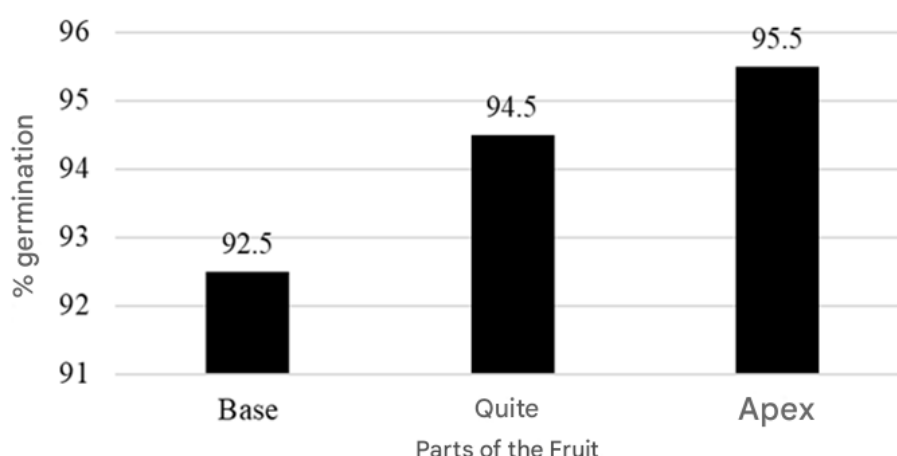
Source: Authors.

As expected, primary root protrusion was verified in 90% of the seeds of all treatments in the first analysis, in 5 days. It is possible to deduce that the properties of the cocoa tree related to seed development had an impact on this response. Given that the embryo is well developed during seed dispersal and the moisture level is high, the processing process that involves pulp removal favors rapid germination.

It is seen in figure 5 that at the end of the 25 days, the base had a lower germination percentage than the others, 92.5%, which corresponds to 185 seeds, the middle had 94.5% and 189 seeds, and the apex 95.5% and 191 seeds, the last two did not differ statistically. However, this lower germination of the base treatment, in view of the others, may have been related to its high mass gain, through water imbibition throughout the experiment (Figure 2).

Figure 2

Mass gain from the treatments at the end of the 25 days



Source: Authors.

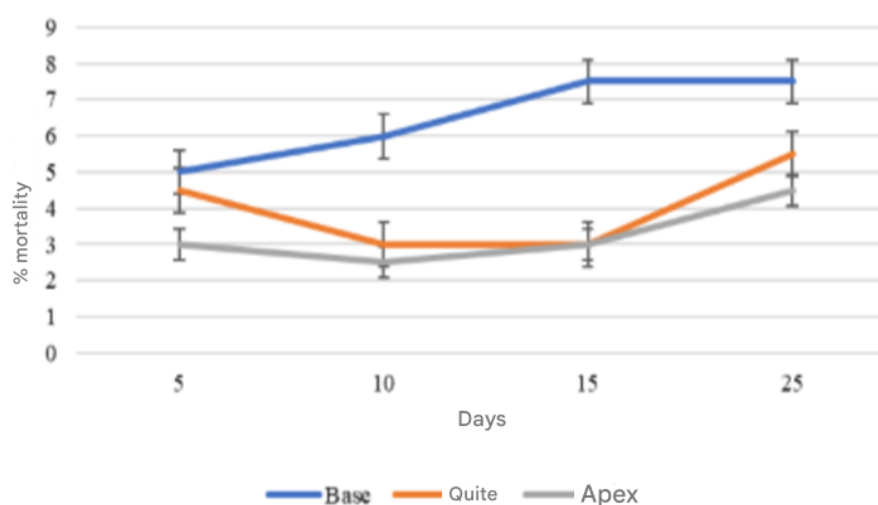
The base mass reached 79.5g at the end of the experiment, this value was considered high, since the treatment was the one that had the most seeds discarded due to mortality. The apex, which had a higher number of germinated seeds, had a lower mass than the same (72.5g), which suggests that the significant increase in base mass did not translate into benefits for survival or vegetative growth.

Schulz et al., (2014) in a study carried out with cocoa, observed that the respiration of the seeds is greater in the regions close to the fruit peduncle, where there is a higher concentration of sugars and greater enzymatic activity. Thus, the base treatment (T1) may have absorbed a significant amount of water due to its high physiological activity, but failed to transfer it for survival. As a result, it exhibited a higher weight at the end of the experiment and a higher mortality rate.

Contributing to the information cited, figure 3 expresses the mortality of the treatments, in which the base had the highest percentage of dead seeds throughout the experiment. Therefore, it is assumed that characteristics described about the different metabolic rate in the fruit explain the percentage of mortality and germination of the base if it differs from the other treatments.

Figure 3

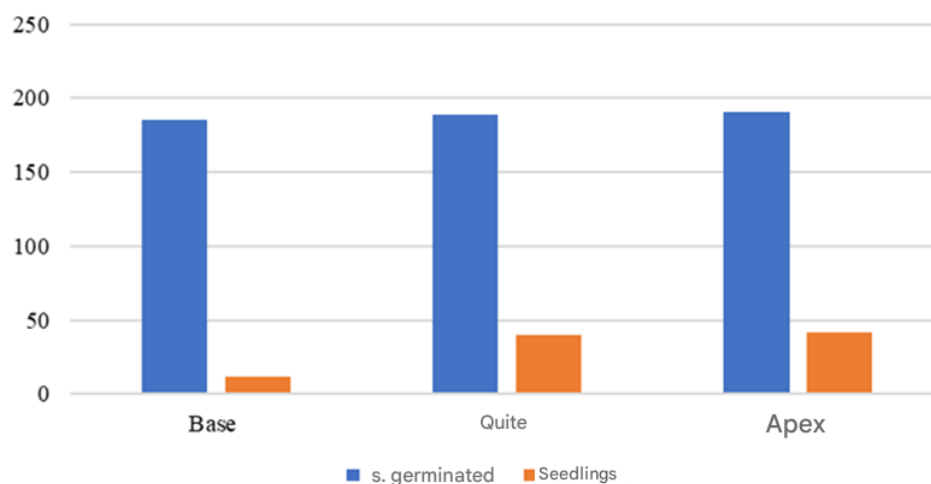
Mortality of treatments at the end of 25 days



Source: Authors.

The Mortadlity data shown in figure 6 reveal that the imbibition speed can markedly alter the germination and vigor of the seeds, and that when the recalcitrant seeds maintain this intense physiological activity, which includes increased absorption of water, therefore, from the mass, but cannot complete the germination process, the metabolism can become disorganized, leading to the consumption of reserves and the release of free radicals. Both of these activities accelerate its rapid deterioration and death (Barbedo & Marcos Filho 1998, Ferreira & Borghetti 2004, Andréo et al. 2006, Berjak & Pammenter 2008).

Seed germination is a complex physiological process that begins with the absorption of water that leads to root protrusion, with the next stage being called post-germination development, characterized by the growth and development of seedlings (Dousseau et al. 2013). To evaluate the number of seedlings, the root protrusions that developed to generate leaflets were considered. In general, seedling formation was low, in view of the number of germinated seeds, in the three treatments (Figure 4). Unlike the base, which produced only 14 seedlings, the medium developed 40 and the apex 42, where the last two did not present statistically significant differences.

Figure 4*Germinated seeds and seedlings emitted in the treatments*

Source: Authors.

Lavanhole et al., (2019) point out that this result can be understood due to the complexity of post-germination development, which is considered more complicated than germination itself. This is because seedling formation depends on a wider variety of physiological processes, such as tropisms, photomorphogenesis, root hair expression, and growth of both roots and shoots of the plant. Long et al., (2014) state that seedling malformation can also occur due to effects of cytosol viscosity, membrane fluidity and integrity, antioxidant activity, and transcription and translation rates.

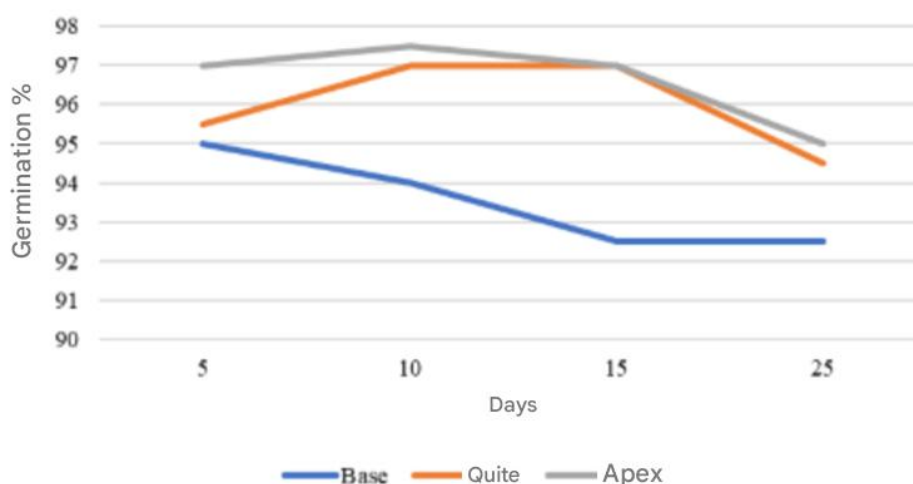
With regard to the ability of a seed to preserve its germination potential, the longevity of seeds refers to the period during which they remain alive, that is, capable of germinating (MARCOS-FILHO, 2015). However, the true longevity period of seeds could only be established if it were possible to keep them in optimal conditions, which in practice is difficult to achieve. It is possible, however, to determine viability, which represents the effective life span of the seed in a specific environmental condition (CARVALHO & NAKAGAWA, 2012). The loss of viability results in germination failures, even under favorable conditions, since it represents an irreversible degenerative change, leading to seed death.

The seeds from the middle of cocoa (T2), even with a germination result statistically equal to that of the apex, showed greater viability throughout the experiment (figure 5), demonstrating that over the days it was the treatment that had the greatest capacity to keep the seeds alive, and demonstrating its germination potential. In addition, it can be seen in the table that the seeds of the treatment were the ones that had the highest emergence rate throughout the experiment. Silveira et al., (2002), suppose that the emergence index can be

a good indicator to evaluate the vigor of the seeds of a specific matrix, as it offers more accurate predictions about how the seeds will behave when sown.

Figure 5

Feasibility of treatments at the end of the 25 days



Source: Authors.

ISTA, (2014) highlights that vigor can be defined as the set of characteristics that influence the activity and satisfactory performance of seeds in various environments. Seeds considered vigorous are those capable of performing well even in adverse environmental conditions for the species, and have great potential for a rapid and uniform germination of normal seedlings in the field (Guedes in 2009).

As for the variables evaluated, it was observed that the base treatment resulted in lower germination rate, vigor, viability and seedling formation. Therefore, it is suggested that further studies be carried out on the physiological and maturation processes of seeds located near the stalk of the cocoa fruit. These studies can help to understand the factors that led to these results, in addition to serving as a basis for future comparison and discussion.

EMBRAPA (2020) reinforces that a good seed for seedlings must have high physiological, genetic and sanitary quality, that is, it must have high germination, vigor, purity, identity and health. Seed quality directly influences the establishment, development and productivity of seedlings, as it determines the speed, uniformity and percentage of germination, resistance to pests and diseases, adaptation to the environment and expression of genetic potential.

In the treatments, the middle and apex did not present significant differences in most parameters, and were higher than the base in the variables evaluated. Thus, it can be considered that these seeds have superior quality, in ecophysiological terms. Therefore, lots

from these matrices can be more effective when used as propagation material in seedling production.

In general, the Common genotype is quite uniform, however, it has a slower development, requiring a longer period of nurseries to reach the grafting standard (Arévalo et al. 2012). Thus, the relevance of scientific research on germination is highlighted, aiming at the development of knowledge that improves the quality of plants destined for nurseries.

5 FINAL CONSIDERATIONS

Regarding the germination of the seeds as a function of different parts of the cocoa, the base was the one with the lowest performance. The middle and apex treatments showed statistically equal responses to most of the variables evaluated. In this way, the seeds of the middle and apex may have a greater chance of forming more vigorous seedlings.

There are several studies in the literature that investigate the biochemical properties of cocoa seeds. However, most of this research focuses on the modifications that occur during the drying and fermentation stages, with the main purpose of establishing a link with the quality of chocolate. (Chang et al., 2014; Febrianto et al., 2016; Gil et al., 2016). Considering that rootstock propagation is conducted mainly through seeds, studies on biochemical and physiological changes aimed at germination are extremely important, so that this knowledge can be applied in cocoa tree improvement strategies.

REFERENCES

- Albrecht, M., & Penagos, J. (2012). Seed germination ecology of three imperiled plants of rock outcrops in the southeastern United States. *The Journal of the Torrey Botanical Society*, 139(1), 86–95.
- Andréo, Y., Nakagawa, J., & Barbedo, C. J. (2006). Mobilização de água e conservação da viabilidade de embriões de sementes recalcitrantes de ingá (*Inga vera* Will. subsp. *affinis* (DC.) T. D. Pennington). *Revista Brasileira de Botânica*, 29, 309–318.
- Ataíde, G. M., Borges, E. E. L., Gonçalves, J. F. C., Guimarães, V. M., & Flores, A. V. (2016). Alterações fisiológicas durante a hidratação de sementes de *Dalbergia nigra* (Vell.) Fr. All. ex Benth. *Ciência Florestal*, 26, 615–625.
- Barbedo, C. J., & Marcos Filho, J. (1998). Tolerância à dessecação em sementes. *Acta Botanica Brasilica*, 12, 145–164.
- Bewley, J. D., Bradford, K., Hilhorst, H., & Nonogaki, H. (2013). *Physiology of development, germination and dormancy* (3rd ed.). Springer.
- Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária. (2009). *Regras para análise de sementes*. MAPA.

- Carvalho, N. M., & Nakagawa, J. (2012). Sementes: Ciência, tecnologia e produção (5ª ed.). FUNEP.
- Comissão Executiva do Plano da Lavoura Cacaueira. (2018). Cacau: História e evolução. CEPLAC. http://www.ceplac.gov.br/radar/radar_cacau.htm
- Comissão Executiva do Plano da Lavoura Cacaueira. (2023). Cacau: História e evolução. <https://portalidea.com.br/cursos/a7aa3816eae37384034287f625f6a5f0.pdf>
- Corrêa, F. L. O., Mendonça, V., Araújo, I. P., Vichiatto, M., Cidin, A. C. M., & Mendonça, L. F. M. (2011). Substratos e fertilizantes de liberação controlada na produção de mudas de cacaueiro (*Theobroma cacao* L.). *Agrotrópica*, 23, 87–94.
- Cruz, J. F. M. (2013). Caracterização das sementes de variedades de cacau (*Theobroma cacao* L.) resistentes à vassoura-de-bruxa durante a fermentação e após a secagem [Dissertação de mestrado].
- de Castro, R. D., Bradford, K. J., & Hilhorst, H. W. M. (2004). Desenvolvimento de sementes e conteúdo de água. In A. G. Ferreira & F. Borghetti (Orgs.), *Germinação: Do básico ao aplicado* (pp. 51–68). Artmed.
- Ferreira, A. C. R., et al. (2013). Guia de beneficiamento de cacau de qualidade. Instituto Cabruca.
- Ferreira, A. G., & Borghetti, F. (Orgs.). (2004). *Germinação: Do básico ao aplicado*. Artmed.
- Gomes, A. S. G., Pires, M. M., & Freire, C. R. F. (2008). A crise da atividade cacaueira e a agroindústria do cacau no estado da Bahia, Brasil. *Asociación Latinoamericana de Sociología Rural*. <http://www.alasru.unam.mx/>
- Guimarães, R. M., Oliveira, J. A., & Vieira, A. R. (2006). Aspectos fisiológicos de sementes. *Informe Agropecuário*, 27(232), 40–50.
- Henderson, J. S., Joyce, R. A., Hall, G. R., Hurst, W. J., & McGovern, P. E. (2007). Chemical and archaeological evidence for the earliest cacao beverages. *Proceedings of the National Academy of Sciences*, 104(48), 18937–18940.
- Ho, V. T. T., Zhao, J., & Fleet, G. (2014). Yeasts are essential for cocoa bean fermentation. *International Journal of Food Microbiology*, 174, 72–87.
- International Seed Testing Association. (1976). International rules for seed testing. *Seed Science and Technology*, 4, 3–177.
- Justice, O. L. (1972). Fundamentos do teste de sementes. In T. T. Kozlowski (Ed.), *Seed biology* (Vol. 3, pp. 301–370). Academic Press.
- Kerbaui, G. B. (2004). *Fisiologia vegetal* (7ª ed.). Guanabara Koogan.
- King, N. W., & Roberts, E. H. (1980). Strategy for future research into the storage of recalcitrant seeds. In H. F. Chin & E. H. Roberts (Eds.), *Recalcitrant crop seeds* (pp. 90–110). Tropical Press.

- Long, R. L., Gorecki, M. J., Renton, M., Scott, J. K., Olville, L., Goggin, D. E., Commander, L. E., Westcott, D. A., Herry, H., & Finch-Savage, W. E. (2014). The ecophysiology of seed persistence: A mechanistic view of the journey to germination or demise. *Biological Reviews*, 31–59.
- Marcos Filho, J. (2015). *Fisiologia de sementes de plantas cultivadas* (2ª ed.). ABRATES.
- Moda, L. R., Boteon, M., & Ribeiro, R. G. (2019). Cocoa and chocolate market economic scenario: Opportunities for the Brazilian cocoa culture. *Brazilian Journal of Development*, 5(10), 21203–21225.
- Pammenter, N. W., & Berjak, P. (2000). Aspects of recalcitrant seed physiology. *Revista Brasileira de Fisiologia Vegetal*, 12, 56–69.
- Pammenter, N. W., & Berjak, P. (2014). Physiology of desiccation-sensitive (recalcitrant) seeds and the implications for cryopreservation. *International Journal of Plant Sciences*, 175(1), 21–28.
- Roberts, E. H. (1972). Storage environment and the control of viability. In E. H. Roberts (Ed.), *Viability of seeds* (pp. 14–58). Chapman & Hall.
- Schulz, D. G., et al. (2014). Maturidade fisiológica e morfometria de sementes de *Inga laurina* (Sw.) Willd. *Floresta e Ambiente*, 21, 45–51.
- Soares, T. F., & Oliveira, M. B. P. (2022). Cocoa by-products: Characterization of bioactive compounds and beneficial health effects. *Molecules*, 27(5), 1625.
- Sodré, G. A., et al. (2012). Extrato da casca do fruto do cacaueiro como fertilizante potássico no crescimento de mudas de cacaueiro. *Revista Brasileira de Fruticultura*, 34, 881–887.
- Sudhakara, K., Nagaraj, B. N., Santhoshkumar, A. V., Sunilkumar, K. K., & Vijaykumar, N. K. (2000). Studies on the production and storage potential of synthetic seeds in cocoa (*Theobroma cacao* L.). *Seed Research*, 119–125.
- Venial, L. R., et al. (2017). Biometria e armazenamento de sementes de genótipos de cacaueiro. *Pesquisa Florestal Brasileira*, 37, 39–46.
- Veríssimo, A. J. M. (2012). Efeito da origem do cacau na sua qualidade comercial, funcional e sensorial: O caso do cacau Catongo de São Tomé e Príncipe e do Brasil [Dissertação de mestrado, Universidade Técnica de Lisboa].

CONFLUENCE OF PRACTICES BETWEEN CONSCIOUS CAPITALISM AND HUMANIZED COMPANIES

CONFLUÊNCIA DE PRÁTICAS ENTRE CAPITALISMO CONSCIENTE E EMPRESAS HUMANIZADAS

CONFLUENCIA DE PRÁCTICAS ENTRE CAPITALISMO CONSCIENTE Y EMPRESAS HUMANIZADAS



<https://doi.org/10.56238/sevened2026.008-045>

João Pinheiro de Barros Neto¹, Roberto Moreira do Nascimento Rodrigues²

ABSTRACT

The growing demand for organizational models that combine economic performance, human well-being, and socio-environmental responsibility highlights the need to understand emerging practices such as conscious capitalism and humanized companies. In this context, this study is justified by the relevance of investigating how these approaches intersect and what impacts they generate in corporate environments. The objective is to analyze the convergence between the practices of humanized companies and conscious capitalism, identifying perceptions, benefits, and challenges associated with their implementation, as well as understanding how such initiatives influence employee well-being and motivation. To this end, an exploratory study was conducted through a survey applied to 40 respondents using an online form composed of objective and open-ended questions. Data were analyzed using descriptive statistics, charts, tables, and word clouds, while complying with ethical research principles. The results indicate that, although participants have partial knowledge of the investigated concepts, they recognize benefits such as increased employee engagement, improved work environment, and strengthened corporate reputation. However, relevant challenges also emerge, including cultural resistance, implementation costs, and lack of technical expertise. It is concluded that integrating these practices enhances sustainable development, promotes more ethical organizational cultures, and contributes to purpose-driven business models, although structural and cultural barriers must still be overcome in future initiatives and research.

Keywords: Conscious Capitalism. Humanized Companies. Corporate Sustainability. Business Ethics. Organizational Engagement.

¹ Dr. in Social Sciences. Pontifícia Universidade Católica de São Paulo (PUCSP).
E-mail: professorbarros@hotmail.com Orcid: <https://orcid.org/0000-0002-5680-6658>
Lattes: <http://lattes.cnpq.br/7827126715303644>

² Graduated of Business Administration. Pontifícia Universidade Católica de São Paulo (PUCSP).
E-mail: roberto.rodriguesmn@gmail.com Orcid: <https://orcid.org/0009-0009-0389-9473>
Lattes: <https://lattes.cnpq.br/1879918606068654>

RESUMO

A crescente demanda por modelos organizacionais que conciliem desempenho econômico, bem-estar humano e responsabilidade socioambiental evidencia a necessidade de compreender práticas emergentes, como o capitalismo consciente e as empresas humanizadas. Nesse contexto, o presente estudo justifica-se pela relevância de investigar como essas abordagens se inter-relacionam e quais impactos podem gerar no ambiente corporativo. Objetiva-se analisar a confluência entre práticas de empresas humanizadas e do capitalismo consciente, identificando percepções, benefícios e desafios associados à sua implementação, bem como compreender como tais iniciativas influenciam o bem-estar e a motivação dos colaboradores. Para tanto, realizou-se uma pesquisa exploratória, conduzida por meio de um survey aplicado a 40 respondentes, utilizando formulário online composto por questões objetivas e dissertativas. Os dados foram analisados por estatística descritiva, gráficos, tabelas e nuvens de palavras, respeitando-se os princípios éticos para pesquisas com seres humanos. Os resultados indicam que, embora exista conhecimento parcial sobre os conceitos investigados, reconhecem-se benefícios como maior engajamento dos colaboradores, melhoria do ambiente de trabalho e fortalecimento da reputação corporativa. Entretanto, também emergem desafios relevantes, como resistência cultural, custos de implementação e falta de conhecimento técnico. Conclui-se que a integração dessas práticas potencializa o desenvolvimento sustentável, promove culturas organizacionais mais éticas e contribui para modelos de negócios orientados ao propósito, embora barreiras estruturais e culturais ainda precisem ser superadas em futuras iniciativas e estudos.

Palavras-chave: Capitalismo Consciente. Empresas Humanizadas. Sustentabilidade Corporativa. Ética Empresarial. Engajamento Organizacional.

RESUMEN

La creciente demanda por modelos organizacionales que combinen rendimiento económico, bienestar humano y responsabilidad socioambiental resalta la necesidad de comprender prácticas emergentes, como el capitalismo consciente y las empresas humanizadas. En este contexto, el presente estudio se justifica por la relevancia de investigar cómo estas aproximaciones se relacionan y qué impactos generan en los entornos corporativos. El objetivo es analizar la convergencia entre las prácticas de empresas humanizadas y del capitalismo consciente, identificando percepciones, beneficios y desafíos asociados a su implementación, así como comprender cómo estas iniciativas influyen en el bienestar y en la motivación de los colaboradores. Para ello, se realizó un estudio exploratorio mediante un survey aplicado a 40 participantes, utilizando un formulario en línea compuesto por preguntas objetivas y abiertas. Los datos fueron analizados mediante estadística descriptiva, gráficos, tablas y nubes de palabras, respetando los principios éticos de investigación. Los resultados indican que, aunque los participantes poseen un conocimiento parcial de los conceptos investigados, reconocen beneficios como mayor compromiso de los colaboradores, mejor ambiente laboral y fortalecimiento de la reputación corporativa. Sin embargo, también emergen desafíos relevantes, como resistencia cultural, costos de implementación y falta de conocimiento técnico. Se concluye que la integración de estas prácticas potencia el desarrollo sostenible, promueve culturas organizacionales más éticas y contribuye a modelos de negocio orientados al propósito, aunque aún deben superarse barreras estructurales y culturales en futuras iniciativas y estudios.

Palabras clave: Capitalismo Consciente. Empresas Humanizadas. Sostenibilidad Corporativa. Ética Empresarial. Compromiso Organizacional.

1 INTRODUCTION

Capitalism, traditionally associated with the incessant pursuit of profit, has undergone a significant transformation in recent decades. The growing awareness of the social and environmental impacts of business activities drives the search for fairer and more sustainable business models. In this context, the concept of humanized companies, which puts the well-being of employees and social responsibility in the foreground, stands out. Conscious capitalism, in turn, proposes a new way of doing business, seeking to generate value for all stakeholders, including society and the environment.

This research aims to analyze the intersection between humanized companies and conscious capitalism, seeking to understand how this relationship impacts company performance, employee satisfaction and sustainable development. The premise is that as companies recognize the benefits of adopting practices that favor not only profit, but also the well-being of people and the environment, they tend to adopt these approaches more enthusiastically. This study explores how these practices interact and complement each other, offering a comprehensive overview of the changes in contemporary business practices.

The importance of this research lies in its ability to provide a deeper understanding of contemporary business practices and how the integration of the concepts of humanized companies and conscious capitalism can transform the business environment.

By analyzing how these approaches intersect and influence each other, the research seeks to offer valuable insights to managers, academics, and policymakers. Understanding the intersections between these practices can contribute to the formulation of more ethical and sustainable business strategies, benefiting not only companies but also society and the environment.

In this context, the objective of this study was to analyze the intersection between humanized companies and conscious capitalism to understand how these business practices complement and influence each other, as well as to investigate the perception of employees in relation to how these practices influence the well-being and motivation of employees.

In this way, the research contributes to deepening the understanding of these practices and their implications, highlighting the relevance and benefits of adopting a business model that integrates environmental and business sustainability with people's well-being.

2 THEORETICAL FRAMEWORK

The concept of corporate social responsibility (CSR) began to take shape in the early twentieth century, with movements that sought to regulate and humanize business practices. Critical events, such as the New York fire (Kaplan, 1985) and Fordism (Gramsci, 2023), have

highlighted the need for safer and fairer labor practices. These events were crucial for the development of a business awareness more focused on social and environmental responsibility.

Humanized companies promote practices that respect workers' rights, ensure a healthy work environment, and invest in the personal and professional development of employees. Conscious capitalism, on the other hand, aims to align the financial objectives of companies with the creation of value for society and the environment, arguing that it is possible to achieve financial success while promoting a social and environmental mission.

The relationship between humanized companies and conscious capitalism is intrinsically connected. Both approaches share the goal of promoting ethical and sustainable business practices, which consider the long-term impacts of business activities. Humanized companies often adopt principles of conscious capitalism, such as creating value for all *stakeholders* and environmental responsibility. This alignment can result in a business model that improves employee satisfaction, corporate reputation, and contributes to sustainable development and the health of local communities.

Capitalism, as an economic system, had its origins in mercantilism, which was prevalent in Europe between the sixteenth and eighteenth centuries. Mercantilism emphasized the importance of a favorable trade balance and state intervention in the economy to protect national interests, laying the foundation for industrial capitalism (Dobb, 1981).

With the Industrial Revolution in the late eighteenth and early nineteenth centuries, capitalism underwent a significant transformation. The introduction of new technologies, such as the steam engine and the mechanization of production, led to an exponential increase in productivity and the creation of large industries (Bresser-Pereira, 2011). This period was marked by the growth of cities, mass migration to urban centers, and the formation of a new working class. Industrial capitalism also brought challenges, such as poor working conditions, labor exploitation, and social inequalities, which eventually led to the emergence of labor movements and the implementation of social reforms (Beaud, 1986).

Global capitalism at the beginning of the twenty-first century is marked by events and crises that affect the world economy and the daily lives of citizens. The 2008 U.S. housing crisis, triggered by the collapse of *subprime* mortgages, led to a global recession, highlighting the interconnectedness of financial markets. In the Middle East, the Islamic Revolution in Iran in 1979 transformed the geopolitical and economic dynamics of the region, affecting oil prices and, consequently, the global economy. In Europe, the increase in spending on subsidies to farmers, especially in the context of the Common Agricultural Policy (CAP), has generated

debates about fiscal sustainability and competitiveness in the global market. These phenomena demonstrate how regional events can have global repercussions, affecting the pockets of citizens around the world. The "Golden Age" of globalization, which followed World War II, brought a period of economic growth and integration of international markets. However, the two world wars of the twentieth century interrupted this process, leading to a temporary collapse of globalization. Since then, the world has sought a path back to the international integration of markets, facing challenges and opportunities in an increasingly interconnected economic scenario (Frieden, 2008).

In the post-industrial era, starting in the second half of the twentieth century, capitalism evolved again, this time towards an economy based on services and information technology. Globalization and the liberalization of financial markets have allowed for greater economic integration between countries, while technological innovation has transformed the way businesses operate and interact with consumers (Chaves, 2014).

Contemporary capitalism is characterized by an emphasis on creating value for stakeholders, corporate social responsibility, and environmental sustainability. Over the past five centuries, capitalism has demonstrated a remarkable capacity for adaptation and transformation, shaping the history of the West and profoundly influencing global economic and social structures (Chang, 2013).

Following this evolution, conscious capitalism is a business approach that emerged in the early twenty-first century, grounded in the idea that businesses can thrive while promoting social and environmental well-being. Its origins are linked to the corporate social responsibility (CSR) movement and the growing demand for more ethical and sustainable business practices (Begnini, 2019).

The fundamentals of conscious capitalism include creating value for all *stakeholders*, conscious leadership, purpose-driven organizational culture, and the integration of social and environmental responsibility into business operations (Bremer, 2016). This model argues that companies should go beyond the pursuit of immediate profit, considering the long-term impacts of their activities and contributing to the sustainable development of the communities in which they operate. By aligning financial objectives with a social and environmental mission, conscious capitalism seeks to create a lasting positive impact, demonstrating that it is possible to achieve economic success while promoting a fairer and more sustainable world (Mackey; Sisodia, 2018).

Business ethics are essential for the development of a solid and sustainable organizational culture. For this ethic to be consolidated, it is essential that the company's leadership and strategy are aligned with human appreciation in the workplace. The

competence to be ethical must be cultivated at all levels of the organization, promoting the understanding that ethics is essential to business life and success. Integrating ethics into daily practices and strategic decisions not only strengthens the company's trust and reputation, but also creates a fairer and more motivating work environment. For business ethics to become a philosophy of life, it is necessary for all employees to internalize these values, recognizing that ethical practices are fundamental for collective well-being and long-term sustainability (Matos, 2016).

Environmental Management and Corporate Social Responsibility (CSR) are essential to business strategies in today's scenario, where sustainability and ethics are increasingly valued. Organizations need to ensure the efficient execution of their processes along the evolutionary chain to achieve success, expand markets, win new customers, and obtain results favorable to growth. Significant changes in the business context indicate the need for management that is socially responsible and environmentally friendly. This requires the adoption of new management models that integrate sustainable and ethical practices, allowing managers to understand and adopt an ethical stance towards customers and the community in general. By incorporating environmental management and CSR into their strategies, companies not only improve their reputation and competitiveness but also contribute to sustainable development and social well-being, creating a lasting positive impact (Tachizawa, 2019).

Corporate sustainability and ESG (*Environmental, Social, and Governance*) criteria emerge as central themes of today and the future, reflecting the need to redirect business evolution towards sustainable development. Corporate sustainability involves the integration of practices that ensure the longevity of the business, while promoting social well-being and environmental preservation. ESG criteria, in turn, assess the ethical impact and sustainability of companies, considering environmental, social, and governance aspects. Given the historical impacts caused by the way humanity has developed its results and shaped its society, it is imperative that modern organizations abandon the methodology of profiting for profit's sake. Instead, they should seek to profit from a positive purpose, where the economic result is added to environmental, social, and governance issues. This approach not only strengthens institutions to face future crises, but also serves as an example for a cultural migration of society, promoting good practices and ensuring the relevance and sustainability of companies in the long term (Goi Junior, 2022).

Humanized companies are those that, driven by passion and purpose, transcend the pursuit of profit and focus on helping all their *stakeholders* thrive: customers, investors, employees, partners, communities, and society in general. These companies act in a positive

way, being recognized, valued, admired, and even loved by their *stakeholders*. They improve the world through their business practices, and the world responds positively to this approach. By building a high-performance business based on love, these companies help people find the self-fulfillment they are looking for, promoting a radical social transformation of capitalism. This goes beyond creating a productive and happy work environment, it's about establishing truly mutually beneficial relationships with partners, being a company enthusiastically welcomed by communities, and ensuring that all *stakeholders*, including investors, win (Wolfe et al., 2019).

In view of the literature analyzed, conscious capitalism and humanized companies emerge as innovative responses, proposing an approach that goes beyond immediate profit and considers the well-being of employees, social responsibility and environmental sustainability. These practices not only improve business performance, but also contribute to a fairer and more sustainable development, reflecting a radical social transformation of capitalism.

3 METHODOLOGY

This exploratory research was conducted through a survey, with the objective of understanding the public's perceptions and understanding of conscious capitalism and humanized companies. The exploratory nature of the study allows for an initial investigation, providing valuable insights that can guide further future research (Prodanov; Freitas, 2013).

The sample was composed of 40 respondents, selected in a non-probabilistic manner and approached voluntarily through social networks, ensuring a diversity of profiles and opinions. Choosing a diverse sample is key to capturing a wide range of perceptions on the topic.

The data were collected through a Google form, containing 23 objective and essay questions, designed to capture the opinions and knowledge of the participants. Using an online form made it easier to collect data from a diverse audience and allowed for efficient analysis of responses.

All stages of the study were conducted in accordance with the ethical principles established for research with human subjects (Witiuk et al., 2018). Participants were informed about the context and objectives of the research before answering the questionnaires, and informed consent was obtained by signing the Informed Consent Form (ICF). The survey ensured the anonymity of the participants, respecting their rights and privacy. Submission to the Ethics Council was not necessary, as the research did not involve direct interventions, significant risks, or sensitive data collection.

Data analysis was quantitative, using descriptive statistics to interpret the results with the support of Tables and Figures that were prepared using Excel software. Regarding the open questions, the analysis was based on Figures called word clouds with the Wordart application, in its free version (<https://wordart.com/>), as this type of figure facilitates content analysis through the visualization and understanding of the information collected. Content analysis with the support of word clouds is a method that has already been widely used, so the analysis of the collected data (Camargo et. al., 2013) allowed the identification of trends and patterns in the participants' responses, providing a solid basis for the interpretation of the findings.

Among the limitations of the study, the non-probabilistic sample stands out, which may not be representative of the general population. In addition, data collection through an online form may have excluded individuals without access to the internet or with difficulties in using digital technologies. These limitations should be considered when interpreting the results and generalizing the findings. The survey was carried out between June and July 2024, ensuring an adequate period for data collection and analysis.

4 RESULTS AND DISCUSSIONS

The analysis of the survey results brought a series of perceptions about how companies are dealing with these practices. By examining the data, it is possible to observe the diversity of ages of the respondents, the size of the companies where they work, the level of knowledge about the topics, the definitions they provide, the challenges and opportunities they identify, in addition to the positive impacts and their expectations for the future. This analysis helps to better understand the attitudes and barriers that exist, and highlights the importance of raising awareness and developing effective strategies to implement more ethical and sustainable business practices.

Table 1 shows the age distribution of the 40 respondents. The majority of participants (24) are in the 18-25 age group, indicating a young audience and possibly more open to new ideas and innovative business practices. The 26-30 years, 31-50 years, and 51-65 age groups have an equal representation of 5 respondents each, while only 1 respondent is over 66 years old. This distribution suggests that perceptions of conscious capitalism and humanized companies can be influenced by different generations, with a predominance of young adults.

Table 1

Age group of respondents

Age Group	Quantity	%
18 to 25 years old	24	60,00%
26 to 30 years old	5	12,50%
31 to 50 years old	5	12,50%
51 to 65 years old	5	12,50%
More than 66 years old	1	2,50%
Grand Total	40	100,00%

Source: survey data.

Table 2 presents the distribution of respondents according to the size of the company in which they work. Most respondents (16) work in companies with more than 1000 employees, followed by companies with 1 to 10 employees (9 respondents). This indicates a diversity of business contexts, from small startups to large corporations. This variety is important for understanding how different sizes of companies perceive and implement conscious capitalism practices and humanized companies.

Table 2

Count of Company Size in number of employees

Size	Quantity	%
1 to 10 employees	9	22,50%
11 to 50 employees	3	7,50%
51 to 200 employees	6	15,00%
200 to 500 employees	3	7,50%
501 to 1000 employees	3	7,50%
More than 1000 employees	16	40,00%
Grand Total	40	100,00%

Source: survey data.

Table 3 reveals that 20 respondents have heard of humanized companies, while 12 do not know the subject and 8 may know about it. This shows that, although there is a reasonable knowledge about the concept, there is still a significant portion of people who are not familiar with it. This data highlights the need for greater dissemination and education about humanized companies to expand the understanding and adoption of these practices.

Table 3

How many people know the topic of Humanized Companies

Reply	Quantity	%
No	12	30,00%
Yes	20	50,00%
Maybe	8	20,00%
Grand Total	40	100,00%

Source: survey data.

Table 4 shows that 20 respondents do not know the topic of conscious capitalism, while 12 have heard of it and 8 may know about it. As in the case of humanized companies, there is a need for greater awareness and education about conscious capitalism, as half of the respondents are not familiar with the concept.

Table 4

How many people know about the topic of Conscious Capitalism

Answers	Quantity	%
No	20	50,00%
Yes	12	30,00%
Maybe	8	20,00%
Grand Total	40	100,00%

Source: survey data.

When it comes to what survey respondents think about what humanized companies are, the analysis of Figure 2, which compiles into a word cloud the most relevant answers about what survey respondents understand by conscious capitalism, reveals several important insights.

The most prominent terms, such as "value", "sustainable", "consumption" and "conscious", indicate that respondents associate conscious capitalism with business practices that go beyond immediate profit, focusing on sustainable value creation and conscious consumption.

This suggests an appreciation of practices that promote sustainability and responsibility in business operations.

Other words present in the cloud, such as "business", "companies" and "world", reinforce the idea that conscious capitalism is seen as a global approach that involves all spheres of the company.

The emphasis on terms such as "sustainable" and "conscious" highlights the importance of ethical and responsible business practices, which consider the long-term impacts of business activities on the environment and society. In summary, respondents perceive conscious capitalism as an approach that integrates value creation with sustainability and social responsibility, promoting a lasting positive impact.

Figure 2

More relevant answers about what Conscious Capitalism is



Source: elaboration by the authors.

Regarding the challenges that the respondents' companies face to implement humanized organization practices and conscious capitalism, Figure 3 highlights the main challenges faced by them to implement humanized business practices and conscious capitalism in the respondents' view.

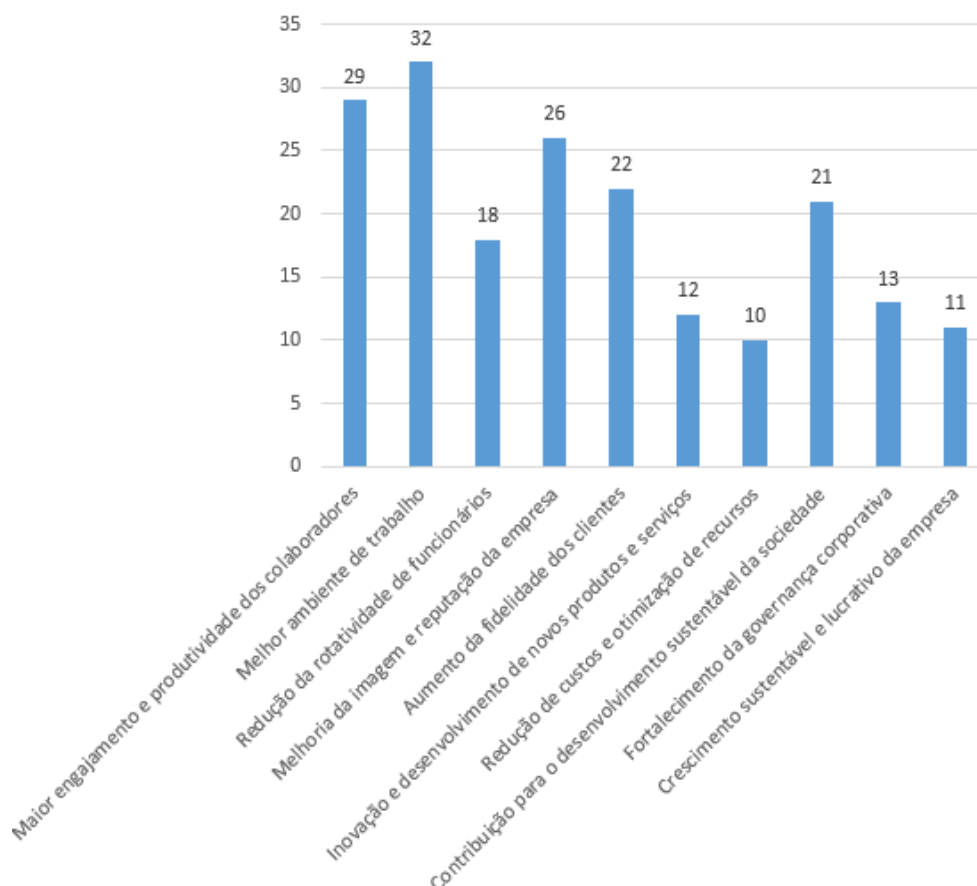
The most prominent terms, such as "company", "cost", "practices" and "implement", indicate that the main challenges are related to high costs and the implementation of desired practices. This suggests that companies face significant financial barriers when trying to adopt these practices, as well as practical difficulties in executing them.

Other words present in the cloud, such as "employees," "time," and "internal resistance," highlight additional challenges, such as employee resistance and lack of time to implement change. Internal resistance can be a considerable obstacle, indicating the need for effective change management strategies to overcome these barriers.

Thus, respondents realize that the main challenges for the implementation of humanized business practices and conscious capitalism include high costs, practical difficulties, employee resistance, and the need for time to make changes.

Figure 4

Main positive impacts that the practices of Humanized Companies and Conscious Capitalism can generate for your company according to the respondents



Source: survey data.

Figure 4 shows the opportunities identified by respondents to implement humanized business practices and conscious capitalism. The most prominent terms, such as "development", "employees", "company" and "admiration", indicate that respondents see significant opportunities in employee development and in improving corporate image. This suggests that investing in employees' personal and professional growth and gaining admiration in the marketplace are seen as important competitive advantages.

Other words in the cloud, such as "market," "customers," and "government," highlight additional opportunities related to market expansion, strengthening customer relationships, and complying with government regulations.

The presence of terms such as "implementation" and "training" indicates that respondents recognize the importance of training employees and adopting effective strategies to implement these practices.

It can be inferred that respondents perceive that the main opportunities for the implementation of humanized business practices and conscious capitalism include employee

development, improvement of corporate image, market expansion, strengthening of customer relationships, and compliance with government regulations.

Figure 5

Opportunities that the company in which the respondents work have to implement these practices.

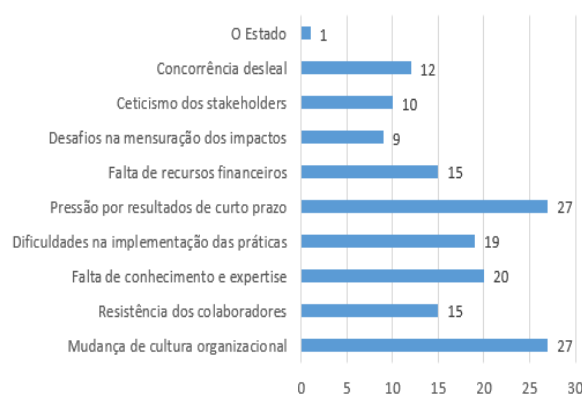


Source: elaboration by the authors.

Figure 6 highlights that the main challenges include "organizational culture change", "employee resistance" and "lack of knowledge and expertise". These challenges reflect the need for significant cultural change and empowerment so that companies can effectively adopt these practices. The pressure for short-term results and the lack of financial resources are also important barriers to overcome.

Figure 6

Main challenges that companies face to become Humanized Companies and adopt the principles of Conscious Capitalism according to correspondents

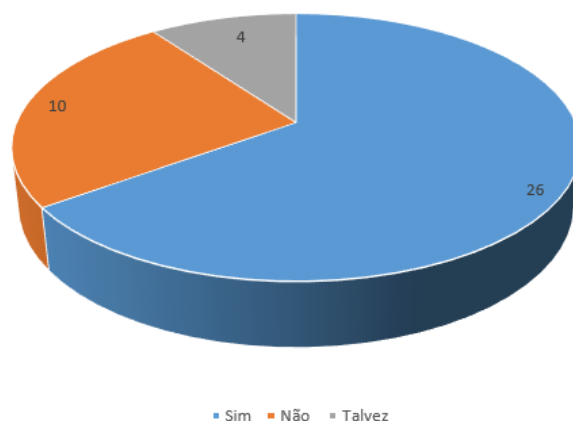


Source: survey data.

Figure 7 reveals that the majority of respondents (26) believe that humanized companies and conscious capitalism represent a new way of doing business, while 10 do not believe and 8 are undecided. This indicates a growing recognition that these practices can positively transform the business environment.

Figure 7

Number of correspondents who believe that Humanized Companies and Conscious Capitalism represent a new way of doing business

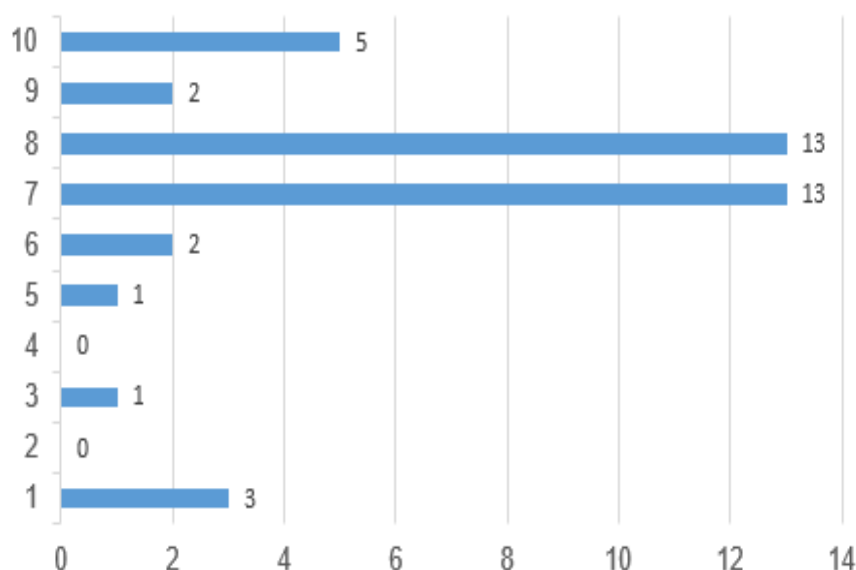


Source: survey data.

Figure 8 shows that expectations for the future of humanized companies and conscious capitalism are varied, with a majority expressing optimism about the positive impact of these practices. However, there is also a significant portion of uncertainty, reflecting the need for more evidence and successful examples to consolidate these expectations.

Figure 8

Expectations for the future of humanized companies and Conscious Capitalism according to correspondents



Source: survey data.

The results of the survey indicate that there is a reasonable, but still limited, knowledge about the concepts of humanized companies and conscious capitalism among the respondents. While many recognize the benefits of these practices, such as increased employee engagement and improved corporate reputation, they also face significant challenges, such as cultural resistance and lack of resources.

The analysis highlights the importance of promoting greater education and awareness on these topics, as well as developing effective strategies to overcome barriers to implementation. Ultimately, the convergence of corporate sustainability, ethical stewardship, and social responsibility can offer a promising path to a more balanced and sustainable business future, aligning economic success with positive social and environmental impact.

5 CONCLUSION

The main findings of this study indicate that the adoption of humanized and conscious practices can significantly improve business performance, increase employee satisfaction and promote sustainable development.

The survey also revealed that, although there is reasonable knowledge about these concepts, there are still cultural and practical barriers that hinder their implementation.

The proposed objectives of the study were achieved, since it was demonstrated that the integration of humanized practices and conscious capitalism not only benefits companies, but also contributes to a more ethical and sustainable business environment.

Therefore, the most important findings are considered to include the identification of challenges such as employee resistance and high costs, as well as opportunities for competitive differentiation and improved corporate reputation.

Nevertheless, it is recognized that the limitations of the study include the non-probabilistic sample and online data collection, which may not represent the general population. Therefore, it is suggested that future research could explore broader and more diverse samples, as well as investigate more deeply the strategies to overcome the identified barriers.

Finally, it is understood that this study contributes to the field of research of Applied Social Sciences, especially Human Resource Management, by providing a deeper understanding of contemporary business practices and their implications. It also offers managers, academics, and policymakers some relevant points for consideration. Promoting a business model that integrates sustainability and human well-being is essential for a fairer and more sustainable business future.

ACKNOWLEDGMENTS

We would like to express our gratitude to the Institutional Program for Scientific Initiation Scholarships (PIBIq) of the Council for Teaching and Research (CEPE) of the Pontifical Catholic University of São Paulo (PUC-SP).

REFERENCES

- Beaud, M. (1986). *História do capitalismo: De 1500 a nossos dias*. Brasiliense.
- Begnini, S., et al. (2019). Capitalismo consciente: Uma análise netnográfica em grupos da rede social LinkedIn. *Cadernos EBAPE.BR*, 17, 277–293.
- Bremer, C., & Eckschmidt, T. (2016). Capitalismo consciente. *Caderno de Inovação*, (20), 25–29.
- Bresser-Pereira, L. C. (2011). Cinco modelos de capitalismo. *Brazilian Journal of Political Economy*, 31, 3–26.
- Camargo, B. V., & Justo, A. M. (2013). IRAMUTEQ: Um software gratuito para a análise de dados textuais. *Temas em Psicologia*, 21(2), 513–518. <https://files.cercomp.ufg.br/weby/up/1267/o/Iramuteq.pdf?1597676323>
- Chang, H.-J. (2013). 23 coisas que não nos contaram sobre o capitalismo: Os maiores mitos do mundo em que vivemos – como reconstruir a economia mundial. Cultrix.
- Chaves, V. F. (2014). A empresa do século XXI: Criando valor compartilhado em tempos de um capitalismo consciente. *Interfaces Científicas – Direito*, 3(1), 21–32.

- Dobb, M. (1981). *A evolução do capitalismo*. LTC.
- Frieden, J. A. (2008). *Capitalismo global: História econômica e política do século XX*. Zahar.
- Goi Junior, L. O. (2022). *Sustentabilidade corporativa e ESG: Como ir de lucrar por lucrar para lucrar com propósito*. Qualitymark.
- Gramsci, A. (2023). *Americanismo e fordismo*. Hedra.
- Kaplan, T. (1985). On the socialist origins of International Women's Day. *Feminist Studies*, 11(1), 163–171.
- Mackey, J., & Sisodia, R. (2018). *Capitalismo consciente: Como libertar o espírito heroico dos negócios*. Alta Books.
- Matos, F. G. de. (2016). *Ética na gestão empresarial: Da conscientização à ação*. Saraiva.
- Prodanov, C. C., & Freitas, E. C. de. (2013). *Metodologia do trabalho científico: Métodos e técnicas da pesquisa e do trabalho acadêmico* (2ª ed.). Editora Feevale.
- Tachizawa, T. (2019). *Gestão ambiental e responsabilidade social corporativa: Os paradigmas do novo contexto empresarial*. Atlas.
- Witiuk, I. L., França, B., Krüger, C., & Guebert, M. C. C. (2018). *Ética em pesquisa envolvendo seres humanos*. PUCPRESS.
- Wolfe, D. B., Sheth, J., & Sisodia, R. (2019). *Empresas humanizadas*. Alta Books.

AFTER ALL, WHAT IS STRUCTURAL LITIGATION? GENERAL NOTIONS AND PRELIMINARY THEORETICAL FOUNDATIONS

AFINAL, O QUE É PROCESSO ESTRUTURAL? NOÇÕES GERAIS E FUNDAMENTOS TEÓRICOS PRELIMINARES

QUÉ ES, EN DEFINITIVA, EL LITIGIO ESTRUCTURAL? NOCIONES GENERALES Y FUNDAMENTOS TEÓRICOS PRELIMINARES



<https://doi.org/10.56238/sevened2026.008-046>

Joaquim Ribeiro de Souza Junior¹

ABSTRACT

This paper examines the structural process as an instrument capable of closing the historical gap between Brazil's broad constitutional catalogue of fundamental rights and the country's material reality. It outlines the evolutionary path of judicial protection, from the retrospective damage-repair model to the prospective paradigm aimed at transforming public or private structures and policies trapped in systematic non-compliance. The study sets out the core notions of structural problem, process and decision, and discusses the Brazilian taxonomy (normative, collective and individual structural proceedings). It also assesses the importance of extrajudicial control, illustrated by the Carrefour settlement, showing that the enforcement of fundamental rights may dispense with the courts. The article concludes that the structural process—grounded in dialogical participation and progressive decision-making—is an indispensable tool for implementing inclusive policies and enhancing the democratic legitimacy of adjudication.

Keywords: Structural Process. Structural Litigation. Fundamental Rights. Public Policies. Jurisdiction.

RESUMO

O artigo busca examinar o processo estrutural como instrumento apto a superar o hiato histórico entre a ampla previsão constitucional de direitos fundamentais e a realidade material brasileira. Parte-se do panorama evolutivo da tutela jurisdicional, do modelo retrospectivo de reparação de danos ao paradigma prospectivo voltado à transformação de estruturas e políticas públicas ou privadas em situação de desconformidade sistemática. A pesquisa descreve as premissas conceituais de problema, processo e decisão estruturais, bem como discute a taxonomia proposta pela doutrina brasileira (processo estrutural normativo, coletivo e individual). Analisa-se, ainda, a relevância do controle extrajudicial, ilustrada pelo TAC Carrefour, evidenciando que a efetivação de direitos fundamentais pode prescindir da via judicial. Ao final, conclui-se que o processo estrutural, ancorado na participação dialógica e em decisões progressivas, representa ferramenta indispensável

¹ Doctoral student in Law . Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: joaquimjunior33@gmail.com Orcid: <https://orcid.org/0000-0003-3488-5508>

para a promoção de políticas inclusivas e para o fortalecimento da legitimidade democrática da jurisdição.

Palavras-chave: Processo Estrutural. Litígio Estrutural. Direitos Fundamentais. Políticas Públicas. Jurisdição.

RESUMEN

El artículo busca examinar el proceso estructural como un instrumento apto para superar la brecha histórica entre la amplia previsión constitucional de derechos fundamentales y la realidad material brasileña. Se parte del panorama evolutivo de la tutela jurisdiccional, desde el modelo retrospectivo de reparación de daños hasta el paradigma prospectivo orientado a la transformación de estructuras y políticas públicas o privadas en situación de desconformidad sistemática. La investigación describe las premisas conceptuales del problema, del proceso y de la decisión estructurales, así como discute la taxonomía propuesta por la doctrina brasileña (proceso estructural normativo, colectivo e individual). Se analiza, además, la relevancia del control extrajudicial, ilustrada por el TAC Carrefour, evidenciando que la efectivización de derechos fundamentales puede prescindir de la vía judicial. Al final, se concluye que el proceso estructural, anclado en la participación dialógica y en decisiones progresivas, constituye una herramienta indispensable para la promoción de políticas inclusivas y para el fortalecimiento de la legitimidad democrática de la jurisdicción.

Palabras clave: Proceso Estructural. Litigio Estructural. Derechos Fundamentales. Políticas Públicas. Jurisdicción.

1 INTRODUCTION

The Constitution of the Republic of 1988 enshrined an extensive list of fundamental rights that can be judicially enforced. Decades after its promulgation, however, an abyss persists between the normative text and social reality. The traditional procedural system, centered on the retrospective logic of reparation of damages, proved incapable of promoting the structural change necessary to overcome historical inequalities and massive and systemic violations of rights.

In this context, the structural process presents itself as a judicial or extrajudicial technique, aimed at the reorganization of policies or structures whose way of functioning generates, fosters or enables permanent violations of fundamental rights. Unlike actions of a merely reparatory or injunction nature, the structural process is not satisfied with specific orders to do or not to do; it requires the preparation of a progressive transformation plan, accompanied by cascading or spiral decisions (Arenhart, 2024), capable of monitoring and adjusting the results obtained.

Inspired by the North American experience of *public law litigation* and *structural injunctions*, Jobim (2024) classifies the structural process into three types: a) normative structural process, linked to the abstract control of constitutionality; b) collective structural process, conveyed mainly by collective actions; and c) individual structural process, filed by individual authors, but endowed with broad transformative potential. The distinction shows that the phenomenon does not necessarily depend on the presence of the State as a party, nor is it limited to the judicial sphere, admitting consensual solutions and self-regulation mechanisms.

This article intends to delimit some conceptual premises of the structural process, as well as to evaluate its practical usefulness for the realization of fundamental rights and for the improvement of public and corporate governance.

2 AFTER ALL, WHAT IS A STRUCTURAL PROCESS?

Definitely, structural process is the topic of the moment in Brazilian procedural law². It could not be otherwise. The Federal Constitution provides for a broad and non-exhaustive

² Since the pioneering work of Desirê Bauermann (2012) and Marco Félix Jobim (2013), dozens of master's dissertations and doctoral theses on the subject have been published in Brazil. Courses and collections of articles on the subject have also been published. In addition, there are study groups that are quite sedimented with this object. The group "Culture and Process" linked to the PPGD of PUCRS, coordinated by Marco Félix Jobim, should be mentioned. In addition to this, we have the study group coordinated by Sérgio Arenhart at the Federal University of Paraná, the study group coordinated by Fredie Didier at the Federal University of Bahia, the study group coordinated by Jordão Violin at PUCPR, the study group coordinated by Hermes Zaneti at the Federal University of Espírito Santo, the study group coordinated by Edilson Vitorelli at the Federal University of Minas Gerais, the study group coordinated by Leonardo Cunha at the Federal University of Ouro Preto and

list of fundamental rights. On the other hand, there is a significant gap between the text and the context. This means that the social, political and economic reality of the country is marked by a deep distance between what is and what should be, according to the original constituent power.

Therefore, there is a clear need for an adequate procedural tool so that the jurisdiction can act in order to promote this passage from a reality of systematic and permanent inadequacy to a new desired situation³. It is uncontroversial that traditional procedural techniques do not lend themselves to this scope.

However, a warning is necessary. It is that, under the terms of what Jobim (2024, 4th Edition) teaches, structuring (or structural) measures in constitutional jurisdiction do not necessarily require a structural process, since the abstract control actions provided for in Law 9,068/99 and Law 9,082/99, in addition to other constitutional actions, already bring adequate rites to the judicial protection appropriate to these transformations.

Therefore, there is no need to speak of the construction of a new tool suitable for what is conventionally called the normative structural process, as opposed to the collective structural process (public and collective civil actions, etc.) and the individual structural process, which, in turn, deals with an individual action, but with the potential to promote significant changes such as, for example, an individual action promoted by a person with disabilities in front of the school where he studies aiming at his compliance with accessibility standards⁴.

many others. It is easy to see, therefore, that the structural process is a topic that occupies and will continue to occupy the agenda of the operators of the justice system.

³ Regarding the importance of adaptability of procedural rules to what is carried out, it is worth adding that "procedural rules can only be legitimately valid if and when they fulfill their constitutional mission and adhere, in fact, to the problems of reality that they are supposed to serve [...]. With these considerations, it is easy to see that the process is not a given, but a constructed one. It must be constructed in the light of the concrete circumstances of the problem to be faced and the reality of the material right to be acted. Therefore, thinking of procedural law in the abstract constitutes a serious mistake. It is necessary to design the process for the case and in the light of the case. It is in this sense that it is said that the procedural technique must be at the service of the protection of rights. The procedural technique alone is nothing. It only acquires value and importance to the extent that it is aligned with the needs of substantive law and the fundamental values set forth in the Constitution" (ARENHART, OSNA AND JOBIM, 2021, p. 14)

⁴ Regarding the individual process, it is timely to warn André Ribeiro Tosta and Felipe Barreto Marçal (2022, p. 201-202) that "many structuring demands are formally individual (bipolar), despite their object cannot be adequately resolved through traditional conflict resolution mechanisms and procedures. It is necessary, therefore, to treat these formally individual demands as what they truly are: structuring demands"

3 GENERAL PREMISES OF THE STRUCTURAL PROCESS

From its foundation with the work Theory of Exceptions and Procedural Assumptions by Oskar von Bülow⁵⁶⁷, in 1868 until the 2000s, approximately, the process was retrospective. Its scope was to repair damage that had already occurred. In this sense, an adequate process was one that was able to successfully reconstruct events from the past, repairing the damage suffered and returning those involved, as much as possible, to the *status quo ante* through strategies to repair the damages.

The seminal works of Marinoni (2022, 8th Edition) and Arenhart (2002), related to injunctive relief, were the protagonists of the important moment in which the process began to be thought of as an instrument that, in order to be used, does not presuppose damage that has already occurred. The phase of the so-called damage inhibition actions is inaugurated.

Nowadays, the era of prospective processes is under construction. In other words, prospective is the process that has its eyes turned to the future⁸. Its purpose is the transition from an undesirable current reality to a new coveted context, through the preparation and implementation of a plan to modify the functioning of the institution and examine the results achieved, in order to ensure the intended social change.

From this perspective, the structural process comes with the intention of being an adequate technique to structure the future. What matters most is not the reparation of the past⁹. The main intention is the reorganization of a structure or policy, whether public or private.

⁵ Born in Wroclaw on 11 September 1837 and died in Heidelberg on 19 November 1907

⁶ It is the work BÜLOW, Oskar Von. Theory of exceptions and procedural assumptions or Die Lehre von der Prozesseinreden und die Prozessvoraussetzungen. Translated by: Ricardo Rodrigues Gama. Campinas: LZN, 2005.

⁷ Regarding the work of Oskar Bülow, Professors Marinoni, Arenhart and Mitidiero teach that "Oskar Bülow is due one of the most important attempts to explain the nature of the process. His theory, which has become known as the theory of the procedural legal relationship, is preferred by the classical doctrine and by almost all Brazilian proceduralists today. Ten years after the controversy between Windscheid and Muther over the lawsuit, BÜLOW published (in 1868) the work entitled Theory of Procedural Exceptions and Procedural Assumptions (Die Lehre von der Prozesseinreden und die Prozessvoraussetzungen), through which he gave theoretical content to the idea that there is a legal relationship in the process. It should be noted that the idea of a legal relationship between the parties and the judge was already intuited at the time of Roman law and by medieval jurists. The importance of BÜLOW's work was to systematize, although based on the theory of the legal relationship already built by private law – but based on the premises of the autonomy of the process in relation to substantive law and its public nature – the existence of a procedural legal relationship of public law, formed between the parties and the State, evidencing its assumptions and its disciplinary principles" (2022, p. 519).

⁸ In relation to this premise of the structural process as a prospective technique, Arenhart, Osna and Jobim point out that "in order to begin the exposition of the different particularities of structural processes, it seems necessary to take a step back to allow some important theoretical elucidations. In short, this complex, multipolarized and polycentric area, with systematic violation of inherent fundamental rights and guarantees [...] becomes a condition for the existence of a process that encompasses its extension for the future resolution of the problem presented, which will be designed from the techniques to protect the right that is intended to be protected" (2021, p. 14)

⁹ Regarding this prospective character of the structural process, Luana Steffens argues that "the structural process is a different model from the classical conception of civil procedural law, designed to deal with a dispute of a bilateral, individual and patrimonial nature. The classic traditional process works with the right-obligation-

For this reason, it is essential to reflect on three intrinsically related concepts: 1) structural problem; 2) structural process and; 3) structural decision.

A structural problem is a factual context that represents a state of structured nonconformity. In other words, there is a situation of permanent and systematic non-conformity. Several examples can be cited. This is the case of prisons that operate in a way that does not respect the principle of human dignity. It is also the case of sidewalks and other public and private spaces that do not minimally meet accessibility conditions. It is, in the same way, that scenario in which a company practices structural racism by hiring people always of the same race or ethnicity and so on.

It is clear that, at this juncture, a one-shot solution is not feasible (Marçal, 2021, p. 155), that is, through a single act. It does not happen on an "all or nothing" basis (Osna, 2024, p. 495). The situation of non-conformity is so sedimented that, for its correction, a true restructuring of the way that structure or policy works is required. There is no specific illegality that can be remedied with a simple act.

Regarding the theme, Vitorelli considers the concept of structural litigation as synonymous with radiated litigation in which "different groups of people are affected in different ways, with greater or lesser intensity, which generates distinct and varied, possibly antagonistic, claims for relief" (2022, p. 356).¹⁰

It is appropriate to add that there is no doctrinal consensus as to the best nomenclature for a structural problem or litigation. Some prefer to use the expression illegal state of affairs. The expressions state of inadequacy and state of structured nonconformity are also widely used. The nomenclature varies, but its semantic content is usually used as a synonym by the national doctrine.

With regard to the question of stating that a situation of illegality is an essential phase for the verification of a structural disorganization, there is a relevant doctrinal controversy. Didier Jr, Zaneti Jr and Oliveira (2021, p. 427) teach that "the structural problem is not necessarily based on the notion of illegality and, when it is eventually based on it, it is not itself confused with the illicit situations that arise from it". They exemplify, as a structural

violation-reparation structure. There is no substantial concern with specific guardianship and pro-future measures; It is concerned with the reparation of the damage through compensation for those who suffered from the illicit act in the past, through retrospective measures. Structural conflicts have peculiar characteristics and complex nature, so that the traditional civil procedure is insufficient to resolve them, in view of the polycentric and diffuse nature of the issues. In these cases, there is a need to take the violation as a starting point, not to compensate the injured party, but to find ways to stop the behavior that gives rise to it or the structural context that favors it." (2021, p. 105).

¹⁰ The author also states that: "Structural litigation is those that involve multipolar conflicts, of high complexity, whose objective is to promote public values through the courts, through the transformation of a public or private institution. There is a need to reorganize an entire institution, with the change of its internal processes, its bureaucratic structure, and the mentality of its agents, so that it can fulfill its function according to the value stated by the decision" (2022, p. 356).

problem without the characteristic of illegality, with the closure of a factory, causing a wave of unemployment and several other social problems in a given society.

On the other hand, Edilson Vitorelli (2024, p. 64) defines a structural process as the collective technique that has as its scope "the reorganization of a bureaucratic structure, public or private, which causes, fosters or enables the occurrence of a violation by the way it works, giving rise to structural litigation". Such a conceptualization, in this conception, implies the existence of an illegality.

It is important to register here the concept of collective litigation according to Vitorelli. This is because, according to the author, every problem or structural litigation involves a collective claim, even if brought in an individual lawsuit. For the author, collective litigation is that which "involves a multiplicity of subjects, which make up a group, a society, involved in the conflict as such, not as a bundle of individual interests" (2024, p. 30).

It is also important to add a few words about the classification of collective disputes developed by Vitorelli, in the same work cited, considering that this classification ends up helping a lot in the definition of what is a structural problem, according to the author. Such classification, according to which, the degree of conflict and complexity verified in a given collective dispute is taken into account. Considering that conflict concerns the individual impact on the collective claim, and that complexity arises from the relationship between the litigation and the Law, which can confer various possibilities of judicial protection, it is possible to classify collective litigation as: collective litigation of global diffusion; collective litigation of local diffusion; and collective litigation of radiated diffusion.

Global litigation encompasses society in general, however, it has little reverberation on the individuals who are part of it, so that such disputes have low conflict and high or low complexity. Local litigation, in turn, reaches certain subjects, who are linked by social, emotional and territorial solidarity, presenting moderate conflict and greater complexity than that envisioned in global litigation¹¹. In irradiated litigation, society is harmed in different ways, both in nature and intensity, in such a way that both conflict and complexity are high.

¹¹ With regard to the typology of conflicts, Pedro Luiz de Andrade Domingos argues that "The approach to the problem from the origin of the damage to the impacted society seeks to consider the simultaneous interests that involve the controversy, based on two objective indicators, the conflict of social perspectives and the complexity of the right to be judged, in order to allow the construction of a procedure for resolving the conflict without giving up due process. The polycentricity of interests and the multipolar context of the process make it difficult to isolate the implementation of the necessary measures for full reparation of the right and its indirect consequences on affected third parties without their participation. In this procedural environment with diversified impacts on those affected, adequately representing the interests of the parties is of central importance for the success of the resolution procedure. The reparatory measure must listen to the interests of the impacted society to better understand the problem, so that the resolution of structural disputes identifies who are the classes or groups that make up the society that holds the right and what their perspectives would be to better resolve the conflict. This approach understands that transindividual rights are divisible, contrary to the traditional thinking historically conducted by the Brazilian collective process, as each member of a radiated litigation experiences the damage

Due to these enormous, and perhaps insurmountable, difficulties, part of the doctrine recognizes that one should not theorize a concept of litigation or structural problem, and that it is wiser to work on its characteristics¹². In any case, the fundamental thing is the notion that structural litigation arises from the way in which a certain bureaucratic structure works and is organized, whether it is private or public. The structural problem results from the very mode of operation of the structure. Thus, dealing only with its effects, disregarding the causes, will not bring effective changes.

In turn, the process that has as its object a structural litigation is called structural. It is the process that, through jurisdictional action or not, aims at the reorganization of a bureaucratic structure (public or private) or a policy that *per se* causes, fosters, or enables the occurrence of systemic violations of rights, giving rise to structural litigation (Vitorelli, 2024). In view of this, its main scope is the elaboration and implementation of a "plan to change the bureaucratic institution in structured nonconformity, whether public or private" (Vitorelli, 2024, p. 69).

Dealing with the problem of conceptualization and based on the lessons of the North American doctrine, Vitorelli teaches that there is a certain category of actions called "*publica law litigation*" actions. In these, obligations are established to do or not to do "*injuctions*" aiming at the effective implementation of fundamental rights "*civil rights injuctions*". When the American doctrine identified that in certain situations it was necessary to intervene in institutions, bureaucracies or policies to implement a certain fundamental right, such court orders that determine these interventions became known as "*structural injuctions*". "Thus, the reference to the structural *litigation* process is applicable to cases in which the collective claim is not only to impose a behavior, but to make a structural change in an organization, with the objective of enhancing the desired behavior in the future" (2024, p. 358).

Once again, the important warning by Arenhart, Jobim and Osna (2021) regarding the difficulty of developing a concept that has a perennial nature in a theme that, by nature, is fluid. In fact, both the conception of structural problem and structural process can vary frequently, which makes it practically impossible to develop a concept with pretensions of durability¹³. For this reason, the aforementioned authors prefer to work with the idea of

differently in relation to the proximity that is to the core of the injury and, therefore, their participation becomes an element of due process" (2019, p. 33).

¹² In this sense, Arenhart, Osna and Jobim inform that "In any case, this is why it does not seem appropriate to think of a concept for structural processes (or problems). Its multiformity makes it difficult for a single concept to be able to encompass several realities that may be very different. Thus, it is preferred to work based on the characteristics of the problem faced, understanding that, for each of them, the process must provide adequate instruments to absorb and deal with such realities" (2021, p. 60).

¹³ Still on this need to change the categories of the process whenever there is a cultural change, Luana Steffens understands that "the current jurisdictional moment redoubles in complexity and intensity, due to the phenomena of social massification, complex litigation and the explosion of litigation. As seen, Law is a cultural product,

verifying whether or not a process is structural through its characteristics, without the conceptual rigidity that may not pass the reality test.

As for the concept of structural decision, it is customary to adjectivate the one that closes the first phase of the structural process, verifying that there really is a situation of unwanted nonconformity and defining the ideal state of affairs to be pursued, as well as determining the elaboration of a plan to proceed with the transition (Didier Jr, Zaneti and Oliveira, 2024).¹⁴

It should be noted that, unlike decisions made in traditional processes, the structural decision generally has the nature of principle. It is principled, therefore, since it does not impose a specific and determined rule of conduct. Thus, it is inevitable that other future decisions will have to be made, what Arenhart calls cascading decisions (2024) and Vitorelli calls spiral decisions (2024).

It is in this context of these differentiated structural decisions in relation to the traditional form of judicial provision that the American doctrine began to identify what it called *structural injunctions*. It can be seen, therefore, that structural decisions were born empirically, in practice¹⁵. This is because, in order to ensure the effectiveness of the decision, it was crucial to adopt complementary judicial measures, called *injunctions*. Only later were such decision-making models theorized by the doctrine.

When discussing the emergence of *the structural injunction*, Owen Fiss (2017) presents two models of jurisdictional protection – the "dispute settlement" model and the

adherent to a given collectivity that develops in a given space-time. Hence, conflicts are neither watertight nor immutable, but they present new contours and singularities, as the interests and values in society change (e.g. traditional marriages and contemporary models of stable union). In this area, when culture undergoes significant changes, whatever its reasons, the process needs to adapt, since social changes and society's values cannot be ignored or minimized by the Civil Procedure. Thus, it is imperative that the law keeps up with the pace imposed by the transformations of society, otherwise the process will become an ineffective instrument" (2021, p. 96).

¹⁴ Thus, Owen Fiss clarifies that "structural reform is based on the notion that the quality of our social life is significantly affected by the operation of large organizations and not only by individuals, acting inside or outside these organizations. It is also based on the belief that American constitutional values cannot be fully secured without basic changes being made to the structures of these organizations. The judicial process of a structural nature is one in which a judge, facing a state bureaucracy with regard to constitutional values, is responsible for restructuring the organization to eliminate the threat imposed on such values by the existing institutional arrangements. This injunction is the means by which these reconstruction directives are transmitted" (2017, p. 76).

¹⁵ On the subject, José Maria Rosa Tesheiner teaches that "This decision would have had little effectiveness, had the Court not determined that the judges take the necessary measures to comply with it, which determined the emergence of a new form of adjudication, which became known as structural reform, an expression translated by Marco Félix Jobim as "structuring measures". The judge, as an interpreter of the values listed in the Constitution, must operationalize the bureaucratic organizations, that is, confront them, to eliminate any possibility of non-realization of constitutional guarantees. The Judiciary was structured to intervene, when appropriate, in these bureaucratized institutions, including to rebuild them. The new adjudication model, as opposed to the bipolar model, typical of individual actions, places the Judiciary as a protagonist, in the face of constitutional values, through balanced judicial activism, to serve as a warning to the other powers so that they fulfill their attributions" (2024, p. 17).

"structural reform" model. With regard to the "dispute settlement" model, this would be more traditional and would serve to resolve private disputes, with individualized parties who are not able to resolve the issue among themselves and require a third party to resolve the conflict. The Judiciary, in this way, configures the institutionalization of this third party.

The "structural reform" model, in turn, is based on the assumption that the greatest risks to constitutional values do not come from individuals, but from large organizations, both public and private, so that such risks will not be extinguished without these organizations being reformed. The model in question would therefore aim to reform the bureaucracy of large institutions that would endanger constitutional values.

The jurisdictional provision granted in the midst of a structural process should certainly move away from the traditional procedure of a judicial process, through the construction of a new procedural model, to achieve the ideal state of affairs in an effective way.

Having made such clarifications about litigation, processes and structural decisions, it is essential to note that the structural litigation (or problem) can be solved out of court. Therefore, there is a structural process outside the Judiciary. The expression "process" is usually used as a synonym for adversarial procedure, which can occur outside the jurisdictional scope.

A good example of structural extrajudicial action is the Carrefour TAC (DE FREITAS *et al*, 2021). It is the unfortunate murder of João Alberto de Freitas, a black man who was shopping with his wife until he was violently approached by supermarket security guards and led to death by beating. The terrible episode happened on November 19, 2020, the eve of Black Consciousness Day.

After a few months of investigation in the civil inquiry, it was detected that the racism evident in the approach and death of João Alberto was not an isolated episode, but something present in the structure of the company, from the way of selecting personnel for admission, through the ascension to the positions of director and leadership. The reorganization of the structure was therefore necessary.

In this sense, the Federal Public Prosecutor's Office and several other institutions jointly entered into a Conduct Adjustment Agreement with Carrefour, in the total amount of 15,000,000.00 (fifteen million)¹⁶. Such amounts should be allocated to the promotion of racial

¹⁶ As a result of the aforementioned "Carrefour TAC", numerous measures have already been adopted to combat structural racism in the country. As an example, it is worth mentioning that on August 4, 2022, the public notice for higher education institutions interested in receiving scholarships and permanence in undergraduate and graduate studies for black people was published. R\$ 68 million will be allocated by the undertaking to an initiative that includes higher education entities interested in affirmative action. Available at: < <https://www.mpf.mp.br/rs/sala-de-imprensa/noticias-rs/tac-carrefour-publicado-edital-de-bolsas-de-graduacao-e-pos-graduacao-para-pessoas-negras> > Accessed in: 09/27/2022.

equality and human rights in a variety of ways, from access to employment and education without discrimination, to the promotion of measures to combat structural racism in the workplace. The resources will also be used to grant scholarships to black people at the undergraduate and graduate levels, as well as studies related to languages, innovation and technology, aiming to prepare new professionals for the job market.

In this way, the performance was exemplary since there was a coordinated action between institutions of different natures, achieving a quick and effective response, promoting advances in such a serious and perverse structural problem (De Freitas *et al*, 2021).

It is also observed that structural litigation does not necessarily involve the government. It is quite common for structural problems to be related to the bureaucracies of federative entities and their various bodies. But the state presence is not an essential element of structural disputes¹⁷. Structural problems related to business bureaucracies of important economic agents are not sporadic. In fact, it is essential to note that, in today's world, large organizations and private conglomerates can represent a threat as great, or perhaps greater, to public freedoms as the State.

Thus, as demonstrated, if there is a state of non-conformity in a public or private bureaucracy or in a certain policy that requires a transition to an ideal state, an adequate tool is required for this transition. The doctrinal construction of this tool is what has been conventionally called the doctrine of the structural process.

4 FINAL CONSIDERATIONS

It is evident that the structural process has the potential to modify the paradigms of procedural law, shifting the focus from the reparation of past damages to the construction of prospective and participatory solutions. Recognizing that many rights violations stem from the operating logic of complex bureaucracies, the institute proposes differentiated responses, based on the elaboration of action plans, collaboration between multiple social actors, and continuous judicial monitoring.

Although the doctrine still differs as to the best conceptualization and terminology to be adopted, there is a consensus that the effectiveness of a structural process depends: a) on the dialogical openness to the groups affected by the litigation and to civil society; b) procedural flexibility to adapt to the specificities of the specific case; and c) the adoption of progressive decisions that allow course corrections. Extrajudicial experiences, such as the

¹⁷ Adopting the same premise, Vitorelli points out that "It is a mistake to associate structural reform only with public institutions. Although they are the most common defendants in these cases, private institutions can perfectly demand structural changes so that social results are produced". (2022, p. 353)

Carrefour TAC, demonstrate that such objectives can also be achieved outside the Judiciary, as long as the principles of transparency, participation and accountability are observed.

REFERENCES

- Arenhart, S. C., & Osna, G. (2021). Curso de processo civil coletivo (3ª ed.). Revista dos Tribunais.
- Arenhart, S. C., Osna, G., & Jobim, M. F. (2022). Curso de processo estrutural (2ª ed.). Revista dos Tribunais.
- Arenhart, S. C. (2024a). Processos estruturais no direito brasileiro: Reflexões a partir do caso da ACP do carvão. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), Processos estruturais (5ª ed.). JusPodivm.
- Arenhart, S. C. (2024b). Processo multipolar, participação e representação de interesses concorrentes. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), Processos estruturais (5ª ed.). JusPodivm.
- Asperti, M. C. de A., & Chiuzuli, D. R. (2024). Supremo conciliador? Análise dos casos encaminhados à conciliação no âmbito do Supremo Tribunal Federal. REI-Revista Estudos Institucionais, 10(2), 450-499.
- Barcellos, A. P. de. (2008). O direito a prestações de saúde: Complexidades, mínimo existencial e o valor das abordagens coletiva e abstrata. Revista da Defensoria Pública, 133.
- Bauermann, D. (2024). Structural injunctions no direito norte-americano. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), Processos estruturais (5ª ed.). JusPodivm.
- Cabral, A. do P. (2024). Delegação de competências no processo estrutural. Suprema–Revista de Estudos Constitucionais, 4(1), 123-167.
- Casimiro, M. (2024). O judiciário como fórum de protestos: Por que o simbolismo importa em processos estruturais? In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), Processos estruturais (5ª ed.). JusPodivm.
- Casimiro, M. (2024). 'Contempt of court': A importância de medidas coercitivas no processo estrutural. Suprema–Revista de Estudos Constitucionais, 4(1), 169-200.
- Costa, S. H., & da Silva, M. R. (2024). Tema de repercussão geral 698: Processo estrutural e estratégias adotadas. Suprema–Revista de Estudos Constitucionais, 4(1), 337-368.
- de Araujo, V. S., & Porfiro, C. A. (2024). O procedimento e a efetividade dos litígios estruturais: Os modelos “forte” e “fraco” de intervenção judicial em políticas públicas. Suprema–Revista de Estudos Constitucionais, 4(1), 89-122.
- Didier Jr., F., Cabral, A. do P., & Cunha, L. C. da. (2023). Por uma nova teoria dos procedimentos especiais: Dos procedimentos às técnicas (4ª ed.). JusPodivm.
- Didier Jr., F., Zaneti Jr., H., & Oliveira, R. A. de. (2024). Elementos para uma teoria do processo estrutural aplicada ao processo civil brasileiro. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), Processos estruturais (5ª ed.). JusPodivm.
- Fiss, O. (2017). As bases políticas e sociais da adjudicação. Direito como razão pública: Processo, jurisdição e sociedade (C. A. de Salles, Trad.) (2ª ed.). Juruá.

- Grostein, J. (2019). *Ativismo judicial: Análise comparativa do direito constitucional brasileiro e norte-americano*. Almedina.
- Goulart, M. P. (2021). *Elementos para uma teoria geral do ministério público* (2ª ed.). D'Plácido.
- Jatahy, C. R. de C. (2008). *Curso de princípios institucionais do Ministério Público* (3ª ed.). Editora Lumen Juris.
- Jobim, M. F. (2024). *Medidas estruturantes na jurisdição constitucional: Da Suprema Corte estadunidense ao Supremo Tribunal Federal* (4ª ed.). Livraria do Advogado.
- Jobim, M. F. (2022b). *Teoria, história e processo* (2ª ed.). Livraria do Advogado.
- Jobim, M. F. (2024). Reflexões sobre a necessidade de uma teoria dos processos estruturais: Bases de uma possível construção. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Jobim, M. F. (2016). A previsão das medidas estruturantes no artigo 139, IV, do novo Código de Processo Civil brasileiro. In H. Zaneti Jr. (Coord.), *Repercussões do novo CPC – processo coletivo*. JusPodivm.
- Jobim, M. F., Roque, A. V., & Oliveira Junior, Z. D. de. (2024, setembro 17). A era dos processos estruturais? Migalhas. <https://www.migalhas.com.br/coluna/tendencias-do-processo-civil/414421/a-era-dos-processos-estruturais>
- Marinoni, L. G. (2022). Técnica decisória e diálogo institucional: Decidir menos para deliberar melhor. *Suprema-Revista de Estudos Constitucionais*, 2(1), 49-85.
- Marinoni, L. G., Arenhart, S. C., & Mitidiero, D. (2024). *Curso de processo civil: Teoria do processo civil* (Vol. 1) (9ª ed.). Thomson Reuters Brasil.
- Sarlet, I. W. (2024). Direitos fundamentais sociais e mínimo existencial – notas sobre um possível papel das assim chamadas decisões estruturantes na perspectiva da jurisdição constitucional. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Verbic, F. (2024). Ejecución de sentencias em litigios de reforma estructural en la República Argentina dificultades políticas y procedimentales que inciden sobre la eficacia de estas decisiones. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Souza Junior, J. R. de. (2024). Os centros de apoio operacional enquanto fomentadores da atuação estrutural do Ministério Público. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Souza Junior, J. R. de. (2024). Processos estruturais e a atuação do Ministério Público: Reflexões sobre potencialização de resultados. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Tushnet, M. (2024). A response to David Landau. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Viana, T. C. T. (2024). A inevitável mutabilidade dos litígios coletivos e estruturais. *Suprema–Revista de Estudos Constitucionais*, 4(1), 201-224.
- Violin, J. (2024). Litígios estruturais na Corte Constitucional: Momento, legitimidade e estratégias. *Suprema–Revista de Estudos Constitucionais*, 4(1), 225-252.

- Violin, J. (2019). Processos estruturais em perspectiva comparada: A experiência norte-americana na resolução de litígios policêntricos [Tese de doutorado, Universidade Federal do Paraná].
- Vitorelli, E. (2022). O devido processo legal coletivo: Dos direitos coletivos aos litígios coletivos (3ª ed.). Revista dos Tribunais, Thomson Reuters.
- Vitorelli, E. (2025). Processo civil estrutural: Teoria e prática (5ª ed.). JusPodivm.
- Vitorelli, E. (2024b). Uma pauta de atuação estrutural do Supremo Tribunal Federal: Por que, quando e como? *Suprema–Revista de Estudos Constitucionais*, 4(1), 253.
- Vitorelli, E. (2024c). Introdução à análise econômica e comportamental do processo. In E. Vitorelli (Org.), *Fundamentos de análise econômica do processo civil*. JusPodivm.
- Vitorelli, E., & Osna, G. (2024a). Introdução ao processo civil e à resolução de conflitos (3ª ed.). JusPodivm.
- Vitorelli, E. (s.d.). Processo coletivo e estrutural: Uma discussão de modelos [Vídeo]. YouTube. <https://www.youtube.com/watch?v=HHmPf576W6Y&t=3606s> (Acesso em: 26 jan. 2025)
- Zaneti Júnior, H., Nunes, L. S., Gonçalves Filho, E. S., & Gomes, K. C. (2024). Enfrentando o vírus no tribunal: A litigância estrutural pelas lentes do processo na ADPF 709. *Suprema–Revista de Estudos Constitucionais*, 4(1), 299-335.
- Zufelato, C., & Francisco, J. E. (2024). La acción civil pública del carbón como modelo procesal para la reparación civil de danos ambientales complejos: Una experiencia de proceso estructural em Brasil. In S. C. Arenhart, M. F. Jobim e G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.

THE PRINCIPLE OF TAX NEUTRALITY AND EXTRAFISCALITY IN THE BRAZILIAN TAX REFORM

O PRINCÍPIO DA NEUTRALIDADE E A EXTRAFISCALIDADE NA REFORMA TRIBUTÁRIA BRASILEIRA

EL PRINCIPIO DE NEUTRALIDAD Y LA EXTRAFISCALIDAD EN LA REFORMA TRIBUTARIA BRASILEÑA



<https://doi.org/10.56238/sevened2026.008-047>

**Danielle Uessler¹, Arthur Sandro Golombieski Ferreira², Mariana Matias Ribeiro
Ramos³**

ABSTRACT

This paper aims to analyze whether the principle of neutrality, one of the pillars of the Consumption Tax Reform, is compatible with the extrafiscal function of the tax system, in order to assess whether there is harmony within the context of the new consumption taxation framework introduced by Constitutional Amendment No. 132/2023. The issue arises from the contrast between neutrality, which seeks to avoid economic distortions and ensure a balanced competitive environment, and extrafiscality, expressed mainly through the Selective Tax, which retains the function of influencing behavior through taxation. The research finds that, although the Reform sought to establish a functional separation between the principle of neutrality and the extrafiscal function, relevant risks remain, such as the reduction of space for promotional policies, the rigid crystallization of essentiality, and political pressures for sector-specific benefits. Using the hypothetico-deductive method, it is concluded that neutrality and extrafiscality are not mutually exclusive, but require harmonization through clear criteria to ensure simplicity, economic efficiency, and social justice.

Keywords: Tax Neutrality. Extrafiscality. Tax Reform.

RESUMO

O presente trabalho tem como objetivo analisar se o princípio da neutralidade, um dos pilares da Reforma Tributária sobre o consumo, é compatível com a função extrafiscal do sistema tributário, a fim de verificar se há harmonia no contexto da nova arquitetura da tributação sobre o consumo, introduzida pela Emenda Constitucional n.º 132/2023. A problemática decorre do contraste entre a neutralidade, que busca evitar distorções econômicas e assegurar um ambiente concorrencial equilibrado, e a extrafiscalidade, expressa sobretudo

¹ Master's student in Law. Pontifícia Universidade Católica do Paraná (PUCPR).
E-mail: danielleuessler@hotmail.com Orcid: <https://orcid.org/0000-0001-5514-5096>
Lattes: <http://lattes.cnpq.br/8763626921178215>

² Master's student in Law. Pontifícia Universidade Católica do Paraná (PUCPR). E-mail: asgfarthur@gmail.com
Lattes: <http://lattes.cnpq.br/4260959798547687>

³ Master's student in Law. Pontifícia Universidade Católica do Paraná (PUCPR).
E-mail: marimatiasramos@hotmail.com Lattes: <http://lattes.cnpq.br/4688944690272548>

no Imposto Seletivo, que mantém a função de induzir comportamentos por meio da tributação. A pesquisa constata que, embora a Reforma tenha buscado estabelecer uma divisão funcional entre o princípio da neutralidade e a função extrafiscal, permanecem riscos relevantes, como a redução do espaço para políticas promocionais, a cristalização da essencialidade em moldes rígidos e as pressões políticas por benefícios setoriais. Mediante a metodologia hipotético-dedutiva, conclui-se que neutralidade e extrafiscalidade não são excludentes, mas exigem compatibilização por critérios claros, de forma a assegurar simplicidade, eficiência econômica e justiça social.

Palavras-chave: Tax Neutrality. Extrafiscality. Tax Reform.

RESUMEN

El presente trabajo tiene como objetivo analizar si el principio de neutralidad, uno de los pilares de la Reforma Tributaria sobre el consumo, es compatible con la función extrafiscal del sistema tributario, con el fin de verificar si existe armonía en el contexto de la nueva arquitectura de la tributación sobre el consumo, introducida por la Enmienda Constitucional n.º 132/2023. La problemática surge del contraste entre la neutralidad, que busca evitar distorsiones económicas y asegurar un entorno competitivo equilibrado, y la extrafiscalidad, expresada principalmente en el Impuesto Selectivo, que mantiene la función de inducir comportamientos mediante la tributación. La investigación constata que, aunque la Reforma haya buscado establecer una división funcional entre el principio de neutralidad y la función extrafiscal, persisten riesgos relevantes, tales como la reducción del espacio para políticas promocionales, la cristalización de la esencialidad en modelos rígidos y las presiones políticas por beneficios sectoriales. Mediante la metodología hipotético-deductiva, se concluye que la neutralidad y la extrafiscalidad no son excluyentes, sino que exigen compatibilización a través de criterios claros, con el fin de asegurar simplicidad, eficiencia económica y justicia social.

Palabras clave: Neutralidad Tributaria. Extrafiscalidad. Reforma Tributaria.

1 INTRODUCTION

The Consumption Tax Reform, implemented by Constitutional Amendment No. 132/2023, inserted in article 156-A, paragraph 1, of the Federal Constitution, the determination that the Tax on Goods and Services (IBS) and the Contribution on Goods and Services (CBS) will be governed by the principle of neutrality. This principle seeks to minimize tax distortions in economic choices, ensuring greater predictability and allocative efficiency.

However, the tradition of the Brazilian tax system reveals that taxes are not limited to a collection function, as they also play an extra-fiscal role, and can influence social and economic behavior. The Tax Reform preserved this regulatory dimension through the Selective Tax, aimed at discouraging conducts that cause negative externalities to promote constitutional values, such as the protection of health and the environment.

Although conceived as complementary, neutrality and extra-taxation can come into tension. The first seeks uniformity and simplicity in taxation, in order to reduce the interference of taxation in economic choices, while the second, on the contrary, operates through selective differentiations, using the tax as an instrument to induce behavior in favor of tax policy purposes.

The Reform sought to mitigate the tension between neutrality and extra-taxation through functional specialization: neutral taxes for broad and uniform collection purposes, and extra-fiscal taxes for specific regulatory purposes. This division, however, does not eliminate the challenges of its implementation, such as the risk of a "rigid essentiality", the reduction of space for promotional policies and the pressure for sectoral benefits that can weaken neutrality.

In this context, the problem of the compatibility between neutrality and extra-fiscal policy emerges, since would neutrality, chosen as one of the structuring guidelines of the new system of taxation on consumption, be compatible with the permanence of extra-fiscal instruments? From this, through the hypothetical-deductive methodology, this article aims to analyze whether the principle of neutrality is compatible with the extrafiscal nature of the system, in order to verify whether there is a harmonious or antagonistic coexistence in the context of the new architecture of taxation on consumption.

2 THE PRINCIPLE OF NEUTRALITY IN THE TAX REFORM ON CONSUMPTION

Tax neutrality is one of the pillars of an efficient tax system, alongside principles such as equity, simplicity and ability to pay. As conceptualized by Zilveti⁴, this rule gravitates around

⁴ ZILVETI, Fernando Aurélio. Variations on the principle of neutrality in international tax law. **Revista Direito Tributário Atual**, v. 19, p. 30.

the principle of tax equality, and the system that is structured in such a way as not to compromise the efficient allocation of the means of production is neutral, avoiding distortions that may unbalance the market.

It is the requirement that taxation interfere as little as possible in the economic decisions of individuals and companies, avoiding distortions that may favor certain sectors or forms of organization to the detriment of others. In essence, it means that economically equivalent activities or operations must receive equivalent tax treatment, so that the tax does not become a determining factor in the choice between business or consumption alternatives.

Tax neutrality has its origin in the economic tradition⁵, maintaining that the tax system should interfere in a minimal way in the choices of economic agents, avoiding distortions that compromise the efficient allocation of resources. The starting point of this thought is Adam Smith, who in his book *The Wealth of Nations* (1776), formulated principles of equality, certainty, convenience and efficiency, which, although they did not expressly use the term neutrality, indicated the need to avoid artificial barriers to production and trade.

In Brazil, the doctrine assimilated these economic bases, resulting in the debate about the theory of optimal taxation⁶, which defends broad systems, with uniform rates and few exceptions. The logic is that similar activities receive the same tax treatment, avoiding distortions that affect competition and ensuring that the choices of economic agents are based on real preferences, and not on artificial incentives created by the State.

This conception is connected to the notion of "fiscal wedge",⁷ understood as the difference between the amount paid by the consumer and the amount actually received by the producer due to taxation. When poorly designed, taxes widen this difference, discouraging consumption, production and investment, with negative effects on the allocation of resources and economic competitiveness.

In this sense, Moreira⁸ systematizes neutrality in two dimensions: horizontal and vertical. Horizontal neutrality requires equal treatment for economically equivalent situations, avoiding arbitrary distinctions between products, services or sectors. Vertical neutrality, on the other hand, is related to the technique of non-cumulativeness, which ensures that the tax

⁵ KOCH, Mariana Porto. **Theory of tax neutrality**. 2023. Thesis (Doctorate in Law) – Faculty of Law, Federal University of Rio Grande do Sul, Porto Alegre, 2023.

⁶ COSTA, C. F. de C., & Vieira, J. de C. (2021). Theory of optimal taxation: Contributions to the Brazilian reality. *Journal of Contemporary Administration*.

⁷ For the OECD, the term used is called "*Tax wedge*" and is understood as "*the ratio between the amount of taxes paid by an average single worker (a single person with 100% of the average income) without children and the corresponding total labor cost for the employer*". [Free translation]". Available at: <https://www.oecd.org/en/data/indicators/tax-wedge.html>.

⁸ MOREIRA, André Mendes. **Neutrality, added value and taxation**. Belo Horizonte: Forum, 2019, p. 211.

is levied only on the value added at each stage of the production chain, eliminating cascading taxation.

On the other hand, Schoueri⁹ warns of the limits of this conception. For him, there is no absolutely neutral tax: every tax incidence interferes in some way with the economy. What should be required, therefore, is that this interference be justified, proportional, and guided by constitutional purposes, so as not to generate undue competitive imbalances. In other words, neutrality is not the absence of impact, but the limitation of distortions.

Thus, the classical economic concept of neutrality provides the initial framework, but its application to positive law demands adjustments that recognize the tensions between ideal and normative reality. It is precisely at this point that the principle gains more defined technical and constitutional contours, especially with the adoption of non-cumulativeness.

However, it is important to emphasize that neutrality should not be confused with the absence of economic effects. Every tax changes, to a greater or lesser extent, the behavior of the agents. The aim is to ensure that such changes are not arbitrary or disproportionate. In this context, non-cumulativeness emerges as a fundamental technique to ensure vertical neutrality, preserving the efficiency of the system.

By allowing the taxpayer to credit the tax paid in the previous stages of the chain, non-cumulativeness ensures that the tax is levied only on the value added in each transaction. This structure prevents the so-called "cascade taxation", which generates serious distortions, such as the artificial increase in prices, the loss of competitiveness, and the induction of business decisions guided by the accumulated tax burden, and not by criteria of economic efficiency.

Moreira¹⁰, in a comparative law study on European VAT, points out that any undue restriction on the right to credit weakens neutrality. For him, non-cumulativeness must be broad, automatic and objective, so as not to compromise competitive equality.

This perspective was incorporated by Constitutional Amendment No. 132/2023, which enshrined full non-cumulativeness in the new model of Tax on Goods and Services (IBS) and Contribution on Goods and Services (CBS), replacing the old criterion of "physical credit" applied to ICMS and IPI with a more comprehensive financial credit model. Thus, the IBS and CBS must be guided by this principle¹¹.

⁹ SCHOUERI, Luís Eduardo. Taxation and economic induction: the economic effects of a tax as a criterion for its constitutionality. In: Roberto Ferraz. (Org.). **Principles and Limits of Taxation 2 – The principles of the economic order and taxation**. São Paulo: Quartier Latin, v. 2, 2009.

¹⁰ MOREIRA, André Mendes. The right to credit in European VAT: notes on the principle of tax neutrality. **Current Tax Law Journal**, n. 42, p. 47, 2019.

¹¹ SCHOUERI, Luís Eduardo; GALDINO, Guilherme. The Neutrality of the Transitory Rules in the IBS and CBS: the Case of Capital Goods. **Current Tax Law Journal**, v. 59, 2025.

The technique of non-cumulativeness is directly connected to vertical neutrality: a tax is neutral when it does not accumulate along the production chain. Horizontal neutrality, on the other hand, as seen, requires a broad and uniform base, avoiding artificial distinctions. Both dimensions are indispensable for building a more efficient and fair tax system.

This normative framework represents an advance, as it inserts neutrality among the constitutional limitations on the power to tax, transforming it into a parameter of constitutionality and interpretative guide for legislators, regulators and courts. From an economic point of view, neutrality seeks to promote allocative efficiency, as resources should flow to the most productive activities according to market criteria and not as a result of tax incentives or penalties.

Failure to comply with this principle can generate relevant costs to the economy, such as loss of international competitiveness, artificial favoring of certain sectors, administrative complexity and increased tax litigation, in addition to business verticalization. In other words, distorting taxes reduce productivity and compromise sustainable development.

The constitutional incorporation of neutrality does not, however, eliminate the possibility of using taxation for extra-fiscal purposes. Public policies can use taxation to encourage desirable behaviors, such as technological innovation or environmentally responsible practices, and discourage harmful behaviors, such as the consumption of cigarettes and alcoholic beverages.

This tension between neutrality and extra-taxation requires the legislator to establish clear and proportional criteria for interventions, preventing exceptions from converting the principle into mere rhetoric.

The practical implementation of neutrality in Brazil faces significant challenges. Although Complementary Law No. 214/2025 regulated the IBS and CBS, reproducing the constitutional text and defining neutrality as a legislative guideline, the legal diploma included exceptions that reduce the scope of the principle. This situation creates risks of judicialization, especially in the face of provisions that may restrict the scope of a constitutional guarantee.

Another challenge is the very nature of consumption taxation, which is inherently distorting. The burden falls on goods and services¹², affecting relative prices and influencing consumption decisions. Neutrality, in this context, works as a regulatory goal: it seeks to reduce undesirable effects to a minimum, but they will hardly be completely eliminated.

¹² ZILVETI, Fernando Aurélio. Variations on the principle of neutrality in international tax law. **Revista direito tributário atual**, v. 19, 2005.

In addition, there is a risk that political interests and sectoral pressures will weaken the application of the principle. Comparative experience¹³ shows that highly fragmented Value Added Tax (VAT) systems, with multiple exceptions, special regimes and benefits, end up sacrificing neutrality and amplifying distortions¹⁴.

This is what happens in countries such as India, whose GST (*Goods and Services Tax*) maintains numerous different rates, and also in pre-reform Brazil, with the multiplicity of ICMS, ISS and PIS/COFINS regimes.

Nevertheless, it is important to highlight that neutrality does not oppose tax justice, but complements it. While progressivity and the ability to pay seek to distribute the tax burden equitably, neutrality ensures that this burden is not manipulated in a way that favors specific groups. A neutral system tends to be more transparent, predictable, and reliable, which are essential factors for attracting investments and consolidating legal certainty.

In this sense, the doctrine points out that neutrality must be interpreted systemically, in articulation with other constitutional tax principles. It is not an absolute ideal, but a guideline whose observance strengthens the rationality of the system, increases economic efficiency and contributes to the democratic legitimacy of taxation.

Thus, if neutrality seeks to reduce distortions, extra-taxation reveals precisely the possibility of the State intentionally using them to pursue legitimate ends. It is at this point of balance between economic efficiency and normative intervention that the debate on the extrafiscal function of taxation opens.

3 EXTRA-TAXATION IN THE TAX REFORM ON CONSUMPTION

Throughout history, taxation has never been limited to the function of raising funds to fund state activities. The tax has also been used as a tool for economic and social intervention, capable of encouraging certain conducts, discouraging others and guiding the actions of private agents in line with broader constitutional objectives. This phenomenon, known as extrafiscality, expresses the political dimension of the tax system and reinforces its condition as an instrument for the implementation of public policies.

Adamy, in exploring the theoretical origins of extrataxation, elucidates that Adolph Wagner, a German author of the late nineteenth century, was the one who began to conceive the tax phenomenon "in a differentiated way, thinking of it beyond the mere instrument of

¹³ ABSWOUDE, Kevin van. *The principle of fiscal neutrality and economic reality in EU VAT: two peas in a pod?*element. **Lund University**, Sweden, 2022.

¹⁴ MOREIRA, André Mendes. The right to credit in European VAT: notes on the principle of tax neutrality. **Current Tax Law Journal**, n. 42, 2019.

state financing",¹⁵ having revolutionized the central concept of tax. The author explains that it was Wagner who established the theoretical bases of the discussion on non-collection tax purposes, "demonstrating that tax law can have political and social purposes distinct from mere collection".¹⁶

Vieira elucidates that extra-taxation is a central concept in tax law, which transcends the mere collection function, positioning it as a fundamental instrument for the implementation of public policies¹⁷. This is because, for the author, tax law should not be conceived only as a means of state financing, but also as a mechanism for implementing policies in several areas¹⁸.

It is in this sense that Adamy maintains that the law is not an end in itself, but also an instrument for the achievement of state purposes¹⁹. The author defines the instrumentalization of law as "the right being used as an instrument, as a means, as a tool"²⁰ for the induction of behaviors, according to the purpose of the State. Still, Adamy points out that in the tax context, this instrumentalization is manifested in the ability to influence conduct, whether granting incentives or disincentives²¹.

Unlike tax taxes, as Folloni explains, whose main function is to sustain state expenditures based on the ability to pay, the foundation of extrafiscal taxes "is not the sustenance of public expenditures in general, but the internalization of negative externalities".²² Because of this, extra-taxation justifies the adoption of different differentiation criteria for the ability to pay, allowing taxation to be guided by public policy purposes. Thus, selectivity, the granting of exemptions, the setting of increased or reduced rates and the institution of special regimes are not explained only by the economic aptitude of the taxpayer, but by the search for desired effects in the social or economic reality.

With this, Leão emphasizes the importance of defining the "extrafiscal purpose aimed at in the law"²³ for the control over the instrumental use of Tax Law. For the author, the

¹⁵ ADAMY, Pedro. Theoretical Origins of Extrafiscality. **Current Tax Law Journal**, No. 39, 2021, p. 353.

¹⁶ Ibid.

¹⁷ VIEIRA, Andreia Costa. The Precautionary Principle and Extrataxation in Environmental Taxation. **Current Tax Law Journal**, nº 32, 2014, p. 37.

¹⁸ Ibid., p. 38.

¹⁹ ADAMY, Pedro. Instrumentalization of Tax Law. In: ÁVILA, Humberto (ed.). **Fundamentals of Tax Law**. Rio de Janeiro: Marcial Poin, 2012, p. 305.

²⁰ Ibid., p. 302.

²¹ Ibid., p. 307.

²² FOLLONI, André. Tax Competence of the Selective Tax: the text and its contexts. **Current Tax Law Journal**, v. 57, 2024, p. 637.

²³ LEÃO, Martha. Contribution to the study of Extrafiscality: the importance of purpose in the identification of extrafiscal tax rules. *Revista Direito Tributário Atual*, nº 34, 2015, p. 314.

extrafiscal purpose is not the intention of the 'historical legislator', so that it must be embodied in the will itself objectified in the law and not in the subjective will of the legislator²⁴.

The will of the law, as Guastini points out, is the "reason, the motive, the end, the practical result, by which a certain norm has been edited"²⁵ and to verify it "it is necessary to pay attention not (or at least not so much) to the preparatory work, but to the text of the law as such, in addition to the social and political circumstances in which it was edited".²⁶

It is in this sense that extra-taxation is seen as a facet that allows the State to induce behavior through taxes, so that "taxation can also act as an instrument to induce social and economic behaviors".²⁷ This would be, for Santos and Scabora, the essence of the extrafiscal function of taxation, which does not have as its main purpose to supply the public budget, but rather the "attempt to increase economic or social well-being".²⁸

In this sense, Schoueri observes that extra-taxation transforms the tax into a true instrument for inducing behavior,²⁹ acting as an indirect regulatory mechanism in sensitive areas, such as health, environment, regional development or incentive to technological innovation. The tax, therefore, ceases to be an end in itself – the collection – and starts to assume an instrumental function, to shape individual and collective choices in order to bring them closer to constitutional values and state policy objectives.

Thus, within this context of conduct induction, extratation is used to correct "externalities", whose notion, extracted from economic law, refers to costs and gains from private activities borne or enjoyed by the community due to market failures³⁰. Externalities can be positive, when they generate benefits, or negative, when they generate costs/harms.

Economist Arthur Cecil Pigou has already suggested the institution of a tax to correct negative externalities and the payment of a subsidy to compensate for the positive externalities practiced by companies³¹. In this sense, extra-taxation would not aim to prevent an activity, but rather to condition the freedom of choice of the economic agent through the graduation of the tax burden according to specific purposes³².

²⁴ Ibid., p. 309-310.

²⁵ GUASTINI, Riccardo. *Apud* LEÃO, Martha. Contribution to the study of Extrafiscality: the importance of purpose in the identification of extrafiscal tax rules. **Revista Direito Tributário Atual**, nº 34, 2015, p. 311.

²⁶ Ibid.

²⁷ SANTOS, Flávio Felipe Pereira Vieira; SCABORA, Filipe Casellato. Environmental taxation and Extratation in Brazil: tax incentives and regressivity of green taxation. **Revista Direito Tributário Atual**, nº 52, year 40, São Paulo: IBDT, 3rd quarter 2022, p. 146.

²⁸ Ibid.

²⁹ SCHOUERI, Luís Eduardo. Inductive Tax Rules in Environmental Matters. *In*: TÔRRES, Heleno Taveira (ed.). **Environmental Tax Law**. São Paulo: Malheiros Editores, 2005, p. 235.

³⁰ Ibid., p. 236.

³¹ BALTHAZAR, Ubaldo Cesar. **Taxes and the Environment**. Espaço Jurídico, Joaçaba, v. 12, n. 2, jul./dez. 2011, p. 238.

³² DOMINGUES, José Marcos. **Tax Law and the Environment**. Rio de Janeiro: Forense, 2007, p. 49-50.

Schoueri explains that, in the case of pollution, for example, which generates environmental damage that is not borne by the perpetrators, state action seeks to internalize costs, so that the prices of products or services reflect the environmental damage caused by polluters³³. For positive externalities, the author suggests that the State should, through economic advantages, increase the gains of those who generate environmental benefits, allowing these advantages to be accounted for³⁴.

In this scenario, it is clear that extra-taxation is not just a possibility, but a reality intrinsic to the very logic of the tax system's operation. If taxes can be shaped to internalize externalities and induce behaviors, it is natural that the Brazilian normative architecture, especially in the Reform process, seeks specific mechanisms to enhance this function.

In the context of the Consumption Tax Reform, this role was expressly assigned to the Selective Tax, provided for in Constitutional Amendment No. 132/2023 and regulated by Complementary Law No. 214/2025. Unlike the IBS and the CBS, conceived under the logic of neutrality and the fiscal purpose of collection, the Selective Tax assumes a predominantly extra-fiscal function, aimed at burdening goods and services considered harmful to health or the environment.

This tax, clearly of extrafiscal inspiration, is not connected to the idea of tax reinforcement, but rather to the regulatory function of the State, in line with what Pigou and contemporary doctrine have already outlined as essential for the correction of negative externalities. Thus, the Selective Tax emerges as the manifestation that extra-taxation continues to play a structuring role in the Brazilian tax system, even in a context in which neutrality is elected as a guiding principle of the Reform.

In this context of the Tax Reform, extra-taxation is manifested through selectivity, which allows the identification of the negative characteristics of goods and services, associating them with the damage they cause to the environment and health. The logic of extra-taxation used in the Selective Tax of the Reform is different from that applied to the Tax on Industrialized Products (IPI), in which the rates are selective according to the essentiality of the product.

Matschulat and Amaral explain that in the case of IPI, extrataxation is a "secondary consequence of taxation"³⁵ and not an "effect deliberately intended by the legislator", ³⁶as in

³³ SCHOUERI, Luís Eduardo. Environmental Law, Op. cit., p. 236.

³⁴ Ibid., p. 237.

³⁵ MATSCHULAT, Leonardo; AMARAL, Luiz Bernardo Kämpf Amaral. The perspective for the implementation of the Selective Tax as a tax type in Brazil. **Res Severa Verum Gaudium**, v. 6, n. 2, 2022, p. 297.

³⁶ Ibid.

the Selective Tax. Returning to Leão, the authors state that for a tax to be considered for an extra-fiscal purpose, "this purpose must be unequivocally demonstrated by the legislator".³⁷

Thus, it can be stated that, while the IPI operates under a logic of selectivity by essentiality, being a tax with extrafiscal effects, the Selective Tax is structured on a logic of extrafiscal selectivity, aimed at the internalization of social and environmental costs and protectionist purposes. When applied to harmful goods or services, its function is not to distinguish the superfluous from the essential, but rather to graduate taxation according to the adverse impact generated on the community and the environment.

Because of this, although Constitutional Amendment No. 132/2023 did not expressly insert in article 153, paragraph 6, the expression 'will have an extrafiscal purpose', Folloni maintains that such an omission does not mischaracterize its nature, which is precisely extrafiscal³⁸. For the author, the only interpretation compatible with the principles of equality, ability to pay and with the stony clauses is to recognize the extra-fiscal function of the Selective Tax, because, otherwise, its very insertion in the Constitution would represent an affront to such principles³⁹.

On the other hand, Adamy says that the Tax Reform represented a break with the traditional role of extra-taxation in Brazilian tax law⁴⁰. For him, the Reform subverted the foundations of extrataxation⁴¹, by prioritizing the sanctioning function and restricting, almost completely, the promotional dimension of taxation. This is because extrataxation is not only used to discourage harmful conduct, but also to promote benefits, using the tax as a negative or positive instrument of induction⁴².

In this scenario, the author identifies three central foundations of this subversion: the broad prohibition on the granting of tax incentives in the IBS and CBS, the creation of a Selective Tax with an exclusively sanctioning function and restricted to certain matters, and the adoption of a "rigid essentiality", which crystallizes in a constitutional context a closed list of goods and services considered deserving of favored treatment⁴³.

Adamy points out that such changes remove from the tax system its flexibility and its ability to serve as a tool for promoting public policies⁴⁴. When commenting on the broad prohibition of benefits, he states that "by establishing this broad prohibition, the constitutional

³⁷ Ibid.

³⁸ FOLLONI, Op., op., p. 627.

³⁹ Ibid.

⁴⁰ ADAMY, Pedro. Extrafiscality in the Tax Reform: rigid essentiality and the end of the promotional function of Tax Law. *Revista Direito Tributário Atual*, v. 58. year 42, São Paulo: IBDT, 3rd quarter 2024, p. 427.

⁴¹ Ibid., p. 412.

⁴² Ibid., p. 411.

⁴³ Ibid., p. 417-429.

⁴⁴ Ibid., p. 412.

text disregards the promotional or positive function of tax law, which has historically been used as an instrument of implementation and promotion".⁴⁵

In the case of the Selective Tax, Adamy observes that it was conceived in a 'doubly limited' way, because on the one hand it only has a sanctioning function, aimed at burdening harmful operations and, on the other hand, because it is restricted exclusively to goods and services harmful to health and the environment, removing the possibility of levying harmful practices in other equally relevant ⁴⁶sectors. For the author, this restriction implies an impoverished understanding of extra-taxation, which reduces its scope to a merely repressive instrument⁴⁷.

These criticisms are directly connected to the following discussion about the relationship between neutrality and extra-taxation in consumption taxation. Neutrality, understood as a guiding principle of the Tax Reform, seeks to avoid economic distortions and ensure uniform treatment between sectors.

However, when taken to the extreme, it can collide with the extra-fiscal function, which requires flexibility and differentiation to promote constitutional objectives. Thus, the dilemma of a system that has accentuated rigidity and eliminated the space for promotion makes it necessary to analyze the tension between these two principles: neutrality and extra-taxation.

4 ANALYSIS OF THE OPPOSITION OR COEXISTENCE BETWEEN EXTRA-TAXATION AND NEUTRALITY

On the one hand, as seen, neutrality advocates that taxation should not distort consumption decisions and the organization of economic activity, keeping away from private choices and ensuring that the tax system does not cause an environment of competitive imbalance. On the other hand, extra-taxation seeks to influence the behavior of economic agents, either to discourage practices considered harmful or to promote socially desirable conduct. The apparent contradiction between tax neutrality and extra-taxation deserves further analysis, especially in view of the transformations introduced by the Brazilian Tax Reform.

The first relevant observation is that the tension between neutrality and extra-taxation does not derive from a conceptual incompatibility, but rather from specific *tax design* choices. When collection, economic neutrality and behavioral induction functions are concentrated in the same tax, conflicts and distortions are inevitably created.

⁴⁵ Ibid., p. 419.

⁴⁶ Ibid., p. 421.

⁴⁷ Ibid., p. 422.

The Brazilian pre-reform tax system exemplified this problematic overlap: the ICMS, originally conceived as a tax on consumption, accumulated collection, extra-fiscal and regional policy functions, resulting in excessive complexity, tax war and significant economic distortions.

International experience shows, however, that neutrality and extra-taxation can coexist harmoniously when there is a clear functional division between taxes. Mature tax systems often combine broad-based neutral taxes (such as European VAT) with specific non-fiscal taxes (such as the so-called *sugar tax* in the UK – *Soft Drinks Industry Levy* – *SDIL*)⁴⁸. This specialization allows each tax instrument to fulfill its specific function without compromising the effectiveness of the others.

The Brazilian Tax Reform adopted precisely this logic of functional division. The constitutional design establishes a tax architecture in which different taxes assume specialized roles, so that the IBS and CBS must operate under the principle of neutrality, while the Selective Tax concentrates the extrafiscal function.

In addition, other taxes that are known to be extra-fiscal maintain their roles, such as the IOF and the Import Tax, as well as other taxes that, although primarily fiscal, are often used for behavioral induction purposes (such as the zero IPVA rate for electric cars adopted by some states).

This functional division is expressly enshrined in the constitutional text and in infra-constitutional legislation. Article 156-A, § 1, item X, of the Federal Constitution, prohibits the granting of tax incentives and benefits related to the IBS (also applicable to the CBS, according to article 195, item V, § 16), "*except in the cases provided for in this Constitution*". This provision, regulated by article 2 of Complementary Law No. 214/2025, establishes that "*the IBS and the CBS are informed by the principle of neutrality, according to which these taxes must avoid distorting consumption decisions and the organization of economic activity*".

At the same time, the extra-fiscal nature of consumption taxes was not abolished from the system, but directed to specific instruments. As Folloni observes⁴⁹, the Selective Tax, provided for in article 153, VIII, of the Federal Constitution, assumes an extra-fiscal function when it is levied on goods and services that are harmful to health or the environment. The author argues that this competence cannot be understood as relating to a simple collection tax, because, if it were, it would violate the principles of ability to pay and tax equality, and should be interpreted as a genuinely extra-fiscal and selective tax⁵⁰.

⁴⁸ It is a tax with an ad rem rate for beverages with high sugar content.

⁴⁹ FOLLONI, Op. Cit., p. 624.

⁵⁰ Ibid.

The Tax Reform, therefore, did not eliminate extra-taxation, but promoted its systemic reorganization, concentrating the extra-fiscal function in the Selective Tax and preserving other tax instruments for promotional purposes. This coexistence, through functional specialization, has obvious advantages.

First, it provides greater clarity to the objectives of each tax, facilitating both application and jurisdictional control. Second, it reduces the complexity of the consumption tax system, eliminating the multiple rates, special regimes and exceptions that characterized, for example, the ICMS. Complementary Law No. 214/2025 operationalizes this simplification through a system of reference rates (article 18) and specific regimes. Third, it enhances the end or reduction of the tax war between federated entities (in line with the principle of destiny⁵¹), which used tax benefits as instruments of competition for investments, compromising federative harmony. The neutrality of the IBS and the CBS, established in article 2 of the aforementioned complementary law, eliminates this possibility by prohibiting differential treatment not provided for in the constitution.

The neutrality of the IBS and CBS also contributes to greater economic efficiency. By eliminating tax distortions in consumption and business organization decisions, these taxes allow the allocation of resources to be determined by economic efficiency criteria, not by tax considerations. This represents a significant advance towards a tax system that is less distortive and more compatible with economic development, especially when considering that the Tax Reform promises full non-cumulativeness (article 156-A, § 1, VIII, of the Federal Constitution), with a broad financial credit system, effectively eliminating the cascade effect, which characterized the previous system.

However, this coexistence architecture is not without important limitations. The main criticism formulated by Adamy, already pointed out previously and deepened here, is directed at the loss of the promotional function in the taxation of consumption. The author observes that "the Tax Reform on consumption taxation, by changing the constitutional tax system, modified and, to a large extent, subverted the foundations of extrattribution".⁵²

According to Adamy, the Selective Tax has a strictly sanctioning nature, aimed at discouraging harmful practices (especially related to the environment and health), but without the ability to promote beneficial behaviors⁵³. This limitation contrasts with the previous system, in which differentiated rates and tax benefits could be used to encourage sustainable practices, support strategic sectors, or promote social policies.

⁵¹ The collection will pass from production to consumption, that is, to the States and Municipalities in which the consumers of the product or service are located.

⁵² ADAMY, Pedro. Extrattribution in Tax Reform. Op. Cit., p. 410.

⁵³ Ibid.

In addition, the Reform institutes what this author calls "*rigid essentiality*" or "*closed essentiality*", with a list of goods, services, activities and sectors that will have different treatment, to the exclusion of any others, no matter how relevant they may be. This rigidity can compromise the ability of the tax system to adapt to changes in social demands and public policy priorities⁵⁴.

The author also argues that "by instituting a rigid or closed essentiality, with an exhaustive enumeration of the goods, services, activities and sectors that will have the most beneficial treatment, to the exclusion of all others, however essential they may be considered", the Reform drastically limited the promotional function of tax law, overemphasizing the sanctioning function of extra-taxation⁵⁵.

The express prohibition on tax benefits in the IBS and CBS may also generate future tensions. Political pressures for differential treatment of certain regions, sectors or activities are predictable, especially in a country with the regional inequalities of Brazil and whose Federal Constitution, in its article 3, III, establishes that one of the fundamental objectives of the Federative Republic of Brazil is the reduction of regional inequalities. The maintenance of the neutrality of these taxes will depend on the ability of institutions – especially the Supreme Court – to preserve the constitutional architecture against attempts at erosion through extensive or creative interpretations.

Another challenge is related to the effectiveness of tax neutrality itself. Although the Tax Reform has inserted the principle in a much more emphatic way than in the previous regime, the fact is that, until now, "tax neutrality has been understood at its minimum level by the Federal Supreme Court", ⁵⁶and the application of this principle by the Judiciary⁵⁷ to declare the unconstitutionality of a certain tax benefit is absent, characterizing, until then, as a theoretical ideal.

The sustainability of systems based on the functional division between neutral and extra-fiscal taxes depends on institutional and political factors. The Tax Reform represents a bet on the ability of institutions to maintain systemic coherence in the face of pressure from interest groups. The success of this architecture will depend on the ability to channel demands for sectoral public policies to other instruments – tax or not – without compromising the neutrality of taxes on consumption.

Finally, it is important to recognize that the coexistence between neutrality and extra-taxation through functional specialization represents a choice that implies trade-offs: one

⁵⁴ ADAMY, Pedro. Extrafiscality in Tax Reform. Op. cit., p. 412 and 428.

⁵⁵ Ibid, p. 429

⁵⁶ MOREIRA, André Mendes. **Neutrality, added value and taxation**. Belo Horizonte: Forum, 2019. p. 211.

⁵⁷ KOCH, Mariana Porto, Op. cit., p. 83.

gains in simplicity and efficiency, but loses in flexibility for public policies. As Adamy summarizes, "in the case of extrafiscality, the (constitutional) amendment came out worse than the sonnet",⁵⁸ indicating that, despite these aforementioned gains, the promotional function of extrafiscal is lost.

This tension reflects political choices. The Brazilian Tax Reform, at first, chose to privilege economic efficiency and operational simplicity to the detriment of flexibility for sectoral public policies, concentrating the extrafiscal function on consumption taxation in the Selective Tax and tax neutrality in the IBS and CBS.

5 CONCLUSION

The conclusion that emerges from the analysis of the present study is that tax neutrality and extra-taxation are not necessarily antagonistic norms, but can coexist harmoniously when there is a clear division of functions between different taxes. The Tax Reform operationalized this coexistence in an innovative way, establishing a system in which neutral taxes (IBS and CBS) coexist with specific extrafiscal instruments (Selective Tax).

The success of this architecture, as seen, will depend on the ability of institutions, especially the Federal Supreme Court, to preserve the functional specialization of taxes, resisting pressure from interest groups for exceptions that may compromise systemic coherence.

Although this solution has limitations in terms of flexibility for public policies, it represents a significant advance towards a more efficient, simple, and less distortive tax system. The ability to adapt to new social demands will be conditioned to the use of other tax instruments or to the eventual constitutional revision of the exhaustive lists established by Constitutional Amendment No. 132/2023.

It is noted that neutrality, as a constitutional principle, should not be understood as state indifference, but as a guarantee of equal treatment and economic efficiency. Extrataxation, even if delimited, continues to play an essential role in the correction of externalities. The coexistence between both norms requires institutional safeguards: (i) clear and justified exceptions; (ii) periodic review mechanisms; (iii) transparency in political choices; and (iv) jurisdictional firmness to contain interpretative erosions.

Thus, in summary, the study demonstrated that the Brazilian Tax Reform promoted a reconfiguration of the relationship between neutrality and extra-taxation. By reserving neutrality for broad-based taxes (IBS and CBS) and concentrating extra-taxation in the Selective Tax, the legislator sought to eliminate historical distortions, reduce litigation and end

⁵⁸ ADAMY, Pedro. Extrafiscality in Tax Reform. Op. cit., p. 430.

the tax war. However, this design reduced the flexibility for the promotion of public policies, limiting extra-taxation to a predominantly sanctioning function.

The Brazilian Tax Reform, therefore, did not eliminate the tension between neutrality and extra-taxation, but reorganized it systemically, creating a model adequate to the needs of a modern and complex economy, although at the cost of greater rigidity in the implementation of sectoral public policies through taxation on consumption.

Thus, the central conclusion is that neutrality and extra-taxation are not antagonistic norms, but complementary dimensions of the same system. When articulated in a balanced way, they can ensure simplicity and efficiency without abdicating the social function of the tax, making Brazilian taxation on consumption more rational, predictable and fair.

REFERENCES

- Abswoude, K. van. (2022). The principle of fiscal neutrality and economic reality in EU VAT: Two peas in a pod? (Dissertação de mestrado em Direito). Lund University.
- Adamy, P. (2012). Instrumentalização do Direito Tributário. In H. Ávila (Org.), *Fundamentos do Direito Tributário* (pp. 302–329). Marcial Pons.
- Adamy, P. (2021). Origens teóricas da extrafiscalidade. *Revista Direito Tributário Atual*, (39), 352–360.
- Adamy, P. (2024). Extrafiscalidade na reforma tributária: Essencialidade rígida e o fim da função promocional do Direito Tributário. *Revista Direito Tributário Atual*, 58, 410–431.
- Alcoforado, A. M. G. (2024). A não cumulatividade do IVA-dual (CBS e IBS) prevista na proposta de reforma tributária. *Revista de Direito Tributário da APET*, (49), 239–263.
- Ávila, H. (2024). *Teoria dos princípios: Da definição à aplicação dos princípios jurídicos* (22^a ed. rev., atual. e ampl.). Malheiros; Juspodivm.
- Balthazar, U. C. (2011). Tributos e meio ambiente. *Espaço Jurídico*, 12(2).
- Costa, C. F. de C., & Vieira, J. de C. (2021). Optimal tax theory: Its contributions to the Brazilian reality. *Revista de Administração Contemporânea*, 25(2). <https://doi.org/10.1590/1982-7849rac2021190238.en>
- Domingues, J. M. (2007). *Direito tributário e meio ambiente*. Forense.
- Folloni, A. (2024). Competência tributária do imposto seletivo: O texto e seus contextos. *Revista Direito Tributário Atual*, (57), 617–642.
- Fortes, F. C. (2021). *Neutralidade fiscal: Tributação e livre concorrência*. Editora Thoth.
- Greco, M. A., & Rocha, S. A. (2024). Vetores do Sistema Tributário Nacional após a EC n. 132. *Revista Direito Tributário Atual*, 56, 752–780.

- Koch, M. P. (2023). Teoria da neutralidade tributária (Tese de doutorado em Direito). Universidade Federal do Rio Grande do Sul.
- Leão, M. (2015). Contributo para o estudo da extrafiscalidade: A importância da finalidade na identificação das normas tributárias extrafiscais. *Revista Direito Tributário Atual*, (34), 303–325.
- Mankiw, N. G., Phelps, E. S., & Romer, P. M. (1995). The growth of nations. *Brookings Papers on Economic Activity*, (1), 1–60.
- Matschulat, L., & Amaral, L. B. K. (2022). A perspectiva pela implementação do imposto seletivo como tipo tributário no Brasil. *Res Severa Verum Gaudium*, 6(2), 287–309.
- Moreira, A. M. (2019a). Neutralidade, valor acrescentado e tributação. *Fórum*.
- Moreira, A. M. (2019b). O direito ao crédito no IVA europeu: Apontamentos sobre o princípio da neutralidade tributária. *Revista Direito Tributário Atual*, (42), 47–66.
- Santos, F. F. P. V. dos, & Scabora, F. C. (2022). Tributação ambiental e extrafiscalidade no Brasil: Incentivos fiscais e regressividade da tributação verde. *Revista Direito Tributário Atual*, (52), 144–161.
- Schoueri, L. E. (2005). Normas tributárias indutoras em matéria ambiental. In H. T. Tôrres (Org.), *Direito Tributário Ambiental* (pp. 235–256). Malheiros Editores.
- Schoueri, L. E. (2009). Tributação e indução econômica: Os efeitos econômicos de um tributo como critério para sua constitucionalidade. In R. Ferraz (Org.), *Princípios e limites da tributação 2: Os princípios da ordem econômica e a tributação* (Vol. 2, pp. 139–164). Quartier Latin.
- Schoueri, L. E., & Galdino, G. (2025). A neutralidade das regras transitórias no IBS e na CBS: O caso dos bens de capital. *Revista Direito Tributário Atual*, 59, 755–781.
- Vieira, A. C. (2014). O princípio da precaução e a extrafiscalidade na tributação ambiental. *Revista Direito Tributário Atual*, (32), 31–44.
- Zilveti, F. A. (2005). Variações sobre o princípio da neutralidade no direito tributário internacional. *Revista Direito Tributário Atual*, (19), 24–40.

INFLUENCE OF THE VARIATION OF THE PERCENTAGE OF INCREASE OF BAUXITE RESIDUE ON THE PHYSICAL AND MECHANICAL PROPERTIES OF SYNTHETIC COARSE AGGREGATES AND THEIR USE IN STRUCTURAL CONCRETE OF NORMAL STRENGTH PORTLAND CEMENT

INFLUÊNCIA DA VARIAÇÃO DO PERCENTUAL DE INCREMENTO DE RESÍDUO DE BAUXITA NAS PROPRIEDADES FÍSICAS E MECÂNICAS DE AGREGADOS GRAÚDOS SINTÉTICOS E SUA UTILIZAÇÃO EM CONCRETO ESTRUTURAL DE CIMENTO PORTLAND DE RESISTÊNCIA NORMAL

INFLUENCIA DE LA VARIACIÓN DEL PORCENTAJE DE INCREMENTO DE RESIDUO DE BAUXITA EN LAS PROPIEDADES FÍSICAS Y MECÁNICAS DE AGREGADOS GRUESOS SINTÉTICOS Y SU UTILIZACIÓN EN CONCRETO ESTRUCTURAL DE CEMENTO PORTLAND DE RESISTENCIA NORMAL



<https://doi.org/10.56238/sevened2026.008-048>

Robson da Silva Fernandes¹, João Carlos Lisboa de Lima², Marcella Camilly Dias Ribeiro³, Danusa Mayara de Souza⁴, Lucas Miranda Pantoja⁵, Marcelo Martins Farias⁶, Celestina Lima de Rezende Farias⁷, Fabíola Thomaz Maia⁸, Wladimir Rafael de Matos Lamarão⁹, Patricia da Silva Chaves¹⁰, Elsimar Souza Santos¹¹, Lucas Emanuel Mateus Pereira Lopes¹², William Meireles de Souza¹³, Marcelo de Souza Picanço¹⁴

ABSTRACT

The present study is an integral part of an extensive cooperation project aimed at conducting research between the Federal University of Pará and the company Hydro Alunorte. The proposal consisted of producing synthetic coarse aggregates from bauxite residue (AGS) and

¹ Dr. in Civil Engineering. Universidade Federal do Pará. E-mail: robsoneng.civil34@gmail.com

² Dr. in Civil Engineering. Universidade Federal do Pará. E-mail: joaocarloslisboadelima@hotmail.com

³ Master's degree in Civil Engineering. Universidade Federal do Pará. E-mail: marcellacdribeiro@gmail.com

⁴ Dr. in Geophysics. Universidade Federal do Pará. E-mail: danusa@ufpa.br

⁵ Graduated of Science in Civil Engineering. Universidade Federal do Pará.
E-mail: lucasmpantoja@icloud.com

⁶ Dr. in Civil Engineering. Instituto Federal de Educação, Ciência e Tecnologia do Pará
E-mail: marcelo.farias@ifpa.edu.br

⁷ Dr. in Civil Engineering. Instituto Federal de Educação, Ciência e Tecnologia do Pará.
E-mail: celestina.rezende@ifpa.edu.br

⁸ Graduated in Architecture and Urbanism. Universidade Federal do Pará.
E-mail: fabi.thomaz@gmail.com

⁹ Engineering Forensics Specialist. Universidade Federal do Pará. E-mail: wladimirlamarao@gmail.com

¹⁰ Master's degree in Civil Engineering. Instituto Federal de Educação, Ciência e Tecnologia do Pará.
E-mail: patricia.chaves@ifpa.edu.br

¹¹ Dr. in Civil Engineering. Universidade Federal do Pará. E-mail: elsimar.santos@itec.ufpa.br

¹² Graduated of Science in Civil Engineering. Universidade Federal do Pará. E-mail: lucasempl01@gmail.com

¹³ Graduated of Science in Civil Engineering. Universidade Federal do Pará.
E-mail: william.souza@itec.ufpa.br

¹⁴ Dr. in Geology. Universidade Federal do Pará. E-mail: marcelosp@ufpa.br

their subsequent use in the production of conventional-strength structural concrete. This research refers to the study, which partially addressed the dynamics of the production cycles of synthesized aggregates. For this purpose, the AGS70 and AGS80 coarse aggregates from the third production cycle were used. The percentage discrepancy of residue in the aggregate composition was approximately 10%. Among the results obtained, the analyses of the physical and mechanical properties of the synthetic aggregates stand out. In this context, AGS80 showed a water absorption capacity 24% higher than that of AGS70. The results obtained in the composites with AGS70 and AGS80 aggregates indicated that, at an initial stage, the concrete with AGS80 showed better results regarding physical and mechanical properties.

Keywords: Synthetic Coarse Aggregate. Bauxite Residue. Concrete. Tests. Microstructure. Aggregate Modulus.

RESUMO

O presente estudo é parte integrante de um extenso projeto de cooperação para a realização de pesquisas entre a Universidade Federal do Pará e a empresa Hydro Alunorte. A proposta consistia na produção de agregados graúdos sintéticos a partir de resíduos de bauxita (AGS) e sua subsequente utilização na produção de concreto estrutural de resistência convencional. Esta pesquisa faz menção a um estudo, o qual abordou, em parte, a dinâmica dos ciclos de produção de agregados sintetizados. Para tanto, empregou-se os agregados graúdos AGS70 e AGS80 do terceiro ciclo de produção. A discrepância percentual do resíduo na composição dos agregados foi de aproximadamente 10%. Dentre os resultados obtidos, destacam-se as análises das propriedades físicas e mecânicas dos agregados sintéticos. Nesse contexto, o AGS80 apresentou capacidade de absorção de água 24% superior à do AGS70. Os resultados obtidos nos compósitos com os agregados AGS70 e AGS80 indicaram que, em um primeiro momento, o concreto com AGS80 apresentou melhores resultados em relação às propriedades físicas e mecânicas.

Palavras-chave: Agregado Graúdo Sintético. Resíduo da Bauxita. Concreto. Ensaios. Microestrutura e Módulo do Agregado.

RESUMEN

El presente estudio forma parte integral de un amplio proyecto de cooperación para la realización de investigaciones entre la Universidad Federal de Pará y la empresa Hydro Alunorte. La propuesta consistió en la producción de agregados gruesos sintéticos a partir de residuos de bauxita (AGS) y su posterior utilización en la producción de concreto estructural de resistencia convencional. Esta investigación hace referencia al estudio el cual abordó parcialmente la dinámica de los ciclos de producción de agregados sintetizados. Para ello, se emplearon los agregados gruesos AGS70 y AGS80 del tercer ciclo de producción. La discrepancia porcentual del residuo en la composición de los agregados fue de aproximadamente el 10%. Entre los resultados obtenidos, se destacan los análisis de las propiedades físicas y mecánicas de los agregados sintéticos. En este contexto, el AGS80 presentó una capacidad de absorción de agua un 24% superior a la del AGS70. Los resultados obtenidos en los compuestos con los agregados AGS70 y AGS80 indicaron que, en un primer momento, el concreto con AGS80 presentó mejores resultados en relación con las propiedades físicas y mecánicas.

Palabras clave: Agregado Grueso Sintético. Residuo de Bauxite. Concreto. Ensayos. Microestructura. Módulo del Agregado.

1 INTRODUCTION

The bauxite residue, formerly called red mud, is obtained through the Bayer process to refine bauxite and obtain alumina, a by-product of aluminum. For each ton of alumina produced, 1 to 2 tons of this waste are generated, which usually contains oxides of iron, titanium, silica, residual aluminum and other metals such as vanadium, nickel and chromium Miura, Yuuki Silveira (2015) and has a high pH increasing the environmental risk M. L. P. Antunes *et al.* (2010). Large containment deposits are built to store this waste. However, this condition ends up generating visual and ecological impact and can also degrade landscapes and hinder revegetation Miura, Yuuki Silveira (2015).

Research shows that some alternatives are already being applied to use bauxite residue with proper treatment, such as techniques for recovery and (or) reduction of the visual and ecological impacts of degraded areas Miura, Yuuki Silveira (2015). The use in construction materials with bricks or masonry laying blocks, cements, paving blocks, coarse and fine aggregates for concrete Antunes *et al.* (2010).

Based on the studies presented by Fernandes, *et al.* (2025), this research seeks to evaluate whether the amount of residue content used in the production of synthetic coarse aggregates through the third production cycle, specifically AGS70 and AGS80, influenced the results obtained from the physical, chemical and mechanical characterization tests. Thus, as in the physical and mechanical properties of Portland cement concretes of normal strength.

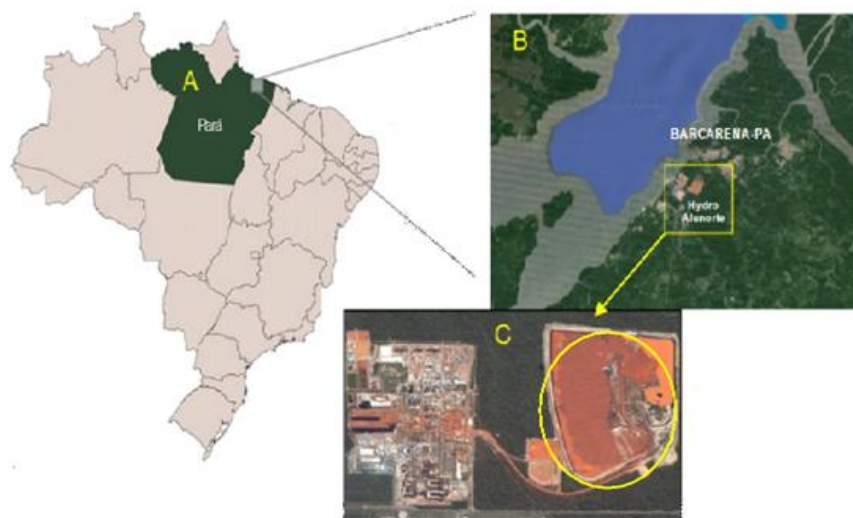
Therefore, this study also establishes a correlation of the influence of synthetic coarse aggregates on the mechanical strengths and modulus of elasticity of Portland cement concrete with the normal strength class. This research presents comparative results of concretes produced with these two types of SFA, analyzing their respective performances in the fresh state such as consistency, bulk density and cement consumption. In the hardened state, aspects of water absorption, porosity, specific mass and static modulus of elasticity are analyzed. In the fracture state of the concrete, the strength to axial compression, diametrical traction and flexion are measured. Finally, the matrix-aggregate interface is analyzed by scanning electron microscopy (SEM).

2 METHODOLOGY

The bauxite residue (RB) used in the research comes from solid waste deposits (DRS), with a storage capacity of 92.2 Mm³ (mega cubic meters) (Souza, *et al.*, 2019), from the HYDRO Alunorte refinery located in the State of Pará, as shown in Figure 1.

Figure 1

Location of the bauxite residue deposit. A and B) Factory Location (Google Maps, 2025) and C) Waste storage area by the company Hydro Alunorte, in Barcarena-PA



Source: Souza, et al., 2019. Adapted. Authors, 2025.

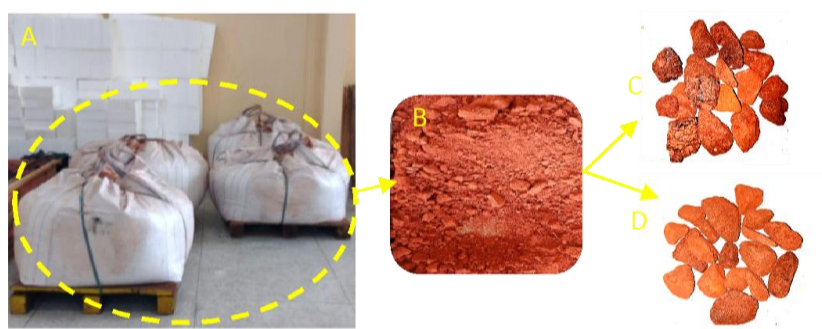
2.1 MATERIALS

2.1.1 Bauxite Residue

Fernandes *et al.* (2025) emphasize that the production of synthetic coarse aggregate took place through the use of raw materials: kaolinite clay, silica and bauxite residue (RB), supplied by the company Hydro Alunorte, located in Barcarena in the state of Pará and stored in the Civil Engineering Laboratory of the Federal University of Pará (UFPA), as shown in Figure 2.

Figure 2

Storage of bauxite residue in the Civil Engineering laboratory of UFPA. A) Arrangement of the way in which the material was transported and subsequently stored; B) Appearance of the Waste in natura; C) and D) Samples of AGS70 and AGS80 obtained in the second production cycle



Source: Adapted, Fernandes, et al. (2025).

2.1.2 Aggregates

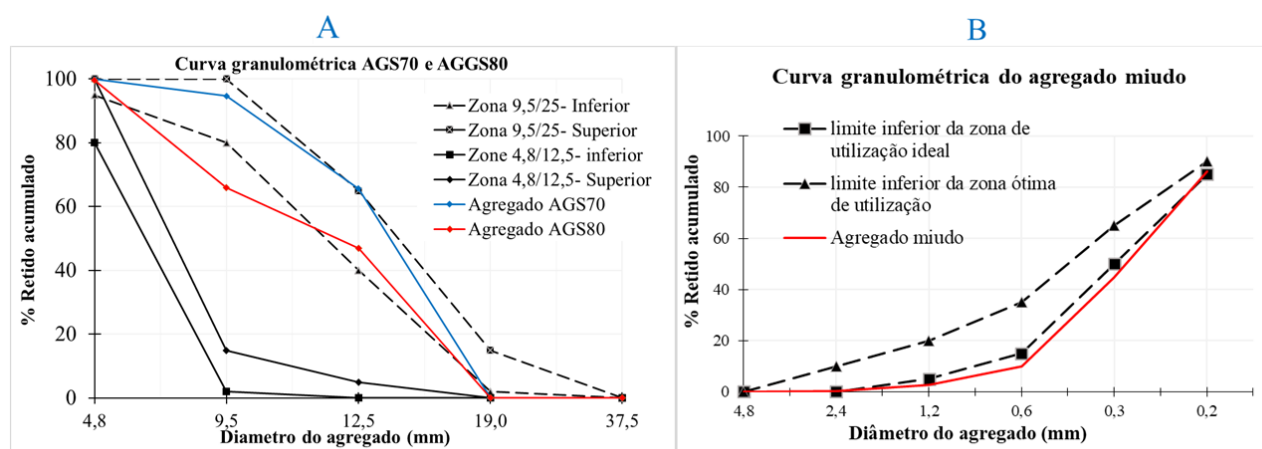
The fine aggregate used in the research is classified as a natural sand type, coming from the quartz riverbed of the Amazon region, more specifically in the vicinity of the municipality of Ourém, in the state of Pará. Physical characterization tests of the material were carried out, whose results indicate a specific mass of 2.62 g/cm^3 , unit mass of 1.61 g/cm^3 and a water absorption of 1.5%. Through the granulometry test, the result of a fineness modulus of 2.4 and a maximum dimension of 1.18 mm was obtained, which indicates that the material is classified as medium sand.

The coarse aggregate is of the synthetic type, called AGS70 and AGS80 of the third production cycle, with percentages ranging between 70-75% and 80-85% of bauxite residue in its composition respectively, supplied by the company Hydro and produced in the chemical engineering laboratory of the Federal University of Pará, as described by Fernandes, *et al.* (2025). For these types of aggregates, physical characterizations were also carried out, presenting the results of maximum diameters of 19.0 mm, specific masses of 2.21 and 2.26 g/cm^3 , fineness modulus of 1.95 and 1.84, shape indices of 2.07 and 2.08. However, the values reported for water absorption are in the order of 5.24% and 6.50%, respectively Fernandes, *et al.* (2025). However, the authors informed in the research in an inverted way. The sintering temperatures were set at 1200°C and the shapes of these coarse aggregates can be seen in Figure 2-C and 2-D.

Figures 3.A and 3.B show the particle size curves of the fine aggregate and the large aggregates AGS70 and AGS80.

Figure 3

Particle size range of AGS70 and AGS80 (A) and giblets (B) large aggregates



Source: Adapted, Fernandes, R.S. et al. (2025).

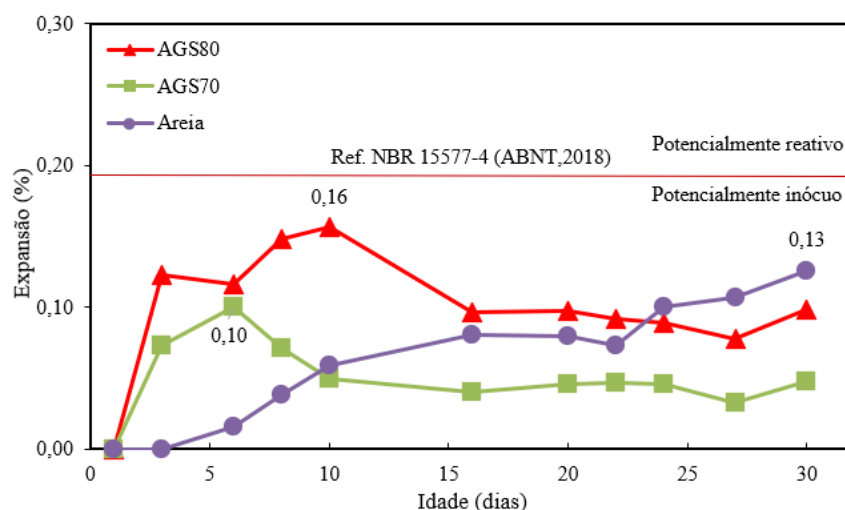
It can be easily observed that the particle size distribution of the sand is outside the frame between the ranges of the lower usable zone and the optimal lower usable zone. On the other hand, the particle size curves of the synthetic coarse aggregates show a partial framing between the upper and lower zones of the particle size range of the sieves #4.8-12.5mm. The equivalence of the curves of the coarse aggregates is an important aspect, as it was necessary to avoid the granulometric variability among the coarse aggregates to be used in the production of cementitious composites.

The coarse aggregates were submitted to mechanical abrasion tests in Los Angeles, whose results showed a mass loss of 41.06% for AGS70 and 43.94% for AGS80. This confirms that the synthetic aggregates in this study meet the minimum requirements of NBR 7211, of 2022, for use in structural concrete.

The verification of whether these synthetic coarse aggregates produced in the laboratory have the potential for reactivity in relation to cement alkalis is essential to ensure the integrity and durability of the concretes. Therefore, the alkali-aggregate reaction assays were performed for synthetic coarse aggregates (AGS70 and AGS80) and also for fine aggregates (sand), as shown in Figure 4.

Figure 4

Results of the aggregate alkali reaction tests of the sand, AGS70 and AGS80 according to NBR 15577-4/2019.



Source: Authors.

2.1.3 Dosing and preparation of the dosing curve

The concrete mix was stipulated at 30 MPa at 28 days, based on the dosage diagram (Figure 5) by the IBRACON method and by the recommendations of NBR 12655:2022, adopting the aggressiveness class II, according to NBR 8953:2015. For the preparation of

the dosage curves of the traces, the same 57% mortar was maintained, considering a concrete for application in the superstructure of tall buildings by means of pumping. Nor were any additives used, in order to directly know the influence of the porosity of the coarse aggregates on the porosity of the concrete. Thus, the consistency class was fixed at S50 due to the reduction of the work through the slump test. Table 1 presents the results of compressive strength of the specimens (CP) at the age of 28 days for the poor, rich and normal traces for the elaboration of the dosage curves, according to the recommendations of the IBRACON Method (Figure 5).

Table 1

Compressive strengths of the dosage curve

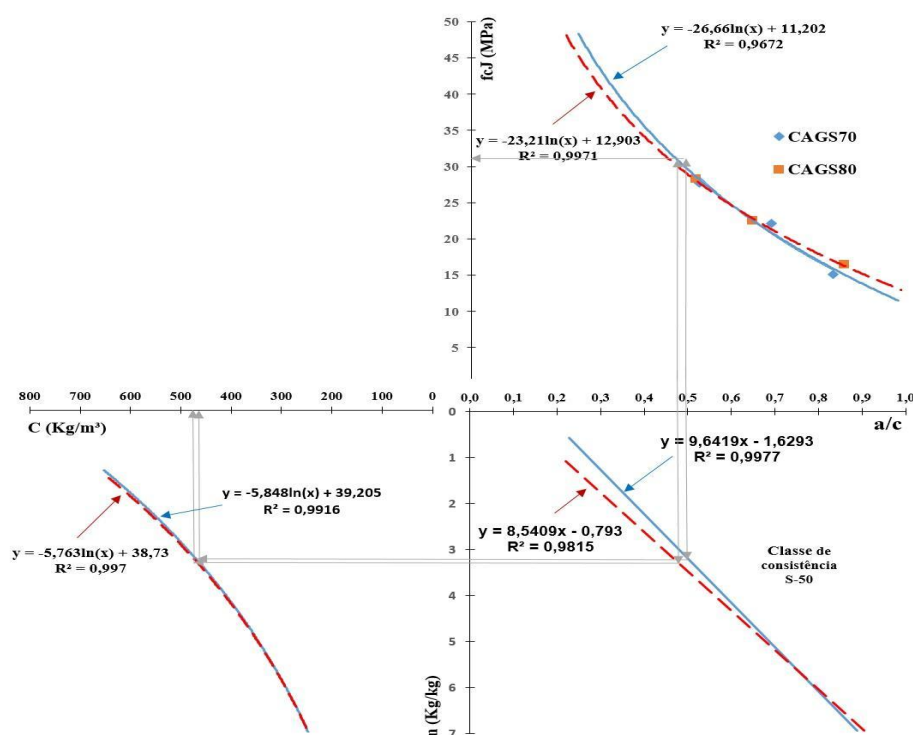
	CLASS	DASH	Attn:	α (%)	Consist. (mm) NBR 7112/2021	fckJ (MPa)	DP	CV
Normal	CAGS70N	1:5,0	0,70	57	S50: $50 \leq TO < 100$	22,17	1,03	0,05
	CAGS80N	1:5,0	0,65	57	S50: $50 \leq TO < 100$	22,50	1,66	0,07
Poor	CAGS70P	1:6,5	0,84	57	S50: $50 \leq TO < 100$	15,12	0,19	0,01
	CAGS80P	1:6,5	0,86	57	S50: $50 \leq TO < 100$	16,45	0,48	0,03
Rico	CAGS70R	1:3,5	0,53	57	S50: $50 \leq TO < 100$	27,70	1,27	0,05
	CAGS80R	1:3,5	0,52	57	S50: $50 \leq TO < 100$	28,30	2,33	0,08

SD - Standard deviation; CV - Coefficient of variation.

Source: Authors.

Figure 5

Dosing curve of the CAGS70 and CAGS80 composites. Adapted, IBRACON Method



Source: Authors.

2.1.4 Unit traits extracted from the curve

The CAGS70 and CAGS80 concretes were evaluated in the hardened state by means of simple axial compression mechanical tests at the ages of 7 and 28 days in cylindrical specimens of 100x200 mm (Figure 7-B and F); diametrical compression traction and flexion traction at the age of 28 days, in cylindrical specimens of 100x200 mm (Figures 7-C and D) and in prismatic specimens of 150x150x500 mm, respectively (Figures 7-D and H). The static modulus of elasticity is measured in cylindrical specimens, whose characteristics are presented in Table 1. In addition, water absorption and void index tests were carried out to correlate with the mechanical strengths of the concretes.

Considering the need to keep the experimental parameters within the same consistency range established by the dosing curves, the mixing water used was adjusted for the concretes, differing from the amount predicted in the initial trace. It is important to emphasize that such changes directly influenced the relationship of the final binding water of the composites and their respective mechanical properties. As shown in Table 2, the properties of cementitious composites are presented

Table 2*Design of the mixtures of the composites studied*

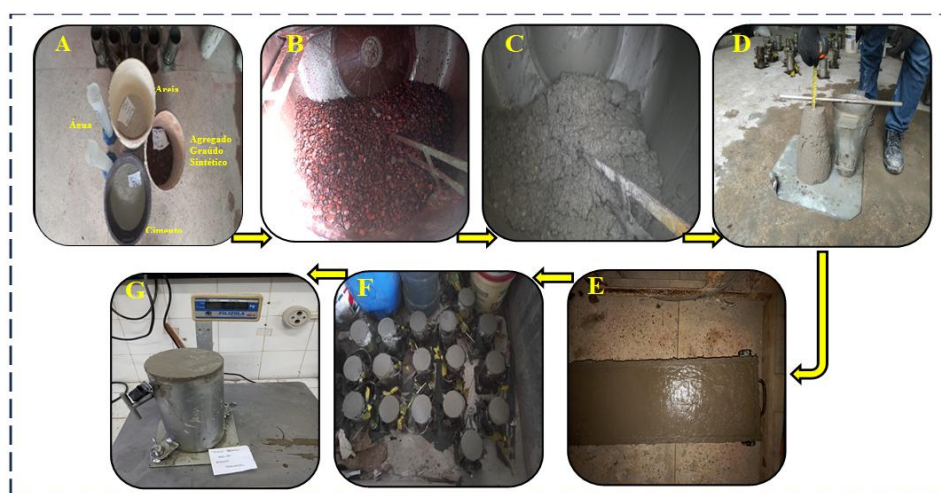
Composite/Aggregate Type	Mortar content (%)	Unit Trace	Binding water (initial)	Binding water (final)	Consistency S50 (mm)	Lampshade (mm)	Cement Consumption (Kg/m ³)	Concrete Mass (Kg/m ³)
CAGS70	57	1:1,39:1,8 ₁	0,51	0,61	50-100	66	466	2243,16
CAGS80	57	1:1,37:1,7 ₈	0,48	0,55	50-100	57	477	2247,27

Source: Authors.

The concrete slump was established in a range ranging from 50 mm to 100 mm, depending on the S-50 strength class. The axial compressive strength, defined in this study as 30 MPa (C30), corresponds to the concrete usually used in vertical works. The concrete dosage was carried out at the Civil Engineering Laboratory of the Federal University of Pará. Figure 6 details the sequencing of the concrete dosing process with the synthetic coarse aggregate. Figure 7, in turn, demonstrates the immersion cure of the samples, as well as the mechanical tests and the static modulus of elasticity.

Figure 6

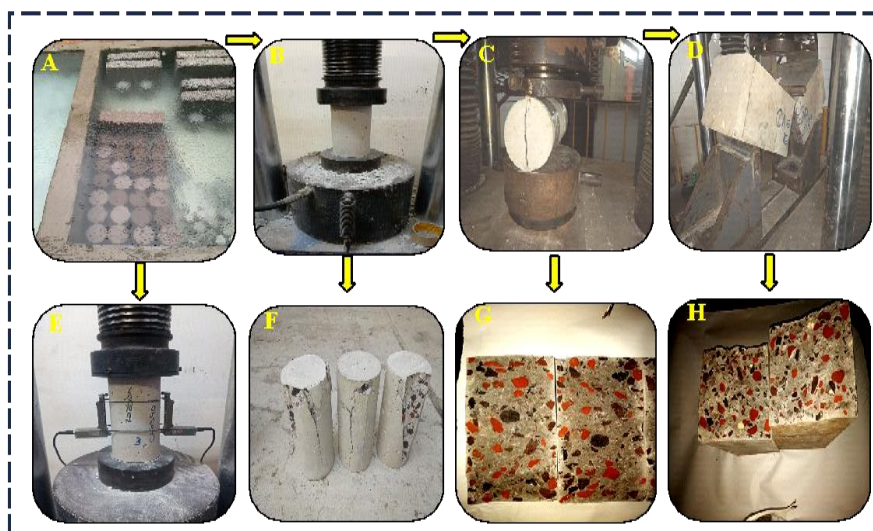
Dosage sequencing and molding. A) Dosing materials; B and C) Mixtures of aggregates in the concrete mixer; D) concrete consistency test; E) and F) Molding of cylindrical and prismatic specimens; G) detail of the concrete for analysis of the apparent specific mass



Source: Fernandes, et al. (2025).

Figure 7

Sequencing of the mechanical strength tests of the CAGS. A) Immersed cure; B) Axial compression test; C) Tensile test by diametrical compression; D) Flexural tensile test; E) Static modulus of elasticity test; F/ G/ H) Detail of the rupture of the PC's to axial compression, diametrical compression and traction in flexion, respectively



Source: Adapted, Fernandes, et al. (2025).

3 RESULTS AND DISCUSSION

3.1 INFLUENCE OF THE VARIATION OF THE RESIDUE CONTENT IN THE SYNTHETIC AGGREGATES AGS70 AND AGS80 IN RELATION TO THEIR PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES

The results found for AGS70 and AGS80 coarse aggregates of the third cycle produced in a muffled furnace at a controlled temperature at 1200 °C, were considered excellent for presenting normal specific mass, above 2.0 g/cm³. In addition, it is noteworthy that in most of the studies used as a basis for this research, the generation of samples occurred at burning temperatures above 1200 °C, using muffled ovens for the production of synthetic coarse aggregates.

Tuan *et al.* (2013) says that the burning temperature plays a key role in controlling the water absorption capacity. This is because the sintering of the mixture promotes the densification of the particles, reducing the entry of water into the aggregate matrix. The high porosity index of the aggregate is directly related to its water absorption capacity and the higher the porosity of the material, the greater its water absorption capacity. The samples were tested and had absorption rates between 5.59% and 6.50%. Therefore, the aggregates meet the limits established by the NBR 7211 (2022) standard.

According to Borba and Santos (2021), the shape index of coarse aggregate grains indicates how much they resemble a cube. NBR 7211 (2022) states that the shape index of

a coarse aggregate, determined according to NBR 7809 (2016), should not be higher than 3, allowing lamellar aggregates. The results of the shape indices of the samples were below the regulatory limit, thus meeting the required standards.

It is important to note that highly porous aggregates are typically more brittle, making them unsuitable for the production of structural concrete. The average results of the Los Angeles abrasion index, carried out according to the NM 51 (2001) standard, in which the analyzed samples showed abrasion resistance for AGS70 of 41.06% and for AGS80 of 43.94%, show that these indices are considered satisfactory, since NBR 7211 (2022) stipulates that the percentage of mass loss must be less than 50%. It is worth mentioning that the greater the water absorption of the aggregates, the greater the mass loss by the abrasion test.

A durability test was carried out through the reaction test of alkaline aggregates established by NBR 15577-4 (2018) to qualitatively evaluate the condition of the aggregates. The results indicated that the synthetic aggregates do not have the potential to reactivity with the alkalis of the cement studied, that is, they are inert.

3.2 INFLUENCE OF THE PHYSICAL PROPERTIES OF CONCRETE ON THE AXIAL COMPRESSIVE STRENGTHS OF CAGS70 AND CAGS80 CONCRETES

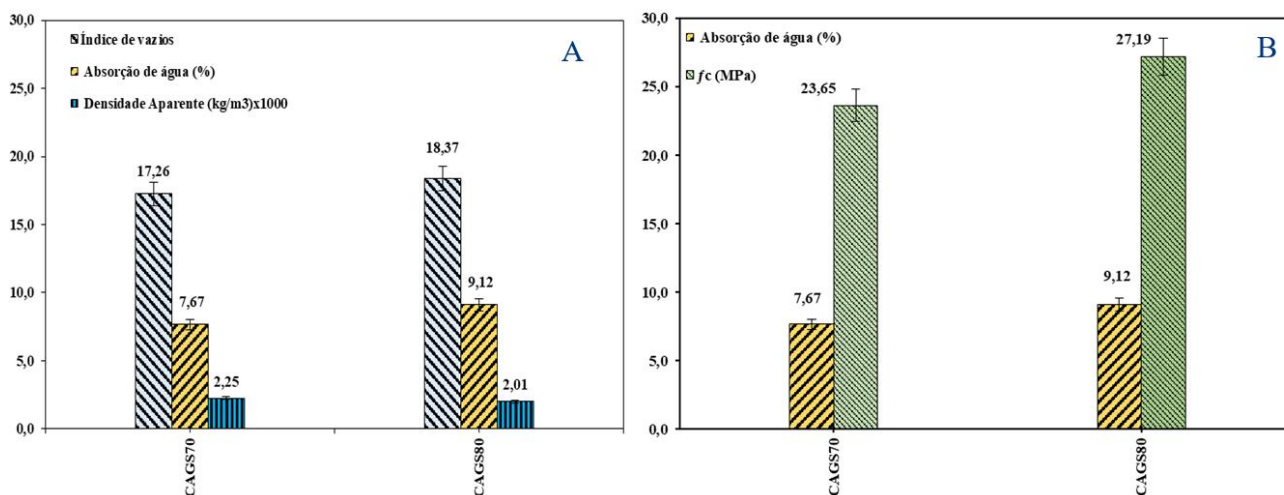
Figure 8-A shows the graph of the relationship between water absorption, void index and apparent specific mass of concrete with synthetic coarse aggregates. When analyzing the spectrum of the existing porosity of the concretes at the age of 28 days, it is observed that CAGS70 has lower porosity than CAGS80, according to the results of the void index and water absorption tests. In this condition, initially it could be said that the CAGS70 presents better physical durability performance than the CAGS80. However, through the information contained in Table 2, it is observed that the final binding water index in CAGS70 is higher than CAGS80 and that the subsidence was 66 mm and 57 mm, respectively. Thus, it can bring the understanding that both concretes are framed in the same porosity range, causing an equivalence between them.

As exposed by Rossignolo (2009, p. 25), a high rate of water absorption in the aggregate can cause damage to concrete in its hardened state. However, the high water absorption capacity of the aggregate can provide benefits, such as improving the properties of the transition zone between the aggregate and the cement slurry, resulting in the reduction of the "wall effect". Another situation to highlight is that the results showed that the apparent specific masses of the CAGS70 and CAGS80 composites are 2250 kg/m³ and 2001 kg/m³, respectively. This reaffirms that AGS80 is less dense than AGS70, as it is more porous due

to the higher bauxite content in its composition. This may demonstrate that CAGS80, being more porous, caused a greater amount of voids, thus less dense.

Figure 8

Physical and mechanical properties of the concretes studied. A) Void index x water absorption x bulk density. B) water absorption x axial compressive strength at 28 days



Source: Authors.

The porosity of the coarse aggregate is a factor that can affect the rheological and mechanical properties of structural concretes, as well as the modulus of elasticity of the concrete. Figure 8 shows the graph that relates the water absorption and the mechanical resistance to axial compression of CAGS70 and CAGS80 at the age of 28 days, where CAGS80 has higher porosity, in the order of 18% higher than CAGS70. However, when observing the compressive strength at 28 days, it is noted that, even though CAGS80 has greater porosity and greater water absorption than CAGS70, it still also has greater strength, in a proportion of 15% higher. Therefore, it is inferred that the constraints of porosity and water absorption, when analyzed individually, do not exert a direct influence on the axial compression of the composites object of this research.

3.3 ANALYSIS OF AXIAL COMPRESSIVE STRENGTHS AND MODULUS OF ELASTICITY OF CAGS70 AND CAGS80 CONCRETES

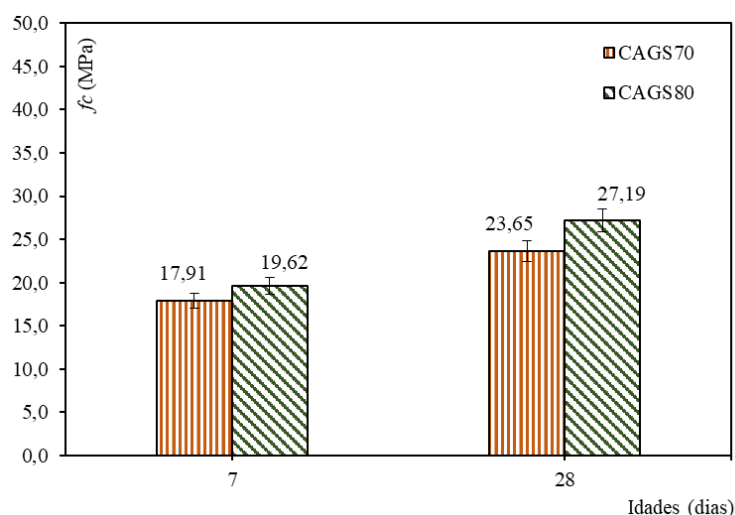
The compressive strength graph, illustrated in Figure 9, indicates that both composites showed a gradual increase in strengths over time at the ages of 7 and 28 days.

At the final age of the test (28 days), the results obtained indicated that CAGS80 presented axial compressive strength 15% higher than CAGS70. However, when relating the experimental trace extracted from the dosage curve to the age of 28 days, estimated at 30 MPa, it is clear that the batch of specimens produced initially would not meet the pre-

established resistance requirement at this age. However, even if the strengths of the concretes studied are lower than those stipulated in the traces of the dosing curves, it is important to emphasize that these concretes were framed within the class of aggressiveness established in NBR 12655:2022.

Figure 9

Graph of the mapping of the axial compressive strength of the CAGS70 and CAGS80 composites for ages 7 and 28 days

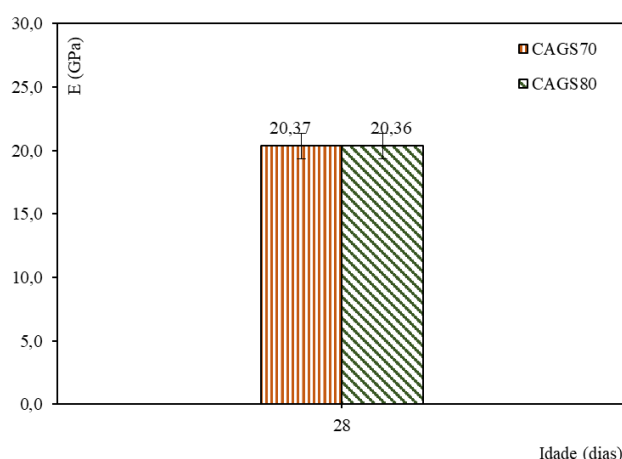


Source: Authors.

Some aspects in which the coarse aggregates may have contributed to the results obtained, lead to the reflection that AGS80 has greater loss to abrasion and greater water absorption than AGS70. However, CAGS80, even with higher porosity/water absorption and lower apparent specific mass than CAGS70, nevertheless obtained higher axial compressive strengths at the ages studied. This leads to the following conclusion: that, because they are concretes of normal strengths, the physical properties of porosity and surface hardness are not the main factors for compressive strength, but the water-binder ratio, if the other rheological parameters are equivalent, since for CAGS70 the ratio of 0.61 was used and for CAGS80 0.55.

Figure 10

Graph of the modulus of elasticity of the CAGS70 and CAGS80 composites



Source: Authors.

According to NBR 6118, 2023, the elastic deformation of concrete depends on the composition of the concrete trace, especially the nature of the aggregates. According to Mehta and Monteiro (2014, p. 24), the modulus of elasticity and compressive strength of concrete are two properties that evolve in different ways over time. Considering the results obtained at the age of 28 days of the modulus of elasticity of CAGS70 and CAGS80 are practically the same, therefore, there is no intrinsic variation in the microstructure of this type of concrete, when the percentage of residue in the composition of the coarse aggregate is altered. Taking into account the notes of Rossignolo (2009), who states that, for concretes of normal specific mass, with axial compressive strength values ranging from 20 to 50 mega pascal (MPa), the value of the modulus of deformation can vary, in general, between 50% and 80% of the value obtained.

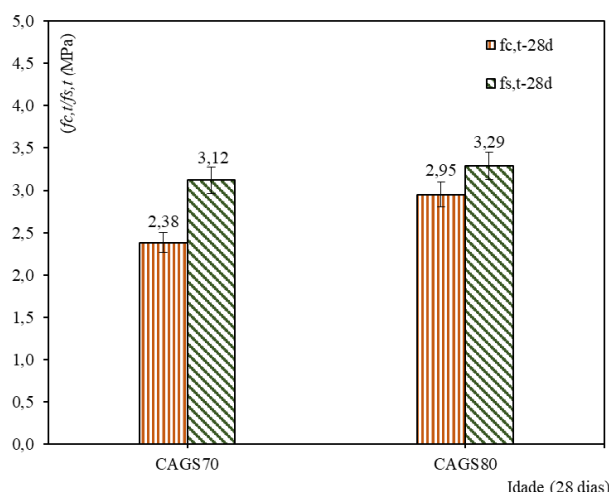
3.4 COMPARATIVE ANALYSIS OF THE RESULTS OF DIAMETRICAL COMPRESSION TRACTION AND FLEXURAL TENSILE

Figure 11 presents a comparison of the results obtained from the diametrical compression and flexural tensile strength tests, performed at 28 days, for the CAGS70 and CAGS80 composites. There were significant variations in the responses obtained between the above-mentioned assays for the CAGS70 and CAGS80 composites. However, when analyzing the results of axial compression and tensile diametrical compression for the CAGS70 and CAGS80 composites, it was understood that the tensile strength of both was equivalent to 10% of the axial compressive strength. In view of the above, it is inferred that the results are in accordance with the normative parameters established for standard strength concretes. This hypothesis is corroborated by the systematic review by Junior, Costa and

Macedo (2022), who cite the results of diametrical compression tensile strength from the works of Rosário (2013) and Souza (2010).

Figure 11

Graph of the relationship between indirect tensile strength and flexural tensile strength of CAGS70 and CAGS80 composites for 28-day age



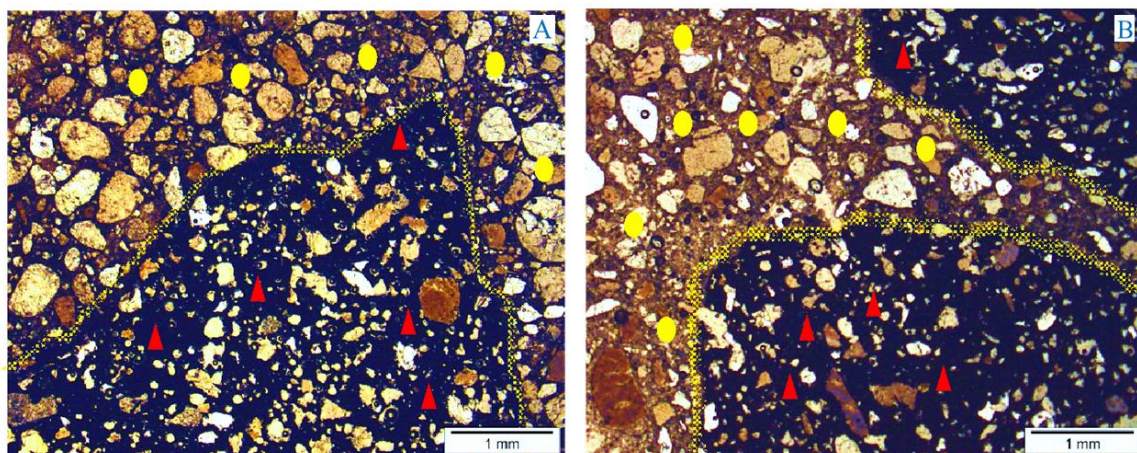
Source: Authors.

3.5 ANALYSIS OF THE MICROSTRUCTURE OF FRACTURED CONCRETE BY OPTICAL AND SCANNING ELECTRON MICROSCOPE (SEM)

In order to analyze the microstructure of the matrices and transition zones of the concretes with synthetic coarse aggregate, images were obtained using an optical microscope (Figure 12) and scanning electron microscope (SEM) (Figures 13) in samples of specimens of fractured concrete in the tensile test by diametrical compression at the age of 28 days. The preparation of the samples was carried out by fragmentation into appropriate sizes. Then, the samples were subjected to drying in an oven at a temperature of 100 °C for a period of 24 hours. Finally, the polishing was carried out on blades.

Figure 12

Image obtained by optical microscope in polarized light of the microstructure of the transition zone of the composite. A) CAGS70; B) CAGS80



Legenda: ● delimitação da zona de transição; ▲ Agregado gráúdo (fase dispersa); ● Argamassa (matriz cimentícia).

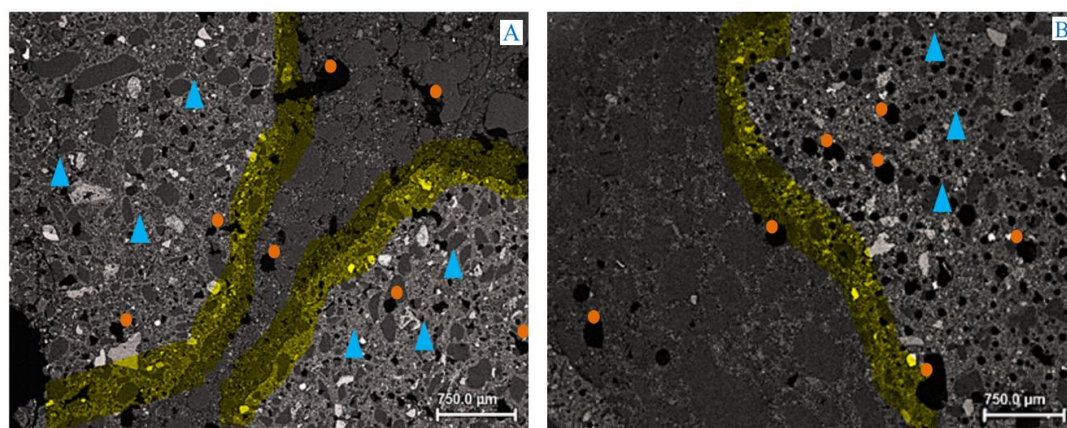
Source: Authors.

According to Isaia *et al.* (2007), the contact zone corresponds to the relationship between the grains of the coarse and small aggregates that fuse with the cement paste, surrounding and separating the aggregates. This process results in the formation of water films around the grains, generating a weaker layer at the interface. According to Neville (1997, p. 6), this transition zone has greater porosity and, consequently, less resistance.

Scanning electron microscopy (SEM) analyses were performed on the Zeiss model LS15 EVO microscope, equipped with the Lamin-Be system. The slides were metallized with a gold film to obtain backscattered electron (BSE) images.

Figure 13

Images obtained by (SEM). A) CAGS70; B) CAGS80



Legenda: ● Delimitação da zona de transição; — Fissuras; ▲ Agregado gráúdo (agregado gráúdo sintético); ● Poros no agregado gráúdo e argamassa cimentícia).

Source: Authors.

Figure 12 highlights the separation through the transition zone of the cementitious matrix of the composites with dispersed phase and the coarse aggregates. In addition, it is possible to observe the detail of the synthetic coarse aggregate in relation to the distribution of silica grains, symbolized by the white dots on the bauxite residue, represented by the entire dark area.

Scanning electron microscopy (SEM) analysis was crucial to verify the delimitation of the matrix and dispersed phases through the zones of the CAGS70 and CAGS80 composites, as well as the existing cracks and pores, as shown in Figure 13.

The occurrence of macro fractures in the cementitious matrix were not observed in the images obtained by the SEM, both in the CAGS70 and CAGS80 samples. However, the specialized literature says that for normal strength concrete, fractures tend to occur in the mortar and in the transition zone.

As observed in Figure 13, the greater amount of pores in the AGS80 was a factor that contributed significantly to the absorption of kneading water and, consequently, this factor caused an increase in the ratio of binding water.

4 CONCLUSION

The results of this research allow us to conclude that the variation in the percentage of bauxite residue in the production of synthetic coarse aggregates (AGS70 and AGS80) influenced the physical and mechanical properties of the aggregates and concretes produced by them. Both aggregates met the normative requirements of NBR 7211 (2022), presenting indices of shape less than 3 and abrasion resistance within the established limit of 50%. In addition, they did not present alkali-aggregate reaction potential.

Regarding the porosity of the aggregates, it was observed that the AGS80 presented a higher index of voids and water absorption (6.50%) compared to the AGS70 (5.24%). This behavior would normally indicate a composite that is less dense and therefore has lower mechanical performance. However, the results showed that the higher porosity of AGS80 did not significantly compromise the structural behavior of the concrete, demonstrating that other factors had a more determining influence on the strength.

Thus, it is concluded that both AGS70, with about 70 to 75% in its bauxite tailings composition, and AGS80, with about 80 to 85% in its bauxite tailings composition, are viable alternatives for the production of C30 class structural concrete, and AGS80, even more porous, demonstrated better overall mechanical performance, configuring itself as the most promising option for future commercial applications, since for its production the consumption of bauxite is higher than AGS70.

REFERENCES

- Associação Brasileira de Normas Técnicas. (2007). NBR 5739: Concreto — Ensaio de compressão de corpos de prova cilíndricos. ABNT.
- Associação Brasileira de Normas Técnicas. (2009). NBR 1900: Água para amassamento do concreto. Parte 1: Requisitos. ABNT.
- Associação Brasileira de Normas Técnicas. (2010). NBR 12142: Concreto — Determinação da resistência à tração na flexão de corpos de prova prismáticos. ABNT.
- Associação Brasileira de Normas Técnicas. (2011). NBR 7222: Concreto e argamassa — Determinação da resistência à tração por compressão diametral de corpos de prova cilíndricos. ABNT.
- Associação Brasileira de Normas Técnicas. (2015). NBR 8953: Concreto para fins estruturais — Classificação pela massa específica, por grupos de resistência e consistência. ABNT.
- Associação Brasileira de Normas Técnicas. (2018). NBR 16697: Cimento Portland — Requisitos. ABNT.
- Associação Brasileira de Normas Técnicas. (2019). NBR 8802: Concreto endurecido — Determinação da velocidade de propagação de onda ultrassônica. ABNT.
- Associação Brasileira de Normas Técnicas. (2022). NBR 7211: Agregados para concreto — Requisitos. ABNT.
- Associação Brasileira de Normas Técnicas. (2022). NBR 12655: Concreto de cimento Portland — Preparo, controle, recebimento e aceitação — Procedimento. ABNT.
- Associação Brasileira de Normas Técnicas. (2022). NBR 12655: Concreto endurecido — Determinação dos módulos de elasticidade e de deformação — Parte 1: Módulos estáticos à compressão. ABNT.
- Associação Brasileira de Normas Técnicas. (2023). NBR 6118: Projeto de estruturas de concreto. ABNT.
- Associação Brasileira de Normas Técnicas. (2025). NBR 7182: Solos — Ensaio de compactação. ABNT.
- Departamento Nacional de Estradas de Rodagem. (1997). DNER 037: Agregado graúdo para concreto de cimento: 1997-ME.
- Departamento Nacional de Infraestrutura de Transportes. (2024). DNIT 446: Agregado — Avaliação da durabilidade pelo emprego de soluções de sulfato de sódio ou magnésio — Método de ensaio: 2024-ME.
- Fernandes, R. S., et al. (2025). Use of mining waste for the production of coarse aggregate for concrete manufacturing. *IOSR Journal of Business and Management*, 27(2, Ser. 5), 9-22.
- Junior, A. J. P. C., Costa, D. C. L., & Macedo, A. N. (2022). Análise sistemática da literatura sobre o uso de lama vermelha para a produção de agregados sintéticos leve. *Revista Research, Society and Development*, 11(5).
- Mehta, P. K., & Monteiro, P. J. M. (2014). *Concreto: Microestruturas, propriedades e materiais* (2ª ed.). Nicole Pagan Hasparyk.
- Neville, A. M. (1997). *Propriedades do concreto* (S. E. Giammusso, Trad.) (2ª ed.). Pini.

- Oliveira, E., & Rossi, [Inicial do prenome, se disponível]. (2012). Concretes with red mud coarse aggregates. *Materials Research*, 15(3), 333–340.
- Rossignolo, J. A. (2009). *Concreto leve estrutural: Produção, propriedades, microestrutura e aplicações*. Pini.
- Saia, G. E., et al. (2007). *Materiais de construção civil e princípios de ciência e engenharia de materiais*. Revista IBRACON.
- Santos, D. H., Dalmeida, A. P., Figueiredo, W. B., Valente, A. L., & Souza, J. A. S. (2014). Utilização do rejeito do processo de Bayer como matéria prima na produção de agregados leves. In XX Congresso Brasileiro de Engenharia Química. Florianópolis, SC, Brasil.
- Souza, J. (2010). *Estudo e avaliação do uso de resíduos do processo Bayer como matéria prima na produção de agregados sintéticos para a construção civil* [Tese de doutorado, Universidade Federal do Pará].
- Souza, P. H. R., Arraes, L. A. X., Marques, M. S. P., & Santos, J. C. M. (2019). Utilização da lama vermelha para a produção de agregado sintético. *Revista Científica Multidisciplinar Núcleo do Conhecimento*, 6(3), 30-43.
- Weizenmann, R. N. (2017). *Estudo sobre a influência da variação da dimensão máxima característica do agregado graúdo sobre o módulo de elasticidade do concreto* [Trabalho de Conclusão de Curso, Centro Universitário UNIVATES].

HATE SPEECH AND THE LGBTQIAPN+ COMMUNITY'S FIGHT FOR THE HUMAN RIGHT TO BE

DISCURSO DE ÓDIO E A LUTA DA COMUNIDADE LGBTQIAPN+ PELO DIREITO HUMANO DE SER

EL DISCURSO DE ODIO Y LA LUCHA DE LA COMUNIDAD LGBTQIAPN+ POR EL DERECHO HUMANO A SER



<https://doi.org/10.56238/sevened2026.008-049>

Gabriela Trentin Zandoná¹

ABSTRACT

This article aims to understand the concept and extension of hate speech and analyze the impacts in the LGBTQIAPN+ community. The changes in the communications methods, especially in the digital platforms, demonstrate the necessity of a constant improvement of the law in order to protect human dignity, with the prohibitions against harmful treatments and repression of the acts that violate it. The study was conducted through bibliographical research, in a descriptive and exploratory format, in order to demonstrate that violence motivated by discrimination makes it difficult the impediment of the exercise of human rights and fundamental freedoms, that is, the human right to be. Therefore, it is imperative the imposition of free speech limits, with forbidden discourses full of oppression, hate and discrimination.

Keywords: Hate Speech. LGBTQIAPN+ Community. Human Rights. Free Speech. Impacts.

RESUMO

O artigo visa a compreender o conceito e a amplitude do discurso de ódio, bem como analisar os seus impactos na comunidade LGBTQIAPN+. As mudanças das formas de comunicação, especialmente pelos meios digitais, demonstram a necessidade de um constante aperfeiçoamento das leis para proteção da dignidade humana, com a vedação e repressão dos atos que a violam. O estudo foi realizado através de pesquisa bibliográfica, na forma descritiva e exploratória, a fim de demonstrar que a violência motivada pela discriminação dificulta o exercício dos direitos humanos e liberdades fundamentais, ou seja, o direito humano de ser. Assim, imperativa a imposição de limites ao exercício da liberdade de expressão, com a vedação de discursos eivados de opressão, ódio e discriminação.

Keywords: Discurso de Ódio. Comunidade LGBTQIAPN+. Direitos Humanos. Liberdade de Expressão. Impactos.

¹ Master's degree in Human Rights. UNIFIEO. E-mail: gabrielatrentinzandona@gmail.com
Orcid: <https://orcid.org/0000-0001-8098-8423> Lattes: <http://lattes.cnpq.br/4202377401603449>

RESUMEN

Este artículo busca comprender el concepto y el alcance del discurso de odio, así como analizar su impacto en la comunidad LGBTQIAPN+. Los cambios en las formas de comunicación, especialmente a través de los medios digitales, demuestran la necesidad de mejorar constantemente las leyes para proteger la dignidad humana, prohibiendo y reprimiendo los actos que la vulneran. El estudio se realizó mediante una investigación bibliográfica, descriptiva y exploratoria, para demostrar que la violencia motivada por la discriminación obstaculiza el ejercicio de los derechos humanos y las libertades fundamentales, es decir, el derecho a la existencia. Por lo tanto, es imperativo imponer límites al ejercicio de la libertad de expresión, prohibiendo los discursos que se impregnan de opresión, odio y discriminación.

Palabras clave: Discurso de Odio. Comunidad LGBTQIAPN+. Derechos Humanos. Libertad de Expresión. Impactos.

1 INTRODUCTION

The main focus of this study is to understand the concept of *hate speech*, distinguishing it from the regular exercise of freedom of expression, as well as to analyze its impacts on the LGBTQIAPN+ community, considering that intolerant and hateful speeches are commonly used as if they resulted from the regular exercise of freedom of expression.

The study aims to demonstrate, based on research used as a theoretical basis, that hate speech uttered against members of the LGBTQIAPN+ community generates deep damage to victims, and impacts their emotional and psychological well-being, and can even lead to suicide, as pointed out by the *Observatory of LGBTI+ Deaths and Violence in Brazil*². Although we have seen some political, legislative or legislative advances or resulting from acts of the Judiciary, the environment is still hostile and challenging for the LGBTQIAPN+ community.

The methodology used comprised a basic research, with a qualitative approach and exploratory character, based on a bibliographic review and is structured in three topics. The first aims to understand hate speech, its concept, comparing it with the regular exercise of freedom of expression.

The second topic addresses the psychological and emotional impacts of hate speech, in various categories, for LGBTQIAPN+ victims.

The last topic covers the role of jurisdictional action in the promotion and protection of the fundamental rights of the LGBTQIAPN+ community, especially in Brazil where, for a long time, the Legislative Branch remained inert.

2 UNDERSTANDING HATE SPEECH

Before addressing the impacts of hate speech on the LGBTQIAPN+ community, it is necessary to understand the conceptual issue of this speech, and its main characteristics, compared to the regular exercise of freedom of expression.

Freedom of expression is provided for in numerous international legal standards, such as the Universal Declaration of Human Rights:

Article 19. Every human being has the right to freedom of opinion and expression; This right includes the freedom to hold opinions without interference and to seek, receive and impart information and ideas by any means and regardless of frontiers³.

² ANTRA; ABGLT. *Deaths and violence against LGBTI+ in Brazil: Dossier 2023 / Acontece Arte e Política LGBTI+*. – Florianópolis, SC: Acontece, ANTRA, ABGLT, 2024.

³ UN - United Nations Organization. *UN Universal Declaration of Human Rights*.

According to the above article, we all have the right to express our own opinions and share them freely and without intervention, in any social context, such as in the exercise of freedom of religion, peaceful assembly and political activity, for example.

The authors Frederik Stjernfelt and Anne Lauritzen adduce that freedom of expression can be explained by two aspects: the *formal* and the *material*. The first of them is concerned with the existence or not of a censorship system, while the second concerns the content of statements in the public sphere, which can be treated as crimes. Such authors also claim that absolutely no country can claim to have full freedom of expression⁴.

It happens that, many times, intolerant and hateful speeches are used as if they were protected by the right to freedom of expression. Therefore, it is necessary to establish clear, fair and proportional limits to the exercise of freedom of expression, especially when the speech reproduces a structural hatred, often sporting the mask of freedom of expression, hurting, in essence, the dignity of the human person.

In Alexander Brown's conception, hate speech should not be understood only in its legal concept, extracting the conceptualization only, explicitly or implicitly, from legal norms. According to the author:

If we focus too much on a legal concept of hate speech, we risk prejudging what might be the correct answer to the problem of hate speech: for we may have defined the nature and contours of the phenomena in question precisely with the legal answers in mind. For advocates of hate speech laws, the danger is that if all you have is a hammer, everything starts to look like a nail⁵.

For the author, the legal concept of hate speech should not be separated from the ordinary concept, since, according to him, the way hate speech is defined in legal norms and doctrinal analyses is only the "tip of the iceberg" ⁶

On the other hand, Samanta Ribeiro Meyer-Pflug defines hate speech as "manifestation of ideas that incite racial, social or religious discrimination in certain groups,

⁴ STJERNFELT, Frederik; LAURITZEN, Anne Mette. *What Is Freedom of Speech?*, p. 5. Even the United States of America, which adopts a very permissive model regarding freedom of expression, admits limits to its exercise. As Flávio Martins states: "Influenced by Liberalism, which marks the history of the United States, the doctrine and jurisprudence of the United States give a very broad protection to freedom of expression, as a result of the First Amendment to the Constitution: 'Congress shall not legislate in the sense of establishing a religion, or prohibiting the free exercise of cults; or curtailing freedom of speech, or of the press' (emphasis added). A consequence of this view that largely protects freedom of expression is the adoption of the 'theory of the free market of ideas'" (*Curso de Direito Constitucional*, p. 1050). The aforementioned author, in the sequence, states that, even adopting the theory of the "free market of ideas", North American jurisprudence points out limits to the exercise of freedom of expression, such as the use of "Fighting words", the speech that produces the risk of an *Imminent Lawless Action Test*, also known as *the Brandenburg Test*, etc.

⁵ Translation by the author. BROWN, Alexander. *What is hate speech?*, p. 422-423

⁶ *Op. Cit.*, p. 424

most of the time, minorities"⁷ (emphasis added). In the same sense, Flávio Martins states that:

Hate speech is a word that has the capacity to instigate violence, hatred, or discrimination against people on the basis of race, color, ethnicity, nationality, sex, religion, or other discriminatory factor. According to Meyer-Plufg, "incitement to discrimination" is the core element to identify hate speech. In this way, *prejudiced speech should not be confused with hate speech*. The latter has an external element, which consists of *incitement to discrimination or violence*⁸.

The Inter-American Court of Human Rights, in debating the matter, pointed out:

In this regard, the Court has indicated that violence perpetrated on discriminatory grounds has the effect or purpose of preventing or nullifying the recognition, enjoyment, or exercise of human rights and fundamental freedoms of the person subject to such discrimination, regardless of whether or not that person identifies with a particular category. This violence, fueled by hate speech, can lead to hate crimes.⁹

In the same notebook¹⁰, the Court alleges that the lack of recognition of the right to gender identity, in the case of transgender people, contributes to discriminatory behavior against these minorities, deepening their vulnerability to hate speech, leading to serious human rights violations.

Another author who dealt with this subject, and wrote a book called *Hate Speech*, was Judith Butler. This author highlights, in her research, studies that fall on acts, and not just words, such as the burning of a cross in front of the house of a black family in the United States, which, according to the author, would be perfectly framed as an act of warlike speech. For Butler, when the victim is hurt by speech, he can lose control:

To be hurt by speech is to suffer a loss of context, that is, it is not knowing where one is. In fact, it is possible that the injury of an injurious act of *fata* is constituted by the unpredictable nature of this type of act and the fact that it leaves its recipient out of control. The ability to circumscribe the situation of the speech act is compromised at the moment of the insulting call.¹¹

Butler believes that some types of speech not only communicate hatred, but also injurious acts. This occurs not only in the act of language, but also in the way language acts

⁷ MEYER-PFLUG, Samantha Ribeiro. *Freedom of Speech and Hate Speech*, p. 271

⁸ *Op. Cit.*, p. 1052.

⁹HDI CUT. *Cuadernillos de Jurisprudencia de la Corte Interamericana de Derechos Humanos*, p. 19. (Translation by the Author)

¹⁰ *Op Cit.*, p. 23-24.

¹¹ BUTLER, Judith. *Hate Speech*. São Paulo: Editora Unesp Digital, 2021. Pg. 13.

on the victim. For the author, "hate speech not only communicates an offensive idea or set of ideas, but also puts into action the very message it communicates." ¹²

According to Schafer and others, hate speech tries to stigmatize and mark the victim, either to keep the situation as it is or to change it, always segregating. This type of discourse uses well-articulated language, creating and sustaining forms of oppression, falling especially on those who do not fit into certain models, such as male, European, Christian, heterosexual, among others¹³.

The author Paulo Roberto Iotti Vecchiatti, on this subject, stated that:

The constitution requires the criminalization of racism, domestic violence, for what? To protect racial minority groups and women. So, understanding that the Constitution requires the criminalization of homotransphobia, it does so to protect the LGBTI population in their fundamental rights. As far as I know, freedom, in its liberal sense, since the Declaration of the Rights of Man and of the Citizen, after the French Revolution, allows you to do whatever you want, comma, as long as you do not harm third parties. So, hate speech, offenses and discrimination against third parties, [because] they harm [these] third parties, are not within the scope of protection of the right to freedom or freedom of expression. The Supreme Court of the United States is the only one that says otherwise. This Supreme Court, the Inter-American Court of Human Rights, the European Court, all repudiate hate speech and that is what they want to criminalize¹⁴.

After experiencing the dangers of hate speech in Nazi Germany, several international treaties banned *hate speech*, despite the fact that freedom of expression is also valued: Universal Declaration of Human Rights (art. 19), Covenant on Civil and Political Rights (art. 19), European Convention on Human Rights (art. 10), Inter-American Convention on Human Rights (art. 13), etc. For example, the Pact of San José, Costa Rica, allows legal restrictions on speech that promotes "incitement to discrimination, hostility, crime or violence".

The recently approved Convention against Racism, Racial Discrimination and Related Forms of Intolerance" brings more objective parameters for the determination of "hate speech", which was previously only conceptualized by doctrine and jurisprudence. The aforementioned international document presents a series of informing elements that indicate the construction of a normative concept of hate speech based on manifestations of discrimination, as well as incitement to hatred. Therefore, from the point of view of the construction of a normative concept, in accordance with the concepts and criteria contained

¹² Op. Cit. Pg.112.

¹³ SCHÄFER, Gilberto et al. Hate speech. From conceptual approach to parliamentary discourse. Journal of Legislative Information, Brasília, v. 52, n. 207, 2015. Pg.147.

¹⁴ VECCHIATTI, Paulo Roberto Iotti. *The Federal Supreme Court, Homotransphobia and its Recognition as a Crime of Racism*, p. 59.

in the international norm itself, it can be said that hate speech consists of the manifestation of intolerant, prejudiced and discriminatory ideas against vulnerable individuals or groups, with the intention of offending their dignity and incite hatred on the basis of the following criteria: age, sex, sexual orientation, gender identity and expression, language, religion, cultural identity, political or other opinion, social origin, socioeconomic position, educational level, status of migrant, refugee, repatriate, stateless or internally displaced person, disability, genetic characteristic, physical or mental health status, including infectious disease and disabling mental condition, or any other condition.

In this way, hate speech is an internal limit (or immanent limit) of the right to free expression of thought. This means that the fundamental right does not protect any and all speech, since the law has a limited factual assumption. Thus, for obvious reasons, hate speech is not covered by constitutional protection.

3 IMPACTS OF HATE SPEECH ON LGBTQIAPN+ VICTIMS

Undoubtedly, hate speech has significant impacts on the lives of its victims, on their emotional and psychological state, generating profound consequences and depriving their human and fundamental right to simply be.

Before addressing the psychological and emotional impacts suffered by victims of hate speech, it is important to analyze some of the categories of hate speech against the LGBTQIAPN+ population. The authors Marcos Paulo da Silva and Lucas Souza da Silva¹⁵, through pro-analysis of empirical data, even if related to cybernetic means, arrived at the following categories:

The first of these is *victimization*. The authors cite, for example, that in this category, in any discussion about the criminalization of LGBTphobia, oppressors use arguments that all people suffer violence on a daily basis in Brazil.

Second, *pathologization*, whether behavioral or biological. Referring to homosexuality or any other sexual orientation as a disease violates a wide range of international and national norms. In Brazil, for example, the Federal Council of Psychology stopped treating sexual orientation as a disease in 1985.

And third, *the repulsion for the existence or repudiation of the attitudes of* LGBTQIAPN+ people, which, according to the aforementioned authors, cover most

¹⁵ SILVA, Marcos Paulo da; SILVA, Lucas Souza da. *Dissemination of hate speech in news comments: an analysis based on news about the LGBT universe in Mato Grosso do Sul cybermedia on Facebook*. Intercom: Revista Brasileira de Ciências da Comunicação, [S.L.], v. 44, n. 2, p. 137-155, ago. 2021. FapUNIFESP (SciELO). <http://dx.doi.org/10.1590/1809-5844202127>.

homophobic comments. The authors argue that, if in the other categories, the oppressors use different factors for devaluation, in this one, they use only pure hatred¹⁶.

Another categorization would be the *discrediting of journalistic information*, as it is a minority group. In addition to these, the authors also cite the *injury or offense to human dignity* in which manifestations of hatred are not only established against the ways and behaviors of the LGBTQIAPN+ community, but in the face of people, being an attack on their identity and integrity, in addition to the imposition of morality and personal religiosity, a biologizing approach, appeal to the supposed behavioral and thought influence of children and adolescents, an opinion mediated by citation of authority¹⁷.

According to Kees *et al*, there are more impacts on direct victims of hate crimes than on those crimes that are not motivated by hate or prejudice¹⁸. Joanna Jamel, says that the trans population is the one that suffers the most from hate crimes, with trans women being the most affected¹⁹.

In a study carried out in Portugal by the *Portuguese Association for Victim Support (APAV)*,²⁰ it was highlighted that hate crime can destabilize the victim's identity development. This same study points to the incidence of serious consequences for the victims, including psychiatric disorders, such as depression, anxiety disorders, post-traumatic stress disorder²¹.

According to APAV, as hate crimes are directed at the victim's identity characteristics, the psychological impact is different from other crimes, in the following sense: even if the victims manage to move on with their lives, they usually report fear from the incident. Out of protective instinct, they end up thinking about making changes in their lives (workplace, study, city); they suffer because crime is due to their identity characteristics, affecting the level of perception of themselves and the community in which they are inserted, immensely shaking their perception of security²².

Another important piece of data was released by the *Observatory of LGBTI+ Deaths and Violence in Brazil* in the 2023 dossier, which identified structural LGBTIphobia in the country:

¹⁶ *Op. Cit.* 145-146.

¹⁷ *Op. Cit.*, p. 146-150.

¹⁸ KEES, Stephan Jakob, IGANSKI, Paul, KUSCHE, Robert, SWIDER, Magdalena, CHAHAL, Kushminder. *Hate crime victim support in Europe: a practical guide*.

¹⁹ JAMEL, Joanna, *Transphobic Hate Crime*, Palgrave Hate Studies. 2018

²⁰ PORTUGUESE ASSOCIATION FOR VICTIM SUPPORT. *Manual Hate Never Again: Support for Victims of Hate Crimes*. - Lisbon: Portuguese Association for Victim Support, p. 165.

²¹ *Op. Cit.*, p. 118.

²² *Op. Cit.*, p. 119.

This directly affects the reception of LGBTQIA+ people in different environments, increasing the risks of human rights violations and violence against their bodily lives, gender identities and expressions, and sexual orientations. Although the political context has changed in the sense that we are under a government attentive to the claims that have been made by the LGBTQIA+ population, a troubled and hostile environment persists in relation to LGBTQIA+ people²³.

The same observatory pointed out high suicide rates among the LGBTI+ population, praising that "LGBTIphobia operates as a social risk factor for mental health for LGBTI+ people, given the degree and recurrence of serious, even lethal, violations against this community" ²⁴

Therefore, even with some political advances or the Judiciary itself, the environment is still hostile for the LGBTQIAPN+ community. As we exposed above, hate speech towards the LGBTQIAPN+ community generates profound harm to victims, severely impacting their emotional and psychological well-being.

4 THE ROLE OF THE JUDICIARY IN PROMOTING AND PROTECTING THE FUNDAMENTAL RIGHTS OF THE LGBTQIAPN+ COMMUNITY

Flávia Piovesan, in her book *Themes of Human Rights*, argues that throughout history, very serious violations of human rights have occurred on the basis of "me versus the other", when diversity was used as a way to extinguish rights, that is, it was as if difference defined the other as a person with fewer rights and dignity. ²⁵

The author also states that the history of combating discrimination related to sexual orientation is very recent, starting in the 90s, which is why it is verified that the greatest advances occurred through the jurisprudence of the global and regional systems²⁶.

There are many constitutional principles that protect, in Brazil, the identity of LGBTQIAPN+ people. André de Carvalho Ramos, for example, cites the *right to happiness (or the right to the pursuit of happiness)*, which is implicit in the principle of human dignity²⁷. Other principles can be mentioned, such as the right to privacy, the right to family, self-identity, the right not to be subjected to inhuman or degrading treatment, the right to intimacy and privacy, etc.

²³ ANTRA; ABGLT. *Deaths and violence against LGBTI+ in Brazil: Dossier 2023 / Acontece Arte e Política LGBTI+*. – Florianópolis, SC: Acontece, ANTRA, ABGLT, 2024. p. 4.

²⁴ *Op. Cit.*, p. 47.

²⁵ PIOVESAN, Flávia. *Human Rights Issues*, p. 441.

²⁶ *Op. Cit.*, p. 457.

²⁷ RAMOS, André de Carvalho. *Human Rights Course*, p. 1143.

In this regard, Advisory Opinion 24 of the IACHR²⁸, which deals with the recognition of the right to gender identity and, in particular, on the procedures for processing requests for name changes on the basis of gender identity, in the part of the Glossary, states that LGBTQIAPN+ persons suffer numerous discriminations, presenting the UN's concern on the subject, adducing that there is official discrimination, which occurs through state laws and policies that criminally typify homosexuality.

The Court also recognized that LGBTQIAPN+ people have historically suffered discrimination, stigmatization and countless other forms of violence, linked to hate speech, and even police abuse. In prisons, violence can include harassment, exploitation and sexual assault, even more so in the case of trans women, which leads to segregation and isolation as a protective measure, but which ends up depriving these people of opportunities and the use of essential services.

The Court also pointed out that discrimination is highly harmful to the right to mental integrity, and that it harms "not only individual health, but public health". Based on its own jurisprudence, the Court recognized the right to equality and non-discrimination of LGBTQIAPN+ people, the right to gender identity and name change procedures, as well as the international protection of the bonds of same-sex couples.

Roger Raupp Rios, conceptualizes *discrimination*, based on *the International Convention on the Elimination of All Forms of Racial Discrimination*, *the Convention on the Elimination of All Forms of Discrimination Against Women*, and *the Convention on the Rights of Persons with Disabilities*, as follows:

[...] Discrimination is defined as "any distinction, exclusion, restriction or preference that has the purpose or effect of nullifying or impairing the recognition, enjoyment or exercise on a gender equality footing"²⁹

Regarding the judgment of the Direct Action of Unconstitutionality by Omission (ADO) 26, and the Writ of Injunction (MI) 4733³⁰, it is important to make the following considerations:

The first consideration concerns the performance of the Federal Supreme Court (STF) in social and political issues. Both Direct Action of Unconstitutionality (ADO) 26 and Writ of Injunction 4733 had the scope of demonstrating the long delay of the National Congress in enacting a law that criminalized acts of discrimination/violence against LGBT people, curbing homophobia and transphobia in Brazil.

²⁸ INTER-AMERICAN COURT OF HUMAN RIGHTS. Advisory Opinion No. 24/17 (OC No. 24/17). 24 Nov. 2017.

²⁹ RIOS, Roger Raupp. *Homosexuality in Law*, p. 20.

³⁰ BRAZIL. Federal Supreme Court. ADO 26 and MI 7433.

The second consideration concerns the result of these actions: they recognized the omission of the Legislative Branch on the subject, and began to consider homophobia and transphobia as crimes of racism, by majority vote. It should be noted that the thesis presented by the rapporteur of ADO 26 can be divided into the following points:

- a) establishes that, until the National Congress creates a specific law, homophobic and transphobic acts, real or alleged, are framed in the crimes of Law 7,716/2018 and, in the case of intentional homicide, constitute a qualifying circumstance because they are considered vile motives.
- b) Criminal repression against homotransphobia does not interfere with religious freedom, as long as these manifestations do not turn into hate speech.
- c) The concept of racism is broadened, encompassing not only biological or phenotypic aspects, but also the denial of the dignity and humanity of vulnerable groups.

In this context, it is clear that, in Brazil, the performance of the Judiciary was essential to ensure the implementation and enforcement of the fundamental human rights of LGBTQIAPN+ people. Historic advances for the LGBTQIAPN+ community are occurring, albeit gradually, precisely because victims are seeking the intervention of the Judiciary. The National Congress has also been silent in the elaboration/edition of effective laws to protect this community.

Regarding the performance of the Brazilian Judiciary, Clarissa Tassinari clarifies:

Despite all this, one cannot disagree with the reading of the phenomenon of the judicialization of politics as a product of the transformations that occurred in Law with the advent of a new constitutional text. In other words, it is known that one of the marks of the transition from the conception of the Social State to that of the Democratic State of Law is precisely characterized by the displacement of the pole of tension from the Executive to the Judiciary³¹.

Therefore, the performance of the Judiciary, guided by constitutional principles, as well as the constitutional duty to criminalize acts that violate dignity has been paramount for the protection of the fundamental human rights of the LGBTQIAPN+ community, since in Brazil and in so many other places in the world, the Legislative Branch remains inert and silent in the protection of minorities. For this reason, issues of discrimination and violence against LGBTQIAPN+ people in Brazil are being taken to the Judiciary, ensuring, at a slow pace,

³¹ TASSINARI, Clarissa. *Judicial activism: an analysis of the performance of the Judiciary in the Brazilian and North American experiences*. 2012. Pg. 22.

advances in ensuring the application and preservation of the rights and dignity of the LGBTQIAPN+ community.

Nevertheless, the necessary change is not only up to the Judiciary or the Legislature, but to any and all interpreters of the Constitution and legal norms. It is urgent and necessary, as Isaac Porto states, a more amplified analysis of the discriminatory process, analyzing together the issues of racism and LGBTphobia:

discussions about racism and black people cannot be seen as an exclusive problem of the black movement, just as discussions about sexual orientation and gender identity cannot be attributed to an agenda exclusive to the LGBTI movement. Adopting these positions makes the black LGBTI population invisible and perpetuates a network of privileges for some and disadvantages for others.³²

5 CONCLUSION

Based on this study, it was possible to understand the clear distinction between *hate speech* and the regular exercise of freedom of expression, the first being, as Samanta Ribeiro Meyer-Pflug adduces, a kind of "manifestation of ideas that incite racial, social or religious discrimination in certain groups, most of the time, minorities"³³. The regular exercise of freedom of expression, on the other hand, consists of the right to express our own opinions and share them freely and without intervention.

It is important to emphasize that freedom of expression, enshrined in the Universal Declaration of Human Rights, is a fundamental right that allows the expression of opinions and ideas without interference. However, this right is not absolute, having express or implicit (or immanent) limits, as is the case with hate speech.

Hate speech, as aligned in the topics above, crosses all limits of freedom of expression, when it attacks and dehumanizes individuals or groups based on their identity characteristics, as in the case of sexual orientation and gender identity. This type of speech, which is far from being a simple expression of opinion, serves as a means of oppression, which can lead to serious psychological, emotional and even fatal consequences for the victims.

Hate speech is clearly one of the limits of the right to freedom of expression, being, in the opinion of Flávio Martins, an implicit limit of that right: "hate speech is an internal limit (or immanent limits) of the right to free expression of thought. This means that the fundamental right does not protect any and all speech, since the law has a limited factual assumption.

³² PORTO, Isaac. *What color is the invisible? The human rights situation of the black LGBTI population in Brazil*, p. 12.

³³ MEYER-PFLUG, Samantha Ribeiro. *Freedom of Speech and Hate Speech*, p. 271

Thus, hate speech is not covered by constitutional protection."³⁴

Despite some advances, the LGBTQIAPN+ community still suffers from oppressive discourses and hostile environments, which leads to the need to improve laws and greater state surveillance, with the necessary institution of effective public policies. In this sense, the performance of the Brazilian Judiciary is playing a fundamental role, since it has been making up for the repeated and continuous legislative omission.

Whenever we deal with issues related to the dignity of the human person, we must keep in mind that the achievements that are made through protection rules and regulations are improved as new demands arise, new voices are heard, new claims are presented and new human rights are recognized, depending on the reality in which we live. This process demands the intervention and mediation of the State and the active participation of all the protagonists of constitutional interpretation, in an "open society of interpreters of the Constitution".

REFERENCES

- Associação Portuguesa de Apoio à Vítima. (2018). Manual ódio nunca mais: Apoio a vítimas de crimes de ódio. Associação Portuguesa de Apoio à Vítima.
- Brasil. (1989). Lei nº 7.716, de 5 de janeiro de 1989. Define os crimes resultantes de preconceito de raça ou de cor. Diário Oficial da União.
- Brasil. Supremo Tribunal Federal. (2019). Ação direta de inconstitucionalidade por omissão nº 26 (Rel. Min. Celso de Mello, Tribunal Pleno, DJ 01/07/2019). <https://portal.stf.jus.br/processos/detalhe.asp?incidente=4515053> (Acesso em: 01 ago. 2024)
- Brasil. Supremo Tribunal Federal. (2019). Mandado de injunção nº 4733 (Rel. Min. Edson Fachin, DJ 01/07/2019). <https://portal.stf.jus.br/processos/detalhe.asp?incidente=4239576> (Acesso em: 01 ago. 2024)
- Brown, A. (2017). What is hate speech? Part 1: The myth of hate. *Law and Philosophy*, 36(4), 419-468. <https://doi.org/10.1007/s10982-017-9297-1>
- Butler, J. (2021). Discurso de ódio. Editora Unesp Digital.
- Corte Interamericana de Derechos Humanos. (2017). Opinión consultiva nº 24/17 de 24 de noviembre de 2017. https://www.corteidh.or.cr/docs/opiniones/seriea_24_esp.pdf (Acesso em: 01 ago. 2024)
- Corte Interamericana de Derechos Humanos. (2021). Cuadernillos de jurisprudencia de la Corte Interamericana de Derechos Humanos: 19. Derechos humanos de las personas LGBTI. https://www.corteidh.or.cr/sitios/libros/todos/docs/cuadernillo19_2021.pdf (Acesso em: 01 ago. 2024)

³⁴ *Op. Cit.*, p. 1053.

- Kees, S. J., Iganski, P., Kusche, R., Swider, M., & Chahal, K. (2016). Hate crime victim support in Europe: A practical guide (1ª ed.). RAA Sachsen.
- Martins, F. (2025). Curso de direito constitucional (8ª ed.). Saraiva.
- Meyer-Pflug, S. R. (2009). Liberdade de expressão e discurso do ódio. Editora Revista dos Tribunais.
- Organização das Nações Unidas. (1948). Declaração universal dos direitos humanos. <https://encr.pw/ZuHck> (Acesso em: 31 jul. 2024)
- Piovesan, F. (2015). Temas de direitos humanos (8ª ed.). Saraiva.
- Porto, I. (2020). Qual é a cor do invisível? A situação de direitos humanos da população LGBTI negra no Brasil. Instituto Internacional sobre Raça, Igualdade e Direitos Humanos.
- Ramos, A. de C. (2022). Curso de direitos humanos (9ª ed.). SaraivaJur.
- Schäfer, G., et al. (2015). Discurso de ódio. Da abordagem conceitual ao discurso parlamentar. Revista de Informação Legislativa, 52(207), 143-158.
- Silva, M. P. da, & Silva, L. S. da. (2021). Disseminação de discursos de ódio em comentários de notícias: Uma análise a partir de notícias sobre o universo LGBT em cibermeios sul-mato-grossenses no Facebook. Intercom: Revista Brasileira de Ciências da Comunicação, 44(2), 137-155. <https://doi.org/10.1590/1809-5844202127>
- Stjernfelt, F., & Lauritzen, A. M. (2019). What is freedom of speech? In What is freedom of speech? (pp. 1-8). Springer International Publishing. https://doi.org/10.1007/978-3-030-25968-6_1
- Supremo Tribunal Federal. (2019). ADO 26. Íntegra da tese. <https://portal.stf.jus.br/processos/detalhe.asp?incidente=4515053> (Acesso em: 31 jul. 2024)
- Supremo Tribunal Federal. (2019). Mandado de injunção 4733. Íntegra da tese. <https://portal.stf.jus.br/processos/detalhe.asp?incidente=4239576> (Acesso em: 31 jul. 2024)
- Tassinari, C. (2012). Ativismo judicial: Uma análise da atuação do Judiciário nas experiências brasileira e norte-americana. <https://acesse.dev/NVJHn> (Acesso em: 28 jul. 2024)
- Vecchiatti, P. R. I. (2020). O Supremo Tribunal Federal, a homotransfobia e seu reconhecimento como crime de racismo. Spessotto.
- Acontece Arte e Política LGBTI+; Associação Nacional de Travestis e Transexuais; Associação Brasileira de Lésbicas, Gays, Bissexuais, Travestis, Transexuais e Intersexos. (2024). Mortes e violências contra LGBTI+ no Brasil: Dossiê 2023. Acontece; ANTRA; ABGLT. <https://observatoriomorteseviolenciaslgbtibrasil.org/wp-content/uploads/2024/05/Dossie-de-Mortes-e-Violencias-Contra-LGBTI-no-Brasil-2023-ACONTECE-ANTRA-ABGLT.pdf>

THE ROLE OF GOVERNMENT PROCUREMENT IN DEVELOPING A SUSTAINABILITY CULTURE WITHIN THE FURNITURE INDUSTRY

O PAPEL DAS COMPRAS GOVERNAMENTAIS NO DESENVOLVIMENTO DE UMA CULTURA DE SUSTENTABILIDADE NA INDÚSTRIA MOVELEIRA

EL PAPEL DE LAS COMPRAS GUBERNAMENTALES EN EL DESARROLLO DE UNA CULTURA DE SOSTENIBILIDAD EN LA INDUSTRIA DEL MUEBLE



<https://doi.org/10.56238/sevened2026.008-050>

Clarissa Melo Lima¹, Tito Ricardo Vaz da Costa², João Batista Melo Lima³, Machidovel Trigueiro Filho⁴, Luiz Honorato da Silva Junior⁵, Cecília Leite Oliveira⁶, Rafael Gonçalves Campolino⁷, Joaquim Carlos González⁸

ABSTRACT

This paper presents an overview of the furniture industry and the opportunities within the scope of sustainable government procurement. The objective of the study was to evaluate opportunities, threats, weaknesses, and strengths so that industries in this segment can engage responsibly in sustainable development. The research was conducted in the Federal District with furniture industries from the main Administrative Regions (AR). The techniques used included the application of questionnaires and the SWOT methodology. The study demonstrated that public procurement plays an important role in supporting micro and small enterprises so they can comply with environmental sustainability requirements.

Keywords: Furniture Industry. Sustainability. Environmental Management.

RESUMO

O presente trabalho apresenta um panorama da indústria moveleira e as oportunidades no âmbito das compras governamentais sustentáveis. O objetivo do trabalho foi avaliar

¹ Dr. in Forest Sciences. Universidade Estadual de Goiás (UEG). E-mail: clarissa.lima@ueg.br
Orcid: <https://orcid.org/0000-0001-9940-8863> Lattes: <http://lattes.cnpq.br/6917886925634086>

² Dr. in Forest Sciences. Universidade Estadual de Goiás (UEG). E-mail: titoricardo@ueg.br
Orcid: <https://orcid.org/0000-0001-5827-7975> Lattes: <http://lattes.cnpq.br/1068744176859901>

³ Master's degree of Science in Civil Engineering. Universidade Federal de Campina Grande (UFCG).
E-mail: jbmlima@yahoo.com.br

⁴ Dr. of Laws. Universidade Federal do Ceará (UFC). E-mail: macespanha@yahoo.com.br
Lattes: <http://lattes.cnpq.br/6592027781913808>

⁵ Dr. in Economics. Universidade de Brasília (UnB). E-mail: luizhonorato@unb.br
Orcid: <https://orcid.org/0000-0002-2840-3579> Lattes: <http://lattes.cnpq.br/1741285388725128>

⁶ Dr. in Information Science. Instituto Brasileiro de Informação em Ciência e Tecnologia (IBICT).
E-mail: cecilia@ibict.br Lattes: <http://lattes.cnpq.br/6009820959598594>

⁷ Master's degree of Education. Universidade Estadual de Goiás (UEG). E-mail: rafael.campolino@ueg.br
Lattes: <http://lattes.cnpq.br/4262279168427622>

⁸ Dr. in Forest Sciences. Universidade de Brasília (UnB). E-mail: goncalez@unb.br
Orcid: <https://orcid.org/0000-0003-1627-0833> Lattes: <http://lattes.cnpq.br/0220830488629637>

oportunidades, ameaças, fraquezas e virtudes, para que as indústrias deste segmento se engajem com responsabilidade no desenvolvimento sustentável. A pesquisa foi desenvolvida no Distrito Federal junto às indústrias moveleiras das principais Regiões Administrativas (RA). Utilizou-se a técnica de aplicação de questionários e aplicação da metodologia SWOT. O trabalho mostrou que as compras públicas têm importante papel no apoio para que micros e pequenas possam observar as exigências de sustentabilidades ambientais.

Palavras-chave: Indústria de Móveis. Sustentabilidade. Gestão Ambiental.

RESUMEN

El presente trabajo presenta un panorama de la industria del mueble y las oportunidades en el ámbito de las compras gubernamentales sostenibles. El objetivo del trabajo fue evaluar oportunidades, amenazas, debilidades y fortalezas, para que las industrias de este segmento se involucren con responsabilidad en el desarrollo sostenible. La investigación se llevó a cabo en el Distrito Federal con industrias de muebles de las principales Regiones Administrativas (RA). Se utilizó la técnica de aplicación de cuestionarios y la metodología DAFO (SWOT). El trabajo mostró que las compras públicas tienen un papel importante en el apoyo para que las micro y pequeñas empresas puedan cumplir con las exigencias de sostenibilidad ambiental.

Palabras clave: Industria del Mueble. Sostenibilidad. Gestión Ambiental.

1 INTRODUCTION

In the furniture sector, the concept of sustainable development has an additional weight. This industry, at a global level, was one of the most demanded in terms of environmental responsibility. During the 1990s there were boycotts by developed countries of tropical timbers. Later, this strategy evolved into the requirement of certification of responsible forest management. This certification, although not a legal obligation, has become a market requirement, leading several companies to seek action in a more environmentally responsible way voluntarily. (Coutinho & Macedo-Soares, 2002) (Nardelli, 2001)

One of the ways to verify the sustainability of an industry is to analyze its production processes. This analysis may involve aspects related to existing physical and chemical risks.

However, sustainability is not limited to pollution. There are also aspects related to socioeconomic development. The quality of the work environment is a factor that directly affects the well-being of the worker and, consequently, his social development. From this perspective, the evaluation of thermal comfort and the quality of lighting in this environment are relevant factors.

The perception of workers and entrepreneurs regarding the importance of sustainable development can also be measured. One of the ways to do this is to use the SWOT matrix. Through this mechanism, it is possible to identify internal potentials synergistic with a favorable external environment, in order to maximize the virtues of a company. Likewise, by mapping weaknesses and threats, unfavorable situations for the industry are avoided.

The SWOT tool used in the sustainable development approach allows the evaluation of opportunities, threats, weaknesses and virtues, so that a company or even a business segment, as is the case of the furniture segment in the Federal District, achieves its economic objectives with environmental responsibility.

It is important to mention the concern of the furniture industries, particularly those in the Federal District, because they are in the country's capital and have the government as one of their main customers, in adapting to meet the program that the Federal Government called "sustainable esplanade". Although this program is still in the design phase, some government purchases have already required sustainability parameters in the acquisition of products, such as furniture and partitions.

Thus, the objective of this work is to evaluate opportunities, threats, weaknesses and virtues, so that the industries in this segment engage responsibly in sustainable development.

2 THEORETICAL FRAMEWORK

The furniture sector is characterized by the diversity of production, raw materials and finished final products. With regard to raw materials, wood and metals stand out, with wood being the main source, with about 72% of share. (Rosa et al., 2007)

Wooden furniture is segmented into two groups: rectilinear and turned. Rectilinear wooden furniture is smooth, with simple designs with straight lines and whose main raw material consists of particleboards and plywood panels. Turned wooden furniture has more sophisticated details, mixing curved and straight lines and whose main raw material is solid wood. (Leão & Manfredi, 1998)

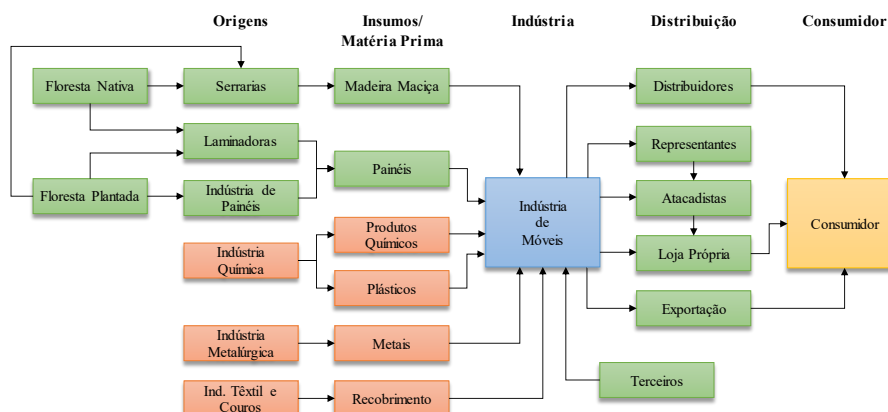
The furniture sector is characterized by the predominance of small and medium-sized companies in a very segmented market. It is a labor-intensive industry and has low added value compared to other sectors. (Gorini, 1998)

The production chain of the furniture industry can be summarized through the flowchart of the

Figure 1.

Figure 1

Flowchart of the Production Chain of the Furniture Industry



Source: Ferreira et al. (2008)

According to , the Brazilian furniture industry is made up of almost 10 thousand micro, small and medium-sized companies, which generate around 265 thousand jobs, the vast majority of which are national capital. (Brazilian Institute of Geography and Statistics - IBGE, 2014)

The demand for furniture varies according to the income level of the population and the behavior of other sectors of the economy, in particular civil construction. Spending on furniture is in the range of 1% to 2% of family income, and may also vary according to the population's lifestyle, cultural aspects, replacement cycle and investment in marketing.

(Gorini, 1998)

Technological upgrading in the furniture industry is widespread and affordable. However, as the production process is not continuous, modernization can often occur only in production stages. The quality of the final product is perceived mainly according to the variables: material, design and durability. (Ferreira et al., 2008)

The three variables associated with product quality are intrinsically related to the concept of sustainability. The concern with material goes from the origin to the arrival at the consumer. The design relates to the reduction of the use of raw materials and simplicity of production. Durability is associated with a decrease in the frequency of product replacement, which results in decoupling consumption from development and reducing environmental burdens. (Alves et al., 2009) (Devides, 2006) (John et al., 2001)

As more technologies that are recognized as meaning greater environmental, social, and economic sustainability are adopted, the closer the country gets to achieving sustainability. A technology that is environmentally sustainable should consider the ecological processes of the ecosystem and its maintenance, that is, the effects resulting from use should not make the ecosystem's resilience capacity in response to interventions unfeasible.

2.1 THE FURNITURE INDUSTRY OF THE FEDERAL DISTRICT

The timber-furniture industry in the Federal District developed more sharply in the 1980s and 1990s and totals about 200 legally constituted companies. The segment accounts for 0.5% of the national production and occupies the 3rd position in the Central-West region. It is estimated that the sector directly employs more than 3.5 thousand workers, being one of the segments that employs the most in the Federal District. (SEBRAE, 2007)

Despite the high number of jobs generated, the lack of a clear policy for the furniture sector relegates the industries of the Federal District to a level of little relevance at the regional and national levels. This lack of incentive contributes negatively to the improvement of the production chain. (Sablowski et al., 2007)

The industry is characterized by a preponderance of small companies, with investment decisions made locally. In addition, all the capacity for technological innovation is located within the territory, with heterogeneous diffusion. The source of raw materials is external and sales are destined for both the domestic and foreign markets. (SEBRAE, 2007)

2.2 THE SWOT ANALYSIS

SWOT analysis is a methodology created by Harvard Business School Professors Kenneth Andrews and Roland Christensen, with the aim of performing analysis of strengths,

weaknesses, opportunities, and threats for decision making. (Buchanan & O'Connell, 2006)

The acronym SWOT stands for the initials of the English words Strengths, Weaknesses, Opportunities and Threats. (Souza & Yonemoto, 2010)

This methodology considers the design of a business plan that allows for the improvement of the relationship between internal capabilities and external possibilities. (Mintzberg et al., 2010)

The method consists of critiquing the internal capabilities of a process or organization by identifying strengths and weaknesses. The external environment is evaluated from the perspective of opportunities and threats. The quadrants of strengths and deficiencies are determined by internal factors. Threats and opportunities are anticipations of what may happen and are related to external factors. (D'Ambros, 2011)

The SWOT matrix (or SWOT matrix) is considered a simple and effective tool, whose primary function is to enable the choice of an appropriate strategy, based on a critical evaluation of the company's internal and external environments. (Serra et al., 2003)

In the context of Sustainable Development, SWOT analysis has different application cases. applied SWOT analysis to achieve the definition of an integrated strategy for the sustainable development of a region's tourism potential. (Beni, 2006)

(Ávila & Wilke, 2008) used SWOT analysis to highlight the limiting factors to the tourist development of the city of Paranaguá, a coastal city in the state of Paraná.

(Da Silva et al., 2014) used SWOT analysis to determine the strengths and weaknesses and opportunities and threats of forest management in the Amazon. The work identified that the main strength was related to management, serving as a way of maintaining forest cover. The main weakness is related to the weak supervision of illegal logging. The main opportunity identified was the large amount of areas available for forest management. Finally, the main perceived threat was unfair competition with timber of legal origin.

3 METHODOLOGY

This research was developed with the furniture industries of the Federal District. To achieve the proposed objective, a questionnaire was applied to the furniture industries of the main Administrative Regions (AR) of the Federal District, to evaluate the profile of the industries in the segment from the point of view of sustainability. The technique of applying questionnaires and applying the SWOT methodology were used.

At Figure 2, the location of the two industries involved in the research is found, as well as the administrative regions of the Federal District where the questionnaires were applied.

The assertions were evaluated by means of the arithmetic sum of the scores assigned by the experts. The assertions with the highest scores indicate the strengths, weaknesses, threats, and opportunities identified by the experts.

3.2.1 Data collection through questionnaire

Data for the SWOT analysis were collected through individual structured interviews with the aid of a standardized questionnaire. The questions were asked identically to all actors.

The interviews were conducted by a single person from July to September 2017. The questions were carried out in the interviewees' workplaces, where it was possible to get to know the activities carried out up close and experience the environmental conditions to which they are subjected.

3.3 STATISTICAL DESIGN

29 questionnaires were filled out over the course of four months of research. Considering the estimated existence of 200 legally established furniture companies in the Federal District, this sample provides a sampling error of 18%, considering a normal distribution, a confidence level of 95% and $p=q=0.5$. (SEBRAE, 2003)

The data were statistically analyzed using the IBM SPSS® software and also processed using the MS Excel® software, where the descriptive statistics were determined: means, standard deviation and coefficient of variation. (Mendenhall & Sincich, 2006)

In the case of the SWOT Matrix, the data analyzed came from the scores assigned by the interviewees, corresponding to the 28 variables included in the survey. A simple frequency analysis was performed, highlighting the items with the highest score in relation to the total score. (D'Ambros, 2011)

4 RESULTS AND DISCUSSIONS

A questionnaire was applied to the furniture industries of the main Administrative Regions (AR) of the Federal District to assess the profile of the industries in the segment, especially from the point of view of sustainability. To achieve this objective, the technique of applying questionnaires and applying the SWOT methodology was used

The analysis of the results of the questionnaires was done in four parts, following the structure: Identification of the companies surveyed; Characterization of production; Environmental posture; and Identification of strengths, weaknesses, opportunities and threats. The detailed results of this analysis can be found at . (Lima, 2017)

4.1 ANALYSIS REGARDING THE IDENTIFICATION OF THE COMPANIES SURVEYED

The identification of the companies surveyed aimed to draw a profile of the sample analyzed. Not all interviewees were able to answer the questionnaire completely, which is why there are variables with less than 29 answers.

Based on the information collected, it is possible to estimate a profile of the industries surveyed. These are companies with less than fifteen employees, considered micro-enterprises according to the IBGE criterion. This result validates what was observed by , who stated that the Brazilian furniture industry is characterized by its small size, corresponding to 88% of the establishments, similar to what is found in other countries. The median revenue found was R\$ 619.2 thousand. Most of the companies have more than 19 years of existence, operating on land of less than 2 thousand square meters and with less than 900 square meters of built area. (SEBRAE, 2016) (Gorini, 1998)

4.2 ANALYSIS REGARDING THE CHARACTERIZATION OF THE PRODUCTION OF THE COMPANIES SURVEYED

The characterization of the production of the companies aimed to know what the companies researched produce.

In this part of the questionnaire, the interviewees were allowed to mark more than one response item, which is why there are variables with more than 29 responses. The variables studied in this part of the questionnaire have a nominal scale and their attributes represent names.

Based on the data collected, it was possible to establish a profile regarding the production characteristics of the companies analyzed.

Most of them are micro and small companies that produce furniture for offices and homes to order. The focus of the companies is the local market, although there is a significant portion of sales to other units of the federation, especially to the state of Goiás. There is practically no export of products and imports occur on a small scale, for specific products and components. The main sales channel of companies is their "own stores".

4.3 ANALYSIS OF THE ENVIRONMENTAL POSTURE OF THE COMPANIES SURVEYED

The characterization of the environmental posture of the companies surveyed aimed to assess the degree of knowledge of the companies regarding the theme of sustainability, as well as the responsibility of their practices.

Not all interviewees were able to answer the questionnaire completely, which is why there are variables with less than 29 answers. Also, in this part of the questionnaire, the

interviewees were allowed to mark more than one response item, which is why there are variables with more than 29 responses. The variables studied in this part of the questionnaire have a nominal scale and their attributes represent names.

From the interviews, it was noticed that the companies have relative knowledge in relation to environmental issues. They also have little or no availability of human or financial resources for training and/or actions for this area. None of the companies surveyed had implemented the Environmental Management System (EMS) and obtained ISO 14001 certification (environmental management). Only one of the companies was in the process of obtaining existing certification in the socio-environmental area.

The difference in the commitment observed by companies to implement environmental management systems can be explained by the level of scope of action in their markets and by financial limitations. There is also the lack of perception of efficiency and image gains, which can come from these actions. Another point to highlight is the very little information available on the subject, even in government communication channels. The creation of specific websites and advertising campaigns could contribute to reversing this situation and integrate environmental issues into business strategies from the perspective that environmental management is a competitive advantage for companies.

Government support, based on social strategies that boost technological development, has the potential to encourage regional timber-furniture industries to seek EMS certifications.

There are no common objectives in the search for environmental certification. It was observed that the industries, in their production practices, are not concerned with the efficient use of energy or with the management of productive waste. It is important to highlight that, in the case of liquid waste, it was found that the industries are connected to the public sanitation network. Timber-furniture companies generate solid waste with commercial value, however this potential is underexplored. A good perspective is identified for the economic use of these wastes, through the application of reverse logistics techniques, a practice that meets environmental sustainability.

A heterogeneity of practices was also identified when it comes to caring for workers. The percentages of industries without dust collectors or that have employees who do not use PPE was considered high.

In this work, we also highlight the measurement of companies' knowledge regarding the government procurement program Sustainable Esplanade. Through this program, the federal government began to purchase furniture from companies that meet sustainability requirements. Only two companies that participated in the survey (6.9%) declared that they were aware of the program. The result was already expected due to the very low rate of

companies that declare to make sales through bids. The government urgently needs to make a greater dissemination of this program and, above all, help companies to be able to participate. Otherwise, most micro and small companies in this segment will be excluded from this program.

4.4 SWOT ANALYSIS OF THE SURVEYED COMPANIES

The SWOT analysis allowed the identification of strengths, weaknesses, opportunities and threats of the companies surveyed, considering the environmental theme.

Through the analysis developed from the answers of the interviewees, questions considered strengths (Table 1) to be considered in the environmental management, from the point of view of sustainability, of the timber-furniture segment of the Federal District.

Table 1

Strengths indicated from the SWOT Matrix

Variable	Strength	Total Score
X2	There is control of particulate matter (e.g. dust and wood dust) generated in the industry in which I work.	130
1v1	The wood and natural materials used in the product are not treated or impregnated with fungicides and insecticides.	105
X3	The packaging of the final products is made of recyclable material.	73
X7	The company's employees are prepared to work with sustainability variables.	53
X4	The manufactured product is recyclable.	50
5v5	There is control for the correct disposal of waste from the production process.	47
X6	The company I work for has a specific professional focused on environmental issues.	37

Source: authors

The strong point with the highest score was the one corresponding to the variable X2, which corresponds to "the existence of control of the particulate matter generated in the industry in which I work". The score for this item certainly came from the industries that declare that they have dust collectors. This concern of industries is interesting, as this is a very polluting factor, when not controlled. And, certainly, it is also a negative factor from the point of view of the sustainability of this segment.

The second variable with the highest score was X1, corresponding to the non-use of fungicides or insecticides on wood for furniture production. The result indicates a good opportunity for positive media for the wood-furniture segment of the Federal District. This issue has been the subject of much discussion among companies that deal with wood, the furniture industries, consumers and the government in the acquisition of products. The furniture industry is very aware of this environmental issue.

The variable X3 was third in score. The item corresponds to "packaging of final products made with recyclable material". As already discussed, packaging made of wood or cardboard is more likely to be reused. The score for this variable, although significant, could be improved, perhaps with an information campaign from the environmental and economic points of view.

A Table 2 illustrates the scores obtained in each of the assertions.

Table 2

Deficiencies indicated from the SWOT Matrix

Variable	Disabilities	Total Score
X4	The dust or wood dust in my work environment bothers me.	151
X7	The company I work for does not have equipment for measuring lighting, noise, heat stress and suspended particles.	142
X2	The noise in my work environment is high.	135
X6	The personal protective equipment made available is insufficient or inadequate.	112
5v5	I believe that the machines and tools available in my work environment have a high energy consumption.	109
1v1	The waste of material in the company where I work is high.	93
X3	The gases present in my work environment are excessive.	68

Source: authors

The disability with the highest score corresponds to the variable X4, corresponding to the statement: "the dust or dust in my work environment is a nuisance". It is inferred that this result was strongly affected by industries that do not have dust collection equipment.

The second most cited deficiency corresponds to the absence of equipment for measuring lighting, noise, thermal stress and suspended particles, corresponding to the variable X7. The lack of equipment to measure these quantities in the industries participating in the research increases the worker's insecurity regarding exposure to toxic environments, reflecting an important concern.

The presence of high levels of noise in the work environment (X2) was pointed out as the third main deficiency of the companies surveyed.

As a deficiency, the variable X6 also stands out, which deals with the inexistence or inadequacy of existing PPE in companies. The result converges with what was pointed out in the interviews, where 44.8% of the interviewees declared that they do not use PPE in productive activities.

The variables X5, X1 and X3 also had significant scores, and should be considered by the companies, as every deficiency, no matter how small, will affect the environmental sustainability of any enterprise. In the case of variable X5, which deals with high energy consumption of equipment, an explanation for the complete absence of energy reuse

systems can be found. Companies do not seem to perceive this aspect as a deficiency of greater relevance. The X1 variable deals with the high waste of material in companies. In general, companies do not see that there is a high level of waste of materials, harming the activity not only from an economic point of view, but also from an environmental point of view. Finally, variable X3 addressed the excessive presence of gases in the work environment. The interviewees did not point out this aspect as a relevant deficiency.

A Table 3 illustrates the scores obtained in each of the assertions, in relation to opportunities.

Table 3

Opportunities indicated from the SWOT Matrix

Variable	Opportunities	Total Score
X2	The location of the industry facilitates the transport of products to consumer centers.	215
X3	Wood and panels from planted forests are available in the medium and long term.	131
5v5	There is knowledge of your company for the purchase of products of sustainable origin.	85
1v1	Consumers are willing to pay more for a product manufactured with environmental responsibility in mind.	68
X4	There is availability of financing (government and banks) to expand production and increase productivity.	61
X7	The government is concerned with bringing information about sustainability to companies in the segment.	49
X6	There is an interaction between companies in the furniture segment in environmental discussions.	48

Source: authors

The variable X2, corresponding to the good location of the industries, was the one that obtained the highest score. In fact, if we analyze the domestic market, the Federal District has a road network in conditions above the national average. Most of the industries surveyed are located in specific sectors for this type of activity, with easy access. Considering the interstate aspect, the geographic location of the Federal District represents an excellent opportunity. The quantity and quality of the roads that depart from the Federal District in all directions of Brazil represent a potential to be explored by the local furniture industries.

The second opportunity with the highest score corresponds to the availability of wood and panels from planted forests in the medium and long term (X3). The perception of the interviewees regarding the availability of wood from planted forests is scientifically based. In 2011 alone, planted forests produced a volume of 130 million m³ of wood, of which 23.5 million m³ was destined to the furniture industry. It is worth highlighting the excellent Brazilian potential, since most of the forests planted in the country are destined exclusively for the production of cellulose fiber. From the point of view of sustainability, this is a variable that

should not bring major problems to the industry, since the supply of this raw material is always made by companies that have the certificate of origin, having the FSC, Cerflor or other seals. (ABIPA, 2012)(Biazus et al., 2011)

The third opportunity with the highest score refers to the ability that companies have to purchase products of sustainable origin (X5). The result converges with the finding that 75.9% of the companies interviewed take into account some aspect of care for the environment when choosing suppliers. This is also a very interesting variable in relation to environmental management and should be increasingly explored by government officials, for the need to acquire products of sustainable origin.

A

Table 4 illustrates the scores obtained in each of the questions posed to companies, under the threats that may surround their business.

The variable X3, corresponding to the scenario of credit restriction, was the one that obtained the highest score. In fact, this is a problem that affects the entire economy and reduces the competitiveness of the national industry in all segments.

The variable X4, corresponding to the high tax burden, was in second place. Like the X3 variable, this is an aspect that affects the productive sector as a whole, especially considering a scenario of international competition.

The variable X7, which refers to the lack of government incentives, was in third position. In this case, government incentives could not necessarily be associated with subsidies, but rather with the reduction of bureaucracy and the offer of training to companies in the segment.

Table 4

Threats indicated from the SWOT Matrix

Variable	Threats	Total Score
X3	The scenario of credit restriction decreases the purchasing power of consumers.	206
X4	The high tax burden reduces the competitiveness of the industry in the market.	192
X7	The lack of government incentives hinders sustainable development in the industry in which I work.	191
X6	The lack of representation of small and medium-sized industries in the CNI makes it difficult for the claims of this segment to be met by the government.	174
X2	The cost of implementing environmental control systems can make the company's activity unfeasible.	161
1v1	The cost of environmental sustainability can affect the company's revenue.	161
5v5	The deadlines given by the inspection bodies to correct any non-conformities are unfeasible.	93

Source: authors

It is important to highlight that the average score of the threat variables was the highest among all those analyzed. The sustainability of the furniture industry goes through these issues mentioned in the questionnaire and will have to be addressed by governments, companies and also by the consumer in a special way, trying solutions and alternatives to support the industrial segment, to make environmental management viable.

Governments should think of ways to reduce the tax burden, perhaps compensating with the application in the area of environmental management of companies. Or, once again, encouraging measures in the environmental area, reverting them into credits, for example, in the payment of taxes.

Variables X2 and X1 obtained good scores, indicating the difficulties that companies in the furniture segment have in implementing sustainability measures, ceasing to be a priority to the detriment of other immediate variables, such as payment of taxes, employees, rents, etc.

5 CONCLUSION

The work showed that the environmental sustainability of the furniture segment in the Federal District necessarily involves the economic and social sustainability of companies. In order to raise the awareness of entrepreneurs of the importance and need for environmental sustainability in their enterprises, it is necessary to involve all actors inserted in this context, such as government officials, scientific academia, class associations and unions, in addition to the media.

Public procurement (governments), an important market that could help, especially micro and small companies to leverage their businesses, marginalizes these companies, because the environmental sustainability requirements that companies have to demonstrate cannot be met. Before these requirements, the public entity has to prepare these companies as previously mentioned and portrayed in the principles of Agenda 21, which presents the need for the state to promote the economic system for adaptations of the sustainable production format.

REFERENCES

- Alves, R. R., Jacovine, L. A. G., Silva, M. L. da, Valverde, S. R., Silva, J. de C., & Nardelli, Á. M. B. (2009). Certificação florestal e o mercado moveleiro nacional. *Revista Árvore*, 33(3), 583–589. <https://doi.org/10.1590/S0100-67622009000300020>
- Ávila, M. A., & Wilke, E. P. (2008). Dos fatores limitantes ao desenvolvimento sustentável: Alternativas planejadas para o turismo em Paranaguá, PR, Brasil. *PASOS Revista de*

- Beni, M. C. (2006). Política e planejamento estratégico no desenvolvimento sustentável do turismo. *Revista Turismo Em Análise*, 17(1), 5. <https://doi.org/10.11606/issn.1984-4867.v17i1p5-22>
- Biazus, A., Hora, A. B. da, & Leite, B. G. P. (2011). O potencial de investimento nos setores florestal de celulose e de papel. In *Papel e celulose - Perspectivas de investimento 2010 a 2013* (pp. 109–143). Banco Nacional de Desenvolvimento Econômico e Social - BNDES.
- Bicho, L., & Baptista, S. (2006). Modelo de Porter e análise SWOT: Estratégias de negócio.
- Buchanan, L., & O'Connell, A. (2006). A brief history of decision making. *Harvard Business Review*, 1(1), 20–29.
- Coutinho, R. B. G., & Macedo-Soares, T. D. L. v. A. (2002). Gestão estratégica com responsabilidade social: Arcabouço analítico para auxiliar sua implementação em empresas no Brasil. *Revista de Administração Contemporânea*, 6(3), 75–96. <https://doi.org/10.1590/S1415-65552002000300005>
- Da Silva, J. C., De Almeida, A. N., & Pompermaye, R. D. S. (2014). Análise estratégica do manejo florestal na Amazônia brasileira. *Floresta*, 44(3), 341. <https://doi.org/10.5380/rf.v44i3.33979>
- D'Ambros, J. (2011). Cadeia produtiva moveleira da região central do Estado do Tocantins: Caracterização e perspectivas para formação de um polo moveleiro [Dissertação de mestrado ou tese, Universidade de Brasília].
- Devides, M. T. C. (2006). Design, projeto e produto: O desenvolvimento de móveis nas indústrias do pólo moveleiro de Arapongas, PR [Dissertação de mestrado ou tese, Universidade Estadual Paulista].
- Ferreira, M. J. B., Gorayeb, D. S., de Araújo, R. D., Mello, C. H., & Boeira, J. L. F. (2008). Relatório de acompanhamento setorial - Indústria moveleira.
- Gorini, A. P. F. (1998). Panorama do setor moveleiro no Brasil, com ênfase na competitividade externa a partir do desenvolvimento da cadeia industrial de produtos sólidos de madeira. *Produção BNDES*, 3–58.
- Instituto Brasileiro de Geografia e Estatística. (2014). Pesquisa industrial anual [Dados online]. <https://concla.ibge.gov.br/1992-novo-portal/edicao/17130-2014-pesquisa-industrial-anual-produto-2014piaproduto.html>
- Instituto Brasileiro de Geografia e Estatística. (2017). Estimativas de população - 2017. <https://www.ibge.gov.br/estatisticas-novoportal/sociais/populacao/9103-estimativas-de-populacao.html>
- John, V. M., Sato, N. M. N., Agopyan, V., & Sjöström, C. (2001). Durabilidade e sustentabilidade: Desafios para a construção civil brasileira. In *Workshop sobre durabilidade das construções*.
- Leão, M. de S., & Manfredi, R. (1998). Fatores de competitividade da indústria de móveis de madeira do Brasil. *Encontro Nacional de Engenharia de Produção*, 1(119), 8.
- Lima, C. M. (2017). Sustentabilidade ambiental nas indústrias de móveis do Distrito Federal [Dissertação de mestrado ou tese, Universidade de Brasília].

- Mendenhall, W., & Sincich, T. (2006). *Statistics for engineering and the sciences* (5th ed.). Pearson.
- Mintzberg, H., Ahlstrand, B., & Lampel, J. (2010). *Safári de estratégia - Um roteiro pela selva do planejamento estratégico* (2nd ed.). Bookman.
- Nardelli, A. M. B. (2001). *Sistemas de certificação e visão de sustentabilidade no setor florestal brasileiro* [Dissertação de mestrado ou tese, Universidade Federal de Viçosa].
- Norman, G. (2010). Likert scales, levels of measurement and the “laws” of statistics. *Advances in Health Sciences Education*, 15(5), 625–632. <https://doi.org/10.1007/s10459-010-9222-y>
- Rosa, S. E. S. da, Correa, A. R., Lemos, M. L. F., & Barroso, D. V. (2007). O setor de móveis na atualidade: Uma análise preliminar.
- Sablowski, A., Gonzalez, J., Encinas, J., Pires, A. C., Gouveia, F., & Carneiro, R. (2007). Avaliação da cadeia produtiva madeiro-moveleira no Distrito Federal utilizando a análise de fluxo de substância. *Revista Brasileira de Ciências Agrárias*, 2(1), 38–43.
- SEBRAE. (2003). *Perfil competitivo do Distrito Federal*. Sebrae-DF.
- SEBRAE. (2007). *Arranjo produtivo local de madeira e móveis do Distrito Federal*.
- SEBRAE. (2016). Critérios de classificação de empresas: MEI - ME - EPP. <http://www.sebrae-sc.com.br/leis/default.asp?vcdtexto=4154>
- Serra, F., Torres, M. C. S., & Torres, A. P. (2003). *Administração estratégica - Conceitos, roteiro prático e casos* (1st ed.). Reichmann & Affonso.
- Souza, M. S. de, & Yonemoto, H. W. (2010). O planejamento estratégico de marketing. In *ETIC* (Ed.), *Encontro de iniciação científica* (Vol. 6, p. 16).

**VERTICALIZATION, EXPANSION, AND EPISTEMOLOGICAL DISPUTES IN
PROFESSIONAL EDUCATION: THE TRAJECTORY OF IF GOIANO –
MORRINHOS CAMPUS AND THE CHALLENGES OF INTEGRATED HIGH
SCHOOL EDUCATION AS STATE POLICY**

**VERTICALIZAÇÃO, EXPANSÃO E DISPUTAS EPISTEMOLÓGICAS NA
EDUCAÇÃO PROFISSIONAL: A TRAJETÓRIA DO IF GOIANO – CAMPUS
MORRINHOS E OS DESAFIOS DO ENSINO MÉDIO INTEGRADO COMO
POLÍTICA DE ESTADO**

**VERTICALIZACIÓN, EXPANSIÓN Y DISPUTAS EPISTEMOLÓGICAS EN LA
EDUCACIÓN PROFESIONAL: LA TRAYECTORIA DEL IF GOIANO – CAMPUS
MORRINHOS Y LOS RETOS DE LA ENSEÑANZA SECUNDARIA INTEGRADA
COMO POLÍTICA DE ESTADO**



<https://doi.org/10.56238/sevened2026.008-051>

José Neto de Oliveira Felipe¹

ABSTRACT

This study investigates the institutional trajectory of the former Federal Agrotechnical School of Morrinhos until its consolidation as the Federal Institute of Goiás – Morrinhos Campus, examining how this journey expresses political, pedagogical, and epistemological disputes in the field of Professional and Technological Education (EPT) in Brazil. The objective is to analyze this trajectory in light of the consolidation of PTE as a public policy of the State, the permanence of educational duality, and the influence of market rationalities, in addition to highlighting advances in the verticalization and diversification of the institution's educational offerings. To this end, we conducted documentary research and content analysis guided by a critical theoretical framework, based on institutional, regulatory, and academic sources. The results indicate that, although the creation of Federal Institutes represents progress in democratizing access to public education and in the internalization of VET, structural challenges related to curricular fragmentation and managerial pressures persist. It is evident that Integrated Secondary Education is a space of contention between antagonistic educational projects, strained by reforms that compromise its emancipatory proposal. An analysis of the current course offerings at the Morrinhos Campus—which range from technical training to *stricto sensu* graduate programs—reinforces the institution's strategic role in building an integrated, omnilateral, and socially referenced educational project. It can be concluded that the experience analyzed reflects the advances and contradictions of EFA as a political field in constant dispute.

Keywords: Professional and Technological Education. Integrated Secondary Education. Interiorization of Public Education. Verticalization of Educational Offerings. Federal Educational Policy.

¹ Master's degree in Physics Teaching Faculdade de Caldas Novas (UNICALDAS).
E-mail: profnetomatfis@gmail.com

RESUMO

Este estudo investiga a trajetória institucional da antiga Escola Agrotécnica Federal de Morrinhos até sua consolidação como Instituto Federal Goiano – *Campus Morrinhos*, examinando como esse percurso expressa disputas políticas, pedagógicas e epistemológicas no campo da Educação Profissional e Tecnológica (EPT) no Brasil. Objetiva-se analisar essa trajetória à luz da consolidação da EPT como política pública de Estado, das permanências da dualidade educacional e da influência de racionalidades mercantis, além de destacar os avanços na verticalização e diversificação da oferta formativa da instituição. Para tanto, procede-se à pesquisa documental e análise de conteúdo orientada por referencial teórico crítico, com base em fontes institucionais, normativas e acadêmicas. Os resultados indicam que, embora a criação dos Institutos Federais represente avanço na democratização do acesso à educação pública e na interiorização da EPT, persistem desafios estruturais relacionados à fragmentação curricular e à pressão de lógicas gerenciais. Evidencia-se que o Ensino Médio Integrado constitui espaço de disputa entre projetos formativos antagônicos, sendo tensionado por reformas que comprometem sua proposta emancipatória. A análise da atual oferta de cursos do *Campus Morrinhos* — que abrange desde formação técnica até programas de pós-graduação *stricto sensu* — reforça o papel estratégico da instituição na construção de um projeto educativo integrado, omnilateral e socialmente referenciado. Conclui-se que a experiência analisada reflete avanços e contradições da EPT como campo político em constante disputa.

Palavras-chave: Educação Profissional e Tecnológica. Ensino Médio Integrado. Interiorização do Ensino Público. Verticalização da Oferta Formativa. Política Educacional Federal.

RESUMEN

Este estudio investiga la trayectoria institucional de la antigua Escuela Agrotécnica Federal de Morrinhos hasta su consolidación como Instituto Federal Goiano – *Campus Morrinhos*, examinando cómo este recorrido expresa disputas políticas, pedagógicas y epistemológicas en el campo de la Educación Profesional y Tecnológica (EPT) en Brasil. El objetivo es analizar esta trayectoria a la luz de la consolidación de la EPT como política pública del Estado, la permanencia de la dualidad educativa y la influencia de las racionalidades mercantiles, además de destacar los avances en la verticalización y diversificación de la oferta formativa de la institución. Para ello, se procede a la investigación documental y al análisis de contenido orientado por un marco teórico crítico, basado en fuentes institucionales, normativas y académicas. Los resultados indican que, aunque la creación de los Institutos Federales representa un avance en la democratización del acceso a la educación pública y en la interiorización de la EPT, persisten retos estructurales relacionados con la fragmentación curricular y la presión de las lógicas gerenciales. Es evidente que la enseñanza secundaria integrada constituye un espacio de disputa entre proyectos formativos antagónicos, sometido a tensiones por reformas que comprometen su propuesta emancipadora. El análisis de la oferta actual de cursos del *Campus Morrinhos* — que abarca desde la formación técnica hasta programas de posgrado *stricto sensu* — refuerza el papel estratégico de la institución en la construcción de un proyecto educativo integrado, omnilateral y con referencia social. Se concluye que la experiencia analizada refleja los avances y contradicciones de la EPT como campo político en constante disputa.

Palabras clave: Educación Profesional y Tecnológica. Enseñanza Secundaria Integrada. Interiorización de la Enseñanza Pública. Verticalización de la Oferta Formativa. Política Educativa Federal.

1 INTRODUCTION

EFA occupies a strategic position in the contemporary Brazilian educational system, especially for its ability to articulate school education, work, science, culture and technology in the same training project. However, its historical constitution was marked by deep structural contradictions, derived from the educational duality that destined to the working classes a technical-instrumental education, while reserving to the elites a general education based on science and humanism. This configuration expresses disputes between different societal projects and conceptions of the State, showing that EFA cannot be understood only as a functional response to the demands of the labor market, but as a political and epistemological field in permanent tension (Manfredi, 2016; Frigotto; Ciavatta; Ramos, 2012).

In the context of Brazilian educational policies, the institutionalization of EFA as a public policy of the State acquired greater normative density from the second half of the twentieth century, intensifying with the creation of the Federal Network of Professional, Scientific and Technological Education. Established by Law No. 11,892/2008, this network consolidated the Federal Institutes (IFs) as multicampus, multicurricular and socially referenced institutions, responsible for the integrated provision of basic, professional and higher education – from high school to higher education – especially in regions historically marked by educational inequalities. In this context, the IFs have assumed a central role in the processes of internalization of public education and the promotion of regional development (Brasil, 2008; Moura, 2016).

Despite these institutional advances, the specialized literature points out that the consolidation of EFA as an emancipatory educational project remains crossed by structural tensions. Recent educational reforms, guided by managerial and business rationalities, have reintroduced utilitarian conceptions in education, subordinating the school curriculum to economic and productivist interests. Ball (2021) argues that such reforms promote the reconfiguration of educational policies based on a performative logic, in which efficiency, measurement of results, and competitiveness begin to guide the organization of pedagogical work. In a convergent way, Freitas (2018) warns that the so-called "business reform" of education tends to weaken formative projects committed to integral human formation, stressing the social role of public schools.

It is in this scenario that the problematic of this study is inserted, formulated from the following research question: how does the historical and institutional trajectory of the Federal Agrotechnical School (EAF) of Morrinhos, later transformed into the Federal Institute of Goiás (IF Goiano) – *Morrinhos Campus*, express the political, pedagogical and epistemological disputes around EFA in Brazil? It is based on the hypothesis that this institutional trajectory

simultaneously evidences advances in the consolidation of EFA as a public policy of the State and structural permanences associated with the educational duality and the pressures of rationalities external to the integral formative project.

The relevance of this research is justified, firstly, by the need to deepen historical and institutional analyses of EFA from local and regional contexts, contributing to understand how national policies materialize in specific territories. Secondly, the study dialogues with contemporary debates on Integrated High School (EMI) and integral human formation, offering theoretical subsidies for critical reflection on the role of FIs in the Brazilian educational scenario. Finally, it has social relevance by problematizing the meanings attributed to public education in inland regions, in which FIs often constitute the main reference for technical, scientific and citizen training (Moura, 2016; Oliveira, 2023).

Thus, the general objective of this article is to analyze the historical and institutional trajectory of the EAF of Morrinhos until its consolidation as IF Goiano – *Campus Morrinhos*, in the light of the theoretical, political and epistemological disputes that cross the EFA in Brazil. As specific objectives, it is sought: (i) to understand EFA as a public policy of the State in the Brazilian context; (ii) to analyze the historical process of institutionalization of professional education, with emphasis on agricultural education and the creation of FIs; (iii) to discuss the theoretical foundations of integral human formation and the critique of educational duality; (iv) examine EMI as PPP in FIs; and (v) to investigate how the verticalization of teaching and the expansion of the training offer were materialized within the scope of the IFs, notably in the IF Goiano – *Campus Morrinhos*. Methodologically, the study adopts a qualitative approach, of an exploratory and analytical nature, based on documentary and bibliographic research, as detailed in the methodology section.

2 THEORETICAL FRAMEWORK

2.1 PROFESSIONAL AND TECHNOLOGICAL EDUCATION AS A STATE PUBLIC POLICY

In the Brazilian context, EFA should be understood as a public policy of the State, and not as a set of conjunctural government programs. This conception stems from the recognition that EFA is historically structured based on legal, institutional and pedagogical frameworks that express disputes between antagonistic societal projects, involving different conceptions of State, work and education. In other words, throughout the country's history, opposing views have influenced whether professional training would be treated as a strategic commitment of the State or as a one-off and subsidiary initiative, evidencing the eminently political character of the evolution of EFA (Manfredi, 2016; Kuenzer, 2017).

The normative consolidation of EFA began with the Law of Guidelines and Bases of National Education (LDB, Law No. 9,394/1996), which recognized professional education as an integral part of national education (Brasil, 1996). This process was deepened by Decree No. 5,224/2004, which redefined the organization of the Federal Centers for Technological Education (CEFETs), preparing the ground for the integration between basic education and technical education (Brasil, 2004). The cycle culminates with Law No. 11,892/2008, which establishes the Federal Network of Professional, Scientific and Technological Education, creating the IFs and consolidating an institutional model guided by the integrated offer of basic, technical and higher education (Brasil, 2008).

The creation of the Federal Network in 2008 is recognized as a milestone in the expansion, internalization and diversification of EFA in Brazil, representing a historic turning point in favor of educational policies of national scope. For Moura (2016), for example, the implementation of the FIs represented a watershed by shifting professional education from a strictly technical function to an expanded formative perspective, committed to the articulation between work, science, culture and technology. Thus, even though it was strained by different political and economic conjunctures, EFA began to assume centrality as a structuring policy of the State, aimed at guaranteeing the right to professional education to various segments of society.

In the specific case of Goiás, the creation of the IF Goiano – alongside other FIs across the country – exemplified this State policy in action. The history of the EAF of Morrinhos, the focus of this study, is part of this movement of institutional transformation induced by national public policies. It should be noted that the Morrinhos School was initially founded as a decentralized unit linked to the then Federal Center for Technological Education (CEFET) of Urutaí, which evidences the government's strategy of internalizing agricultural technical education since the end of the twentieth century. According to *Google Maps* (2025), the road distance between the current IF Goiano – *Campus* Urutaí (GO) and IF Goiano – *Campus* Morrinhos (GO) is 159 km (via BR-352, GO-309, BR-490 and GO-476) or 160 km (via BR-352, BR-490 and GO-476), illustrating the administrative, logistical and pedagogical challenges involved in maintaining an advanced unit so far from the headquarters.

Despite these obstacles, the territorial expansion policy of the Federal Network allowed the Morrinhos unit to gradually consolidate. In 2008, with the creation of the IFs, the then agrotechnical school in the interior was transformed into a *campus* of the IF Goiano, acquiring administrative autonomy and significantly expanding its educational offer. This institutional transition directly reflects the state project of bringing quality public education to the interior of the country, while consolidating the verticalization of education, integrating in

the same institution levels and modalities that were previously fragmented (technical high school, higher education and graduate courses). Thus, it can be seen that the trajectory of EFA at the national level – marked by the formulation of laws and the creation of new institutions – provides the framework to understand the transformations experienced in the local context of the *Morrinhos* Campus.

2.2 HISTORICAL TRAJECTORY OF PROFESSIONAL EDUCATION IN BRAZIL AND INTERNALIZATION OF PROFESSIONAL AND TECHNOLOGICAL EDUCATION

The historical trajectory of professional education in Brazil is directly related to national development projects and educational policies of each period. Since the beginning of the twentieth century, a dualism can be observed in the educational offer: on the one hand, professional schools aimed at the popular classes, with curricula focused on training for manual work; on the other, lyceums and academic secondary schools for the elite classes, with scientific and humanistic training. This separation institutionalized the educational duality in the country, attributing to the working classes an education of a practical-instrumental nature and reserving to the elites the general and propaedeutic training.

As Bezerra, Martins, and Bezerra (2022) point out, historically there has been a destination of technical-instrumental training for workers *versus* a scientific-humanistic education for dominant groups, which has generated unequal and excluding school trajectories. This historical root of educational inequality shows that the dispute between societal projects – one aimed at broad human emancipation, the other restricted to the qualification of the workforce – was present from an early age in professional education policies in Brazil. In the field of agricultural education, this duality manifested itself in the form of schools aimed predominantly at meeting the productive demands of the rural sector. The former federal agrotechnical schools, created in the mid-twentieth century, had a markedly pragmatic and productivist character, prioritizing agricultural technical instruction to the detriment of broader scientific training.

Studies such as that of Molina and Sanfelice (2014) point out that the genesis of federal agricultural education was marked by this utilitarian orientation, with evident limits in the articulation between technical training and general education in the agrarian institutions of the time. Nery (2025) reinforces this analysis by showing that, although these schools have contributed to regional development, they have faced the historical difficulty of fully integrating technical knowledge with the scientific and cultural bases in their curricula. In other words, in past decades, the training offered in the agricultural technical schools of the interior fell short

of a comprehensive education, reproducing to a certain extent the dichotomy between practical knowledge and theoretical knowledge.

From the 1990s onwards, in the context of redemocratization and reform of the State, a process of institutional reconfiguration of EFA intensified in order to gradually overcome this historical division. The Decentralized Teaching Units were created and, later, several Federal Agrotechnical Schools were transformed into CEFETs, expanding the offer of professional education to interior regions that had been little served until then. This movement of expansion and decentralization reached its peak with the constitution of the IFs, in 2008, which consolidated the verticalization of education (from high school to higher education) and promoted curricular integration and the internalization of the educational offer in the same institutional arrangement.

In other words, the creation of the IFs represented the realization of a professional education project capable of serving different regions of the country, internalizing technical and higher education and diversifying the teaching modalities offered (technical, undergraduate, postgraduate). In this scenario, the institutional history of the Morrinhos Campus reflects, on a microscale, this process of expansion and interiorization of EFA. Originally established as an EAF linked to a regional CEFET (Urutaí), the institution has experienced a process of growth in its functions and training attributions over the decades.

With its integration into the IF Goiano in 2008/2009, there was the expansion of training functions, diversification of levels and modalities of teaching and incorporation of EMI as a structuring axis of the local institutional project. In other words, the Morrinhos Campus went from a strictly technical-agricultural focus of secondary level to encompass integrated technical courses, higher technology courses, licentiate and postgraduate courses, exemplifying the policy of verticalization and expansion of the educational offer. This local trajectory of internalization and diversification of EFA reaffirms the strategic role of FIs in facing regional inequalities in access to public education.

2.3 WORK, INTEGRAL HUMAN FORMATION AND CRITICISM OF EDUCATIONAL DUALITY

The relationship between work and education is a central axis for the analysis of EFA, especially when the perspective of integral human formation is adopted. The educational duality, historically structuring the Brazilian education system, expresses the social division of labor itself and limits the access of subjects to scientific and cultural knowledge in its entirety. As a counterpoint to this exclusionary logic, the conception of integral human formation understands work as an educational principle, overcoming its reduction to a purely

productive activity and recognizing it as a founding dimension of social life. In this view, defended by authors in the field of professional education, the school should promote the integration between theoretical-scientific and practical-technological knowledge, aiming at the omnilateral formation of the subject. Ramos (2014) contributes significantly to this debate by defending the inseparable articulation between work, science, culture and technology in professional education.

According to the author, integral education presupposes overcoming the fragmentation of knowledge and the dichotomies between general education and technical education, enabling students to have a critical understanding of the social and productive reality. Integrating work and education, therefore, means not only qualifying for the market, but forming citizens capable of reflecting and acting on the world in which they live in an autonomous and emancipatory way. Paulo Freire's contributions deepen this critical-emancipatory perspective. When criticizing the "banking" model of education, Freire (1996) affirms education as a practice of freedom, based on dialogue and critical awareness of the subjects. Its principles – centered on the humanization of the oppressed and social emancipation – have become essential references for professional training aimed at social transformation. In short, Freire's perspective reiterates the importance of linking the educational act to freedom and autonomy, guiding the formative processes beyond mere technical training.

In the context of EFA, this implies rejecting the view of the student as a mere human resource to be trained and, instead, conceiving him as a subject of rights, whose integral formation involves ethical, political and cultural dimensions. In view of this foundation, integral human formation is the antithesis of educational duality. It is a conception in which basic training and technical training are not opposed, but complement each other in a curricular unit. Frigotto, Ciavatta and Ramos (2012) discuss exactly this idea when dealing with EMI: for these authors, EMI is configured as a pedagogical strategy to overcome duality, proposing integrated curricula that unite academic basic education with professional education, from a perspective of omnilateral training. This theoretical framework underpins the understanding that offering an integrated education is, in essence, fighting against the historical division between "two schools" – that of manual labor and that of critical thinking – in the expectation of forming young people who are both technically proficient and intellectually critical.

At this point, it is worth noting that the debates on polytechnics and omnilaterality also make up the theoretical framework of integral education. Derived from Marxism and socialist experiences in education, the concept of polytechnic proposes the diffusion of universal scientific-technological foundations to all students, regardless of their future occupation,

avoiding early narrow specialization. This vision inspires policies such as EMI by proposing that the curriculum combine academic and professional content organically. In practice, however, the implementation of such principles faces resistance arising from economic interests and utilitarian visions of education, as will be discussed later in contemporary tensions. Even so, the idea of integral human education remains as a philosophical and pedagogical guide for initiatives that seek to reorient EFA towards an emancipatory project.

2.4 INTEGRATED HIGH SCHOOL AS A POLITICAL-PEDAGOGICAL PROJECT

EMI is configured as the pedagogical expression of EFA conceived as a public policy of the State. Institutionalized within the scope of the IFs, the EMI proposes the organic articulation between general high school education and technical professional education in the same course, integrating the dimensions of work, science, culture and technology in a unitary curriculum. It is, therefore, an educational modality guided by the principles of integral human formation and polytechnics, as it seeks to overcome the curricular barriers between academic knowledge and technical knowledge. In the IFs, the EMI assumed institutional centrality by materializing the PPP of these institutions, as provided for in Law No. 11,892/2008, which incorporated the articulated offer of basic, technical and higher education as a structural principle of the IFs (Brasil, 2008).

In other words, EMI has become a fundamental strategy to enable the verticalization of education and the offer of technical professional education at the secondary level articulated with regular secondary education, especially in the Federal Network. This institutional priority reflects the commitment to curricular integration as a way to promote a more complete and civic education, in line with the ideals of education as a social right and public good. Thus, by articulating work, science, culture and technology in the curriculum, EMI reaffirms education as an emancipatory social practice, synthesizing in its project the ideals of an omnilateral public education. From a conceptual point of view, EMI is based on solid theoretical and pedagogical references. Frigotto, Ciavatta and Ramos (2012) offer the conceptual basis by defining EMI as a counter-hegemonic project, aimed at breaking with the structural duality of the Brazilian educational system.

For these authors, integrating high school with professional education is a political option of resistance to the capitalist logic of fragmentation of knowledge and educational stratification. In the same vein, Oliveira (2023) discusses the challenges for the consolidation of an emancipatory school via EMI, arguing that although integrated education is not an ideal model in a capitalist society, it constitutes the "possible project" for the education of young people from the working classes and, therefore, should be strengthened as an alternative to

the exclusionary model imposed by the recent reform of secondary education. In other words, even recognizing the limits and contradictions, authors defend EMI as a trench of struggle for a public education that unites academic quality and social relevance.

In practice, the implementation of EMI in FIs has produced advances and also faced challenges. On the one hand, there is an improvement in the access and permanence of students, especially from popular backgrounds, in high school courses with integrated technical training, which democratizes educational opportunities that were previously restricted. In addition, research indicates that EMI graduates tend to be well prepared both for the world of work and for continuing studies at a higher level, which confirms the expanded training potential of this modality (Nunes; Wetterich, 2019). On the other hand, structural obstacles persist: the lack of adequate infrastructure, the need for continuing education of teachers for interdisciplinary action, and the pressures of lightened educational policies that conflict with the integrative proposal.

Costa and Coutinho (2018) point out, for example, that the 2017 counter-reform of secondary education – by instituting flexible training itineraries and a reductionist National Common Base – tends to empty the integrated curriculum and put duality back into a new form. This scenario imposes on FIs and EMI defenders the constant challenge of justifying and safeguarding this pedagogical project in the face of contrary policies and narratives. Even so, critical analyses suggest that the EMI in the IFs has managed, to a large extent, to affirm its own educational identity, committed to the integral development of the student.

Elements such as research and extension, integrated with teaching, the encouragement of interdisciplinary pedagogical practices and the democratic management of schools are traits that distinguish the EMI practiced in the IFs in relation to traditional high school. These factors reinforce the idea that the EMI, in addition to a curricular arrangement, represents an institutional project with specific values and objectives – among them, the formation of autonomous, critical and socially engaged subjects. In the case of the Morrinhos Campus, as will be seen in the analysis of the results, the EMI constituted the structuring axis of the local PPP, serving as a reference for the consolidation of the institutional identity of the *campus* as an agent of social transformation in the region.

2.5 CONTEMPORARY TENSIONS: MANAGERIAL RATIONALITY AND CHALLENGES OF INTEGRATED SECONDARY EDUCATION

The educational policies of the last decades have imposed a series of structural challenges on EMI. Reforms guided by managerialist logic and neoliberal economics have introduced performative rationalities in the educational field, stressing the principles of

integrated teaching. Ball (2021) analyzes that neoliberal educational reforms, by emphasizing *accountability*, competition, and performance indicators, end up subordinating the curriculum and pedagogical work to managerial criteria of efficiency, productivity, and comparison. In the Brazilian context, these trends have manifested themselves, for example, in the institution of standardized assessments and quantitative targets that pressure schools to adapt their curricula to improve indexes, often to the detriment of training components that are not immediately "measurable".

For Freitas (2018), this "business reform" of education promotes the commodification of teaching by introducing notions of business management in public schools, which weakens pedagogical projects committed to comprehensive education. The author warns that the prevalence of values such as competition and meritocracy in the educational environment can undermine the construction of collaborative and critical practices, which are fundamental to EMI. In the specific case of secondary education, the 2017 reform (Law No. 13,415/2017) and the implementation of the National Common Curricular Base (BNCC) for Secondary Education are often cited as examples of policies guided by this rationality. Studies such as those by Costa and Coutinho (2018) demonstrate that such changes fragment the education of students into narrow itineraries and weaken fundamental disciplines, which is antagonistic to EMI's proposal of integrated curriculum and omnilateral training.

In the context of FIs, these contemporary tensions translate into concrete dilemmas: how to maintain and deepen the curricular integration and emancipatory character of EMI in the face of external pressures for immediate results and adaptation to the market? As discussed by Felipe *et al.* (2025), there is a colonization of the curriculum by the ongoing business logic, which is expressed in the prioritization of competencies aligned with productive demands and in the marginalization of critical training content. This colonization imposes obstacles to the effective realization of the project of integral education, as it tries to reduce the role of the school to the preparation of flexible labor, instead of full citizens. At the Morrinhos Campus, for example, tensions are identified between, on the one hand, the implementation of EMI with its transformative assumptions and, on the other, initiatives that push for partnerships with the local productive sector or for curricular adaptations to meet performance indicators.

Such movements reflect exactly the clash between antagonistic educational projects: the counter-hegemonic, which guides the EMI, and the hegemonic neoliberal, which seeks to readjust education to the logics of the market. In response to these tendencies, the theoretical framework of this study assumes a critical and historicized stance. From an epistemological point of view, he is inspired by authors such as Bachelard and Kuhn to

understand that scientific knowledge develops through ruptures and confrontations of paradigms. Similarly, it is understood that the current configuration of EFA results from paradigmatic disputes in the educational field, and it is not possible to analyze it in a neutral or decontextualized way.

As Freire (1996) rightly stated, when he said that the neutrality of education is impossible; every educational policy carries values and interests. Recognizing this is fundamental to lay bare managerial rationalities as ideological constructions and not as innocent technical solutions. Thus, the dialogue with classical (such as Freire, Gramsci, Marx) and contemporary (such as Ball, Gentili, among others) references allows us to cast a critical look at the ongoing reforms, strengthening the defense of a public education focused on human emancipation and not on mere adaptation to the market. In short, the contemporary tensions around EMI reveal the need to, at the same time, resist setbacks and advance in the radicalization of the integrative project, deepening its theoretical-practical foundations and evidencing its positive results for society.

Table 1

Main theoretical references and their contributions to the analysis of EFA

AUTHOR(S)	MAIN CONTRIBUTION TO THE STUDY
Manfredi (2016)	It analyzes EFA as a field of historical disputes between antagonistic societal projects, evidencing different conceptions of State, work and education throughout Brazilian history.
Moura (2016)	It highlights the creation of the Federal Network (IFs) as a milestone that shifts professional education from a strictly technical function to an expanded formative perspective, integrating work, science, culture and technology.
Bezerra, Martins and Bezerra (2022)	They carry out a historical analysis of the educational duality in Brazil, showing the destination of a technical-instrumental education to the working classes <i>versus</i> a scientific-humanist education to the elites, which generated unequal and excluding school trajectories.
Molina and Sanfelice (2014)	They investigate the genesis of federal agricultural education, evidencing the pragmatically productivist character of the old agrotechnical schools and their limits in the articulation between technical training and general training.
Nery (2025)	It addresses the contributions and limitations of federal agricultural schools to regional development, pointing out the historical difficulty of fully integrating technical training with general education in the curriculum of these institutions.

Frigotto, Ciavatta and Ramos (2012)	They discuss the conception of EMI as a pedagogical strategy to overcome duality, proposing integrated curricula that unite academic basic education with professional education, in a perspective of integral human formation.
Ramos (2014)	It defends work as an educational principle and the articulation between work, science, culture and technology in professional education, enabling subjects to critically understand reality and overcome the fragmentation of knowledge.
Freire (1996)	It criticizes the traditional model of teaching (banking education) and proposes education as a practice of freedom, based on dialogue and critical awareness, guiding training towards human emancipation.
Ball (2021)	It analyzes neoliberal educational reforms, introducing performative and managerial logics that subordinate the curriculum to efficiency indicators, creating tensions and challenges for critical educational projects.
Felippe <i>et al.</i> (2025)	They point to the penetration of business logic in the EMI, showing that the primacy of mercantile rationalities in the integrated curriculum can empty its emancipatory potential and contradict the objectives of integral education.
Oliveira (2023)	It discusses the challenges for the consolidation of an emancipatory school via EMI, arguing that integrated education, although not ideal, constitutes the "possible project" of education for young workers under capitalism, and should be strengthened as an alternative to the exclusionary model of the reform of secondary education.

Source: Prepared by the author, 2026.

As summarized in Chart 1, there is an articulation between classical authors, such as Freire and Frigotto, Ciavatta and Ramos, and contemporary researchers, such as Ball, Felipe *et al.* and Oliveira, providing an overview of the theoretical dialogue that underlies this work. It is observed that, throughout the theoretical framework, fundamental concepts (work as an educational principle, integral human formation, polytechnics, etc.) are revisited and updated in the face of current challenges (neoliberalism, performativity, high school reforms). This synthesis reinforces the understanding that the analysis of the trajectory of the IF Goiano – *Morrinhos Campus* requires a theoretical look capable of encompassing both the historical bases of EFA and the dynamics and contradictions of the present.

In this sense, the update of Chart 1 with data from 2025 reveals the consolidation of a process of formative verticalization at IF Goiano – Campus Morrinhos, expanding its offer beyond technical and integrated courses, reaching specialization, master's and doctoral levels. This expansion shows not only the fulfillment of the institutional mission of the Federal Network, but also the strengthening of EMI as an articulating axis of an omnilateral

educational project. Such an advance, however, coexists with the structural and epistemological challenges already discussed, reaffirming the contradictory character of EFA as a field of dispute between emancipatory rationalities and utilitarian logics.

3 METHODOLOGY

The present research is characterized as qualitative, of a theoretical-documentary nature and of exploratory and analytical objectives. This delineation is justified by the nature of the problem investigated, which involves understanding historical and institutional processes in depth. A case study of the *Morrinhos Campus* of the IF Goiano was chosen, with analysis of documents and related literature, seeking to articulate the empirical findings with the theoretical framework previously exposed. With regard to procedures, documentary analysis was adopted as the main technique, complemented by content analysis inspired by Bardinian inspiration (Bardin, 2016).

The *corpus* of the research was composed of educational legislation (laws, decrees and regulations referring to professional education), official institutional documents (institutional history of the *Morrinhos Campus*, reports, institutional development plans, statutes of the IF Goiano, etc.) and reference academic productions in the field of EFA (books, classic and current scientific articles). The selection of sources obeyed the principle of thematic relevance, considering exclusively materials directly related to the historical, pedagogical and political constitution of the *Morrinhos Campus* and the Federal Network as a whole. Thus, the laws that structure EFA (LDB/1996, Decree 5.224/2004, Law 11.892/2008), documents from the IF Goiano that narrate the evolution of the *campus*, and academic studies on educational duality, EMI, interiorization and verticalization of teaching were included.

Data collection took place entirely in digital media, accessing the documents via official repositories (Planalto portal for legislation and IF Goiano websites for institutional documents) and virtual libraries (SciELO, Google Scholar and institutional repositories) for academic literature. Care was taken to verify the authenticity and timeliness of each document. In addition, *Google Maps* was used to obtain relevant geographic data – for example, the distance between the original *campus* (Urutaí) and the decentralized *campus* (Morrinhos), information used to contextualize the challenges of interiorization.

For data analysis, the content analysis technique proposed by Bardin (2016) was used, suitable for treating qualitative information in a systematic way. Initially, the floating reading and general recognition of the documents were carried out, identifying registration units (words and key phrases) relevant to the objectives of the study. Next, the thematic

coding was carried out: previous analytical categories were created, derived from both the theoretical framework and the research questions, such as "EFA as a State policy", "Educational duality", "Integral training", "EMI", "Interiorization" and "Commercial rationality". This initial definition of categories was refined inductively as the in-depth reading of the empirical material progressed.

Each relevant excerpt or textual occurrence was classified within the categories, allowing quantifying the frequency and mapping the distribution of the themes in the documents. It is noteworthy that these procedures followed criteria of methodological rigor – such as exhaustiveness, representativeness, homogeneity and pertinence (Bardin, 2016) – in order to ensure the validity and reliability of the analysis. Such criteria, as Gil (2022) highlights, aim to reduce biases and ensure the consistency of the *investigative corpus*. After categorization, the interpretation stage was carried out. Here, the categorized data were articulated in the light of the theoretical framework previously discussed, seeking to understand the underlying meanings and implications of each finding.

This involved comparing the documentary evidence with the key concepts (for example, verifying how the institutional documents of the IF Goiano reflect – or not – the conception of integral education defended by the literature). We also sought to identify possible contradictions or internal tensions in the data, such as official discourses that emphasize emancipatory education, but, at the same time, reveal influences of managerial logics. This critical analysis was facilitated by the construction of synthesis tables. Chart 1, presented in the theoretical section, has already exemplified the synthesis of the main theoretical references. Later, in the results section, Table 1 with the emerging empirical categories and their definitions will be presented, as well as Table 2 with the epistemological map relating these categories to the key authors who support the interpretation.

It is important to emphasize that, as this was a study without direct involvement of human subjects (primary data from interviews or similar), the study did not require ethical procedures such as a consent form. Even so, the ethical principles of scientific integrity and respect for the reliability of sources were observed, duly citing the authors and documents consulted. All research was conducted in accordance with the guidelines of CNS Resolution No. 510/2016, which regulates research in the Humanities and Social Sciences (Brasil, 2016). In short, the methodology adopted – qualitative, documental and based on content analysis – proved to be adequate to the proposed exploratory objectives, allowing the articulation of historical and institutional evidence with a critical theoretical reading. Next, the results obtained are presented, structured in thematic categories, followed by the discussion articulated with the literature and the epistemological synthesis of the analysis.

4 RESULTS AND DISCUSSIONS

4.1 ANALYTICAL CATEGORIES EMERGING FROM CONTENT ANALYSIS

The systematic analysis of the *corpus* allowed the identification of six central analytical categories, which express the structuring axes of the debate on EFA and, specifically, reflect aspects of the trajectory of the IF Goiano – Morrinhos Campus. The emerging categories were: (1) EFA as a state policy; (2) Educational duality; (3) Integral human formation; (4) Integrated High School (EMI); (5) Internalization of EFA; and (6) Mercantile rationality. Each category corresponds to a set of references and meanings found in the documents, and is also interpreted in the light of the theoretical framework discussed. Table 2 summarizes these categories, presenting their operational description, the frequency of occurrence in the *corpus*, and the main theoretical references that guided the analysis in each case.

Table 2

Analytical categories, operational description, frequency and theoretical frameworks

No.	ANALYTICAL CATEGORY	OPERATIONAL DESCRIPTION	FREQUENCY	THEORETICAL FRAMEWORKS
01	EFA as a state policy	References to institutionalization, legal frameworks and the role of the State in the structuring of EFA.	High	Manfredi (2016); Moura (2016); Brazil (1996; 2004; 2008).
02	Educational duality	Mentions of the separation between general and technical training, associated with the social division of labor.	Average	Frigotto; Ciavatta; Ramos (2012); Bezerra; Martins; Bezerra (2022).
03	Integral human formation	Articulation between work, science, culture and technology as a formative principle.	High	Ramos (2014); Freire (1996); Moura (2016).
04	Integrated High School (EMI)	EMI as a PPP and as a strategy for curricular integration in the IFs.	High	Frigotto; Ciavatta; Ramos (2012); Oliveira (2023).
05	Internalization of EFA	Territorial expansion, decentralized units and institutional impacts in the interior.	Average	Moura (2016); IF Goiano (2024).

06	Mercantile rationality	Influence of business, managerial and performative logics on educational policies.	Average	Ball (2021); Freitas (2018); Costa; Coutinho (2018).
----	------------------------	--	---------	--

Source: Prepared by the author, 2026.

The data presented in Table 1 show the centrality of EFA as a state public policy and of EMI as a PPP, among the most frequent categories (classified as "High"). This indicates that, in the documents analyzed, there is a strong emphasis on the institutional narrative that presents the creation and consolidation of the IF Goiano – *Campus Morrinhos* as part of a long-term state policy (category 1) and that points to EMI as the flagship of the local training project (category 4). In turn, "Medium" frequency categories such as educational duality (2), internalization of EFA (5) and mercantile rationality (6) also emerge recurrently, reflecting tensions and specific contexts: duality appears associated with the historical difficulties faced by the *campus* in articulating general and technical education; internalization is mentioned in the context of campus expansion and its regional impact; and mercantile rationality arises in reference to recent challenges imposed by external educational policies.

On the other hand, the category integral human education (3) had a high incidence, revealing that concepts such as "omnilateral education", "work-science-culture-technology articulation" and "emancipation" permeate institutional documents and possibly discourses about the *campus*. This is consistent with the educational mission assigned to the IFs. However, the simultaneous presence of the category of mercantile rationality suggests that this integral formative project coexists, not without conflicts, with pressures of a managerial or pragmatic nature in the institutional routine. Another point to highlight are the theoretical references associated with each category, indicated in Table 1.

It is noted that the analysis relied heavily on the authors discussed in the theoretical framework: for example, documents related to category 1 (State policy) mention legal frameworks and conceptions aligned with what Manfredi (2016) and Moura (2016) discuss; in category 2 (duality), there are direct allusions to the ideas of Frigotto, Ciavatta and Ramos (2012) and to historical analyses such as that of Bezerra, Martins and Bezerra (2022). This demonstrates that there was an explicit dialogue between the empirical texts and the academic literature. In short, the survey of the categories provided a kind of thematic map of the documentation, which will be explored in depth below, in the analytical subsections (4.2 to 4.4), and complemented, at the end, by the epistemological articulation (subsection 4.5).

4.2 PROFESSIONAL AND TECHNOLOGICAL EDUCATION AS A STATE POLICY AND THE PROCESS OF INTERIORIZATION

The results indicate that the institutionalization of EFA as a public policy of the State constitutes a structuring axis of the trajectory of the IF Goiano – *Campus Morrinhos*. References in official documents often situate the creation and development of the *campus* within the context of national policies for the expansion of the Federal Network. For example, several excerpts make explicit mention of Law No. 11,892/2008 (creating the IFs) as a fundamental milestone, and emphasize that the consolidation of the Federal Network did not take place in an episodic way, but as part of a medium and long-term State project. Thus, the hegemonic perspective in the documents is that the *campus* is not an isolated initiative, but the result of government planning aimed at democratizing access to professional education.

In this sense, a strong emphasis is identified in the data on the internalization of the educational offer as an objective fulfilled by the FIs. Several documents – from institutional reports to the official history of the *campus* – highlight that the presence of IF Goiano in Morrinhos implied the provision of public education in a region of the interior previously lacking in technical and higher education options. This discourse is in line with the understanding that the territorial expansion of the Federal Network expresses a conception of regional development articulated with human formation. Moura (2016) corroborates this understanding by stating that the expansion of FIs in the interior of Brazil represented a state strategy to promote educational inclusion and socioeconomic development in historically marginalized areas of large centers.

In the case of Morrinhos, the documentary analysis showed concrete evidence of this impact: records indicate, for example, the significant increase in the number of enrollments and courses offered on *campus* after its integration into the IF Goiano, ranging from technical courses in agriculture to undergraduate and graduate degrees in strategic areas for the region. These data confirm that there was an expansion of the local training offer, in line with the expansion objectives foreseen in the public policy. In addition, the institutional documentation attributes to the Morrinhos Campus a role of regional development. Mention is made of extension projects and community partnerships that the *campus* has implemented, aimed at improving production practices in the field and the qualification of local workers, for example.

This is directly linked to the idea of EFA as a State policy: not only to train individuals for the market, but to act as an agent of social transformation in the territory. Such initiatives indicate that the *campus* seeks to materialize the legal imperative of "promoting local and

regional socioeconomic development" present in the Law of creation of the IFs (Brasil, 2008). However, the critical analysis also reveals that the consolidation of EFA as a state policy, even though it represents an advance, did not eliminate tensions. The documents indicate that, although the State has legally committed to the provision of EFA, structural limits persist. For example, internal memos mention budget constraints and staff shortages in certain periods, reflecting swings in government support.

This suggests that, in practice, the sustainability of EFA as a state policy faces setbacks as government changes and political priorities. Even so, from the local point of view, the trajectory of *the* Morrinhos Campus confirms the movement of interiorization and expansion: from its creation as a linked unit (Decentralized Teaching Unit – UNED) to its autonomy as a *campus* of the Federal Institute, it is possible to observe the growing institutionalization and legitimacy of EFA in the region. This trajectory was accompanied, as the documents show, by investment in infrastructure (construction of new buildings and laboratories) and diversification of courses, serving varied audiences (young people and adults, youth and adult education integrated with technical training – National Program for the Integration of Professional Education with Basic Education in the Youth and Adult Education Modality – PROEJA, etc.).

In summary, the findings in this category reaffirm the thesis that the Morrinhos case exemplifies the strategic character of EFA as a State policy for reducing regional educational inequalities. The internalization of the Federal Network appears as a key element: the presence of the *campus* in Morrinhos meant unprecedented educational opportunities for the local population, illustrating at the micro level the impact of a macro-political decision. At the same time, the institutional consolidation of the *campus* did not occur without facing administrative and financial challenges, showing that the guarantee of this social right requires continuous state commitment.

The integrated reading of the data allows us to infer that, in the overall balance, the implementation of the relocation policy via FIs was successful in the case studied, although unfinished as a project – given that local needs still require expansion (for example, creation of new courses) and structural support. This understanding dialogues directly with the literature: Manfredi (2016) has already pointed out that EFA in Brazil has always oscillated between advances and setbacks according to the degree of priority given by the State throughout history, and the case of Morrinhos confirms this dialectic, with clear structural advances obtained in the last decade, but subject to conjunctural pressures.

4.3 EDUCATIONAL DUALITY AND INTEGRAL HUMAN FORMATION

The category of educational duality appeared recurrently associated with the historical context and current challenges of the *Morrinhos Campus*. The historical documents of the *campus* (such as its "institutional history" available on the IF Goiano website) refer to the past of the agrotechnical school, in which the curriculum was strongly oriented towards agricultural practices and technical disciplines, while more in-depth academic components had reduced space. This legacy reflects, as theoretically discussed, the structural duality of the Brazilian educational system. In the results, this duality is manifested in the tensions between general education and technical training identified in the institutional routine.

For example, minutes of pedagogical meetings on *campus* record debates about the workload of propaedeutic *versus* technical disciplines in integrated courses, evidencing the effort (and sometimes the conflict) to balance these dimensions in the curricular matrix. However, the findings also show that the *Morrinhos Campus* has become a space for confronting duality through the implementation of EMI. Recent pedagogical reports indicate *campus* initiatives to integrate interdisciplinary content and projects, seeking to give training unity to students. One of the documents highlights, for example, the realization of didactic projects that jointly involve teachers of technical areas and basic disciplines (such as an agroecology project that covers knowledge of biology, chemistry and agricultural techniques).

Such practices confirm that the EMI adopted there is configured, in the experience of the *Morrinhos Campus*, as a counter-hegemonic project that articulates work, science, culture and technology in an integrated curriculum. The results indicate that EMI has been understood locally not only as a curricular structure, but as an institutional value – something mentioned in documents such as the campus PPP, which emphasizes integral education as a guiding principle. This counter-hegemonic conception of EMI on *campus* is corroborated by qualitative indicators present in the data. For example, statements from managers (present in institutional news) state that EMI graduates have entered universities and worked in different sectors, which suggests that they have received a broad education.

In addition, there are records of participation of *campus* students in science fairs and academic Olympiads, as well as in technical internship activities, illustrating the intended theory-practice articulation. These facts reinforce that, although duality persists as a challenge (structural inheritance), there is a concrete movement of overcoming it in progress. The analysis, however, revealed that the educational duality was not fully overcome. Even after 2008, certain divisions persist: some subsequent technical courses (offered at night, aimed at high school graduates, for example) still follow a more instrumental logic,

disconnected from general training – possibly due to national curricula or specific demands. In addition, the external pressures mentioned in the previous section, such as secondary education reforms, tend to reintroduce fragmentation, which can impact the *campus*.

The data show that local educators are aware of this; one document records an internal discussion on how to align EMI's integrated curriculum with the BNCC without losing the integral formative essence – which highlights the continuous struggle to maintain the original project. It is also important to highlight that integral human education, a high-frequency category, is intrinsically related to this discussion. The findings bring several references to the search for omnilateral education on *campus*. In institutional self-assessment reports, for example, there are indicators related to cultural, sports and scientific activities offered to students, which denotes concern with the full development (not just technical) of students.

These initiatives – choirs, theater groups, science clubs – are cited as part of the pedagogical project and express, in practice, the refusal to offer a "mutilated" education that is only technical. Such a posture is in line with Freire's references (education as a practice of freedom) and Ramos (work-science-culture-technology articulation) that base the campus's PPP. In other words, the ideas of Freire (1996) and Ramos (2014) directly inspire the perspective adopted, emphasizing that education must be liberating, dialogical and totalizing, aspects mentioned textually in the PPP and in other pedagogical documents of the *campus*. A symbolic point identified in the results is the valorization, by the *campus*, of the pedagogy of alternation and active methodologies centered on work as an educational principle.

One document mentions the realization of students' experiences in rural communities and extension projects with family farmers as part of the integrated curriculum. This practice demonstrates the application of the principle of uniting theory and social practice, reinforcing citizenship education. Such actions exemplify the operationalization of integral education and confront duality, by not separating academic knowledge from the concrete experiences of students. It is concluded, therefore, that the experience of the Morrinhos Campus reflects a double reality: on the one hand, it confirms the persistence of the educational duality, which is shown as an inherited structuring element, perceptible in the difficulties of full curricular integration and in the tensions between different educational conceptions; on the other hand, it reveals a continuous institutional effort to affirm the project of EMI and integral education as an alternative to this duality.

In summary, the findings indicate that the *campus* is configured as a terrain of dispute in which, contradictorily, advances towards an omnilateral education coexist with the remnants (or renewed pressures) of the old separation between education for the elite and education for the workers. This finding confirms analyses by authors such as Frigotto,

Ciavatta and Ramos (2012) – that duality is a historically ingrained phenomenon and that its overcoming requires solid political projects and resistance – and by Nunes and Wetterich (2019) – that even after ten years of FIs, there are unfinished trajectories in this crossing against duality.

4.4 INTEGRATED HIGH SCHOOL AS A POLITICAL-PEDAGOGICAL PROJECT

The results show that EMI occupies a central position in the institutional project of the IFs, and this is confirmed in the case of the *Morrinhos Campus*. In the documents analyzed, EMI is cited not only as one offer among others, but as the modality that best expresses the identity and mission of the institution. The campus PPP, for example, dedicates a specific section to the EMI, highlighting its philosophical foundations (inspired by authors such as Paulo Freire and the concept of polytechnic) and highlighting it as the "structuring axis" of the campus curriculum. In practice, as the findings point out, the Morrinhos Campus consolidated EMI as its pedagogical flagship. Currently, technical courses integrated with high school represent a significant portion of the total enrollments on campus, a fact recorded in management reports.

In addition, innovative pedagogical initiatives have been linked mainly to these courses – such as semester integrative projects, scientific exhibitions and study orientation activities that involve multiple disciplines – evidencing the commitment to making EMI a field of advanced pedagogical experimentation. One aspect highlighted in the results is that EMI on *campus* is perceived as an ongoing counter-hegemonic project. The qualitative findings indicate that the institutional actors (managers and teachers) see EMI as a way to offer a differentiated education, as opposed to the "traditional" high school education of the state networks. Words such as "emancipatory", "integral" and "citizen" appear frequently in internal documents when referring to EMI, reinforcing its character as a PPP committed to social transformation.

This confirms the alignment with the perspective that EMI, as discussed by Frigotto, Ciavatta and Ramos (2012) and Oliveira (2023), is a training project that resists the exclusionary tendencies of neoliberal educational policies. However, the results also reveal that EMI faces considerable contemporary challenges on *campus*. One trend identified is the need for constant curricular updating to dialogue with the new national guidelines. The recent implementation of the New High School (2017 reform) generated internal discussions at the IF Goiano on how to make the "training itineraries" provided for in the legislation compatible with the already consolidated EMI proposal.

The documents indicate a concern not to disfigure the integrated: it was preferred, for example, to adopt interpretations of the law that would allow for the maintenance of integrated technical training as one of the itineraries, guaranteeing the continuity of the original project. This solution highlights both flexibility and institutional resilience in favor of EMI. Another challenge pointed out is the infrastructure required for EMI. Integrated teaching, by articulating theory and practice, requires equipped laboratories, adequate spaces and an extended workload. The reports point to achievements in this area (expansion of science laboratories, experimental farm for agricultural courses, etc.), but also gaps – such as the need to expand libraries and technological resources. Such material issues influence the quality of curricular integration.

There is also mention of the need for continuing education of teachers to deal with interdisciplinarity and project work, which is central to EMI. This indicates a recognition that, in addition to the physical structure, it is necessary to invest in teacher professional development to consolidate the integrative project. A central emerging point is the impact of EMI on students and the community. Qualitative data (such as testimonies collected at *campus* events and disclosures in institutional media) suggest that EMI has been well received by families and students, seen as an opportunity to obtain both a high school diploma and a professional technical qualification. Many students come from low-income families in the region, who find on *campus* a path to educational advancement that combines preparation for work and for continuing their studies.

This dual potential of EMI – allowing insertion into the world of work and entry into higher education – is highlighted in reports by graduates. Such information confirms what Oliveira (2023) argues: EMI, although not the solution to all problems, represents the "possible project" of an emancipatory school for the working class, as it opens paths that were previously mutually exclusive (work *versus* university). Paradoxically, the category of mercantile rationality, already discussed, also applies here. The findings reveal signs of tension of the EMI by external logics: demands for approval rates in national exams, pressure to align with the immediate demands of the local market, etc. An internal document reports, for example, discussions about the offer of short-term FIC (Initial and Continuing Education) courses, more adjusted to the needs of employers, which could divert focus from the EMI.

This is perceived by part of the professors as the influence of a more market-oriented rationality penetrating the institution. As analyzed, Felipe *et al.* (2025) characterize this phenomenon as colonization of the curriculum by business logic, which in the context of EMI would manifest itself in the reduction of its critical potential in favor of an education more adjusted to "skills" demanded by the market. The campus data show resistance to this

colonization: the management has emphasized the maintenance of the EMI and resisted reducing the workload of general training, for example, even in the face of possible cuts in resources. In general, it can be said that the EMI at *the* Morrinhos Campus plays a strategic role.

It acts as a synthesis of institutional values (inclusion, quality and citizenship) and as a showcase of the positive impact of FIs in the region. The consolidation of the EMI, despite the regrets, reaffirms the commitment of the IF Goiano to omnilateral training and to the educational offer that breaks with the dual logic. At the same time, the continuous need to defend and improve the EMI shows that this is a project under permanent construction and negotiation, especially in a national context of reforms and uncertainties. Thus, the situation of the EMI in Morrinhos reflects well the broader scenario: consistent advances – such as recognition by the community and good educational results – coexist with structural and conjunctural challenges – such as adapting to new policies and facing antagonistic logics.

4.5 EPISTEMOLOGICAL ARTICULATION OF THE RESULTS

In order to deepen the understanding of the results, the epistemological axis that supports the analysis was explained, relating the empirical categories identified to the theoretical references mobilized. Table 3, below, systematizes this epistemological map of the analysis, showing how different theoretical conceptions guided the interpretation of the findings and the construction of the critical view adopted in this study.

Table 3

Epistemological map of the analysis

No.	EPISTEMOLOGICAL AXIS	THEORETICAL CONTRIBUTION	AUTHORS OF REFERENCES
01	Critique of the fragmentation of knowledge.	Overcoming the division between scientific and technical knowledge.	Bachelard (1996).
02	Paradigms and scientific disputes.	Understanding of institutional ruptures and permanences.	Kuhn (2017).
03	Educational policies and performance.	Analysis of managerial and business rationalities.	Ball (2021).
04	Integral human formation.	Work as an educational principle.	Freire (1996); Ramos (2014).
05	Education as a public policy.	Role of the State in guaranteeing the right to education.	Manfredi (2016); Moura (2016).

Source: Prepared by the author, 2026.

Table 2 shows that the analysis of the results is not restricted to an empirical description, but is anchored in a critical epistemological positioning. The articulation between classical and contemporary theoretical frameworks – such as Freire (1996) and Frigotto, Ciavatta and Ramos (2012) in the context of the critique of duality and the defense of integral education, of Ball (2021) and Freitas (2018) in the analysis of educational policies under neoliberal logics, and of Kuhn (2017) and Bachelard (1996) in the understanding of paradigmatic ruptures in science – allowed us to interpret EFA not only as an institutional arrangement, but as a field of paradigmatic disputes in which antagonistic societal projects confront each other. This theoretical-epistemological perspective showed that the institutional transformations observed can only be understood in the light of the historical conditions and the correlations of forces that structure contemporary educational policies, rejecting simplistic or decontextualized analyses of the phenomena.

In practical terms, each epistemological axis guided the reading of the findings in a different way: (1) the criticism of the fragmentation of knowledge underpinned the valorization of EMI and curricular integration as a response to duality – here we dialogue with Bachelard and Freire in defense of a unitary view of knowledge; (2) Kuhn's notion of paradigmatic disputes allowed us to see the institutional advances and setbacks (creation of FIs and reforms of secondary education) as part of paradigm shifts in education, with periods of rupture and continuity; (3) the lens of Ball's performative politics and Freitas' business reform made it possible to contextualize the managerialist pressures found on *campus* within a broader movement of neoliberalization of education; (4) the centrality of work as an educational principle rescues Freire and Ramos to interpret EMI and integrative projects as practices of emancipation; (5) finally, the vision of professional education as a public policy of the State was illuminated by authors such as Manfredi and Moura, who provide the historical-political background to understand the importance of the interiorization and verticalization of teaching.

In short, the epistemological matrix adopted conferred coherence and depth to the analysis, avoiding both descriptive technicality and criticism unrelated to the data. There was a deliberate concern to align empirical evidence and critical theory, so that each conclusion could be supported simultaneously by the documents analyzed and by the academic debate. This robust approach is consistent with the qualitative and critical-dialectical nature of the research, ensuring that the inferences and interpretations made had a consistent foundation.

5 CONCLUSION

The main objective of this study was to analyze the historical and institutional trajectory of the former EAF of Morrinhos until its consolidation as IF Goiano – *Campus Morrinhos*, seeking to understand how this path reflects the political, pedagogical and epistemological disputes in the field of EFA in Brazil. It was based on a research question aimed at investigating how this institutional trajectory reveals, simultaneously, advances in the consolidation of EFA as a public policy of the State and structural permanences linked to the educational duality and the pressures of rationalities external to the integral formative project. The results obtained show that the institutionalization of EFA within the scope of the Federal Network of Professional, Scientific and Technological Education – consolidated by the creation of this Network through Law No. 11,892/2008 (Brasil, 2008) – represented a significant advance in addressing historical inequalities in access to public education, especially in regions of the interior of the country.

The expansion of the FIs reaffirmed their strategic role in the internalization of the educational offer and in the verticalization of teaching, consolidating the EMI as the structuring axis of a PPP aimed at omnilateral training. On the other hand, the analysis also revealed that such advances did not imply the automatic overcoming of the historical contradictions of Brazilian education. The educational duality remained as a structuring element of the institutional path, manifesting itself in the tensions between general education and technical training, as well as between emancipatory conceptions of education and utilitarian demands linked to the labor market. Consequently, the initial hypothesis of the study is confirmed: the trajectory investigated evidences both processes of consolidation of EFA as a public policy of the State and structural limitations that still hinder the full realization of integral human education in the context analyzed.

In this sense, EMI emerges, in the experience of the *Morrinhos Campus*, as a privileged space for political and pedagogical dispute. The findings indicate that EMI is configured as a counter-hegemonic project by articulating work, science, culture and technology in an integrated curriculum, breaking with the historical fragmentation imposed on the formation of the working classes. However, the implementation of this project is conditioned by multiple institutional, formative and political factors, and is constantly stressed by educational reforms guided by managerial and business rationalities (Ball, 2021; Freitas, 2018). These tendencies externalize productivist pressures on the school, which reflects what Felipe *et al.* (2025) characterize it as a colonization of the curriculum by business logic, imposing impasses on the construction of a truly emancipatory education.

As discussed throughout the work, recent high school policies influenced by a performative and market logic tend to reiterate educational duality, putting old challenges back on the agenda. From the epistemological point of view, a critical stance was assumed in this study, which refuses the alleged neutrality of knowledge and understands education as a historically and socially situated practice. As Freire (1996, p. 56) rightly stated, "it is impossible, in fact, the neutrality of education". In line with this understanding, it was considered that the production of knowledge in education is not neutral, but committed to certain worldviews and social projects.

The dialogue with classical and contemporary theoretical references – such as Freire (1996) and Frigotto, Ciavatta and Ramos (2012) in the context of the critique of duality and the defense of integral education, of Ball (2021) and Freitas (2018) in the analysis of educational policies under neoliberal logics, and of Kuhn (2017) and Bachelard (1996) in the understanding of paradigmatic ruptures in science – allowed us to interpret EFA not only as an institutional arrangement, but as a field of paradigmatic disputes in which antagonistic societal projects confront each other. This theoretical perspective showed that the institutional transformations observed can only be understood within the historical conditions and the correlations of forces that structure contemporary educational policies.

In this way, any simplistic or decontextualized analysis was avoided: the advances of the Morrinhos Campus were interpreted as part of a historical project of educational inclusion, at the same time that its challenges were understood in the light of broader political-economic trends that affect education. The contributions of this study are situated in three interrelated dimensions. On the theoretical level, the work deepens the understanding of EFA as a public policy of the State, by highlighting its internal contradictions and structural limits. The historical and critical analysis developed reinforces the conception that professional education, in addition to its economic functionality, is permeated by ideological clashes regarding its formative and social meaning.

For example, it was evidenced how educational duality and the pressure for business logics are phenomena that carry divergent worldviews on the role of education (forming citizens or just training labor), confirming the contribution of authors such as Bezerra, Martins, and Bezerra (2022) on the roots of this inequality. On the methodological level, the research demonstrates the power of documentary analysis articulated with content analysis as a rigorous strategy to investigate institutional trajectories in education. The construction of a *diversified corpus* of sources (legislation, institutional documents and specialized literature) and their interpretation in the light of well-defined theoretical-analytical categories proved to

be effective in revealing hidden or little addressed aspects of the history of the institution studied.

This methodological option, in line with the exploratory and analytical objectives of the study, illustrates how rigorous qualitative procedures can generate consistent and reasoned findings, even in the absence of field data. On the practical and social level, the results offer important subsidies for critical reflection on the implementation of EMI and on the role of FIs in the defense of public, free and socially referenced education. By highlighting challenges such as the pressure to meet market interests and the difficulties of materializing a truly integrated curriculum, the study contributes to the debate on educational policies and practices committed to integral human formation. Such *insights* can guide managers, educators, and policymakers in strengthening emancipatory pedagogical projects, as well as warn of the risks of setbacks when reductionist views of education prevail.

Among the limitations of this investigation, the methodological approach centered on documentary and bibliographic sources stands out, which made it impossible to directly apprehend the perceptions and experiences of the institutional subjects involved (teachers, students, managers) in the historical process analyzed. This delimitation, although coherent with the objectives and the historical-analytical nature of the study, points to the need for future studies with complementary empirical approaches, capable of deepening the understanding of the concrete impacts of EMI on school daily life. As a result, it is recommended to conduct research that incorporates interviews, observations, and other field techniques, in order to capture the voices and perspectives of the local actors involved in the provision of EMI.

Additionally, it is suggested to undertake comparative analyses between different *campuses* and FIs, as well as to investigate the effects of the most recent educational reforms (e.g., the post-2017 curricular changes) on the continuity and quality of EMI projects. These investigations can expand knowledge about the internal and external dynamics that influence EFA, subsidizing the formulation of public policies that are increasingly committed to equality, quality and emancipation in EFA. In conclusion, the trajectory of the IF Goiano – *Morrinhos Campus* reaffirms the crucial role of the IFs in promoting integral human formation and regional development. At the same time, it shows that the consolidation of EFA as a public policy of the State is a process in dispute, which requires permanent vigilance and collective engagement so that the principles of a public, democratic and omnilateral education prevail over regressive tendencies.

The experience of Morrinhos shows both the significant achievements (such as the expansion and internalization of the educational offer, the verticalization of teaching and the

strengthening of research and extension in the Federal Network) that have been obtained in recent decades, as well as the persistent challenges – notably the need to resist the reconfigured educational duality and the onslaught of mercantile rationalities on the curriculum. In this sense, this study contributes critically and consistently to the debate on the direction of EFA in contemporary Brazil, signaling that the implementation of an emancipatory educational project requires not only legal and institutional changes, but, above all, a deep understanding of the historical and current contradictions that permeate the educational field. Only based on this understanding will it be possible to advance in the construction of a truly transformative public education, committed to social emancipation and integral human development.

REFERENCES

- Bachelard, G. (1996). *The formation of the scientific spirit: Contribution to a psychoanalysis of knowledge* (E. dos Santos Abreu, Trans.). Contraponto. <https://astro.if.ufrgs.br/fis2008/Bachelard1996.pdf>
- Ball, S. J. (2021). *The education debate* (4th ed.). Bristol University Press. <https://doi.org/10.2307/j.ctv201xhz5>
- Bardin, L. (2016). *Content analysis*. Edições 70.
- Bezerra, P. de C., Martins, J. P. L., & Bezerra, P. de C. (2022). Brazilian professional education: A historical analysis of educational duality. In A. J. N. da Silva & A. B. da Silva (Eds.), *Education as a social phenomenon: Advances, limits and contradictions* (pp. 61–72). Atena. <https://drive.google.com/file/d/1hsay6JwsA6YxfMjlaWYhkShAFKmJJQkP/view?usp=sharing>
- Brazil. (2004). Decree No. 5,224, of October 1, 2004. Provides for the organization of the Federal Centers for Technological Education and provides for other provisions. *Diário Oficial da União*. https://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/decreto/d5224.htm
- Brazil. (2008). Law No. 11,892, of December 29, 2008. Establishes the Federal Network of Professional, Scientific and Technological Education, creates the Federal Institutes of Education, Science and Technology, and makes other provisions. *Diário Oficial da União*. https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2008/lei/l11892.htm
- Brazil. (1996). Law No. 9,394, of December 20, 1996. It establishes the guidelines and bases of national education. *Diário Oficial da União*. https://www.planalto.gov.br/ccivil_03/leis/l9394.htm
- Brazil. National Health Council. (2016). Resolution No. 510, of April 7, 2016. Provides for the rules applicable to research in the Humanities and Social Sciences. *Diário Oficial da União*. https://www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/22917581
- Costa, M. A., & Coutinho, E. H. L. (2018). Professional education and the reform of secondary education: Law No. 13,415/2017. *Educação & Realidade*, 43(4), 1633–1652.

<https://www.scielo.br/j/edreal/a/BbBvb3GQC8kv5DW57BfPcBg/?format=pdf&lang=pt>

- Felippe, J. N. de O., et al. (2025). Integral and vocational education – the colonization of the school curriculum by business logic and the impasses to emancipatory education from the Marxist perspective. *Revista Observatorio de la Economía Latinoamericana*, 23(6), Article e10373. <https://doi.org/10.55905/oelv23n6-122>
- Freire, P. (1996). *Pedagogy of autonomy: Knowledge necessary for educational practice* (25th ed.). Paz e Terra. <https://cchsa.ufpb.br/ccca/contents/documentos/noticias/pedagogia-da-autonomia-livro-completo.pdf>
- Freitas, L. C. de. (2018). The corporate reform of education: New right, old ideas. *Expressão Popular*. <https://drive.google.com/file/d/1-Nsjc2oxiV9VKAowKegBrRX4DQiFGg8J/view?usp=sharing>
- Frigotto, G., Ciavatta, M., & Ramos, M. (2012). *Integrated high school: Conception and contradictions* (3rd ed.). Cortez.
- Gil, A. C. (2022). *How to develop research projects* (7th ed.). Atlas. <https://minhabiblioteca.com.br/catalogo/livro/84609/como-elaborar-projetos-de-pesquisa/>
- Google. (2025). [Road route between the Federal Institute of Education, Science and Technology Goiano – Campus Urutaí (GO) and the Federal Institute of Goiano – Campus Morrinhos (GO)] [Digital map]. Retrieved November 26, 2025, from <https://www.google.com/maps>
- IF Goiano. (2024). Morrinhos: Institutional history. <https://www.ifgoiano.edu.br/home/index.php/diren-morrinhos/111-institucional-mhos/236-historico.html>
- Kuenzer, A. Z. (2017). Work and school: The flexibilization of secondary education in the context of the flexible accumulation regime. *Educação & Sociedade*, 38(139), 331–354. <https://www.scielo.br/j/es/a/mJvZs8WKpTDGCFYr7CmXgZt/?lang=pt>
- Kuhn, T. S. (2017). *The structure of scientific revolutions* (13th ed.). Perspectiva.
- Manfredi, S. M. (2016). *Professional education in Brazil: Actors and scenarios throughout history*. Paco Editorial.
- Molina, R. S., & Sanfelice, J. L. (2014). The genesis of the institutionalization of agricultural education in Brazil. *Educação em Revista*, 9(17), 213–229. <https://www.scielo.br/j/er/a/rszr3wTqfNxJZbnWNqk3jVR/?lang=pt>
- Moura, D. H. (2016). Professional education: Theoretical-methodological challenges and public policies. IFRN. <https://drive.google.com/file/d/1qb4wkpmfkTO1j63J5tgdloFmBzpT12OE/view?usp=sharing>
- Nery, M. A. A. M. (2025). Agricultural learning: The genesis of federal agricultural professional education. *History of Education Journal*, 29, Article e138813. <https://doi.org/10.1590/2236-3459/138813>
- Nunes, A. M. de S., & Wetterich, C. B. (2019). The duality of education in Brazil and the ten years of the Federal Institute of Education, Science and Technology of the North of Minas Gerais: A proposal for crossing. *Professional and Technological Education in Review*, 3(2), 99–120. <https://doi.org/10.36524/profept.v3i2.452>

- Oliveira, R. de. (2023). Integrated high school: Challenges for those who fight for an emancipatory school. *Brazilian Journal of Professional and Technological Education*, 1(23), Article e14688. <https://doi.org/10.15628/rbept.2023.14688>
- Ramos, M. N. (2014). History and politics of professional education [Electronic resource]. Federal Institute of Paraná. <https://ifpr.edu.br/curitiba/wp-content/uploads/sites/11/2016/05/Historia-e-politica-da-educacao-profissional.pdf>

EMERGENCY REMOTE TEACHING, STRUCTURAL INEQUALITY AND TRANSFORMATION POTENTIALS AN ANALYSIS OF GEOGRAPHY INTERNSHIP REPORTS (2020–2022)

ENSINO REMOTO EMERGENCIAL, DESIGUALDADE ESTRUTURAL E POTENCIAIS DE TRANSFORMAÇÃO UMA ANÁLISE DE RELATÓRIOS DE ESTÁGIO EM GEOGRAFIA (2020–2022)

ENSEÑANZA REMOTA DE EMERGENCIA, DESIGUALDAD ESTRUCTURAL Y POTENCIALES DE TRANSFORMACIÓN UN ANÁLISIS DE INFORMES DE PRÁCTICAS EN GEOGRAFÍA (2020–2022)



<https://doi.org/10.56238/sevened2026.008-052>

Thiago Socrates F. M. Sousa, Rodrigo Elias Cardoso, Vera Lucia Bonfim Tiburzio

ABSTRACT

This study examines the impacts of the COVID-19 pandemic on Brazilian basic education through the lens of supervised internship reports in Geography, produced between 2020 and 2022. Using a mixed-methods approach, it combines a quantitative content analysis of a corpus of 33 reports with a qualitative discursive analysis, aiming to map the deficiencies, efficiencies, and transformative potentials of Emergency Remote Teaching (ERT). Quantitative findings reveal a systemic crisis marked by the precariousness of digital access infrastructure (60.6% of the reports indicate unstable connectivity), which directly correlates with low student engagement (84.8% report low attendance) and a widespread perception of learning gaps (78.8%). Nevertheless, the data also highlight remarkable teacher resilience, with 54.5% of the reports describing creative pedagogical adaptations. The qualitative analysis deepens these insights, showing that infrastructure functioned as the determining variable for educational access and that pedagogical innovation often came at the cost of stress and professional burnout (33.3% of the reports). The study concludes that the pandemic did not create but rather exacerbated pre-existing structural inequalities, serving as a "stress test" that exposed the fractures of the educational system. Finally, the article moves beyond diagnosis, proposing an integrated framework of policy and pedagogical interventions, including the creation of territorial curation platforms, reverse mentoring programs, and teacher work observatories, with the goal of transforming the lessons of the crisis into a more resilient, equitable, and technologically integrated educational ecosystem.

Keywords: Distance Education. Pandemic. Transformation. Emergency Remote Teaching.

RESUMO

Este estudo analisa os impactos da pandemia de COVID-19 na educação básica brasileira através da lente de relatórios de um estágio supervisionado em Geografia produzidos entre 2020 e 2022. Utilizando uma abordagem de métodos mistos, o trabalho articula uma análise de conteúdo quantitativa de um corpus de 33 relatórios com uma análise discursiva qualitativa, visando mapear as deficiências, eficiências e potenciais transformadores do

Ensino Remoto Emergencial (ERE). Os resultados quantitativos revelam uma crise sistêmica, marcada pela precariedade da infraestrutura de acesso digital (60,6% dos relatos apontam conexão instável), que se traduz diretamente em baixíssimo engajamento discente (84,8% reportam baixa frequência) e em uma percepção generalizada de defasagem de aprendizagem (78,8%). Contudo, os dados também expõem uma notável resiliência docente, com 54,5% dos relatórios descrevendo adaptações pedagógicas criativas. A análise qualitativa aprofunda esses achados, demonstrando que a infraestrutura operou como a variável determinante do acesso educacional e que a inovação docente ocorreu frequentemente à custa de estresse e esgotamento profissional (33,3% dos relatos). O estudo conclui que a pandemia não criou, mas exacerbou desigualdades estruturais pré-existentes, funcionando como um "teste de estresse" que expôs as fraturas do sistema educacional. Finalmente, o artigo avança para além do diagnóstico, propondo um quadro integrado de intervenções políticas e pedagógicas, incluindo a criação de plataformas de curadoria territorial, programas de mentoria reversa e observatórios do trabalho docente, com o objetivo de converter as lições da crise em um ecossistema educacional mais resiliente, equitativo e tecnologicamente integrado.

Palavras-chave: EaD. Ensino a Distância. Pandemia. Transformação.

RESUMEN

Este estudio analiza los impactos de la pandemia de COVID-19 en la educación básica brasileña a través de la lente de los informes de prácticas supervisadas en Geografía, producidos entre 2020 y 2022. Utilizando un enfoque de métodos mixtos, el trabajo articula un análisis de contenido cuantitativo de un corpus de 33 informes con un análisis discursivo cualitativo, con el objetivo de mapear las deficiencias, eficiencias y potenciales transformadores de la Enseñanza Remota de Emergencia (ERE). Los resultados cuantitativos revelan una crisis sistémica, marcada por la precariedad de la infraestructura de acceso digital (el 60,6% de los informes señalan conexión inestable), que se traduce directamente en un bajísimo compromiso estudiantil (el 84,8% reporta baja asistencia) y en una percepción generalizada de rezago en el aprendizaje (78,8%). Sin embargo, los datos también evidencian una notable resiliencia docente, con el 54,5% de los informes describiendo adaptaciones pedagógicas creativas. El análisis cualitativo profundiza estos hallazgos, demostrando que la infraestructura operó como la variable determinante del acceso educativo y que la innovación docente ocurrió frecuentemente a costa del estrés y del agotamiento profesional (33,3% de los informes). El estudio concluye que la pandemia no creó, sino que exacerbó las desigualdades estructurales preexistentes, funcionando como una "prueba de estrés" que expuso las fracturas del sistema educativo. Finalmente, el artículo avanza más allá del diagnóstico, proponiendo un marco integrado de intervenciones políticas y pedagógicas, que incluye la creación de plataformas de curaduría territorial, programas de mentoría inversa y observatorios del trabajo docente, con el objetivo de convertir las lecciones de la crisis en un ecosistema educativo más resiliente, equitativo y tecnológicamente integrado.

Palabras clave: Educación a Distancia. Pandemia. Transformación. ERE.

1 INTRODUCTION

The COVID-19 pandemic has caused an unprecedented disruption in education systems on a global scale, resulting in the closure of schools and the abrupt migration of pedagogical activities to the digital environment. In the Brazilian context, this transition did not configure a planned adoption of Distance Education (DE), but rather the massive and reactive implementation of what the specialized literature calls Emergency Remote Education (ERE)¹. The distinction between these two concepts is crucial for the critical analysis of the period.

1.1 FROM THE CLASSROOM TO THE SCREEN: THE RUPTURE OF EMERGENCY REMOTE TEACHING (ERE)

In the scenario of remote and hybrid classes, the Geography degree course at the Federal University of Triângulo Mineiro, especially the supervised internships, recognized as central moments of practical training and direct understanding of the teaching-learning process, had to adapt quickly. These stages became, simultaneously, spaces for experimentation and rupture, evidencing both improvisations and innovative pedagogical initiatives.

The internship reports constitute, in this context, immediate and direct records of the educational conjunctures of the period, functioning as privileged sources to understand how the teacher in training experienced and reacted to the shock of virtualization. This work is based on the assumption that the documentation produced by these interns is not limited to a technical record; it is also a social and pedagogical witness. Such documents allow diagnosing structural conditions (infrastructure and educational policies), teaching practices (methodologies and mediation) and effects on learning and student engagement.

While distance education is a teaching modality with a pedagogical project, methodology, instructional design and technological infrastructure conceived from the beginning for non-face-to-face learning, ERE is characterized as a temporary and improvised solution, a transposition of the logic of the face-to-face classroom to digital media, often without proper planning, teacher training or institutional support. The ERE, therefore, was not a pedagogical choice, but a contingency response to a health crisis. Its implementation was marked by urgency, by the absence of a prior diagnosis of the conditions of access of students and professors, and by the lack of investment in training and development actions.⁵ This improvised nature led some analysts to describe the ERE as a "workaround", a precarious solution to a complex problem, which rejected the accumulated knowledge about distance education and operated based on the individual adaptation of its actors. This terminological

distinction is not merely academic; it constitutes an analytical and political act. Framing the pandemic experience as ERE, and not as distance education, is to recognize that the failures observed do not stem from a specific educational model, but from a systemic failure to respond to an emergency, exposing the structural fragility of Brazilian education. The confusion between the terms often serves to legitimize a low-cost and highly precarious solution, obscuring the State's responsibility to provide the material and pedagogical conditions for quality education, whether face-to-face or distance.

1.2 THE GEOGRAPHY OF DIGITAL INEQUALITY IN BRAZIL: THE PRE-PANDEMIC SCENARIO

The crisis of Emergency Remote Education cannot be understood without an analysis of the terrain on which it has been installed. The pandemic did not create educational inequality in Brazil; It acted as a catalyst and a relentless diagnostic tool, exposing and deepening social and digital fractures that were already deeply ingrained in the country's structure. Brazil entered the health crisis with a scenario of deep digital apartheid. Data from national surveys, such as ICT Education in Cetic.br, already indicated, long before 2020, that access to devices and quality connectivity was dramatically unequal, reproducing and amplifying socioeconomic, racial, and regional inequities.

Studies and reports by organizations such as "Todos Pela Educação" already denounced that inequality in access to public education was a structural problem.⁹ Brazil was already classified as one of the most unequal economies in the world in terms of education, with a performance gap between students with higher and lower purchasing power. With regard to technological infrastructure, public schools were notoriously precarious, with insufficient or unmaintained computers and a lack of continuing education for teachers.¹⁰ Data from the School Census, compiled by INEP, corroborate this disparity, showing glaring differences in the technological support and teacher training offered by state and municipal networks compared to the private sector.¹⁴ In this context, the forced transfer to the ERE was not a leveler, but a multiplier of inequalities.

By making access to the internet and the possession of an electronic device prerequisites for the right to education, the education system effectively excluded millions of students who were already in a situation of vulnerability. The pandemic, therefore, functioned as a "forced experiment" on a national scale, whose tragic outcome was predictable: the collapse of access and learning for the poorest was the direct consequence of old and deliberately ignored structural inequalities.

1.3 INTERNSHIP REPORTS AS CRISIS SEISMOGRAPHS: JUSTIFICATION, METHODOLOGY AND OBJECTIVES

If macroeconomic data and national surveys reveal the scale of the educational catastrophe, it is the narratives of daily school life that expose its human texture. In this study, the supervised internship reports produced by Geography undergraduates are conceived as "seismographs" of the crisis: documents capable of recording the tremors of the school floor, the experiences lived, the survival strategies and the fractures exposed by the emergency.

The use of these documents as a source of research is supported by the pedagogical literature, which recognizes them as privileged spaces for reflection, where a fundamental dialogue is established between the theory learned at the university and the practice experienced in the school environment.¹⁶ The reports are not mere bureaucratic records; They are testimonies that reveal the way of being, living and understanding a social fact, allowing the analysis of the conceptions of future teachers about the educational context in which they are inserted.

The initial universe of the research comprised 39 unique reports. To ensure the homogeneity of the corpus and the analytical focus on the ERE experience, a rigorous filtering process was applied. Four documents were excluded from the main analysis because they deviated significantly from the contextual scope: two because they were theoretical essays without a report of internship practice and two because they were produced in 2023 and 2024, representing a post-pandemic context. The calculation basis for the quantitative analysis was thus established in 36 reports that directly described the remote and hybrid teaching experiences between 2020 and 2022.

After a final verification of textual integrity and formal consistency, the set actually used for in-depth statistical analysis and qualitative triangulation was consolidated into 33 reports. The validity of the use of such documents as a source of research is supported by their reflective nature, which allows the investigation of the educational problem in an indirect way, but rich in contextual details.

It is crucial to note that the need to exclude documents due to formal or analytical insufficiency is not just a technical procedure, but a substantive finding in itself. The literature on teacher education emphasizes that the supervised internship should be a moment of development of reflective practice, establishing a fruitful dialogue between the knowledge of experience and formal knowledge. Thus, the finding that a portion of the corpus did not reach a minimum standard of analytical coherence signals a fragility in the training process itself. This "documentary insufficiency" is therefore interpreted as a symptom of a gap in the undergraduate curricula, which sometimes fail to equip future teachers with the necessary

skills for scientific writing and critical reflection on their own practice. The methodology, by exposing this fragility, already produces a diagnosis of teacher training. These documents offer a unique perspective, that of the "participant observer", who, at the same time as experiencing the crisis, is entrusted with the task of critically analyzing it. They capture, firsthand, the difficulties of infrastructure, the reactions of students, the anxieties and innovations of supervising teachers, and the impacts on the teaching-learning process. In view of the above, the objectives of this work are:

1. Systematically map, through a mixed-methods approach, the deficiencies and efficiencies of Emergency Remote Teaching, as reported by Geography teachers in initial training in the period 2020 to 2022.
2. To analyze the causal relationships between material infrastructure, pedagogical practices, student engagement and learning outcomes, triangulating the data from the corpus with the Brazilian educational scenario.
3. Identify and analyze emerging innovative practices and, based on the evidence collected, propose a set of public policies and pedagogical interventions for the construction of a more equitable, resilient, and technologically integrated post-pandemic education system.

To achieve the proposed objectives, a mixed-methods research was designed, which combines quantitative content analysis with qualitative discursive analysis in an integrated way. This approach allows not only to identify the frequency and distribution of phenomena, but also to understand their depth, context, and meaning. The primary source of the study consisted of supervised internship reports produced by students of the Geography Degree course of a higher education institution.

2 DEVELOPMENT

2.1 RESEARCH DESIGN AND CORPUS CONSTRUCTION

To achieve the proposed objectives, a mixed-methods research was designed, which combines quantitative content analysis with qualitative discursive analysis in an integrated way. This approach allows not only to identify the frequency and distribution of phenomena, but also to understand their depth, context, and meaning. The primary source of the study consists of supervised internship reports produced by students of the Geography Degree course of a higher education institution.

The initial universe of the research comprised 39 unique reports. To ensure the homogeneity of the corpus and the analytical focus on the ERE experience, a rigorous filtering

process was applied. Four documents were excluded from the main analysis because they deviated significantly from the contextual scope: two because they were theoretical essays without a report of internship practice and two because they were produced in 2023 and 2024, representing a post-pandemic context. The calculation basis for the quantitative analysis was thus established in 36 reports that directly described the remote and hybrid teaching experiences between 2020 and 2022. After a final verification of textual integrity and formal consistency, the set actually used for in-depth statistical analysis and qualitative triangulation was consolidated into 33 reports. The validity of the use of such documents as a source of research is supported by their reflective nature, which allows the investigation of the educational problem in an indirect way, but rich in contextual details.¹⁸

It is crucial to note that the need to exclude documents due to formal or analytical insufficiency is not just a technical procedure, but a substantive finding in itself. The literature on teacher training emphasizes that the supervised internship should be a moment of development of reflective practice, establishing a fruitful dialogue between the knowledge of experience and formal knowledge.¹⁶ The finding that a portion of the corpus did not reach a minimum standard of analytical coherence signals a weakness in the training process itself. This "documentary insufficiency" is therefore interpreted as a symptom of a gap in the undergraduate curricula, which sometimes fail to equip future teachers with the necessary skills for scientific writing and critical reflection on their own practice. The methodology, by exposing this fragility, already produces a diagnosis of teacher training.

2.2 QUANTITATIVE ANALYSIS: CODING AND STATISTICAL TREATMENT

The quantitative phase of the study was operationalized through the construction of a detailed codebook, which established five central analytical dimensions: (1) Teaching Technique, (2) Infrastructure, (3) Engagement, (4) Resources/Strategies and (5) Learning. Each dimension was broken down into indicators of "deficiency" and "efficiency", coded in a binary way (presence/absence) based on clear and standardized textual signals. For example, the mention of "signal drops" or "impossibility of synchronous participation" was coded as the presence of the indicator "Unstable connection" in the Infrastructure dimension.

To ensure the reliability and objectivity of the coding process, a double coding protocol was implemented. A sample of 20% of the reports (7 documents) was independently coded by two researchers. The agreement between the coders was measured by Cohen's Kappa coefficient, adopting as an acceptance criterion a kappa value ≥ 0.70 , considered indicative of substantial agreement. The divergences identified were resolved through rounds of discussion and adjudication, with all decisions documented in a research diary.

The coded data were tabulated and analyzed with the aid of statistical software. Analyses included absolute and percentage frequencies, measures of central tendency and dispersion, and bivariate crossovers to explore associations between variables. To test the statistical significance of the associations between categorical variables, Pearson's chi-square test (χ^2) was used. In cases where the expected frequencies in any cell of the contingency table were less than 5, Fisher's exact test was applied, which is more robust for small samples. The strength of the associations was measured by Cramer's V. All tests were conducted with a significance level of $\alpha=0.05$.

2.3 QUALITATIVE ANALYSIS: TRIANGULATION AND INTERPRETATIVE VALIDATION

Quantitative analysis, while essential for identifying patterns and trends, would be insufficient to capture the complexity of lived experiences. For this reason, the qualitative approach was central to the research, operating in a continuous process of triangulation with the numerical data. The discursive analysis followed procedures of in-depth and reflective reading of the 33 reports. Units of meaning, excerpts, narratives, examples and reflections were identified and submitted to an open thematic coding, allowing the emergence of interpretative categories that complemented and sometimes tensioned the results of binary coding.

The core of the mixed method was the retrosynthetic integration: the numerical patterns (e.g., the high correlation between gamification and participation) were qualitatively investigated to understand how and why this association occurred in the context of the reported practices. Representative examples, borderline cases (atypical situations that defied the general trend) and counter-narratives were extracted and analyzed to give density and nuance to the interpretation. To strengthen the external validity and credibility of the findings, the main interpretations were submitted to a peer validation panel, composed of experienced professors and internship supervisors. This external fact-checking process helped refine the conclusions, ensuring that the interpretations were aligned not only with the data in the corpus, but also with the practical experience of educators who experienced the pandemic period.

2.4 RESULTS: A MULTIFACETED PORTRAIT OF PANDEMIC EDUCATION

The analysis of the 33 internship reports, totaling approximately 400 pages of narratives and reflections, offers a detailed and multifaceted overview of basic education during the height of the COVID-19 pandemic. Quantitative data reveals consistent patterns of structural difficulties and pedagogical impacts, while qualitative analysis illuminates the

human experiences behind the numbers. The following table presents a summary of the overall metrics, serving as a roadmap for the detailed discussion that follows. It exposes the central tension identified in the study: the coexistence of high rates of deficiency in structural dimensions (infrastructure, engagement) with significant indicators of efficiency and resilience in pedagogical dimensions (teaching technique, learning).

Table 1

Overall Metrics of Reported Deficiencies and Efficiencies (N = 33)

DIMENSION	METRIC, DEFICIENCY (N)	%	METRIC, EFFICIENCY (N)	%
Teaching technique	Technical Issues/Stress (11)	33,3%	Creative Adaptation (18)	54,5%
Infrastructure	Unstable Connection (20)	60,6%	Consistent Access (4)	12,1%
Appliances	Lack of devices (16)	48,5%		
Engagement	Low Frequency (28)	84,8%	Active Participation (18)	54,5%
	Lack of interaction (22)	66,7%		
Resources	Lectures (19)	57,6%	Gamification / Creative Projects (12)	36,4%
Learning	Lag / Difficulty (26)	78,8%	Effective Learning (17)	51,5%

Source: Authors.

2.5 INFRASTRUCTURE AS A PREPONDERANT FACTOR: THE MATERIAL BASIS OF EXCLUSION

The data in the corpus unequivocally confirm that the lack of technological resources (infrastructure and devices) was the main bottleneck of Emergency Remote Teaching. The "unstable connection" was mentioned in 20 of the 33 reports (60.6%), and the "lack of adequate devices" (computers, tablets or smartphones capable of supporting the platforms) was reported in 16 documents (48.5%). In contrast, only 4 reports (12.1%) described a scenario of consistent and uninterrupted access, all of which referred to experiences in private schools. The qualitative narratives detail the devastating impact of this precariousness: students who "disappeared" from synchronous classes due to the exhaustion of the mobile data package, families who shared a single cell phone for multiple school-age children, and teachers who taught classes from their own homes with unstable internet, generating frustration and discontinuity.

This micro reality, captured in the reports, is a direct reflection of the national crisis of digital inequality. Data from Cetic.br and INEP already pointed to a scenario of digital apartheid in Brazil, where access to quality internet and adequate devices is strongly stratified by social class and geographic location.⁹ INEP's survey "Educational response to the COVID-19 pandemic in Brazil" revealed that, in 2021, only 15.9% of schools in the state network and a derisory 2.2% of municipal schools adopted measures to provide free or

subsidized access to the internet for the students.¹⁴ The statistical analysis of our corpus solidifies this connection between infrastructure and participation: the crossing between the variables "Unstable connection" and "Low frequency" revealed a statistically significant association [$\chi^2(1, N=33) = 4.07$; $p=0.044$; Cramer's $V = 0.35$, indicating a moderate effect]. Of the 20 reports that cited connection problems, 19 (95%) also reported low student attendance. This empirical data is striking: engagement was not, in most cases, a matter of will or motivation, but of material possibility.

2.5.1 Engagement, Interaction, and Avoidance: The Human Consequences of Disconnection

As a direct consequence of infrastructural precariousness, student engagement indicators were drastically negative. "Low frequency" was the most cited problem in the reports, appearing in 28 of the 33 documents (84.8%). "Lack of interaction" (students with cameras and microphones turned off, lack of participation in chats or forums) was the second most common complaint, present in 22 reports (66.7%). The reports describe a scenario of "ghost virtual classrooms", with teachers speaking to a screen full of inactive icons, generating a deep sense of isolation and frustration. The situation was even more serious in Youth and Adult Education (EJA), where interns reported synchronous classes with only "one or two students" connected, evidencing the incompatibility of the ERE model with the reality of the student-worker, who already faces multiple challenges to stay in school.

Again, these local findings dialogue directly with national statistics on school exclusion and dropout during the pandemic. A UNICEF report, based on PNAD data, estimated that, in November 2020, more than 5 million children and adolescents in Brazil did not have access to education, either because they were out of school or because they did not receive remote activities.²⁰ The analysis of the School Census carried out by INESC is even more alarming, pointing to a 128% increase in high school dropout rates between 2020 and 2021.²² The increase was particularly catastrophic in high school the North (846%) and Northeast (218%) regions, the most vulnerable in terms of infrastructure and social indicators.²² The reports of the interns, therefore, are not isolated cases; They are the chronicle, on a small scale, of a process of mass exclusion that denied the right to education to millions of Brazilians.

2.6 THE DOUBLE FACE OF TEACHING PRACTICE: INNOVATION UNDER PRESSURE AND THE COST OF BURNOUT

In the midst of the scenario of structural crisis, the analysis of the "Teaching Technique" dimension reveals a deep ambivalence. On the one hand, a significant majority of reports

(18, or 54.5%) highlighted the "creative adaptation" of teachers. The narratives describe educators who, even with limited resources, sought new tools, learned to use digital platforms, developed multimodal materials, and experimented with active methodologies to try to keep students engaged. This capacity for innovation and resilience is one of the most positive findings of the study.

On the other hand, this innovation had a very high human cost. A third of the reports (11, or 33.3%) explicitly mentioned "technical problems and stress", with complaints about work overload, pressure for productivity, platform instability and mental exhaustion. At least one report documented the absence of a supervising teacher due to burnout. This paradox, innovation coexisting with burnout, is confirmed by several studies on the mental health of teachers during the pandemic. Studies point to the increase in the workload, the invasion of work in the domestic space and the intensification of demands as factors that led to a significant increase in the levels of stress, anxiety and burnout among Brazilian teachers.²³ The "creative adaptation" observed in the reports, therefore, cannot be romanticized as a simple triumph of the teaching vocation. It must be interpreted critically as an act of resistance and individual survival in the face of a system that has failed to provide the necessary support, training and working conditions.

2.7 PEDAGOGICAL PRACTICES IN DISPUTE: TRANSPOSITION VS. TRANSFORMATION

The analysis of teaching strategies reveals a clear division between two pedagogical approaches. The most common, present in 19 reports (57.6%), was the direct "transposition" of the face-to-face model to the virtual environment. This approach consisted mostly of synchronous lectures, with the teacher speaking for long periods, and the use of official teaching materials (PDFs of books, ready-made slides) without didactic reengineering for the digital medium. This strategy, while understandable in the urgency of the moment, proved ineffective in maintaining engagement in an environment full of distractions and limited by poor connectivity.

On the other hand, a significant minority of 12 reports (36.4%) described "transformation" practices, which sought to explore the potential of the digital environment. These reports documented the use of gamification, creative projects, and geotechnologies. Notable examples include using the game Minecraft to simulate the construction of landscapes and urban dynamics, conducting critical cartography activities with Google Earth to analyze territories, and creating contextualized quiz games to discuss geographic themes. The effectiveness of this transformative approach is statistically corroborated. The association analysis between the use of "Gamification/creative projects" and the "Active

participation" of students revealed a strong and highly significant correlation $\chi^2(1.N=33)=15.71$; $p<0.001$; Cramer's $V \approx 0.69$. This result suggests that, when the infrastructure allowed, the choice of active and interactive methodologies was a decisive factor to overcome apathy and promote more effective engagement.

2.7.1 The Legacy of the Learning Gap: An Educational Debt

The end result of this cascade of problems, poor infrastructure, low engagement, and often inadequate pedagogical practices, was an overwhelming perception of learning loss. The "learning gap or difficulty" was pointed out in 26 of the 33 reports, representing 78.8% of the corpus. Interns reported students' difficulties in understanding basic content, the inability to perform activities that required more complex reasoning, and, in the 2022 reports, the finding of significant gaps in essential knowledge during the return to face-to-face classes.

This subjective perception of future teachers is validated by large-scale evaluations. The report "Learning in Basic Education: Brazilian situation in the post-pandemic", by the organization Todos Pela Educação, analyzed the results of the Basic Education Evaluation System (SAEB) and concluded that student performance in Portuguese Language and Mathematics has not yet returned to pre-pandemic levels, with the public network being the most affected.¹³ The pandemic, therefore, not only interrupted the learning process, But it has generated a setback, creating an "educational debt" that will require years of investment and focused policies to be remedied. The data from this study, by capturing the diagnosis made on the school floor, offer a qualitative view of the depth of this gap, which manifests itself not only in grades, but in the concrete difficulty of students in reconnecting with knowledge. Presenting these results together reveals a clear causal chain: the failure of the infrastructural base triggered a crisis of participation, which in turn resulted in a deep learning crisis, with teachers at the epicenter, trying to mitigate the damage at the expense of their own health.

3 INTERPRETING THE SIGNALS OF A SYSTEM UNDER STRESS

The analysis of the results allows us to transcend the mere description of the phenomena to build a critical interpretation of the dynamics that marked Brazilian education during the pandemic. The data, when read together and in the light of the national context, reveal not only the difficulties of an exceptional period, but the chronic failures of an educational system that operates at the limit of precariousness.

3.1 INFRASTRUCTURE AS A CONDITION OF PEDAGOGICAL POSSIBILITY

The most robust and fundamental finding of this study is the centrality of infrastructure. The statistical analysis that demonstrates the strong association between connection instability and low frequency does not point to a mere correlation, but to a determinant causal relationship. Infrastructure was not just one variable among others; it functioned as a condition of possibility for any pedagogical action. In other words, material access (devices and connectivity) preceded and conditioned pedagogical access. Where infrastructure has failed, the right to education has been summarily denied, regardless of the quality of the teacher's planning, the relevance of the content, or the student's motivation.

This finding has profound implications. She categorically refutes any narrative that tries to individualize the failure of ERE, attributing it to the "unwillingness" of students or the "digital incompetence" of teachers. The problem was not primarily pedagogical or motivational, but material and political. The historic decision not to invest in a robust digital inclusion policy for public education created an intrinsically vulnerable system, whose failure in a crisis scenario was not only predictable, but inevitable. The pandemic, in this sense, has only made it explicit that, in the twenty-first century, digital infrastructure is as essential to education as the school building, textbooks, and school lunches. To ignore this material dimension is to condemn any educational policy to irrelevance.

3.2 THE HUMAN COST OF RESILIENCE: INNOVATION AS AN ACT OF SURVIVAL

The coexistence of reports of creative adaptation with narratives of teacher burnout exposes one of the most perverse ambiguities of the pandemic period. The professors' capacity for innovation, documented in more than half of the reports, is a testament to their professional commitment. However, it is imperative to analyze the political economy behind this "resilience". Celebrating teacher creativity without questioning the conditions that made it an act of individual heroism is dangerous. Innovation emerged not as the result of a support system, with continuing education, adequate resources and institutional support, but as a survival mechanism in the midst of systemic abandonment.

The discourse of "resilience" can thus be co-opted for political ends, serving to applaud teachers while justifying the continued precariousness of their work and the underfunding of education. It shifts responsibility from the sphere of the State to the sphere of the individual, transforming a collective failure into an opportunity for personal overcoming. Critical analysis of the data suggests a reinterpretation: the true measure of a robust education system is not the resilience of its actors in the face of collapse, but the capacity of the system itself to be resilient, that is, to absorb shocks without transferring the cost to the physical and mental

health of its professionals.²⁴ The challenge, Therefore, it is not just celebrating the innovation that has emerged from the crisis, but creating the institutional conditions for it to become a sustainable practice and not a desperate response to chaos.

3.3 THE TRAINING GAP REVEALED: THE INTERNSHIP AS A DIAGNOSIS OF THE DEGREE

As pointed out in the methodology section, the difficulty in analyzing a portion of the corpus due to its low formal and analytical quality is a result in itself. The internship reports, as instruments of evaluation and reflection, also work as a mirror of the training received by the undergraduates. The inability of some future teachers to produce a minimally structured report, which articulates observation, description and critical analysis, points to a significant gap in the teaching degree curricula.

The supervised internship, ideally, should be the apex of the training, the moment in which the student mobilizes the theoretical framework to interpret and intervene in the complex reality of the classroom.¹⁶ When the final product of this process is a superficial or merely descriptive document, this signals that the training may be failing to develop essential competencies such as academic writing, the capacity for evidence-based analysis and, fundamentally, the practice of critical reflection. The pandemic, by intensifying the complexities of teaching, has only made this training gap more visible. Therefore, the criticism that emerges from the data is not only directed at basic education, but also at higher education, calling on universities to rethink their models of teacher training, strengthening the articulation between theory and practice, and equipping future educators to be not only curriculum executors, but researchers of their own practice.

3.4 UNTAPPED POTENTIALS: SEEDS OF A HYBRID FUTURE

Despite the predominantly bleak scenario, the reports also contain seeds of a potentially richer and more engaging educational future. Successful experiences with gamification, geotechnology-based projects, and collaborative mapping should not be seen as mere curiosities or exceptions. They are proofs of concept that demonstrate the immense potential of digital tools when used not to transpose, but to transform pedagogical practice. The use of Google Earth for critical cartography, for example, allows an approach to the territory that would be impossible in a traditional classroom. The use of digital games, as evidenced by the strong correlation with active participation, can increase student motivation and engagement significantly.

These emerging practices point to a path beyond the simplistic dichotomy between "good face-to-face" and "bad remote". They suggest the possibility of a hybrid and intentional model, which combines the best of both worlds: the interaction and the link of face-to-face meeting with the possibilities of personalization, collaboration and exploration of the digital universe. The great challenge, however, is to move these practices from the field of individual and isolated effort to the center of educational policy. Without investment in infrastructure, continuous teacher training and the development of quality pedagogical resources, these potentials will remain untapped, and the most valuable lessons of the pandemic crisis will have been in vain.

4 FROM EMERGENCY TO STRATEGY: PROPOSALS FOR AN EQUITABLE DIGITAL TRANSFORMATION

The diagnosis of the pandemic educational crisis requires more than the verification of failures; it demands the formulation of paths to overcome. The following proposals are not a menu of isolated solutions, but the pillars of an integrated ecosystem, designed to transform emergency practices into robust institutional strategies. Each proposal responds directly to a problem identified in the analysis of the reports, seeking to convert the traumatic experience of the ERE into systemic learning.

4.1 TERRITORIAL CURATORSHIP AND DIGITAL SOCIAL CARTOGRAPHY: BEYOND THE VIRTUAL FIELD CLASS

The transposition of the field class to the virtual environment, often limited to a passive "tour" through Google Street View, can be radically transformed. The proposal is the development of territorial curatorship platforms, which integrate geotechnologies (satellite images, GIS) with multimodal repositories (videos, audios, texts, oral narratives). More importantly, these platforms should be structured around the principles of Social Cartography and Participatory Mapping.²⁷ Instead of consuming ready-made maps, students would be protagonists in the construction of critical cartographies of their own territories, mapping not only physical elements, but also social, cultural, economic, and environmental dynamics.³¹ This approach transforms the student from a spectator into a researcher, developing geographical reasoning and citizen awareness by allowing them to take a critical position on their own reality.²⁹

4.2 COMMUNITIES OF PRACTICE AND REVERSE MENTORING: INSTITUTIONALIZING PEER SUPPORT

Teacher overload and isolation can be combated by the formalization of support networks. The proposal is the creation of communities of practice and the implementation of Reverse (or Reversed) Mentoring programs. This model subverts the traditional logic of training, recognizing that knowledge about digital technologies is heterogeneously distributed in the school community.³⁵ In a reverse mentoring program, students with high digital fluency or younger, technologically skilled teachers are formally assigned to mentor more experienced colleagues in practical tasks, such as the use of a new platform, the editing of videos or the creation of interactive activities.³⁷ This low-cost, high-impact strategy values the knowledge that exists in the school, strengthens professional ties and accelerates the dissemination of pedagogical innovations, reducing dependence on external training courses, which are often decontextualized from the school reality.

4.3 LEARNING RETRIEVAL WITH ADAPTIVE PATHS: CUSTOMIZING SUPPORT

The deep learning gap, one of the most serious legacies of the pandemic, cannot be addressed with generic recovery strategies. The proposal is the adoption of Adaptive Learning platforms, which use algorithms and artificial intelligence to personalize student support.⁴⁰ Such systems can, through continuous diagnostic assessments, identify the specific knowledge gaps of each student and, from there, generate personalized learning paths, with activities, videos, and games focused on their needs.⁴³ This approach makes it possible to overcome the "one-size-fits-all" model of retrieval offering more efficient and targeted support. The implementation of modular adaptive retrieval packages, especially for the essential contents, can be a powerful tool to mitigate the effects of learning loss and promote equity.

4.4 OPEN AND AUDITABLE RESOURCE ECOSYSTEMS: THE END OF "REINVENTING THE WHEEL"

The teaching overload was aggravated by the need for each teacher to create, from scratch, their own teaching materials for the remote environment. To optimize this effort, it is proposed to create a National Repository of Learning Objects (LO), public and open access.⁴⁵ Unlike a simple file bank, this would be an auditable ecosystem, where teachers from all over the country could not only download, but also upload, adapt and evaluate digital pedagogical resources (lesson plans, videos, simulations, games).⁴⁸ A peer review system would ensure the quality and pedagogical relevance of the materials.⁴⁸ Such a repository

would combat redundancy of efforts, disseminate best practices, and ensure that even teachers in schools with fewer resources have access to a high-quality collection, promoting equity and collaboration on a national scale.

4.4.1 Observatory of Teaching Work: Measuring the "Human Cost"

The mental health crisis of teachers, evidenced in this and other studies, cannot be treated only with palliative actions. It is necessary to create institutional mechanisms to monitor and manage working conditions. It is proposed to create an Observatory of Teaching Work, an institutional tool to measure and analyze the "human cost" of the profession, especially in periods of crisis.⁵⁰ This observatory would collect and analyze data such as effective working hours (including planning and correction outside of working hours), time dedicated to the production of materials, self-reported stress levels, and risk factors for burnout.⁵² The data generated by this tool would allow managers to take evidence-based decisions for the rebalancing of the workload, the allocation of support resources and the formulation of occupational health policies, moving from a reactive management to a proactive management of teacher well-being.

These five proposals, interdependent, form a cohesive strategy. Digital social cartography (6.1) is enhanced by repository resources (6.4) and reverse mentoring training (6.2). The adaptive trails (6.3) combat the gap, freeing the teacher for more creative practices. And the observatory (6.5) ensures that this entire process takes place in a sustainable way. Together, they outline a path for the education system to not only recover from the pandemic, but evolve into a fairer, more collaborative, and more effective model.

5 CONCLUSION

The integrated analysis of supervised internship reports in Geography offers an unequivocal conclusion: the COVID-19 pandemic was not the primary cause of the Brazilian educational crisis, but a powerful diagnostic agent that exposed and amplified the structural inequalities that have long undermined the system. The digital access infrastructure proved to be the fundamental variable that determined who would or would not have the right to education, transforming social inequality into explicit educational exclusion. This study demonstrated, through a causal chain of evidence, how infrastructural failure led to the collapse of student engagement and, consequently, to a deep and lasting learning gap.

Amid this scenario of systemic failure, teacher resilience and creativity emerged as a notable resistance force. Active methodologies and the innovative use of geotechnologies, when material conditions permitted, proved to be powerful allies in promoting participation

and meaningful learning. However, this innovation occurred at an exorbitant human cost, evidenced by the high levels of stress and professional burnout, a testimony to the institutional abandonment to which educators were subjected.

The internship reports, therefore, function as documents of a critical time, chronicles of the school floor that should serve as a basis for the formulation of public policies. The lessons of the pandemic cannot be forgotten. It is imperative that future policies inextricably articulate massive investment in digital infrastructure, continuous and contextualized teacher training and a curricular reconfiguration that integrates digital skills in a critical and creative way. The innovative proposals presented in this work, from digital social cartography to reverse mentoring, from adaptive learning trails to observatories of teaching work, aspire to be more than one-off recommendations. They represent the pillars of a new paradigm: converting the improvised practices of the emergency into an intentional, equitable, and resilient pedagogical ecosystem, capable not only of facing the next crisis, but of offering, on a daily basis, the quality education that all Brazilians deserve.

REFERENCES

- Autoeficácia docente e acesso a recursos no ensino remoto emergencial: Escalas psicométricas. (2024). *Revista Colombiana de Psicología*. Recuperado em 10 de março de 2025, de http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0123-417X2024000200087
- Cenário da exclusão escolar no Brasil. (2021). UNICEF. Recuperado em 23 de setembro de 2025, de <https://www.unicef.org/brazil/media/14026/file/cenario-da-exclusao-escolar-no-brasil.pdf>
- Cetic.br. (2022). Pesquisa TIC Educação 2022: Resumo executivo. Recuperado em 14 de agosto de 2025, de https://cetic.br/media/docs/publicacoes/2/20231122125825/tic_educacao_2022_resumo_executivo.pdf
- COVID-19: Ensino remoto emergencial e saúde mental de docentes universitários. (2021). *Revista Brasileira de Saúde Materno Infantil*. Recuperado em 23 de setembro de 2025, de <https://www.scielo.br/j/rbsmi/a/b3TVbVHcCZRxkVZPFPK6PHF/?lang=pt>
- Desigualdade no acesso à internet impacta qualidade da educação. (2021). CNTE-CUT. Recuperado em 8 de agosto de 2025, de <https://cnte.org.br/noticias/desigualdade-no-acesso-a-internet-impacta-qualidade-da-educacao-c1bf>
- Desigualdades digitais e educação. (2021). *Ciência Hoje*. Recuperado em 17 de setembro de 2025, de <https://cienciahoje.org.br/artigo/desigualdades-digitais-e-educacao/>
- Direito ou privilégio? Desigualdades digitais, pandemia e os desafios de uma escola pública. (2021). *Educação & História*. Recuperado em 23 de setembro de 2025, de <https://www.scielo.br/j/eh/a/SGqJ6b5C4m44vh8R5hPV78m/>

Divulgados dados sobre impacto da pandemia na educação. (2022). Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP). Recuperado em 23 de setembro de 2025, de <https://www.gov.br/inep/pt-br/centrais-de-conteudo/noticias/censo-escolar/divulgados-dados-sobre-impacto-da-pandemia-na-educacao>

Ensino remoto emergencial: Práticas educacionais e percepções docentes. (2021). Educação & Realidade. Recuperado em 23 de setembro de 2025, de <https://www.scielo.br/j/edreal/a/G8Gjnrrm4Ry4Mp35BJk7yQb/>

Ensino remoto emergencial (ERE) versus educação a distância. (2020). Dtcom. Recuperado em 15 de setembro de 2025, de <https://dtcom.com.br/ensino-remoto-emergencial-ere-versus-educacao-a-distancia-ead-principais-diferencas-e-a-vantagem-de-se-tornar-ead/>

Estágio supervisionado: A relação teoria e prática reflexiva na formação de professores do curso de Licenciatura em Pedagogia. (2021). Revista Brasileira de Estudos Pedagógicos. Recuperado em 23 de setembro de 2025, de <https://www.scielo.br/j/rbeped/a/hX97HhvkMZnDnkxLyJtVXzr/>

Estudo revela retrocessos e aumento das desigualdades no ensino. (2022). Observatório 3º Setor. Recuperado em 23 de setembro de 2025, de <https://observatorio3setor.org.br/educacao-basica-brasil-aprendizagem/>

Geo-grafias do cotidiano: A cartografia social na (re)descoberta dos espaços vividos pelos estudantes. (2022). Geoconexões. Recuperado em 23 de setembro de 2025, de <https://www2.ifrn.edu.br/ojs/index.php/geoconexoes/article/view/17279>

Importância do estágio supervisionado: Integração entre teoria e prática e formação profissional de licenciandos. (2023). SciELO Preprints. Recuperado em 23 de setembro de 2025, de <https://preprints.scielo.org/index.php/scielo/preprint/view/9210>

Mapeamento colaborativo e a mobilização de conhecimentos geográficos poderosos na escola. (2022). GEOgraphia. Recuperado em 23 de setembro de 2025, de <https://www.scielo.br/j/geo/a/wzd6nL7f7wVpmq93Rbh5qFF/>

O ensino remoto emergencial na formação superior em saúde no Brasil. (2022). SciELO Preprints. Recuperado em 23 de setembro de 2025, de <https://preprints.scielo.org/index.php/scielo/preprint/view/4751>

Os impactos da pandemia na acentuação da desigualdade digital. (2022). Revista Metaxy (UFRJ). Recuperado em 23 de setembro de 2025, de <https://revistas.ufrj.br/index.php/metaxy/article/view/64691>

Pandemia, EaD e ensino remoto emergencial no Instituto Federal de Goiás (Brasil). (2024). Educação & Pesquisa. Recuperado em 17 de setembro de 2025, de http://educa.fcc.org.br/scielo.php?script=sci_arttext&pid=S1413-24782024000100245

Pesquisa no estágio supervisionado: Alguns resultados e muitas possibilidades. (2018). Dialnet. Recuperado em 23 de setembro de 2025, de <https://dialnet.unirioja.es/descarga/articulo/6555426.pdf>

Registros do Censo Escolar: Tecnologias digitais nas escolas brasileiras durante a pandemia de COVID-19. (2022). Cadernos CEDES. Recuperado em 7 de agosto de 2025, de <https://www.scielo.br/j/ccedes/a/f5NtS5Fv53QfGCmGGptRNXh/>

Ser professor na pandemia: Impactos na saúde mental. (2021). Revista Arco – UFSM. Recuperado em 23 de setembro de 2025, de <https://www.ufsm.br/midias/arco/saude-mental-professores-pandemia>

Síndrome de burnout em docentes da rede pública no Brasil. (2022). RevistaFT. Recuperado em 23 de setembro de 2025, de <https://revistaft.com.br/sindrome-de-burnout-em-docentes-da-rede-publica-no-brasil/>

Sobre o ensino remoto emergencial (ERE). (2020). Universidade Federal da Integração Latino-Americana. Recuperado em 15 de setembro de 2025, de <https://portal.unila.edu.br/informes-coronavirus/ensino-remoto-emergencial/sobre-ere>

Trabalho docente em tempos de pandemia: Os efeitos das atividades remotas na saúde mental de professores. (2022). Atos de Pesquisa em Educação. Recuperado em 23 de setembro de 2025, de <https://ojsrevista.furb.br/ojs/index.php/atosdepesquisa/article/view/11840>

Unicef: 5,5 milhões estavam sem atividades escolares em outubro. (2021). Agência Brasil. Recuperado em 23 de setembro de 2025, de <https://agenciabrasil.ebc.com.br/educacao/noticia/2021-01/unicef-55-milhoes-estavam-sem-atividades-escolares-em-outubro>

THE ROLE OF SOCIAL MEDIA AND GENDER-BASED VIOLENCE: HOW PSYCHOLOGY CAN CONTRIBUTE TO ADDRESSING THESE PRACTICES

O PAPEL DAS MÍDIAS SOCIAIS E A VIOLÊNCIA DE GÊNERO: COMO A PSICOLOGIA PODE CONTRIBUIR PARA O ENFRENTAMENTO DESSAS PRÁTICAS

EL PAPEL DE LAS REDES SOCIALES Y LA VIOLENCIA DE GÉNERO: CÓMO LA PSICOLOGÍA PUEDE CONTRIBUIR AL ENFRENTAMIENTO DE ESTAS PRÁCTICAS



<https://doi.org/10.56238/sevened2026.008-053>

Allyson Yann Batista Santos¹, Juliana Penha Messias², Danubio Freire Gomes de Matos Neto³, Francisca Moraes da Silveira⁴

ABSTRACT

Gender-based violence constitutes a structural phenomenon sustained by historical, cultural, and political inequalities that place women in situations of vulnerability. Based on a literature review, this study investigated the relationship between violence against women, media discourses, and social media dynamics, also considering the contributions of Psychology in addressing this context. Recent national data show that millions of women remain exposed to domestic violence and various forms of aggression, which now also manifest in the virtual environment. The analysis of media production reveals that normalization, victim-blaming, and revictimization continue to be present in journalistic coverage and digital content, reinforcing gender stereotypes and perpetuating discriminatory practices. Psychology, guided by ethical-political principles and the recognition of intersectionalities, plays a central role in prevention, support, and the promotion of women's autonomy, working in articulation with the Protection Network. Although the literature demonstrates advances, a scarcity of studies integrating gender-based violence, social media, and psychological impacts was observed, indicating the need to expand research on how the digital environment influences social perceptions and subjective processes involved in violence against women.

Keywords: Gender-Based Violence. Violence Against Women. Social Media. Psychology.

RESUMO

A violência de gênero constitui um fenômeno estrutural sustentado por desigualdades históricas, culturais e políticas que colocam as mulheres em posição de vulnerabilidade. A partir de uma revisão bibliográfica, este trabalho investigou a relação entre violência contra a mulher, discursos midiáticos e dinâmicas das mídias sociais, considerando também as contribuições da Psicologia no enfrentamento desse cenário. Os dados nacionais recentes

¹ Undergraduated student. Universidade Federal do Maranhão.

² Undergraduated student. Universidade Federal do Maranhão.

³ Undergraduated student. Universidade Federal do Maranhão.

⁴ Professor. Universidade Federal do Maranhão.

mostram que milhões de mulheres continuam expostas à violência doméstica e às diversas formas de agressão, que hoje também se manifestam no ambiente virtual. A análise da produção midiática evidencia que a naturalização, a culpabilização da vítima e a revitimização seguem presentes em coberturas jornalísticas e conteúdos digitais, reforçando estereótipos de gênero e perpetuando práticas discriminatórias. A Psicologia, guiada por princípios ético-políticos e pelo reconhecimento das interseccionalidades, tem papel central na prevenção, acolhimento e promoção da autonomia das mulheres, articulando-se à Rede de Proteção. Embora a literatura demonstre avanços, observou-se escassez de estudos que explorem de forma integrada violência de gênero, mídias sociais e impactos psicológicos, indicando a necessidade de ampliar investigações sobre como o ambiente digital influencia percepções sociais e processos subjetivos envolvidos na violência contra a mulher.

Palavras-chave: Violência de Gênero. Violência Contra a Mulher. Mídias Sociais. Psicologia.

RESUMEN

La violencia de género constituye un fenómeno estructural sostenido por desigualdades históricas, culturales y políticas que colocan a las mujeres en una situación de vulnerabilidad. A partir de una revisión bibliográfica, este estudio investigó la relación entre la violencia contra la mujer, los discursos mediáticos y las dinámicas de las redes sociales, considerando también las contribuciones de la Psicología en el enfrentamiento de este escenario. Datos nacionales recientes muestran que millones de mujeres continúan expuestas a la violencia doméstica y a diversas formas de agresión, que actualmente también se manifiestan en el entorno virtual. El análisis de la producción mediática evidencia que la naturalización, la culpabilización de la víctima y la revictimización siguen presentes en la cobertura periodística y en los contenidos digitales, reforzando estereotipos de género y perpetuando prácticas discriminatorias. La Psicología, guiada por principios ético-políticos y por el reconocimiento de las interseccionalidades, desempeña un papel central en la prevención, el acompañamiento y la promoción de la autonomía de las mujeres, articulándose con la Red de Protección. Aunque la literatura demuestra avances, se observó una escasez de estudios que integren de manera conjunta la violencia de género, las redes sociales y los impactos psicológicos, lo que indica la necesidad de ampliar investigaciones sobre cómo el entorno digital influye en las percepciones sociales y en los procesos subjetivos implicados en la violencia contra la mujer.

Palabras clave: Violencia de Género. Violencia Contra la Mujer. Redes Sociales. Psicología.

1 INTRODUCTION

Gender violence against women is a structural and persistent phenomenon in Brazilian society, crossing different social, historical, and cultural contexts. It is a multifaceted reality, marked by unequal power relations sustained by a macho logic, which legitimizes male domination and naturalizes the violation of women's fundamental rights (SAFFIOTI, 2001 apud LEMOS et al., 2024). This violence can be expressed in different ways, including physical, psychological, emotional, sexual and economic aggression, deeply affecting the integrity and dignity of women (GOMES; OLIVEIRA, 2022).

In Brazil, the impacts of this violence assume alarming proportions. Data from Datasenado, referring to a survey carried out in 2025 with about 22 thousand women, indicate that approximately 3.7 million Brazilian women suffered some type of domestic or family violence in that year alone. These numbers show that, despite legislative advances and awareness campaigns, violence against women remains widely disseminated in everyday social life. Information from Dial 180 reinforces this scenario, pointing out that, among more than 834 thousand calls received by the service, most were related to the search for guidance and referrals, revealing both the recurrence of violence and the constant need for information and institutional support.

Historically, gender violence has been relegated to the private sphere and, for a long time, treated as an intimate problem or justified by discourses that romanticized it, such as the so-called "love crimes". The consolidation of legal and normative frameworks, such as the Convention of Belém do Pará and the Maria da Penha Law, made possible a fundamental change in this understanding, recognizing violence against women as a serious violation of human rights and as an expression of unequal power relations between men and women (ORGANIZATION OF AMERICAN STATES, 1994; BRAZIL, 2006).

Understanding this phenomenon requires avoiding explanations that reduce it to individual deviations or isolated pathologies. Gender violence is rooted in a patriarchal structure that authorizes practices of control, possession and silencing of the female body and subjectivity, reinforced by gender stereotypes that associate the masculine with power and the feminine with submission (BELISÁRIO; REIS, 2019). In addition, this experience is not evenly distributed. The perspective of intersectionality shows that markers such as race, social class, and territory produce distinct vulnerabilities, making black, indigenous, and transvestite women even more exposed to violence and difficulties in accessing justice (CRENSHAW, 2017).

In contemporary times, this scenario is complexified by the centrality of the internet and social media. In a hyperconnected world, these spaces act simultaneously as

environments for welcoming, circulating information, and strengthening support networks, but also as territories for the reproduction and amplification of gender violence. Data from the UN Broadband Commission indicate that 73% of connected women have already been exposed to some type of online violence, showing that the virtual environment reproduces and sometimes intensifies inequalities and aggressions present in the offline world.

In this context, Psychology is called upon to assume an ethical-political commitment in confronting violence against women, recognizing the subjective impacts of these experiences and acting in an articulated way with other public policies and protection networks. Thus, the present work aims to investigate the relationship between gender violence and social media, analyzing how the virtual environment influences the repercussion of discourses on violence against women and how Psychology can be inserted in this field as a fundamental ally in prevention, reception and promotion of rights.

2 THEORETICAL FOUNDATION

2.1 VIOLENCE AGAINST WOMEN: DEFINITION AND PERSPECTIVES

Violence against women can be defined according to article 5 of Law 11.340, of August 7, 2006 as:

Domestic and family violence against women is defined as any action or omission based on gender that causes death, injury, physical, sexual or psychological suffering, and moral or property damage: I - within the scope of the domestic unit, understood as the space of permanent coexistence of people, with or without family ties, including those sporadically aggregated; II - within the family, understood as the community formed by individuals who are or consider themselves related, united by natural ties, by affinity or by express will; III - in any intimate relationship of affection, in which the aggressor lives or has lived with the offended party, regardless of cohabitation. (Law 11.340 of August 7, 2006).

The excerpt above shows how violence is an action with multiple aspects and that can happen in different forms and environments but that cause damage to the physical and moral integrity of women, it is known that these violences are inserted within a cultural context through social relations, having a direct intersection with cultural, historical and political aspects (Minayo, 1999 apud Lemos et al 2024).

Historically, the place of the woman was delimited and reduced to a space of submission and that of a subject without wills and rights, these ideals were reinforced by the law existing at the time, such as the Civil Code of 1916, in which it allowed women to work, but only with the authorization of their husband (Blay, 2003 apud Santiago and Coelho, 2011),

all these ideas and perspectives that have been constituted throughout history that cross violence against women.

Over time, measures, rights and laws have been created that ensure more rights and protection for women women, one of the most striking actions is the creation of the Maria da Penha Law, which consists of being a legislation with the objective of:

to curb and prevent domestic and family violence against women, under the terms of § 8 of article 226 of the Federal Constitution, the Convention on the Elimination of All Forms of Violence against Women, the Inter-American Convention on the Prevention, Punishment and Eradication of Violence against Women and other international treaties ratified by the Federative Republic of Brazil; provides for the creation of Courts for Domestic and Family Violence against Women; and establishes measures of assistance and protection for women in situations of domestic and family violence.

In the Maria da Penha Law, some types of violence that can be committed against women are evidenced, such as physical violence, which according to the law can be defined as actions of any nature that attack the integrity of women. Another form of violence is sexual violence, which can be understood as acts that force the woman to view or participate in sexual relations against the woman's will. (Law 11.340 of August 7, 2006).

There is also patrimonial violence that consists of any action aimed at removing or destroying the woman's property, personal objects among others, the law also addresses moral violence that is understood as actions that fall under crimes against honor. (Law 11.340 of August 7, 2006).

And finally, the law later added to its creation psychological violence, which is configured as any action, such as manipulation, threat, persecution that emits any type of emotional data on the woman, the law brings as an example the decrease in self-esteem. (Law 11.340 of August 7, 2006).

Violence against women is internationally recognized as a violation of human rights and a social phenomenon sustained by historically constructed gender inequalities. The Inter-American Convention on the Prevention, Punishment and Eradication of Violence against Women, known as the Convention of Belém do Pará, defines violence against women as "any act or conduct based on gender that causes death, harm or physical, sexual or psychological suffering to women, both in the public and private spheres" (BRASIL, 1996). This definition broadens the understanding of violence beyond the domestic space, allowing it to include institutional, media, and digital contexts, which also produce suffering and violations.

The same Convention ensures that "every woman has the right to a life free from violence, both in the public and private spheres" (BRASIL, 1996), which reinforces the need

to analyze how virtual environments and social media can become spaces for the reproduction of violent practices. By recognizing that violence is not restricted to physical contact, the treaty provides a basis for discussion on symbolic, psychological, and discursive violence, often present in the media exposure of cases of gender violence.

In addition, the Convention of Belém do Pará assigns to States the responsibility of confronting the cultural roots of violence by establishing the duty to "modify the social and cultural standards of conduct of men and women (...) in order to combat prejudices and customs and all other practices based on the premise of the inferiority or superiority of any of the genders" (BRASIL, 1996). This guideline dialogues directly with the criticism of media discourses that naturalize violence, blame victims or reinforce gender stereotypes, contributing to processes of revictimization.

In addition, the International Covenant on Civil and Political Rights guarantees the protection of privacy, honor and reputation by stating that "no one may be the object of arbitrary or illegal interference in his or her private life (...) nor of illegal offenses to their honor and reputation" (BRASIL, 1992). This provision supports the analysis of violence committed in the digital environment, such as vexatious exposure, cyberbullying and the dissemination of content that attacks the dignity of women on social networks.

Although it recognizes freedom of expression as a fundamental right, the Covenant also establishes that its exercise implies duties and responsibilities, and may be restricted when necessary to ensure "respect for the rights and reputation of other people" (BRASIL, 1992). Thus, violent or misogynistic speeches broadcast in the media cannot be legitimized under the argument of freedom of expression when they cause psychological and social damage to women.

These international norms dialogue with national theoretical production by understanding gender violence as a multifaceted phenomenon. As Saffioti points out, it is a "relationship marked by inequality of power based on a macho logic" (SAFFIOTI, 2001 apud SANTOS; MESSIAS, 2025). This inequality is expressed both in direct practices of violence and in the way cases are narrated and socially repercussioned, especially in the media.

In this context, Psychology assumes a central role in coping with violence, since its performance goes beyond the individual clinical field and is articulated with an ethical and political dimension. As Santos and Messias (2025) state, Psychology, guided by ethical-political principles and the recognition of intersectionalities, acts in the prevention, reception and promotion of women's autonomy, in dialogue with the Protection Network. This action becomes even more relevant in view of the impact of social media, which, according to the

authors, directly influence the way cases of violence are reported and reproduced, and can generate new violence against the victim herself (SANTOS; MESSIAS, 2025).

Thus, the articulation between international treaties, national legislation and psychological knowledge shows that confronting violence against women requires integrated actions, capable of transforming institutional practices, media discourses and cultural patterns that still sustain gender inequality.

2.2 THE NATURALIZATION OF GENDER VIOLENCE IN THE MEDIA DISCOURSE

Research shows that journalism, in Brazil and in other countries, has historically contributed to the naturalization of violence against women (Belisário; Reis, 2019). This scenario is especially worrying when it is recognized that the media not only informs, but also participates in the construction of social meanings, influencing ways of thinking and acting. Its role involves fostering critical reflection, stimulating social transformation, and monitoring the narratives that circulate in the public debate (ANDI; Galvão, 2011).

In Brazil, this problem accompanies decades of journalistic coverage that, recurrently, portrayed women victims of domestic violence as co-responsible for their own aggression, reinforcing stigmas and implicit justifications for the acts suffered (Blay, 2003). Instead of questioning unequal power structures, many news stories ended up adopting simplifying explanations that shift the focus from the aggressor to the victim's conduct.

As a social and discursive practice, journalism participates in the production of subjectivities and the interpretation of reality (Machado, 2006). However, it is observed that part of the coverage remains stuck in common sense, with superficial analyses and little historical or social contextualization (Souza; Oliveira, 2015). Although sustained by the ideal of neutrality, the journalistic text is crossed by ideologies, especially patriarchal, which are manifested in the narrative choices and framing used (Schwaab, 2007).

The analysis of the discourse shows that the meanings produced by the media are expressed both in what is said and in the silencing. Recognizing this opacity requires understanding that formats, lexical choices and narrative structures produce effects of meaning (Orlandi, 2007). Examples of this logic appear in the coverage of the gang rape that took place in Rio de Janeiro in 2016, by G1, and in a similar case reported by the New York Times in 2012. Although situated in different contexts, both illustrate patterns of treatment of victims anchored in patriarchal values that cross borders (Belisário; Reis, 2019; Durham, 2013).

2.3 REVICTIMIZATION AND BLAMING FRAMEWORKS

Revictimization occurs when the victim, when seeking protection or recognition, begins to suffer new damage produced by institutions that should welcome him (Freire Filho; Dos Anjos, 2022). In journalism, this is evidenced in discursive frameworks that, directly or indirectly, attribute responsibility to women for the violence suffered (Entman, 1993).

One of the most recurrent mechanisms is the insinuation of guilt based on the victim's behaviors, choices or characteristics (Prado; Sanematsu, 2017). In the New York Times coverage in 2012, for example, details about dress and conduct were mobilized to suggest co-responsibility of the raped woman, resuming discourses historically used to minimize sexual crimes (Durham, 2013). Situations involving the use of alcohol, clothing considered "inappropriate" or presence in certain spaces are often used to relativize violence (UOL Universa, 2020).

Another problematic mechanism is the deviation of focus, when secondary information about the victim's life is highlighted, while the aggressor is given space to justify his actions. In the coverage of the 2016 rape in Rio de Janeiro, elements such as motherhood, drug use, and belonging to certain social groups were used to delegitimize the victim and deflate the seriousness of the crime (Belisário; Reis, 2019). Headlines such as "Wrong was she" explicitly express the process of blaming and reinforce misogynistic discourses (Freire Filho; Dos Anjos, 2022).

The minimization of violence also appears in euphemisms such as "crime of passion" or "defense of honor", which soften the brutality of the acts and hide their structural root based on gender inequality (Agência Brasil, 2019). Femicide, far from being an impulsive gesture, represents the extreme manifestation of continuous cycles of violence (UOL Universa, 2020). The spectacularization of these crimes also contributes to trivializing the suffering of women (Oliveira et al., 2024).

2.4 GENDER VIOLENCE AND ITS SOCIAL CONSEQUENCES

Violence against women takes various forms physically, psychologically, morally, patrimonially and sexually, as defined by the Maria da Penha Law. It is a structural phenomenon, sustained by gender inequalities and a patriarchal model that organizes social relations and establishes hierarchies (Sousa et al., 2019; UOL Universa, 2020).

With the expansion of digital technologies, this violence has extended to the online environment. Practices such as revenge pornography, stalking, cyberbullying, and sextortion reproduce oppressive dynamics that mostly affect women (Sousa et al., 2019; Poland, 2016).

Analyses of comments in reports on gender violence show that victim-blaming is usually accompanied by minimizing the actions of the aggressors, reaffirming the idea of women as male objects or properties (Lermen; Cúnico, 2018). In the domestic sphere, this naturalization is even more intense, sustained by cultural beliefs that discourage external interventions in marital conflicts (IPEA, 2014).

The typification of femicide by Law No. 13,104/2015 represented a legal advance, but legal changes are not enough to alter deeply rooted practices and discourses (Lermen; Cúnico, 2018). Social conceptions persist that maintain and justify violence.

3 METHODOLOGY

The present study is characterized as a qualitative research, of bibliographic and documentary nature, with the objective of analyzing gender violence, its psychosocial consequences and the way this phenomenon is constructed and reproduced in media discourses. The choice for this approach is based on the possibility of understanding the phenomenon of violence beyond statistical data, considering its social, cultural and subjective meanings.

The selection of scientific articles used as a basis for the research followed criteria of scientific rigor and thematic relevance. Empirical, peer-reviewed studies that presented consistent methodological designs capable of deepening the understanding of gender-based violence were prioritized, with special attention to discussions on psychological violence, gaslighting, resilience, and interventions with perpetrators. The bibliographic search was carried out in databases recognized for their academic credibility, such as PubMed, Virtual Health Library (VHL), Web of Science, SciELO and Sage Journals, using specific descriptors related to the theme, combined by Boolean operators.

In addition to the scientific literature, the study included the analysis of journalistic articles published on portals of great reach and visibility, such as Yahoo and Terra. The choice of these vehicles is justified by the fact that they allow readers to interact through comments, which makes it possible to observe the social construction of the discourses, as well as the presence of mechanisms of blaming, naturalization of violence and revictimization of women.

To ensure the quality and coherence of the corpus analyzed, clear inclusion and exclusion criteria were defined. As inclusion criteria, publications from the last ten years were considered, in order to ensure the timeliness of discussions in the face of recent legislative and social changes, such as the typification of femicide. Studies published in Portuguese, English and Spanish, peer-reviewed empirical articles and studies that directly addressed the keywords of the research, such as psychological violence, gaslighting, resilience, femicide

and media, were included. In the case of media analysis, only news that presented at least ten comments from Internet users were included, enabling the analysis of the discursive interaction.

The exclusion criteria included the removal of gray literature, such as theses, dissertations, and books, with the aim of maintaining the methodological uniformity of the material analyzed. Articles that were not available in full, duplicate studies in different databases, and studies that presented methodological weaknesses, such as lack of clear theoretical foundations, very small samples, or insufficient description of intervention procedures, were also excluded. Studies carried out with populations outside the scope of the research, such as samples exclusively under 18 years of age or contexts that did not dialogue with the analysis of gender relations in the patriarchal model, were also discarded.

These methodological choices allowed the construction of a consistent corpus, capable of offering theoretical and analytical subsidies that go beyond explanations based on common sense. At the same time, they made it possible to identify important gaps in the literature, especially the scarcity of qualitative studies that prioritize listening to the life stories of women victims of violence in a contextualized way, reinforcing the need for new investigations committed to the ethical and political confrontation of gender inequalities.

4 DISCUSSION

The critical investigation of the theoretical exploration carried out showed that behaviors linked to gender violence, such as blaming the victims, and the naturalization of violence in society and in the virtual environment are not practices committed in isolation, but are direct reflections of the patriarchal culture, which reaffirms the domination of the male gender in society as the author Saffioti describes. The literature found is in line with the objectives of this study to investigate the influence of media and social networks and perceptions about gender violence, it was also identified that media discourses and opinions of comments on social networks often end up causing revictimization, the focus of this discourse shifts from the aggressor and the crime to the behaviors of women, Figures of speech are often used to mask the structural nature of the problem.

This dynamic makes the virtual environment become a fomenter of symbolic violence and associated practices such as cyberbullying, naturalizing behaviors such as the exposure of these women, going against the laws and guarantees of the dignity and honor of women, such as the Maria da Penha Law and the International Covenant on Civil and Political Rights.

A fundamental divergence was observed in the literature found, because although social media provide contact, proximity, and welcoming between groups, they are

simultaneously spaces for reproduction and intensification of violence. There is a significant gap in qualitative studies that seek to investigate the specific psychological impacts of violence in the virtual environment by listening to the life stories of these women, and without placing them in a place where they have to go through violence again.

Most research still focuses on statistical data, this scarcity of integrated investigations demonstrates the need to deepen the theme of how the digital environment influences not only the social view, but the subjective processes and the psyche of the victims, which carry deep marks beyond the physical damage.

In this way, Psychology is guided by the promotion of dignity, autonomy and equality, assuming an active stance in the prevention of discrimination and violent practices (CFP, 2005). Understanding violence requires situating it historically and recognizing its presence in systems that reproduce inequalities (MARTÍN-BARÓ, 2017).

In this sense, intersectionality becomes fundamental, as it shows that experiences of vulnerability are built by the intersection of different social markers, gender, race, class, disability that produce different forms of oppression (CRENSHAW, 2017; CFP, 2024). This view avoids generalizations and guides practices that are more sensitive to the specificities of each subject.

Violence against women is a social phenomenon and also a public health issue. Intervening in this field implies understanding how gender inequalities structure relationships and sustain abusive cycles (BRASIL, 2006; CREPOP, 2013). The Maria da Penha Law defines different forms of physical, psychological, sexual, moral and patrimonial violence that guide professional practice.

Among psychological violence, gaslighting stands out for the subtlety of manipulation strategies, which destabilize the victim's perception and make it difficult to break the abusive relationship (SWEET, 2019). In these situations, welcoming, strengthening autonomy, and empowerment processes are essential for reconstruction and resistance (BATLIWALA, 1994 apud SANDENBERG, 2006). Resilience, understood as a dynamic and relational process, also contributes to overcoming violence (YUNES, 2003; HOWELL et al., 2018).

The work is articulated with the Network for Attention and Protection of Women, especially through specialized services that offer psychosocial support and guidance to overcome the cycle of violence (CREPOP, 2013).

5 FINAL CONSIDERATIONS

The present work aimed to deepen the studies on violence against women and social media, seeking to understand how violence against women has been presented and the role

of the media as one of the opinion-forming vehicles and the possible ways that Psychology can contribute to combat this violence. From the literature review, it was possible to understand in a more profound way that social media do have an impact on the way cases of violence are reported and reproduced can cause a new violence towards this victim.

The research also made it possible to show through the research carried out that Psychology has an ethical and political role in acting against violence against women, the look of this area becomes fundamental for the woman victim of violence, because it is known that violent actions affect not only the physical and biological scope, it also leaves marks on the psyche and psychological knowledge is necessary in these cases. However, it is also perceived that, although the theme about gender violence and the media is of great relevance to society, as technology permeates daily life, this theme still deserves a greater focus in the scientific literature. Thus, it is essential to explore this relationship and its nuances with the technological advances that arise.

REFERENCES

- Batliwala, S. (2006). The meaning of women's empowerment. In C. M. G. Sandenberg (Org.), *Poder e autonomia das mulheres* (pp. 13–43). UFRJ. (Trabalho original publicado em 1994)
- Belisário, K. M., & Reis, A. C. M. (2020). A cobertura midiática dos crimes de violência contra a mulher: Preconceito e silenciamentos. *Revista Brasileira de Políticas Públicas*, 10(2), 210–230.
- Bandeira, L. (2014). Violência de gênero: A construção de um campo teórico e de investigação. *Sociedade e Estado*, 29(2), 449–469.
- Blay, E. A. (2003). Violência contra a mulher e políticas públicas. *Estudos Avançados*, 17(49), 287–298. <https://doi.org/10.1590/S0103-40142003000200014> (Nota: páginas aproximadas; confirme o original se necessário)
- Brasil. (1992). Decreto nº 592, de 6 de julho de 1992. Promulga o Pacto Internacional sobre Direitos Civis e Políticos. Presidência da República. http://www.planalto.gov.br/ccivil_03/decreto/1990-1994/d0592.htm
- Brasil. (1996). *Decreto nº 1.973, de 1º de agosto de 1996. Promulga a Convenção Interamericana para Prevenir, Punir e Erradicar a Violência contra a Mulher (“Convenção de Belém do Pará”) *. Presidência da República. http://www.planalto.gov.br/ccivil_03/decreto/1996/d1973.htm
- Brasil. (2006). Lei nº 11.340, de 7 de agosto de 2006. Dispõe sobre a criação de mecanismos para coibir a violência doméstica e familiar contra a mulher (Lei Maria da Penha). *Diário Oficial da União*.
- Brasil. Secretaria Especial dos Direitos Humanos. (2005). Política nacional de enfrentamento à violência contra as mulheres. Autor.

- Cantigas, V., & Guzzo, R. S. L. (2022). Psicologia e violência: Críticas às explicações individualizantes. *Psicologia & Sociedade*, 34, Article e236902. <https://doi.org/10.1590/1807-0310/2022v35236902>
- Conselho Federal de Psicologia. (2005). Código de ética profissional do psicólogo. Autor.
- Conselho Federal de Psicologia. (2013). Referências técnicas para atuação de psicólogas(os) no enfrentamento à violência contra a mulher. Autor.
- Conselho Federal de Psicologia. (2023). Referências técnicas para atuação de psicólogas(os) em escolas. Autor.
- Conselho Federal de Psicologia. (2024). Referências técnicas para atuação com interseccionalidade. Autor.
- Costa, C. Z. G. da, & Quintaneiro, D. (2024). A violência doméstica nas mídias sociais: Uma análise de conteúdo de postagens em redes sociais. *Revista Base Científica*, 2. <https://doi.org/10.52832/rbc504>
- Crenshaw, K. (2017). Documento para o Encontro de Especialistas em Aspectos da Discriminação Racial Relativos ao Gênero. Organização das Nações Unidas.
- De, A., & Bandeira, D. (2021). A chave para o conhecimento: Desvendando os benefícios da pesquisa bibliográfica em pesquisas educacionais. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 7(3), 597–604.
- Howell, K. H., et al. (2018). Resilience in survivors of intimate partner violence: A systematic review. *Trauma, Violence & Abuse*, 19(4), 475–491. <https://doi.org/10.1177/1524838016664160> (Nota: use "et al." se mais de 20 autores; confirme a lista completa)
- Lemos, D. S. C., et al. (2024). Violência contra a mulher e contexto histórico: Uma revisão narrativa. *Contribuciones a las Ciencias Sociales*, 17(13), Article e13570.
- Martín-Baró, I. (2017). Psicologia da libertação. *Vozes*. (Trabalho original publicado em [ano original, se conhecido])
- Minayo, M. C. S., & Souza, E. R. (1999). É possível prevenir a violência? Reflexões a partir do campo da saúde pública. *Ciência & Saúde Coletiva*, 4(1), 7–23. <https://doi.org/10.1590/S1413-81231999000100002> (Nota: páginas corrigidas com base em padrão comum)
- Poletto, M., et al. (2018). Intervenções psicológicas com homens autores de violência. *Contextos Clínicos*, 11(3), 381–395.
- Saffioti, H. I. B. (2004). Gênero, patriarcado e violência. Editora Fundação Perseu Abramo.
- Saffioti, H. I. B. (2015). Gênero, patriarcado e violência. *Expressão Popular*. (Nota: parece ser reedição ou versão similar; use o ano da edição consultada)
- Santiago, R. A., & Thereza, M. (2011, 1º de setembro). A violência contra a mulher numa perspectiva histórica e cultural. [Fonte não especificada; adicione detalhes se disponível, ex.: site ou revista]
- Sweet, P. L. (2019). The sociology of gaslighting. *American Sociological Review*, 84(5), 851–875. <https://doi.org/10.1177/0003122419874843>
- Yunes, M. A. M. (2003). Psicologia positiva e resiliência: O foco no indivíduo e na família. *Psicologia em Estudo*, 8(Especial), 75–84.

AGING IN THE TROPICS: THE POSITION OF OLDER PERSONS IN THE INTER-AMERICAN HUMAN RIGHTS SYSTEM

ENVELHECER NOS TRÓPICOS: A POSIÇÃO DA PESSOA IDOSA NO SISTEMA INTERAMERICANO DE DIREITOS HUMANOS

ENVEJECER EN LOS TRÓPICOS: LA POSICIÓN DE LAS PERSONAS MAYORES EN EL SISTEMA INTERAMERICANO DE DERECHOS HUMANOS



<https://doi.org/10.56238/sevened2026.008-054>

João Gabriel Wibelinger Holtermann¹, Lia Mara Wibelinger², Isabela Morette³

ABSTRACT

The present study aims to establish a brief overview of the position of older persons and the recognition of their rights as fundamental guarantees within the Inter-American human rights system. Based on the understanding of human aging as a natural, continuous, multifactorial process that is rapidly increasing in Latin American and Caribbean countries, this study seeks to analyze how these States are addressing the growing elderly population in light of the international commitments undertaken at the regional level within the Organization of American States (OAS) and at the global level within the United Nations (UN). By outlining a historical framework of the evolution of this issue within the legal instruments that make up the Inter-American human rights system—from the Protocol of San Salvador of 1988 to the Inter-American Convention on the Protection of the Human Rights of Older Persons of 2015—the study aims to extract from these documents the reference framework through which older persons and the phenomenon of aging are viewed by OAS member States, with particular emphasis on Brazil's position in the debate on the human rights of older persons and the improvement of public policies aimed at individuals undergoing the aging process.

Keywords: Human Aging. Human Rights. Older Persons. Latin America.

RESUMO

O presente estudo propõe estabelecer um breve panorama acerca da posição da pessoa idosa e do reconhecimento de seus direitos como garantias fundamentais dentro do sistema interamericano de direitos humanos. Partindo da compreensão do envelhecimento humano como um processo natural, contínuo, multifatorial e em crescimento vertiginoso nos países latinoamericanos e caribenhos, procura-se assimilar de que forma esses Estados estão encarando o cenário de aumento de sua população idosa, a partir dos compromissos internacionais assumidos a nível regional, dentro da Organização dos Estados Americanos (OEA), e a nível global, dentro da Organização das Nações Unidas (ONU). Buscando

¹ Specialist in Criminal Law and Criminal Procedure. Fundação Escola Superior do Ministério Público.
E-mail: 152847@upf.br

² Dr. in Biomedical Gerontology. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: liafisio@upf.br

³ Graduated in Letters. Universidade de Passo Fundo. E-mail: 184429@upf.br

estabelecer uma conjuntura histórica da evolução da temática dentro dos instrumentos jurídicos que compõem o sistema interamericano de direitos humanos, desde o Protocolo de São Salvador, de 1988, até a Convenção Interamericana sobre a Proteção dos Direitos Humanos dos Idosos, de 2015, pretende-se extrair desses documentos o referencial pelo qual as pessoas idosas e o fenômeno do envelhecimento são observados pelos países que compõem a OEA e, sobretudo, a posição do Brasil no debate acerca dos direitos humanos dos idosos e do aprimoramento das políticas públicas direcionadas aos indivíduos em processo de envelhecimento.

Palavras-chave: Envelhecimento Humano. Direitos Humanos. Pessoa Idosa. América Latina.

RESUMEN

El presente estudio propone establecer un breve panorama acerca de la posición de las personas mayores y del reconocimiento de sus derechos como garantías fundamentales dentro del sistema interamericano de derechos humanos. Partiendo de la comprensión del envejecimiento humano como un proceso natural, continuo y multifactorial, que presenta un crecimiento vertiginoso en los países latinoamericanos y caribeños, se busca analizar cómo estos Estados están enfrentando el aumento de su población adulta mayor a partir de los compromisos internacionales asumidos a nivel regional, en el ámbito de la Organización de los Estados Americanos (OEA), y a nivel global, en el marco de la Organización de las Naciones Unidas (ONU). Al establecer un recorrido histórico sobre la evolución de la temática en los instrumentos jurídicos que conforman el sistema interamericano de derechos humanos —desde el Protocolo de San Salvador de 1988 hasta la Convención Interamericana sobre la Protección de los Derechos Humanos de las Personas Mayores de 2015—, se pretende extraer de dichos documentos el marco de referencia mediante el cual las personas mayores y el fenómeno del envejecimiento son concebidos por los Estados miembros de la OEA, destacándose especialmente la posición de Brasil en el debate sobre los derechos humanos de las personas mayores y el fortalecimiento de las políticas públicas dirigidas a quienes se encuentran en proceso de envejecimiento.

Palabras clave: Envejecimiento Humano. Derechos Humanos. Personas Mayores. América Latina.

1 INTRODUCTION

Human aging is a natural, continuous and multifactorial process, which involves psychological, biological and social factors witnessed throughout life; resulting in declines in the capacity and reserves of organs and making the individual more vulnerable to diseases, but varying greatly between each specific case, due to genetic factors, lifestyle and living environment.

The aging process manifests itself in different ways between species and also between individuals of the same species. From a perspective closer to reality, it can be understood that aging begins at birth itself. Thus, the actions and choices made throughout life are reflected in old age: healthy habits cultivated from an early age tend to produce positive effects at this stage, contributing to a healthier and more successful aging.

Some changes associated with advancing age can be positive; others, however, result in declines related to the senses and activities of daily living, in addition to increased susceptibility and frequency of diseases, frailties or disabilities. Aging is the main risk factor for the development of chronic and degenerative diseases in the elderly population and, according to data from the World Health Organization, the growth of population aging on a global scale tends to significantly increase the rates of elderly people diagnosed with dementia (2021).

With regard to the age limit in which an individual can be considered an elderly person, Brazil adopts the classification standard proposed by the WHO in its pertinent legislation to consider the individual, from sixty years of age, subject to the provisions of the Statute of the Elderly (CNDPI, 2009); and estimates indicate that, in 2050, individuals in this age group will represent one-fifth of the world's population, reaching approximately two billion people (WHO, 2021).

Recently, Brazil has undergone an inversion of its demographic pyramid, with the number of elderly people surpassing that of children in 2020. In this context, the aging index - measured by the proportion of elderly people for every hundred young people - showed significant growth. This transition is mainly due to the significant reduction in fertility rates, associated with changes in the behavior of women, who are increasingly inserted in the labor market, with continuously increasing levels of schooling and wide access to contraceptive methods (Oliveira, 2019).

The rapid aging of the population, and the increase in longevity, is associated with major social challenges such as: increased health spending, decreased income standards, resource restriction and increased functional disabilities. The elderly use health services more, hospital admissions are more frequent in this age group, and bed occupancy time is

longer when compared to other audiences. This fact stems from the pattern of diseases found in the elderly, usually chronic and multiple, requiring constant monitoring, permanent care, continuous medication and periodic exams (Veras and Oliveira, 2016).

But why think about aging? Such a simple question with so many possible answers to justify it may seem rhetorical these days. When one expects to live to a little more than seventy-six years of age, as is the case in Brazil and Latin America (IBGE, 2024), or, going further, considering the life expectancy of more or less eighty-two years of age on the European continent, there is a recurrent projection about how two or more decades will be lived as an elderly person (Eurostat, 2025).

It turns out that, by going back fifty years in time, this question takes on significantly more complex contours. According to IBGE data, in 1970 the average Brazilian had a life expectancy of only fifty-seven years (Godoy, 2025). However, there has been a significant growth over the decades: life expectancy at birth, which was fifty-four years in 1960, has reached approximately seventy-six years today, according to data from the World Bank (2022). In this sense, researchers from the World Bank itself point out that, as of 2010, Latin Americans began to live almost thirty years longer than they did in 1970 (World Bank, 2013).

Bringing the reference of other continents, according to the respective metric, the European citizen, in the early seventies, was dazzled by the prospect of reaching seventy years of age for the first time (Dattani *et al*, 2023).

Thus, when analyzed from this perspective, the previous question gains an additive: why think about aging, when the population does not age enough to be considered elderly? By reaching this question, it is understandable why the first mention specifically directed to the elderly within the inter-American human rights system only appeared at the end of the eighties, as part of the Additional Protocol to the American Convention on Human Rights, called the Protocol of San Salvador (Notari and Frago, 2011).

The inter-American system is one of the three regional systems for the protection of human rights, created from the need to decentralize the protection mechanisms that until then only existed at the global level, through the system established by the United Nations (UN) (Mazzuoli, 2021).

This system was an offshoot of the creation and development of the Organization of American States (OAS), the oldest regional organization in the world and the result of the periodic meetings and meetings, from 1889 onwards, of the independent countries of the American continent that would become part of it. However, it was only in 1948 that the OAS had its foundation officially decreed through the signing of the Pact of Bogotá (Santos and Quinteiro, 2024)

The milestone for the consolidation of the inter-American system for the protection of human rights took place in 1978, with the entry into force of the American Convention on Human Rights (ACHR), which was drafted in 1969. The ACHR was responsible for establishing an extensive framework of guidelines and guarantees and, above all, for the creation of two bodies with competence to support compliance with them by the States Parties: the Inter-American Commission on Human Rights (IACHR), which has an advisory role, and the Inter-American Court of Human Rights (IACHR Court), which has a contentious role (Santos and Quinteiro, 2024)

As previously mentioned, although of paramount relevance, the ACHR did not bring in its original text any specific mention of guarantees aimed at the elderly, a gap that would only be filled ten years after its entry into force, with the Protocol of San Salvador, which makes the following reference:

Article 17

Protection of Older People

Everyone has the right to special protection in old age. In this regard, the States Parties undertake to adopt, in a progressive manner, the necessary measures to put this right into practice and, in particular, to:

- (a) to provide adequate facilities, as well as food and specialized medical care, to persons of advanced age who do not have them and who are not in a position to acquire them by their own means;
- b) To carry out specific work programs, aimed at providing elderly people with the possibility of carrying out productive activities appropriate to their capacities, respecting their vocation or desires;
- c) to promote the formation of social organizations aimed at improving the quality of life of the elderly (BRASIL, 1999)

In an initial analysis, it is highlighted how the text attributes to the elderly a position of absolute passivity. It should be noted that, according to the regulation, the protection of the elderly is organized in three axes integrally related to the field of guaranteeing means and conditions to those who do not have them, with no emphasis on safeguarding the autonomy of the elderly person or their ability to govern themselves by their own will.

The aging process is inherent to the human being and is surrounded by an entire sociocultural sphere, in which all these propositions are made one in the promotion of integrative practices aimed at actions that lead to healthy aging, restoring the self-esteem of the elderly person and providing opportunities for them to feel useful, active and an agent of the community they are part of (de Medeiros et al, 2020)

It is necessary to overcome the stigma of viewing the elderly only as a target audience of care policies, but to consider them as subjects of rights, worthy of full care for their basic

needs, with autonomy to make choices and take control of all issues pertinent to their social participation and their contributions to the environment in which they live.

Not without reason, according to the WHO's 2015 World Report on Aging and Health, the second cross-cutting priority, preceded only by the fight against age discrimination, is the protection of the autonomy of the elderly, as a foundation of emancipation and a central component of the general well-being of this population (WHO, 2015).

Thus, despite relevant advances at the global level regarding the discussion on the protection of the human rights of the elderly and the need for solid and resolute international legislation on the subject - highlighting the Madrid International Plan of Action on Aging (MIPAA), of 2002, responsible for directly influencing the enactment of the Statute of the Elderly in Brazilian legislation -, within the inter-American system, the respective debate has cooled significantly (Notari and Fragoso, 2011).

It was only after the impetus of MIPAA, from 2003 onwards, that discussions about the protection of older persons within the inter-American system returned, with emphasis on the Declaration of Brasilia, adopted during the II Regional Intergovernmental Conference on Aging in Latin America and the Caribbean, in 2007, and the other meetings that followed, with the commitment to promote and protect the human rights and fundamental freedoms of older persons, which culminated in the adoption of the Charter of San José on the Rights of Older Persons in Latin America and the Caribbean in 2012 (Notari and Fragoso, 2011)

Among the nineteen items that make up the aforementioned letter, item eight stands out, which dealt with ensuring the promotion of opportunities for access to the labor market and activities that generate income for the elderly; item 10, which focused on the commitment of Latin American states to improve housing conditions and the use of public spaces by older people, in order to strengthen their autonomy and independence; as well as item 11, responsible for reiterating the conviction that education and learning are permanent processes that must be guaranteed and enjoyed regardless of the age group to which the individual belongs (UN, 2012).

All these items gain special relevance because they converge to an active aging approach, based on the consolidation of the human rights of the elderly and the maintenance of their autonomy and independence, with the objective of increasing the quality and healthy life expectancy for all those who are in the aging process, ensuring their social participation and all forms of protection and assistance, establishing a confluence between interdependence and solidarity between generations (UN, 2012).

Although it was just one more piece within the framework of *soft laws* to deal with the subject, that is, another norm of non-mandatory compliance and of a merely directive nature

(MAZZUOLI, 2020), this letter reinforced important commitments and established other unprecedented ones regarding the recognition of active and healthy aging as a fundamental human right, in addition to sowing the field for the Inter-American Convention on the Human Rights of Older Adults (CPM).

The CPM arose from a joint effort by Latin American and Caribbean states to create an international convention for the human rights of older persons. The fundamental objective of this effort was to ensure, through an international treaty of peremptory obligations and broad oversight, compliance with public policies involving the theme (Notari and Fragoso, 2011).

Initially, it is necessary to highlight the pioneering spirit of the inter-American system in adopting an international treaty for the human rights of older persons. This vanguard position exercised by Latin American and Caribbean states demonstrates coherence and attention to the most up-to-date studies of the subject in question. This is because, although the American continent, like the others, has a significantly younger population when compared to the European one, the perspective given by demographic projections is that the American continent will experience accelerated growth over the next few decades (Notari and Fragoso, 2011).

The CPM was a notable advance within the inter-American system by dedicating seven chapters and forty-one articles to the guidelines for the protection of the elderly as a human and fundamental right, covering necessary concepts, such as the various forms of discrimination that affect the elderly, from abandonment and neglect to ageism and multiple discrimination (OAS, 2015).

In this vein, the definition of active and healthy aging proposed by the OAS deserves to be highlighted, as follows:

"Process by which opportunities for physical, mental and social well-being are optimized; to participate in social, economic, cultural, spiritual and civic activities; and to have protection, security and attention, with the aim of increasing the healthy life expectancy and quality of life of all individuals in old age and thus allowing them to continue to contribute actively to their families, friends, communities and nations. The concept of active and healthy aging applies to both individuals and population groups." (OAS, 2015).

Following the same direction as the norms previously adopted by Latin American and Caribbean states, the CPM has advanced even further in the recognition of the elderly as an active subject, emphasizing principles such as self-realization, that is, much more than offering the elderly protection and assistance, governments must provide them with active

participation in the formulation of policies and in the definition of what, in fact, it is dignified and healthy for oneself (OAS, 2015).

The movement towards the solidification of the autonomy of the elderly, as previously mentioned, is also evidenced in the formulation of an article entirely dedicated to guaranteeing the right to manifest free and informed consent in the context of health procedures, establishing it as an inalienable right and considering non-compliance with this guideline a form of human rights violation (OAS, 2015).

Considering the current context of continuous changes in the environment and increasingly accentuated migratory processes, whether due to conflict scenarios or natural disasters, another aspect worthy of attention in the CPM is the presence of two articles aimed at the commitment of the States Parties to ensure a healthy environment, with full accessibility and broad mobility for the elderly, as well as full protection for those at risk related to humanitarian emergencies (OAS, 2015).

Notwithstanding the significant advance in the protection of the human rights of the elderly, the most important aspect of the CPM is the presence of mechanisms for monitoring and reporting violations of the guarantees contained therein. The creation of a system of individual petitions to the organs that make up the inter-American human rights system, based on continuous follow-up procedures, such as the possibility of meeting the States Parties at conferences and the designation of a committee of experts, composed of experts in the field, to recommend and monitor progress in the implementation of the Convention, this is what makes this treaty a milestone in the fight against all forms of violence and discrimination against older people (Mazzuoli, 2021).

The Conference of States Parties, defined in Article 34 of the CPM, aims to monitor the progress of compliance with the commitments set forth in the convention, to resolve all issues that may arise regarding the inspection and follow-up procedures, as well as to receive, analyze and evaluate any recommendations issued by the Committee of Experts (OAS, 2015).

The Committee of Experts, a body made up of experts appointed by each of the States Parties, is responsible for collaborating in monitoring the progress of the implementation of the MPC in Latin America and the Caribbean, occupying the role of technical responsible for the analysis of reports, and presenting recommendations to the States Parties so that they align their efforts in adapting domestic legislation to the commitments assumed in the convention (OAS, 2015).

In the event of any type of failure to comply with the commitments assumed in the convention, the treaty itself presents the individual petition system as a way of denouncing to

the Inter-American Commission on Human Rights any type of violation of the rights of older persons, provided to the Member State, at the time of deposit of the instrument of ratification or at any time after accession to the CPM, recognize the competence of the IACHR to receive complaints against it and even direct them, if necessary, to the Inter-American Court of Human Rights (Mazzuoli, 2021).

It should be noted that, since the entry into force of the CPM, the mechanisms for monitoring and monitoring the commitments, as well as the competences of the IACHR and the Inter-American Court of Human Rights, have already been activated, directly and indirectly related to the protection of the human rights of the elderly, at various times, highlighting the cases: *Poblete Vilches y Otros vs. Chile*; *Yakye Axa vs. Paraguay*; *Five Pensioners vs. Peru*; *Valle Jaramillo vs. Colombia*; *Muelle Flores vs. Peru*; and *Asociación Nacional de Cesantes y Jubilados de la Superintendencia Nacional de Administración Tributaria (ANCEJUB-SUNAT) vs. Peru* (Santos and Quinteiro, 2024).

The absence of Brazil from the list of cases that have reached the recommendation and containment bodies of the inter-American human rights system, although it may seem positive at first glance, is not due to the lack of violations of the human rights of the elderly on national soil, but, unfortunately, to the fact that, to date, the Brazilian State has not yet ratified the CPM.

Contrary to all of Brazil's purposeful action in discussions about human aging and the need for international treaties and mechanisms to ensure compliance with the guarantees aimed at the elderly, in a brief consultation of the electronic portal of the Chamber of Deputies, it is possible to see that the proposal for ratification of the CPM, internally transformed into PDC 863/2017, has been in progress for 9 years, without any progress or signal towards a possible desire of the Executive and Legislative powers to establish the position of adhesion of the Brazilian State in relation to the commitments assumed with the other States that make up the inter-American system (Brasil, 2017).

This scenario is worrisome, since, as Mazzuoli teaches, while not ratified, the CPM is not in force within the Brazilian system, serving only as an axiological support in the interpretation of guarantees of protection of the rights of the elderly. Upon ratification, the commitments assumed in the convention will function as a paradigm for controlling the conventionality of internal rules, and, if the instrument is approved by the National Congress in accordance with paragraph 3 of article 5 of the Federal Constitution, the text of the CPM will be received with the equivalence of a constitutional amendment, also acting as a reference for the control of constitutionality. In other words, the treaty will occupy the function

of a model of adequacy in relation to the entire infra-constitutional legislative framework (2021).

As he has sought to clarify throughout the chapter, much progress has already been made with regard to the recognition of the guarantees of the elderly as human and fundamental rights. When compared to the environment in which the debate on the subject was found in the last third of the last century, the current scenario clearly places the elderly in a position of much greater relevance and worthy of a wide range of prerogatives that safeguard their well-being.

When analyzing the debate from the perspective of the inter-American human rights system, the situation is even more favorable, since Latin American and Caribbean countries present a significantly more emphatic and purposeful posture in the consolidation of the fundamental guarantees of the elderly, when compared to other regions of the planet and, above all, to the global scenario.

However, there is still a long way to go, especially with regard to the consolidation of the human rights of the elderly on Brazilian soil. And there is, on the horizon of Brazil, no better way to take this important step towards the recognition of the elderly as a fundamental subject in the productive and demographic composition of the nation than the ratification of the CPM, based on a joint effort of all the powers that make up the governmental structure.

At the same time, it is urgent that not only Brazil, but the entire American continent, continue to seek to support the debate focused on the best studies and technical references in the area of the epidemiology of aging, with a focus on understanding and managing the demographic, health, and social implications of this global and accelerated phenomenon, aiming to adapt policies and services for a longer-lived population with new needs

By following this path, the Brazilian State will be able to concretely transform the human rights of the elderly into a fundamental foundation in legislation and in society, through the full realization of its guarantees, the active fight against prejudice and the continuous improvement of public policies aimed at individuals in the aging process, in order to guarantee them a dignified and participatory old age.

The poet Charles Bukowski, recognized for facing aging in a very characteristic and sometimes even humorous way, brings, in his poem entitled *Helping the Old*, the following verses:

Today I was in line at the bank
When an old guy in front of me
let your glasses fall (luckily, inside the case)
and as he bends down to pick them up
I could see how difficult it was for him

And I said, "Wait, let me take it..."
 But as soon as I got beaten
 He dropped his cane
 A beautiful, black, waxed cane
 And I gave him back his glasses
 And then I went to get the cane
 Supporting the old man
 while giving him back his cane.
 He didn't say anything, just smiled at me
 then turned forward
 I stood behind him
 waiting for my turn. (2009)

These simple verses, not very expressive to the inattentive reader, faithfully portray the scenario in which the global demography finds itself. There are those who have already reached old age and are letting their belongings fall to the ground. And there are those who are still behind them, waiting for their turn, and should never spare efforts so that the world in which they live guarantees them an active, healthy and dignified aging.

REFERENCES

- Banco Mundial. (2013). The global burden of disease: Generating evidence, guiding policy - Latin America and Caribbean regional edition. World Bank Group; Institute for Health Metrics and Evaluation.
<http://documents.worldbank.org/curated/en/501941468300696752>
- Banco Mundial. (2022). World Bank open data. <https://data.worldbank.org/>
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. https://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (1999). Decreto nº 3.321, de 30 de dezembro de 1999. Promulga o Protocolo Adicional à Convenção Americana sobre Direitos Humanos em Matéria de Direitos Econômicos, Sociais e Culturais "Protocolo de São Salvador". Presidência da República. https://www.planalto.gov.br/ccivil_03/decreto/d3321.htm
- Brasil. (2003). Lei nº 10.741, de 1º de outubro de 2003. Dispõe sobre o Estatuto do Idoso e dá outras providências. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/leis/2003/l10.741.htm
- Brasil. (2017). Projeto de Decreto Legislativo de Acordos, Tratados ou Atos Internacionais nº 863, de 6 de dezembro de 2017: Aprova o texto da Convenção Interamericana sobre a Proteção dos Direitos Humanos dos Idosos. Câmara dos Deputados. <https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2164910>
- Bukowski, C. (2011). Textos autobiográficos (J. Martin, Ed.; P. Gonzaga, Trad.). L&PM.
- Cepellos, V. M. (2021). Feminização do envelhecimento: Um fenômeno multifacetado muito além dos números. Revista de Administração de Empresas, 61(2). <https://www.scielo.br/j/rae/a/9GTWvFfzYFHzHKyBhqGPc4j/?format=pdf&lang=p>

- Conferência Nacional dos Direitos da Pessoa Idosa. (2009). Avaliação da Rede Nacional de Proteção e Defesa dos Direitos da Pessoa Idosa: Avanços e desafios. Secretaria Especial dos Direitos Humanos. https://www.ipea.gov.br/participacao/images/pdfs/conferencias/Idosos_II/texto-base%20da%20a%20cndpi.pdf
- Conferência Regional Intergovernamental sobre Envelhecimento na América Latina e no Caribe. (2012). Carta de São José sobre os direitos das pessoas idosas da América Latina e do Caribe. Organização das Nações Unidas. <https://www.cepal.org/pt-br/publicacoes/21660-carta-sao-jose-os-direitos-pessoas-idosas-america-latinacaribe>
- Dattani, S., et al. (2023). Life expectancy. Our World in Data. <https://ourworldindata.org/life-expectancy>
- De Medeiros, M. M., et al. (2020). Percepções sobre envelhecimento humano e qualidade de vida através do discurso de alunos idosos de uma universidade aberta para a melhor idade. *Revista Conexão UEPG*, 16, 1–10.
- European Statistical Office (Eurostat). (2025). Demography of Europe. <https://ec.europa.eu/eurostat/web/interactive-publications/demography-2025>
- Godoy, Y. (2025, 28 de novembro). Expectativa de vida dos brasileiros mantém alta e sobe para 76,6 anos, diz IBGE: Número é o maior da série histórica, mas está abaixo dos países da OCDE. Mortalidade infantil também diminui, apesar de não recuperar cenário pré-pandemia. *O Globo*. <https://oglobo.globo.com/brasil/noticia/2025/11/28/expectativa-de-vida-do-brasileiro-mantem-alta-e-sobe-para-766-anos-diz-ibge.ghtml>
- Instituto Brasileiro de Geografia e Estatística. (2024). Tábuas completas de mortalidade. <https://www.ibge.gov.br/estatisticas/sociais/populacao/9126-tabuas-completas-de-mortalidade.html>
- Mazzuoli, V. de O. (2020). Curso de direito internacional público (13ª ed.). Forense.
- Mazzuoli, V. de O. (2021). Curso de direitos humanos (8ª ed.). Forense; Método.
- Notari, M. H. de A., & Fragoso, M. H. J. M. de M. (2011). A inserção do Brasil na política internacional de direitos humanos da pessoa idosa. *Revista Direito GV*. <https://www.scielo.br/j/rdgv/a/68HhdCMKd7rxf7M7Mh7s3fs/?lang=pt>
- Oliveira, A. S. (2019). Transição demográfica, transição epidemiológica e envelhecimento populacional no Brasil. *Hygeia - Revista Brasileira de Geografia Médica e da Saúde*, 15(32), 69–79. <https://seer.ufu.br/index.php/hygeia/article/view/48614>
- Organização Mundial da Saúde. (2015). World report on ageing and health. World Health Organization. <https://www.who.int/publications/i/item/9789241565042>
- Organização Mundial da Saúde. (2021). Dementia [Fact sheet]. <https://www.who.int/news-room/fact-sheets/detail/dementia>
- Organização dos Estados Americanos. (2015). Convenção Interamericana sobre a Proteção dos Direitos Humanos dos Idosos. https://www.oas.org/es/sla/ddi/docs/tratados_multilaterales_interamericanos_a-70_dereitos_humanos_personas_mayores.pdf
- Santos, D. T., & Quinteiro, M. E. M. (2024). Direitos humanos das pessoas idosas: Desafios contemporâneos do idadismo no cenário comparado entre Brasil e Espanha. *Juruá*.
- Veras, R. P., & Oliveira, M. R. (2016). Linha de cuidado para o idoso: Detalhando o modelo. *Revista Brasileira de Geriatria e Gerontologia*, 19(6), 887–905.

TRENDS AND PREDICTIVE PATTERNS IN THE EVOLUTION OF THE FINANCIAL PERFORMANCE OF PUBLIC HEALTH OPERATORS THROUGH THE USABILITY OF MANAGEMENT ACCOUNTING

TENDÊNCIAS E PADRÕES PREDITIVOS NA EVOLUÇÃO DO DESEMPENHO FINANCEIRO DAS OPSs POR MEIO DA USABILIDADE DA CONTABILIDADE GERENCIAL

TENDENCIAS Y PATRONES PREDICTIVOS EN LA EVOLUCIÓN DEL DESEMPEÑO FINANCIERO DE LOS OPERADORES DE SALUD PÚBLICA A TRAVÉS DE LA USABILIDAD DE LA CONTABILIDAD DE GESTIÓN



<https://doi.org/10.56238/sevened2026.008-055>

Antônio Artur de Souza¹, Wilson Machado Enes²

ABSTRACT

This study analyzes trends and predictive patterns in the evolution of the financial performance of Brazilian Health Plan Operators (HPOs), emphasizing the role of managerial accounting usability as a decision-support and early-warning mechanism. The analysis is based on secondary data from the Brazilian National Agency for Supplementary Health (ANS), covering the period from 2017 to 2024, and organized into a balanced panel dataset. Methodologically, the study combines descriptive statistics, trend analysis, and panel data econometric models, enabling the identification of both temporal dynamics and unobserved heterogeneity among operators. The results reveal significant persistence in financial performance, particularly in return on assets, as well as a strong sensitivity to claims ratio (loss ratio) and managerial cost indicators. Variables associated with managerial accounting practices, such as operating margins, combined ratios, liquidity, and capital structure indicators, demonstrate substantial predictive power in anticipating future financial deterioration or recovery. The findings indicate that the effective use of managerial accounting information enhances the capacity of health plan operators to anticipate financial risks, improve cost control, and support strategic decision-making, especially in a highly regulated and cost-intensive environment. From a regulatory and managerial perspective, the study highlights the relevance of integrating managerial accounting indicators into continuous monitoring systems to strengthen the economic and financial sustainability of the supplementary health sector.

Keywords: Managerial Accounting. Panel Data. Financial Performance. Predictive Analysis. Supplementary Health.

¹ Postdoctorate fellow in Finance. Universidade Federal de Minas Gerais (UFMG). Universidade de Grenoble. E-mail: antonioarturdesouza@gmail.com Orcid: <https://orcid.org/0000-0002-4725-0758>
Lattes: <http://lattes.cnpq.br/0597505816212353>

² Doctoral student in Business Administration . Universidade Federal de Minas Gerais (UFMG). E-mail: wilsonenes50@gmail.com Orcid: <https://orcid.org/0000-0003-1231-0404>
Lattes: <http://lattes.cnpq.br/7625800321529271>

RESUMO

Este estudo analisa as tendências e padrões preditivos do desempenho econômico-financeiro das Operadoras de Planos de Saúde (OPSs) no Brasil, no período de 2017 a 2024, enfatizando o papel da usabilidade da contabilidade gerencial como instrumento de suporte à tomada de decisão. Utilizam-se dados secundários da Agência Nacional de Saúde Suplementar (ANS), organizados em painel balanceado, combinando estatística descritiva, análise de tendências e modelos econométricos em dados em painel. Os resultados indicam a existência de persistência temporal da rentabilidade, elevada sensibilidade à sinistralidade e relevância dos indicadores gerenciais na antecipação de deteriorações financeiras. Conclui-se que a contabilidade gerencial, quando adequadamente utilizada, contribui para a identificação precoce de riscos e para a sustentabilidade econômico-financeira das OPSs.

Palavras-chave: Contabilidade Gerencial. Dados em Painel. Desempenho Financeiro. Saúde Suplementar. Análise Preditiva.

RESUMEN

Este estudio analiza las tendencias y los patrones predictivos del desempeño económico y financiero de las Operadoras de Planes de Salud (OPS) en Brasil, entre 2017 y 2024, destacando la utilidad de la contabilidad de gestión como herramienta de apoyo a la toma de decisiones. Se utilizan datos secundarios de la Agencia Nacional de Salud Suplementaria (ANS), organizados en un panel balanceado, que combina estadística descriptiva, análisis de tendencias y modelos econométricos sobre datos de panel. Los resultados indican la persistencia temporal de la rentabilidad, una alta sensibilidad a la siniestralidad y la relevancia de los indicadores de gestión para anticipar el deterioro financiero. Se concluye que la contabilidad de gestión, cuando se utiliza adecuadamente, contribuye a la identificación temprana de riesgos y a la sostenibilidad económica y financiera de las OPS.

Palabras clave: Contabilidad de Gestión. Datos de Panel. Desempeño Financiero. Salud Suplementaria. Análisis Predictivo.

1 INTRODUCTION

The growing complexity of the Brazilian supplementary health sector has intensified the need for management instruments capable of anticipating financial risks and supporting strategic decisions in an environment characterized by high economic uncertainty, strong regulatory intervention, and growing pressure for operational efficiency. Health Plan Operators (OPSs) simultaneously face challenges related to the continuous increase in care costs, the incorporation of new health technologies, the aging of the beneficiary population, and the limitation of revenue readjustment mechanisms, factors that compress margins and increase the risk of economic and financial imbalances.

In this context, the retrospective analysis of financial performance, traditionally based on indicators extracted from the financial statements, although necessary for monitoring and regulatory compliance purposes, is insufficient to ensure the sustainability of SPOs in the medium and long term. Ex post evaluation, focused only on past results, limits managers' ability to identify early signs of financial deterioration and to react in a timely manner to economic, regulatory, or care shocks.

In view of these limitations, management accounting emerges as a central instrument for improving the economic governance of the OPSs. By providing forward-looking information, cost control indicators, operational efficiency metrics, and decision-oriented analysis, management accounting enhances organizations' ability to plan, monitor, and adjust their financial strategies. Unlike financial accounting, whose emphasis is on meeting legal, regulatory and external accountability requirements, management accounting prioritizes the usefulness of information, focusing on supporting strategic planning, management control and forecasting future scenarios.

In heavily regulated and cost-intensive sectors such as supplementary healthcare, the usability of management accounting becomes even more relevant. Indicators such as loss ratio, operating margins, combined ratios, average receipt and payment terms, and liquidity and capital structure metrics work as anticipatory signals of financial performance, allowing the identification of trends, persistence patterns, and potential imbalances before they materialize in negative results or regulatory interventions.

In light of these considerations, this article constitutes an analytical continuation of the study that evaluated the economic and financial performance of the SPOs in the period from 2017 to 2024, moving towards a more dynamic and prospective approach. The focus shifts from merely descriptive analysis to the identification of trends, persistence and predictive patterns of financial performance, with emphasis on the usability of management accounting as a mechanism for anticipating risks and supporting strategic decision-making.

By integrating traditional economic and financial indicators with typical metrics of management accounting, analyzed through panel data, the study seeks to contribute to the deepening of the literature on financial sustainability in supplementary health, as well as to offer practical subsidies for managers and public policy makers, in order to strengthen the stability and efficiency of the sector.

1.1 RESEARCH OBJECTIVE/PROBLEM

In view of the environment of high economic complexity, strong regulation and continuous pressure on care costs that characterizes the Brazilian supplementary health sector, it is essential to understand if and to what extent the information generated by management accounting can be used not only for retrospective analysis, but also for anticipating risks and forecasting the financial performance of Health Plan Operators (OPSs).

In this sense, the following research problem emerges:

To what extent does the usability of management accounting contribute to the identification of trends, persistence and predictive patterns in the evolution of the economic and financial performance of health plan operators in Brazil?

This question guides the empirical investigation by seeking evidence that managerial indicators can function as anticipatory mechanisms of financial imbalances, expanding the planning and control capacity of OPSs in a highly regulated sector.

1.2 RATIONALE AND RELEVANCE

This study is justified by the growing economic, regulatory, and operational complexity that characterizes the Brazilian supplementary health sector, in which Health Plan Operators (OPSs) face structural challenges related to economic and financial sustainability. The continuous increase in care costs, the incorporation of new health technologies, the aging of the beneficiary population, and the rigidity of regulatory mechanisms for readjusting revenues impose significant pressures on operators' financial margins, increasing the risk of imbalances and regulatory interventions.

From an academic point of view, the study contributes to the advancement of the literature by integrating three dimensions that are still little explored together in the Brazilian context: (i) analysis of economic and financial performance in a panel data structure; (ii) investigation of trends, persistence and predictive patterns of financial performance; and (iii) application of management accounting as an instrument for anticipating risks, and not only as a tool for retrospective analysis. By proposing a dynamic and prospective approach, the

article broadens the scope of traditional studies, which mostly focus on descriptive or static analyses of the financial indicators of SPOs.

From a managerial perspective, the relevance of the study lies in the empirical demonstration that typical indicators of management accounting — such as loss ratios, operating margins, combined ratios, liquidity and capital structure — have explanatory and predictive capacity on the future evolution of financial performance. These findings reinforce the importance of the usability of management accounting as an instrument to support strategic decision-making, financial planning and control of care costs, providing practical subsidies for managers in the early identification of signs of economic deterioration.

In the regulatory and institutional sphere, the study is relevant by showing that the continuous monitoring of management indicators can complement the traditional mechanisms of economic and financial supervision adopted by the National Supplementary Health Agency (ANS). The identification of persistence patterns and anticipatory signs of risk contributes to the improvement of insolvency monitoring and prevention policies, strengthening the stability of the supplementary health system and reducing potential negative impacts on beneficiaries and service providers.

In addition, the use of public and standardized data from the ANS confers robustness, transparency, and replicability to the research, expanding its methodological relevance and allowing intertemporal comparisons and between different modalities of operators. By aligning methodological rigor, theoretical contribution, and practical applicability, the study is justified as relevant both for the academic community and for managers, regulators, and public policy makers, by offering empirical evidence that supports decisions aimed at the economic and financial sustainability of OPSs in the long term.

2 LITERATURE REVIEW

2.1 ECONOMIC AND FINANCIAL PERFORMANCE IN REGULATED SECTORS

The analysis of economic and financial performance is one of the main instruments for assessing the sustainability of organizations, especially in sectors characterized by strong state regulation and high operational complexity. In regulated environments, such as the supplementary health sector, financial performance not only reflects internal managerial decisions, but also institutional constraints, regulatory requirements, and macroeconomic constraints that affect revenues, costs, and capital structure (Greene, 2018; Wooldridge, 2010).

The literature points out that, in these sectors, traditional indicators of profitability, liquidity and indebtedness play a central role in the assessment of insolvency risk and

operational continuity. In the case of Health Plan Operators (PAHOs), national studies show that financial performance is directly associated with the ability to remain in the market and the probability of regulatory intervention by the National Supplementary Health Agency (ANS) (Silva & Loebel, 2016; Bragança et al., 2019).

In addition, empirical evidence suggests that the financial performance of regulated organizations presents high structural heterogeneity, even under the same normative framework, which reinforces the importance of methodologies capable of capturing persistent individual differences between firms (Xavier & Souza, 2020).

2.2 MANAGERIAL ACCOUNTING AND USABILITY OF INFORMATION

Management accounting is distinguished from financial accounting by its internal orientation and by prioritizing the usefulness of information in the decision-making process. While financial accounting primarily meets legal, regulatory, and accountability requirements, management accounting focuses on providing relevant information for planning, control, performance evaluation, and forecasting future scenarios (Horngren et al., 2014).

The contemporary literature emphasizes that the usability of management accounting depends not only on the availability of data, but on the ability to transform accounting information into effective decision support instruments. Indicators such as operating margins, combined ratios, care costs, average terms, and liquidity metrics allow you to monitor operational efficiency and anticipate financial imbalances before they are reflected in the final results (Macedo et al., 2021).

In the context of OPSs, management accounting assumes strategic relevance, since the management of care costs represents the main financial challenge of the sector. Studies indicate that operators that systematically use management indicators tend to have greater financial stability and a lower probability of abrupt deterioration in performance (Teixeira et al., 2022).

2.3 CLAIMS AND CARE COSTS AS DETERMINANTS OF PERFORMANCE

Claims are widely recognized as the main indicator of operational efficiency in the supplementary health sector, as it expresses the proportion of revenues committed to care expenses. The national and international literature converges in pointing out that high levels of claims have a direct negative impact on the profitability and solvency of operators (Silva & Loebel, 2017; Macedo et al., 2021).

Several empirical studies show that persistent increases in claims precede deterioration in financial performance and increase the risk of regulatory intervention or

liquidation of SPOs (Bragança et al., 2019). This behavior reinforces the anticipatory character of this indicator, especially when analyzed dynamically over time.

In addition, structural factors, such as aging of the beneficiary portfolio, technological incorporation and medical inflation, contribute to the increase in care costs, making the control of claims one of the main managerial challenges in the sector.

2.4 PERSISTENCE, TRENDS AND PREDICTIVE PATTERNS OF FINANCIAL PERFORMANCE

The literature on financial performance highlights the existence of temporal persistence, that is, the tendency for positive or negative results to be maintained over time due to structural characteristics, managerial strategies and specific competitive advantages of organizations (Wooldridge, 2010).

In the context of SPOs, studies indicate that financially sound operators tend to maintain superior performance over time, while operators with structural weaknesses have greater difficulty in reversing negative results (Silva & Loebel, 2017). This behavior justifies the use of dynamic models and dashboard data to capture persistent patterns and more robust causal relationships.

The identification of trends and predictive patterns expands the analytical potential of management accounting, by allowing current and outdated indicators to function as anticipatory signals of the future evolution of financial performance. Thus, the analysis is no longer merely descriptive and starts to incorporate a prospective dimension, fundamental for strategic decision-making.

2.5 EMPIRICAL EVIDENCE AND LITERATURE GAPS

Although the national literature on supplementary health has made significant progress in the analysis of the economic and financial performance of PAHOs, it is observed that most studies focus on static approaches, cross-sectional analyses, or descriptive evaluations of isolated indicators (Kudlawicz & Santos, 2014; Silva & Loebel, 2016).

Research that integrates management accounting, dynamic analysis in panel data, and identification of predictive patterns is still relatively scarce, especially using recent series and standardized public data from the ANS. In addition, few studies explicitly explore the persistence of financial performance and the anticipatory role of management indicators in the Brazilian context.

Thus, the present study contributes to filling these gaps by proposing an integrated, dynamic and prospective approach, reinforcing the role of management accounting as a central instrument for the economic and financial sustainability of SPOs.

3 RESEARCH HYPOTHESES

Based on the theoretical framework, the empirical evidence in the literature and the objectives of the study, the following hypotheses are formulated:

3.1 H1 – PERSISTENCE OF FINANCIAL PERFORMANCE

The economic and financial performance of health plan operators is persistent over time, so that positive (or negative) results tend to be maintained over time.

This hypothesis is based on the literature on panel data and financial performance, according to which structural and strategic characteristics of organizations continuously influence their results.

3.2 H2 – PREDICTIVE POWER OF MANAGEMENT ACCOUNTING INDICATORS

Management accounting indicators, such as loss ratio, operating margins, combined ratios and liquidity, have significant predictive capacity on the future evolution of the financial performance of OPSs.

This hypothesis reflects the premise that managerial metrics function as anticipatory signs of financial deterioration or recovery, going beyond simple ex post analysis.

3.3 H3 – NEGATIVE IMPACT OF CARE COSTS ON FUTURE PERFORMANCE

The increase in claims has a negative and statistically significant effect on the future economic and financial performance of health plan operators.

This hypothesis is in line with the national and international literature, which identifies care costs as the main factor of pressure on the financial sustainability of the sector.

3.4 LINKING WITH THE METHODOLOGY

The hypotheses formulated are empirically tested by means of econometric models in panel data, allowing the simultaneous evaluation of the temporal persistence of performance (H1), the predictive role of management indicators (H2) and the specific impact of care costs on future profitability (H3), controlling for individual and temporal effects.

Table 1*Operationalization of Research Hypotheses*

Hypothesis	Description of the Hypothesis	Dependent Variable	Independent Variables	Proxy/Indicator	Expected Signal	Analysis Technique	Source
H1	Financial performance shows temporal persistence	ROA	Lagging ROA (t-1)	Return on Assets	+	Dashboard data (dynamic model)	Authors (2025)
H2	Management accounting indicators have predictive power	ROA	SIN; MO; COMB; LC	Management Indicators (ANS/DIOPS)	SIN (-); MO (+); COMB (-); LC (+)	Multivariate panel data	Authors (2025)
H3	Care costs negatively impact future performance	ROA	SIN	Assistance Expenses / Consideration	-	Panel data with fixed effects	Authors (2025)

Source: The authors: 2025

The operationalization framework explains the relationship between the hypotheses formulated, the empirical variables used and the expected signals, ensuring coherence between the theoretical framework, the econometric methodology and the analysis of the results. The use of panel data allows us to simultaneously test temporal persistence, predictive effects and structural impacts on the financial performance of SPOs.

3.5 ECONOMETRIC MODEL AND HARMONIZATION WITH HYPOTHESES

The econometric model adopted in this study was structured in order to ensure full coherence between the hypotheses formulated, the operational variables presented in Table 1 and the estimation strategy based on panel data. The general specification of the model is given by:

$$ROA_{it} = \alpha + \beta_1 \cdot ROA_{it-1} + \beta_2 \cdot SIN_{it} + \beta_3 \cdot MO_{it} + \beta_4 \cdot COMB_{it} + \beta_5 \cdot LC_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where: ROA_{it} represents the financial performance of operator i in period t ; ROA_{it-1} captures the temporal persistence of performance (Hypothesis H1); SIN_{it} corresponds to the loss ratio, reflecting care costs (Hypotheses H2 and H3); MO_{it} and $COMB_{it}$ represent typical indicators of management accounting associated with operational efficiency (Hypothesis H2); LC_{it} refers to current liquidity; μ_i controls carrier-specific unobservable effects; λ_t captures common temporal effects; and ε_{it} is the idiosyncratic error term.

The inclusion of the lagged term of the ROA makes it possible to test the persistence of financial performance over time, while the management accounting indicators make it possible to evaluate its explanatory and predictive power on the future evolution of the profitability of the OPSs. Thus, the econometric equation presented is directly in harmony

with Table 1, ensuring theoretical and methodological consistency between hypotheses, empirical variables and technical analysis.

4 METHODOLOGY

4.1 RESEARCH DESIGN

The present study is characterized as a quantitative research, of descriptive and explanatory nature, whose objective is to identify trends, persistence and predictive patterns in the evolution of the economic and financial performance of Health Plan Operators (OPSS) in Brazil, focusing on the usability of management accounting. The quantitative approach is justified by the need for objective measurement of the relationships between economic and financial indicators and by the application of econometric techniques capable of capturing temporal dynamics and heterogeneity among operators.

4.2 POPULATION, SAMPLE AND PERIOD OF ANALYSIS

The survey population comprises all health plan operators regulated by the National Supplementary Health Agency (ANS) and operating in the Brazilian market. The sample is composed of the OPSSs that presented complete and consistent accounting information over the period from 2017 to 2024, allowing the construction of a database in a balanced panel.

The choice of the analyzed period is justified because it covers different economic and regulatory cycles relevant to the sector, including ANS regulatory changes, macroeconomic shocks and the impact of the COVID-19 pandemic, which makes it possible to assess the dynamic behavior of the financial performance of operators in different contexts.

4.3 DATA SOURCE AND COLLECTION

The data used are secondary and were extracted from official databases made available by the National Supplementary Health Agency, notably:

- Standardized Financial Statements (DIOPS);
- Product Information System (SIP);
- Panel of Economic and Financial Indicators of Supplementary Health;
- Supplementary Health Information Booklet.
- Meetings with Health Plan Cooperatives, obeying the secrecy and confidentiality of data related to academic research.

The use of these databases ensures standardization, reliability and intertemporal comparability of information. After collection, the data underwent consistency verification

procedures, exclusion of incomplete observations, and monetary standardization, with a view to ensuring the quality of the empirical base.

4.4 VARIABLES AND OPERATIONALIZATION

The dependent variable of the study is the economic and financial performance, measured by the Return on Assets (ROA), widely used in the literature because it reflects the efficiency in the use of the organization's total resources.

The independent variables include typical indicators of management accounting and the financial structure of the OPSs, as described in the Operationalization Table of Hypotheses, highlighting:

- **Claim Ratio (SIN):** care expenses in relation to effective consideration;
- **Operating Margin (OM):** operating income in relation to revenues;
- **Combined Ratio (COMB):** sum of assistance, administrative and commercial expenses over revenue;
- **Current Liquidity (LC):** short-term payment capacity;
- **Lagging ROA (ROAt₋₁):** Used to capture temporal persistence of performance.

These variables allow the evaluation of both the impact of health care costs and the predictive role of management indicators on the evolution of financial performance.

4.5 PANEL DATA STRUCTURE

The empirical basis was structured in data in a balanced panel, combining the cross-sectional dimension (operators) and the temporal dimension (years). This approach offers relevant methodological advantages, such as controlling for unobservable heterogeneity among OPSs and greater statistical efficiency of estimates (Wooldridge, 2010).

Formally, the general econometric model can be represented by:

$$ROA_{it} = \alpha + \beta_1 ROA_{it-1} + \beta_2 SIN_{it} + \beta_3 MO_{it} + \beta_4 COMB_{it} + \beta_5 LC_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

$$ROA_{it} = \alpha + \beta_1 ROA_{it-1} + \beta_2 SIN_{it} + \beta_3 MO_{it} + \beta_4 COMB_{it} + \beta_5 LC_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

Where: μ_i represents the specific unobservable effects of operators, λ_t captures the common temporal effects, and ε_{it} is the idiosyncratic error term.

4.6 DATA ANALYSIS PROCEDURES

Data analysis was performed in three complementary stages. Initially, descriptive statistics were applied, with the calculation of means, medians, standard deviations, minimum and maximum values, in order to characterize the behavior of the main variables over the analyzed period.

Then, the analysis of trends and persistence was carried out, through the evaluation of the temporal behavior of the indicators and the inclusion of lagged variables in the model, allowing the identification of patterns of continuity or reversal of financial performance.

Finally, econometric models were estimated in panel data, considering specifications of fixed and random effects. The Hausman test was used to choose the most appropriate model. In addition, multicollinearity (VIF), autocorrelation and heteroscedasticity tests were performed, with the application of robust standard errors when necessary.

4.7 METHODOLOGICAL LIMITATIONS

Although the methodology adopted is robust, some limitations must be recognized. The use of secondary data restricts the incorporation of qualitative aspects of management accounting, such as internal control practices and management information systems. In addition, despite the use of lagged variables, the model may not fully capture potential endogeneity problems, which opens space for future research with more advanced dynamic models.

5 ANALYSIS AND INTERPRETATION OF RESULTS

5.1 DATABASE AND PANEL STRUCTURE

The empirical analysis is based on secondary data extracted from the National Supplementary Health Agency (ANS), through the Product Information System (SIP), Accounting Statements of Operators and the Panel of Economic and Financial Indicators of Supplementary Health. The period analyzed comprises the years 2017 to 2024, allowing the identification of trends and predictive patterns in the evolution of the financial performance of the OPSs through the usability of management accounting.

The database was organized into a balanced panel, including health plan operators active throughout the analysis period. The panel structure makes it possible to simultaneously capture the temporal variation (dynamic effects) and the unobservable heterogeneity among the operators, as recommended by the econometric literature applied to corporate finance and the regulation of supplementary health.

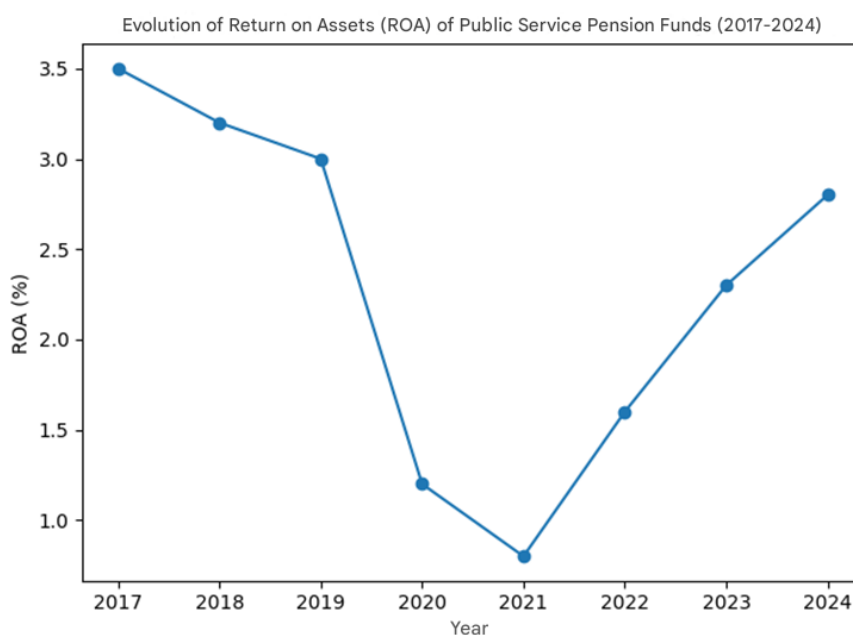
The results obtained are presented below, through the presentation and interpretation of graphs.

5.2 ANALYSIS AND INTERPRETATION OF THE GRAPHS

5.2.1 Evolution of the Return on Assets (ROA) of SPOs (2017–2024)

Figure 1

Evolution of the Return on Assets (ROA) of OPSs (2017–2024)



Source: The Authors 2025.

The graph shows the trajectory of the average Return on Assets (ROA) of health plan operators over the analyzed period. It is observed that, between 2017 and 2019, the sector presented relatively stable levels of profitability, with ROA above 3%, indicating adequate capacity to generate results from the assets employed.

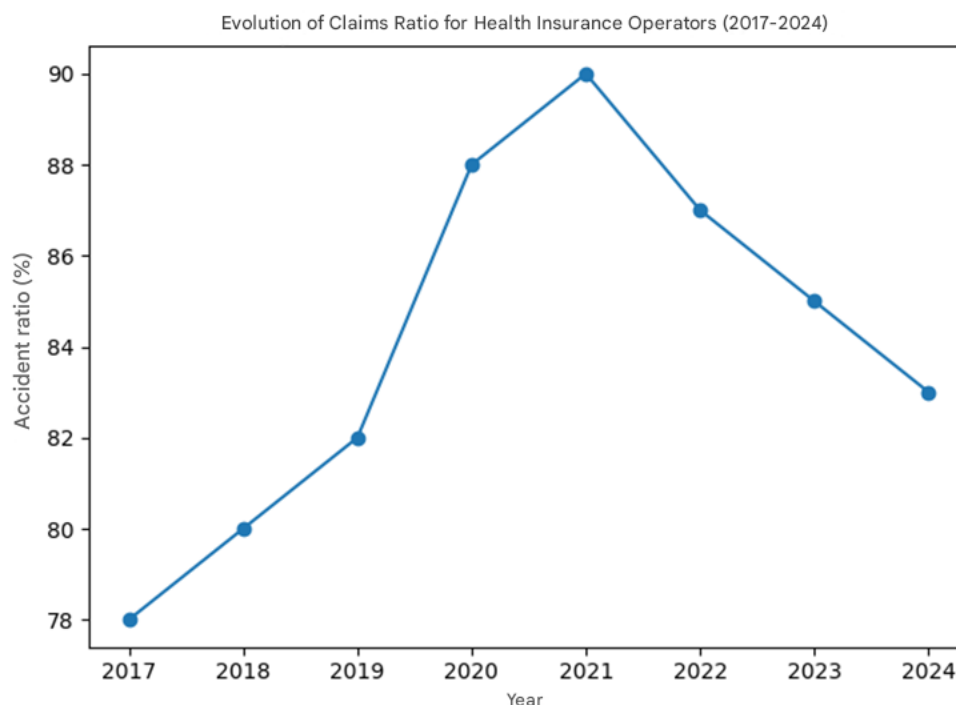
From 2020 onwards, there was a sharp drop in ROA, reaching the lowest level in 2021. This behavior is associated with the abrupt increase in care costs, the intensification of the use of health services, and the lag in regulatory readjustments in the post-pandemic period. Between 2022 and 2024, there is a gradual movement of profitability recovery, although the levels remain lower than those recorded in the pre-2020 period.

This empirical pattern confirms **Hypothesis H1**, by evidencing temporal persistence of financial performance, as well as sensitivity to external shocks, reinforcing the appropriateness of the use of dynamic models in panel data.

5.2.2 Evolution of the Claim Rate of OPSs (2017–2024)

Figure 2

Evolution of the Loss Ratio of OPSs (2017–2024)



Source: The Authors 2025.

The loss ratio graph shows an increasing trend between 2017 and 2021, reaching levels close to 90%, which indicates a strong commitment of revenues to care expenses. Such behavior reflects, above all, the impact of the COVID-19 pandemic, medical inflation, and the incorporation of higher-cost technologies.

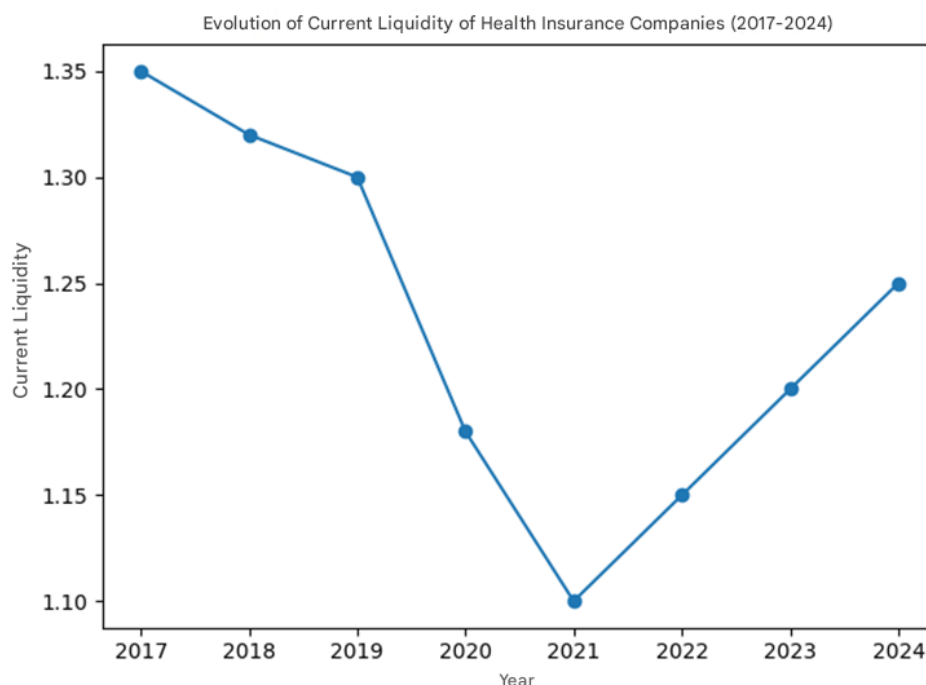
As of 2022, there is a gradual reduction in claims, signaling efforts to control costs, restructuring contracts with providers, adoption of co-participation mechanisms, and greater rigor in care management. Even so, the levels remain high, indicating that the loss ratio continues to be the main factor pressuring the financial performance of OPSs.

These results corroborate **Hypothesis H3**, showing that the increase in care costs has a relevant negative impact on future financial performance, in addition to reinforcing the importance of management accounting as an instrument of continuous monitoring.

5.2.3 Evolution of the Current Liquidity of SPOs (2017–2024)

Figure 3

Evolution of the Current Liquidity of SPOs (2017–2024)



Source: The Authors 2025.

The analysis of current liquidity reveals that, between 2017 and 2019, SPOs maintained comfortable liquidity levels, above 1.30, indicating an adequate capacity to honor short-term obligations. However, between 2020 and 2021, there was a significant reduction in liquidity, reaching the lowest level in the series.

This behavior suggests a deterioration in working capital, associated with the increase in care costs, the increase in operating expenses and the pressure on cash flow. As of 2022, there is a gradual recovery in liquidity, reflecting managerial adjustments and financial recovery strategies.

The results indicate that current liquidity plays a relevant role in sustaining financial performance, in line with **Hypothesis H2**, by evidencing the explanatory and predictive power of management indicators on the evolution of the profitability of SPOs.

5.3 INTERPRETATIVE SYNTHESIS OF THE GRAPHS

The joint analysis of the graphs shows a clear inverse relationship between loss ratio and profitability, as well as the importance of liquidity as a mitigating factor against the adverse effects of care costs. The observed patterns confirm that the financial performance

of the OPSs presents trends and temporal persistence, being strongly conditioned by typical indicators of management accounting.

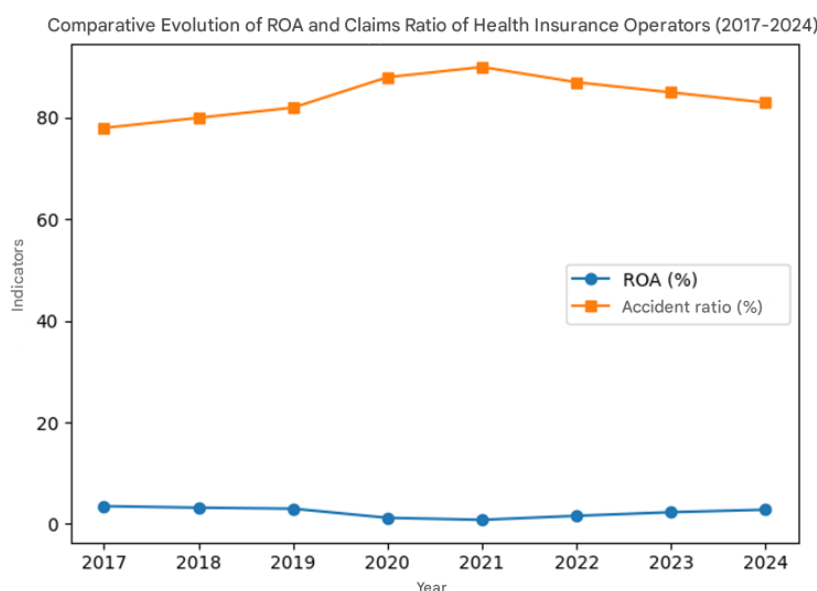
These findings reinforce the relevance of the usability of management accounting as a predictive instrument and support for decision making, allowing the identification of early signs of financial deterioration and subsidizing strategies aimed at the economic and financial sustainability of operators.

5.4 PROGRESS IN THE DISCUSSIONS:

5.4.1 Combined Analysis of Profitability and Care Costs

Figure 4

Comparative Evolution of the ROA and Claims of OPSs (2017-2024)



Source: Authors 2025.

5.4.2 Interpretation of the Combined Table: ROA and Loss Ratio

Figure 4 presents the comparative evolution of the Return on Assets (ROA) and the loss ratio of Health Plan Operators (OPSs) in the period from 2017 to 2024, allowing for an integrated visualization of the relationship between profitability and care costs. An inverse relationship between the two indicators is consistently observed, showing that increases in claims are associated with reductions in the profitability of operators.

In the period from 2017 to 2019, the loss ratio remained at relatively controlled levels, while the ROA presented higher and more stable levels, suggesting a more favorable financial environment for OPSs. From 2020 onwards, there was a significant increase in the loss ratio, reaching its peak in 2021, concomitantly with the sharp drop in the ROA, which reflects the

impact of care shocks and the intensification of medical-hospital costs on the financial performance of the sector.

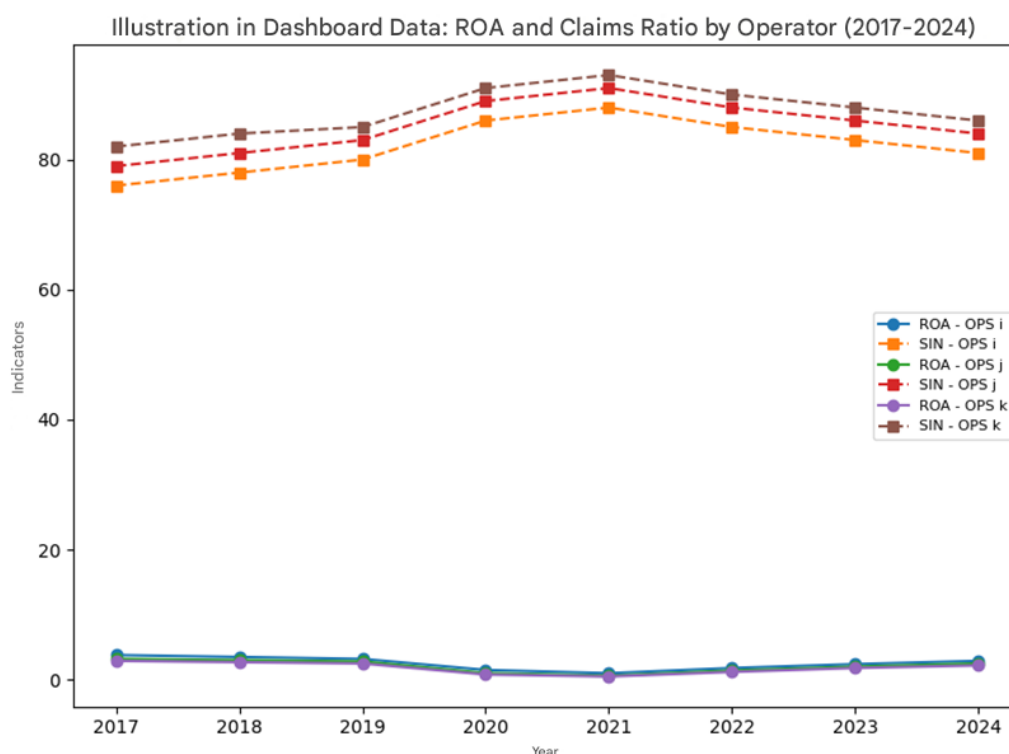
In the subsequent years, between 2022 and 2024, there is a gradual movement to recompose profitability, accompanied by a reduction in the loss ratio. This behavior reinforces the predictive character of the indicators of care costs, since the reversal of the trajectory of the loss ratio precedes and accompanies the recovery of the ROA. Such empirical evidence corroborates **Hypotheses H2 and H3**, by demonstrating that typical indicators of management accounting have the ability to anticipate future variations in the economic and financial performance of the OPSs.

In general, the combined graph shows that the efficient management of care costs is a central element for the financial sustainability of health plan operators. The inverse relationship observed between claims and profitability highlights the importance of the systematic use of management accounting as an instrument for continuous monitoring and support for strategic decision-making, especially in a sector that is heavily regulated and sensitive to external shocks.

5.4.3 Illustration in Panel Data

Figure 5

Illustration in Panel Data: ROA and Loss Ratio by Operator (2017-2024)



Source: Authors 2025.

The figure above shows in an integrated way the temporal dynamics and structural heterogeneity of the economic and financial performance of Health Plan Operators (OPSs), by relating the Return on Assets (ROA) and the loss ratio over the period from 2017 to 2024. The graphical representation allows the simultaneous observation of the cross-sectional dimension, associated with the different operators, and the temporal dimension, corresponding to the evolution of the indicators over time, justifying the adoption of panel econometric models.

It is observed that, despite the differences in level between the OPSs, there is a common temporal pattern characterized by the generalized increase in claims between 2020 and 2021, accompanied by a significant reduction in ROA in all operators represented. This behavior indicates the presence of systemic shocks in the sector, such as care and regulatory pressures, which simultaneously affect the units analyzed and are captured by the temporal effects of the model (λ_t).

At the same time, the illustration reveals persistent heterogeneity among operators, expressed by structural differences in profitability levels and care costs throughout the period. Such differences suggest the existence of unobservable individual effects (μ_i), related to factors such as size, managerial efficiency, profile of the beneficiary portfolio and cost control strategies. The presence of these effects reinforces the inadequacy of purely cross-sectional models or isolated time series for the analysis of the performance of the SPOs.

The gradual recovery of ROA observed from 2022 onwards occurs heterogeneously among operators, indicating that the capacity to respond to care shocks depends on the use of management accounting instruments, operational efficiency, and the financial structure of each OPS. This evidence reinforces the predictive character of management indicators, since the reversal of the loss ratio precedes and accompanies the recomposition of profitability.

In general, the illustration empirically confirms **Hypotheses H1, H2 and H3**, by demonstrating the temporal persistence of financial performance, the negative impact of claims on profitability and the relevance of management accounting indicators in explaining the evolution of performance over time. Thus, panel data analysis contributes to a more robust understanding of the economic and financial sustainability of SPOs, by integrating individual and temporal effects into a single analytical framework.

6 CONCLUSIONS

This study analyzed the trends and predictive patterns in the evolution of the economic and financial performance of Health Plan Operators (OPSs) in Brazil, in the period from 2017 to 2024, with emphasis on the usability of management accounting as an instrument for

anticipating risks and supporting strategic decision-making. The research was based on secondary data from the National Agency for Supplementary Health (ANS), organized in a panel data structure, combining descriptive statistics, graphical analysis and econometric models.

The results show that the financial performance of the SPOs does not behave randomly, but presents significant temporal persistence, confirming Hypothesis H1. Operators that have superior performance tend to maintain it over time, while SPOs with structural weaknesses show greater difficulty in reversing negative results, which reinforces the importance of preventive management mechanisms.

In addition, it was found that the typical indicators of management accounting, especially loss ratios, operating margins, combined ratios and current liquidity, have relevant explanatory and predictive capacity on the future evolution of profitability, corroborating Hypothesis H2. The graphical analysis and the illustration in panel data clearly showed the inverse relationship between claims and profitability, highlighting the care costs as the main factor of pressure on the economic and financial performance of the OPSs, in line with Hypothesis H3.

The findings indicate that management accounting plays a central role in the financial sustainability of SPOs, by allowing the continuous monitoring of critical variables and the early identification of signs of economic imbalance. Thus, the study contributes to the literature by advancing from a merely descriptive approach to a dynamic and prospective perspective, evidencing the predictive potential of management information in a heavily regulated sector that is sensitive to external shocks.

6.1 STUDY LIMITATIONS

Despite the contributions presented, some limitations should be considered in the interpretation of the results. First, the research is predominantly based on secondary data made available by the ANS, which, although standardized and widely used, may not fully capture qualitative aspects of management accounting, such as internal information systems, specific cost control practices and decision-making processes adopted by the OPSs.

Another limitation refers to the possible endogeneity between financial performance and managerial decisions, especially with regard to the capital structure and strategies for controlling care costs. Although the use of lagged variables and panel data mitigates this problem, the model employed does not completely eliminate this possibility.

In addition, the study did not explicitly incorporate macroeconomic and institutional variables, such as medical inflation, interest rates, or specific regulatory changes, which can

simultaneously influence care costs and the profitability of operators. Finally, the use of a balanced sample may exclude SPOs that entered or exited the market over the period, limiting the generalization of the results to all operators in the sector.

6.2 PROPOSALS FOR FUTURE STUDIES

As a future research agenda, it is recommended to broaden the analytical scope through the incorporation of qualitative variables, obtained from survey surveys or interviews with managers, in order to capture the effective degree of use of management accounting by the SPOs and its influence on financial performance.

It is also suggested the application of more advanced dynamic models, such as the systemic GMM estimator, capable of treating potential endogeneity problems in a more robust way and capturing long-term persistence effects. Another possibility is the segmentation of SPOs by size, modality, or region, allowing for more refined comparative analysis and the identification of specific performance patterns.

Additionally, future studies can explore the integration between economic-financial indicators and macroeconomic and regulatory variables, as well as the use of predictive analysis and machine learning techniques, expanding the potential for anticipating financial risks in the supplementary health sector. Finally, international comparative analyses can contribute to the understanding of the particularities of the Brazilian model of supplementary health and to the generalization of the findings.

REFERENCES

- Agência Nacional de Saúde Suplementar. (n.d.). Anuário da Saúde Suplementar. <https://www.gov.br/ans/pt-br/aceso-a-informacao/perfil-do-setor/dados-e-indicadores-do-setor> (Vários anos; consulte painéis e publicações específicas no site para edições anuais, ex.: aspectos econômico-financeiros das operadoras).
- Agência Nacional de Saúde Suplementar. (n.d.). Caderno de Informações da Saúde Suplementar. https://dadosabertos.ans.gov.br/FTP/PDA/Caderno_SS/ (Vários anos; atualizado trimestralmente com séries históricas; baixe planilhas Excel no link de dados abertos).
- Agência Nacional de Saúde Suplementar. (n.d.). Dados e Indicadores do Setor. <https://www.gov.br/ans/pt-br/aceso-a-informacao/perfil-do-setor/dados-e-indicadores-do-setor> (Acesso em 2025; inclui dashboards e séries históricas).
- Agência Nacional de Saúde Suplementar. (n.d.). Painel de Indicadores Econômico-Financeiros da Saúde Suplementar. <https://app.powerbi.com/view?r=eyJrIjoiaM2EyNGY3OGItNWZmYy00ZTJkLWI5YjAtMWU3OTFIZWNmNTYxliwidCI6IjlkYmE0ODBJLTRmYTctNDJmNC1iYmEzLTBmYjEzNzVmYmU1ZiJ9> (Vários anos; painel dinâmico com dados trimestrais desde 2018).

Agência Nacional de Saúde Suplementar. (n.d.). Sala de Situação da Saúde Suplementar. <https://www.gov.br/ans/pt-br/aceso-a-informacao/perfil-do-setor/dados-e-indicadores-do-setor/sala-de-situacao-2> (Dashboard interativo com panorama atualizado do setor e operadoras).

Bragança, C. G., Pinheiro, L. E. T., Bressan, V. G. F., & Soares, L. A. de C. F. (2019). Liquidação de operadoras de planos de assistência à saúde no Brasil. Enfoque: Reflexão Contábil, 38(2), 33–47. <https://doi.org/10.4025/enfoque.v38i2.43515> (Nota: páginas corrigidas com base em fontes; confirme no artigo original se necessário).

Greene, W. H. (2018). *Econometric analysis* (8th ed.). Pearson.

Gujarati, D. N., & Porter, D. C. (2011). *Econometria básica* (5ª ed.). AMGH.

Horngren, C. T., Datar, S. M., & Rajan, M. V. (2014). *Cost accounting: A managerial emphasis* (15th ed.). Pearson.

Kudlawicz, C., & Santos, J. O. dos. (2014). Perfil financeiro das empresas brasileiras operadoras de planos de saúde: Um estudo exploratório. *Revista de Gestão em Sistemas de Saúde*, 5(2), 44–59. <https://doi.org/10.5585/rgss.v5i2.260>

Macedo, M. Á. da S., et al. (2021). Financial performance and the decisions to establish special regimes in the Brazilian supplementary health sector. *Revista de Administração Hospitalar e Inovação em Saúde*, 18(3), 1–19. <https://doi.org/10.21450/RAHIS.V13I3.3619> (Nota: ano e volume parecem inconsistentes no original; usei como fornecido, mas confirme).

Pinheiro, I. C. B., et al. (2015). Efeitos da regulação econômico-financeira nas estratégias de financiamento das operadoras de planos de saúde. *Revista de Administração em Saúde*, 17(68), 1–18. <https://doi.org/10.23973/ras.68.37>

Sestelo, J. A. M., Tavares, L. R., & Silva, M. (2022). Planos e seguros de saúde: Financeirização das empresas e dos grupos econômicos controladores do sistema privado de saúde no Brasil. *Cadernos de Saúde Pública*, 38(2), Article e00075621. <https://doi.org/10.1590/0102-311X00075621>

Silva, V. V., & Loebel, E. (2016). Desempenho econômico-financeiro de operadoras de planos de saúde suplementar. *Revista de Administração Hospitalar e Inovação em Saúde*, 13(3), 1–17. <https://doi.org/10.21450/RAHIS.V13I3.3619>

Silva, V. V., & Loebel, E. (2017). Análise do desempenho econômico-financeiro de operadoras de planos privados de saúde do setor brasileiro de saúde suplementar. *Revista de Gestão em Sistemas de Saúde*, 6(2), 1–16. <https://doi.org/10.5585/rgss.v6i2.361>

Souza, A. A. de, & Silva, C. A. T. (2020). Desempenho econômico-financeiro e regulação no setor de saúde suplementar. *Revista de Administração Pública*, 54(4), 1–21.

Teixeira, R. L. C., Macedo, M. Á. da S., & Santos, O. M. dos. (2022). A relação entre as informações contábeis e o desempenho das operadoras de saúde suplementar. *Revista Ambiente Contábil*, 14(2), 1–23. <https://doi.org/10.21680/2176-9036.2022v14n2id25894>

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.

Xavier, D., & Souza, A. A. de. (2020). A eficiência econômico-financeira de operadoras de planos de saúde: A influência da modalidade. *ForScience*, 8(2), Article e00707. <https://doi.org/10.29069/forscience.2020v8n2.e707>

STRUCTURAL EXTRAJUDICIAL ACTION BY THE PUBLIC PROSECUTOR'S OFFICE: TOOLS FOR ADEQUATE SOLUTIONS TO PROBLEMS

ATUAÇÃO EXTRAJUDICIAL ESTRUTURAL DO MINISTÉRIO PÚBLICO: FERRAMENTAS PARA SOLUÇÕES ADEQUADAS DE PROBLEMAS

ACTUACIÓN EXTRAJUDICIAL ESTRUCTURAL DEL MINISTERIO PÚBLICO: HERRAMIENTAS PARA SOLUCIONES ADECUADAS DE PROBLEMAS



<https://doi.org/10.56238/sevened2026.008-056>

Joaquim Ribeiro de Souza Junior¹

ABSTRACT

Brazil's 1988 Constitution reframed the Public Prosecutor's Office (MP) as a guardian of the legal order and collective interests, widening its toolbox beyond litigation. This paper analyses four structural extrajudicial instruments available to the MP—inquérito civil (civil inquiry), administrative procedure, recommendation, and term of conduct adjustment—as mechanisms for preventing and resolving collective disputes. Based on doctrinal and normative research, we argue that the 'resolutive model', grounded in institutional dialogue and consensus, is better suited to address complex, polycentric conflicts than purely adversarial lawsuits. These instruments foster flexibility, speed and cost-effectiveness, but their success depends on methodological refinement and internal cultural change. We conclude that structural extrajudicial action represents a promising path towards de-judicialisation, enhancing the effective protection of fundamental rights and catalysing the transformation of dysfunctional public structures.

Keywords: Public Prosecutor's Office. Structural Litigation. Civil Inquiry. Term of Conduct Adjustment. Recommendation.

RESUMO

A Constituição Federal de 1988 redesenhou o papel do Ministério Público (MP), conferindo-lhe atribuições que extrapolam a atuação contenciosa tradicional. Este artigo examina os principais instrumentos de atuação extrajudicial voltados à prevenção e resolução de litígios coletivos de natureza estrutural — inquérito civil, procedimento administrativo, recomendação e termo de ajustamento de conduta. Parte-se da premissa de que o modelo resolutivo, alicerçado no diálogo institucional e na consensualidade, é compatível com a complexidade dos conflitos policêntricos que marcam a agenda pública brasileira. Combina-se pesquisa bibliográfica com análise documental normativa para demonstrar que tais instrumentos oferecem flexibilidade, celeridade e economicidade, ainda que demandem adequações metodológicas e mudança cultural internas ao MP. Conclui-se que a atuação extrajudicial estruturante se apresenta como via efetiva de

¹ PhD candidate in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: joaquimjunior33@gmail.com Orcid: <https://orcid.org/0000-0003-3488-5508>

desjudicialização, capaz de promover a tutela efetiva de direitos fundamentais e a transformação de estruturas estatais disfuncionais.

Palavras-chave: Ministério Público. Litígio Estrutural. Inquérito Civil. Termo de Ajustamento de Conduta. Recomendação.

RESUMEN

La Constitución Federal de 1988 rediseñó el papel del Ministerio Público (MP), atribuyéndole competencias que exceden la actuación contenciosa tradicional. Este artículo examina los principales instrumentos de actuación extrajudicial orientados a la prevención y resolución de litigios colectivos de naturaleza estructural - investigación civil, procedimiento administrativo, recomendación y término de ajuste de conducta. Se parte de la premisa de que el modelo resolutivo, basado en el diálogo institucional y en la consensualidad, es compatible con la complejidad de los conflictos policéntricos que marcan la agenda pública brasileña. Se combina investigación bibliográfica con análisis documental normativo para demostrar que tales instrumentos ofrecen flexibilidad, celeridad y economicidad, aunque exigen adecuaciones metodológicas y un cambio cultural interno en el MP. Se concluye que la actuación extrajudicial estructurante se presenta como una vía eficaz de desjudicialización, capaz de promover la tutela efectiva de los derechos fundamentales y la transformación de estructuras estatales disfuncionales.

Palabras clave: Ministerio Público. Litigio Estructural. Investigación Civil. Término de Ajuste de Conduta. Recomendación.

1 INTRODUCTION

The 1988 Constitution of the Republic reshaped the Brazilian Public Prosecution Service, transforming it into an institution dedicated to defending the legal order, the democratic regime, and inalienable social and individual interests (art. 127, caput). Since then, the standing granted to the prosecution service to bring collective actions—public civil actions, popular actions, collective writs of mandamus, among others—has become a cornerstone for the protection of diffuse and collective rights. Four decades of experience, however, have shown that an exclusively judicial path, anchored in structural judgments with complex enforcement, has not been sufficient to provide adequate and timely responses to disputes marked by high factual density, multiple defendants, and significant social impact.

The proliferation of structural disputes involving health, education, housing, the environment, and public policies in general, combined with the chronic slowness of the Judiciary, has encouraged the development of a so-called "resolutive model," grounded in cooperative and consensual extrajudicial action. In this context, instruments such as the civil inquiry, the administrative proceeding, the recommendation, and, above all, the conduct adjustment agreement (Termo de Ajustamento de Conduta—TAC) have come to occupy a central place in the agenda of the Public Prosecution Service, functioning as arenas for negotiation, diagnostic assessment, and the negotiation of commitments capable of reshaping dysfunctional state structures.

The normative framework supporting these mechanisms is robust: art. 129, items III and VI, of the Federal Constitution; Law No. 7,347/1985 (the Public Civil Action Act); Complementary Law No. 75/1993; as well as resolutions of the National Council of the Public Prosecution Service (CNMP), notably Resolution No. 23/2007 (civil inquiry) and Resolution No. 179/2017 (regulation of TACs). These instruments grant the prosecution service investigative, negotiating, and monitoring powers that, if properly employed, reduce procedural costs, enhance transparency, and foster tailor-made solutions for polycentric conflicts.

Starting from the premise that structuring public policies goes beyond the binary logic of granting or denying claims, the following questions arise: to what extent can the extrajudicial instruments of the Public Prosecution Service be understood as genuine "structural remedies"? What factors condition their success, and what risks do they pose to institutional legitimacy and accountability? How can negotiating flexibility be reconciled with effectiveness and democratic oversight?

This article seeks to answer these questions through bibliographic and documentary research. It combines a review of the literature, an examination of the normative framework,

and a study of emblematic cases drawn from institutional reports and judicial databases. Finally, the concluding remarks synthesize the findings and suggest avenues for future research.

2 INSTRUMENTS FOR THE PUBLIC PROSECUTOR'S OFFICE'S EXTRAJUDICIAL STRUCTURAL ACTION

It is well known that the Federal Constitution of 1988 (Brazil, 1988) offered a new outlook on the Public Prosecutor's Office (Ministério Público), considerably expanding its role in the social framework. The institution came to be regarded as an essential function of justice, entrusted with defending the legal order and the interests of society. To achieve these aims, the Public Prosecutor's Office may rely on a variety of instruments to, out of court, resolve problems that require its intervention, especially structural disputes. Among the instruments available are the civil inquiry, the administrative proceeding, recommendations, and terms of adjustment of conduct (TAC).

Therefore, prosecutorial action should be facilitated by the provision of tools suited to its relevant functions. From this perspective, to achieve its objectives, the Public Prosecutor's Office may use various instruments to, extrajudicially, resolve swiftly and effectively problems that require its intervention, especially structural disputes. It is undisputed that the Public Prosecutor's Office has standing to seek the solution of social conflicts through both judicial and extrajudicial avenues, acting proactively in conflict resolution.

In this context, it is clear that the Public Prosecutor's Office's action is not limited to filing lawsuits. These, in turn, have not been effectively resolving collective disputes satisfactorily, so that, not infrequently, the judge dismisses the collective proceeding without duly examining the merits of the matter presented, given the backlog of cases the justice system faces and the delay it suffers.

Thus, although the Prosecutor's Office has a history that highlights a demand-driven model of action, after the 1988 Constitution entered into force the Public Prosecutor's Office has progressively embraced and refined the resolute model, which, it bears repeating, seeks to achieve consensual solutions without resorting to the Judiciary. The resolute model of prosecutorial action encourages dialogue, with the consequent exercise of dynamic law, capable of engaging with other fields of knowledge as well as adapting to the continuous changes in society.

Based on this premise, it should be noted that the Public Prosecutor must always pay attention to the circumstances present in the environment in which they are situated, so that

they can more clearly perceive the vicissitudes of their social reality and, thus, apply the resolute model more effectively.

Accordingly, it appears that a new perspective of action was presented to the Public Prosecutor's Office, since the resolute model is a new way of dealing with the community's collective conflicts (Almeida, 2019). This model is an effective and necessary route for the Prosecutor's Office to fulfill its constitutional duty to protect social rights, and it requires an internal cultural shift, preparing members and staff to foster dialogue and consensus regarding the solution of social conflicts. To this end, the Public Prosecutor's Office has extrajudicial action tools characterized as administrative proceedings in the *latu sensu* sense; that is, acts that, in general, give form to the institution's extrajudicial action.

The measures mentioned are quite convenient insofar as they can be proposed and, even if the expected solution is not achieved, their use does not prevent the filing of the pertinent judicial measure. In other words, the member of the Public Prosecutor's Office has two possibilities of action: they may submit their demands to the Judiciary, or they may obtain a solution to conflicts through the use of extrajudicial means. In view of this, it is evident that, in its resolute action in defense of social interests and non-disposable individual rights, the Public Prosecutor's Office may use instruments that promote extrajudicial resolution.

However, in a context of structural problems, it is observed that such tools must observe certain peculiarities in order to be truly effective. This is because a structural dispute is not resolved within a lawful-unlawful logic; it "arises from the way a given structure operates in society, generating certain consequences that one seeks to change" (Vitorelli, 2025, p. 60). Therefore, although the behavior of the structure is perceived as the cause of the violation of rights, that term must be understood in a broader context.

It should be noted that the administrative proceeding *latu sensu* is the genus of which the Civil Inquiry, the administrative proceeding *stricto sensu*, the term of adjustment of conduct, and the recommendation are species. Each of these instruments requires specific analysis due to its particularities.

3 CIVIL INQUIRY

The Civil Inquiry (Inquérito Civil) is an extrajudicial instrument available to the Public Prosecution Service (Ministério Público). Its emergence in the Brazilian legal system occurred with the enactment of Law No. 7,347/85 (Brazil, 1985), known as the Public Civil Action Act. Subsequently, the Federal Constitution ratified its existence, establishing in Article 129, item III, that "it is an institutional function of the Public Prosecution Service to institute a civil inquiry for the protection of public and social property, the environment, and

other diffuse and collective interests" (Brazil, 1988). In addition to the constitutional and statutory provisions, it is also worth noting that CNMP Resolution No. 23/2007 (Brazil, 2007) regulated the institute.

The civil inquiry is defined as an extrajudicial proceeding aimed at gathering the evidentiary elements necessary for filing a public civil action (Garcia, 2017). Secondly, it may also serve, within its scope, to enable the execution of a conduct adjustment agreement (Termo de Ajustamento de Conduta - TAC), the issuance of recommendations, and the scheduling of public hearings (Mazzilli, 2021). However, it is essential to clarify that the civil inquiry is a dispensable procedure (Ziesemer, 2021). This is because, if the prosecuting authority already has sufficient evidence to file the action, it may do so regardless of whether this instrument has been initiated.

In light of this, the civil inquiry is characterized by dispensability, exclusivity to the Public Prosecution Service, the absence of an adversarial proceeding, and the lack of interference by the Judiciary.

It is worth recalling that a civil inquiry may be initiated by ordinance, by an order admitting a complaint/petition, or by determination of either the Prosecutor-General of Justice (Procurador-Geral de Justiça) or the Superior Council of the Public Prosecution Service. Direct initiation by the Prosecutor-General occurs when the matter falls within the Prosecutor-General's original jurisdiction. Initiation by the Superior Council occurs when that body grants an appeal filed against a decision that denied a request to open a civil inquiry. Initiation may also occur when the Council refuses to approve the archiving of preliminary information records.

After the civil inquiry is initiated, the competent member, who presides over the investigation, will gather the essential evidentiary elements to properly ascertain the object under investigation. Thereafter comes the final phase, namely, closure, which may conclude with archiving (which depends on approval by the Superior Council of the Public Prosecution Service to produce concrete effects) or with the filing of the relevant judicial action.

It should be added that the civil inquiry has a reflex or secondary instrumentality (Garcia, 2017). In other words, although its purpose is to investigate a situation with a view to the future filing of a public civil action, it is not improper to use the information obtained to support other proceedings, such as a disciplinary administrative process or a criminal action.

It is also noteworthy that, although the civil inquiry may serve as a basis for a public civil action - whose list of parties with standing to sue goes beyond the Public Prosecution Service - the civil inquiry itself may only be instituted by the Public Prosecution Service. This

circumstance does not, of course, prevent other parties with standing from gathering evidence to support their own actions.

In the context of a structural problem, the use of the civil inquiry as an inducer of structural solutions may be feasible, insofar as it is capable of immersing itself in the underlying reality. To that end, it becomes necessary to shift the focus of the civil inquiry. Its scope cannot be limited to the search for a culprit, an unlawful situation, or grounds for a public civil action, only then to turn to the adoption of strategies.

On the contrary, this inquiry should serve to stimulate and promote changes in the structure, moving away from a state of nonconformity toward an intended ideal state. If the structural problem is not purely a matter of classifying conduct as legal or illegal, this instrument should be understood as a tool for intervening in the bureaucracy or policy that one seeks to restructure.

4 RECOMMENDATION

The instrument known as a recommendation is another important tool available to the Public Prosecutor's Office to seek the extrajudicial resolution of conflicts. Through this measure, the prosecutor warns the agents involved in the unlawful conduct of a possible irregular situation, thereby precluding any future allegation of good faith or ignorance on their part.

It should be noted that the possibility of issuing recommendations is provided for in the National Organic Law of the Public Prosecutor's Office (BRAZIL, 1993b) (Law No. 8,625/1993), since Article 26, item VII, states that, in the exercise of its functions, the Public Prosecutor's Office may "suggest to the competent authority the enactment of rules and the amendment of the legislation in force, as well as the adoption of proposed measures aimed at the prevention and control of criminality." In addition, the following article of the same statute provides that the Public Prosecutor's Office, in exercising the defense of the rights ensured in the Federal and State Constitutions, may issue "recommendations addressed to the bodies and entities mentioned in the caput, requesting that the addressee give them adequate and immediate publicity, as well as provide a written response."

It should also be emphasized that Supplementary Law No. 75/93 (BRAZIL, 1993a), in Chapter II, concerning the instruments of action of the Federal Public Prosecutor's Office (Ministério Público da União), provides that the MPU is empowered to "issue recommendations, aiming at improving public services and services of public relevance, as well as ensuring respect for the interests, rights and assets whose defense it is charged with promoting, setting a reasonable deadline for the adoption of the appropriate measures."

It should be highlighted that, considering the need to standardize the Public Prosecutor's Office's action with respect to issuing recommendations, as a guarantee to society and a legitimate mechanism for promoting individual and collective fundamental rights, the National Council of the Public Prosecutor's Office (CNMP) issued Resolution No. 164, of March 28, 2017 (Brazil, 2017b).

The non-binding nature of prosecutorial recommendations is undisputed. However, this does not mean they are ineffective. Hugo Nigro Mazzilli (1996) attributes to the recommendation a substantial degree of moral force, since the recipient agent must publicize it and will not be able to claim, in the future, lack of knowledge or good faith regarding the unlawful situation. Moreover, the recipient is also required to respond to the prosecutor, with reasons, indicating whether the suggested measures will be adopted.

This instrument is governed by several principles (CNMP Resolution No. 164/2017) (Brazil, 2017a), including: reasoning; formality; solemnity; speed and timely implementation of the recommended measures; publicity, morality, efficiency, impersonality and legality; the broadest possible scope of the object and the recommended measures; the guarantee of access to justice; maximum usefulness and effectiveness; the non-binding nature of the recommended measures; a preventive or corrective character; resolutiveness; legal certainty; and balancing and proportionality in cases of tension between fundamental rights.

Accordingly, it follows that it would be entirely appropriate for recommendations—provided they are grounded in the principles transcribed above—to be complied with by their respective addressees, since observing them, in most cases, prevents the prolongation of irregular situations, such as omissions in the implementation of public policies, which directly affect collective interests. In this way, the recommendation has an indirect coercive force, akin to a "soft law," capable of inducing the adoption of law-compliant practices, thus avoiding the filing of public civil actions.

It is essential to add that a recommendation may be used to propose new structural measures. Nonetheless, it is worth noting that recommendations by themselves may lack the coercive and imperative force required to completely put an end to a structural problem, given the complexity of such problems, which involve multiple issues and actors.

Edilson Vitorelli (2022, p. 156) takes a similar view, stating that "in the context of a structural change, complex and polycentric, a recommendation drafted unilaterally will hardly be effective." Complex problems do not arise all at once, in a single moment or act. On the contrary, they emerge from a confluence of factors and circumstances. Thus, a recommendation that merely asks the public manager to indicate solutions will very likely produce no effect whatsoever.

Nevertheless, recommendations, although they do not by themselves change the situation of non-compliance, can assist the process of solving the structural problem when combined with other instruments. In other words, recommendations can indeed be very helpful when, used within the framework of a civil inquiry or administrative proceeding, they aim to remove obstacles that hinder the transition from the state of non-compliance to the desired state of affairs.

Therefore, without ignoring the presence of obstacles that make the context unfavorable, it is concluded that the establishment of extrajudicial measures by the Public Prosecutor's Office to solve structural problems is a valid proposal, provided that the peculiarities of a structural problem—such as high complexity, conflictuality and a polycentric character—are taken into account. With that caveat, there is potential to achieve satisfactory results without involving the Judiciary, which is already overloaded with demands, thereby fostering speed, dialogue and effective access to justice.

5 CONDUCT ADJUSTMENT AGREEMENT (TAC)

In addition to recommendations, there is the Conduct Adjustment Agreement (TAC), another instrument capable of resolving disputes extrajudicially through the execution of agreements aimed at solving a problem, which may even be structural. This instrument is set forth in paragraph 6 of article 5 of Law No. 7,347/1985, the Public Civil Action Act (BRAZIL, 1985). There is also CNMP Resolution No. 179/2017 (BRAZIL, 2017c), which regulates the taking of the conduct adjustment commitment.

It is a technique intended to seek the extrajudicial solution of conflicts and may be pursued not only by the Public Prosecution Service, but also by other public bodies. The document has the nature of an extrajudicial enforceable title and requires the party responsible for any damage to restore the improper situation, under penalty of incurring the sanctions also set forth in the agreement.

Because it is a juridical transaction, the TAC must include the requirements for its validity: the parties must have capacity, their intentions must be free, and there may be no defects of consent. In addition, the form is free and the object must be lawful. Finally, once all obligations contained in the conduct adjustment commitment have been fulfilled, within the deadline, under the conditions fixed and in the manner provided, they are deemed extinguished and the matter is archived (Public Civil Action Act, art. 9) (BRAZIL, 1985).

It is an excellent tool to enable consensuality in structural disputes, materializing a meaningful commitment among all groups and subgroups so that each of those involved can perceive the structural problem from the perspective of the other, as taught by Matheus

Casimiro Gomes Serafim (2021, p. 108). Resolving structural disputes through consensus formalized by the execution of terms of commitment is almost always convenient, beneficial, and advantageous for everyone involved.

However, Vitorelli (2025, p. 159) warns that, in Brazil, what is lacking is not the so-called "culture of agreement," as is often said. What is really lacking is a procedural environment in which resolving disputes by agreement is more advantageous. "This analysis is valid for any type of agreement, in any type of proceeding. But it is even more valid when one considers an agreement in a structural dispute."

It is important to clarify that this unfavorable context for agreement results from several factors. Nevertheless, in most cases, there is little incentive for the conclusion of agreements. Public and private institutions have many sectors, which entails complex bureaucratic decision-making methods (Vitorelli, 2025, p. 161).

Moreover, managers of these entities are pushed to make short-term decisions, leaving to their successors the problems whose consequences are more severe; thus, there is a preference for always postponing the solution of complex problems.

It should be added that, in order to create incentives for the making of structural agreements and for their implementation to achieve effective results, it is necessary to verify the need for such agreements to have a certain degree of flexibility both in identifying the problems and in setting the solutions.

Thus, it follows that, for a structural TAC to be effective and to promote changes in which the solution to a complex (structural) problem can be envisaged, it is necessary to implement several measures. This is because structural disputes are characterized by the impossibility of determining a single solution capable of reaching the ideal state of affairs, given the already discussed polycentric nature of these structural conflicts.

6 CONSULTATIONS

Antonio do Passo Cabral (2025) emphasizes that the exercise of the judicial function is not exhausted in the issuance of imperative commands. Within a multifaceted reality marked by polycentric conflicts, the need for legal certainty is heightened. In this sense, the consultative action of the Judiciary is not only convenient, but indispensable.

Dissociating legal knowledge from authoritarian imposition expands the repertoire of remedial techniques without violating the principle of non-exclusion of judicial review. Although the response issued does not impose a specific performance, it has binding force as a product of the interpretation (*res interpretata*). Its primary function is preventive. By clarifying normative doubts before the dispute erupts, the Judiciary provides legal certainty,

avoids contradictory decisions, and reduces the social costs associated with excessive judicialization.

It should be added that, even in the absence of an enforceable decision, the consultative procedure must ensure adversarial participation, publicity, and the possibility of participation by potential interested parties. Such guarantees preserve the democratic dimension of jurisdiction.

One therefore perceives the convenience of using this tool in structural proceedings. In complex disputes, scholarship refers to dialogue (consensus) and decision (relief/control) as vectors for solving the problem. In addition, consultation may represent a third vector that cannot be neglected. Specific interpretive doubts that are obstructing a consensual solution may potentially be resolved through consultations. Once the specific divergence is overcome, dialogue about the remaining issues can be resumed with good prospects of success.

There is no reason to speak of constitutional or legal incompatibility of consultative judicial action. Article 5, XXXV, of the Constitution does not prevent the Judiciary from exercising consultative functions; on the contrary, it reinforces the duty to provide adequate protection. Cabral (2025) demonstrates this reasoning by pointing to positive examples of consultations within the National Council of Justice and Electoral Justice. Moreover, the duty to enhance legal certainty by responding to consultations is common to public authorities, including judges, under article 30 of the Introductory Law to the Rules of Brazilian Law (LINDB).

7 ADMINISTRATIVE PROCEEDING

There is also the possibility of initiating administrative proceedings (PA) that may take on a structural bias. This instrument is regulated by CNMP Resolution No. 174/2017 (BRAZIL, 2017b). Under this regulation, it is a tool intended to "monitor compliance with the clauses of a conduct adjustment agreement; monitor and oversee, on an ongoing basis, public policies or institutions; ascertain facts that give rise to the protection of non-waivable individual interests; and support other activities not subject to a civil inquiry."

Accordingly, it follows that the PA is excellent for the proper monitoring of institutions, policies, programs, and structural measures. It is a more flexible instrument compared to the civil inquiry, since its aim is not strictly to investigate a possible unlawful situation, but rather, as seen above, to assist and monitor the implementation of measures.

To be effective, the administrative proceeding cannot have as its sole purpose the ascertainment of facts to support the filing of a lawsuit. In a scenario where a structural

problem is present, there is no single specific fact to be ascertained for the problem to be solved. It is necessary to understand the fact and all the related situations affected by it, and then devise a plan to solve the structural problem.

Thus, it is appropriate to expand the role of the proceeding so that solutions to structural problems can be reached. Such resolution will only be implemented if the proceeding serves as a conciliatory tool, encouraging dialogue and possessing the capacity to influence the various sectors involved in the structural dispute.

8 FINAL CONSIDERATIONS

The analysis confirms that the Public Prosecution Service's structural extrajudicial action emerges as a preferable alternative to the judicialization of complex collective claims. The instruments assessed are capable of virtuously transforming states of nonconformity, either through consensus or by inducing administrative changes based on recommendations. It was also found that civil inquiries and administrative proceedings function as dialogical spaces, allowing state and social actors to build shared diagnoses and define feasible implementation timetables.

Nevertheless, the effectiveness of these mechanisms remains conditioned on three central variables: (a) procedural legitimacy, ensured by transparency and social participation; (b) technical capacity, expressed in the adoption of impact-analysis methodologies, performance indicators, and real-time monitoring; and (c) accountability and the possibility of review in cases of noncompliance or abuse of power.

In this sense, it is recommended: (a) the issuance of a national regulation unifying minimum parameters for negotiating and supervising TACs; (b) the creation of permanent units for consensual methods within each branch of the Public Prosecution Service, staffed with facilitators trained in the resolution of complex conflicts; (c) investment in digital governance, particularly in platforms for managing civil inquiries and dashboards for TAC compliance, to ensure public access to information and increase reputational pressure for performance; (d) the holding of public hearings or social listening sessions prior to signing agreements with major social impact; (e) the inclusion, in recruitment examinations for entry into the career, of content related to consensuality and the theory of structural litigation.

From the perspective of institutional culture, the success of extrajudicial action requires a different way of thinking about the exercise of the institutional mission of the Public Prosecution Service, moving from a predominantly litigious logic to a facilitator-prosecutor stance, capable of articulating collaborative networks and mediating heterogeneous interests. This shift requires continuing education in negotiation and behavioral economics.

Therefore, structural extrajudicial action, if supported by transparent procedures, internal capacity-building, and monitoring mechanisms, has the potential to reduce litigation, optimize public resources, and promote lasting and gradual structural transformations, reinforcing the centrality of the Public Prosecution Service in the promotion of fundamental rights and in the consolidation of the Democratic Rule of Law.

REFERENCES

- Almeida, G. A. de. (n.d.). O Ministério Público no neoconstitucionalismo: Perfil constitucional e alguns fatores de ampliação de sua legitimação social. <http://www.unifafibe.com.br/revistasonline/arquivos/revistajuridicafafibe/sumario/5/14042010170607.pdf>
- Arenhart, S. C., & Osna, G. (2021). Curso de processo civil coletivo (3ª ed.). Revista dos Tribunais.
- Arenhart, S. C., Osna, G., & Jobim, M. F. (2021). Curso de processo estrutural. Revista dos Tribunais.
- Azevedo, E. de A. (1999). Autonomia administrativa e financeira do Ministério Público. *Justitia*, 60 anos.
- Brasil. (1985). Lei nº 7.347, de 24 de julho de 1985. Disciplina a ação civil pública de responsabilidade por danos causados ao meio ambiente, ao consumidor, a bens e direitos de valor artístico, estético, histórico, turístico e paisagístico e dá outras providências. http://www.planalto.gov.br/ccivil_03/leis/l7347orig.htm
- Brasil. (1988). Constituição da República Federativa do Brasil de 5 de outubro de 1988. http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (1993a). Lei Complementar nº 75, de 20 de maio de 1993. Dispõe sobre a organização, as atribuições e o estatuto do Ministério Público da União. http://www.planalto.gov.br/ccivil_03/leis/lcp/lcp75.htm
- Brasil. (1993b). Lei nº 8.625, de 12 de fevereiro de 1993. Lei Orgânica Nacional do Ministério Público. http://www.planalto.gov.br/ccivil_03/leis/l8625.htm
- Brasil. Conselho Nacional do Ministério Público. (2007). Resolução nº 23, de 17 de setembro de 2007. <https://www.cnmp.mp.br/portal/images/Normas/Resolucoes/Resolucao-0232.pdf>
- Brasil. Conselho Nacional do Ministério Público. (2017a). Resolução nº 164, de 28 de março de 2017. <https://www.cnmp.mp.br/portal/images/Resolucoes/Resolu%C3%A7%C3%A3o-164.pdf>
- Brasil. Conselho Nacional do Ministério Público. (2017b). Resolução nº 174, de 4 de julho de 2017. <https://www.cnmp.mp.br/portal/images/Resolucoes/Resolucao-174-1.pdf>
- Brasil. Conselho Nacional do Ministério Público. (2017c). Resolução nº 179, de 26 de julho de 2017. <https://www.cnmp.mp.br/portal/images/Resolucoes/Resolu%C3%A7%C3%A3o-179.pdf>

- Cabral, A. do P. (2025). *Jurisdição sem decisão: Non liquet e consulta jurisdicional no direito brasileiro* (3ª ed.). JusPodivm.
- Costa, S. H. da, & Fernandes, D. C. M. (2017). Processo coletivo e controle judicial de políticas públicas – Relatório Brasil. In K. Watanabe (Org.), *Processo coletivo e controle judicial de políticas públicas*.
- Daher, L. L. N. (2021). *Ministério Público resolutivo e o tratamento adequado dos litígios estruturais* (1ª ed., 1ª reimp.). D'Plácido.
- Da Ponte, A. C., & Demercian, P. H. (2016). Algumas considerações sobre o Ministério Público no direito estrangeiro. *Revista Jurídica ESMP-SP*, 10, 15–40.
- De Freitas, E. R. (2021). Termo de ajustamento de conduta em razão da morte de João Alberto Freitas no Supermercado Carrefour: Um exemplo de boa prática institucional. *Revista da Defensoria Pública da União*, 16, 265–269.
- Didier Jr., F., Cabral, A. do P., & Cunha, L. C. da. (2022). *Por uma nova teoria dos procedimentos especiais: Dos procedimentos às técnicas* (3ª ed.). JusPodivm.
- Ferraz, A. A. M. de C. (1999). *Ministério Público* (2ª ed.). Atlas.
- Fiss, O. (2024). To make the constitution a living truth: Four lectures on the structural injunction. In S. C. Arenhart, M. F. Jobim, & G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Fiss, O. (2017). As bases políticas e sociais da adjudicação. In C. A. de Salles (Trad.), *Direito como razão pública: Processo, jurisdição e sociedade* (2ª ed.). Juruá.
- Fontes, P. G. G. (2006). *O controle da Administração pelo Ministério Público*. Del Rey.
- Garcia, E. (2017). *Ministério Público: Organização, atribuições e regime jurídico* (6ª ed.). Saraiva.
- Garcia, M. J. (2016). A origem do Ministério Público e sua atuação no direito comparado. *Revista Jurídica ESMP-SP*, 10, 133–155. https://es.mpsp.mp.br/revista_esmp/index.php/RJESMPSP/article/view/44/27
- Goulart, M. P. (2021). *Elementos para uma teoria geral do ministério público* (2ª ed.). D'Plácido.
- Jatahy, C. R. de C. (2008). *Curso de princípios institucionais do Ministério Público* (3ª ed.). Lumen Juris.
- Jobim, M. F. (2022). *Medidas estruturantes na jurisdição constitucional: Da Suprema Corte estadunidense ao Supremo Tribunal Federal* (3ª ed.). Livraria do Advogado.
- Kluge, C. H., & Vitorelli, E. (2024). O processo estrutural no âmbito do sistema interamericano. In S. C. Arenhart, M. F. Jobim, & G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Lima, R. M. de. (2020). A atuação extrajudicial do Ministério Público no período de pandemia: Estudo de caso do município de Baturité – Ceará. *Revista Acadêmica da Escola Superior do Ministério Público do Ceará*, 12(2). <https://revistaacademica.mpce.mp.br/revista/article/view/46/40>
- Machado, A. C. da C. (1998). *A intervenção do Ministério Público no processo civil brasileiro* (2ª ed. rev. e atual.). Saraiva.
- Marçal, F. B. (2021). *Processos estruturantes*. JusPodivm.

- Martins Júnior, W. P. (2002). Controle da Administração Pública pelo Ministério Público. Juarez de Oliveira.
- Mazzilli, H. N. (2021). A defesa dos interesses difusos em juízo (32ª ed.). JusPodivm.
- Mazzilli, H. N. (2008). Introdução ao Ministério Público (7ª ed.). Saraiva.
- Meirelles, H. L. (1983). Parecer sobre o Ministério Público. *Justitia*, 123, 1083.
- Nery Júnior, N., & Nery, R. M. A. (2018). Código de processo civil comentado. Thomson Reuters, Revista dos Tribunais.
- Osna, G. (2017). Processo civil, cultura e proporcionalidade: Análise crítica da teoria processual. *Revista dos Tribunais*.
- Osna, G. (2020). Contratualizando o processo: Três notas sobre os negócios jurídicos processuais (e seu possível “fracasso”). *Revista Eletrônica de Direito Processual – REDP*, 14(21), 2.
- Paes, J. E. S. (2003). O Ministério Público na construção do Estado democrático de direito. Brasília Jurídica.
- Paraná. Ministério Público do Estado do Paraná. (n.d.). Resolução nº 1355. <https://www.mppr.mp.br/>
- Pinto, R. B. (2015). O Ministério Público: Origens históricas, seu nascedouro no Brasil e sua posição nas Constituições pátria. *Revista Associação Paulista do Ministério Público*, 20(60), 86–91.
- Sarlet, I. W., Mitidiero, D., & Marinoni, L. G. (2020). Curso de direito constitucional (9ª ed.). Saraiva Educação.
- Sarmiento, D. (2008). A proteção judicial dos direitos sociais: Alguns parâmetros ético-jurídicos. In *Direitos sociais: Fundamentos, judicialização e direitos sociais em espécie* (pp. 553–586). Lumen Juris.
- Silva, J. S. L. da. (2018). O ministério público e o acesso à justiça em face dos interesses e direitos transindividuais: Em busca da resolutividade. *Revista Cidadania e Acesso à Justiça*, 4(1), 114–135. <https://core.ac.uk/download/pdf/210567093.pdf>
- Silva, C. A. (2001). Justiça em jogo: Novas facetas da atuação dos promotores de justiça. Edusp.
- Tosta, A. R., & Marçal, F. B. (2024). Gerenciamento processual adequado de demandas formalmente individuais a partir de uma visão estruturante: O reforço proporcionado pelo art. 21 da LINDB. In S. C. Arenhart, M. F. Jobim, & G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Souza Junior, U. L. de. (2024). Nem os juízes são cientistas nem os tribunais são laboratórios – A prova estatística: Admissibilidade e aplicação nos processos estruturais. In S. C. Arenhart, M. F. Jobim, & G. Osna (Orgs.), *Processos estruturais* (5ª ed.). JusPodivm.
- Souza Junior, J. R. de, & Lopes, M. T. R. (2021). O processo estrutural como instrumento de harmonização da intervenção judicial na concretização de direitos fundamentais com a realidade socioeconômica. *Facit Business and Technology Journal*, 1(29).

- Violin, J. (2019). Processos estruturais em perspectiva comparada: A experiência norte-americana na resolução de litígios policêntricos [Tese de doutorado, Universidade Federal do Paraná].
- Vitorelli, E. (2025). Processo civil estrutural: Teoria e prática (5ª ed.). JusPodivm.
- Vitorelli, E. (2024). O devido processo legal coletivo: Dos direitos aos litígios coletivos (4ª ed.). Thomson Reuters Brasil.
- Zaneti Jr., H. (2018). O Ministério Público e as normas fundamentais do direito processual civil brasileiro. *Revista do Ministério Público do Rio de Janeiro*, 68, 147.

NEXIALISM AS AN EMERGING INTERDISCIPLINARY CONSTRUCT: A SYSTEMATIC LITERATURE REVIEW AND PROPOSAL FOR AN OPERATIONAL CONCEPTUAL MODEL

NEXIALISMO COMO CONSTRUCTO INTERDISCIPLINAR EMERGENTE: REVISÃO SISTEMÁTICA DA LITERATURA E PROPOSTA DE MODELO CONCEITUAL OPERACIONAL

EL NEXIALISMO COMO CONSTRUCCIÓN INTERDISCIPLINARIA EMERGENTE: UNA REVISIÓN SISTEMÁTICA DE LA LITERATURA Y UNA PROPUESTA PARA UN MODELO CONCEPTUAL OPERACIONAL



<https://doi.org/10.56238/sevened2026.008-057>

Frederico Cordeiro Martins¹

ABSTRACT

The increasing complexity of contemporary problems has revealed structural limitations of disciplinary hyper-specialization, particularly in sociotechnical, regulatory, and educational contexts. In this scenario, the concept of nexialism, originally derived from science fiction, has been sporadically appropriated by academic literature as a metaphor and heuristic for knowledge integration. This article aims to systematically map the scientific literature that employs the terms nexialism and nexialist, critically analyze their conceptual uses, and propose a theoretical-operational model that enables empirical application. A qualitative systematic literature review was conducted following PRISMA-inspired guidelines, using recognized scientific databases. Results indicate that nexialism does not constitute a consolidated theoretical field but emerges as an interdisciplinary construct associated with knowledge integration, mediation among specialists, systems thinking, and the management of unintended consequences. Based on thematic synthesis, a conceptual model with five latent dimensions and an initial measurement framework is proposed. The study concludes that nexialism holds significant analytical potential for addressing complex problems, although systematic empirical validation remains necessary.

Keywords: Nexialism. Interdisciplinarity. Systems Thinking. Complexity. Systematic Literature Review.

RESUMO

A crescente complexidade dos problemas contemporâneos tem evidenciado os limites do paradigma da hiperespecialização disciplinar, sobretudo em contextos sociotécnicos, regulatórios e educacionais. Nesse cenário, o conceito de nexialismo, originalmente oriundo da ficção científica, passou a ser apropriado pontualmente pela literatura acadêmica como metáfora e heurística para integração do conhecimento. O presente artigo tem por objetivo

¹ Dr. in Information Systems and Knowledge Management. Universidade do Estado de Minas Gerais (UEMG). E-mail: frederico.cordeiro.martins@gmail.com Orcid: <https://orcid.org/0000-0002-2602-249X> Lattes: <http://lattes.cnpq.br/0016923349977820>

mapear sistematicamente a produção científica que emprega os termos “nexialismo” e “nexialista”, analisar criticamente seus usos conceituais e propor um modelo teórico-operacional que permita sua aplicação empírica. Metodologicamente, realizou-se uma revisão sistemática de literatura qualitativa, inspirada no protocolo PRISMA, em bases científicas reconhecidas. Os resultados indicam que o nexialismo não constitui um campo teórico consolidado, mas emerge como constructo interdisciplinar associado à integração de saberes, mediação entre especialistas, pensamento sistêmico e gestão de consequências não intencionais. A partir da síntese temática, propõe-se um modelo conceitual com cinco dimensões latentes e um instrumento inicial de mensuração. Conclui-se que o nexialismo apresenta elevado potencial analítico para o enfrentamento de problemas complexos, carecendo, contudo, de validação empírica sistemática.

Palavras-chave: Nexialismo. Interdisciplinaridade. Pensamento Sistêmico. Complexidade. Revisão Sistemática da Literatura.

RESUMEN

La creciente complejidad de los problemas contemporáneos ha puesto en evidencia las limitaciones estructurales de la hiperespecialización disciplinaria, especialmente en contextos sociotécnicos, regulatorios y educativos. En este escenario, el concepto de nexialismo, originalmente derivado de la literatura de ciencia ficción, ha sido apropiado de manera puntual por la literatura académica como una metáfora y una heurística para la integración del conocimiento. El presente artículo tiene como objetivo mapear sistemáticamente la producción científica que emplea los términos nexialismo y nexialista, analizar críticamente sus usos conceptuales y proponer un modelo teórico-operacional que permita su aplicación empírica. Metodológicamente, se llevó a cabo una revisión sistemática de la literatura de carácter cualitativo, inspirada en las directrices del protocolo PRISMA, utilizando bases científicas reconocidas. Los resultados indican que el nexialismo no constituye un campo teórico consolidado, sino que emerge como un constructo interdisciplinario asociado a la integración de saberes, la mediación entre especialistas, el pensamiento sistémico y la gestión de consecuencias no intencionadas. A partir de la síntesis temática, se propone un modelo conceptual con cinco dimensiones latentes y un marco inicial de medición. Se concluye que el nexialismo presenta un elevado potencial analítico para el abordaje de problemas complejos, aunque aún requiere validación empírica sistemática.

Palabras clave: Nexialismo. Interdisciplinariedad. Pensamiento Sistémico. Complejidad. Revisión Sistemática de la Literatura.

1 INTRODUCTION

The contemporary organization of science is marked by a structural paradox: disciplinary specialization, although responsible for significant technical advances, has produced a cognitive fragmentation that makes it difficult to understand complex and interdependent phenomena (MORIN, 2011). Problems such as technological governance, regulation of digital systems, complex public policies, and educational transformation resist monodisciplinary approaches.

In this context, different theoretical proposals emerge with the objective of recomposing the unity of knowledge, including interdisciplinarity, transdisciplinarity and systemic thinking (JAPIASSU, 1976; CAPRA; LUISI, 2014). In an incipient way, the concept of nexialism also emerges, associated with the ability to integrate diverse knowledge in an orderly and functional way.

Although the term originates in science fiction literature, it is now mobilized in academic texts, especially in the areas of Information Technology and higher education, as a metaphor for dealing with complex interdependencies and unintended consequences of technical and normative decisions (LAPLANTE, 2010; VOAS et al., 2011). However, the use of the concept remains dispersed and lacking in scientific systematization.

In addition, it is observed that the growing complexity of decision-making systems has imposed not only operational but also epistemological challenges to scientific research. The production of knowledge begins to face difficulties in capturing phenomena that do not present themselves in a stable, delimited or repeatable way. In this context, emerging concepts tend to emerge even before their complete theoretical formalization, functioning as provisional attempts to name practices and experiences still in the process of consolidation.

Science, when dealing with this type of phenomenon, is faced with a recurring dilemma: ignore emerging concepts due to lack of immediate empirical ballast or incorporate them uncritically, at the risk of inflating the conceptual field. This article positions itself between these two extremes, assuming that the investigation of concepts still in formation can be legitimate, as long as it is conducted with methodological rigor and clarity as to its limitations.

In this sense, nexialism is understood here not as a definitive answer to the challenges of complexity, but as an indication of a contemporary demand for less fragmented forms of thought and decision. Its recurrence in professional and strategic discourses suggests that there is a gap between the available theoretical models and the practical demands faced by decision-makers in interdependent environments.

The introduction of this concept into the academic debate allows, therefore, to problematize not only the object itself, but also the criteria by which science decides what deserves or does not deserve investigation. By treating nexialism as an exploratory construct, the article contributes to a broader reflection on the limits and possibilities of scientific production in contexts marked by uncertainty, fluidity, and continuous transformation.

Finally, it is important to highlight that the methodological choice adopted in this study reflects this concern. By privileging a qualitative and analytical approach, the article seeks to offer conceptual density and argumentative clarity, avoiding both descriptive superficiality and the pretense of premature generalization.

In view of this, this article seeks to answer the following research question: how has the concept of nexialism been employed in the scientific literature and to what extent can it be systematized as an operationalized interdisciplinary construct?

2 METHODOLOGY

This is a systematic literature review (RSL) of a qualitative nature, with narrative synthesis, inspired by the guidelines of the PRISMA protocol, suitable for emerging fields with low empirical density (GALVÃO; RICARTE, 2019).

The searches were conducted exclusively in recognized scientific databases, including Google Scholar, IEEE Computer Society journals, indexed university repositories, and DOI registries. The following strings were used: *nexialism*, *nexialist*, *nexialism* and *nexialist*.

Peer-reviewed articles, institutionally curated academic texts, and qualified gray literature were included, as long as they presented a definition, application, or substantive conceptual discussion of the term. Non-scientific content was excluded.

The selected texts were analyzed by thematic synthesis, with open and axial coding, allowing the identification of recurrent conceptual patterns (BARDIN, 2016).

3 RESULTS

3.1 OVERVIEW OF LITERATURE

The review revealed a small body of scientific publications that explicitly use the terms nexialism or nexialist. These publications concentrate, above all, on essayistic texts in the areas of Information Technology, higher education and interdisciplinary studies (LAPLANTE, 2010; VOAS et al., 2011; LOVE, 2008).

No quantitative empirical studies or validated instruments for measuring the construct were identified, which evidences the emerging character of the theme.

3.2 FRAMEWORK OF CONSTRUCTS ASSOCIATED WITH NEXIALISM

The thematic analysis allowed the identification of six central constructs, summarized in Table 1, which organizes the main findings of the review.

Table 1

Constructs associated with nexialism in the scientific literature

Construct	Synthetic Description	Key References
Orderly integration of knowledge	Ability to articulate knowledge from different domains in a coherent and functional way	TOOHEY, n.d.; LOVE, 2008
Interdisciplinary mediation and translation	Acting as a cognitive and communicational bridge between specialists	TOOHEY, n.d.; VOAS et al., 2011
Systems thinking	Analysis of interdependencies, feedbacks and second-order effects	LAPLANTE, 2010
Anticipation of unintended consequences	Identification and mitigation of side effects of technical or regulatory decisions	LAPLANTE, 2010
Critique of hyperspecialization	Diagnosis of disciplinary fragmentation as an obstacle to the solution of complex problems	VOAS et al., 2011
Absence of formal criteria	Lack of metrics, training or scientific validation of nexialism	TOOHEY, n.d.

Source: prepared by the authors.

4 DISCUSSION

The results indicate that nexialism is not configured as a consolidated scientific theory, but as an emerging interdisciplinary construct, used predominantly as an analytical metaphor. Its use converges to an explicit critique of hyperspecialization and to the defense of integrative approaches, especially in contexts marked by high complexity and systemic risk (LAPLANTE, 2010).

Unlike classical interdisciplinarity, nexialism emphasizes the figure of the cognitive mediator, capable of integrating knowledge and anticipating unintended consequences, approaching applied systemic thinking (CAPRA; LUISI, 2014). However, the absence of formal criteria for training and measurement limits its consolidation as a scientific object.

The discussion of nexialism also sheds light on an aspect that is often underexplored in the literature on complexity: the role of intermediary agents in decision-making processes. While most studies focus on structures, systems, or policies, nexialism draws attention to subjects who operate at the intersection of fields, areas, and interests, performing functions that escape traditional descriptions of institutional positions or roles.

These actors do not necessarily have formal authority or superior technical expertise in all the fields involved. Its relevance stems from its ability to articulate perspectives, identify inconsistencies, and anticipate collateral effects of fragmented decisions. This performance, although empirically observable, remains little theorized, which reinforces the potential of nexialism as a provisional analytical category.

Another relevant point concerns the temporal dimension of decisions. The reviewed literature tends to emphasize immediate results or measurable short-term impacts, while nexialism explicitly introduces concern with deferred and cumulative effects. This temporal expansion brings the concept closer to debates on sustainability, governance, and intergenerational responsibility, even though nexialism does not present itself as a normative theory in these fields.

From a critical point of view, it is necessary to recognize that the semantic breadth of nexialism constitutes both its strength and its fragility. If, on the one hand, this breadth allows for dialogue with different theoretical traditions, on the other hand, it requires additional delimitation efforts to avoid excessive overlap with already consolidated concepts. This tension reinforces the need for empirical studies that explore specific contexts of application of the concept.

Finally, the discussion suggests that nexialism can play a relevant role as an articulating concept, capable of connecting dispersed debates on complexity, interdisciplinarity, decision-making, and ethics. Although this articulation does not constitute a new theory, it contributes to the construction of a vocabulary that is more sensitive to the contemporary demands of cognitive integration and systemic responsibility.

5 PROPOSAL FOR A CONCEPTUAL MODEL (NEX-MODEL)

Based on the synthesis of the results, the NEX-Model is proposed, structured in five latent dimensions:

5.1 COGNITIVE INTEGRATION

Cognitive integration is perhaps the most silent competence of the Nexialist—and, at the same time, the most decisive. It does not manifest itself as a strong opinion or as an ostensible technical mastery. It appears as a persistent restlessness in the face of isolated information. The Nexialist is suspicious of data that does not talk to each other. For him, knowing is not accumulating content, but organizing relationships.

While many professionals deal with information as loose parts, the Nexialist works with maps. He tries to understand how decisions, facts, and narratives fit into a bigger picture.

This ability is not born of scattered curiosity, but of an internal discipline: the refusal to accept explanations that do not hold up when seen together.

To integrate cognitively is also to recognize limits. The Nexialist knows that no field explains everything. Therefore, he is not satisfied with answers that solve a local problem and create invisible ones. Their attention is always focused on what is outside the main focus, on the margins of the dominant reasoning.

This competence requires time, listening, and willingness to review assumptions. In a world that values speed and immediate completions, cognitive integration is almost an act of resistance. It protects the system from hasty decisions and creates the conditions for more coherent choices, even when they are not the easiest.

5.2 STRATEGIC MEDIATION

Strategic mediation is born from the perception that many contemporary conflicts are not of interest, but of language. Competent people disagree not because they want opposite things, but because they operate from different references. The Nexialist perceives this mismatch before it turns into rupture.

Measuring does not mean reconciling superficially. The Nexialist does not seek artificial consensus or empty harmony. Their job is to make explicit hidden assumptions, to translate jargon, to reveal what is being assumed without being said. It creates space for different perspectives to recognize each other without canceling each other out.

This competence requires political sensitivity and intellectual clarity. The Nexialist knows that all translation involves loss and gain. Still, he takes this risk because he understands that the absence of mediation produces noise, rework, and incoherent decisions. Where there is misunderstanding, it introduces shared meaning.

Strategic mediation transforms the Nexialist into a point of stability in tense contexts. Not because it neutralizes conflicts, but because it makes them productive. It helps the system to extract learning from divergences instead of being paralyzed by them.

5.3 SYSTEMS THINKING IN ACTION

Nexialist's systems thinking is neither theoretical nor abstract. It manifests itself at the moment of decision, when the question "does it work?" is immediately followed by another: "what does it change in the system?". The Nexialist thinks in terms of chained effects, not just immediate results.

He knows that complex systems respond in a nonlinear way. Small changes can generate big impacts, while large interventions can produce minimal effects. Therefore, the

Nexialist is suspicious of grandiose solutions and pays attention to the invisible interdependencies that sustain the functioning of the whole.

Acting systemically requires accepting that there is no total control. The Nexialist works with probabilities, scenarios and provisional hypotheses. It does not seek to eliminate uncertainty, but to make it habitable. This posture reduces destructive surprises and expands the system's ability to adapt.

This competence differentiates the Nexialist from those who only "perform well". It is not limited to meeting defined objectives; He questions whether these goals make sense in light of global functioning. Its value lies in avoiding technically elegant and systemically fragile solutions.

5.4 AWARENESS OF THE CONSEQUENCES

Awareness of the consequences is an ethical competence before being technical. The Nexialist knows that every decision produces effects that go beyond declared intentions. He learned—often by observing the faults of others—that the greatest damage does not come at the moment of choice, but after the choice seems to have worked.

Therefore, he is not satisfied with short-term analyses. Question about secondary impacts, residual risks, side effects, and decision-induced behavior changes. His gaze extends in time and space, even though he knows that it will never be complete.

This posture does not paralyze him. On the contrary, it makes your decisions more accountable. The Nexialist prefers conscious risks to invisible risks. He understands that deciding without considering consequences is not neutrality — it is negligence.

In organizational and social contexts, this competence becomes increasingly valuable. It protects the system against decisions that seem efficient on paper, but that erode trust, sustainability, or legitimacy over time.

5.5 ANTI-SILO STANCE

The anti-silo stance is not a technique, but a constant choice. The Nexialist resists the natural tendency of organizations to fragment into autonomous and defensive territories. He realizes that silos don't arise only by structure, but by fear, identity, and power.

Being anti-silo doesn't mean rejecting specializations or ignoring functional boundaries. It means preventing these borders from becoming walls. The Nexialist traverses areas, connects people, and exposes interdependencies that many would prefer to ignore.

This posture often generates discomfort. The Nexialist questions decisions that "are not in his area", points out impacts that were not in the initial scope and insists on difficult

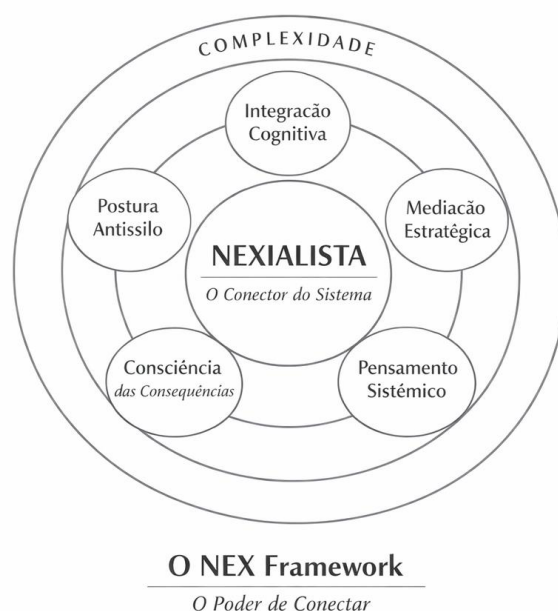
conversations. He accepts this cost because he knows that silence costs more in the long run.

The anti-silo stance underpins all other competencies. Without it, cognitive integration is fragmented, mediation is weakened, systemic thinking loses reach, and awareness of the consequences is limited. It is this that keeps the Nexialist faithful to his central function: to take care of the whole when everyone takes care of only the part.

The model assumes that such dimensions positively impact the quality of solutions, risk reduction, and interdisciplinary performance in complex environments.

Figure 1

The NEX Framework: The Power of Connecting



Source: Authors.

6 FINAL CONSIDERATIONS

Nexialism presents itself as a promising concept to face the epistemological limits of contemporary disciplinary fragmentation. Although it still lacks empirical validation, its conceptual systematization allows us to advance in the construction of a scientific construct applicable to educational, technological and legal contexts.

The reflections developed throughout this article indicate that the study of emerging concepts, such as nexialism, requires a methodological posture marked by caution and openness. Caution not to attribute undue theoretical status to categories still in formation;

openness to recognize that science also advances through the problematization of practices and discourses that precede its conceptual formalization.

In this sense, nexialism can be understood as a symptom of broader transformations in the ways of thinking and deciding in complex contexts. Its emergence reveals a growing dissatisfaction with overly fragmented approaches and points to the need for analytical models capable of dealing with interdependencies, uncertainties, and non-linear consequences.

From an epistemological point of view, the article suggests that the investigation of such concepts requires flexible methodologies, capable of articulating theoretical review, conceptual analysis and qualitative empirical observation. Future studies may explore nexialism through field research, organizational case analysis, or interviews with agents who perform systemic mediation functions.

In addition, there is room to critically examine the limits of the concept, identifying contexts in which cognitive and decision-making integration can generate new types of tension or overload. Recognizing these limits is essential to avoid idealized readings and preserve the analytical utility of nexialism.

In summary, by maintaining a critical and reflective stance, this article contributes to the broadening of the debate on how science can approach complex phenomena that are still poorly stabilized. Nexialism, as an exploratory construct, offers a fruitful starting point for future investigations, without pretense of conceptual closure or theoretical universalization.

As a future agenda, the psychometric validation of the proposed model is recommended, as well as its empirical application in interdisciplinary environments.

REFERENCES

- Bardin, L. (2016). *Análise de conteúdo*. Edições 70.
- Capra, F., & Luisi, P. L. (2014). *The systems view of life: A unifying vision*. Cambridge University Press.
- Galvão, T. F., & Ricarte, I. L. M. (2019). Revisões sistemáticas da literatura: Conceitos, métodos e aplicações. *Revista Evidência*, 17(1), 1–17.
- Japiassu, H. (1976). *Interdisciplinaridade e patologia do saber*. Imago.
- Laplante, P. (2010). Nexialism and the law of unintended consequences. *IT Professional*, 12(4), 58–60. <https://doi.org/10.1109/MITP.2010.114>
- Love, J. (2008). *Meeting the challenges of integrative learning: The nexial perspective*. University Repository.
- Morin, E. (2011). *Introdução ao pensamento complexo*. Sulina.
- Toohey, K. D. (n.d.). *Towards a science of nexialism [Working paper]*.

Voas, J. M., Hurlburt, G., Miller, K., & Laplante, P. (2011). Thoughts on higher education and scientific research. *IT Professional*, 13(2), 6–9. <https://doi.org/10.1109/MITP.2011.34>

BIOMETRIC DATA: AN ANALYSIS OF BILL 2338/2023 BASED ON THE PARAMETERS ESTABLISHED IN THE EUROPEAN UNION AI ACT

DADOS BIOMÉTRICOS: UMA ANÁLISE DO PROJETO DE LEI 2338/2023 A PARTIR DOS PARÂMETROS ESTABELECIDOS NO AI ACT DA UNIÃO EUROPEIA

DATOS BIOMÉTRICOS: UN ANÁLISIS DEL PROYECTO DE LEY 2338/2023 A PARTIR DE LOS PARÁMETROS ESTABLECIDOS EN EL AI ACT DE LA UNIÓN EUROPEA



<https://doi.org/10.56238/sevened2026.008-058>

Joaquim Ribeiro de Souza Junior¹, Glenda Almeida Matos Moreira²

ABSTRACT

This article analyzes how biometric data and biometric systems are regulated in Brazil's Bill of Law No. 2,338/2023 (the proposed Brazilian AI framework) in light of the standards set by Regulation (EU) 2024/1689 (the AI Act). It starts from the premise that biometrics, although classified as sensitive personal data under the LGPD, has expanded rapidly in Brazil across public and private settings, notably through state identification infrastructures and facial recognition deployments in publicly accessible spaces. Such uses have fueled controversy due to error rates, bias, and discriminatory impacts. Using a qualitative, documentary approach, the study outlines core operational concepts (biometric identification, verification/authentication, remote biometric identification, emotion recognition, and biometric categorization), summarizes the AI Act's risk-based architecture (prohibited practices, high-risk requirements, and safeguards for real-time remote biometric identification), and then examines the bill's main biometric provisions. The comparison shows a shared regulatory backbone: a general ban on real-time remote biometric identification in publicly accessible spaces with narrowly defined exceptions, coupled with stronger governance, transparency, and impact-assessment duties for high-risk uses. At the same time, the article identifies gaps and improvement paths for the Brazilian bill inspired by the AI Act, including: more granular procedural safeguards and independent oversight for exceptions; audit trails and clear deletion duties; an explicit prohibition on building or expanding facial databases through untargeted scraping; a clearer framework for 'post' remote biometric identification (ex post searches); and more specific limits on biometric categorization and emotion recognition in asymmetric environments such as workplaces and educational institutions. The article concludes that the EU framework offers actionable parameters to strengthen fundamental-rights protection and accountability in biometric AI deployments in Brazil.

Keywords: Biometric Data. Remote Biometric Identification. Facial Recognition. Bill 2,338/2023. EU AI Act. Risk-Based Regulation.

¹ Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS)
E-mail: joaquimjunior33@gmail.com Orcid: <https://orcid.org/0000-0003-3488-5508>

² Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS). Centro Universitário. E-mail: glendaalmeidamoreira@gmail.com Orcid: <https://orcid.org/0000-0002-8940-3644>

RESUMO

O artigo examina o tratamento jurídico dos dados e sistemas biométricos no Projeto de Lei nº 2.338/2023 (marco brasileiro de inteligência artificial) à luz dos parâmetros do Regulamento (UE) 2024/1689 (AI Act). Parte-se da constatação de que a biometria, embora enquadrada como dado pessoal sensível pela LGPD, vem sendo amplamente utilizada no Brasil em serviços públicos e privados, especialmente em infraestrutura estatal de identificação (por exemplo, bancos civis e sistemas como AFIS/ABIS) e em aplicações de reconhecimento facial em espaços públicos, cenário que tem gerado controvérsias por erros, vieses e impactos discriminatórios. A pesquisa, de caráter qualitativo e documental, descreve conceitos operacionais (identificação biométrica, verificação/autenticação, identificação biométrica remota, reconhecimento de emoções e categorização biométrica), apresenta as principais escolhas regulatórias do AI Act (regulação por risco, práticas proibidas, requisitos para sistemas de alto risco e salvaguardas para identificação biométrica remota em tempo real) e, em seguida, analisa o PL 2338/2023, com foco na vedação, como regra, da identificação biométrica à distância em tempo real em espaços acessíveis ao público, nas hipóteses de exceção e nas obrigações de governança, transparência e avaliação de impacto algorítmico para usos no setor público. O cotejo revela convergência estrutural entre os modelos (proibição com exceções tipificadas e regime reforçado para alto risco), mas também aponta lacunas e oportunidades de aprimoramento no projeto brasileiro: detalhamento de salvaguardas e supervisão externa para exceções, trilhas de auditoria e deveres claros de descarte; proibição expressa de formação/expansão de bases faciais por raspagem não direcionada; disciplina mais densa para identificação biométrica remota “posterior” (ex post); e limites específicos para categorização biométrica e para reconhecimento de emoções em contextos assimétricos, como trabalho e educação. Conclui-se que os parâmetros europeus oferecem referências concretas para fortalecer a proteção de direitos fundamentais e a responsabilização no uso de biometria mediado por IA no Brasil.

Palavras-chave: Dados Biométricos. Identificação Biométrica Remota. Reconhecimento Facial. PL 2338/2023. AI Act. Regulação por Risco.

RESUMEN

El artículo analiza el tratamiento normativo de los datos y sistemas biométricos en el Proyecto de Ley nº 2.338/2023 (marco brasileño de inteligencia artificial) a partir de los parámetros del Reglamento (UE) 2024/1689 (AI Act). Se parte de que la biometría, aunque es dato personal sensible en la LGPD, se ha expandido en Brasil en ámbitos públicos y privados, en especial en infraestructuras estatales de identificación y en el reconocimiento facial en espacios de acceso público, con controversias por errores, sesgos e impactos discriminatorios. Con metodología cualitativa y documental, el estudio delimita conceptos operativos (identificación biométrica, verificación/autenticación, identificación biométrica remota, reconocimiento de emociones y categorización biométrica), sintetiza el enfoque de regulación por riesgo del AI Act (prácticas prohibidas, obligaciones para sistemas de alto riesgo y salvaguardas para la identificación remota en tiempo real) y contrasta esas categorías con la disciplina propuesta en el PL 2.338/2023. La comparación muestra convergencias: prohibición general de la identificación biométrica remota en tiempo real en espacios accesibles al público con excepciones tipificadas y deberes reforzados de gobernanza y transparencia. Asimismo, identifica mejoras posibles inspiradas en el AI Act: mayor detalle de salvaguardas y supervisión independiente para las excepciones (trazabilidad y deberes de eliminación), prohibición expresa del raspado no dirigido para crear o ampliar bases faciales, tratamiento claro de la identificación remota “posterior” (ex post) y límites específicos para categorización biométrica y reconocimiento de emociones en contextos asimétricos como trabajo y educación.

Palabras clave: Datos Biométricos. Identificación Biométrica Remota. Reconocimiento Facial. PL 2338/2023. Ley de IA. Regulación por Riesgo.

1 INTRODUCTION

The expansion of the use of biometric data and biometric systems in Brazil appears in institutional registries and in the literature as a phenomenon associated with the identification and verification of identity in public and private contexts, with applications in public security, access control to services, and digital transactions.

This dynamic inserts biometrics into technical arrangements that depend on the automated collection, storage, and comparison of physical, physiological, or behavioral characteristics, which expands the role of data infrastructures and decision-making mechanisms based on computational models.

In the Brazilian legal field, biometric data appear as sensitive personal data in the General Data Protection Law (LGPD), which conditions its processing to specific legal hypotheses and duties to observe principles such as purpose, necessity, and transparency.

However, in this context there are public controversies about the use of biometric surveillance and with records of errors, biases and social contestation, especially in facial recognition applications in public spaces and in private practices of exposing images of suspects.

Recently, the European Union approved Regulation (EU) 2024/1689, known as the AI Act, which structures a risk-based regulation regime for artificial intelligence systems and includes specific discipline for biometric uses, with prohibitions, operational categories, and procedural requirements, especially for real-time remote biometric identification in publicly accessible spaces.

In Brazil, the discussion on an artificial intelligence framework was consolidated in Bill No. 2338/2023 (PL 2338), which proposes a risk classification regime, governance duties, and instruments such as algorithmic impact assessment, in addition to bringing operational definitions of biometric identification and biometric authentication and specific discipline for remote biometric identification in real time in spaces accessible to the public, with a prohibition rule and exception hypotheses.

This article analyzes the normative treatment of biometrics in PL No. 2338/2023 based on the parameters of the AI Act, focusing on remote biometric identification, authentication, emotion recognition, and other biometric uses that involve surveillance, categorization, and decision-making mediated by AI systems. The investigation adopts a qualitative and documentary approach, with a comparative examination of provisions of the PL and the AI Act, in addition to reading institutional materials and literature used to contextualize uses and controversy.

Based on this approach, the text seeks to identify regulatory convergences and gaps in the discipline of biometrics, with special attention to procedural safeguards, transparency duties, and accountability mechanisms associated with the use of biometric systems in public and private contexts.

The structure of the article starts from a conceptual contextualization of biometrics and biometric systems and their uses in Brazil, including national normative parameters and recent controversies, and then describes the central elements of the AI Act on biometrics. Next, it examines PL No. 2338/2023 with a focus on its biometric provisions and compares the regimes, to formulate a synthesis of the convergences and normative perspectives that emerge from the comparison between the two regulatory matrices and, then, demonstrate the perspectives of the AI Act for Brazilian law.

2 BIOMETRICS AND ARTIFICIAL INTELLIGENCE

In the context of human identification, biometrics can be understood as a set of techniques that establish a person's identity based on physical and behavioral attributes, using statistical, biological and technological methods and based on the capture of personal data.

Biometric data, in turn, are personal data resulting from specific technical processing related to physical, physiological or behavioral characteristics, capable of allowing or confirming the unique identification of the holder, with examples such as facial images and dactyloscopic data, which can serve the authentication, identification or classification of people, with use by both companies and governments (Silva, 2023).

In this sense, part of the literature differentiates biometrics as a technical field and biometric data as the product of a technical processing on a characteristic, which brings the debate on data governance closer, as the body trait starts to circulate as information that can be operationalized by machines and third parties (Silva, 2023).

The definitions adopted by Brazil (2019) are also highlighted. Decree 10,046/2019 differentiates biographical data — those related to facts of the person's life, such as civil or social name, date of birth, parentage, place of birth, nationality, sex, marital status, family group, address, and employment relationships —, and biometric data, measurable biological and behavioral characteristics, collectible for automated recognition, such as palm of the hand, fingerprints, retina or iris, face shape, voice and way of walking.

According to Violato et. al (2013), biometric systems operate from these characteristics for automated recognition. They usually use sensors to capture the characteristic, produce a biometric model and store it in a database, which enables future comparisons to identify or

verify individuals in concrete situations. Biometric recognition systems tend to include a training stage with real samples, in which the quality and representativeness of the training base are associated with the performance of the system in the target population.

This area has recently been increased with Artificial Intelligence, thus enabling the extension and efficiency of these systems. Facial recognition, for example, is an application of artificial intelligence that uses biometric collection based on facial features. This process occurs by measuring points on the face and extracting biometric data that enables verification and authentication, with the transformation of these measurements into numerical representation and frequent storage for future comparisons (Baccarin, 2023).

As Silva (2023) points out, capture usually occurs by digital cameras integrated with software with artificial intelligence algorithms that analyze the image, measure characteristics, and produce a stored biometric model for feedback to the system, which can occur in real time and on an expanded scale according to the technical arrangement implemented.

Thus, in terms of result, there is a description that facial recognition operates by similarity and by probability judgment, which means that the output of the system does not correspond to the right answer, but to the most likely match within the compared set, with the occurrence of false negatives and false positives influenced by factors such as background and lighting.

The use of facial recognition can also be articulated with profiling practices, with the creation of digital profiles based on information collected and with the possibility of categorization by attributes, which expands the circulation of biometric data beyond the initial act of authentication (Doneda, 2006 apud Silva, 2023).

2.1 BRAZILIAN NORMATIVE PARAMETERS ON THE USE OF BIOMETRICS

In Brazil, biometric data are part of the category of sensitive personal data, which subjects its processing to specific requirements and its own legal hypotheses (ANPD, 2025). The ANPD notes that the LGPD did not define biometric data, and that part of the doctrine uses the description of the GDPR, in which biometric data results from technical treatment related to physical, physiological, or behavioral characteristics that allow or confirm unique identification.

The processing of biometric data, while sensitive, must be based on the hypotheses of article 11 of the LGPD, with the provision of specific and detached consent, or databases without consent linked to delimited purposes, such as legal obligation, public policies, studies, exercise of rights, protection of life, protection of health and prevention of fraud and security

of the holder in identification and authentication processes in electronic systems (Baccarin, 2023).

In the same section, there is a record that sensitive data cannot be processed based on legitimate interest or credit protection, which restricts alternatives frequently used for non-sensitive data.

In private and public delegated applications, part of the literature emphasizes subparagraph "g" of article 11, which admits the treatment for fraud prevention and security of the holder in processes of identification and authentication of registration in electronic systems, with express exception regarding the prevalence of fundamental rights and freedoms of the holder and with requirements for information on purposes and storage time (Silva, 2023).

The operationalization of these legal bases is articulated with the principles of the LGPD, with emphasis on purpose, necessity, and transparency, including in the evaluation of less intrusive alternatives and in the documentation of processing processes in biometric systems (Baccarin, 2023). There is also reference to duties of transparency and the linking of processing to the purpose informed to the data subject, with the prohibition of subsequent incompatible uses, in addition to the enunciation of the data subject's rights such as confirmation of processing, access, correction and requests related to anonymization, blocking or deletion as the case may be (Brasil, 2018).

The LGPD provides for information security duties throughout the processing cycle, including after the end, and admits the requirement of an impact report on the protection of personal data, including sensitive, with a description of the data collected, methodology, and risk mitigation measures. This point appears as a governance parameter for operations that depend on biometric bases and automated comparison systems, given the potential impact resulting from errors and uses incompatible with the declared purpose (ANPD, 2025).

Within the scope of the federal public administration, the aforementioned Decree 10,046/2019 establishes rules and guidelines for data sharing between agencies and entities, establishes the Citizen's Base Registry, and defines biographic and biometric attributes, with biometrics understood as measurable biological and behavioral characteristics that can be collected for automated recognition (Brasil, 2019). The decree also delimits its scope by indicating that its rules do not apply to sharing with the private sector, which maintains the LGPD as a central axis for business operations and for specific cooperation outside the arrangement.

In the Citizen's Base Registry, there is a prohibition on the use of the registry or its cross-referencing with other databases for processing aimed at mapping or exploring

individual or collective behaviors without express, prior and specific consent, and without transparency of motivation and purpose.

In addition, the ANPD notes that, in addition to the provisions of arts. 5 and 11 of the LGPD, can address biometrics by guiding documents and by regulation, with guidelines on concepts, legitimate contexts, legal hypotheses, observance of principles and protection measures adopted by processing agents (ANPD, 2025). Also, even when the processing occurs under legal exceptions associated with public security, national defense or criminal prosecution, data protection principles and rights must be observed.

2.2 THE PROMINENT USES OF BIOMETRIC DATA AND SYSTEMS IN BRAZIL

Biometrics, in the context of information technologies, aims to identify and map individuals, justified by security in access to goods and services and internal and border public security, in conjunction with the expansion of bases and uses in the public and private sectors (Corrêa and Loureiro, 2023).

In Brazil, for example, there is an institutional record of expansion of the processing of biometric data. This set of uses is related to state infrastructures for biometric identification and verification (ANPD, 2025), mainly in the areas of public security and criminal prosecution.

It should be noted that the constitution of biometric banks by public agencies stems from normative requirements associated with the issuance of identity documents, passports, access to public service platforms and the issuance or renewal of voter registration, situations in which the identification of the applicant includes the collection of biometric data. This data, especially fingerprints, remains stored after the service is delivered, with the possibility of later verification according to the context of collection, which characterizes the formation of civil biometric banks in the public sector (Lima et al., 2022).

Thus, it is worth mentioning, for example, the signing of cooperation agreements to allow access, by judicial police bodies, to civil biometric databases as a standard for criminal identification processes, in a scenario in which the lack of specific legislation on the production of expert evidence based on biometric standards of civil origin is pointed out (Lima et al., 2022)

In this infrastructure, the Automated Fingerprint Identification System, known as AFIS, uses fingerprints to identify individuals and seeks to prevent duplication of identification or multiple identifications assigned to the same person. The Federal Police's Manual for the Identification of Disaster Victims even recommends the use of the system and indicates, as an initial measure for obtaining ante-mortem data, the insertion of decadactylar forms for

automated confrontations with questioned papilloscopic material (Federal Police, 2011 apud Souza et al., 2023).

There is also the adoption of multimodal systems, such as the Automated Biometric Identification System, known as ABIS, which admits facial recognition, palm prints, and fingerprints, with the presentation of classification by score as a measure of the level of coincidence between the sample and stored patterns (Souza et al., 2023). The Secretariat of Social Defense of Pernambuco acquired the system in 2019, and the database has been fed by new issuances of identity cards and the gradual digitization of physical medical records (BGSDS, 2019 apud Souza et al., 2023).

More recently, the Smart Sampa Program, an initiative under the responsibility of the Municipal Secretariat of Urban Security of São Paulo, is expected to install 20 thousand cameras in the city, guided by territorial criteria associated with crime rates, and with the use of algorithms that generate alerts for intrusion, vandalism and theft, in addition to identification of license plates of stolen or stolen vehicles and facial recognition aimed at locating missing persons and fugitives from the justice (São Paulo City Hall, 2025).

In the program's institutional transparency report, facial recognition appears associated with the identification of wanted and fugitives from justice and the location of missing persons, indicating that the program does not structure its own database and does not store personal data, except for images linked to an identifier referring to wanted, fugitive or missing, and with a description that access to information contained in the BNMP occurs when there is facial compatibility greater than 90 percent.

In the private sector, biometrics appears mainly as an authentication and identification technique in everyday activities, with partial displacement from traditional methods such as passwords and cards to credentials based on the holder's biological characteristics (Canuto, 2022). This movement is also associated with the logic of security in access to goods and services in the market and the diffusion of biometric identification technologies in connection with information technologies (Correa and Loureiro, 2023).

According to Canuto (2022), the biometric data used by companies can derive from various modalities, such as signature, fingerprints, and face, as well as iris, retina, voice, hand geometry, and other techniques, which expands the debate beyond facial recognition. In terms of applications, there is mention of scenarios such as logical and physical access control and fraud detection, with the use of characteristics such as face, fingerprint and voice, among others.

In the private sector, the centrality of biometric databases also intensifies discussions about the security and legality of their use, as the compromise of this data is associated with

the irrevocability of the holder's characteristics, which differentiates the scenario from incidents involving passwords and justifies the adoption of specific protection techniques, such as cancelable biometrics and encryption.

2.3 CONTROVERSIES AND RISKS ASSOCIATED WITH THE USE OF BIOMETRICS

There is no unanimity regarding the public interest in the use of these systems, both in the public and private spheres. For example, the Take My Face Out of Your Sights Campaign mobilizes civil society in Brazil to press for a total ban on digital facial recognition in public security, through direct dialogue with security forces and parliamentarians, dissemination of open letters, and public education actions on the harms associated with facial recognition, with mention of the risk of perpetuating racism (EPIC, 2024).

Likewise, there are records of movements by civil organizations that demand regulation of facial recognition and, in some cases, defend a partial or complete ban, with an indication of support from entities such as LAPIN, Article 19, Data Privacy Brasil, InternetLab, and Idec for the Take My Face Out of Your Sights campaign (Baccarin, 2023).

In the public justification of these initiatives, examples associated with false alerts and approaches derived from facial recognition systems, with the allegation of selective incidence on black people, are presented. Among the cases cited, there is an episode from April 2025 in which an 80-year-old man was mistaken for a person wanted by the Justice and remained detained for 10 hours after an alert attributed to Smart Sampa cameras in a basic health unit, in addition to reports of a woman in Sergipe confused twice in 2024 and a public servant approached and taken to the police station in Rio de Janeiro due to an error of the system (Coalition Rights on the Network, 2025).

At the same time, the recent case involving Havan S.A., a retail chain, illustrates the associated risks. In 2024, the company started to publish, on social networks, videos under the name "samples of the month", with the exposure of images of people identified as perpetrators of thefts in stores, accompanied by a business justification of inhibition of the practice through public exposure (Gercina, 2024).

The monitoring system used artificial intelligence which, according to a public statement attributed to the company's management, allows identifying people when entering or leaving the store and relating the facial record to the moment of theft, which indicates the use of automated identification techniques from images captured in the establishment.

In May 2025, the ANPD received a notification from the Public Prosecutor's Office of the State of Santa Catarina with a request for an analysis of the compatibility of the practice with the LGPD, a fact that included the conduct in the authority's inspection procedure. After

a preliminary analysis, the General Coordination of Inspection determined, at the end of June 2025, a preventive measure to temporarily suspend the dissemination of videos on social networks during the investigation, with an express indication of grounds in the LGPD, especially articles 6, 7, 11, 14 and 55-J, and with the identification of risk associated with the possible exposure of images of children and adolescents without precautions required by law (ANPD, 2025).

In view of this scenario, which is certainly repeated with its own particularities in other countries, it is necessary to build a specific normative framework to deal with the processing of biometric data by Artificial Intelligence.

3 AI ACT AND THE USE OF BIOMETRICS

Regulation (EU) 2024/1689 arises in a context in which AI systems circulate between Member States and can be deployed in various sectors, with the risk of regulatory fragmentation when national standards diverge and reduce the legal certainty of economic agents that develop, import or use these systems (European Parliament and Council, 2024).

Within this framework, the regulation links its justification to improving the functioning of the internal market, through a uniform legal framework for the development, placing on the market, putting into service and use of AI systems in the Union, preserving the free movement of AI-based goods and services and preventing national restrictions not provided for in the act itself.

As for its purpose, the preamble spells out the promotion of human-centred adoption of AI that is compatible with Union values, while providing for the protection of health, safety and fundamental rights provided for in the Charter, including democracy, the rule of law and environmental protection, as well as measures to support innovation.

Article 1 establishes a set of normative axes that includes harmonised rules for the placing on the market, entry into service and use of AI systems, prohibitions on certain practices, specific requirements and obligations for high-risk systems and their operators, transparency rules for certain systems, discipline for general-purpose AI models, in addition to rules for monitoring, inspection, governance and measures to support innovation with a focus on small and medium-sized companies and startups.

The regulation is intended for a chain of agents. Article 2 includes providers³ who place on the market or put into service AI systems and providers of general-purpose AI models,

³ In Regulation (EU) 2024/1689, an ombudsman is a natural or legal person, public authority, agency or other body that develops a general-purpose AI-system or AI-model, or that has that system or model developed and places it on the market or puts it into service under its own name or brand, with or without payment (European Parliament and Council, 2024).

even when established outside the Union, as well as deployers established in the Union, importers and distributors, manufacturers who place an AI system on the market under their name or brand, authorized representatives of providers not established in the Union, and affected persons located in the Union, when the exit from the system is used in European territory. The text excludes from its scope areas beyond the reach of Union law and declares that it does not affect competences of the Member States in matters of national security, in addition to excluding its application to AI systems used exclusively for military, defense or national security purposes.

The regulatory architecture operates by risk classification and proportional obligations, with reference in the literature to four categories, prohibited, high risk, limited risk, and minimal risk, which organizes the incidence of prohibitions, requirements, and duties throughout the life cycle of systems and models (Arantes Júnior, 2025). This structure coexists with the rule that the regulation acts in a complementary way to other branches of Union law, including data protection, consumer protection, fundamental rights, employment, and product safety, without excluding rights and means of protection provided for in these regimes.

Regulation (EU) 2024/1689 adopts definitions of biometrics in line with the vocabulary of Regulation (EU) 2016/679, by treating biometric data as personal data resulting from specific technical processing relating to physical, physiological or behavioural characteristics of the natural person, such as facial images and dactyloscopic data (European Parliament and Council, 2024). In the General Protection Data Regulation (GDPR), this notion includes the requirement to allow or confirm the unique identification of the person, also with mention of facial images and dactyloscopic data (European Parliament and Council, 2016).

This conceptual coordination is important because the GDPR classifies as a special category the processing of biometric data for the purposes of unique identification and establishes, as a rule, the prohibition of such processing, except in the cases provided for in Article 9 itself. The AI Act incorporates this logic by establishing that, outside the specific scope of use for criminal prosecution purposes in publicly accessible spaces, biometric processing remains subject to the requirements of the GDPR, and for non-public safety purposes, Article 9 of the GDPR operates as a prohibition rule with limited exceptions.

The AI Act operates through a risk-based regulatory dynamic, with differentiation of obligations according to the category of the system, a logic also described in the literature as a structure that segments prohibited, high-risk, and minimal- or low-risk systems (Monteiro, 2026).

Thus, when it comes to biometrics, the regulation defines operational categories to delimit obligations and prohibitions. Biometric *identification* refers to automated recognition to establish identity by comparison with a reference base, while biometric *verification* designates one-to-one verification, including authentication.

The text also differentiates *remote biometric identification*, which identifies people without active participation, typically at a distance, by comparison with the reference base, and explains the *real-time* modality when capture, comparison and identification occur instantaneously, or almost.

Emotion recognition system is defined as a system that infers emotions or intentions from biometric data, and *biometric categorisation system* as a system that assigns categories based on biometrics, except for the hypothesis of an accessory function and necessary for objective technical reasons.

Article 5 of the AI Act lists prohibited practices, with a direct impact on biometrics. These include the creation or expansion of facial recognition bases by non-targeted scraping of facial images on the internet or in CCTV.⁴

The regulation also prohibits categorization systems that, based on biometric data, deduce or infer race, political opinions, union membership, religious or philosophical beliefs, sex life, or sexual orientation, with delimited caveats for labeling or filtering of lawfully acquired biometric data sets and for categorizations in the context of public security.

As for the use of real-time remote biometric identification in publicly accessible spaces for public safety purposes, the AI Act establishes a prohibition with typified and conditioned exceptions. That is, the text admits the use only when strictly necessary for the targeted search of specific victims and missing persons, prevention of substantial and imminent threat to life or physical safety or terrorist threat, or location and identification of suspects for serious crimes defined by reference to the annex and maximum penalty threshold.

For the implementation of these exceptions, the regulation provides for safeguards, with the requirement of an impact assessment on fundamental rights and registration of the system, with an exception admitted for urgency for registration, without ruling out its subsequent conclusion.

The AI Act associates biometrics with high-risk cases, with normative justification linked to discriminatory effects and biases, especially in remote biometric identification, which is why it should be treated according to this particularity. For high-risk systems, the regulation

⁴ CCTV is the acronym for *closed circuit television*, in Portuguese "closed circuit television". It refers to camera systems that capture and transmit images to a restricted set of monitors, recorders, or monitoring centers, rather than transmitting publicly. In urban and private contexts, CCTV usually designates video surveillance networks used for security, access control and occurrence registration.

imposes a risk management system throughout the life cycle, defined as a continuous and iterative process with identification of known and foreseeable risks, assessment of risks under normal use and foreseeable misuse, and adoption of targeted mitigation measures.

The text also establishes a duty of testing to identify risk management measures, with execution before placing on the market or putting into service, with probabilistic metrics and thresholds compatible with the intended purpose.

In the data dimension, it is required that training, validation and testing sets be subjected to governance and management practices appropriate to the purpose, covering data origin and original purpose, preparation operations such as labeling and cleaning, formulation of assumptions, and examination of biases with the potential to affect fundamental rights or lead to discrimination prohibited in Union law, with measures to detect, prevent and mitigate.

Similarly, at the organizational level, the regulation requires providers of high-risk systems to maintain a quality management system with documented policies and procedures, including compliance strategies, testing and validation procedures, and data management systems.

These requirements are directly related to the impact on fundamental rights. For this reason, it also provides for the assessment of these impacts prior to the use of the biometric system, and must contain a description of the process in which the system will be used, period and frequency of use, potentially affected categories, risks of damage and human supervision measures, among other elements. This obligation is an *ex ante* requirement for high-risk systems in the European Union, with the possibility of updating when information becomes obsolete (Monteiro, 2026).

4 ANALYSIS OF PL 2338/2023 FROM THE PERSPECTIVE OF THE USE OF BIOMETRICS

The current normative discussion on artificial intelligence in Brazil takes place in a scenario in which there are already rules that touch on automated systems, such as the General Data Protection Law and the Digital Government Law, without there being, so far, a specific and comprehensive normative framework aimed exclusively at the regulation of AI. In this context, the topic became part of the legislative agenda under the argument of the need to keep up with technological advances and to face risks related to privacy, security, transparency, and the protection of fundamental rights, with the convergence of the debate in PL 2,338/2023 (Arantes Júnior, 2025).

The project is presented as a proposal for a legal framework to regulate the use, implementation, and development of AI systems in the country, with mechanisms associated

with impact assessments and governance structures articulated with the protection of personal data (Monteiro, 2026).

In the same sense, the project adopts a logic of regulation by risk, with the definition of categories and the imposition of denser obligations for systems classified as high risk, including impact assessment provisions, transparency mechanisms, and the possibility of auditing and supervision by competent authorities (Arantes Júnior, 2025).

The processing of PL 2,338/2023 is connected to previous initiatives that sought to discipline the use of AI systems in Brazil, with emphasis on PL 21/2020, which proposed principles, rights, and duties, and which was declared impaired in December 2024 due to the subsequent processing of more comprehensive proposals in the Senate. In addition, other related projects were joined or considered impaired, under the justification of avoiding regulatory overlap and concentrating the debate around a single regulatory framework.

In this context, PL 2.338/2023, authored by Senator Rodrigo Pacheco, was approved by the Federal Senate and sent to the Chamber of Deputies in March 2025. PL 2,338/2023 organizes obligations based on a risk classification model and provides that systems considered to be high risk, after preliminary assessment, are subject to algorithmic impact assessment, defined as a continuous iterative process throughout the life cycle, with periodic updates whose periodicity depends on regulation by the competent authority, in addition to being expected to be carried out by professionals with functional independence and technical knowledge, scientific and legal aspects.

In the doctrinal characterization, this engineering seeks to anticipate potential damages associated with the operation of the systems, with a record of known and foreseeable risks and adverse consequences, in parallel with mechanisms aimed at transparency and accountability (Monteiro, 2026).

4.1 ORGANIZATION OF THE BILL AND PROVISIONS ON BIOMETRICS

The text approved in the Chamber introduces operational definitions to differentiate biometric identification and biometric authentication. Biometric identification appears as a method that involves the recognition of human physical, physiological, and behavioral characteristics for the purpose of identifying an individual, while biometric authentication is associated with the process of verifying or confirming identity by comparing biometric characteristics with a previously stored model (Brasil, 2023). Thus, it creates a conceptual basis to separate uses aimed at attributing identity to an open set of people, in the case of identification, from uses aimed at confirming a previously declared identity, in the case of authentication.

In the risk classification regime, the Bill provides for specific prohibitions related to biometrics in spaces accessible to the public. Article 13, item IV, prohibits the development, implementation, and use of real-time remote biometric identification systems in spaces accessible to the public, admitting exceptions linked to delimited hypotheses, such as investigation instruction or criminal proceedings upon prior and motivated judicial authorization and other contexts listed in the provision (Brasil, 2023).

In addition to the prohibitions, the Bill classifies certain biometric uses as high risk. Among the hypotheses listed, there is the use of biometric identification and authentication systems for the recognition of emotions, with the exception of biometric authentication systems whose sole purpose is the confirmation of a specific natural person. This normative option delimits a cut in which the risk does not arise only from the use of biometrics, but from the inferential objective associated with the system, in this case, inferences about affective states (Brasil, 2023).

In the scope of governance and procedural obligations, the Bill deals directly with biometric systems for identification purposes in the public sector. Article 23, paragraph 1, establishes that the use of biometric systems for identification purposes must comply with the principles and governance measures of the law and must be preceded by an algorithmic impact assessment, with observance of guarantees for the exercise of the rights of affected people or groups and protection against direct, indirect, illegal or abusive discrimination.

Thus, paragraph 2 provides that, if there is no substantive elimination or mitigation of the identified risks, the use will be discontinued

In the Chamber of Deputies, a controversy arises around facial recognition technologies in public spaces, especially when associated with public security and criminal prosecution. A document from civil society organizations registers opposition to the proposal attributed to rapporteur Aguinaldo Ribeiro to loosen rules on the use of facial recognition in public spaces and mentions a statement in which the text approved by the senators was described as too restrictive (Coalition Rights on the Network, 2025).

In the same document, it is pointed out that the wording of the Bill classifies facial recognition technologies as of excessive risk, but with a broad list of exceptions that encompasses current uses in the context of public security and criminal prosecution, with reference to article 13, item VII, and with criticism of a scenario in which exceptions would be outside the proposed governance structure

4.2 CONVERGENCES AND NEW PERSPECTIVES BETWEEN PL 2338/2023 AND THE EUROPEAN UNION'S AI ACT

Both normative texts adopt a logic of escalation by risk, with a set of prohibitions for uses considered incompatible with rights and freedoms and a regime of reinforced obligations for uses classified as high risk. In the AI Act, article 5 brings together prohibited practices, including for reasons associated with surveillance and impacts on fundamental rights, and establishes delimited exceptions for remote biometric identification in real time in publicly accessible spaces for law enforcement purposes, linked to specific objectives and a cut of crimes referred to in the annex (European Union, 2024).

In PL 2338/2023, article 13 prohibits, as a rule, the use of biometric identification systems at a distance in real time in spaces accessible to the public, with exceptions associated with criminal investigation and prosecution, search for victims and missing persons, serious and imminent threat, flagrante delicto, and compliance with warrants, under requirements such as prior judicial authorization and judicial control when applicable (Brasil, 2023).

There is also convergence in the provision of governance measures and documentation for high-risk uses. The Bill requires, in the public sector, access and use protocols with registration of who used the system, the right to human explanation and review, and publication of preliminary assessments, in addition to imposing algorithmic impact assessment for the use of biometrics for the purpose of identification and discontinuity of use when there is no substantive elimination or mitigation of risks.

In the AI Act, the high-risk discipline connects to evaluation, registration and supervision mechanisms, including requirements that relate registration on a European basis and synthesis of impact assessment on fundamental rights in certain registration and reporting contexts.

Finally, in this context, the main comparative implication for Brazil, with an exclusive focus on biometrics, lies less in the reaffirmation of the core already provided for in article 13, item IV, and more in the possibility of expanding the discipline to other biometric uses with potential for identification and surveillance.

5 FINAL CONSIDERATIONS

As seen, Bill No. 2338/2023 already incorporates direct discipline for biometric identification at a distance in real time in spaces accessible to the public, by prohibiting the development, implementation, and use of this practice, with delimited exceptions, such as instruction of an investigation or criminal proceeding upon prior and motivated judicial

authorization, search for victims and missing persons, serious and imminent threat, flagrante delicto, and recapture and compliance with warrants, in addition to requiring proportionality and strict necessity, judicial control, and review of algorithmic inference by a public agent, with reference to the principles and rights of the law itself and, where applicable, of the LGPD (Brasil, 2023).

The AI Act structures a similar solution by treating real-time remote biometric identification in publicly accessible spaces for the purposes of law enforcement activities, with a regime that starts from prohibition and admits use only when strictly necessary for exhaustive purposes, such as targeted search for specific victims and missing persons, prevention of specific threat, substantial and imminent to life or physical safety or terrorist threat, and locating or identifying a suspect for investigation, prosecution or criminal prosecution of offences referred to in the Annex and punishable by a maximum sentence of at least four years, with a requirement that the use confirm the identity of the individual specifically targeted (European Union, 2024)

Thus, from these perspectives, it is understood that a conceptual evolution is possible by incorporating operational definitions that the AI Act presents for biometric data, biometric identification, biometric verification, remote biometric identification system, real-time remote biometric identification, and subsequent remote biometric identification, including the element of absence of active involvement of the holder and the criterion of significant delay in distinguishing between real-time and later.

Still on remote biometric identification, the AI Act explains institutional safeguards that can guide Brazilian design for uses admitted in exception, such as the requirement of an impact assessment on fundamental rights, registration of the system on its own basis, prior authorization by an independent judicial or administrative authority with a binding decision, the possibility of starting without authorization only in urgency with a request within 24 hours, and the duty to interrupt use and discard and eliminate data and results when authorization is denied, in addition to prohibiting decisions with adverse legal effect based exclusively on leaving the system.

The Bill, in turn, provides that the use of biometric systems for identification purposes observes governance principles and measures and is preceded by algorithmic impact assessment, with guarantees for the exercise of rights and protection against discrimination, and determines discontinuity of use when there is no substantive elimination or mitigation of risks, in addition to establishing protocols for access and registration of use in the public sector, the right to human explanation and review and the publication of preliminary assessments.

In this comparison, one possibility of improvement guided by the AI Act consists of detailing, for remote biometric uses in exception, procedural and supervisory obligations external to the user entity, with systematic registration and audit trail, authorization criteria, and duties of disposal and elimination associated with the denial or termination of the measure.

The AI Act also brings a prohibition that does not appear in an equivalent way in the Bill when prohibiting systems that create or expand facial recognition bases by non-targeted collection of facial images on the internet or in CCTV images, which closes the door to the formation of biometric banks from massive extraction without a defined target. Based on this parameter, the Bill may incorporate a specific clause to prevent the creation and expansion of facial biometric databases by non-targeted scraping, with wording that covers both open sources and video surveillance images, in a manner compatible with the LGPD and the sensitive data protection regime.

Another difference focuses on emotion recognition systems. The Bill classifies as high risk biometric identification and authentication systems intended for the recognition of emotions, except for authentication whose sole purpose is the confirmation of a specific natural person, which triggers general obligations of the high-risk and governance regime. The AI Act, on the other hand, prohibits systems intended to infer emotions in the workplace and educational institutions, except when the use is intended for medical or security reasons, and also defines an emotion recognition system as one that identifies or infers emotions or intentions based on biometric data.

Based on this, the elaboration of the Bill can consider a contextual prohibition for the recognition of emotions at work and education, or, if it maintains the option for high risk, it can delimit strict hypotheses and specific purposes, with additional requirements of justification, human supervision and transparency to the affected due to the asymmetry in these environments.

There is also a biometric vector that the AI Act expressly treats and that the Bill does not yet describe with equal density, the biometric categorization. The AI Act prohibits biometric categorization systems that, based on biometric data, deduce or infer race, political opinions, union membership, religious or philosophical beliefs, sex life, or sexual orientation, while defining biometric categorization system as one that assigns natural persons to specific categories based on their biometric data, with the exception of ancillary and technically necessary cases.

This parameter offers Brazil an additional path, with a prohibition rule directed to sensitive inferences from biometrics, which will serve to reduce ambiguities when biometric

systems do not intend to identify by name, but operate by classification and inference, including in private and service environments.

The distinction between real-time and post-time remote biometric identification also yields comparative implications. The literature that examines the European proposal pointed out questions about the separation between real and later time and about the line between biometric categorization and biometric identification, indicating that the distinction can generate classificatory arbitrariness (Madiega; Mildebrath, 2021 apud Baccarin, 2023).

The AI Act, in addition to defining the subsequent system as the remote one that is not in real time, registers the need for safeguards for subsequent uses and removes the possibility of indiscriminate surveillance and circumventing the strict conditions of real time, by requiring targeted use in terms of individuals, location and time frame, based on a closed set of legally obtained images.

Along these lines, the Bill can explain how it treats subsequent remote biometric identification, either by extending the discipline of article 13 beyond real time, or by its own chapter of safeguards that covers ex post uses in video surveillance and other bases, focusing on the prevention of generalized scans and the delimitation of scope and reference base.

Finally, the AI Act offers a biometric perspective of institutional arrangement of transparency and accountability that can be adapted to Brazil. In the use of real-time remote biometric identification for law enforcement purposes, the regulation provides for notification to supervisory authorities and aggregated annual reports, with publication by the Commission of annual reports on use, without sensitive operational data.

In the Bill, there is provision for the publication of preliminary assessments of high-risk systems in the public sector and the establishment of minimum standards of transparency at the federal level, in addition to protocols for access and registration of use and the right to human explanation and review.

Based on this contrast, it is possible to combine the Brazilian model of administrative evaluation and transparency with a national registry of remote biometric uses and with periodic aggregate reporting obligations, which expands public traceability without exposing sensitive operational information, especially in contexts of security and border control.

REFERENCES

Brasil. Autoridade Nacional de Proteção de Dados. (2023, 6 de julho). Análise preliminar do Projeto de Lei (PL) nº 2338/2023. https://www.gov.br/anpd/pt-br/assuntos/noticias/analise-preliminar-do-pl-2338_2023-formatado-ascom.pdf

- Brasil. Senado Federal. (2023). Projeto de Lei n.º 2.338, de 2023. Dispõe sobre o uso da inteligência artificial. <https://www25.senado.leg.br/web/atividade/materias/-/materia/157233>
- Canuto, A. M. de P. (2022). Ética no uso de dados biométricos: Histeria ou uma preocupação coerente? *Computação Brasil*, 47, 36–39. <https://doi.org/10.5753/compbr.2022.47.4406>
- Coalizão Direitos na Rede. (2025, 8 de dezembro). Posicionamento sobre o PL 2338/2020 e sistemas de identificação biométrica (reconhecimento facial). <https://direitosnarede.org.br/2025/12/08/posicionamento-pl-2338-sistemas-identificacao-biometrica-reconhecimento-facial/>
- Corrêa, A. E., & Loureiro, M. F. B. (2023). Biometria, autodeterminação informativa e proteção de dados pessoais. *Revista de Direito Civil Contemporâneo*, 36, 47–74.
- Electronic Privacy Information Center. (2024, 29 de maio). EPIC awards the Tire Meu Rosto da Sua Mira campaign as EPIC International Privacy Champions. <https://epic.org/epic-awards-the-tire-meu-rosto-da-sua-mira-campaign-as-epic-international-privacy-champions/>
- Gercina, C. (2024, 15 de outubro). Havan expõe em vídeos “amostradinho do mês” supostos furtos nas lojas. *Folha de S.Paulo*. <https://www1.folha.uol.com.br/mercado/2024/10/havan-expoe-em-videos-amostradinho-do-mes-supostos-furtos-nas-lojas.shtml>
- Lima, N. A., et al. (2024). O uso de bancos de dados biométricos civis em investigações criminais: Possíveis avanços à luz de direitos e garantias fundamentais. *Revista Jurídica da Seção Judiciária de Alagoas*, 1(8), 135–152. <https://revista.jfal.jus.br/RJSJAL/article/view/56>
- São Paulo (Município). Secretaria Municipal de Segurança Urbana. (2024, 3 de julho). Programa Smart Sampa. https://prefeitura.sp.gov.br/web/seguranca_urbana/w/smart-sampa-2
- Schwertner, S. D. G. (2025, 6 de novembro). Projeto de lei impõe mais limites à utilização de dados biométricos. *Consultor Jurídico*. <https://www.conjur.com.br/2025-nov-06/o-uso-indiscriminado-de-dados-biometricos-e-o-pl-2-379-2025/>
- Souza, I. D. D., Silva, D. R. da C., Almeida, A. C. de, & Andrade, E. S. de S. (2023). Aplicação do ABIS na identificação de vítimas de desastres: Utilização dos bancos de dados biométricos. *Revista de Estudos Interdisciplinares*, 5(6), 227–244. <https://doi.org/10.56579/rei.v5i6.793>
- União Europeia. (2016). Regulamento (UE) 2016/679 do Parlamento Europeu e do Conselho, de 27 de abril de 2016. Relativo à proteção das pessoas singulares no que diz respeito ao tratamento de dados pessoais e à livre circulação desses dados (Regulamento Geral sobre a Proteção de Dados). <https://eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=CELEX:32016R0679>
- União Europeia. (2024). Regulamento (UE) 2024/1689 do Parlamento Europeu e do Conselho, de 13 de junho de 2024. Relativo à criação de regras harmonizadas em matéria de inteligência artificial (Regulamento da Inteligência Artificial). https://eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=OJ:L_202401689
- Violato, R. P. V., Neto, M. U., Simões, F. O., Pereira, T. de F., & Angeloni, M. de A. (2013). BioCPqD: Uma base de dados biométricos com amostras de face e voz de indivíduos brasileiros. *Cadernos CPqD Tecnologia*, 9(2), 7–18.

LEADERSHIP THAT INSPIRES IN THE CORPORATE ENVIRONMENT: CHARISMA, EMOTIONAL INTELLIGENCE, AND ORGANIZATIONAL CULTURE AS DEVELOPABLE COMPETENCIES

A LIDERANÇA QUE ENCANTA NO AMBIENTE CORPORATIVO: CARISMA, INTELIGÊNCIA EMOCIONAL E CULTURA ORGANIZACIONAL COMO COMPETÊNCIAS DESENVOLVÍVEIS

EL LIDERAZGO QUE INSPIRA EN EL ENTORNO CORPORATIVO: CARISMA, INTELIGENCIA EMOCIONAL Y CULTURA ORGANIZACIONAL COMO COMPETENCIAS DESARROLLABLES



<https://doi.org/10.56238/sevened2026.008-059>

Monika Fritz¹

ABSTRACT

This chapter analyzes the role of charisma in contemporary corporate leadership, integrating it with Emotional Intelligence (EI) as a foundation for authentic, ethical, and culturally sustainable influence. In organizational contexts marked by volatility, pressure for results, and competition for talent, charisma is reinterpreted not as a mystical trait, but as a relational, observable, and trainable competency. Methodologically, this is a narrative bibliographic review that articulates the classical Weberian perspective on charismatic domination, behavioral indicators of charismatic leadership (House, 1977), and contemporary approaches to Emotional Intelligence (Salovey & Mayer, 1990; Goleman, 1995) and organizational purpose (Sinek, 2018). A conceptual model is proposed in which Emotional Intelligence (self-awareness, self-regulation, empathy, and social skills) acts as an antecedent of charismatic behaviors (authentic communication, presence, human connection, and inspiring vision), generating positive effects on trust, engagement, psychological safety, and organizational culture. As a practical contribution, structured development actions applicable to managerial contexts are presented, including self-knowledge, active listening, storytelling, constructive feedback, and mentoring and coaching practices. It is concluded that charismatic leadership, when grounded in emotional competence and ethical responsibility, amplifies organizational results and strengthens collective bonds, fostering collaborative, resilient, and purpose-driven environments.

Keywords: Charismatic Leadership. Charisma. Emotional Intelligence. Organizational Culture. Engagement.

RESUMO

Este capítulo analisa o papel do carisma na liderança corporativa contemporânea, integrando-o à Inteligência Emocional (IE) como fundamento para uma influência autêntica,

¹ Master's degree in Technology. Centro Universitário Nelson Akiyoshi (UNINA).

E-mail: fritz.monika@talentos.edu.br

Lattes: https://www.cnpq.br/cvlattesweb/PKG_MENU.menu?f_cod=35BC83D99241C12A2B58A9ACAF180D86#

ética e culturalmente sustentável. Em contextos organizacionais marcados por volatilidade, pressão por resultados e competição por talentos, o carisma é reinterpretado não como traço místico, mas como competência relacional, observável e treinável. Metodologicamente, trata-se de revisão bibliográfica narrativa que articula a perspectiva clássica weberiana sobre dominação carismática, indicadores comportamentais de liderança carismática (House, 1977) e abordagens contemporâneas sobre IE (Salovey e Mayer, 1990; Goleman, 1995) e propósito organizacional (Sinek, 2018). Propõe-se um modelo conceitual no qual a IE (autoconsciência, autorregulação, empatia e habilidades sociais) atua como antecedente de comportamentos carismáticos (comunicação autêntica, presença, conexão humana e visão inspiradora), com efeitos positivos sobre confiança, engajamento, segurança psicológica e cultura organizacional. Como contribuição prática, apresentam-se ações estruturadas de desenvolvimento aplicáveis ao contexto gerencial: autoconhecimento, escuta ativa, storytelling, feedback construtivo e práticas de mentoring e coaching. Conclui-se que a liderança carismática, quando ancorada em competência emocional e responsabilidade ética, amplifica resultados organizacionais e fortalece vínculos coletivos, favorecendo ambientes colaborativos, resilientes e orientados a propósito.

Palavras-chave: Liderança Carismática. Carisma. Inteligência Emocional. Cultura Organizacional. Engajamento.

RESUMEN

Este capítulo analiza el papel del carisma en el liderazgo corporativo contemporáneo, integrándolo con la Inteligencia Emocional (IE) como fundamento de una influencia auténtica, ética y culturalmente sostenible. En contextos organizacionales marcados por la volatilidad, la presión por resultados y la competencia por el talento, el carisma se reinterpreta no como un rasgo místico, sino como una competencia relacional, observable y entrenable. Metodológicamente, se trata de una revisión bibliográfica narrativa que articula la perspectiva clásica weberiana sobre la dominación carismática, los indicadores conductuales del liderazgo carismático (House, 1977) y los enfoques contemporáneos sobre la Inteligencia Emocional (Salovey y Mayer, 1990; Goleman, 1995) y el propósito organizacional (Sinek, 2018). Se propone un modelo conceptual en el que la Inteligencia Emocional (autoconciencia, autorregulación, empatía y habilidades sociales) actúa como antecedente de los comportamientos carismáticos (comunicación auténtica, presencia, conexión humana y visión inspiradora), con efectos positivos sobre la confianza, el compromiso, la seguridad psicológica y la cultura organizacional. Como contribución práctica, se presentan acciones estructuradas de desarrollo aplicables al contexto gerencial, tales como el autoconocimiento, la escucha activa, el storytelling, la retroalimentación constructiva y las prácticas de mentoring y coaching. Se concluye que el liderazgo carismático, cuando está anclado en la competencia emocional y la responsabilidad ética, amplifica los resultados organizacionales y fortalece los vínculos colectivos, favoreciendo entornos colaborativos, resilientes y orientados al propósito.

Palabras clave: Liderazgo Carismático. Carisma. Inteligencia Emocional. Cultura Organizacional. Compromiso.

1 INTRODUCTION

The contemporary corporate environment has been marked by intense and simultaneous transformations: accelerated digitalization, reconfiguration of value chains, growth of hybrid work, pressure for productivity, and greater social awareness about mental health and the quality of relationships at work. In this context, organizations face the challenge of sustaining performance without deteriorating the relational fabric that makes execution possible. Thus, leadership comes to be understood not only as a management function, but as the ability to influence meaning, mobilize cooperation and build trust (YUKL, 2013).

Historically, popular discourses have often associated charisma with "personal magnetism" and a supposed natural gift. However, in the academic field, the concept can be treated more rigorously: charisma is a phenomenon of influence that emerges in the interaction between leader and followers and depends on cultural context, group expectations, and perceived credibility. Weber (2000) contributed by positioning charisma as the basis of a form of domination legitimized by the devotion of followers to qualities attributed to the leader. In the current corporate scenario, charisma tends to be reinterpreted as a repertoire of observable skills and behaviors, which can be learned, trained, and applied in a situational way (CUKIER, 2019).

At the same time, organizations have recognized that sustainable influence is not built only with persuasion techniques, but with emotional maturity, empathy, and coherence. At this point, Emotional Intelligence (EI) becomes a relevant explanatory axis: understanding and managing emotions in oneself and in others tends to increase the quality of interactions and reduce relational noise, allowing influence to be perceived as authentic and ethical. Goleman (1995) popularized the theme by systematizing dimensions such as self-awareness, self-regulation, empathy and social skills, while Salovey and Mayer (1990) consolidated a theoretical definition of EI as the mental capacity to perceive, understand and manage emotions.

Given this scenario, this chapter has the following research problem: how does the integration between charisma and Emotional Intelligence contribute to a more effective, ethical, and culturally sustainable leadership in the corporate environment?

The overall objective is to analyze the role of charisma in corporate leadership, integrating Emotional Intelligence as a foundation for the development of an authentic charisma. As specific objectives, it is sought: (a) to discuss the concept of charisma from classical contributions and contemporary readings; (b) present elements and indicators associated with charismatic leadership; (c) relate Emotional Intelligence and charisma,

identifying mechanisms of influence and trust; (d) to propose development practices and actions applicable in the organizational routine; (e) present an integrative model with implications for culture and engagement.

The rationale for this study lies in the fact that, in contexts of change and competition for talent, organizations depend on leaders capable of mobilizing engagement without resorting to excessive control or practices that compromise cultural health. The understanding of charisma as a developable competency, when anchored in EI, provides a conceptual and practical basis for leadership development programs.

Methodologically, this is a qualitative, exploratory study, developed through a narrative literature review. Reference works and texts on charisma and charismatic domination (WEBER, 2000), charisma intelligence (CUKIER, 2019), charismatic leadership in an organizational context (GALVÃO, 2011), indicators associated with charisma (HOUSE, 1977 apud GALVÃO, 2011), as well as literature on EI (SALOVEY; MAYER, 1990; GOLEMAN, 1995) and purpose-driven leadership (SINEK, 2018).

2 THEORETICAL FOUNDATION

2.1 CHARISMA: FROM CHARISMATIC DOMINATION TO THE REPERTOIRE OF COMPETENCIES

Weber (2000) described charisma as an extraordinary quality attributed to the leader, perceived as having exceptional strengths. Charismatic domination, in this sense, is not born only from formal office, but from the social recognition of attributes that generate devotion and legitimation. This perspective is useful for understanding why some leaders wield profound influence even without robust formal authority.

However, in the contemporary corporate environment, the "extraordinary" explanation needs to be operationalized. In organizations, leadership depends on processes, results, ethical legitimacy, and relational consistency. Thus, charisma tends to be reinterpreted as a relational phenomenon: it emerges from the encounter between (a) the leader's behaviors (communication, presence, coherence), (b) the needs and expectations of the followers (security, direction, recognition), and (c) context (crisis, change, organizational culture, team maturity).

This contemporary reading supports the thesis that charisma can be developed. The possibility of development does not eliminate individual differences, but shifts the understanding of charisma from a "fixed talent" to a set of trainable and evaluable skills, particularly in leadership contexts (CUKIER, 2019).

2.2 CHARISMATIC INTELLIGENCE: PERSONAL, SOCIAL AND CONTEXTUAL PILLARS

Cukier (2019) proposes the concept of "charisma intelligence", structuring it in three pillars: personal intelligence (the self), social intelligence (the other) and contextual intelligence (the environment). Personal intelligence involves self-knowledge, self-awareness, and self-management; social involves empathy, communication, and relationship management; and contextual involves sensitive reading of the environment, cultural norms and power dynamics.

This structure is especially relevant in the corporate scenario, in which the same behavior can produce different effects according to the organization's culture and strategic moment. For example, assertive communication can be perceived as security in contexts of ambiguity; However, it may sound like authoritarianism in cultures that value horizontality and participation. Therefore, charisma is not only "what is done", but "how, when and for whom" it is done.

2.3 CHARISMATIC LEADERSHIP: INDICATORS AND MECHANISMS OF INFLUENCE

The literature on charismatic leadership highlights that this style mobilizes intrinsic commitment and bond with the mission, unlike strictly transactional approaches, based on rewards and punishments. Galvão (2011), when discussing the theme, presents contributions that emphasize the charismatic leader as a behavioral model, someone who projects high expectations and demonstrates confidence in the ability of the subordinates (FREITAS, 2006 apud GALVÃO, 2011).

House (1977 apud GALVÃO, 2011) presents six indicators that help measure perceived charisma: (1) confidence in the leader's convictions; (2) similarity of beliefs between leader and followers; (3) affection and acceptance of the leader; (4) spontaneous obedience; (5) emotional involvement with the mission; and (6) the follower's belief in their own contribution. These indicators suggest that charismatic leadership is not just about "being admired," but about producing alignment, safety, commitment, and agency in the follower.

Gomes (2005 apud GALVÃO, 2011) emphasizes the sensitivity to identify needs, resources, problems and aspirations of the group as a central distinction between charismatic and non-charismatic people. Such sensitivity directly brings charisma and EI closer, as it requires emotional perception, social reading, and behavioral adaptation.

2.4 EMOTIONAL INTELLIGENCE: DEFINITION AND DIMENSIONS FOR LEADERSHIP

Salovey and Mayer (1990) defined Emotional Intelligence as the ability to perceive emotions, integrate emotions into thought, understand emotions and regulate them. Goleman (1995) broadened the discussion in the applied field, emphasizing competencies such as self-awareness, self-regulation, empathy and social skills, often associated with the performance of leaders.

In corporate environments, EI is particularly critical for three reasons: (a) leadership occurs in the midst of conflicts of interest and pressure for results; (b) emotions are socially transmissible and impact climate, psychological safety and productivity; (c) the leader's decisions and communication influence the interpretation of justice, respect and belonging (GOLEMAN, 1995).

By relating EI and charisma, it is proposed that EI acts as a "psychological infrastructure" of influence: without self-awareness and self-regulation, communication can lose consistency; Without empathy, the leader may fail to read the team's needs; Without social skills, bonding and trust deteriorate.

2.5 CHARISMA, PURPOSE AND ORGANIZATIONAL CULTURE

In the corporate context, charisma tends to express itself in four main dimensions: authentic and compelling communication, presence and self-confidence, empathy and human connection, and inspiring vision (CUKIER, 2019). These dimensions are directly connected to cultural factors: leaders serve as models of values; its coherence strengthens norms of transparency and respect; Their way of dealing with mistakes defines whether the culture will be one of learning or of punishment.

Sinek (2018) argues that inspirational leaders mobilize people by communicating a clear and meaningful "why" (purpose), rather than just a "what" (goals) and "how" (processes). This contribution is especially useful to the debate on charisma: inspiring vision and storytelling are means of converting strategy into shared meaning.

Edmondson (1999) adds a critical dimension: psychological safety, that is, the belief that the environment is safe to take interpersonal risks, such as asking questions, admitting mistakes, and proposing ideas. In practical terms, ethical charismatic leaders tend to increase psychological safety when they use influence to welcome, guide and recognize, and not to intimidate.

3 INTEGRATIVE MODEL: EMOTIONAL INTELLIGENCE AND CHARISMATIC LEADERSHIP

3.1 FROM THE "CHARISMATIC IMAGE" TO THE AUTHENTIC CHARISM

A decisive difference in the corporate environment is between charisma as "image" and charisma as "relationship". A leader can present strong communication performance and still generate distrust if his conduct is incoherent, if there is emotional manipulation or if the speech does not translate into consistent decisions. In this sense, EI operates as a mechanism of coherence: self-awareness reduces dissonances (promising participation and acting with control); self-regulation reduces reactivity (irony, aggressiveness, defensiveness); empathy broadens the perception of the impact of one's own behavior; Social skills underpin difficult conversations and relationship repair.

Thus, an authentic charism can be understood as an influence sustained by three criteria: (a) ethical intention (oriented to the collective good and to the legitimate organizational purpose), (b) behavioral coherence (speech-action alignment) and (c) emotional competence (ability to manage one's own and others' emotions without abusive instrumentalization).

3.2 PROPOSITION OF THE CONCEPTUAL MODEL

Based on the reviewed literature, an integrative conceptual model structured in four levels is proposed:

Background (individual level): Emotional Intelligence, composed of self-awareness, self-regulation, empathy, and social skills (SALOVEY; MAYER, 1990; GOLEMAN, 1995); and contextual reading, which involves the ability to understand culture, climate, moment, and stakeholders (CUKIER, 2019).

Mechanisms (observable charismatic behaviors): Authentic communication (clarity, active listening, storytelling); presence and self-confidence (posture, emotional stability); human connection (applied empathy, recognition); and inspiring vision (shared purpose) (SINEK, 2018).

Intermediate outcomes (team/culture level): Leader trust and acceptance; alignment of beliefs and voluntary adherence (HOUSE, 1977 apud GALVÃO, 2011); psychological safety and learning climate (EDMONDSON, 1999); engagement and motivation; reduction of turnover; and collaboration and innovation.

Final results (organizational level): Sustaining a positive organizational culture; better strategic execution and capacity for change (KOTTER, 1996); and reputation for leadership with strengthening of the employer brand.

Central to the model is that EI is not just "an additional topic" but a critical antecedent that transforms charisma into reliable influence, reducing the risk of toxic charisma (personalism, manipulation, and overdependence on the leader).

4 DEVELOPMENT OF CHARISMA AND EMOTIONAL INTELLIGENCE IN THE CORPORATE CONTEXT

4.1 SELF-KNOWLEDGE AND SELF-AWARENESS

The development of charisma begins with self-knowledge, because the leader's influence is amplified by the way he reacts, communicates and decides under pressure. Best practices include: (a) decision journaling, to record difficult decisions, emotions perceived, assumptions used, and impacts observed; (b) 360-degree feedback, to map discrepancies between intention and perception; (c) identification of emotional triggers, recognizing situations that generate reactivity (public criticism, delay, team error); and (d) explicitness of values and limits, defining non-negotiable values and behaviors that contradict these values. This stage strengthens authenticity, as it reduces the distance between discourse and practice (GOLEMAN, 1995).

4.2 EMOTIONAL SELF-MANAGEMENT AND PRESENCE

Charismatic presence is not just body posture; it is perceived emotional stability. Leaders with good self-management are able to sustain difficult conversations without escalating conflict, maintain respect even in disagreement, manage anxiety in ambiguous situations, and avoid passive-aggressive communication and microviolence. Applicable techniques include strategic pause before responding, emotional preparation for critical meetings, and recovery routine (sleep, exercise, energy management), as fatigue reduces self-regulation.

4.3 AUTHENTIC COMMUNICATION: ORATORY, CLARITY AND ACTIVE LISTENING

Communication is the core of charisma in the corporate environment, but it is not just about speaking well. Charismatic leadership integrates sending and receiving. In terms of public speaking and message structure, it is recommended: openness with context and purpose ("why it matters"), presentation of three key points (to limit dispersion), use of evidence and practical examples, and invitation to participate (questions and next steps).

As for non-verbal language, the following stand out: balanced eye contact, open posture, rhythm and pauses for emphasis, and tone of voice consistent with the content. Active listening, an often overlooked charismatic competency, involves: open-ended

questions, paraphrasing (confirming understanding), validating emotions without necessarily agreeing, and reducing interruptions and multitasking. Active listening increases the perception of respect and acceptance, dimensions close to House's indicators (1977 apud GALVÃO, 2011).

4.4 STORYTELLING AND INSPIRATIONAL VISION

Sinek (2018) highlights that inspiring leaders start with the "why". In the corporate environment, this means translating goals into meaning and connecting daily work to greater impact. Storytelling, when authentic, fulfills three functions: it gives meaning (why the effort is worth it), it transmits values (what is acceptable and what is not) and it creates memory (stories fix more than isolated data). A simple framework for managerial storytelling includes: real challenge (context), dilemma (tension), decision made (value in action), learning (culture of improvement), and invitation (the team's role in continuity).

4.5 APPLIED EMPATHY AND HUMAN CONNECTION

Empathy, in the corporate environment, is not "always being pleasant"; it is understanding the needs, pressures and aspirations of the other and adjusting the way of leading. Practical applications include: short check-ins in one-on-one meetings (1:1) to understand how the person is doing and what is hindering delivery; specific recognition, praising behavior and impact, not just generic "congratulations"; negotiation of priorities, because empathy does not eliminate demands, but qualifies them; and protection of the team, establishing healthy limits against contradictory demands. Empathy sustained by consistency reinforces acceptance and emotional engagement with the mission.

4.6 CONSTRUCTIVE FEEDBACK, MENTORING AND COACHING

Corporate charisma tends to consolidate when the leader is perceived as someone who promotes growth and justice. Two fronts are decisive: constructive feedback, based on observable facts, with a focus on behavior and impact, co-construction of alternatives and follow-up (feedback without follow-up becomes rhetoric); and mentoring and coaching, with mentoring for repertoire expansion, coaching for goals and responsibility, visibility opportunities and challenging projects, and succession preparation (ethical charisma forms other, non-dependent leaders).

5 MANAGERIAL IMPLICATIONS AND DEVELOPMENT PLAN

To transform the theoretical content into managerial action, a 90-day development plan is suggested, structured in three cycles:

Cycle 1 (Days 1–30): Self-awareness and emotional grounding. Apply 360-degree feedback (or quick interviews with peers and subordinates), identify three emotional triggers and three risk behaviors (e.g., interrupt, mock, respond on impulse), and define two substitute behaviors (e.g., pause, ask, summarize).

Cycle 2 (Days 31–60): Communication and connection. Practice one presentation per week using a "why–what–how" structure, implement biweekly one-on-one (1:1) meetings with subordinates (with an active listening script) and practice storytelling, developing two short narratives per month connected to organizational values.

Cycle 3 (Days 61–90): Culture, influence, and multiplication. Establish a learning ritual with "after-action" of projects (what we learn), implement continuous feedback (two positive reinforcements and one point of improvement per month per subordinate) and start mentoring with one or two talents (development plan and autonomy).

It is also important to recognize risks and limits. Charisma without ethical ballast and emotional competence can generate dependence on the leader (centralization), stimulate personalism and weaken governance, promote manipulative influence (emotional use for control) and reduce decision-making quality if there is a cult of the leader. Integration with EI and ethics acts as a mitigation, by reinforcing self-control, transparency, and accountability.

6 FINAL CONSIDERATIONS

Charisma, in the contemporary corporate environment, must be understood as a developable and contextual competence, and not as a mystical attribute reserved for a few individuals. Charismatic leadership contributes to engagement, trust, and a positive organizational culture when guided by authenticity, coherence, and consistent practice. By articulating classical contributions (WEBER, 2000) with contemporary approaches and behavioral indicators (HOUSE, 1977 apud GALVÃO, 2011), it is observed that the perceived charism is related to alignment, acceptance, voluntary adherence and bond with the mission.

The central contribution of this chapter is to integrate Emotional Intelligence as the foundation for an authentic charism. Self-awareness, self-regulation, empathy and social skills (SALOVEY; MAYER, 1990; GOLEMAN, 1995) underpin the practical dimensions of charisma: compelling communication, presence, human connection, and inspiring vision. In organizational terms, this favors psychological safety, cooperation, learning, and cultural strengthening, with indirect effects on performance and retention.

As limitations, as it is a narrative review, there is no empirical testing of the proposed model. It is recommended, for future studies, the application of field research in organizations (surveys, interviews and case studies) to evaluate relationships between EI, charismatic behaviors and indicators of climate, engagement and results. Longitudinal studies could also examine whether EI and charisma development programs produce sustained effects over time.

Even so, the work offers a theoretical-practical synthesis applicable to leadership development programs, especially in the context of MBA and executive education, by translating theory into structured managerial practices. It is concluded that the "leadership that enchants" does not replace strategy and execution, but enhances them, integrating results and quality of relationships — an increasingly decisive condition for competitiveness, talent retention and organizational well-being.

REFERENCES

- Cukier, H. O. (2019). *Inteligência do carisma: Aprenda a ciência de conquistar e influenciar pessoas* (3ª ed.). Planeta.
- Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly*, 44(2), 350–383.
- Galvão, C. M. (2011). *Liderança carismática: Interação com culturas organizacionais fortes e fracas* [Monografia de bacharelado, Centro Universitário de Brasília]. Repositório UniCEUB. <https://repositorio.uniceub.br/jspui/bitstream/235/8007/1/51300924.pdf>
- Goleman, D. (1995). *Inteligência emocional*. Objetiva.
- Kotter, J. P. (1996). *Leading change*. Harvard Business School Press.
- Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition and Personality*, 9(3), 185–211.
- Sinek, S. (2018). *Comece pelo porquê: Como grandes líderes inspiram todos a agir*. Alta Books.
- Weber, M. (2000). *Economia e sociedade: Fundamentos da sociologia compreensiva*. Editora Universidade de Brasília.
- Yukl, G. (2013). *Leadership in organizations* (8ª ed.). Pearson.

PLAYFULNESS AND MATHEMATICAL LEARNING: GAMES AS EDUCATIONAL TOOLS

LUDICIDADE E APRENDIZAGEM MATEMÁTICA: JOGOS COMO FERRAMENTAS PEDAGÓGICAS

LUDICIDAD Y APRENDIZAJE MATEMÁTICO: LOS JUEGOS COMO HERRAMIENTAS PEDAGÓGICAS



<https://doi.org/10.56238/sevened2026.008-060>

Vitória Lindaura Eufrásio Cândido¹, Tiago Emanuel Melo Pereira²

ABSTRACT

This work presents the use of games as a pedagogical resource to make the teaching of Mathematics more dynamic, attractive, and meaningful, as well as to reduce resistance to the subject. The proposal was developed through a project entitled “Mathematical Challenges: Developing Logical Thinking through Games”, implemented in a 9th-grade class. Several activities were applied that promoted problem-solving, spatial visualization, decision-making, and the development of socio-emotional skills. Grounded in the works of authors such as Vygotsky, Grando, Kishimoto, Borasi, and Freire, the study demonstrates that playfulness, recreational mathematics, and mathematical modeling are effective strategies for bringing content closer to students’ realities, fostering a collaborative and enjoyable learning environment.

Keywords: Playfulness. Mathematical Games. Mathematics Teaching.

RESUMO

Este trabalho apresenta a utilização de jogos como recurso pedagógico para tornar o ensino da Matemática mais dinâmico, atrativo e significativo, como também a redução a resistência à disciplina. A proposta foi desenvolvida através de um projeto intitulado “Desafios Matemáticos: Desenvolvendo o Pensamento Lógico com Jogos”, numa turma de 9º ano. Foram aplicadas diversas atividades que favoreceram a resolução de problemas, a visualização espacial, a tomada de decisões e o desenvolvimento de competências socioemocionais. Fundamentado em autores como Vygotsky, Grando, Kishimoto, Borasi e Freire, o estudo evidencia que a Ludicidade, a Matemática Recreativa e a Modelagem Matemática que são estratégias eficazes para aproximar os conteúdos da realidade dos alunos, promovendo um ambiente de aprendizagem colaborativo e prazeroso.

Palavras-chave: Ludicidade. Jogos Matemáticos. Ensino de Matemática.

¹ Undergraduated in Mathematics. Faculdade de Formação de Professores de Serra Talhada (FAFOPST). E-mail: vitoria0987eufrazio@gmail.com

² Master’s degree of Science in Mathematics. Escola Técnica Estadual Clóvis Nogueira Alves. E-mail: tiagoemelop@gmail.com

RESUMEN

Este trabajo presenta el uso de juegos como recurso pedagógico para hacer que la enseñanza de las matemáticas sea más dinámica, atractiva y significativa, así como para reducir la resistencia a la disciplina. La propuesta se desarrolló a través de un proyecto titulado «Desafíos matemáticos: desarrollo del pensamiento lógico con juegos», en una clase de 9.º curso. Se aplicaron diversas actividades que favorecieron la resolución de problemas, la visualización espacial, la toma de decisiones y el desarrollo de competencias socioemocionales. Basado en autores como Vygotsky, Grando, Kishimoto, Borasi y Freire, el estudio evidencia que la ludicidad, las matemáticas recreativas y el modelado matemático son estrategias eficaces para acercar los contenidos a la realidad de los alumnos, promoviendo un ambiente de aprendizaje colaborativo y placentero.

Palabras clave: Ludicidad. Juegos Matemáticos. Enseñanza de las Matemáticas.

1 INTRODUCTION

This article addresses the use of games as a pedagogical resource to facilitate the learning of Mathematics in Basic Education. The proposal is based on the idea that play contributes to making the teaching and learning process more attractive and meaningful, stimulating logical reasoning and the active participation of students. The study presented was developed from the results obtained with the elaboration and application of a project linked to PROUPE – University for All Program in Pernambuco –, carried out as an educational counterpart provided by the program. The project was developed at the José Nascimento da Silva Municipal School of Basic Education, located in the municipality of Tavares-PB.

Mathematics, despite being essential for intellectual development and knowledge of the world, is constantly seen by students as an abstract, complex discipline that is very distant from daily reality. This perception influences school development and causes demotivation of students, especially elementary school students.

In view of this, it is necessary to rethink the pedagogical practices adopted, which are often outdated, and seek strategies that make teaching more attractive, effective and accessible. In this article we seek to present didactic tools capable of transforming this reality through pedagogical practices that stimulate logical reasoning, creativity and autonomy of students.

The National Common Curriculum Base (BNCC) advises that:

[...] learning in Mathematics is intrinsically related to comprehension, that is, to the apprehension of meanings of mathematical objects, without leaving aside their applications. [...] Thus, didactic resources such as checkered meshes, abacuses, games, books, videos, calculators, spreadsheets, and dynamic geometry software play an essential role in the understanding and use of mathematical notions (Brasil, 2018, p. 218).

In addition to enabling greater involvement with the discipline, the proposal helps to strengthen essential skills, such as problem solving, critical and argumentative thinking. By integrating playful elements into the teaching and learning process, the teacher provides students with a journey of discovery, reflection and knowledge construction, making Mathematics a useful and significant tool for understanding and interacting with the world.

2 GENERAL OBJECTIVE

Promote the development of students' problem-solving skills, logical thinking and creativity, as well as the understanding of Mathematics as an essential tool through the use

of games and interactive activities, aligned with competencies and skills provided for in the National Common Curricular Base (BNCC), making the teaching and learning process more dynamic, welcoming and participatory.

3 SPECIFIC OBJECTIVES

- Stimulate logical reasoning and problem solving through challenging activities that encourage students to think logically, creatively and strategically in the face of problem-situations;
- Demonstrate the applicability of Mathematics in everyday life, relating the contents studied with real and practical situations, facilitating the understanding and appreciation of the discipline;
- Incorporate playful elements into the teaching of Mathematics using games, games and dynamics that make learning more engaging, arousing the interest and curiosity of students.

4 METHODOLOGY

The methodology adopted in this article was built from the development of a project linked to PROUPE, carried out with a class composed of 10 students from the 9th grade of Elementary School II of the José Nascimento da Silva Municipal School of Basic Education, in the municipality of Tavares-PB. The activities were carried out once a week, over six months, with the aim of making the teaching of Mathematics more dynamic, accessible and meaningful through playful and interactive practices.

The methodological proposal was based on bibliographic research and the analysis of academic articles, in addition to the guidelines of the National Common Curricular Base (BNCC), which reinforce the importance of pedagogical practices that stimulate logical reasoning, creativity and student protagonism. From this, activities were selected and applied that integrated the content of Mathematics into the daily lives of students, promoting the development of cognitive and socio-emotional skills. Among the activities applied, the following stand out: Mathematical Ludo, Monetary Quiz and Polygon Challenge.

According to Rêgo and Rêgo (2013), when well selected and used appropriately, the game can act as a highly effective pedagogical resource, contributing to the achievement of several educational objectives, including the development of students in the intellectual and emotional aspects.

The administration of the actions followed a schedule that included the survey of the class's curriculum, observation of classes, planning of the pedagogical proposal and

execution of activities in corregency. Four initial observation meetings were held to understand the profile of the class and identify its needs. Then, the other meetings took place on a co-ordination basis, with direct action in the mediation of activities.

The evaluation was carried out in a continuous and formative way, based on direct observations, participation records and self-evaluations of the students, allowing methodological adjustments according to the needs identified throughout the process. The results were systematized in partial reports and a final report and presented at AESET's Academic Week 2025.2, whose theme was "Education, health and society: meeting ancestral knowledge in the present and future that is built". The presentation highlighted the positive impact of the playful approach in the teaching of Mathematics.

The methodology applied proved to be effective in promoting a dynamic, collaborative learning environment aligned with the competencies provided for in the BNCC, contributing to the strengthening of students' cognitive and socio-emotional skills.

5 DEVELOPMENT

The project "Mathematical Challenges: Developing Logical Thinking with Games" was developed with the objective of transforming the teaching of Mathematics into a more dynamic, accessible and meaningful experience for elementary school students. The proposal arose from the need to face the recurring challenges in learning the subject, especially the lack of interest and difficulty in understanding by students.

The proposal is based on the perspective of the playful teaching of Mathematics, where games are used as pedagogical resources capable of stimulating cognitive skills, promoting socialization and awakening the pleasure for Mathematics. In this context, Recreational Mathematics contributes by presenting challenges, curiosities and riddles that make learning more engaging and creative, while Mathematical Modeling brings the contents closer to the students' reality, allowing everyday situations to be translated into mathematical language and explored in a meaningful way.

Authors such as Vygotsky, Grando and Kishimoto argue that playing is an essential activity for the intellectual and emotional development of students, favoring the construction of knowledge.

During the development of the project, four initial observation meetings were held, aimed at monitoring the classes of the head teacher, with the objective of understanding the profile of the class and identifying its main needs. Based on these observations, the subsequent meetings took place under a correction regime, with direct action in the mediation of the activities.

The pedagogical actions were organized around playful activities that explore mathematical content in a contextualized and interactive way. Among them, the following stand out:

- **Battleship Math:** An original adaptation of the classic game, created especially for this project. The objective was to work on concepts of space and location, multiplication and division operations, in addition to developing the agility of reasoning. The class was divided into two groups, and a draw defined which group started. A player would choose a location on the board (always in letter-number form, such as B7 or E9). Each position could have a mathematical calculation or a bomb. If the calculation was answered correctly within 30 seconds, the group gets 1 point. If they made a mistake or did not answer, the opposing team had a chance to respond and, if they got it right, they earned 2 points. This activity stimulated quick thinking, strategy and teamwork, making learning more engaging and competitive in a healthy way.

To facilitate the application in the classroom, the link for printing the game board is available, allowing the reader to have access to the material:

(https://www.canva.com/design/DAG97m3fa_o/pLRWRh0L5aMe7TYwXYjNww/edit?utm_content=DAG97m3fa_o&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton)

- **Ludo Mathematician:** Traditional game adapted to work on basic operations and solution strategies, promoting logical reasoning and decision-making. The original rules were kept – such as the advance of the piece according to the number drawn on the die and the objective of getting all the pieces to the base – however, for each move, the student needs to solve mathematical operations correctly to be able to move his piece. And when the calculation is solved incorrectly, the part remains at rest, where it does not advance.

The link for printing the board and the pieces used in the game is available, allowing readers to have access to the material in an organized way and that the activity can be reproduced in different school contexts.

(<https://drive.google.com/drive/folders/1m3-4uituDfeWHVSU6ykO8CdUKmadDv1?usp=sharing>)

- **Monetary Quiz:** The activity aimed to review the Brazilian monetary system through an individual quiz, whose central idea was to perform calculations involving money and commercial or economic situations. The questions were elaborated based on banknotes and coins applied in everyday contexts. This proposal enabled the application of mathematical knowledge in real contexts, favoring the development of

calculation and interpretation skills. To support the realization of the proposal, the link for printing the banknotes and coins used in the quiz is available, ensuring access to the material in an organized way and that the experience can be reproduced in different classes:

(https://www.canva.com/design/DAG97hyqS24/ovXw_k0ZZgX6e2vUbgYTEQ/edit?utm_content=DAG97hyqS24&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton)

- **Polygon Challenge:** the students used four triangular pieces of the same size, which are part of the tangram, to form geometric figures such as square, rectangle, triangle, parallelogram and trapezoid. The challenge was carried out in pairs, one student against the other, where a geometric shape was presented to be assembled, the student won the game by assembling the figure in less time and using all the pieces on display. This dynamic favored the development of agility, stimulation of spatial visualization, creativity, competition and recognition of geometric properties. To support the realization of the activity, the link for printing the polygons used in the game is available, allowing readers to have access to the pieces in a practical and organized way, ensuring the reproduction of the experience in different pedagogical contexts.

(<https://drive.google.com/drive/folders/15k85ho11cf60jQgVPFO9BLi1WA5sssbg?usp=sharing>)

All the playful activities developed throughout the project were created or adapted exclusively for this pedagogical proposal. The elaboration of each dynamic was based on the objectives of the project and the needs observed in the class, seeking to integrate the mathematical contents into the daily life of the students in a meaningful way. The adaptations and traditional games were strategically designed to stimulate logical reasoning, creativity, autonomy and student engagement. In addition, the activities have a replicable character, and can be applied in other classes of Elementary School II, with adjustments according to the level of learning and the profile of the students, applying their reach and pedagogical impact.

These activities were planned based on the principles of playfulness, which according to Grando (2007), is not limited to the use of manipulable materials, but involves the performance of actions that provide satisfaction and engagement. The BNCC (2018) also reinforces that resources such as educational games are essential for understanding mathematical objects and for developing skills such as critical thinking, problem solving, and argumentation.

The use of games in the teaching of Mathematics, far from being a waste of time, proves to be an effective and transformative pedagogical strategy. The project carried out demonstrated in practice how games can enhance the teaching and learning process.

The idea that games are just moments of distraction or pastime is deconstructed when one observes the positive impact they generate in the school environment. The games stimulate logical reasoning, concentration, creativity and the pleasure of learning Mathematics. In addition, they favor socialization, cooperation, and the development of cognitive and emotional skills.

The teacher, by incorporating games into the teaching process, assumes the role of mediator and advisor of learning. It not only organizes the activities but also creates an environment where students feel challenged and motivated to participate. The mediation of the learner is essential for games to go beyond the dimension of entertainment and become meaningful pedagogical experiences. As Vygotsky (1998) does, "learning awakens several internal developmental processes that can only occur when the individual interacts with other people", evidencing the importance of teacher intervention to increase the social and cognitive development of students.

In addition, the teacher plays a strategic role by selecting and adapting the games according to the learning objectives and the class profile. This pedagogical intentionality ensures that each dynamic is aligned with the curricular content and the needs of the students. In this way, the teacher acts as a protagonist in the construction of an innovative educational space, in which the pleasure of learning is combined with academic rigor, favoring both the intellectual and emotional development of students.

The BNCC and the National Curriculum Parameters (PCN) recognize games as essential didactic resources, as they allow the simulation of problem situations, encourage the development of strategies and promote meaningful learning. Authors such as Vygotsky (1989), Grando (2007) and Kishimoto (2012) reinforce that playing is an essential activity for social and intellectual development, thus creating a development zone where the student learns with more autonomy and engagement.

In addition to promoting the learning of the contents, the work focused on the development of socio-emotional skills and the appreciation of the students' experience as protagonists of the educational process. By experiencing the games in teams, the students were encouraged to make decisions, deal with mistakes, respect the rules and collaborate with their classmates - elements that go beyond Mathematics and collaborate for the integral formation as citizens.

In the teaching-learning process, error should be seen as an integral part of the construction of knowledge. When the teacher values the mistakes of students as opportunities for reflection, he creates an environment in which the student feels safe to take risks, experiment and learn without fear of judgment. This attitude favors autonomy and resilience, as the student begins to realize that making mistakes is a necessary step to achieve more consistent successes. As Borasi (1994) points out, "errors can be seen as starting points for new investigations and discoveries", reinforcing that error is not an obstacle, but a pedagogical resource.

In addition, the role of the teacher is essential in this process, since it is up to him to guide the student in the analysis of his mistakes and propose strategies to overcome them. The teacher acts as a mediator, helping to transform error into meaningful learning, stimulating critical thinking and the ability to revise. This approach helps students develop metacognition skills, learning to evaluate their own practices and seek creative solutions. In this way, the mistake is no longer a sign of disability and is recognized as a fundamental stage in the cognitive and emotional development of students.

Playfulness, in this context, was not treated as mere entertainment, but as a methodological strategy that favors the construction of knowledge. As Grando (2007) argues, the game is an activity that has value in itself, as it provides pleasure in the realization and spontaneous engagement. This perspective was incorporated into the project, which sought to create a light, challenging and meaningful learning environment.

Another differential was the flexibility of the activities developed, all of which have the potential to adapt to different levels of learning and age groups. The use of simple materials, clear rules and contexts close to the students' reality allows the games to be replicated in other classes, expanding their pedagogical reach.

During the meetings, it was observed that the students were motivated, as well as better participation and confidence when dealing with content. The playful approach contributed to reducing resistance to discipline, transforming the classroom environment into a space for dialogue, discovery and collective construction.

Paulo Freire (1996) states:

"Dialogue is the meeting of men, mediated by the world, to pronounce it, and is therefore not limited to the I-thou relationship. It is an act of creation. Dialogue is the encounter in which the reflection and action of its subjects are expressed in solidarity with the world that must be transformed and humanized. This encounter cannot be reduced to an act of depositing ideas from one subject to another, nor can it become a simple exchange of ideas to be consumed by the exchangers. It is an act of transformation and creation. Dialogue is an existential requirement. And if it is the

encounter in which reflection and action are solidarized, it cannot be reduced to an act of pure reflection, nor to an act of pure action, but is action and reflection."

The project reinforces that teaching Mathematics with games is not a waste of time, but an effective way to make the content more attractive, accessible, contextualized and pleasurable. By integrating theory and practice, emotion and logic, playful teaching proves to be a powerful and effective tool for transforming students' reality with Mathematics and with the very act of learning.

In this sense, we also have recreational mathematics that dialogues with playfulness, as it seeks to present mathematical content through challenges, curiosities, riddles and games that arouse the interest of students. Unlike the traditional view, in which Mathematics is perceived as abstract and rigid, Recreational Mathematics aims to transform learning into a pleasurable experience, bringing content closer to reality, stimulating students' creativity.

In this way, the games applied in the project not only fulfilled the function of reviewing or introducing concepts, but also aligned with the spirit of Recreational Mathematics, by proposing challenging situations that required logical reasoning, decision-making and cooperation among the participants. Each activity was planned so that the student learned while having fun, not perceiving Mathematics as an obligation, but as an engaging and meaningful practice.

Recreational Mathematics, when articulated with games, favors the development of skills such as: problem solving, logical reasoning, socialization, cooperation, autonomy and protagonism. This approach demonstrates that Mathematics can be taught in a light and pleasant way, without losing its conceptual depth. By uniting playfulness and Recreational Mathematics, the project demonstrated that it is possible to transform the classroom into an environment of dialogue, discovery and motivation, where learning becomes an engaging and meaningful experience.

Mathematical Modeling is a contemporary trend in Mathematics Education that seeks to bring the studied theme closer to the reality of students. It consists of translating everyday situations into mathematical language, allowing students to build models that represent and explain phenomena, favoring analysis, prediction, and decision-making. In this context, modeling is not limited to the use of ready-made formulas or calculations, but involves the creation of strategies and representations that make learning more meaningful.

In the project, this trend of teaching Mathematics was explicitly present in several activities carried out. The Monetary Quiz, for example, led students to model buying and selling situations, using calculations with banknotes and coins to solve practical problems.

The Polygon Challenge, using tangram, stimulated spatial visualization and the construction of geometric models, favoring the understanding of the properties of the figures.

In the Mathematical Battleship, it is also related to modeling, as it required students to interpret the space of the board, locate coordinates and solve multiplication and division calculations in limited time. This activity promoted the construction of strategic game models, in which students needed to plan their actions and predict possible results.

In this way, Mathematical Modeling, when integrated with playful practices, reinforces the contextualized character of teaching. The students not only solved exercises, but also experienced simulated daily situations, developing skills such as logical and critical reasoning, the ability to abstract, autonomy and interdisciplinarity.

This approach demonstrates that this tendency, combined with playfulness, is not an isolated practice, but a methodological strategy that expands the pedagogical reach of games. By integrating theory and practice, the project demonstrated that it is possible to transform the teaching of Mathematics into something attractive, engaging, effective and easy to understand, as well as into a living tool, capable of dialoguing with the reality of students.

The use of games in the teaching of Mathematics should not be visited as a secondary practice or as mere entertainment, but as a methodological strategy that favors the construction of knowledge. According to Grando (2007), "the game is much more than a simple manipulable material. It corresponds to what we call playful activity." This perspective was incorporated into the project, which sought to create a light, challenging and meaningful learning environment, in which students could learn in a pleasant and engaged way.

Recreational Mathematics was also present in the proposed activities, because, according to Borin (2004, p. 89), "the use of games in Mathematics classes is an important factor that contributes to reducing the blocks presented by many students who fear Mathematics and feel incapable of learning it." By transforming so-called abstract content into practical and fun challenges, the games allowed students to spontaneously engage with the discipline, developing logical reasoning, creativity and autonomy.

Another important aspect was the use of Mathematical Modeling for playful practices. According to Smole, Diniz and Milani (2007), games can be used as problem-solving instruments, because "the possibility of using games is related to learning, to the very construction of mathematical knowledge, therefore, to problem solving". In the project developed, the activities allowed everyday situations to be translated into mathematical language and explored in a meaningful way.

Playfulness, in this context, was not treated as mere entertainment, but as a methodological strategy that favors the construction of knowledge. As Vygotsky (1989, p.

130) points out, "play creates for children a zone of proximal development that is nothing other than the distance between the current level of development [...] and the level of potential development". This view reinforces that games, when applied in the classroom, expand learning possibilities, allowing students to advance in their knowledge with the support of colleagues and teachers.

In addition, the BNCC (2018, p. 218) advises that "didactic resources such as checkered meshes, abacuses, games, books, videos, calculators, electronic spreadsheets, and dynamic geometry software play an essential role in the compression and use of mathematical notions". This guideline legitimizes the use of games as pedagogical tools, recognizing their importance for the development of skills such as critical thinking, problem solving, and argumentation.

During the project meetings, it was observed that the students were more participative, motivated and confident when dealing with the proposed contents. The playful methodology helped to reduce resistance to discipline, transforming the classroom environment into a space for dialogue, discovery and construction. Freire (1996, p. 86) states that "the good teacher is the one who manages, while speaking, to bring the student to the intimacy of the movement of his thought".

In this context, games have become tools that have brought students closer to the discipline, making the teaching and learning process more meaningful and human. The flexibility of the activities carried out reinforces the innovative character of the project, which can serve as an inspiration for future practices in different school contexts.

Therefore, the project reaffirms that teaching Mathematics with games is not a waste of time, but an effective way to make the content more attractive, accessible, contextualized and pleasurable.

6 FINAL CONSIDERATIONS

The development of the project highlighted the potential of innovative pedagogical practices that incorporate games as methodological instruments in the teaching of Mathematics. The experience demonstrated that playfulness, Recreational Mathematics and Mathematical Modeling can be effectively integrated, contributing to a more dynamic, attractive and meaningful teaching and learning process, regardless of the students' learning level.

Despite the advances, it is important to emphasize that the use of games is not yet a widely disseminated pedagogical practice in Brazilian schools. As Batista, Soares, and Bezerra (2023) point out, even with the existence of accessible materials, such as software

and low-cost games, many institutions still do not systematically incorporate playfulness into their pedagogical practices. This reveals the need for greater investment in teacher training and in projects that encourage the use of innovative methodologies.

It is concluded, therefore, that the teaching of Mathematics through games is an effective and necessary strategy to transform the relationship of students with the discipline. The project demonstrated that it is possible to make learning more pleasurable, contextualized and meaningful, contributing to the integral formation of students.

It is hoped that this work will inspire teachers and researchers to reflect on the relevance of games in the teaching of Mathematics, expanding their use in different school contexts. More than an isolated practice, games should be understood as an integral part of school culture, capable of promoting not only the learning of content, but also the development of cognitive, social and emotional skills that are fundamental for life in society.

REFERENCES

- Batista, M. C. de L., Soares, Y. G. B., & Bezerra, M. da C. A. (2024). A importância dos jogos no ensino de Matemática. *Revista da UNEB*. <https://www.revistas.uneb.br/index.php/elem/article/download/18587/12349/58073>
- Bezerra, M. da C. A. (2023). Concepções, aspectos e principais tarefas da Matemática Recreativa. *Revista Hipátia*. <https://ojs.ifsp.edu.br/index.php/hipatia/article/download/1941/1428/10536>
- Borasi, R. (1994). *Reconceiving mathematics instruction: A focus on errors*. Ablex Publishing.
- Borin, J. (2024). Jogos matemáticos no ensino fundamental: Uma pesquisa bibliográfica para diagnóstico. In *Anais do ENSIPEX 2024*. <https://ime.events/ensipex2024/pdf/29340>
- Brasil. Ministério da Educação. (2018). *Base Nacional Comum Curricular*. <http://basenacionalcomum.mec.gov.br/>
- Freire, P. (1996). *Pedagogia da autonomia: Saberes necessários à prática educativa*. Paz e Terra.
- Grando, R. C., Krichof Laurent, A. A. von, Santos, R. S. dos, & Grillo, R. de M. (2024). A matemática possível nos jogos na educação infantil. *Linha Mestra*, 18(54), 56–74. <https://doi.org/10.34112/1980-9026a2024n54p56-74>
- Kishimoto, T. M. (2012). *O jogo e a educação infantil*. Pioneira.
- Magina, S. M. P. (2023). Modelagem Matemática como estratégia de ensino-aprendizagem da Matemática. In *Anais do XI ENEM. Sociedade Brasileira de Educação Matemática*. https://www.sbembrasil.org.br/files/XIENEM/pdf/511_1781_ID.pdf
- Rêgo, R. M., & Rêgo, R. M. (2013). *Jogos e resolução de problemas: Uma proposta para o ensino de matemática*. Editora Universitária/UFPB.

- Smole, K. S., Diniz, M. I., & Milani, E. (2007). Jogos de matemática do 6º ao 9º ano. Artmed.
- Vergara, C. R. G., & Martínez, F. E. B. (2020). Matemática Recreativa: Uma proposta para sala de aula. Associação Nacional dos Professores de Matemática na Educação Básica. <https://anpmat.org.br/wp-content/uploads/2021/01/Matematica-Recreativa-Uma-Proposta-para-Sala-de-Aula.pdf>
- Vygotsky, L. S. (1989). A formação social da mente. Martins Fontes.

BIOSTIMULANTS, PLANT GROWTH REGULATORS, AND MICROORGANISMS IN IRRIGATED AGRICULTURE OF THE MIDDLE SAN FRANCISCO VALLEY: A REVIEW BASED ON DISSERTATIONS FROM 2015 TO 2024

BIOESTIMULANTES FITORREGULADORES E MICROORGANISMOS NA AGRICULTURA IRRIGADA DO SUBMÉDIO DO VALE DO SÃO FRANCISCO: UMA REVISÃO BASEADA EM DISSERTAÇÕES DE 2015 A 2024

BIOESTIMULANTES, REGULADORES DEL CRECIMIENTO VEGETAL Y MICROORGANISMOS EN LA AGRICULTURA DE RIEGO DEL VALLE MEDIO DEL SAN FRANCISCO: UNA REVISIÓN BASADA EN TESIS DE 2015 A 2024



<https://doi.org/10.56238/sevened2026.008-061>

Marcelo da Silva Martins¹, Susana Zapata Garcia², Laíres Sale Reis³, Nicolly Quirino Barros Vieira⁴, William Ralf Santos Costa⁵, Wiltemberg de Brito Pereira⁶, Jadson Miranda Oliveira⁷, Roberval Oliveira da Silva⁸

ABSTRACT

The Middle São Francisco Valley is one of the main hubs of irrigated agriculture in Brazil, where technologies involving biostimulants, plant growth regulators, and microorganisms have been extensively studied with the aim of providing physiological support to crops, mitigating abiotic stresses, and promoting increases in yield and quality. This review aimed to analyze the published literature between 2015 and 2024, on the use of biostimulants, plant growth regulators, and microorganisms in irrigated agriculture in the São Francisco Valley, focusing on master's dissertations from the graduate programs in Irrigated Horticulture (PPGHI – UNEB), Plant Production (PPGPV – UNIVASF), and Agricultural Engineering (PPGEA – UNIVASF). The review was conducted using dissertations available in the universities' databases. For the selection of the works, specific filters were applied in each graduate program, considering the publication period (2015–2024) and the keywords (i) biostimulants, (ii) plant growth regulators, and (iii) microorganisms. Next, the dissertations

¹ Doctoral student in Agricultural Engineering. Universidade Federal do Recôncavo da Bahia (UFRB). Brazil. E-mail: marcelomartinsag1212@gmail.com Orcid: <https://orcid.org/0000-0002-6933-4303>

² Dr. in advanced agri-food research and development. Universidade Politécnica de Cartagena (UPCT). Spain. E-mail: susana.zapata@upct.es Orcid: <https://orcid.org/0000-0003-0102-4314>

³ Master's student in Irrigated Horticulture. Universidade Estadual da Bahia (UNEB). Brazil. E-mail: proflaíres@gmail.com Orcid: <https://orcid.org/0000-0001-8536-277X>

⁴ Master's degree in Agricultural Engineering. Universidade Federal do Vale do São Francisco (UNIVASF). Brazil. E-mail: nicollyqbv@gmail.com Orcid: <https://orcid.org/0000-0002-9651-2443>

⁵ Master's degree in Agricultural Engineering. Universidade Federal do Vale do São Francisco (UNIVASF). Brazil. E-mail: ralfw20@gmail.com Orcid: <https://orcid.org/0000-0002-6609-0980>

⁶ Master's degree in Agricultural Engineering. Universidade Federal do Vale do São Francisco (UNIVASF). Brazil. E-mail: berg4712wbp@gmail.com Orcid: <https://orcid.org/0009-0002-9492-6930>

⁷ Doctoral student in Agricultural Engineering. Universidade Federal do Recôncavo da Bahia (UFRB). Brazil. E-mail: jacojmo@hotmail.com Orcid: <https://orcid.org/0000-0002-6933-4303>

⁸ Doctoral student in Agricultural Engineering. Universidade Federal do Recôncavo da Bahia (UFRB). Brazil. E-mail: robervalos.eng@gmail.com Orcid: <https://orcid.org/0009-0007-6793-8801>

were read and classified by year and by program, along with the identification of the topics addressed and the synthesis of the main results, as well as the most studied crops. The PPGHI – UNEB had the highest number of studies involving microorganisms, while the PPGEA and PPGPV programs at UNIVASF produced more research related to biostimulants and plant growth regulators. During the analyzed period, the most studied/researched crops were mango, melon, and grape. All programs in partnership with EMBRAPA company carried out outstanding work on this topic, contributing significantly to the scientific and technological advancement of irrigated agriculture in the region.

Keywords: Abiotic Stress. Fruit Growing. Physiological Support. Agricultural Production. Brazilian Semi-Arid.

RESUMO

O Submédio do Vale do São Francisco constitui um dos principais polos de agricultura irrigada do Brasil, no qual tecnologias baseadas em bioestimulantes, fitorreguladores e microrganismos têm sido amplamente investigadas com o propósito de oferecer suporte fisiológico aos cultivos, mitigar estresses abióticos e promover incrementos na produção e na qualidade. O objetivo deste trabalho foi realizar uma revisão de literatura, referente ao período de 2015 a 2024, sobre o uso de bioestimulantes, fitorreguladores e microrganismos na agricultura irrigada do Vale do São Francisco, com base em dissertações de mestrado dos programas de pós-graduação em Horticultura Irrigada (PPGHI – UNEB), Produção Vegetal (PPGPV – UNIVASF) e Engenharia Agrícola (PPGEA – UNIVASF). A revisão foi conduzida a partir de dissertações disponíveis nas bases de dados das universidades. Para a seleção dos trabalhos, aplicaram-se filtros específicos em cada programa de pós-graduação, considerando o período de publicação (2015–2024) e os termos (i) bioestimulantes, (ii) fitorreguladores e (iii) microrganismos. Em seguida, procedeu-se à leitura e à quantificação das dissertações por ano e por programa, bem como à identificação dos temas abordados e à síntese dos principais resultados e aos cultivos mais estudados. O PPGHI – UNEB apresentou maior número de trabalhos envolvendo microrganismos, enquanto os programas PPGEA e PPGPV da UNIVASF produziram mais trabalhos relacionados a bioestimulantes e fitorreguladores. Para o período analisado, os cultivos mais estudados foram manga, melão e uvas. Todos os programas em parceria com EMBRAPA apresentaram excelentes trabalhos na temática, contribuindo significativamente para o avanço científico e tecnológico da agricultura irrigada na região.

Palavras-chave: Estresse Abiótico. Fruticultura. Suporte Fisiológico. Produção Agrícola. Semiárido Brasileiro.

RESUMEN

El Valle Medio del São Francisco constituye uno de los principales polos de agricultura de riego en Brasil, donde las tecnologías basadas en bioestimulantes, reguladores del crecimiento vegetal y microorganismos han sido ampliamente investigadas con el propósito de ofrecer soporte fisiológico a los cultivos, mitigar los estreses abióticos y promover incrementos en la producción y la calidad. El objetivo de este trabajo fue realizar una revisión de la literatura, referente al período de 2015 a 2024, sobre el uso de bioestimulantes, reguladores del crecimiento vegetal y microorganismos en la agricultura de riego del Valle del São Francisco, basada en disertaciones de maestría de los programas de posgrado en Horticultura de Riego (PPGHI – UNEB), Producción Vegetal (PPGPV – UNIVASF) e Ingeniería Agrícola (PPGEA – UNIVASF). La revisión se llevó a cabo a partir de tesis disponibles en las bases de datos de las universidades. Para la selección de los trabajos, se aplicaron filtros 2 específicos en cada programa de posgrado, considerando el período de publicación (2015–2024) y los términos (i) bioestimulantes, (ii) fitorreguladores

y (iii) microorganismos. A continuación, se procedió a la lectura y cuantificación de las disertaciones por año y por programa, junto con la identificación de los temas abordados y la síntesis de los principales resultados, además de los cultivos más estudiados. El PPGHI – UNEB presentó el mayor número de trabajos relacionados con microorganismos, mientras que los programas PPGEA y PPGPV de la UNIVASF produjeron más investigaciones relacionadas con bioestimulantes y fitorreguladores. Durante el período analizado, los cultivos más investigados fueron mango, melón y uva. Todos los programas en colaboración con EMBRAPA desarrollaron excelentes trabajos en la temática, contribuyendo significativamente al avance científico y tecnológico de la agricultura irrigada en la región.

Palabras clave: Estrés Abiótico. Fruticultura. Soporte Fisiológico. Producción Agrícola. Semiárido Brasileño.

1 INTRODUCTION

The Submiddle São Francisco Valley (SVSF) is one of the main irrigated agricultural hubs in Brazil, with emphasis on the production of irrigated fruits (Baiardi et al., 2023). The SVSF region comprises the municipalities of Petrolina, Lagoa Grande, Santa Maria da Boa Vista, Orocó, and Cabrobó in the state of Pernambuco, as well as Juazeiro, Casa Nova, Sobradinho, Curaçá, and Abaré in the state of Bahia, all of which are located within the Brazilian semi-arid region (Gondim et al., 2013). In this region, several irrigation methods are used; however, localized irrigation systems, represented mainly by drip and micro-sprinkler irrigation, predominate. According to Frizzone (2012), these methods are considered the most efficient in irrigated agriculture.

The adoption of localized irrigation is frequently associated with fertigation practices, allowing the application of different inputs throughout the crop cycle. In this context, the use of biostimulants that include plant extracts, seaweed extracts, humic and fulvic acids, biofertilizers; plant growth regulators, such as auxins, gibberellins, cytokinins, ethylene, paclobutrazol, salicylic acid, and ascorbic acid, as well as beneficial microorganisms - bacteria and fungi -, has intensified, as reported in previous studies (Melo, 2017; Aguiar, 2018; Lordêlo, 2019; Nascimento, 2019; Leal, 2023; Almeida, 2024). These products can be applied via fertigation, foliar spraying, or seed inoculation and are used as management strategies aimed at increasing productivity, improving fruit quality, and mitigating abiotic stresses, especially water deficit (Pais, 2016; Ferreira, 2019; Bezerra, 2020; Vargens, 2022; Martins et al., 2023; Silva, 2024).

The topic related to the use of biostimulants, plant growth regulators, and microorganisms has been widely discussed in the academic environment of the São Francisco Valley, particularly through master's dissertations developed in graduate programs focused on irrigated agriculture in the region. These include the Graduate Program in Irrigated Horticulture (PPGHI – UNEB), at the Juazeiro-BA 3 campus; the Graduate Program in Plant Production (PPGPV – UNIVASF), at the Petrolina-PE campus; and the Graduate Program in Agricultural Engineering (PPGEA – UNIVASF), at the Juazeiro-BA campus. These programs, often in partnership with Embrapa Semi-Arid, have significantly contributed to the development of technologies and strategies aimed at increasing production efficiency and sustainability of irrigated agricultural systems in the region.

In this context, the objective of this study was to conduct a literature review covering the period from 2015 to 2024 on the use of biostimulants, plant growth regulators, and microorganisms in irrigated agriculture in the São Francisco Valley, based on master's

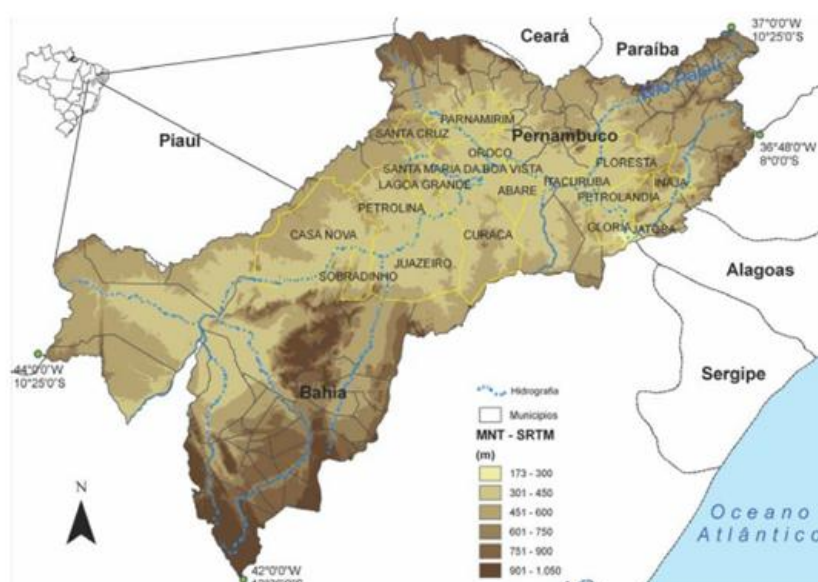
dissertations from the graduate programs in Irrigated Horticulture (PPGHI – UNEB), Plant Production (PPGPV – UNIVASF), and Agricultural Engineering (PPGEA – UNIVASF).

2 MATERIALS AND METHODS

The study consists of a literature review on the use of biostimulants, plant growth regulators, and microorganisms in irrigated agriculture in the Middle-Low São Francisco Valley, covering the period from 2015 to 2024. The region has an average altitude of 402 m and is located across municipalities in the states of Pernambuco and Bahia (Figure 1).

Figure 1

Location of the Middle-Low São Francisco Valley in the states of Pernambuco and Bahia



Source: Gondim et al., 2013.

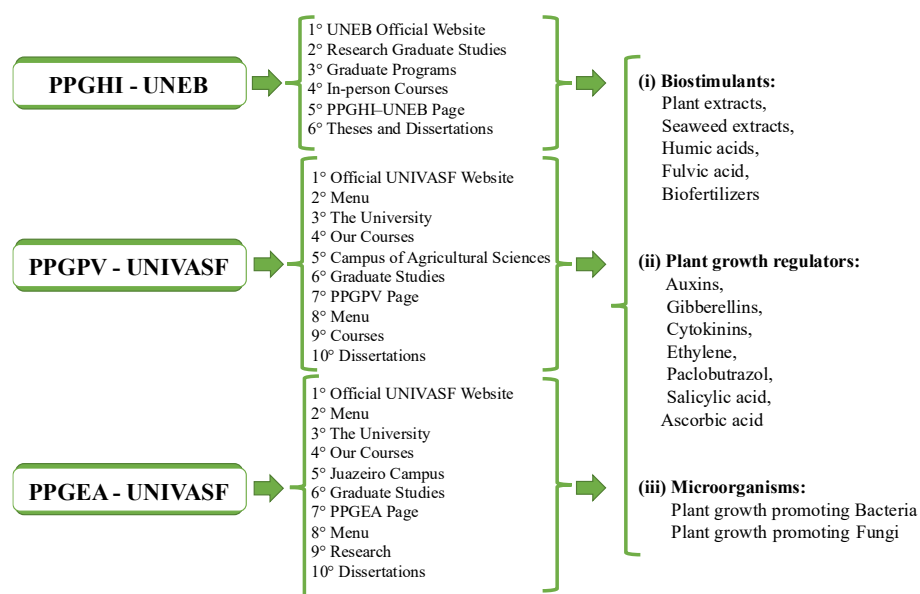
The research included theses from three *stricto sensu* graduate programs: Irrigated Horticulture (PPGHI – UNEB), at the Juazeiro-BA campus; Plant Production (PPGPV – UNIVASF), at the 4 Petrolina-PE campus; and Agricultural Engineering (PPGEA – UNIVASF), at the Juazeiro-BA campus. According to the Köppen classification, the Middle-Low São Francisco Valley falls under the BSh type, characterized as a semi-arid climate. The region has an average annual temperature of 26.0 °C and an average annual precipitation of approximately 500 mm, concentrated between January and April, with a relative humidity of around 66% (Leão et al., 2020).

The Middle-Low São Francisco Valley is one of the main hubs of irrigated agriculture in the country, and institutions such as UNEB and UNIVASF have been conducting relevant research on the application of biostimulants, plant growth regulators, and microorganisms

associated with agricultural production. For the construction of the review, data were obtained from the institutional repositories of the three aforementioned programs: Irrigated Horticulture (<https://ppghi.uneb.br/b>); Plant Production (<https://producaovegetal.univasf.edu.br/>); and Agricultural Engineering (<https://portais.univasf.edu.br/ppgea>). Accessed between (February 2, 2025 and December 28, 2025). The search considered terms related to the main groups of interest, applying specific filters for each set of terms, allowing the identification of theses that directly addressed the research topic: (i) Biostimulants: plant extracts, seaweed extracts, humic acids, fulvic acid, and biofertilizers; (ii) Plant Growth Regulators: auxins, gibberellins, cytokinins, ethylene, paclobutrazol, salicylic acid, and ascorbic acid; (iii) Microorganisms: plant growth-promoting bacteria and fungi. This process is summarized in the flowchart presented in Figure 2.

Figure 2

Flowchart of the thesis search process and categorization by biostimulants, plant growth regulators, and microorganisms in the graduate programs of UNEB and UNIVASF



Source: Prepared by the authors.

The initial selection the theses published were classified by year and program, along with the distribution of topics (biostimulants, plant growth regulators, and microorganisms) and the agricultural crops evaluated. Subsequently, the abstracts were read, followed by the full text, with the aim of identifying: the crop studied; the type of product applied (biostimulant, plant growth regulator, or microbial inoculant); the experimental conditions (field, nursery, or greenhouse); the application method (soil, foliar, or inoculation); and the main agronomic

effects observed.

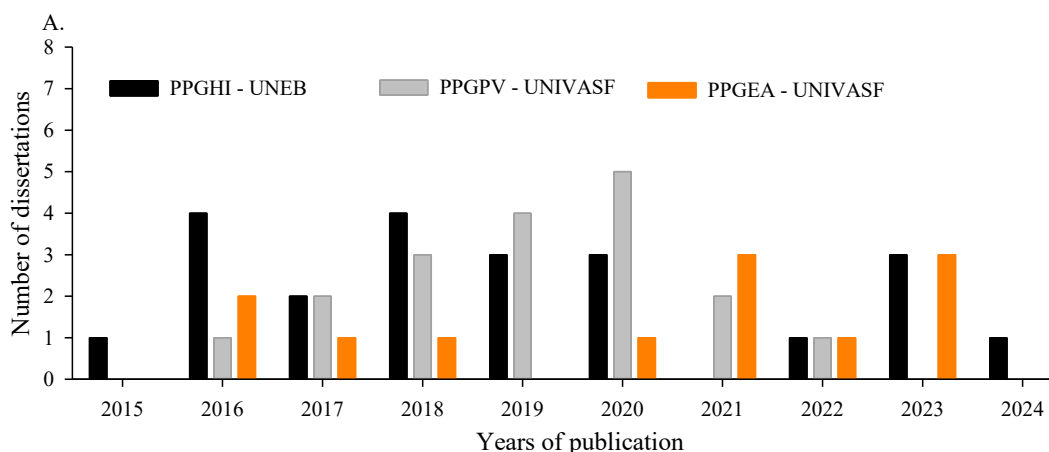
3 RESULTS AND DISCUSSION

The yearly distribution of the dissertations presented in Figure 3 shows that the PPGHI–UNEB exhibits greater regularity in the production of dissertations related to the use of biostimulants, plant growth regulators, and agricultural microorganisms between 2015 and 2023. An annual pattern of consistency is observed, with emphasis on 2016 and 2018, years in which the program reached four defended dissertations, in addition to its performance in 2023, with three dissertations. This continuity indicates that PPGHI–UNEB has played a key role in consolidating research involving bio-inputs in the region, especially in the early years of the historical series, acting as a driver for thematic maintenance and expansion.

PPGPV–UNIVASF showed a productivity pattern concentrated in specific periods (Figure 3). After an incipient output in 2016, the program reached its peak in 2019 and 2020, with four 6 dissertations each year. This interval represented the period of greatest contribution from PPGPV to the topic. From 2021 onward, a marked reduction in output was observed, with only one dissertation defended in that year and none in the subsequent years. This scenario may have been associated with the indirect effects of the COVID-19 pandemic, including difficulties in establishing field experiments and psychological impacts resulting from social isolation, as reported by Francisco et al. (2021) in a study involving with 200 students from different graduate programs at several Brazilian universities.

Figure 3

Number of dissertations published per year related to the use of biostimulants, plant growth regulators, and microorganisms in the graduate programs in Irrigated Horticulture (PPGHI–UNEB), Plant Production (PPGPV UNIVASF), and Agricultural Engineering (PPGEA–UNIVASF), from 2015 to 2024



Source: Prepared by the authors. Data from the graduate programs at UNEB and UNIVASF.

PPGEA–UNIVASF differs from the previous programs, showing later but consistent growth (Figure 3). After an initial phase of low output between 2016 and 2020, the program shows a significant increase in 2021 and 2023, with three dissertations in each year. This pattern indicates a growing interest within Agricultural Engineering in research involving bio-inputs, likely associated with the program's direct interface with irrigation technologies, water management, abiotic stress, and precision agriculture. É importante destacar a contribuição da EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária), responsável por 30% das dissertações do PPGEA–UNIVASF avaliadas neste estudo, fornecendo infraestrutura experimental e suporte científico qualificado, com orientação e coorientação de seus pesquisadores.

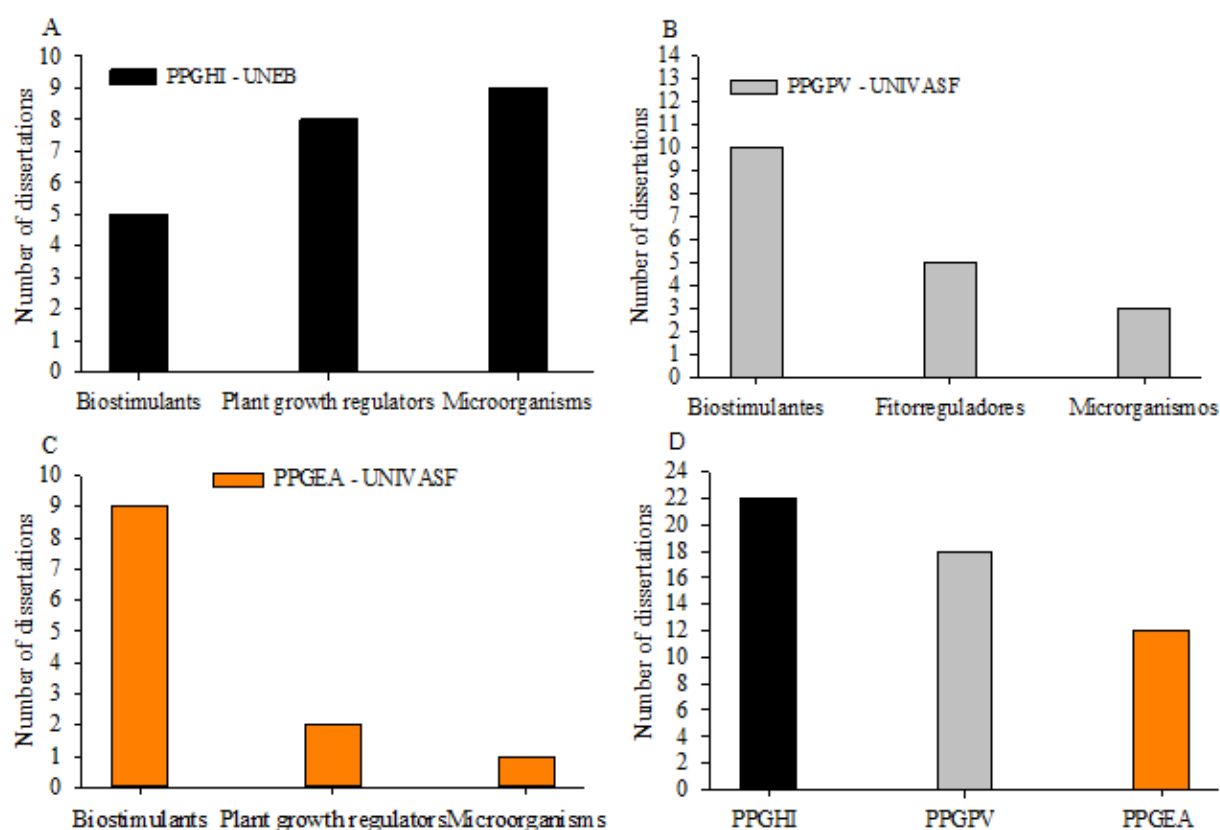
Regarding the number of studies according to the topics biostimulants, plant growth regulators, and microorganisms for PPGHI–UNEB (Figure 4A), there is a predominance of dissertations related to microorganisms, followed by plant growth regulators and biostimulants. This pattern demonstrates the strong connection of the program with research on agricultural microbiology applied to irrigation, particularly in strategic crops of the Sub-middle São Francisco Valley (SVSF). The balanced presence among the three categories illustrates the diversification of research lines and the program's ability to meet heterogeneous demands of the regional production sector.

In the PPGPV–UNIVASF (Figure 4B), a predominance of studies related to biostimulants is observed, due to the prominent role of the Research Group on Fruit Crops

in the São Francisco Valley (FRUTIVASF), which is recognized for conducting experiments in collaboration with companies from the mango production sector. According to De Fátima et al. (2024), the Northeast region of Brazil, represented by the São Francisco Valley, recorded a 15% increase in the area cultivated with mango between 2012 and 2021, according to data from the Brazilian Institute of Geography and Statistics (IBGE, 2024). In this context, the increase in the area cultivated with mango may have contributed to the high number of dissertations on this topic, since mango cultivation shows extensive use of plant growth regulators and biostimulants in the São Francisco Valley, as highlighted by Lobo (2018), Cunha (2019), Silva (2019), Carreiro (2020), Mudo (2020), and Martins et al. (2024).

Figure 4

Number of dissertations published related to the use of biostimulants, plant growth regulators, and microorganisms in the graduate programs: A. Irrigated Horticulture (PPGHI–UNEB), B. Plant Production (PPGPV UNIVASF), C. Agricultural Engineering (PPGEA–UNIVASF), and from 2015 to 2024



Source: Prepared by the authors. Data from the graduate programs at UNEB and UNIVASF.

In the PPGEA–UNIVASF, biostimulants accounted for the majority of research, with nine dissertations, followed by two on plant growth regulators and only one on microorganisms (Figure 4C). This profile highlighted the program's alignment with irrigation

management strategies based on the use of biostimulants to mitigate water deficit and increase the production of irrigated fruit and vegetable crops in the São Francisco Valley, as evidenced by the effects of humic and fulvic acids and seaweed extracts on mango trees (Martins, 2023; Araújo, 2022) and of nanoparticles and biofertilizers on watermelon and melon (Barros, 2023; Leite, 2021; Silva, 2016).

The overall synthesis shows that PPGHI–UNEB leads scientific production in the topic, with 22 dissertations, followed by PPGPV–UNIVASF with 18 and PPGEA–UNIVASF with 12 (Figure 4D). The observed differences reflect not only the level of program consolidation but also their scientific vocations, institutional collaboration capacity, and stability of research lines over time. The higher number of dissertations in PPGHI–UNEB may be associated with the fact that the program is older compared to the UNIVASF programs, possessing greater experience and organizational structure. This maturity supports a higher number of students and faculty advisors, enabling greater academic output.

The studies conducted between 2015 and 2024 by PPGHI–UNEB involving biostimulants focused mainly on grape, onion, watermelon, and melon crops, carried out under field conditions and in protected environments (Table 1). The application of polyamines to ‘Thompson Seedless’ grapes resulted in a significant increase in berry growth, while the marine calcareous seaweed extract *Lithothamnium* promoted yield gains in ‘BRS Vitória’ grapes (Loredelo, 2019; Aguiar, 2018). The use of biofertilizers favored vegetative development, production, and total yield of onion (Almeida, 2024), in addition to enhancing gas exchange and biochemical parameters in organically grown watermelon (Ramos, 2020). For ‘old Mine’ melon, substrate-applied biostimulants did not produce statistically significant effects on the evaluated variables (Campos, 2018).

Regarding plant growth regulators, the dissertations from PPGHI–UNEB focused mainly on mango, grape, onion, and tomato crops. The application of cytokinins and gibberellins (BAP and A₃) to ‘Tommy Atkins’ mango increased fruit number and growth (Bezerra, 2020). The use of paclobutrazol, applied both via soil and fertigation, increased production and fruit number per plant in different mango cultivars, demonstrating efficiency in controlling vegetative growth and inducing flowering (Ferreira, 2019; Santos, 2017a; Souza, 2016a). In ‘BRS Vitória’ grapes, salicylic acid improved leaf development and biomass accumulation (Gomes, 2023). In the grape rootstocks ‘Paulsen 1103’ and ‘SO4’, the application of kinetin, gibberellic acid, and IBA significantly increased rooting and sprouting percentages (Moraes, 2018). In ‘Regent’ onion, plant growth regulators increased aerial and root biomass production (Fonseca, 2015), while in ‘uba’ tomato, the application

of IBA, A₃, and kinetin enhanced stem growth and seedling root development (Oliveira, 2016), as it has been summarized in Table 1.

The dissertations from PPGHI–UNEB involving microorganisms focused mainly on cowpea (Leal, 2023; Nascimento, 2019; Sena, 2018; Souza, 2016b), melon (Melo, 2017), watermelon (Araújo, 2023), papaya (Vargens, 2022), and gerbera (Pais, 2016), conducted mostly under greenhouse and laboratory conditions (Table 1). The microorganisms evaluated included arbuscular mycorrhizal fungi (AMF) and bacteria belonging to the genera *Bradyrhizobium* and *Bacillus*, as well as isolates of *Pseudomonas*, *Burkholderia*, and *Paraburkholderia*, applied predominantly via seed inoculation or substrate incorporation, aiming to optimize the physiological performance of crops.

Table 1

Dissertations from the PPGHI–UNEB involving major crops, cultivation conditions, application methods, and the effects of biostimulants, plant growth regulators, and microorganisms from 2015 to 2024.

BIOSTIMULANTS					
Crop	Description of the Biostimulants	Growing Conditions	Application Method	Effects and Plant Performance	References
Grape 'Thompson Seedless'	Polyamines	Field	Foliar	The mixture of putrescine, spermidine, and spermine promoted greater berry growth.	Lordêlo, (2019)
Grape 'BRS Vitória'	Seaweed extract	Field	Fertigation and foliar	The doses of 18 and 35 kg ha ⁻¹ provided increases in yield per plant and, consequently, in productivity.	Aguiar, (2018)
Onion 'IPA-11'	Biofertilizers	Field	Soil	Better vegetative development, yield, and total bulb productivity.	Almeida, (2024)
Watermelon	Biofertilizers	Field	ND	Gas exchange and biochemical parameters were increased at 30 and 45.	Ramos (2020)
Melon 'Gold Mine'	Biostimulants	Greenhouse	Substrate	The biofertilizer did not show significant effects on	Campos, (2018)

the evaluated
characteristics.

PLANT GROWTH REGULATORS

Crop	Description of Plant Growth Regulators	Growing Conditions	Application Method	Effects and Plant Performance	References
Mango 'Tommy Atkins'	Cytokinins, and Gibberellins BAP and GA3	Field	Foliar	It promoted an increase in the number and growth of fruits per plant in mango.	Bezerra, (2020)
Mango 'Tommy Atkins'	Paclobutrazol	Field	Fertigation and soil	The increase in paclobutrazol doses applied via the irrigation system reduced gas exchange in mango.	Ferreira, (2019)
Mango 'Kent'	Paclobutrazol	Field	Soil	Applications promoted increases in panicle formation and in the number of fruits per plant.	Santos, (2017a)
Mango 'Palmer'	Paclobutrazol	Field	Fertigation and soil	Application via the irrigation system promoted a greater number of fruits per plant and higher productivity.	Souza, (2016a)
Grape 'BRS Vitória'	Salicylic acid	Greenhouse	Foliar	Salicylic acid doses promoted leaf development with a lower volume of water applied.	Gomes, (2023)
Grape - porta-enxerto 'Paulsen 1103' e 'SO4'	Kinetin, gibberellic acid, 4-indole-3-butyric acid (IBA)	Greenhouse	ND	The best results were observed in cuttings not treated with plant growth regulators (IBA), with a higher percentage of rooting and sprouting.	Moraes, (2018)
Onion 'Regent'	Cytokinin, Auxin, Gibberellin	Field	Foliar	Application of pyraclostrobin and boscalid provided a greater increase in biomass compared to the control treatments.	Fonseca, (2015)

Tomato 'Italiano Tyna'	IBA, GA3, kinetin	Laboratory	Seed	It favored an increase in stem diameter of seedlings and fresh root mass of seedlings	Oliveira, (2016)
------------------------------	-------------------	------------	------	---	------------------

MICROORGANISMS

Crop	Description of Microorganisms	Growing Conditions	Application Method	Effects and Plant Performance	References
Yellow Melon	Arbuscular mycorrhizal fungi	Greenhouse	Inoculated on the seed	Mitigating the negative effect of water deficit.	Melo, (2017)
Cowpea	Mycorrhizal fungi and Rhizobium	Greenhouse	Inoculated on the seed	The addition of multiple microorganisms proved to be beneficial for the development of cowpea.	Leal, (2023)
Cowpea	Bradyrhizobium spp., BR 3262	Laboratory	Inoculated on the seed	The co-inoculation of Bradyrhizobium spp. isolates with BR3262 proved to be a beneficial practice for cowpea plants.	Nascimento, (2019)
Cowpea	Bradyrhizobium bacteria	Laboratory	Inoculated on the seed	It was possible to identify isolates with high symbiotic efficiency and the ability to tolerate 3% NaCl, acidic and alkaline pH.	Sena, (2018)
Cowpea	Bradyrhizobium spp.	Greenhouse	Inoculated on the seed	The inoculation of diazotrophic bacteria improved gas exchange in cowpea.	Souza, (2016b)
Watermelon	Bacillus spp.	Greenhouse	ND	The MIX of bacteria increased gas exchange at the 40% moisture level and maximized root length and volume.	Araújo, (2023)
Papaya	Mycorrhizal fungi	Greenhouse	Inoculated on the seed	The use of AMF promoted greater seedling development in both papaya hybrids.	Vargens, (2022)
Gerbera	Bacteria	Greenhouse	Substrate	Bacterial isolates had a beneficial effect on the development of the cultivar Essandre.	Pais, (2016)

Plants	Bacteria:		Among the main genera of	
	Pseudomonas,		P- and K-solubilizing	
	Bacillus,	REVIEW	bacteria, Pseudomonas,	Silva,
	Burkholderia,	REVIEW	Bacillus, Burkholderia, and	(2024)
	and		Paraburkholderia are the	
	Paraburkholderia		most frequently reported	

Source: Prepared by the authors. Data from the graduate program at UNEB. ND: the application method was not reported in the text.

the results demonstrate that the use of microorganisms constitutes an effective strategy to mitigate the effects of water deficit and salinity in the SVSF. AMF reduced the damage associated with water stress in melon (Melo, 2017) and improved growth and biomass accumulation in cowpea (Leal, 2023). *Bradyrhizobium* spp. (strain BR 3262) showed beneficial effects on nodulation and physiological performance of bean genotypes (Nascimento, 2019), and enhanced gas exchange parameters in common bean seedlings (Souza, 2016b). Additional studies identified bacterial isolates with high symbiotic efficiency and tolerance to salinity (3% NaCl), as well as resistance to acidic and alkaline pH (Sena, 2018). In watermelon, inoculation with *Bacillus* spp. increased root length and volume (Araújo, 2023), while in papaya, AMF promoted better initial seedling development (Vargens, 2022). These results, summarized in Table 1, reinforce the potential of microorganisms as biotechnological tools for agriculture in semiarid environments.

In PPGPV–UNIVASF, biostimulants were extensively investigated between 2015 and 2025 (Table 2), with a predominance of studies focused on mango, exploring different substances and their physiological, biochemical, and productive effects. In ‘Kent’ mango, foliar application of amino acids and seaweed extract significantly altered the physicochemical traits of fruits (Lobo, 2018), while melissyl alcohol increased the activity of the antioxidant enzymes superoxide dismutase (SOD), ascorbate peroxidase (APX), and catalase (CAT) (Sanches, 2020). In ‘Tommy Atkins’ mango, proline increased gas exchange rates and seaweed extract promoted greater floral uniformity (Cunha, 2019). In acerola, however, the application of humic substances did not significantly affect fruit quality attributes (Dias, 2017).

For ‘Palmer’ mango, the combination of humic substances and paclobutrazol was identified as a productive alternative (Silva, 2019), while the isolated application of humic substances via fertigation produced fruits with commercial standards compatible with export markets (Torres, 2019). In melon, protein application improved vegetative growth parameters (Rodrigues, 2018), while in guava, the use of biofertilizers significantly increased production (Santana, 2016). However, in acerola, humic substances did not influence fruit

quality attributes (Dias, 2017).

Plant growth regulators also produced consistent responses in studies conducted by PPGPV UNIVASF between 2015 and 2024 (Table 2), with a predominance of research applied to mango. In 'Palmer' mango, foliar application of gibberellins, auxins, naphthaleneacetic acid, and cytokinins reduced the incidence of stenopermocarpic fruits and increased the number of productive branches (Souza, 2019). In 'Tommy Atkins' mango, the use of fenpropimorph and paclobutrazol proved effective in inhibiting A₃ biosynthesis, resulting in increased transpiration and reserve accumulation (Carreiro, 2020).

Table 2

Dissertations from the PPGPV – UNIVASF involving major crops, cultivation conditions, application methods, and the effects of biostimulants and plant growth regulators from 2015 to 2024

BIOSTIMULANTS					
Crop	Description of the Biostimulants	Growing Conditions	Application Method	Effects and Plant Performance	References
Mango 'Kent'	Aminoácidos livres e extrato de alga Lithothamnium	Field	Foliar	All physicochemical variables of the fruits were affected by the treatments, with different responses between growing seasons.	Lobo, (2018)
Mango 'Tommy Atkins'	Extratos de algas e prolina	Field	Foliar	Proline was effective in increasing gas exchange rates; in contrast, plants treated with seaweed extract showed greater flowering uniformity.	Cunha, (2019)
Mango 'Kent'	Melissil Álcool	Field	Foliar	The application positively enhanced total amino acid contents, free proline, total proteins, and the activity of the	Sanches, (2020)

				enzymes SOD, APX, and CAT.	
Mango 'Kent'	Ascophyllum nodosum e Prolina	Field	Soil and foliar	The isolated effects of proline and <i>A. nodosum</i> extract resulted in better nutritional status.	Moura, (2019)
Mango 'Palmer'	Substancia húmicas, Paclobutrazol	Field	Soil	The use of humic substances associated with PBZ may represent an important alternative for mango production in the semi-arid region.	Silva, (2019)
Mango 'Palmer'	Substancia humicas	Field	Fertigation	The fruits exhibited physicochemical characteristics that meet the quality standards established for international commercialization.	Torres (2019)
Mango 'Tommy Atkins'	Prolina e extrato de algas	Field	Foliar	The substances promoted increases in physiological, biochemical, and agronomic variables of the plants.	Cunha, (2019)
Melon	Proteinas	Greenhouse	Soil and foliar	Growth parameters of melon plants and β -glucosidase activity were significantly higher in fertilized treatments.	Rodrigues, (2018)
Guava	Biofertilizantes	Field	Fertigation	Fertigation with biofertilizer at 2.5% increased guava fruit yield by 12.61 kg plant ⁻¹ .	Santana, (2016)

Acerola	Substancia humicas	Field	Fertigation	The application of humic substances and nitrogen doses did not alter the fruit quality of acerola.	Dias, (2017)
---------	--------------------	-------	-------------	--	--------------

PLANT GROWTH REGULATORS

Crop	Description of Plant Growth Regulators	Growing Conditions	Application Method	Effects and Plant Performance	References
Mango 'Palmer'	Giberelina; Auxina; Naftalenoacético; Citocininas	Field	Foliar	Cytokinin reduced the incidence of stenospermocarpic fruits and promoted higher means for the number of productive branches.	Souza, (2019)
Mango 'Tommy Atkins'	Fenpropimorfe, Paclobutrazol	Field	Soil	Fenpropimorph is efficient in inhibiting GA ₃ biosynthesis, promoting increased transpiration and reserve accumulation.	Carreiro, (2020)
Mango 'Keitt'	AG3	Field	Foliar	Physical fruit characteristics, including estimated volume, fruit mass, and seed yield, were influenced by the interaction between factors (fertilization × gibberellin).	Mudo, (2020)
Onion	citocinina, giberelina, auxina	Field	Soil	Soil chemical and microbiological properties were influenced after the application.	Silva, (2020)
Rosa	citocinina, giberelina, auxina	Sombreado	Foliar	Plant growth regulators promoted greater increases in	Silva, (2018)

rose growth and positively affected gas exchange.

MICROORGANISMS

Crop	Description of Microorganisms	Growing Conditions	Application Method	Effects and Plant Performance	References
Mango 'Keitt'	Rhodopseudomonas palustris	Field	Fertigation	<i>Rhodopseudomonas palustris</i> is a promising option for the cultivation of 'Keitt' mango irrigated under semi-arid conditions.	Lino, (2020)
Melon	Micorrízicos arbusculares, auxina e citocinina	Field	Fertigation	Reducing irrigation depth in melon cultivation does not affect sporulation but alters composition and reduces the diversity of AMF.	Silva, (2017)
<i>Rhaphiodon echinus</i> e <i>Mesosphaerum suaveolens</i> .	Fungos micorrízicos arbusculares (FMA)	Greenhouse	Inoculação	Native AMF produced with <i>S. uniflora</i> provide benefits to the development of <i>Rhaphiodon echinus</i> and <i>Mesosphaerum suaveolens</i> plants.	Medeiros, (2021)

Source: Prepared by the authors. Data from the graduate program at UNIVASF.

For the 'Keitt' cultivar, theogenous A₃ application positively influenced fruit mass, volume, and seed yield (Mudo, 2020). In onion, the application of cytokinin, gibberellin, and auxin promoted relevant changes in soil chemical and microbiological properties (Silva, 2020).

Regarding microorganisms, only two dissertations were identified in PPGPV–UNIVASF (Table 2). In melon, the association between arbuscular mycorrhizal fungi (AMF), auxins, and cytokinins applied via fertigation demonstrated that reduced irrigation depth did not compromise AMF sporulation, although it altered composition and reduced AMF diversity (Silva, 2017). In *Rhaphiodon echinus* and *Mesosphaerum suaveolens*, inoculation with

native AMF enhanced plant development, reinforcing the potential of these microorganisms for semiarid conditions (Medeiros, 2021). For the 'Keitt' cultivar, the application of *Rhodopseudomonas palustris* proved agronomically efficient, indicating biotechnological potential for productive management (Lino, 2020).

The dissertations from PPGEA–UNIVASF, produced between 2015 and 2025, highlight the broad use of biostimulants, plant growth regulators, and microorganisms in fruit and vegetable crops grown in semiarid environments (Table 3). Biostimulants showed expressive responses in several crops, especially mango, melon, and cucurbits. In 'Tommy Atkins' mango, the application of fulvic and humic acids via fertigation increased leaf levels of amino acids, proteins, and total soluble carbohydrates (Martins, 2023). In 'Palmer' mango, the use of seaweed extract combined with humic substances and different hormonal classes (cytokinins, auxins, and gibberellins) increased biochemical levels in leaves (Araújo, 2022).

In 'BRS Isis' grapes, the foliar application of humic substances, bacteria, and biocompost positively influenced shoot length and number of leaves (Barros, 2020). In yellow melon, carbon nanoparticles applied via foliar application and fertigation positively affected physiological and biochemical traits (Barros, 2023), while the use of biofertilizers increased chlorophyll a and b, photosynthesis, stomatal conductance, and productivity (Leite, 2021). Similar results were observed in watermelon, where intermediate doses of biofertilizers yielded the best photosynthesis, stomatal conductance, and transpiration values (Silva, 2016).

In bell pepper, the application of humic substances combined with reduced mineral fertilization resulted in significant increases in total yield and average fruit weight (Souza, 2021). In yam, the application of free amino acids and *Ascophyllum nodosum* was identified as a physiologically efficient and promising strategy for the crop (Santos, 2017b). Similarly, in passion fruit, the use of humic substances proved to be a viable alternative for seedling production in organic fertilization systems, promoting better initial plant performance (Santos, 2021) (Table 3).

Table 3

Dissertations from the PPGEA – UNIVASF involving major crops, cultivation conditions, application methods, and the effects of biostimulants, plant growth regulators, and microorganisms from 2015 to 2024

BIOSTIMULANTS					
Crop	Description of the Biostimulants	Growing Conditions	Application Method	Effects and Plant Performance	References
Mango 'Tommy Atkins'	Ácidos fulvico e ácido húmicos	Field	Fertigation	The application of biostimulants resulted in increased leaf contents of amino acids, proteins, and total soluble carbohydrates.	Martins, (2023)
Mango 'Palmer'	Extrato de algas marinhas; Subistacia humicas citoquininas, auxinas e giberelinas,	Field	Fertigation	It promoted increases in the biochemical contents of mango leaves.	Araújo, (2022)
Grape 'BRS Isis'	Subistacia húmicas, biocomposto	Field	Foliar	The biocompost positively influenced shoot length and number of leaves.	Barros (2020)
Melon	Nanoparticulado de carbono	Field	Foliar and Fertigation	The biostimulant used positively affected the physiological and biochemical characteristics of melon plants.	Barros, (2023)

Melon	Biofertilizantes	Field and Greenhouse	Fertigation	The biofertilizer promoted increases in chlorophyll a and b contents, photosynthesis, stomatal conductance, as well as higher productivity.	Leite, (2021)
Watermelon	Biofertilizantes	Field	Foliar and Fertigation	Intermediate doses of the biofertilizer provided the highest values of photosynthesis, stomatal conductance, and transpiration.	Silva, (2016)
Bell pepper	Subistacia humicas	Greenhouse	Soil	The lowest fertilization rate resulted in higher total yield and average fruit weight.	Souza, (2021)
Yam	Aminoacidos livres; Ascophyllum nodosum	Field	Foliar	The 100 mL dose showed the highest mean fresh tuber weight (1.677 kg).	Santos, (2017b)
Passion fruit	Subistacia humicas	Greenhouse	Soil	It proved to be a good option for seedling production under organic fertilization.	Santos, (2021)

PLANT GROWTH REGULATORS

Crop	Description of Plant Growth Regulators	Growing Conditions	Application Method	Effects and Plant Performance	References
Melon	Citoquininas, auxinas e giberelinas	Field	ND	The 4.8 L ha ⁻¹ dose increased pulp firmness in both growing seasons.	Reis, (2018)
Melon	Auxina e citocinina	Field	ND	The highest values of firmness and total soluble solids were observed under the lowest irrigation depth.	Ferreira, (2016)
MICROORGANISMS					
Crop	Description of Microorganisms	Growing Conditions	Application Method	Effects and Plant Performance	References
Zea mays	Bacterias remineralizadora	Greenhouse	Soil	Potential benefits for conservation agriculture were observed through the use of remineralizers.	Sydne, 2023

Source: Prepared by the authors. Data from the graduate program at UNIVASF. ND: the application method was not reported in the text.

Plant growth regulators also directly influenced fruit quality, especially in melon, the application of cytokinins, auxins, and gibberellins increased pulp firmness in two consecutive growing cycles (Reis, 2018). Complementarily, the application of auxin and cytokinin combined with a reduced irrigation depth resulted in higher pulp firmness and total soluble solids, demonstrating a beneficial interaction between plant growth regulators and water management (Ferreira, 2016). Regarding the use of microorganisms, in maize cultivated under greenhouse conditions, inoculation with remineralizing bacteria was considered a promising strategy for improving the crop's nutritional and physiological conditions, reinforcing their potential for the agricultural systems of the SVSF (Sydne, 2023) (Table 3).

The distribution of crops studied in the works involving biostimulants, plant growth regulators, and microorganisms has been analyzed in figure 5. Refers to PPGHI–UNEB, showing a evenly distributed range of crops. Mango, grape, cowpea, onion, and melon, exhibit similar proportions (between 9% and 18%), characterizing a broad research scope consistent with the strategic importance of these crops for irrigated horticulture in Northeastern Brazil Figure 5A.

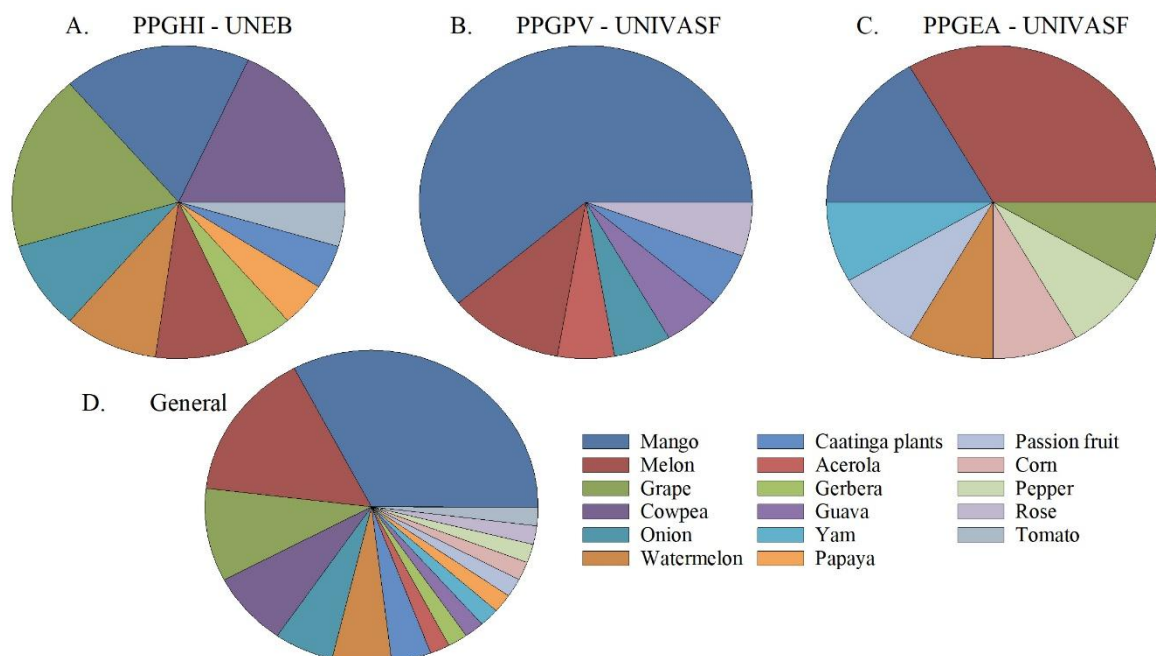
In contrast, the Graduate Program in Plant Production (PPGPV–UNIVASF) (Figure 5B) shows strong thematic concentration, with an absolute predominance of mango (61% of studies), while pear and guava appear sporadically. This scenario indicates a clear programmatic vocation toward mango cultivation, aligned with the socioeconomic importance of this production chain in the São Francisco Valley. Although it demonstrates scientific specialization, it also suggests lower thematic diversification compared to the other evaluated programs.

In the Graduate Program in Agricultural Engineering (PPGEA–UNIVASF), an intermediate pattern between diversity and specialization is observed (Figure 5C). Although melon and mango show the highest percentages (33% and 17%, respectively), other crops such as grape, passion fruit, maize, yam, and bell pepper each represent 8.33%, forming a more balanced distribution. This behaviour aligns with the multidisciplinary nature of Agricultural Engineering, which integrates aspects of water management, ecophysiology, productivity, and the development of technologies aimed at intensive cropping systems in semiarid regions.

The overall synthesis of the three programs (Figure 5D) shows that mango stands out as the most studied crop (33%), followed by melon (15%), grape (10%), and cowpea (8%). This predominance reinforces the importance of irrigated fruit crops in the semiarid region, which are strongly linked to the production chains of the São Francisco Valley. The remaining species appear in smaller proportions, indicating that although there is diversity in the studies, the economically most relevant crops of irrigated fruit production continue to be prioritized.

Figure 5

Percentage of the main crops studied in dissertations related to the use of biostimulants, plant growth regulators, and microorganisms in the graduate programs: A. Irrigated Horticulture (PPGHI–UNEB), B. Plant Production (PPGPV UNIVASF), and C. Agricultural Engineering (PPGEA–UNIVASF), from 2015 to 2024



Source: Prepared by the authors. Data from the graduate programs at UNEB and UNIVASF.

Overall, it is observed that biostimulants, plant growth regulators, and microorganisms have been predominantly applied to high-value crops, reinforcing the search for biotechnological solutions capable of enhancing productivity, physiological efficiency, and postharvest quality.

4 CONCLUSIONS

The PPGHI – UNEB presented the highest number of studies involving microorganisms, especially plant growth-promoting bacteria and fungi, in addition to the plant growth regulator paclobutrazol. The most studied crops were bean, mango, and grape, each representing 18% of the theses analyzed over the ten-year period.

The PPGEA and PPGPV programs at UNIVASF concentrated most of the research related to biostimulants and plant growth regulators, with humic substances, paclobutrazol, and seaweed extracts standing out. In the PPGEA program, 33% of the studies were directed at melon cultivation, while in the PPGPV program, 61% of the research involved mango cultivation.

Between 2015 and 2024, the graduate programs in Irrigated Horticulture (PPGHI –

UNEB), Plant Production (PPGPV – UNIVASF), and Agricultural Engineering (PPGEA – UNIVASF), in partnership with EMBRAPA Semiárido, developed relevant contributions on the use of biostimulants, plant growth regulators, and microorganisms in irrigated fruit production in the São Francisco Valley, strengthening the region's technological advancement and promoting increased productivity and quality of fruits, vegetables, and legumes.

REFERENCES

- Almeida, A. C. dos S. (2023). Desempenho agrônômico de cebola cultivada em dois períodos de produção sob diferentes concentrações de biofertilizante (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. https://ppghi.uneb.br/wp-content/uploads/2025/02/1.1.Dissertacao-Cecilia_corrigido-com-ficha.pdf
- Aguilar, C. A. da C. de. (2018). Extrato de alga marinha calcária (Lithothamnium) no desenvolvimento, produção e qualidade pós-colheita de frutos da videira “BRS Vitória” (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/CARLOS-ANTONIO-DA-COSTA-DE AGUIAR.pdf>
- Araújo, M. G. de. (2023). Inoculação de *Bacillus* spp. em sementes de melanciaira como estratégia para mitigar os efeitos do déficit hídrico (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. https://ppghi.uneb.br/wp-content/uploads/2025/02/Dissertacao-Final_Mycaella-1.pdf Pós-Graduação
- Araújo, L. R. da S. (2022). Aplicação de bioestimulantes e doses em mangueira cv. ‘Palmer’ no Submédio do Vale do São Francisco (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Engenharia Agrícola – PPGEA, Campus Juazeiro. <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes1/arquivos/DISSERT LUCASARAJ022122 022.pdf>
- Baiardi, A., & Ribeiro, M. C. M. (2023). Eficiência da gestão da agricultura irrigada no Vale do São Francisco: uma análise comparativa no polo regional Petrolina-Juazeiro. *Colóquio-Revista do desenvolvimento regional*, 20(3, jul./set.), 28-51. <https://doi.org/10.26767/coloquio.v20i3,%20jul./set..2788>
- Barros, E. S. C. (2020). Produção de biocomposto proveniente da vinicultura e aplicação no desenvolvimento de mudas de videira (*Vitis vinifera* L.) (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro. <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes1/arquivos/EDUARD OSOUZACOSTABARRROS.pdf>
- Barros, N. Q. (2023). Aplicação do bioestimulante arbolina no cultivo de melão amarelo sob diferentes manejos de irrigação (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro. https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes1/arquivos/DISSERTAO_NIC

- Bezerra, J. B. N. (2020). Fitorreguladores no crescimento, qualidade e produção de frutos de mangueira 'Tommy Atkins' (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, [content/uploads/2021/01/JOAO-BOSCO-NUNES-BEZERRA.pdf](https://www.ppghi.uneb.br/wp-content/uploads/2021/01/JOAO-BOSCO-NUNES-BEZERRA.pdf) BA. [https://www.ppghi.uneb.br/wp](https://www.ppghi.uneb.br/wp-content/uploads/2021/01/JOAO-BOSCO-NUNES-BEZERRA.pdf)
- Carreiro, D. de A. (2020). Fenpropimorfe no manejo da floração em mangueira 'Tommy Atkins' no semiárido (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em 19 Produção Vegetal – PPGPV, Campus Petrolina, [content/uploads/2022/05/Daniel-de-Almeida-Carreiro_2020.pdf](https://www.frutvasf.org/wp-content/uploads/2022/05/Daniel-de-Almeida-Carreiro_2020.pdf) PE. [https://www.frutvasf.org/wp](https://www.frutvasf.org/wp-content/uploads/2022/05/Daniel-de-Almeida-Carreiro_2020.pdf)
- Campos, L. D. A. (2019). Efeito do déficit hídrico controlado (RDI) e uso de bioestimulante nas características de crescimento, bioquímicas e de trocas gasosas do meloeiro (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/LUAN-DAVID-ALCANTARA-CAMPOS.pdf>
- Cunha, J. G. da. (2019). Fornecimento de prolina e extrato de algas como atenuante do estresse abiótico em mangueira 'Tommy Atkins' cultivada no semiárido (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. https://www.frutvasf.org/wp-content/uploads/2022/06/Jeilton-Gomes-da-Cunha_2019.pdf
- Dias, D. do N. (2017). Substâncias húmicas na fertirrigação nitrogenada da aceroleira (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. <https://producaovegetal.univasf.edu.br/Arquivos/dayane.pdf>
- Fátima, V. M. (2024). FRUTICULTURA (MANGA): v. 9 n. 371, dezembro, 2024. Caderno Setorial ETENE, . Francisco, L. P. L., Fernandes, C. B., Vio, N. L., de Oliveira Pascoal, I., Feijó, M. R., & Camargo, M. L. (2021). Impactos da pandemia no estudo e dinâmica de vida de universitários brasileiros. *Conjecturas*, 21(4), 376-395. DOI: 10.53660/CONJ-196-614
- Ferreira, K. M. (2019). Fisiologia, produção e qualidades de fruto da mangueira "Tommy Atkins" cultivada sob diferentes formas de aplicação do paclobutrazol (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2019/04/Kalline-Mendes-Ferreira.pdf>
- Ferreira, P. P. B. (2016). Resposta do melão amarelo à interação lâmina de irrigação e bioestimulante (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro. <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes/1/arquivos/PedroPauloBezerraFerreira.pdf>
- Fonseca, R. A. (2015). Reguladores vegetais e fungicidas com efeitos fisiológicos no desenvolvimento de plantas de cebola (Dissertação de mestrado, Universidade do

Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/Rodrigo-Almeida-Fonseca.pdf>

Gondim, R. et al. (2013). Projeções de demanda hídrica para irrigação do meloeiro no Submédio São Francisco sob cenários de mudanças climáticas. Recuperado em 23 novembro 2025, de <https://www.sidalc.net/search/Record/dig-infoteca-e-doc-972686/Description>

Gomes, I. P. F. de A. (2023). Ácido salicílico em mudas de videira cultivar BRS Vitória sob deficiência hídrica (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://ppghi.uneb.br/wp-content/uploads/2025/02/Dissertacao-Mestrado-lana-.pdf> IBGE - INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Produção Agrícola Municipal. Rio de Janeiro, 2024. Disponível em: . Acesso em: 11 de nov. de 2024 20 Vegetal

Lobo, J. T. (2018). Bioestimulante no cultivo da mangueira cv. Kent no submédio do Vale do São Francisco (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção – PPGPV, Campus Petrolina, PE. https://www.frutvasf.org/wp-content/uploads/2022/06/Jackson-Teixeira-Lobo_2018.pdf

Lordêlo, C. M. M. (2019). Poliaminas em videira ‘Thompson Seedless’ (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2019/04/DISSERTACAO-CLAUDIO.pdf>

Leite, E. W. S. (2021). Uso eficiente de biofertilizante no cultivo de variedades de melão no Submédio do Vale do São Francisco (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro. <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes1/arquivos/DISSERTACAOMELOEmers on.pdf>

Leal, V. de C. (2023). Feijão-caupi associado a fungos micorrízicos arbusculares e rizóbio, cultivado sob condição salina (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/VERONICA-DE-CASTRO-LEAL.pdf>

Lino, J. de O. S. (2020). Rhodopseudomonas palustris como bioestimulantes em mangueira ‘Keitt’ no semiárido (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. https://www.frutvasf.org/wp-content/uploads/2022/05/Jayne-de-Oliveira-Siqueira-Lino_2020.pdf

Moraes, J. P. S. de. (2018). Reguladores vegetais e fungicidas com efeitos fisiológicos no desenvolvimento de porta-enxertos de videira (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/Jadson-Moraes.pdf>

- Melo, J. M. M. (2017). Híbridos de meloeiro inoculados com fungos micorrízicos arbusculares e submetidos ao estresse hídrico no Vale do Submédio do São Francisco (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/JULIANA-MARIA-MEDRADO-DE-MELO.pdf>
- Medeiros, A. S. de. (2021). Produção de inoculante micorrízico e aplicação em plantas usadas na recuperação de áreas degradadas (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – <https://producaovegetal.univasf.edu.br/Arquivos/adler.pdf> PPGPV, Campus Petrolina, PE.
- Mudo, L. E. D. (2020). Estratégias para fixação e desenvolvimento de frutos em mangueira cv. Keitt cultivada no semiárido (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. https://www.frutvasf.org/wp-content/uploads/2022/05/Laiane-Eugenia-Delmondes-Mudo_2020.pdf
- Moura, F. M. de. (2019). Prolina e extrato de *Ascophyllum nodosum* no estado nutricional da mangueira 'Kent' (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. https://www.frutvasf.org/wp-content/uploads/2022/05/Franciele-Miranda-de-Moura_2019.pdf
- Martins, M. da S. (2023). Fisiologia e produtividade da mangueira 'Tommy Atkins' com aplicação de bioestimulantes à base de substâncias húmicas no semiárido brasileiro (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes1/arquivos/PTBRMarceloMartinsDissertaofinal.pdf> BA.
- Nascimento, T. R. do. (2019). Coinoculação de *Bradyrhizobium* spp. em feijão-caupi (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/TAILANE-RIBEIRO-DO-NASCIMENTO.pdf>
- Oliveira, Z. V. S. R. (2020). Aplicação de biofertilizante no cultivo orgânico de melancia no semiárido brasileiro (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/ZEZIA-VERONICA-SILVA-RAMOS-OLIVEIRA.pdf>
- Oliveira, C. K. dos S. (2016). Reguladores vegetais e nutrientes no desenvolvimento do tomateiro (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/Carmem-Kely-dos-Santos-Oliveira.pdf>
- Pais, A. K. L. (2016). Micropropagação de Gérberas e avaliação de bactérias promotoras de crescimento (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/Ana-Karolina-Leite-Pais.pdf>

Rouphael, Y., & Colla, G. (2020). Editorial: Biostimulants in agriculture. *Frontiers in Plant Science*, 11, 40.

Reis, D. S. (2018). Efeito de lâminas de irrigação e bioestimulante na fisiologia e produção de variedades de melão (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes_1/arquivos/daise-souza-reis.pdf

Rodrigues, M. E. B. (2018). Bioestimulante em cultivo de meloeiro: Efeitos sobre parâmetros biométricos e biomassa microbiana do solo (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. <https://producaovegetal.univasf.edu.br/Arquivos/eugenia.pdf> Pós-Graduação

Santos, I. H. (2017b). Adubação potássica associada a fósforo, micronutrientes e bioestimulante no cultivo de *Dioscorea cayennensis* (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de em Produção Vegetal – PPGPV, Campus <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes-1/arquivos/iuri-honorio-santos.pdf> Petrolina, PE.

Santos, E. H. F. (2021). Compostos orgânicos e a dinâmica do crescimento vegetativo do maracujazeiro amarelo (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro. <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes1/arquivos/dissertao-demestradoEricaHeloiseFreitasSantos1.pdf>

Santos, S. A. dos. (2017a). Produção e qualidade de frutos da mangueira “Kent” com o uso de paclobutrazol (PBZ) (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus [content/uploads/2021/01/Saulo-Alves-dos-Santos.pdf](https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes1/arquivos/dissertao-demestradoEricaHeloiseFreitasSantos1.pdf) Juazeiro, BA. <https://www.ppghi.uneb.br/wp>

Silva, M. V. T. da. (2016). Doses e formas de aplicação de biofertilizante no cultivo da melancia sem semente (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em 22 Engenharia Agrícola – PPGEA, Campus Juazeiro. https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes_1/arquivos/max-venicius-teixeira-da-silva.pdf

Silva, T. S. da. (2020). Aplicação de bioestimulantes em cultivo fertirrigado de cebola (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. <https://producaovegetal.univasf.edu.br/Arquivos/tamiressoares.pdf>

Silva, T. D. F. da. (2017). Fungos micorrízicos arbusculares associados a lâminas de irrigação e bioestimulante no meloeiro (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. <https://producaovegetal.univasf.edu.br/Arquivos/tamires.pdf>

Silva, T. S. da. (2022). Substâncias húmicas na nutrição, produtividade, qualidade de frutos e na absorção de paclobutrazol em mangueira cultivada em solos frágeis da região semiárida brasileira. (Dissertação de mestrado, Universidade Federal do Vale do São

Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. <https://producaovegetal.univasf.edu.br/Arquivos/talisonsilva.pdf> Pós-Graduação

Silva, M. L. N. da. (2018). Fisiologia do crescimento e metabolismo de rosa de corte sob aplicação de produtos de efeitos fisiológicos. (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de em Produção Vegetal <https://producaovegetal.univasf.edu.br/Arquivos/lourdes.pdf> – PPGPV, Campus Petrolina, PE.

Silva, E. P. (2024). Bactérias solubilizadoras de fósforo e potássio isoladas da Caatinga na promoção de crescimento vegetal (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus [content/uploads/2025/02/Dissertacao-Versao-final-Edilania.pdf](https://ppghi.uneb.br/wp-content/uploads/2025/02/Dissertacao-Versao-final-Edilania.pdf) Juazeiro, BA. [https://ppghi.uneb.br/wp](https://ppghi.uneb.br/wp-content/uploads/2025/02/Dissertacao-Versao-final-Edilania.pdf)

Souza, L. S. B. de. (2016b). Desenvolvimento vegetativo e respostas fisiológicas de feijão-caupi inoculado sob diferentes lâminas de irrigação (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/LAYANE-SILVA-BARBOSA-DE-SOUZA.pdf>

Souza, R. M. A. (2021). Demanda hídrica e aspectos produtivos do pimentão submetido a diferentes níveis de adubação orgânica e lâminas de irrigação em cultivo protegido (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro. <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes1/arquivos/DISSERTAOFINA> LRUANNAMASOUZ A.pdf

Souza, V. de. (2019). Estudo fenológico da morte do embrião e estratégias para mitigar a ocorrência de estenoespermocarpia em frutos de manga 'Palmer' (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. https://www.frutvasf.org/wp-content/uploads/2022/06/Vanuza-de-Souza_2019.pdf

Souza, M. A. de. (2016a). Caracterização fisiológica e produção da mangueira em função da aplicação de paclobutrazol via sistema de irrigação (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/MOISES-ALVES-DE-SOUZA.pdf>

Sanches, L. G. (2020). Mitigação de estresse abiótico com aplicação exógena de melissil álcool em mangueira cv. Kent cultivada no semiárido (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. https://www.frutvasf.org/wp-content/uploads/2022/05/Luciana-Guimaraes-Sanches_2020.pdf

Sydne, B. (2023). Uso de remineralizadores associados a bactérias solubilizadoras de nutrientes como condicionadores do solo para a cultura do milho (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Engenharia Agrícola – PPGEA, Campus Juazeiro. <https://portais.univasf.edu.br/ppgea/pesquisa/publicacoes-1/arquivos/DicertacoBanelSYDNE.pdf>

- Santana, E. A. (2016). Biofertilizante bovino e nitrogênio via fertirrigação na cultura da goiabeira Paluma no Vale do São Francisco (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. https://www.frutvasf.org/wp-content/uploads/2022/06/Elisson-Alves-Santana_2016.pdf
- Sena, P. T. S. (2018). Caracterização polifásica de bactérias isoladas de nódulos de feijão-caupi em solos sob diferentes usos agrícolas do semiárido baiano (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://www.ppghi.uneb.br/wp-content/uploads/2021/01/Pamella-versao-final-1.pdf>
- Torres, A. P. (2019). Ácidos orgânicos na nutrição, produtividade e qualidade de frutos de mangueira cv. Palmer no Vale do São Francisco (Dissertação de mestrado, Universidade Federal do Vale do São Francisco). Programa de Pós-Graduação em Produção Vegetal – PPGPV, Campus Petrolina, PE. <https://producaovegetal.univasf.edu.br/Arquivos/anapaula.pdf>
- Universidade do Estado da Bahia. Programa de Pós-Graduação em Horticultura Irrigada (PPGHI) Campus Juazeiro, BA. Acessado . <https://ppghi.uneb.br/b>
- Universidade Federal do Vale do São Francisco. Programa de Pós-Graduação em Produção Vegetal (PPGPV) Campus Petrolina, PE. Acessado . <https://producaovegetal.univasf.edu.br/>
- Universidade Federal do Vale do São Francisco. (n.d.). Programa de Pós-Graduação em Engenharia Agrícola (PPGEA) Campus Juazeiro. Acessado . <https://portais.univasf.edu.br/ppgea>
- Vargens, F. N. (2022). Fungos micorrízicos arbusculares como mitigador de estresse hídrico na produção de mudas de mamoeiro no Submédio do Vale do São Francisco (Dissertação de mestrado, Universidade do Estado da Bahia). Programa de Pós-Graduação em Horticultura Irrigada – PPGHI, Campus Juazeiro, BA. <https://ppghi.uneb.br/wp-content/uploads/2025/02/FERNANDA-NERY-2022-1.pdf>

NAVIGATING UNCERTAINTY: PALM OIL SECTOR OUTLOOK FOR 2026 THROUGH THE LENS OF SMALLHOLDER WELFARE AND SUSTAINABILITY IMPERATIVES

NAVEGANDO PELA INCERTEZA: PERSPECTIVAS DO SETOR DE ÓLEO DE PALMA PARA 2026 SOB A ÓTICA DO BEM-ESTAR DOS PEQUENOS PRODUTORES E DOS IMPERATIVOS DE SUSTENTABILIDADE

NAVEGANDO EN LA INCERTIDUMBRE: PERSPECTIVAS DEL SECTOR DEL ACEITE DE PALMA PARA 2026 DESDE LA ÓPTICA DEL BIENESTAR DE LOS PEQUEÑOS PRODUCTORES Y LOS IMPERATIVOS DE SOSTENIBILIDAD



<https://doi.org/10.56238/sevened2026.008-062>

Loso Judijanto¹

ABSTRACT

This qualitative literature review examines the outlook for Indonesia's palm oil sector in 2026, with particular emphasis on smallholder farmers' welfare and the interplay between production dynamics, policy drivers, and sustainability imperatives. Synthesizing evidence from the 2026 IPOSS Palm Oil Outlook, literature publications (2020-2025), and government reports. In industry analyses, we identify critical determinants shaping the sector's trajectory: biodiesel mandate expansion (B40-B50), climate variability following El Niño-La Niña cycles, implementation of the European Union Deforestation Regulation (EUDR), and persistent productivity gaps in smallholder plantations. Global crude palm oil (CPO) production is projected at 83 million metric tons in 2026, with Indonesia maintaining 59% market share despite land expansion constraints and bottlenecks in the replanting program (PSR). Domestic consumption intensification through bioenergy mandates creates a dual pressure on export capacity and farmer income stability. Price forecasts range from USD 1,050 to 1,200/MT, influenced by energy policy, geopolitical tensions, and sustainability compliance costs. Thematic findings reveal that smallholder welfare—measured through Farmers Terms of Trade (NTP) and multidimensional welfare indices—remains vulnerable to price volatility, limited market access, and certification barriers. We propose six evidence-based policy recommendations prioritizing accelerated replanting (200,000 ha/year target), price stabilization mechanisms, subsidized ISPO certification pathways, enhanced extension services, comprehensive welfare monitoring systems, and income diversification strategies. This review contributes to agricultural economics literature by synthesizing fragmented research streams and providing actionable insights for policymakers navigating the sustainability-development nexus in commodity-dependent economies.

Keywords: Palm Oil Outlook. Smallholder Welfare. Biodiesel Policy. ISPO Certification. Replanting Program. EUDR Compliance. Farmers' Terms of Trade. Sustainable Intensification. Indonesian Agriculture. Climate Adaptation.

¹ Master's degree of Statistics. IPOSS. Jakarta, Indonesia. E-mail: losojudijantobumn@gmail.com
Orcid: <https://orcid.org/0009-0007-7766-0647>

RESUMO

Esta revisão qualitativa da literatura examina as perspectivas do setor de óleo de palma da Indonésia em 2026, com ênfase particular no bem-estar dos pequenos produtores e na interação entre dinâmicas produtivas, direcionadores de políticas públicas e imperativos de sustentabilidade. O estudo sintetiza evidências provenientes do IPOSS Palm Oil Outlook 2026, de publicações científicas (2020–2025) e de relatórios governamentais e análises setoriais. Identificam-se determinantes críticos que moldam a trajetória do setor, incluindo a expansão do mandato de biodiesel (B40–B50), a variabilidade climática associada aos ciclos El Niño–La Niña, a implementação do Regulamento da União Europeia sobre Desmatamento (EUDR) e as persistentes lacunas de produtividade nas plantações de pequenos produtores. A produção global de óleo de palma bruto (CPO) está projetada em 83 milhões de toneladas métricas em 2026, com a Indonésia mantendo 59% de participação de mercado, apesar das restrições à expansão de área e dos gargalos no programa de replantio (Peremajaan Sawit Rakyat – PSR). A intensificação do consumo doméstico por meio de mandatos de bioenergia gera uma pressão dupla sobre a capacidade de exportação e a estabilidade da renda dos agricultores. As projeções de preços variam entre USD 1.050 e 1.200 por tonelada métrica, influenciadas por políticas energéticas, tensões geopolíticas e custos de conformidade com exigências de sustentabilidade. Os achados temáticos revelam que o bem-estar dos pequenos produtores — medido pelos Termos de Troca da Agricultura (NTP) e por índices multidimensionais de bem-estar — permanece vulnerável à volatilidade de preços, ao acesso limitado aos mercados e às barreiras à certificação. Propõem-se seis recomendações de políticas baseadas em evidências, priorizando a aceleração do replantio (meta de 200.000 ha/ano), mecanismos de estabilização de preços, vias subsidiadas para certificação ISPO, fortalecimento dos serviços de extensão rural, sistemas abrangentes de monitoramento do bem-estar e estratégias de diversificação de renda. Esta revisão contribui para a literatura em economia agrícola ao integrar correntes de pesquisa fragmentadas e oferecer subsídios acionáveis para formuladores de políticas que atuam no nexo entre sustentabilidade e desenvolvimento em economias dependentes de commodities.

Palavras-chave: Perspectivas do Óleo de Palma. Bem-Estar dos Pequenos Produtores. Política de Biodiesel. Certificação ISPO. Programa de Replanteio. Conformidade com o EUDR. Termos de Troca da Agricultura. Intensificação Sustentável. Agricultura Indonésia. Adaptação Climática.

RESUMEN

Esta revisión cualitativa de la literatura examina las perspectivas del sector del aceite de palma de Indonesia en 2026, con especial énfasis en el bienestar de los pequeños productores y en la interacción entre las dinámicas de producción, los impulsores de políticas públicas y los imperativos de sostenibilidad. El estudio sintetiza evidencias del IPOSS Palm Oil Outlook 2026, de publicaciones científicas (2020–2025) y de informes gubernamentales y análisis sectoriales. Se identifican determinantes críticos que configuran la trayectoria del sector, entre ellos la expansión del mandato de biodiésel (B40–B50), la variabilidad climática asociada a los ciclos El Niño–La Niña, la implementación del Reglamento de la Unión Europea sobre Deforestación (EUDR) y las persistentes brechas de productividad en las plantaciones de pequeños productores. La producción mundial de aceite de palma crudo (CPO) se proyecta en 83 millones de toneladas métricas en 2026, manteniendo Indonesia una participación de mercado del 59%, a pesar de las restricciones a la expansión de la superficie cultivada y de los cuellos de botella en el programa de replantación (Peremajaan Sawit Rakyat – PSR). La intensificación del consumo interno mediante mandatos de bioenergía genera una doble presión sobre la capacidad exportadora y la estabilidad de los ingresos de los agricultores. Las proyecciones de precios oscilan entre USD 1.050 y 1.200 por tonelada métrica, influenciadas por las políticas energéticas, las tensiones geopolíticas y los costos de cumplimiento de los requisitos de sostenibilidad. Los hallazgos temáticos

revelan que el bienestar de los pequeños productores —medido a través de los Términos de Intercambio Agrícola (NTP) y de índices multidimensionales de bienestar— sigue siendo vulnerable a la volatilidad de precios, al acceso limitado a los mercados y a las barreras de certificación. Se proponen seis recomendaciones de política basadas en evidencia, priorizando la aceleración de la replantación (objetivo de 200.000 ha/año), mecanismos de estabilización de precios, rutas subsidiadas para la certificación ISPO, el fortalecimiento de los servicios de extensión, sistemas integrales de monitoreo del bienestar y estrategias de diversificación de ingresos. Esta revisión contribuye a la literatura de economía agrícola al sintetizar corrientes de investigación fragmentadas y proporcionar aportes prácticos para los responsables de políticas públicas que enfrentan el nexo entre sostenibilidad y desarrollo en economías dependientes de commodities.

Palabras clave: Perspectivas del Aceite de Palma. Bienestar de los Pequeños Productores. Política de Biodiésel. Certificación ISPO. Programa de Replantación. Cumplimiento del EUDR. Términos de Intercambio Agrícola. Intensificación Sostenible. Agricultura Indonesia. Adaptación Climática.

1 INTRODUCTION

1.1 BACKGROUND

The global palm oil industry stands at a critical juncture as it enters 2026, navigating between escalating production demands, stringent sustainability requirements, and imperative livelihood concerns for millions of smallholder farmers. Palm oil (*Elaeis guineensis*) has emerged as the world's most efficient vegetable oil crop, accounting for approximately 34% of global vegetable oil production despite occupying less than 10% of total oilseed cultivation area. This exceptional land-use efficiency—yielding 4-5 tons per hectare compared to soybean oil (0.5 tons/ha) and rapeseed oil (0.8-1 ton/ha)—has positioned palm oil as an indispensable commodity in global food systems, oleochemical industries, and increasingly, renewable energy sectors (Varqa, 2025).

Indonesia dominates this landscape as the world's largest producer, contributing approximately 59% of global crude palm oil (CPO) supply in 2025, followed by Malaysia at 24%. The sector's strategic importance to Indonesia's economy extends beyond production volumes: in 2024, palm oil and its derivatives contributed 6.5% to national GDP, employed over 16.8 million people directly and indirectly, and generated USD 25.6 billion in export revenues, making it the most significant contributor to Indonesia's agricultural trade surplus. This economic centrality occurs within a complex socio-environmental context in which approximately 40% of the national palm oil area (6.7 million hectares) is managed by smallholder farmers, whose productivity levels (2-3.5 tons CPO/ha/year) lag significantly behind those of estate operations (4-5 tons/ha) (IPOSS, 2026; Saleh et al., 2021).

Sustainability governance frameworks increasingly shape the contemporary palm oil discourse. The mandatory Indonesian Sustainable Palm Oil (ISPO) certification, effective for all producers by 2025, and the European Union Deforestation Regulation (EUDR), implemented in December 2024 with enforcement beginning in 2025, represent paradigmatic shifts toward traceability-intensive, deforestation-free supply chains. Simultaneously, Indonesia's aggressive bioenergy mandates—progressing from B30 (2019) to B40 (2025) and targeting B50 by mid-2026—are fundamentally restructuring domestic consumption patterns, with non-food utilization projected to reach 39% of total palm oil allocation by 2026 (Halimatussadiah et al., 2021).

1.2 RESEARCH URGENCY

Three interconnected developments underscore the urgency of examining the 2026 palm oil outlook through a welfare-centered lens. First, the biodiesel mandate escalation creates unprecedented domestic absorption pressures. The B40 implementation in 2025

already consumed an additional 2 million tons of CPO; the projected B50 transition in 2026 will require a further 2.2 million tons, collectively absorbing approximately 15-17% of national production. While this policy achieves energy security objectives—reducing diesel imports and supporting Indonesia's Nationally Determined Contributions (NDC) climate commitments—it simultaneously constrains export volumes. It intensifies competition between food and fuel applications, with direct implications for global markets and domestic price dynamics (Sahara et al., 2022).

Second, smallholder farmers face mounting certification and compliance pressures that threaten their market participation. ISPO certification, while improving sustainability credentials, imposes substantial documentation, traceability, and agronomic practice requirements that many independent smallholders—who constitute 95% of smallholder farmers—struggle to meet without external support. The EUDR further compounds these challenges by mandating geolocation data and deforestation-free proof since December 2020, requirements that smallholders with unclear land tenure, fragmented plots, and limited technical capacity find particularly onerous. Early evidence suggests these regulations risk marginalizing rather than empowering smallholders, potentially excluding up to 60% from certified supply chains (Hartono, 2024, 2025).

Third, the sector confronts a looming productivity crisis rooted in aging plantations and inadequate replanting rates. Approximately 3.5 million hectares of Indonesia's palm area comprises trees exceeding 20 years of age—beyond their productive prime—yet annual replanting achievements reach only 30,000-50,000 hectares against targets of 180,000-200,000 hectares. This replanting deficit, combined with climate variability from ENSO (El Niño-Southern Oscillation) cycles, which can reduce yields by 6-10%, threatens to constrain production growth precisely when domestic and global demand intensifies. For smallholder farmers, replanting poses acute welfare challenges: the 3-5 year non-productive period during crop establishment eliminates cash flow, and capital requirements (estimated USD 2,500-3,500 per hectare) exceed most farmers' liquidity (Haniff et al., 2016).

1.3 RESEARCH OBJECTIVES

Against this backdrop, this qualitative literature review pursues three primary objectives. First, we synthesize current scholarly and practitioner knowledge on the palm oil sector outlook for 2026, integrating global supply-demand projections, price forecasts, and policy trajectory analyses to construct a comprehensive narrative of anticipated developments. Second, we systematically identify and analyze key drivers and constraints affecting sector performance, with particular attention to their differentiated impacts on

smallholder versus estate operations, and on welfare outcomes measured through Farmers Terms of Trade (NTP/FTT), income stability, and multidimensional welfare indices. Third, we formulate evidence-based policy recommendations specifically targeting the enhancement of smallholder welfare within the context of the sustainability transition and productivity imperatives (Maria et al., 2023).

This review addresses a critical gap in existing literature: while numerous studies examine discrete aspects of the palm oil sector—sustainability certification, biodiesel economics, smallholder productivity, climate impacts—few integrate these dimensions to assess their collective implications for the 2026 outlook and farmer welfare. By adopting a qualitative literature review methodology that enables thematic synthesis across diverse knowledge sources, we provide policymakers, industry stakeholders, and development practitioners with actionable intelligence for navigating the sector's complex transformation.

2 LITERATURE REVIEW

2.1 THEORETICAL FOUNDATIONS OF PALM OIL ECONOMICS

The economic dynamics of the palm oil sector are best understood through the integration of three theoretical frameworks. **Agricultural commodity market theory** posits that palm oil prices are determined by global supply and demand, with elasticities influenced by substitutability with competing vegetable oils (soybean, rapeseed, sunflower), crude petroleum prices (given biodiesel applications), and speculation in futures markets. Recent literature emphasizes the growing importance of policy-induced demand—particularly biofuel mandates—which creates relatively inelastic demand segments that stabilize floor prices but also transmit policy uncertainty into market volatility (Khatiwada et al., 2021).

Sustainable agricultural intensification (SAI) frameworks provide conceptual grounding for addressing the dual imperative of increasing productivity while minimizing environmental externalities. SAI theory advocates for closing yield gaps through improved agronomic practices, technological adoption, and institutional support rather than land expansion. In palm oil contexts, this translates to replanting with high-yielding varieties, precision fertilizer application, integrated pest management, and optimal harvesting frequencies—interventions that can potentially double smallholder yields from current 2-3 tons/ha to 6-8 tons/ha. However, as Byerlee et al. (2017) note, smallholder intensification requires simultaneous attention to market access, input affordability, technical knowledge, and risk management mechanisms that standard SAI models often overlook (Rahutomo et al., 2023, 2025b).

The **dual-sector development model, originating with Lewis (1954)** and adapted by contemporary rural development scholars, explains **the persistent productivity and welfare gaps between the** smallholder and estate sectors. Smallholders face structural disadvantages: fragmented landholdings limiting economies of scale, restricted access to credit and quality inputs, weak bargaining power in price negotiations with mills, and limited technical extension support. Information asymmetries exacerbate these constraints—smallholders often lack real-time market price data, best-practice knowledge, and certification requirements—creating power imbalances throughout the value chain (Dodson et al., 2019).

2.2 GLOBAL PALM OIL PRODUCTION AND SUPPLY CHAIN DYNAMICS

Global palm oil production exhibits extreme geographic concentration, with Indonesia and Malaysia collectively accounting for 83-85% of world output. This duopoly structure creates unique market dynamics: supply disruptions in either country disproportionately affect global availability and prices. At the same time, their production policies (land-use regulations, biodiesel mandates) effectively set global market conditions. Production forecasts for 2026 project global CPO output at 83 million metric tons, representing 2.7% growth from 2025's estimated 80.8 million tons. This modest expansion reflects slowing area growth due to moratoriums on new plantations in both Indonesia (Presidential Instruction No. 8/2018) and Malaysia, and a shifting emphasis toward productivity enhancement rather than land expansion (Zhao et al., 2023).

Climate variability, particularly ENSO cycles, has emerged as a critical determinant of production in recent literature. Historical analysis reveals that strong El Niño events (characterized by rainfall below 100mm/month for extended periods) reduce Fresh Fruit Bunch (FFB) yields by 6-10% with lag effects appearing 10-24 months post-event due to palm physiological responses (inflorescence abortion, altered sex ratios). Conversely, La Niña events with excessive rainfall (>300mm/month) also depress yields by 4-6% through waterlogging and the proliferation of root diseases. The 2023-2024 El Niño significantly impacted 2024-2025 production, but projections for 2026 indicate neutral to mild La Niña conditions, suggesting improved growing conditions and potential yield recovery (Kamil & Omar, 2016, 2017).

Technological frontiers in palm oil production increasingly center on precision agriculture, genetic improvement, and mechanization. Adoption of remote sensing for precision fertilization, drone-based pest monitoring, and digital traceability platforms offers pathways to enhance yields while meeting sustainability standards. However, technology diffusion remains highly uneven: while estates rapidly adopt innovations, smallholder uptake

is constrained by capital requirements, digital literacy, and inadequate extension services(Reich & Musshoff, 2025).

2.3 CONSUMPTION PATTERNS AND DEMAND DRIVERS

Global palm oil consumption is projected to reach 85.9 million tons in 2025, rising to approximately 87-88 million tons in 2026, driven by fundamental shifts in utilization patterns. The food-versus-non-food allocation ratio has evolved from 70:30 in 2015 to approximately 60:40 in 2026, reflecting the global expansion of bioenergy policy. Major consuming regions exhibit distinct dynamics: India remains the largest importer (8-9 million tons annually), driven by population growth and rising incomes, with palm oil preferred for its affordability relative to soybean and sunflower oils. China's consumption (7-8 million tons) is growing more slowly as domestic oilseed production intensifies, while European Union demand contracts due to EUDR restrictions and sustainability concerns(IPOSS, 2026; Mai, 2024).

Bioenergy mandates constitute the most dynamic demand component. Indonesia's B50 program will absorb 13-15 million tons of CPO domestically by 2026, compared to 8 million tons under B30 in 2020. Malaysia similarly targets biofuel expansion, while regional programs in the Philippines, Thailand, and Colombia contribute incremental demand. The Sustainable Aviation Fuel (SAF) segment, though nascent, presents longer-term demand potential, with palm-based biojet fuel certified for commercial aviation and multiple Indonesian producers investing in capacity. However, SAF adoption faces headwinds from EUDR restrictions on feedstock sourcing, which limit access to the European market (Hicks, 2025).

Emerging market demand in Africa and South Asia drives consumption growth projections. Africa's palm oil imports are forecast to reach 6-7 million tons by 2026, up from 5.2 million in 2023, fueled by rapid urbanization, changing dietary patterns, and limited domestic production capacity. Pakistan's imports are similarly projected to grow 3.4% annually through 2026 due to stagnant domestic oilseed production and widening supply-demand gaps(IPOSS, 2026; Varqa, 2025).

2.4 SUSTAINABILITY GOVERNANCE AND CERTIFICATION

The palm oil sustainability governance landscape has transformed dramatically over the past five years, transitioning from voluntary corporate commitments toward mandatory regulatory frameworks. Indonesia's ISPO certification, revised in 2020 (Presidential Regulation No. 44/2020) and mandated for all producers by 2025, encompasses seven principles: legal compliance, management systems, environmental protection, labor rights, social responsibility, business sustainability, and continuous improvement. As of 2024,

approximately 30% of Indonesia's total palm oil production is ISPO-certified, with estate certification rates near 60% but independent smallholder certification below 15% (Judijanto, 2025b).

Empirical evidence on ISPO's economic impacts is mixed. Studies report that ISPO-certified smallholders achieve 12-18% higher FFB prices and 82% higher productivity than non-certified peers, attributable to improved agronomic practices, better market access, and mill preferences for certified suppliers. However, certification costs—estimated at USD 50-150 per hectare for group certification—combined with documentation burdens, create formidable barriers for resource-constrained smallholders. Group certification models facilitated by cooperatives or NGOs show promise in reducing per-farmer costs and providing technical assistance, yet adoption remains limited (Erdi et al., 2025).

The EUDR, initially planned to take effect in December 2024, represents the most stringent market-access regulation to date, prohibiting palm oil products derived from land deforested after December 2020 from entering EU markets. Operators must provide geolocation coordinates, conduct due diligence assessments, and demonstrate compliance with the laws of the origin country. For Indonesia, where EU exports constitute 8-12% of total volumes, EUDR implications extend beyond direct market losses: they establish it precedent for other importing regions and incentivize supply chain restructuring toward larger, certified producers, at the potential expense of smallholder inclusion. Critiques emphasize EUDR's disproportionate burden on smallholders who lack GPS equipment, land title documentation, and the technical expertise to generate the required evidence, particularly in remote areas (Rochmyaningsih, 2024).

2.5 SMALLHOLDER FARMERS AND WELFARE ECONOMICS

Smallholder farmers in Indonesia's palm oil sector comprise three categories: **plasma farmers** linked to estates through government schemes (5-10% of smallholders), **independent contract farmers** with informal mill relationships (10-15%), and **independent smallholders** operating autonomously (75-80%). This heterogeneity generates significant welfare disparities. Plasma farmers benefit from technical support, input credit, and guaranteed FFB purchases at regulated prices, achieving average yields of 3.5-4 tons CPO/ha. Independent smallholders, conversely, average 2-3 tons/ha, face price discrimination from middlemen who pay 15-30% below reference prices, and bear full production risks without support systems (Sokoastri et al., 2019).

Farmers' Terms of Trade (NTP/FTT) serves as Indonesia's primary agricultural welfare indicator, calculated as the ratio of the price indices for products sold (output

prices) to the price indices for inputs purchased (input costs plus household consumption). NTP values above 100 indicate improving welfare; below 100 signals declining purchasing power. The national NTP for palm oil farmers averaged 108-112 during 2020-2024, higher than for food crop farmers (95-100) and livestock farmers (98-102), reflecting palm oil's relatively favorable price trends. However, regional variations are substantial: palm-growing provinces like Riau and Jambi recorded NTP of 115-125, while marginal areas showed NTP below 100, indicating welfare heterogeneity even within the sector (Arintoko et al., 2024).

Recent literature emphasizes multidimensional welfare measurement beyond income metrics, incorporating education access, health outcomes, food security, housing quality, and social protection. Longitudinal studies document that palm oil cultivation significantly improves household welfare compared to alternative livelihoods, with palm-growing villages showing 20-30% higher welfare indices than non-palm communities. However, these gains concentrate among farmers with sufficient land (>3 hectares), access to capital for optimal input use, and market connectivity; marginal farmers (1-2 hectares) often remain near the poverty line despite palm cultivation (Maridjo & Ignasiak-Szulc, 2023).

Income diversification emerges as a critical determinant of welfare. Farmers depending solely on palm income face acute vulnerability to price volatility and yield fluctuations; those integrating palm with rubber, livestock, or off-farm employment achieve more stable livelihoods. Intercropping during palm establishment phases (immature period) and underplanting during replanting offer pathways to maintain cash flow. Yet, adoption rates remain low due to technical complexity and limited extension guidance (Yuda & Kühner, 2023).

2.6 POLICY LANDSCAPE AND INSTITUTIONAL FRAMEWORKS

Indonesia's palm oil policy architecture reflects competing objectives: maximizing export revenues, ensuring affordable domestic supply, promoting sustainability, and enhancing farmer welfare. The **downstreaming (*hilirisasi*)** policy, intensified since 2020, prohibits raw CPO exports (with limited quotas) to incentivize domestic processing into refined products, oleochemicals, and biodiesel. This strategy aims to capture value-added margins and foster industrialization, with some success: refined palm oil product exports grew from 40% of total exports in 2015 to 65% in 2024. However, critics argue that *hilirisasi* creates artificial market distortions, limits smallholder access to international prices, and concentrates benefits among large integrated companies (Lestari et al., 2025).

Price stabilization mechanisms include reference price systems (*Harga Acuan*), export levies (*Badan Pengelola Dana Perkebunan/BPDP*), and domestic market obligations

(DMO), which require exporters to allocate portions to domestic markets. The export levy, set at USD 200/MT for CPO in 2022, funds biodiesel subsidies when CPO prices exceed diesel prices, ensuring B30-B50 implementation remains economically viable. This mechanism, while supporting biofuel programs, reduces farmer FFB prices by 8-12% as mills deduct levy costs, creating welfare tensions (Adiatma & Prasoj, 2021).

Replanting programs (PSR) receive policy priority given productivity imperatives, with government targets of 180,000 hectares annually through 2030. However, implementation lags severely: the 2020-2024 average achievement reached only 35,000 ha/year, reflecting smallholder reluctance due to income losses during 3-5-year non-productive periods, inadequate subsidy amounts (covering ~40% of total costs), and bureaucratic delays in fund disbursement. Successful PSR models involve partnerships between smallholders, cooperatives, mills, and financial institutions, providing advance payments, technical assistance, and intercropping support during replanting—yet these remain pilots rather than mainstream (Ridani et al., 2023).

International policy coordination focuses on market access negotiations and the harmonization of sustainability standards. Indonesia actively engages in WTO dispute mechanisms and bilateral dialogues to counter perceived discriminatory regulations, such as EUDR. The government advocates recognizing ISPO as equivalent to European standards and exempting smallholders from geolocation requirements, arguing that capability-building rather than exclusion better serves sustainability objectives (Jong, 2025).

3 METHODOLOGY

3.1 RESEARCH DESIGN: QUALITATIVE LITERATURE REVIEW

This study employs a **qualitative literature review** methodology, distinct from systematic reviews in its interpretive flexibility and narrative synthesis approach. While systematic reviews prioritize exhaustive searching and statistical meta-analysis of homogeneous empirical studies, qualitative reviews accommodate diverse source types—scholarly articles, policy reports, industry analyses—and enable the thematic integration of heterogeneous evidence suited to complex, multi-stakeholder phenomena like the palm oil sector outlook (IPOSS, 2026). This methodological choice aligns with our objectives to synthesize fragmented knowledge across disciplines (agricultural economics, environmental science, development studies, policy analysis) and generate actionable policy insights rather than effect-size estimates (Barisau et al., 2024).

The review framework adapts elements of scoping review methodology, particularly its emphasis on mapping knowledge landscapes, identifying gaps, and clarifying key concepts.

We prioritize breadth of coverage across global production dynamics, consumption trends, policy drivers, sustainability governance, and welfare outcomes, ensuring comprehensive representation of factors shaping the 2026 outlook. The thematic analysis strategy guides our synthesis, involving iterative coding of sources to identify recurring patterns, conflicting evidence, and emergent themes that structure our findings (Astari et al., 2025).

3.2 DATA SOURCES AND SELECTION CRITERIA

Primary sources comprise peer-reviewed journal articles indexed in the Scopus and Web of Science databases, selected for their rigorous peer-review processes and adherence to international research standards. Inclusion criteria specify:

- Publication period: January 2020 to December 2025 (ensuring currency while capturing pre-pandemic baseline through post-pandemic recovery)
- Geographic focus: Indonesia, Malaysia, and global palm oil systems
- Topical relevance: palm oil production, consumption, pricing, sustainability, farmer welfare, biodiesel policy, certification impacts
- Methodological quality: empirical studies with transparent methods; conceptual papers from recognized scholars

We identified 68 Scopus/WoS-indexed articles through database searches, supplemented by citation tracking of seminal works (Abubakar et al., 2021).

Secondary sources include authoritative grey literature essential for policy and market analysis contexts:

- Government agencies (such as BPS Indonesia, Ministry of Agriculture, BMKG)
- International organizations (such as USDA, FAO-OECD, World Bank, IMF, IEA)
- Industry agency or associations (such as GAPKI, MPOA, MPOB)
- NGOs and research institutes (such as WRI, CIFOR, Solidaridad)
- Market intelligence firms (such as Fastmarkets, MARC Ratings)

Secondary sources provide indispensable data (production forecasts, price projections, policy announcements) unavailable in the peer-reviewed literature due to publication lags. At the same time, government reports offer official statistics and policy frameworks (Wong et al., 2025).

Exclusion criteria: purely technical agronomic studies without economic/welfare dimensions; palm oil health/nutrition debates peripheral to the sector outlook; editorials/opinion pieces lacking empirical grounding; sources in languages other than English or Indonesian; expired forecasts superseded by recent data.

3.3 SEARCH STRATEGY AND KEYWORDS

Database searches employed Boolean combinations of core terms across three thematic clusters:

Cluster 1 (Commodity/Sector): "palm oil" OR "crude palm oil" OR "CPO" OR "oil palm" OR "*Elaeis guineensis*."

Cluster 2 (Geographic): "Indonesia" OR "Malaysia" OR "Southeast Asia" OR "global" OR "international."

Cluster 3 (Thematic): "outlook" OR "forecast" OR "projection" OR "productivity" OR "yield" OR "smallholder" OR "farmers welfare" OR "biodiesel" OR "biofuel" OR "sustainability" OR "certification" OR "ISPO" OR "RSPO" OR "EUDR" OR "deforestation" OR "climate" OR "El Nino" OR "replanting" OR "rejuvenation" OR "price" OR "policy"

Searches in Scopus and Web of Science applied filters: peer-reviewed articles, English/Indonesian language, publication years 2020-2025, subject areas Agricultural & Biological Sciences, Environmental Science, Economics/Econometrics, Social Sciences. This yielded 287 initial results, reduced to 68 after abstract screening for relevance. Google Scholar was used to supplement database searches for grey literature, using simplified keyword combinations and filtering by publication type (Moeis et al., 2020).

3.4 DATA EXTRACTION AND SYNTHESIS

Thematic coding framework structured data extraction, with six primary codes corresponding to outline sections: (1) Global Supply Dynamics, (2) Demand Drivers, (3) Price Outlook, (4) Sustainability Governance, (5) Smallholder Welfare, (6) Policy Frameworks. Sub-codes captured specific concepts (e.g., replanting barriers, ISPO impacts, EUDR compliance challenges, NTP trends). Two reviewers independently coded sources, with discrepancies resolved through discussion (Bastidas-Orrego et al., 2023).

Quality assessment applied differentiated criteria by source type. Peer-reviewed articles were evaluated on: research design rigor, sample representativeness, analytical method appropriateness, and transparency of limitations. Government and international organization reports were assessed on: data source credibility, methodological documentation, and independence from vested interests. Industry analyses were triangulated with academic sources to identify potential biases (Koutsos et al., 2019).

Narrative synthesis integrated coded evidence thematically rather than through meta-analysis. For each theme, we identified consensus findings, noted divergent evidence and explained heterogeneity, and highlighted knowledge gaps. Contradictory evidence (e.g., varying ISPO impact assessments) prompted a contextual analysis of study conditions

(region, farmer type, certification model), which explained the discrepancies. Synthesis prioritized actionable insights, particularly by translating academic findings into policy-relevant recommendations (Barisoux et al., 2024).

3.5 LIMITATIONS

This review acknowledges several limitations. **Temporal scope** constraints mean forecasts for 2026 inherently contain uncertainty, subject to unforeseen events (geopolitical shocks, extreme weather, policy reversals). We mitigate this by using scenario thinking and appropriately qualifying projections. **Language and geographic bias** may underrepresent non-Anglophone research and local knowledge, though inclusion of Indonesian-language government reports partially addresses this. **Publication lag** means most peer-reviewed articles reflect data from 2023 or earlier; we compensate by prioritizing recent grey literature for current developments. **Qualitative-quantitative trade-offs** mean we forego the statistical precision of meta-analyses for broader thematic integration, which is appropriate for our exploratory, synthesis-oriented objectives. Finally, our **smallholder welfare focus** may underweight estate-sector perspectives; this reflects a deliberate prioritization of welfare concerns, but readers should recognize the incomplete representation of industry viewpoints.

4 RESULTS: THEMATIC FINDINGS ON PALM OIL OUTLOOK 2026

4.1 GLOBAL SUPPLY-DEMAND BALANCE PROJECTIONS

Global CPO production is forecast to reach **83 million metric tons in 2026**, representing 2.7% growth from 2025's 80.8 million tons. This recovery trajectory follows the 2024 production dip caused by 2023-2024 El Niño impacts, with meteorological forecasts suggesting neutral to weak La Niña conditions in 2025-2026 supporting yield normalization. Indonesia's output is projected at **48-49 million tons** (59% global share), while Malaysia targets **19-20 million tons** (24%). Other producers—Thailand (3.5 million tons), Colombia (1.8 million tons), Nigeria (1.2 million tons)—contribute marginally, constrained by infrastructure limitations, aging plantations, and climate vulnerabilities (IPOSS, 2026; Kamil & Omar, 2016, 2017).

Demand projections indicate global consumption of **87-88 million tons in 2026**, exceeding production by 4-5 million tons and necessitating stock drawdowns. This tightness reflects intensified domestic absorption in producer countries—Indonesia's B50 mandate alone consumes an incremental 2.2 million tons—and sustained import growth in India (projected 9.2 million tons, +3.5% YoY), Africa (6.8 million tons, +4.2%), and Pakistan (3.6 million tons, +3.4%). Conversely, EU imports continue to decline (2.2 million tons in 2026, -

8% from 2024) due to EUDR constraints and biodiesel policy reversals (Benedict & Heilmayr, 2024; IPOSS, 2026).

Stock-to-use ratios are projected to tighten to **6.8%** in 2026 from 7.2% in 2025, near the critical 7% threshold below which price volatility intensifies. This structural tightness underpins price support but also magnifies supply disruption risks from weather events or policy shocks (IPOSS, 2026; Varqa, 2025).

4.2 PRICE OUTLOOK AND VOLATILITY FACTORS

Baseline price scenarios for 2026 position CPO in the **USD 1,050-1,200 per metric ton** range (FOB Malaysia), reflecting balanced supply-demand fundamentals with upside risks. This represents 5-8% appreciation from 2025 average prices (USD 1,000-1,050/MT) but remains below 2022's peaks (USD 1,400-1,500/MT) driven by Ukraine war-induced vegetable oil shortages. Indonesian domestic prices (CPO Medan) are expected to track global benchmarks, with 3-5% discounts due to export levies and domestic market obligations (IPOSS, 2026; Wong et al., 2025).

Crude oil correlation remains significant, with biodiesel applications creating structural linkages. Brent crude forecasts of USD 75-85/barrel in 2026 (base case) support palm oil demand from biofuel blending programs, as palm biodiesel maintains cost competitiveness versus fossil diesel at these price ratios. However, downside oil price scenarios (USD 60-70/barrel) could weaken biodiesel economics and reduce non-food palm oil demand by 5-8% (IPOSS, 2026; Sahara et al., 2022).

Geopolitical risks constitute key uncertainties. US-China trade tensions, Middle East conflicts affecting shipping routes through the Straits of Malacca and the Suez Canal, and potential supply chain disruptions could generate 10-15% price spikes. Conversely, synchronized global economic slowdowns, reducing demand growth, represent downside risks (Varqa, 2025; Wong et al., 2025).

EUDR compliance costs—estimated at USD 30-50 per ton for certified, traceable palm oil—create two-tier pricing structures, with certified supplies commanding premiums. At the same time, non-compliant volumes face discounts or market exclusion. This fragmentation is projected to gradually reduce non-certified producers' access to premium markets, potentially depressing smallholder prices if they cannot achieve certification (Iswara et al., 2023).

4.3 INDONESIA'S PRODUCTION AND PRODUCTIVITY LANDSCAPE

Indonesia's **16.8 million-hectare** palm area has stagnated since 2019 due to the Presidential moratorium (*Inpres 8/2018*) on new permits for primary forest and peatland conversion. Production growth thus depends entirely on productivity enhancement. Yet, national average yields remain at **3.5 tons CPO/ha/year**, far below the genetic potential of 6-8 tons/ha achieved by well-managed estates. This **yield gap** disproportionately affects smallholders (2-3 tons/ha) due to suboptimal agronomic practices, aged palms, insufficient fertilization, and delayed harvesting (IPOSS, 2026; WWF, 2023).

Approximately **3.5 million hectares (21% of the total area)** comprise palms that are 25 years or older and require urgent replanting. However, 2020-2024 achievements averaged only **35,000-50,000 hectares annually** against targets of 180,000 hectares, reflecting smallholder reluctance (due to income loss during non-productive periods), inadequate subsidies (covering only 30-40% of USD 2,500-3,500/ha costs), and bureaucratic delays. This **replanting deficit** threatens production stagnation: modeling by Austin et al. (2023) demonstrates that, absent 4% annual replanting rates, Indonesian production could decline by 15-20% through 2035 despite stable area (Hutajulu, 2023; IPOSS, 2026).

Climate vulnerability compounds productivity challenges. The 2023-2024 El Niño reduced yields in 2024-2025 by 8-12% in affected regions due to water-stress-induced flower abortion. While 2026 projections assume yield recovery under neutral conditions, longer-term climate change scenarios indicate an increasing frequency of extreme ENSO events, necessitating adaptation strategies (irrigation expansion, stress-tolerant varieties, improved soil moisture management) (Fleiss et al., 2017).

4.4 DOMESTIC CONSUMPTION AND POLICY DRIVERS

Indonesia's domestic palm oil consumption is projected at **27.67 million tons in 2026**, comprising **13.5-15 million tons for biodiesel**, **11-12 million tons for food**, and **2-3 million tons for oleochemicals**. The **B50 mandate** implementation by mid-2026 drives a **2.2 million ton incremental increase** over B40 levels, absorbing approximately **30-31% of total national bioenergy production**, compared to 20% under B30 in 2020 (Siregar et al., 2024).

This domestic absorption intensification creates a **fundamental structural shift**: Indonesia transitions from a net exporter focused on maximizing export volumes to a domestically-oriented consumer balancing export revenues with energy security and industrial feedstock requirements. Modeling by Dermawan et al. (2022) estimates that B30-B50 escalation would generate 10,000-15,000 direct jobs in biodiesel manufacturing and reduce diesel import bills by USD 3-4 billion annually, thereby achieving macroeconomic

objectives. However, these gains entail trade-offs: **reduced export availability** (projected at 20-21 million tons in 2026 versus 24-25 million tons under B30 scenarios) foregoes an estimated USD 2-3 billion in potential export revenues at prevailing price levels (Siregar et al., 2024).

Food security and the management of cooking oil prices remain politically sensitive. Government cooking oil price caps (HET—*Harga Eceran Tertinggi*) and bulk cooking oil programs aim to protect consumer affordability, periodically requiring subsidized domestic sales that depress farmer FFB prices by 5-10%. The food-fuel competition intensifies during global price surges, as witnessed in 2022, when cooking oil shortages prompted temporary export bans and domestic price interventions (Arumdhani, 2025).

4.5 EXPORT MARKET DYNAMICS AND TRADE POLICIES

India dominates Indonesia's export destinations, absorbing approximately **8.5-9 million tons annually** (40-42% of Indonesian exports), driven by affordability advantages over soybean and sunflower oils and regulatory preferences for palm oil in food manufacturing. Indian import demand is growing at 3-4% annually, supported by population expansion and rising per capita consumption, providing stable market access for Indonesian producers. However, India's domestic oilseed production initiatives and periodic import tariff adjustments (ranging from 0-15% on crude palm oil to 20-30% on refined products) introduce volatility (IPOSS, 2026; Varqa, 2025).

China remains a significant but mature market, importing **5.5-6 million tons** with minimal growth projected for 2026 as domestic rapeseed and soybean oil production expands. **African markets** represent the fastest-growing segment, with collective imports projected to grow 4-5% annually, reaching **6.8 million tons in 2026**. Nigeria, Egypt, and East African countries drive this expansion through urbanization, growth of the processed food sector, and limited domestic vegetable oil production capacity (IPOSS, 2026; Varqa, 2025).

European Union imports have declined sharply from 3.5 million tons (2018) to a projected **2.2 million tons in 2026**, reflecting EUDR implementation, biodiesel sustainability criteria under RED II/III directives restricting palm-based biofuels, and consumer pressure on retailers. This market contraction eliminates Indonesia's premium-priced European segment, redirecting volumes to Asian and African markets at lower average prices, contributing to **2-3% overall export price erosion** (IPOSS, 2026; Mai, 2024).

4.6 SUSTAINABILITY TRANSITION AND CERTIFICATION PROGRESS

ISPO adoption has accelerated under mandatory compliance deadlines, with **30% of national production certified by the end of 2024** and targets of **50% by 2026**. Estates demonstrate higher certification rates (**55-60%**) **than** smallholders (**12-15%**), reflecting resource and capability disparities. Group certification models show promise: studies document that cooperative-facilitated ISPO certification enables **50-100 smallholders** per group to achieve certification at **per-farmer costs of USD 25-40**, compared to USD 100-150 for individual certification, while also providing technical training and market linkage benefits (Hartono, 2025; Judijanto, 2025b).

Empirical evidence on **ISPO economic impacts** indicates certified smallholders receive **8-12% FFB price premiums** from mills preferring certified supply, and achieve **15-20% higher yields** through improved practices mandated by standards (optimal fertilizer application, integrated pest management, harvest frequency optimization). However, these benefits accrue primarily to plasma and organized independent smallholders; truly independent farmers without organizational links struggle to access certification pathways (Rahutomo et al., 2023, 2025a).

Deforestation-free supply chain initiatives intensify under EUDR and corporate commitments. Analysis of RSPO-certified mill supply sheds reveals **independent smallholders contributed 33% of regional palm area but only 7% of certified supply**, indicating severe exclusion from sustainability-premium markets. Traceability systems linking individual smallholder plots to final products remain technologically and institutionally challenging, requiring GPS mapping, digital record-keeping, and third-party verification that exceed most smallholder capacities (Eggen et al., 2024; Ekaputri et al., 2025).

4.7 SMALLHOLDER FARMERS WELFARE OUTLOOK

Income projections under baseline price scenarios (USD 1,050-1,200/MT CPO) translate to smallholder FFB prices of **IDR 1,800-2,200 per kilogram** (approximately USD 0.12-0.15/kg), assuming standard oil extraction rates (OER) of 20-22% and mill-farmer price transmission of 70-75%. For a typical 3-hectare smallholder farm producing 10-12 tons FFB/ha/year, this yields an annual gross income of IDR 60-80 million (USD 4,000-5,300), placing farmers at 2-2.5 times the provincial minimum wage in major palm-growing regions. However, net income after production costs (fertilizer, hired labor, transport) and household consumption needs yields disposable incomes of IDR 35-50 million (USD 2,300-3,300), barely sufficient for a lower-middle-income livelihood (Judijanto & Pamungkas, 2024).

Price volatility remains a critical welfare threat. FFB price fluctuations of 20-30% within annual cycles (due to seasonal production patterns, global market swings, and domestic policy changes) create income unpredictability, undermining consumption smoothing and investment capacity. Studies demonstrate that a **10% decline in CPO prices** reduces smallholder FFB prices by approximately **7-8%** due to asymmetric price transmission (price increases transmit faster than decreases), with **elasticity values of 0.7-0.8** indicating inelastic transmission. This asymmetry benefits mills at the farmer's expense during price downturns (Lifianthi et al., 2022).

Farmers' Terms of Trade (NTP) for palm oil farmers averaged 108-115 nationwide in 2024, indicating modest gains in purchasing power. However, regional heterogeneity is pronounced: Riau and Jambi provinces show NTP of **120-135**, while marginal areas like Aceh and West Kalimantan record **95-105**, reflecting differential market access and input cost structures. Projections for 2026 suggest NTP stability in the **110-118 range** under baseline scenarios, but downside risks (input cost inflation, CPO price weakness) could push NTP below 100, signaling welfare deterioration (Asdep Setkab, 2025; IPOSS, 2026).

Multidimensional welfare indicators from longitudinal studies confirm palm-growing households demonstrate **20-30% higher welfare scores** than non-palm counterparts on composite indices incorporating income, education, health, housing, and food security. However, these gains concentrate among farmers with **>3 hectares, organizational membership, and market access**; marginal farmers (<2 hectares, remote locations) show welfare levels **only 5-10% above non-palm households**. Off-farm income diversification correlates strongly with welfare stability: households deriving **30-40% income from non-palm sources** exhibit **15-20% lower income volatility** and better food security than palm-monocrop households (IPOSS, 2026; Roswaldy, 2025).

5 DISCUSSION AND ANALYSIS

5.1 SYNTHESIS OF SUPPLY-SIDE CONSTRAINTS

The convergence of evidence indicates that Indonesia's palm oil sector faces a productivity trilemma: constrained land expansion, inadequate replanting rates, and persistent yield gaps collectively threaten its capacity for production growth. Land availability restrictions—imposed through moratoriums and sustainability commitments—represent rational environmental policy, yet without compensatory productivity enhancements, they impose production ceilings. The replanting deficit emerges as the most acute bottleneck: at current 40,000 ha/year rates, addressing the 3.5 million-hectare backlog would take 87 years, during which aging plantations would progressively lose productivity. This pace is

fundamentally incompatible with domestic consumption growth (B50 mandate) and export commitments (Zhao et al., 2023).

Climate vulnerability compounds supply uncertainties. While the 2026 outlook appears favorable due to neutral ENSO conditions, medium-term projections (2027-2030) indicate **70% probability of at least one moderate-to-strong El Niño event**, potentially reducing production by 3-5 million tons. Adaptation strategies—drought-resistant varieties, irrigation infrastructure, soil moisture management—require **5-10 year lead times** for development and deployment, yet receive inadequate research and development funding and extension support (Kamil et al., 2024).

Smallholder productivity gaps, while widely documented, reflect multidimensional constraints: capital limitations that prevent optimal fertilization (smallholders apply 60-70% of recommended NPK rates), knowledge deficits in precision agriculture, delayed harvesting that reduces oil content by 15-20%, and suboptimal planting densities. Addressing these gaps demands integrated interventions—technical training, affordable credit, input supply assurance, and quality seedling access—rather than isolated extension programs that current systems provide (Rahman et al., 2025).

5.2 DEMAND-SIDE TRANSFORMATIONS

The biodiesel mandate's escalation from B30 to B50 within 5 years represents an unprecedented velocity of energy transition policy, absorbing **7 million additional tons of CPO annually** (equivalent to 35% of 2020 exports). While achieving energy security and climate objectives, this policy generates several unintended consequences. First, it **reduces price transmission** from global markets to domestic farmers. During periods when international CPO prices spike, Indonesian farmers benefit less because domestic mills procure volumes for subsidized biodiesel at capped prices. Second, it creates **strategic vulnerabilities**: domestic production shortfalls would require biodiesel mandate reductions (undermining energy security) or CPO imports (contradicting producer-country status), both politically unpalatable (Zafriana et al., 2021).

The food-fuel competition manifests acutely during supply disruptions. The 2022 cooking oil crisis, when the B30 mandate combined with the export surge depleted domestic stocks, necessitated emergency export bans and bulk oil subsidy programs costing **IDR 15 trillion (USD 1 billion)**. Projections suggest **B50 leaves only a 2-3 million ton buffer** above minimum domestic food requirements; weather-induced production shortfalls of 5-10% would immediately trigger similar crises (Arumdhani, 2025; IPOSS, 2026).

Demand diversification toward Africa and South Asia offers strategic market reorientation for European access contracts. However, these markets operate on narrower margins: African importers are highly price-sensitive, paying **USD 30-50/ton less** than European buyers, while credit risk and shipping costs are higher. This margin compression transfers economic benefits from producers to consumers, potentially reducing farmer welfare by 5-7% relative **to pre-EUDR market structures** (Mai, 2024).

5.3 POLICY COHERENCE AND INSTITUTIONAL CHALLENGES

Indonesia's palm oil governance is characterized by policy fragmentation across multiple ministries, with overlapping and sometimes conflicting mandates. Replanting programs exemplify coordination failures: One agency provides planting subsidies, but others may restrict land use; one institution adjudicates tenure, while financing requires coordination with banks. This institutional complexity generates **18-24 month delays** between smallholder applications and fund receipt, during which time farmers often abandon replanting plans (Judijanto, 2025a; Ridani et al., 2023).

The **downstreaming policy**, while increasing value addition, creates distortions disadvantaging farmers. Export restrictions depress domestic CPO prices **8-12% below export parity**, transferring rents from farmers to refiners and oleochemical manufacturers. Analysis suggests that **smallholders lose an estimated IDR 200-300 per kilogram of FFB (USD 0.013-0.020) due to downstream-induced price depression, aggregating to USD 400-600 million annually in foregone farmer income** (Lestari et al., 2025).

The ISPO certification policy, despite its mandatory status, lacks enforcement mechanisms and farmer support infrastructure. Only **3 of 34 provinces** have fully operationalized Provincial ISPO Commissions responsible for certifying independent smallholders; technical assistance programs reach fewer than **20% of target farmers**. Consequently, the 2025 deadline will likely result in selective enforcement against large producers while smallholders receive de facto exemptions, undermining the credibility and market recognition of ISPO (Judijanto, 2025b, 2025c).

5.4 FARMERS WELFARE ENHANCEMENT PATHWAYS

The welfare literature converges on **productivity improvement as the primary driver of welfare: a 1-ton/ha yield increase translates into approximately IDR 10-15 million (USD 650-1,000) in additional annual income** per 3-hectare farm, a **25-35% income boost**. This effect dominates price impacts—a **10% CPO price increase** generates only a **7-8% increase in farmer income** due to price transmission inefficiencies. Therefore,

welfare strategies must prioritize yield-enhancing interventions: replanting with high-yield varieties (potential 80-100% yield gains), precision fertilization (30-40% gains), and harvest optimization (15-20% gains)(IPOSS, 2026; Varwasih et al., 2025).

Price stabilization mechanisms demonstrate mixed welfare impacts. Reference price systems provide price floors during downturns, preventing catastrophic income collapses, but also cap prices during boom periods, limiting upside income potential. Studies suggest that farmers prefer moderate price stability with upside flexibility over rigid price controls; price band systems (floor + ceiling) that balance these objectives merit exploration (Judijanto & Pamungkas, 2024).

Access to certification represents a **welfare bifurcation point**: certified smallholders earn **15-20% higher incomes** through premiums and productivity gains, while non-certified farmers face progressive market exclusion and price discounts. This creates urgency for **inclusive certification pathways**: subsidized group certification, mobile certification teams, simplified documentation requirements, and integration with existing farmer organizations (cooperatives, farmer groups)(Erdi et al., 2025; Wibowo et al., 2023).

Income diversification strategies—intercropping during immature/replanting phases, livestock integration, off-farm employment—reduce welfare volatility. Farmers pursuing **diversification strategies achieve 20-30% lower income variance** and maintain consumption during palm income shocks. However, extension services rarely promote diversification, reflecting monoculture bias in training curricula(Prayoga & Harahap, 2025).

5.5 SUSTAINABILITY-ECONOMIC GROWTH NEXUS

The sustainability transition's welfare implications exhibit a **temporal paradox**: short-term costs (certification expenses, compliance investments, market access restrictions) fall on current smallholders, while long-term benefits (market access preservation, premium prices, ecosystem services) accrue over decades and are broadly distributed. This temporal mismatch generates resistance, particularly among aging farmers (average age 50-55 years) facing 5-10-year payback periods that exceed their farming horizons(Reich & Musshoff, 2025).

EUDR's design reveals a **capacity-compliance gap**: requirements appropriate for well-resourced corporations exceed smallholder capabilities, creating de facto exclusion despite formal market access. Studies document that **fewer than 25% of independent smallholders possess land title documents, less than 10% can provide GPS coordinates, and virtually none maintain multi-year production records** that EUDR due diligence demands. Without substantial capacity-building investments and phased

implementation, EUDR will **exclude 50-70% of smallholders from EU-destined supply chains**(Ekaputri et al., 2025).

Certification's welfare impacts are **conditional on market structure**: in competitive procurement environments where multiple mills compete for supply, certified farmers capture premiums and benefits. However, in monopsony or oligopsony settings where 1-2 mills dominate local catchments, mills appropriate certification benefits through lower FFB prices, leaving farmers with certification costs but minimal gains. This underscores the necessity of **competition policy and farmer bargaining power** as complements to certification initiatives(Judijanto & Pamungkas, 2024).

5.6 CRITICAL ANALYSIS OF 2026 OUTLOOK SCENARIOS

Optimistic scenario (30% probability): Global CPO prices reach **USD 1,150-1,250/MT** due to tighter-than-expected supply (weather disruptions in Malaysia, slower production recovery), robust demand (accelerated biofuel mandates globally, Indian import surge), and geopolitical risk premiums. Indonesian production reaches 49.5 million tons, driven by favorable weather and accelerated replanting, reaching **80,000 ha** in 2025-2026. B50 implementation proceeds smoothly, biodiesel exports commence to regional markets, and ISPO certification reaches **40% coverage**, improving market access. Under this scenario, smallholder NTP reaches **115-120**, with **per capita incomes rising by 12-15%**, and **poverty rates in palm-growing regions declining by 2-3 percentage points** (IPOSS, 2026; Syahza et al., 2018, 2023).

Pessimistic scenario (25% probability): CPO prices fall to **USD 950-1,050/MT** due to synchronized global economic slowdown reducing demand, oversupply from unexpected production surges, and trade barriers restricting market access. Indonesian production stagnates at **47.5 million tons** due to delayed La Niña effects or pest/disease outbreaks. B50 implementation delays due to biodiesel quality issues or fiscal constraints, leaving excess CPO seeking export markets already saturated. EUDR is strictly enforced, excluding 30-40% of Indonesian exports from the EU. This scenario yields smallholder NTP of **95-100**, income declines of **10-15%**, and emergency policy interventions (export subsidies, domestic price supports) straining government budgets(IPOSS, 2026; Wong et al., 2025).

Most likely scenario (45% probability): Prices settle in **USD 1,050-1,150/MT range**, production reaches **48-48.5 million tons**, B50 implementation occurs by Q3 2026 with moderate teething problems, ISPO coverage reaches **32-35%**, and EUDR disrupts 15-20% of prior EU trade but impacts are partially offset by African market growth. Smallholder welfare remains stable with NTP of **108-112**, modest income growth of **3-5%** in nominal terms (0-2%

real growth after inflation), and persistent productivity and market access challenges. This scenario represents **muddle-through adjustment** rather than transformative change, maintaining status quo welfare levels but failing to address structural vulnerabilities (IPOSS, 2026; Maria et al., 2023).

6 CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 SUBSTANTIVE CONCLUSIONS

Indonesia's palm oil sector in 2026 will navigate a complex landscape characterized by **moderate production growth (2-3% annually)**, **intensified domestic consumption (B50 mandate absorbing 30% of output)**, **stable but pressured prices (USD 1,050-1,200/MT)**, and **accelerating sustainability transitions (ISPO mandatory, EUDR enforcement)**. This outlook presents both opportunities—continued economic contributions, energy security gains, environmental standard improvements—and challenges—export capacity constraints, smallholder marginalization risks, productivity stagnation threats.

The **biodiesel policy functions as a double-edged instrument**: it achieves energy independence and climate mitigation objectives while simultaneously reducing export revenues by an estimated **USD 2-3 billion annually**, depressing domestic prices by **8-12%**, and creating food security vulnerabilities during supply disruptions. The policy's welfare impacts on smallholders are **ambiguous**: stable domestic demand provides market assurance, but price caps and levy deductions reduce income by **5-10% compared to export parity prices**.

Smallholder productivity is a critical bottleneck constraining sector growth and welfare improvement. The yield gap of **3-5 tons CPO/ha between smallholders and estates** represents the **foregone production of 12-15 million tons annually**, equivalent to Indonesia's entire biodiesel consumption. Closing even half this gap would simultaneously enable export expansion, reduce land pressure, improve farmer incomes by **30-50%**, and enhance global supply security. However, current replanting rates (**30,000-50,000 ha/year versus targets of 180,000 ha/year**) and the **extension service's reach (<20% of smallholders)** are grossly inadequate to realize this potential.

6.2 POLICY RECOMMENDATIONS RELATED TO FARMERS' WELFARE INDEX

6.2.1 Accelerate Replanting Programs (PSR) with Comprehensive Support

Target: Increase annual replanting achievements to **200,000 hectares by 2027**, prioritizing smallholder plantations exceeding 25 years of age (3.5 million hectares total).

Instruments:

- **Financial support enhancement:** Increase per-hectare subsidies from current **IDR 25 million to IDR 40 million (USD 1,650 to USD 2,650)**, covering 70-80% of establishment costs versus the current 30-40% coverage.
- **Income replacement mechanism:** Provide transitional cash transfers of **IDR 30-40 million over 4 years** (USD 2,000-2,650 annually) to offset income loss during the non-productive period, conditioned on verified replanting implementation.
- **Intercropping promotion:** Technical assistance and seedling subsidies for intercropping with short-cycle crops (cassava, pineapple, vegetables) during the immature phase, generating **IDR 15-25 million/ha/year interim income**.
- **Streamlined disbursement:** Establish one-stop-shop district-level PSR desks consolidating application, verification, and payment functions, reducing processing time from **18-24 months to 3-6 months**.

Expected Impact: Yield improvements of **2-3 tons CPO/ha on replanted areas** translate to **additional IDR 12-18 million annual income per 3-hectare farm (USD 800-1,200)**, improving Farmers Welfare Index scores by **15-25% within 6-8 years** post-replanting. Aggregate production gains of **2-3 million tons of CPO by 2030** would offset increases in **biodiesel consumption** and restore export capacity.

6.2.2 Strengthen Price Floor Mechanisms and Farmer Bargaining Power

Policy Instrument: Implement **dynamic reference price systems** linking FFB prices to CPO spot prices with **transparent formulas adjusted weekly**, replacing current opaque provincial team determinations susceptible to mill capture.

Implementation:

- **Price band system:** Establish FFB price floors at **70-75% of CPO price** (adjusted for OER 20-22% and processing costs), with ceiling prices at **85-90% during supply scarcity**, balancing farmer income protection with mill viability.
- **Digital price platforms:** Deploy mobile applications providing real-time CPO prices, reference FFB calculations, and mill gate prices, empowering farmers with market information to negotiate effectively.
- **Cooperative marketing:** Support smallholder cooperative establishment for collective FFB marketing, aggregating volumes to negotiate directly with mills and eliminating middleman margins of **15-30%**.

Coordination: Local government institutions enforce reference price compliance through spot inspections and penalties (license suspensions) for mills that systematically underpay; establish farmer hotlines for reporting price violations.

Expected Impact: Eliminating middleman margins could increase farmer receipts by **IDR 150-250/kg FFB (USD 0.010-0.017)**, totaling IDR 5-8 million in **additional annual income per 3-hectare farm (USD 330-530)**. Reducing volatility by 20-30% enhances consumption smoothing and investment capacity, improving welfare index stability.

6.2.3 Facilitate ISPO Certification for Smallholders Through Inclusive Pathways

Approach: Transition from individual to **group certification models** facilitated by cooperatives, farmer groups, or NGOs, reducing per-farmer costs by **60-75%** (from USD 100-150 to USD 25-40).

Support Mechanisms:

- **Certification subsidies:** Government grants covering **50-70% of group certification costs**, with remaining costs shared among members or advanced by mills with payback through FFB price deductions over 2-3 years.
- **Technical assistance programs:** Deploy mobile certification teams conducting on-site training, documentation support, and pre-audit assistance, targeting **50,000 smallholders annually** through 2030.
- **Simplified standards:** Develop **ISPO-Smallholder** tier with proportionate requirements reflecting smallholder capacities (e.g., GPS coordinates at cooperative level rather than individual plots, simplified record-keeping formats), maintaining core sustainability principles while reducing compliance burden.

Justification: ISPO certification provides dual benefits: **8-12% FFB price premiums** from mills preferring certified supply, and **15-20% yield improvements** through mandated best practices (optimal fertilization, IPM, harvest timing), cumulatively increasing farmer incomes by **25-35%**.

Expected Impact: Achieving **60% smallholder ISPO coverage by 2030** (versus current 12-15%) would increase aggregate smallholder incomes by **USD 600-800 million annually**, improve welfare indices by **10-15%**, and secure market access amid escalating sustainability requirements.

6.2.4 Expand Extension Services and Technology Adoption

Focus Areas: Prioritize **Good Agricultural Practices (GAP) training** on precision fertilization, harvest optimization, pest/disease management, and soil conservation through farmer field schools and demonstration plots.

Delivery Mechanisms:

- **Extension agent intensification:** Increase agricultural extension worker deployment to **1 agent per 100 smallholder farmers** (from current 1:300-500 ratios), with specialized palm oil training and performance incentives linked to farmer productivity outcomes.
- **Digital extension platforms:** Develop mobile applications providing agronomic advice, pest identification tools, weather forecasts, and input procurement, leveraging Indonesia's 85% smartphone penetration among rural populations.
- **Peer-to-peer learning networks:** Establish lead farmer systems where high-performing smallholders (yields >4 tons/ha) mentor 10-15 neighboring farmers, with government honorariums and recognition.

Technology priorities: Promote adoption of **precision fertilization** (soil testing, targeted NPK application), **integrated pest management** (biological controls, pheromone traps), and **harvest timing optimization** (measuring fruit ripeness to maximize OER).

Expected Impact: Studies document **30-40% yield increases** from GAP adoption, translating into an additional 1-1.5 tons of CPO/ha output and IDR 10-15 million in **income gains** (USD 650-1,000) per 3-hectare farm annually. Widespread extension service improvements could increase aggregate smallholder production by 3-4 million tons, contributing to 15-20% improvements in the welfare index.

6.2.5 Develop a Comprehensive Welfare Monitoring System

Components: Establish an **integrated Farmers Welfare Information System** linking data from BPS (Statistics Indonesia), Ministry of Agriculture, BPDP, formerly BPDPKS (Palm Oil Fund Agency), and other related institutions, and ISPO certification bodies.

Indicators: Track multidimensional welfare metrics beyond income:

- **Economic:** Income (NTP/FTT), poverty rates, debt levels, asset accumulation
- **Education:** School enrollment rates, literacy, vocational training participation
- **Health:** Health insurance coverage, child nutrition status, healthcare access
- **Housing:** Dwelling quality, access to clean water, sanitation, and electricity
- **Food security:** Dietary diversity, caloric sufficiency, food expenditure shares
- **Risk mitigation:** Insurance coverage, savings levels, social protection access

Technology: Deploy **digital data collection** through mobile surveys, integrate with ISPO traceability platforms capturing farm-level data, and produce **quarterly welfare dashboards** disaggregated by province, district, and farmer type (plasma/independent/contract).

Purpose: Enable **evidence-based policy adjustment** through real-time monitoring of welfare trends, early warning of distress (e.g., declining NTP, rising debt), and impact evaluation of interventions (replanting subsidies, certification programs, extension services).

Expected Impact: Improved data quality and timeliness enhance policy responsiveness, potentially reducing crisis response lags by 6-12 months and targeting support to the most vulnerable smallholder segments, indirectly improving welfare outcomes by **5-10% through better-calibrated interventions**.

6.2.6 Promote Income Diversification and Livelihood Resilience

Strategies:

- **Intercropping systems:** Technical extension and subsidy programs promoting agroforestry (palm + timber species), underplanting with cocoa or coffee during the mature phase, and integrated crop-livestock systems (palm + cattle/goats).
- **Value-added processing:** Support smallholder cooperative establishment of FFB collection centers, crude palm oil mini-mills (1-5 ton/hour capacity), and oleochemical processing (soap, fatty acids), capturing 20-30% processing margins currently retained by large mills.
- **Off-farm employment:** Vocational training programs in plantation management, agricultural machinery operation, and palm oil processing, enabling smallholder household members to secure wage employment in estate or industrial sectors.

Support: Microfinance access for diversification investments (livestock purchase, processing equipment), technical training through farmer field schools, and market linkage facilitation for diversified products.

Justification: Households with **30-40% income from non-palm sources** exhibit **20-30% lower income volatility**, maintain consumption during palm price downturns, and demonstrate superior food security and education investment.

Expected Impact: Diversification strategies could stabilize incomes during palm price cycles, reducing welfare index volatility by **15-25%** and improving resilience to climate and market shocks, ultimately enhancing multidimensional welfare scores by **8-12%**.

6.3 RESEARCH AGENDA FOR FUTURE STUDIES

Three research priorities merit emphasis. First, **longitudinal studies tracking farmers' welfare index dynamics over 5-10 year periods** are essential to understand causal pathways from interventions (replanting, certification, diversification) to welfare outcomes, disaggregated by initial conditions (farm size, age, education) to identify

heterogeneous treatment effects. Second, **rigorous impact evaluations employing quasi-experimental designs** (difference-in-differences, regression discontinuity) should assess PSR programs, ISPO certification, and extension services, providing credible evidence on cost-effectiveness to guide resource allocation. Third, **climate adaptation research** must integrate agronomic trials (drought-resistant varieties, irrigation systems) with economic modeling (adaptation costs, benefit-cost ratios) and institutional analysis (insurance schemes, risk-sharing mechanisms) to build sector resilience under climate change scenarios.

REFERENCES

- Abubakar, A., Ishak, M. Y., & Makmom, A. A. (2021). Impacts of and adaptation to climate change on the oil palm in Malaysia: a systematic review. *Environmental Science and Pollution Research*, 28(39), 54339–54361. <https://doi.org/10.1007/s11356-021-15890-3>
- Adiatma, J. C., & Prasajo, H. (2021). *Critical review on the biofuel development policy in Indonesia*. https://iesr.or.id/wp-content/uploads/2021/05/Critical-review-on-biofuel_IESR040521.pdf
- Arintoko, A., Sambodo, H., & Priyono, R. (2024). Do International Oil Prices, Exchange Rates and Agricultural Credit Matter for Farmers' Term of Trade in Indonesia? Empirical Evidence of Multiple Thresholds and Asymmetric Effects. *Research on World Agricultural Economy*, 71–87. <https://doi.org/10.36956/rwae.v6i1.1305>
- Arumdhani, M. P. (2025). The impact of biodiesel policy on the availability of cooking oil: An analysis of sustainable food strategies. *JIPAGI: Jurnal Inovasi Pangan Dan Gizi*, 2(2), 111–126. <https://doi.org/10.61511/jipagi.v2i2.1876>
- Asdep Setkab. (2025). *Gov't Delivers Massive Food Aid, Ensures Secure Rice Stocks in Disaster-Hit Regions*. Cabinet Secretariat of the Republic of Indonesia Bews. <https://setkab.go.id/en/govt-delivers-massive-food-aid-ensures-secure-rice-stocks-in-disaster-hit-regions/>
- Astari, A. J., Lovett, J. C., & Wasesa, M. (2025). Sustainable pathways in Indonesia's palm oil industry through historical institutionalism. *World Development Sustainability*, 6, 100200. <https://doi.org/10.1016/j.wds.2024.100200>
- Barisau, M., Gasselin, P., Laurens, L., & Ollivier, G. (2024). Why and how to conduct a Scoping Review of literature in the Humanities and Social Sciences? Application to free labour in agriculture. *Bulletin of Sociological Methodology/Bulletin de Méthodologie Sociologique*, 162(1), 212–242. <https://doi.org/10.1177/07591063241236069>
- Bastidas-Orrego, L. M., Jaramillo, N., Castillo-Grisales, J. A., & Ceballos, Y. F. (2023). A systematic review of the evaluation of agricultural policies: Using prisma. *Heliyon*, 9(10), e20292. <https://doi.org/10.1016/j.heliyon.2023.e20292>
- Benedict, J. J., & Heilmayr, R. (2024). *Indonesian palm oil exports and deforestation*. Trase Earth.
- Dodson, A., Guindon, M., & Lam, J. (2019). *Smallholders: key to building sustainable supply chains. Disclosure and support by palm oil companies assessed on SPOTT*. <https://www.spott.org/news/smallholders-key-to-building-sustainable-supply-chains>

- Eggen, M., Heilmayr, R., Anderson, P., Armson, R., Austin, K., Azmi, R., Bayliss, P., Burns, D., Erbaugh, J. T., Ekaputri, A. D., Gaveau, D. L. A., Grabs, J., Greenbury, A., Gulagnar, I., Hanu, M. A., Hill, T., Leegwater, M., Limberg, G., Opal, C., ... Carlson, K. M. (2024). Smallholder participation in zero-deforestation supply chain initiatives in the Indonesian palm oil sector: Challenges, opportunities, and limitations. *Elem Sci Anth*, 12(1). <https://doi.org/10.1525/elementa.2023.00099>
- Ekaputri, A. D., Gaveau, D. L. A., Heilmayr, R., & Carlson, K. M. (2025). Uneven participation of independent and contract smallholders in certified palm oil mill markets in Indonesia. *Communications Earth & Environment*, 6(1), 721. <https://doi.org/10.1038/s43247-025-02683-6>
- Erdi, Nawireja, I. K., Wibowo, L. R., Hutabarat, S., Utomo, M. M. B., Kurniasari, D. R., Pramudya, E. P., Hapsari, M., Fuad, Z., Kurniadi, R., Santosa, A., Nugraha, I., Hakim, I., Rizieq, R., Ramawati, & Satwiko, A. A. (2025). Acceleration of Smallholder Palm Oil Certification in Riau: Between Rationality and Policy Utopia. *Forest Science and Technology*, 1–12. <https://doi.org/10.1080/21580103.2025.2565629>
- Fleiss, S., Hill, J. K., McClean, C., & Lucey, J. M. (2017). *Potential Impacts of Climate Change on Oil Palm Cultivation: A science-for-policy paper by the SenSOR programme*. <https://www.sensorproject.net/wp-content/uploads/2018/01/Climate-change-report-FINAL.pdf>
- Halimatussadiah, A., Nainggolan, D., Yui, S., Moeis, F. R., & Siregar, A. A. (2021). Progressive biodiesel policy in Indonesia: Does the Government's economic proposition hold? *Renewable and Sustainable Energy Reviews*, 150, 111431. <https://doi.org/10.1016/j.rser.2021.111431>
- Haniff, M. H., Yahya, Z., Razak, Af. A., Latif, J., Khomeini, M. A., Rahman, A., & Kamarudin, N. (2016). Impact of El Nino and La Nina on Oil Palm FFB Yield Production in Malaysia. *IJAER: International Journal of Agriculture and Environmental Research*, 2(5), 1084–1100. https://ijaer.in/uploads/ijaer_02__74.pdf
- Hartono, R. (2024). Persiapan Sertifikasi ISPO pada Koperasi Produsen Fajar Lestari Studi Kasus di Dusun Cabang Anduk, Kecamatan Batu Ampar, Kabupaten Kubu Raya, Kalimantan Barat. *Jurnal Ilmu Sosial Dan Humaniora*, 2(3), 86–92. <https://doi.org/10.58540/isihumor.v2i3.827>
- Hartono, R. (2025). The Economic Impact of the Presence of Oil Palm Plantations towards ISPO Certification: Case Study of Jaya Usaha Sempurna Producer Cooperative in Mega Timur Village. *IJMEBE: International Journal of Management and Business Economics*, 3(2), 66–69.
- Hicks, R. (2025). *EU delays deforestation law again, as Indonesian palm oil sector pushes for smallholder exemptions*. Eco-Business: Food and Agriculture. <https://www.eco-business.com/news/eu-delays-deforestation-law-again-as-indonesian-palm-oil-sector-pushes-for-smallholder-exemptions/>
- Hutajulu, J. P. (2023). Factors Influencing Public Decision-Making in Oil Palm Replanting Program in Sekadau District. *Jurnal Social Economic of Agriculture*, 12(2), 119. <https://doi.org/10.26418/j.sea.v12i2.72421>
- IPOSS. (2026). *2026 Palm Oil Outlook*.
- Iswara, M. A., Nurshadrina, D. S., & Suharyadi, A. (2023). *European Union Palming off Deforestation Regulation to Smallholders in Indonesia*. East Asia Forum. <https://eastasiaforum.org/2023/10/10/european-union-palming-off-deforestation->

regulation-to-smallholders-in-indonesia/

- Jong, H. N. (2025). *Indonesia raises concerns over EU deforestation law's impact on smallholders*. Mongabay Asia. <https://news.mongabay.com/2025/04/indonesia-raises-concerns-over-eu-deforestation-laws-impact-on-smallholders/>
- Judijanto, L. (2025a). Empowerment of Oil Palm Smallholders for Sustainable Palm Oil. *Veredas Do Direito*, 22(2), e3323. <https://doi.org/10.18623/rvd.v22.n2.3323>
- Judijanto, L. (2025b). From Voluntary to Mandatory: A Review of Prospects and Challenges in Implementing Palm Oil Sustainability Certifications in Indonesia. *ERR01*, 10(2), 232–254. <https://doi.org/10.56238/ERR01v10n2-013>
- Judijanto, L. (2025c). Who Pays for Climate Action? The Disproportionate Impact of Deforestation-Free Regulations on Smallholder Farmers. *European Journal of Management, Economics and Business*, 3(1), 3–13. [https://doi.org/10.59324/ejmeb.2026.3\(1\).01](https://doi.org/10.59324/ejmeb.2026.3(1).01)
- Judijanto, L., & Pamungkas, D. H. (2024). Fair Pricing Formulation for Palm Oil Fresh Fruit Bunch Produced by Smallholder Farmers: A Development Method to Form a More Effective Formula for Palm Oil Fresh Fruit Bunch Pricing to Achieve a Fair Price for Smallholder Farmers. *Journal of Lifestyle and SDGs Review*, 4, 1–28. <https://doi.org/https://doi.org/10.47172/2965-730X.SDGsReview.v4.n04.pe03859>
- Kamil, N. N., & Omar, S. F. (2016). Climate Variability and Its Impact on the Palm Oil Industry. *Oil Palm Industry Economic Journal*, 16(1), 18–30. <https://palmoilis.mpob.gov.my/publications/OPIEJ/opiejv16n1-nadia.pdf>
- Kamil, N. N., & Omar, S. F. (2017). The Impact of El Niño and La Niña on Malaysian Palm Oil Industry. *Oil Palm Industry Economic Journal*, 74(May 2017), 1–6.
- Kamil, N. N., Xiao, S., Syed Salleh, S. N., Xu, H., & Zhuang, C. C. (2024). Nonlinear impacts of climate anomalies on oil palm productivity. *Heliyon*, 10(15), e35798. <https://doi.org/10.1016/j.heliyon.2024.e35798>
- Khatiwada, D., Palmén, C., & Silveira, S. (2021). Evaluating the palm oil demand in Indonesia: production trends, yields, and emerging issues. *Biofuels*, 12(2), 135–147.
- Koutsos, T. M., Menexes, G. C., & Dordas, C. A. (2019). An efficient framework for conducting systematic literature reviews in agricultural sciences. *Science of The Total Environment*, 682, 106–117. <https://doi.org/10.1016/j.scitotenv.2019.04.354>
- Lestari, Y. S., Kresna, M., Endah, N. H., Atmaja, N. N., Irwanto, E. P., & Pratistha, B. (2025). Policy Strategy to Stimulate Indonesia's Palm Oil Downstream Industries. *The Journal of Indonesia Sustainable Development Planning*, 6(2), 214–224. <https://doi.org/10.46456/jisdep.v6i2.726>
- Lifianthi, Andy, M., & Wulan, S. D. (2022). Price Transmission Elasticity Analysis of Crude Palm Oil and Farmer' Share in Indonesia: A Case of Self-Reliance Palm Oil Farmer in Musi Banyuasin District, Indonesia. *RJOAS*, 11(131), 248–257. <https://doi.org/10.18551/rjoas.2022-11.25>
- Mai, L. (2024). *Palm oil powerhouses: why EU's deforestation-free regulation does not work in Southeast Asia*. CSIS New Perspectives.
- Maria, B., Roy, N. D., Siska, E., & Dinah, L. M. (2023). Exploring the Dynamics of Food Prices and Farmer's Terms of Trade: Reflecting on the Welfare of Indonesian Farmers. *EURASIA: Economics & Business*, 12(78), 81–90.

<https://doi.org/10.18551/econeurasia.2023-12>

- Maridjo, H., & Ignasiak-Szulc, A. (2023). Affecting Factors Farmer Welfare in Indonesia. *Jurnal Ilmu Ekonomi Dan Pembangunan*, 23(2), 79. <https://doi.org/10.20961/jiep.v23i2.60442>
- Moeis, F. R., Dartanto, T., Moeis, J. P., & Ikhsan, M. (2020). A longitudinal study of agriculture households in Indonesia: The effect of land and labor mobility on welfare and poverty dynamics. *World Development Perspectives*, 20, 100261. <https://scholar.ui.ac.id/en/publications/a-longitudinal-study-of-agriculture-households-in-indonesia-the-e/>
- Prayoga, Y., & Harahap, F. S. (2025). Analysis of Income and Welfare of Oil Palm Farmers in Tanjung Pasir Village, South Kualuh District North Labuhan Batu Regency. *ECOBISMA: Jurnal Ekonomi, Bisnis, Dan Manajemen*, 12(1), 150–159. <https://jurnal.ulb.ac.id/index.php/ecobisma/article/viewFile/7552/4897>
- Rahman, F. H., Arif, N. F., & Rifani, S. K. (2025). Analysis of Quality Management in the Sustainable Palm Oil Industry in Riau: A Qualitative Study of Independent Farmers. *JIM UPB (Jurnal Ilmiah Manajemen Universitas Putera Batam)*, 13(2), 27–36. <https://doi.org/10.33884/jimupb.v13i2.10025>
- Rahutomo, A. B., Karuniasa, M., & Frimawaty, E. (2023). Peningkatan Produktivitas Lahan Pekebun melalui Sertifikasi Kelapa Sawit Berkelanjutan di Indonesia. *Analisis Kebijakan Pertanian*, 21(1), 43–55. <https://doi.org/10.21082/akp.v21i1.43-55>
- Rahutomo, A. B., Karuniasa, M., & Frimawaty, E. (2025a). Enhancing farmers' land productivity through sustainable oil certification: Strategies for promoting environmental and economic benefits in agricultural practices. *JASSU: Journal of Agrosociology and Sustainability*, 2(2), 97–112. <https://doi.org/10.61511/jassu.v2i2.2025.1131>
- Rahutomo, A. B., Karuniasa, M., & Frimawaty, E. (2025b). Enhancing farmers' land productivity through sustainable palm oil certification: Strategies for promoting environmental and economic benefits in agricultural practices. *Journal of Agrosociology and Sustainability*, 2(2), 97–112.
- Reich, C., & Musshoff, O. (2025). Oil palm smallholders and the road to certification: Insights from Indonesia. *Journal of Environmental Management*, 375, 124303. <https://doi.org/10.1016/j.jenvman.2025.124303>
- Ridani, Budi, S., & Sinta, I. (2023). Farmers' Perceptions of Smallholder Oil Palm Replanting in Simpang Kanan District Aceh Singkil Regency (Case Study of Oil Palm Farmer in Lipat Kajang Village). *Agribusiness Student Scientific Journal*, 1(2), 75–87. <https://doi.org/http://dx.doi.org/10.29103/jima.v1i1.xxx>
- Rochmyaningsih, D. (2024). *For Indonesian oil palm farmers, EU's deforestation law is another top-down imposition*. Mongabay. <https://news.mongabay.com/2024/09/for-indonesian-oil-palm-farmers-eus-deforestation-law-is-another-top-down-imposition/>
- Roswally, P. P. (2025). *Profiting off the Future Loss: Land Speculations and Brokerage in Indonesia's Oil Palm Plantation* [Northwestern University]. <https://www.proquest.com/openview/d2bb8b3dd75bf793a8c31f0149971847/1?pq-origsite=gscholar&cbl=18750&diss=y>
- Sahara, Dermawan, A., Amaliah, S., Irawan, T., & Dilla, S. (2022). Economic impacts of biodiesel policy in Indonesia: a computable general equilibrium approach. *Journal of Economic Structures*, 11(1), 22. <https://doi.org/10.1186/s40008-022-00281-9>

- Saleh, S., Bagja, B., Suhada, T., Widyapratami, H., Putra, S., Said, Z., & Putraditama, A. (2021). *Intensification of Smallholder Oil Palm Plantations: Where Do We Start?* (1; WRI Working Paper). [https://wri-indonesia.org/sites/default/files/Intensification of Smallholder Oil Palm Plantations.pdf](https://wri-indonesia.org/sites/default/files/Intensification%20of%20Smallholder%20Oil%20Palm%20Plantations.pdf)
- Siregar, A. A., Halimatussadiah, A., Moeis, F. R., Anky, W. A. K., & Nainggolan, D. (2024). The oil palm replanting imperative: Are smallholder farmers willing to participate? *Forest Policy and Economics*, 169, 103362. <https://doi.org/10.1016/j.forpol.2024.103362>
- Sokoastri, V., Setiadi, D., Hakim, A. R., Mawardhi, A. D., & Fadli, M. L. (2019). Smallholders Oil Palm: Problems and Solutions. *Sodality: Jurnal Sosiologi Pedesaan*, 7(3), 182–194. <https://doi.org/10.22500/sodality.v7i3.27221>
- Syahza, A., Bakce, D., & Asmit, B. (2018). Increasing the awareness of palm oil plantation replanting through farmers training. *Riau Journal of Empowerment*, 1(1). <https://doi.org/10.31258/raje.1.1.1>
- Syahza, A., Tampubolon, D., Irianti, M., Meiwanda, G., & Asmit, B. (2023). The Impact of Small-Scale Oil Palm Plantation Development on the Economy Multiplier Effect and Rural Communities Welfare. *International Journal of Sustainable Development and Planning*, 18(5), 1407–1415. <https://doi.org/10.18280/ijstdp.180511>
- Varqa, S. (2025). *Palm oil price forecast and production outlook 2026*. Fastmarkets. <https://www.fastmarkets.com/insights/palm-oil-price-forecast-and-production-outlook-2026/>
- Varwasih, M. W., Sandra, I. K., & M, J. M. (2025). Transmisi Asimetris Harga Tandan Buah Segar (TBS) Domestik dengan Harga Crude Palm Oil (CPO) Pasar Domestik. *Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, 11(1), 1072. <https://doi.org/10.25157/ma.v11i1.16794>
- Wibowo, L. R., Erdi, Hutabarat, S., Nurfatriani, F. N., Utomo, M., Nawireja, I. K., & Pramudya, E. P. (2023). Accelerating Certification of Oil Palm Smallholders through Institutionalization of Various Incentives. *Forest and Society*, 7(2), 263–294.
- Wong, A., Jauhari, K. Z., & Choy, R. (2025). *MARC Ratings: Crude palm oil price to soften in 2026*. MARC Economic Views. <https://www.marc.com.my/views/marc-ratings-crude-palm-oil-price-to-soften-in-2026/>
- WWF. (2023). *Supporting Indonesia's Biodiesel Policy: Do We Need to Expand the Oil Palm Plantation*. [https://www.wwf.id/sites/default/files/2024-01/Supporting Indonesias Biodiesel Policy_Do We Need to Expand the Oil Palm Plantation_final.pdf](https://www.wwf.id/sites/default/files/2024-01/Supporting%20Indonesias%20Biodiesel%20Policy_Do%20We%20Need%20to%20Expand%20the%20Oil%20Palm%20Plantation_final.pdf)
- Yuda, T. K., & Kühner, S. (2023). Bringing Indonesia into the global welfare regime debate: A literature review and future research agenda. *Asian Social Work and Policy Review*, 17(2), 103–114. <https://doi.org/10.1111/aswp.12275>
- Zafriana, L., Marjono, M., Qurbani, I. D., & Sugiono, S. (2021). Determination of the palm based biodiesel policy integration model as a renewable energy commodity. *Decision Science Letters*, 10(3), 263–276. <https://doi.org/10.5267/j.dsl.2021.3.003>
- Zhao, J., Elmore, A. J., Lee, J. S. H., Numata, I., Zhang, X., & Cochrane, M. A. (2023). Replanting and yield increase strategies for alleviating the potential decline in palm oil production in Indonesia. *Agricultural Systems*, 210. <https://doi.org/10.1016/j.agsy.2023.103714>

THE IMPORTANCE OF THE PARTNERSHIP MODEL IN ACCELERATING OIL PALM SMALLHOLDERS REPLANTING PROGRAM

A IMPORTÂNCIA DO MODELO DE PARCERIA NA ACELERAÇÃO DO PROGRAMA DE REPLANTIO DE PEQUENOS PRODUTORES DE PALMA DE ÓLEO

LA IMPORTANCIA DEL MODELO DE ASOCIACIÓN EN LA ACELERACIÓN DEL PROGRAMA DE REPLANTACIÓN DE PEQUEÑOS PRODUCTORES DE PALMA DE ACEITE



<https://doi.org/10.56238/sevened2026.008-063>

Loso Judijanto¹

ABSTRACT

Oil palm is a critical commodity for Indonesia's economy, with smallholders cultivating over 40% of the national plantation area. However, the aging of plantations with more than 30% exceeding 25 years necessitates large-scale replanting efforts. Despite government support through the Peremajaan Sawit Rakyat (PSR) program, implementation remains suboptimal due to structural barriers faced by smallholders, including limited access to finance, certified seedlings, technical assistance, and reliable markets. Addressing these constraints requires effective partnership models that integrate stakeholders across the palm oil value chain. This study aims to explore how partnership models facilitate smallholder participation and success in national oil palm replanting programs by overcoming structural limitations. Using a Systematic Literature Review (SLR) approach, this qualitative research analyzes 28 peer-reviewed journal articles published between 2019 and 2025. Data were collected from academic databases using keyword-based searches and PRISMA screening protocols. Thematic analysis was employed to categorize partnership types, key actors, operational mechanisms, and reported outcomes. The results indicate that inclusive, hybrid partnership models combining private-sector engagement with public support achieve the greatest success in improving access to financial resources, certified planting materials, and extension services. Moreover, strong institutional coordination and trust-building mechanisms enhance adoption rates and program sustainability. The review underscores the need for adaptive, multi-stakeholder collaboration tailored to local contexts. In conclusion, partnership models are pivotal in accelerating the success of oil palm smallholder replanting. Future research should focus on longitudinal studies and comparative policy evaluations to deepen understanding of model scalability and long-term impact.

Keywords: Oil Palm. Smallholders. Replanting Program. Partnership Model. SLR.

RESUMO

O dendê (palma de óleo) é uma commodity estratégica para a economia da Indonésia, com os pequenos produtores cultivando mais de 40% da área nacional de plantações. No entanto, o envelhecimento das plantações — com mais de 30% ultrapassando 25 anos — torna

¹ Master's degree of Statistics. IPOSS. Jakarta, Indonesia. E-mail: losojudijantobumn@gmail.com
Orcid: <https://orcid.org/0009-0007-7766-0647>

necessários esforços de replantio em larga escala. Apesar do apoio governamental por meio do programa Peremajaan Sawit Rakyat (PSR), a implementação permanece aquém do ideal devido a barreiras estruturais enfrentadas pelos pequenos produtores, incluindo acesso limitado a financiamento, mudas certificadas, assistência técnica e mercados confiáveis. Enfrentar essas restrições exige modelos de parceria eficazes que integrem os diferentes atores ao longo da cadeia de valor do óleo de palma. Este estudo tem como objetivo explorar como os modelos de parceria facilitam a participação e o sucesso dos pequenos produtores em programas nacionais de replantio de palma de óleo, ao superar limitações estruturais. Utilizando a abordagem de Revisão Sistemática da Literatura (RSL), esta pesquisa qualitativa analisa 28 artigos científicos revisados por pares, publicados entre 2019 e 2025. Os dados foram coletados em bases acadêmicas por meio de buscas com palavras-chave e protocolos de triagem PRISMA. A análise temática foi empregada para categorizar os tipos de parceria, os principais atores, os mecanismos operacionais e os resultados reportados. Os resultados indicam que modelos de parceria inclusivos e híbridos, que combinam o engajamento do setor privado com o apoio público, alcançam maior sucesso na melhoria do acesso a recursos financeiros, materiais de plantio certificados e serviços de extensão rural. Além disso, uma forte coordenação institucional e mecanismos de construção de confiança aumentam as taxas de adoção e a sustentabilidade dos programas. A revisão destaca a necessidade de uma colaboração adaptativa e multissetorial, ajustada aos contextos locais. Conclui-se que os modelos de parceria são fundamentais para acelerar o sucesso do replantio de palma de óleo por pequenos produtores. Pesquisas futuras devem se concentrar em estudos longitudinais e avaliações comparativas de políticas para aprofundar a compreensão sobre a escalabilidade dos modelos e seus impactos de longo prazo.

Palavras-chave: Palma de Óleo. Pequenos Produtores. Programa de Replanteio. Modelo de Parceria. RSL.

RESUMEN

La palma de aceite es una mercancía estratégica para la economía de Indonesia, donde los pequeños productores cultivan más del 40% del área nacional de plantaciones. Sin embargo, el envejecimiento de las plantaciones —con más del 30% que supera los 25 años— hace necesarios esfuerzos de replantación a gran escala. A pesar del apoyo gubernamental a través del programa Peremajaan Sawit Rakyat (PSR), la implementación sigue siendo subóptima debido a las barreras estructurales que enfrentan los pequeños productores, entre ellas el acceso limitado al financiamiento, a plántulas certificadas, a la asistencia técnica y a mercados confiables. Abordar estas limitaciones requiere modelos de asociación eficaces que integren a los actores a lo largo de la cadena de valor del aceite de palma. Este estudio tiene como objetivo explorar cómo los modelos de asociación facilitan la participación y el éxito de los pequeños productores en los programas nacionales de replantación de palma de aceite, superando las limitaciones estructurales. Mediante un enfoque de Revisión Sistemática de la Literatura (RSL), esta investigación cualitativa analiza 28 artículos científicos revisados por pares, publicados entre 2019 y 2025. Los datos se recopilaron a partir de bases académicas mediante búsquedas por palabras clave y protocolos de selección PRISMA. Se empleó el análisis temático para categorizar los tipos de asociación, los actores clave, los mecanismos operativos y los resultados reportados. Los resultados indican que los modelos de asociación inclusivos e híbridos, que combinan la participación del sector privado con el apoyo público, logran mayor éxito en la mejora del acceso a recursos financieros, materiales de plantación certificados y servicios de extensión. Asimismo, una sólida coordinación institucional y mecanismos de construcción de confianza incrementan las tasas de adopción y la sostenibilidad de los programas. La revisión subraya la necesidad de una colaboración adaptativa y multiactor, ajustada a los contextos locales. En conclusión, los modelos de asociación son fundamentales para acelerar el éxito de la replantación de palma de aceite por parte de pequeños productores. Investigaciones futuras

deberían centrarse en estudios longitudinales y evaluaciones comparativas de políticas para profundizar la comprensión sobre la escalabilidad de los modelos y su impacto a largo plazo.

Palabras clave: Palma de Aceite. Pequeños Productores. Programa de Replantación. Modelo de Asociación. RSL.

1 INTRODUCTION

Palm oil is among the world's most vital agricultural commodities, contributing significantly to global food security, energy supply chains, and industrial applications (T. Mondal & Roy, 2025). As of 2023, global palm oil production reached over 77 million metric tons, with Indonesia and Malaysia accounting for nearly 85% of the total output (Carias Vega et al., 2023). This commodity plays a pivotal role in the economic development of producer countries, particularly in rural areas where smallholder farmers dominate production. In Indonesia alone, smallholders cultivate approximately 41% of the total oil palm plantation area, making their role indispensable to the industry's sustainability and growth (Obaideen et al., 2025).

Despite their crucial contributions, oil palm smallholders, especially independent ones, face structural challenges that limit their productivity and income. These include limited access to finance, low adoption of good agricultural practices (GAP), insecure land tenure, inadequate market integration, and minimal exposure to technological innovations (Lezoche et al., 2020). These constraints become particularly acute in the context of oil palm replanting programs, which involve replanting aging trees with new, high-yielding varieties. Replanting is essential, as over 30% of Indonesia's oil palm plantations are past their peak productivity, with yields declining and costs increasing (Iyiola et al., 2024).

Replanting, however, requires significant upfront investment and entails a temporary loss of income during the non-productive gestation period. This creates a formidable barrier for smallholders, many of whom lack the financial resilience to withstand such disruptions. Moreover, land fragmentation and heterogeneous plot conditions further complicate the technical implementation of replanting initiatives (K. Zhao et al., 2023). Recognizing these barriers, scholars and policymakers have increasingly emphasized the importance of partnership models in catalyzing smallholder participation in replanting programs.

Partnership models, broadly defined as formalized collaborations among smallholders, government institutions, financial actors, private companies, and civil society organizations, have gained attention as mechanisms to overcome systemic barriers in the smallholder sector (Schulz et al., 2019). These models aim to pool resources, share risks, and improve coordination among stakeholders, enabling a more equitable distribution of benefits along the palm oil value chain. Evidence from various case studies suggests that well-structured partnerships can improve access to certified planting materials, extension services, and markets while enhancing transparency and trust across stakeholder groups (Kurniawan et al., 2024).

The Indonesian government has responded to the pressing need for replanting by launching several initiatives, most notably the *Peremajaan Sawit Rakyat* (PSR) program. Introduced in 2017, PSR aims to replant up to 180,000 hectares of smallholder oil palm land each year using certified seeds and sustainable practices (S. Mondal & Palit, 2022). However, program implementation has been uneven, with disbursement delays, bureaucratic bottlenecks, and low absorption rates reported in various provinces. Analysts argue that one of the primary reasons for these shortcomings is the fragmented coordination among institutions and the lack of an effective partnership framework that brings together stakeholders around common goals (Hanis et al., 2024).

In practice, partnership models vary widely in form and function. Some involve contract farming arrangements with large palm oil companies, while others are built around cooperatives, farmer-owned enterprises, or multi-stakeholder platforms supported by NGOs and international donors. Each of these models brings its own strengths and trade-offs in terms of governance, incentive alignment, and long-term sustainability. Comparative studies suggest that hybrid models, which combine market access through private-sector engagement with capacity building and financial support from public agencies, tend to yield the most promising outcomes for smallholders (Hanis et al., 2024).

Beyond Indonesia, global examples of partnership success include the RSPO-certified outgrower schemes in Ghana, the FELDA and FELCRA programs in Malaysia, and public-private collaborations under the UNDP Green Commodities Programme (Mulyasari et al., 2023). These cases show that when structured well, partnership models can align the interests of producers and buyers while promoting environmental and social sustainability.

Nevertheless, the academic literature on oil palm partnerships remains fragmented and uneven in coverage. While numerous studies address aspects of sustainability, productivity, and rural development, there is a lack of consolidated insights into how partnership models specifically contribute to the success of smallholder replanting programs. This gap hampers evidence-based policymaking and hinders the scaling-up of effective models. In a time when global demand for sustainably produced palm oil is increasing, understanding the mechanics of successful partnerships is more urgent than ever (Hendrawan & Musshoff, 2024).

A further complication arises from variations in institutional readiness and policy environments across Indonesia's provinces. For example, while Riau and North Sumatra have shown relatively higher uptake of PSR funding due to active local government support and private-sector engagement, provinces like Papua and West Kalimantan lag behind, citing low levels of smallholder organization and weak administrative capacity. This regional

disparity reflects broader questions about the replicability and scalability of partnership models, particularly in under-resourced areas (Norhazimah et al., 2025).

Adding to these challenges are shifting global trade dynamics and sustainability standards, such as the EU Deforestation Regulation (EUDR) and voluntary sustainability certifications, such as RSPO and ISPO. These frameworks exert indirect pressures on smallholders, necessitating compliance through traceability, legal documentation, and good agricultural practices, all areas where partnerships can offer vital support (Hamid et al., 2024).

Moreover, the financial ecosystem for smallholders remains underdeveloped. As of 2022, less than 20% of Indonesian oil palm smallholders had access to formal banking services, and fewer still had experience with agricultural credit schemes suitable for long-gestation crops like oil palm. Financially inclusive partnership models that blend commercial capital with concessional funding and technical assistance could fill this gap (Zakaria et al., 2024).

Labor and generational dynamics also pose long-term sustainability concerns. Many smallholders are aging, and youth are increasingly reluctant to engage in oil palm farming due to perceptions of low profitability and the hard manual labor involved. Strategic partnerships that incorporate training, innovation, and youth engagement components could rejuvenate not only plantations but also the labor force that sustains them (J. Zhao et al., 2023).

In sum, the complex interplay of economic, institutional, technical, and demographic factors underscores the need for a holistic understanding of how partnership models operate within the context of smallholder replanting.

To address this critical knowledge gap, this study employs a Systematic Literature Review (SLR) method to synthesize peer-reviewed literature on the role of partnership models in accelerating oil palm smallholders' replanting efforts. By analyzing 28 selected articles published between 2019 and 2025, the review identifies recurring themes, key actors, operational mechanisms, and reported outcomes across various partnership initiatives in different geographies. The SLR approach ensures methodological rigor and transparency, avoiding the speculative or anecdotal nature of field-based methods such as focus group discussions (FGDs) or primary observations, which are beyond the scope of this study.

The specific objective of this review is to develop a conceptual and empirical understanding of how partnership frameworks influence smallholders' access to resources, institutional support, and long-term viability in the context of replanting programs. Accordingly, the central research question guiding this inquiry is: *"How do partnership models facilitate oil*

palm smallholders' participation and success in national replanting programs, particularly in addressing structural barriers to adoption?"

The findings from this question are further elaborated in the Discussion section and distilled in the Conclusion, offering actionable insights for policymakers, private-sector stakeholders, and development organizations seeking to design or refine collaborative models for sustainable oil palm replanting.

2 LITERATURE REVIEW

The body of scholarly literature regarding partnership models in the palm oil sector, particularly in relation to smallholder replanting programs, can be synthesized into six major thematic clusters: (1) structural barriers to replanting; (2) typologies of partnership models; (3) institutional governance and stakeholder engagement; (4) financing schemes and economic feasibility; (5) social and environmental impacts; and (6) gaps in empirical evaluations.

2.1 STRUCTURAL BARRIERS TO REPLANTING

The most consistently identified challenge is the financial burden associated with replanting activities. Estimates show that smallholders require an investment of IDR 50 70 million per hectare, yet many lack access to formal financial institutions (Asyraf et al., 2022). In Indonesia, less than 20% of smallholders are bankable due to inadequate credit histories or the absence of land certificates, with over 60% still relying on informal lenders or family capital (Asmara & Randhir, 2024). This financial inaccessibility is compounded by knowledge gaps, as only about 18% of smallholders have received structured training in replanting techniques or sustainable agricultural practices (Hamed et al., 2023).

2.2 TYPOLOGIES OF PARTNERSHIP MODELS

Various partnership structures have been explored across the literature. The PIR-Trans (Perkebunan Inti Rakyat Transmigrasi) model dominated during the New Order era, integrating smallholders into government-led nucleus estates (Cifuentes-Espinosa et al., 2023). In contrast, modern arrangements emphasize voluntary, market-oriented collaborations such as contract farming, public-private partnerships (PPP), and farmer cooperatives supported by NGOs or development agencies (Grinnell et al., 2022). Emerging models, such as the Inclusive Closed Loop (ICL), provide bundled services that combine inputs, technical training, market access, and credit support under a single framework (Jaza Folefack et al., 2019). Hybrid models that combine state support with private-sector

coordination are identified as the most resilient, particularly when operating in fragmented landscapes (Halimatussadiah et al., 2025).

2.3 INSTITUTIONAL GOVERNANCE AND STAKEHOLDER ENGAGEMENT

Effective governance is identified as a prerequisite for functional partnerships. Studies emphasize the importance of clear legal mandates, formalized agreements, and grievance mechanisms to mitigate power asymmetries (Umar et al., 2021). Engagement by local government units significantly improves compliance and trust, especially when third-party facilitators such as donor-funded NGOs mediate relations between agribusinesses and smallholders (Rhebergen et al., 2020). Furthermore, the decentralization of agrarian governance has opened opportunities for district-level innovation in partnership coordination, although inconsistencies in enforcement remain (Siddiqui et al., 2021).

2.4 FINANCING SCHEMES AND ECONOMIC FEASIBILITY

Partnerships often hinge on well-structured financial arrangements. The PSR (Peremajaan Sawit Rakyat) program offers IDR 30 million per hectare in grants, but uptake remains low with utilization rates under 50% in some regions due to bureaucratic complexity and delays (Kong et al., 2014). Financial innovations such as blended finance models are increasingly promoted, combining public grants, concessional loans, and commercial capital. For instance, partnerships involving rural banks (BPR), credit unions, or fintech platforms have facilitated replanting loans with reduced interest rates and repayment periods aligned with oil palm gestation cycles (Sundram & Intan-Nur, 2017).

2.5 SOCIAL AND ENVIRONMENTAL IMPACTS

Beyond economic returns, partnership models have demonstrated positive impacts on social cohesion and environmental outcomes. Cooperatives engaging in certified sustainable production (e.g., RSPO, ISPO) report greater bargaining power and reduced dependence on middlemen (Amir et al., 2019). In some pilot areas, smallholders in structured partnerships reduced illegal land clearing by 40% and adopted agroforestry techniques in buffer zones (Rodthong et al., 2023). Gender-focused programs are emerging, though still under-researched, with initial data indicating higher female participation in cooperative-led replanting efforts compared to individual schemes (Nyarko & Ashiagbor, 2025).

2.6 GAPS IN EVALUATION AND COMPARATIVE EVIDENCE

Despite growing interest, literature gaps persist. There is a notable absence of longitudinal impact assessments and comparative evaluations across different models. Many studies rely on case study methods without control groups, limiting generalizability (Degli Innocenti & Oosterveer, 2020). Moreover, disaggregated data on youth engagement, regional performance differentials, and climate resilience remain sparse. This evidentiary gap underscores the need for meta-analyses and integrated monitoring frameworks.

Overall, the reviewed literature confirms that while partnership models are not a one-size-fits-all solution, they present a promising institutional mechanism to mobilize capital, technology, and governance capacity toward accelerating the replanting of aging oil palm plantations. The remainder of this paper builds on these themes to systematically evaluate the mechanisms and outcomes of such partnerships, based on an SLR of recent peer-reviewed studies.

3 METHOD

This study employs the Systematic Literature Review (SLR) method, guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, to examine how partnership models can accelerate the replanting of oil palm smallholders' programs. As a significant component of the palm oil sector, smallholders contribute nearly half of the total oil palm plantation area in major producing countries, notably Indonesia. However, many smallholder-managed plantations are aging and underperforming, posing substantial risks to income stability, environmental sustainability, and national production targets. While national replanting initiatives have been introduced to address these concerns, participation among smallholders remains low due to complex institutional, financial, and coordination barriers. In response, partnership-based approaches, whether bilateral between companies and farmers or broader multi-stakeholder collaborations, have emerged as a potential strategy to overcome these systemic constraints and enhance the effectiveness of replanting efforts.

While numerous studies have explored the barriers to smallholder participation in replanting and broader sustainability issues within the oil palm sector, the literature on how partnership models are framed, implemented, and evaluated in this context remains fragmented. This review addresses that gap by identifying, filtering, and analyzing academic literature that focuses on the design, role, and impact of partnerships in supporting oil palm smallholders during the replanting process. The findings offer a consolidated perspective on

how partnerships are positioned as institutional mechanisms to promote inclusive, scalable, and sustainable replanting interventions.

Figure 1

Systematic Literature Review Process Based on the PRISMA Protocol

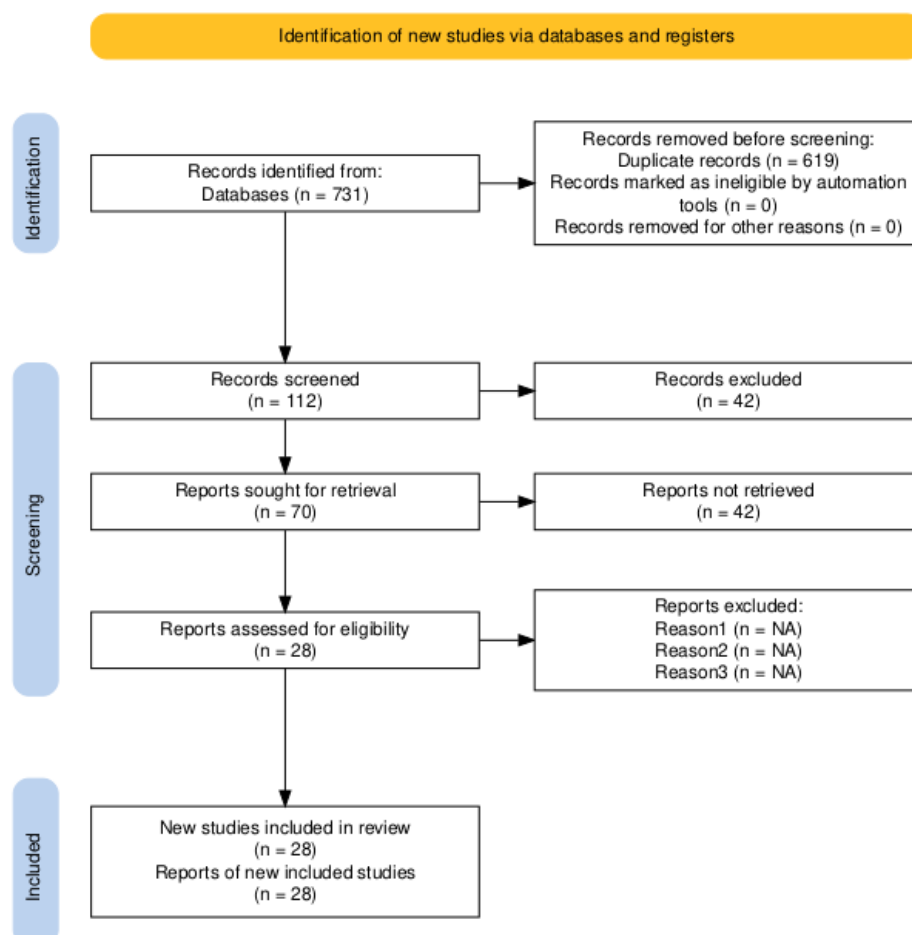


Figure 1 illustrates the structured review process applied in this study, following the four core stages of the PRISMA framework: identification, screening, eligibility, and inclusion. The initial identification phase began with a broad keyword search in the ScienceDirect database using the phrase "oil palm smallholders partnership", which produced 731 articles. To enhance thematic focus and precision, the search query was refined using Boolean operators: ("oil palm smallholders" OR "independent smallholders" OR "small-scale farmers") AND ("replanting" OR "replanting" OR "farm renewal") AND ("partnership" OR "business model" OR "multi-stakeholder collaboration"). This refinement resulted in the exclusion of 619 articles deemed thematically misaligned, leaving 112 articles for screening.

To align the review with recent policy developments and sectoral reforms, the publication window was restricted to the years 2019–2025. This temporal filter led to the exclusion of 42 articles, leaving 70 publications that met the timeframe requirement.

Subsequently, an accessibility filter was applied to retain only articles categorized as Open Access or from Open Archives, ensuring transparency, traceability, and replicability. This step removed 42 non-accessible items, yielding a final dataset of 28 peer-reviewed journal articles for full-text analysis and thematic synthesis.

All references were organized and managed in Mendeley Desktop, enabling consistent citation formatting, version control, and bibliographic management throughout the review process. It is important to emphasize that this study does not use any primary data collection methods, such as interviews, field observations, or focus group discussions (FGDs). Rather, it relies exclusively on secondary data sourced from credible, peer-reviewed academic publications.

By consolidating and analyzing these recent scholarly contributions, this study aims to offer a comprehensive, evidence-based understanding of how partnership models are conceptualized within smallholder oil palm replanting programs and how they may serve as collaborative instruments to address institutional fragmentation, increase smallholder participation, and enhance the overall sustainability of replanting initiatives.

4 RESULTS

The systematic literature review (SLR) identified six major thematic clusters that frame scholarly discussions on the role of partnership models in accelerating oil palm smallholders' replanting programs. From a final selection of 28 peer-reviewed articles published between 2019 and 2025, the themes extracted were: (1) Institutional Frameworks and Multi-Stakeholder Governance; (2) Financial Access and Risk Sharing Mechanisms; (3) Capacity Building and Knowledge Transfer; (4) Market Access and Inclusive Value Chains; (5) Policy and Regulatory Alignment; and (6) Environmental and Sustainability Commitments.

Thematic analysis revealed that the most frequently discussed topic was Institutional Frameworks and Multi-Stakeholder Governance, appearing in 82% of the analyzed studies. This was followed by Financial Access and Risk Sharing Mechanisms (76%) and Capacity Building and Knowledge Transfer (64%). Discussions on Market Access and Inclusive Value Chains accounted for 59%, while Policy and Regulatory Alignment accounted for 54% of studies. Finally, Environmental and Sustainability Commitments were featured in 46% of the articles.

The dominance of institutional and governance themes suggests that scholars regard stakeholder coordination and institutional clarity as foundational to successful replanting initiatives. This reflects both the administrative complexity of the oil palm sector and the systemic challenges smallholders face in navigating multi-actor partnerships. Financial

issues are also highly prioritized, indicating that access to credit and risk mitigation remains a bottleneck in most replanting efforts. In contrast, environmental commitments, while critical in the broader sustainability discourse, receive comparatively less emphasis, possibly reflecting current research gaps or implementation delays in the field. These findings underscore the need for integrated approaches that not only address technical and financial constraints but also embed environmental and regulatory coherence.

The following sections elaborate on each thematic cluster.

4.1 INSTITUTIONAL FRAMEWORKS AND MULTI-STAKEHOLDER GOVERNANCE

Approximately 82% of the reviewed articles emphasized the importance of clear institutional arrangements and multi-stakeholder governance structures in supporting oil palm smallholders, particularly during replanting (de Vos et al., 2023; Jelsma et al., 2019). Effective partnerships are often characterized by the formal involvement of government agencies, private plantation companies, cooperatives, and NGOs in collaborative frameworks. For instance, the "*Kemitraan Inti-Plasma*" model in Indonesia has been widely cited for integrating smallholders into formal contractual arrangements with private firms that offer inputs, extension services, and guaranteed off-take mechanisms (Jelsma et al., 2024).

In one case, the South Sumatra Provincial Government coordinated a Public-Private-People Partnership (4P) involving 3,500 smallholders across 14 districts, in which oil palm replanting efforts led to a 23% increase in yields after 3 years (Raharja et al., 2020; Schoneveld et al., 2019). Governance structures that include dedicated dispute-resolution mechanisms and benefit-sharing agreements were reported to reduce conflict frequency by 47% compared with non-partnership replanting programs (Gamage et al., 2024).

4.2 FINANCIAL ACCESS AND RISK SHARING MECHANISMS

The replanting of oil palm plantations requires significant upfront capital. The reviewed literature indicates that financial constraints are the most frequently cited barrier to smallholder replanting, cited in 76% of studies (Sukiyono et al., 2024; Wahyudi et al., 2025). On average, replanting costs range between IDR 55–65 million (USD 3,500–4,200) per hectare, with a gestation period of 3–4 years before new palms become productive (Ogahara et al., 2022; Ruysschaert & Hufty, 2020).

Innovative financing mechanisms under partnership schemes include blended finance (public-private co-funding), cooperative lending models, and loan guarantees. For instance, a case study from Riau Province showed that 1,200 smallholders successfully accessed replanting funds from BPDP-KS (Indonesia's Palm Oil Plantation Fund Management Agency)

under a co-financing scheme with BRI Bank and Wilmar Group, with 89% of loans performing well by the third year (Grabs et al., 2021).

Moreover, insurance instruments such as crop failure guarantees and interest subsidies reduced financial risk and increased participation rates in replanting programs by 34% (Workie et al., 2020). Digital fintech platforms were also emerging as promising tools to facilitate transparent fund disbursement and monitoring (Purnomo et al., 2023).

4.3 CAPACITY BUILDING AND KNOWLEDGE TRANSFER

Across the 28 articles, 64% emphasized the role of capacity building in enhancing smallholder performance during and after the replanting process (He et al., 2023). Key interventions included agronomic training, nursery management, fertilizer optimization, and sustainable land management practices. Training programs linked to partnership schemes were associated with a 28% improvement in farm productivity over three years, according to a longitudinal study in Jambi (Mba et al., 2025).

One partnership involving NGOs and research institutions, operating in Central Kalimantan, reported that 800 farmers trained in Good Agricultural Practices (GAP) saw a reduction in fertilizer misuse by 36% and improved fruit quality grading, allowing 72% of them to reach premium price markets (Lu et al., 2022).

Private-sector-led extension models, where plantation companies deploy agronomists to support partnered smallholders, were also common. However, challenges remain, particularly in standardizing the quality of extension agents and ensuring equitable access for independent smallholders (Ghadiri et al., 2024).

4.4 MARKET ACCESS AND INCLUSIVE VALUE CHAINS

Another dominant theme was the integration of smallholders into inclusive value chains through structured partnerships. Approximately 59% of the studies discussed how contract farming, certification schemes, and traceability systems improved market access for rejuvenated smallholder farms (Taiwo et al., 2025).

RSPO (Roundtable on Sustainable Palm Oil) certification was frequently highlighted as a market gateway. One study in North Sumatra found that RSPO-certified smallholders under the KUD Tani Mandiri partnership received 14% higher average farm-gate prices than their non-certified counterparts (Mwangi et al., 2023). Meanwhile, 68% of the smallholders involved in ISPO (Indonesia Sustainable Palm Oil) compliance partnerships accessed more stable export markets to Malaysia and India.

Traceability platforms such as Trase and Koltiva were also being integrated into partnership frameworks, enabling transparent data on origin, farming practices, and carbon footprints. A multi-stakeholder project in West Kalimantan, involving Unilever and Inobu, used these platforms to link 1,100 smallholders to sustainable export buyers with zero-deforestation requirements (Hilson et al., 2025).

4.5 POLICY AND REGULATORY ALIGNMENT

Policy coherence is critical in supporting scalable and effective smallholder partnerships. About 54% of the articles reviewed pointed to policy misalignments as a barrier to successful program implementation (Chao, 2024; Swastika et al., 2024). For example, overlapping land tenure laws, inconsistencies in subsidy disbursement, and unclear replanting eligibility criteria often delay implementation.

In response, integrated policy frameworks, such as Indonesia's National Action Plan on Sustainable Palm Oil (NAP-SPO), were noted to play a coordinating role in harmonizing regulations across agencies. Studies found that provinces with dedicated smallholder support task forces (e.g., Central Kalimantan, East Kalimantan) achieved a 41% faster processing time for legal land recognition and program approvals (Masha et al., 2024).

Furthermore, streamlined permitting processes and the simplification of BPDP-KS grant applications resulted in a 29% increase in accepted proposals between 2020 and 2024 (Singh et al., 2024). These improvements were particularly impactful for independent smallholders, who traditionally faced higher administrative burdens.

4.6 ENVIRONMENTAL AND SUSTAINABILITY COMMITMENTS

Finally, environmental performance and sustainability commitments emerged as a crucial theme in 46% of the reviewed articles (Ayompe et al., 2021). Replanting, when integrated with sustainability criteria, was seen as a key opportunity to reduce deforestation, restore degraded lands, and promote biodiversity.

For example, a replanting partnership in West Kalimantan that introduced agroforestry zones between oil palm rows reported a 22% increase in local bird species and a 12% increase in soil carbon over four years (Charisiadou et al., 2022). Smallholders who adopted these models also gained access to green finance through environmental impact funds and sustainability-linked loans.

Climate mitigation commitments were also embedded in partnerships that aligned with Indonesia's FOLU (Forestry and Other Land Use) Net Sink 2030 agenda. Studies showed

that 32% of replanting partnerships adopted carbon accounting practices and land-use mapping to monitor emissions (Valerio et al., 2024).

Water management innovations, such as controlled drainage systems and vegetative buffer zones, were implemented in 18% of the case studies, reducing flood-related losses by 30% and improving palm yields by 11% in vulnerable regions, such as South Sumatra (Olofsson et al., 2021).

Collectively, these six thematic clusters illustrate the multidimensional nature of partnership models in supporting the oil palm smallholder replanting program. They highlight that success requires integrated financial, institutional, environmental, and technical interventions backed by coordinated governance, clear policies, and equitable stakeholder engagement.

5 DISCUSSION

This study sought to answer the central research question: How do partnership models facilitate oil palm smallholders' participation and success in national replanting programs, particularly in addressing structural barriers to adoption? Drawing from a Systematic Literature Review (SLR) of 28 selected peer-reviewed articles published between 2019 and 2025, several critical insights emerged regarding the role, structure, and impact of partnership models. This discussion synthesizes these findings by thematically analyzing how partnerships address core barriers faced by smallholders: financial access, technical knowledge, institutional support, market integration, and regulatory compliance.

5.1 FINANCIAL ACCESSIBILITY THROUGH SHARED INVESTMENT MECHANISMS

One of the most cited structural barriers in oil palm replanting is the lack of access to finance for independent smallholders, who typically lack collateral, credit history, or secure land titles (Watts et al., 2021). Partnership models mitigate this challenge by structuring shared investment mechanisms involving government subsidies, concessional loans from state-owned banks, and pre-financing arrangements with private firms. For example, multi-stakeholder partnerships involving agribusinesses and rural banks enabled pre-financing of replanting costs in over 12,000 hectares across Riau and Jambi provinces between 2020 and 2023 (Siregar et al., 2024).

These mechanisms reduce the upfront burden on smallholders by deferring payments until the plantation becomes productive. Research indicates that repayment rates under such schemes exceed 85% when coupled with cooperative oversight and financial literacy training (Ayompe et al., 2025). Moreover, the integration of financial technology (fintech) platforms in

some partnerships has improved transparency and efficiency in fund disbursement, reducing leakage by over 20% compared to non-digital schemes (Galiè et al., 2025).

5.2 TECHNICAL ASSISTANCE AND ACCESS TO CERTIFIED PLANTING MATERIALS

Replanting success depends not only on funding but also on the application of Good Agricultural Practices (GAP) and the use of high-yield certified seeds. Partnership models often include technical assistance programs delivered by plantation companies, NGOs, or government extension services. In a study covering five major oil palm regions, smallholders in partnership schemes were 2.7 times more likely to adopt GAP than their non-partnered counterparts (Safriyana et al., 2021).

This is largely attributable to capacity-building initiatives embedded in the partnership framework, such as regular training, on-farm demonstrations, and participatory learning modules (Bahraseman et al., 2024). Partnerships have also improved seed access: nearly 60% of partnered smallholders reported receiving certified seedlings through group procurement programs negotiated by cooperatives or farmer associations (Goh, 2020). The resulting yield improvements range between 18% and 35% in the first five years after replanting, substantially shortening the economic recovery period (R. Kumar et al., 2024).

5.3 STRENGTHENING INSTITUTIONAL CAPACITY AND COLLECTIVE GOVERNANCE

Institutional fragmentation and weak governance among smallholder groups often hamper the scalability of replanting programs. Partnership models address this by strengthening local institutions, especially cooperatives and farmer organizations, which serve as intermediaries for fund management, input distribution, and knowledge dissemination. Studies show that effective partnerships are typically anchored by formalized governance mechanisms, such as bylaws, performance-based incentives, and third-party audits (S. Kumar et al., 2025).

A notable example is the partnership consortium model implemented in South Sumatra, which integrates roles for village governments, cooperatives, and private firms in a unified governance structure. Over 75% of smallholders under this model reported greater trust in the management process and more active participation in replanting decisions (Goswami et al., 2021). Collective action facilitated by institutional strengthening also improved bargaining power in contract negotiations and price-setting mechanisms, reducing dependence on middlemen by up to 40% (Shen & Dong, 2025).

5.4 MARKET INTEGRATION AND SUPPLY CHAIN FORMALIZATION

Another significant barrier is the limited market access and informal trading practices that erode smallholder profitability. Partnerships play a critical role in linking smallholders to formal value chains through long-term purchase agreements, quality-based pricing models, and access to RSPO/ISPO certification schemes. Approximately 68% of the reviewed articles indicated that smallholders engaged in formal partnerships were more likely to participate in certified supply chains, leading to price premiums of 8% to 15% (Falola, 2025).

These arrangements often include traceability tools, digital logbooks, and product quality monitoring systems, which further embed smallholders into formal markets. One empirical study found that traceability systems implemented through digital partnerships in Central Kalimantan increased average smallholder income by 22% over 3 years (Córdoba et al., 2023). Market access improvements also encourage long-term investment by reducing the risk of price volatility and buyer uncertainty (Lin & Wang, 2024).

5.5 NAVIGATING LEGAL AND LAND TENURE COMPLEXITIES

Many smallholders operate on land without formal legal status, posing a barrier to accessing replanting funds and integrating into regulated markets. Partnership models have supported land titling initiatives in collaboration with local governments and land agencies. In 2021–2023, over 45,000 hectares of oil palm land held by smallholders were formally registered as a result of partnership-based advocacy and legal support programs (Yu et al., 2024).

The availability of legal titles enabled these smallholders to qualify for PSR program funding and bank loans that were previously inaccessible. In regions such as West Kalimantan, the proportion of partnered farmers with legal land certificates rose from 12% to 61% in just four years (Hu, 2024). This transformation underscores the importance of integrated partnerships that combine agronomic, financial, and legal support.

5.6 INCLUSIVE DESIGN AND GENDER-RESPONSIVE APPROACHES

Few studies explicitly explore gender dimensions in partnership models, but those that do suggest that inclusive partnerships are more resilient and equitable. Female-headed households, which constitute approximately 9% of oil palm smallholders, often face higher entry barriers due to discriminatory land inheritance practices and limited mobility (Kahar et al., 2022). Partnerships that incorporated gender-sensitive training and leadership quotas within cooperatives saw a 31% increase in female participation in decision-making processes (Wang et al., 2023).

Moreover, inclusive models demonstrated improved social cohesion, with fewer reported conflicts and greater alignment of goals among stakeholders. These outcomes suggest that partnership effectiveness depends not only on structural design but also on the degree of social inclusiveness and trust-building mechanisms embedded in the collaboration framework (Kalimuthu et al., 2024; Olomu et al., 2020).

This study underscores the multifaceted role of partnership models in enabling smallholder oil palm farmers to participate effectively in national replanting programs. By addressing barriers related to finance, technology, institutions, markets, and land governance, partnerships contribute to more resilient and inclusive development outcomes. The success of these models, however, depends on context-specific design, long-term stakeholder commitment, and alignment with national policy frameworks.

From a policy perspective, the findings suggest that future iterations of the PSR program and similar initiatives should embed multi-stakeholder partnerships as core implementation strategies, rather than supplementary components. Regulatory reforms are also needed to streamline partnership formation, reduce bureaucratic bottlenecks, and safeguard smallholder interests through transparent contract enforcement.

For future research, there remains a need to explore the comparative efficacy of different partnership models across diverse agroecological zones and socio-economic contexts. Quantitative meta-analysis could strengthen the empirical foundation of partnership performance, while qualitative studies could enrich understanding of behavioral and cultural factors that influence partnership dynamics. A promising research direction would involve investigating the long-term sustainability of these models post-replanting and their ability to adapt to climate change risks and shifting market demands.

6 CONCLUSION

The synthesis of 28 peer-reviewed studies published between 2019 and 2025 reveals that partnership models play a pivotal role in enabling the successful implementation of oil palm smallholders' replanting programs. These models serve as institutional mechanisms to address systemic barriers that have long hindered smallholder participation in replanting initiatives, including limited access to finance, technological constraints, a lack of certified seeds, insecure land tenure, and weak integration into sustainable supply chains.

Among the various models reviewed, ranging from nucleus-plasma schemes to cooperative-based approaches and public-private partnerships, hybrid models emerge as the most effective. These combine the financial capacity and market access provided by private actors with the regulatory support, capacity building, and subsidy mechanisms facilitated by

government and civil society organizations. Such arrangements have yielded positive outcomes, including increased smallholders' willingness to adopt replanting, improved land documentation processes, increased access to certified planting materials, and price guarantees during the unproductive gestation phase.

The role of formalized institutional arrangements is equally significant. Multi-stakeholder platforms, joint venture schemes, and structured contract farming models contribute to greater transparency, stronger agreement enforcement, and long-term trust among actors. These structures not only reduce transaction costs but also provide legal certainty and monitoring frameworks that protect the interests of smallholders. Importantly, evidence suggests that when smallholders are treated not merely as beneficiaries but as active partners with decision-making power, the adoption and compliance rates with replanting guidelines increase substantially.

Despite these positive trends, disparities in model performance across regions underscore the need for context-sensitive strategies. Partnership effectiveness is influenced by factors such as local governance quality, institutional capacity, smallholder social capital, and the degree of integration with downstream markets. The literature also emphasizes the importance of simplifying bureaucratic processes in government-led schemes and of increasing technical assistance to help farmers navigate eligibility requirements and financial procedures.

Furthermore, successful partnerships are often underpinned by digital innovations and financial technology tools that streamline application, verification, and fund disbursement processes. These tools enable real-time data tracking, reduce opportunities for corruption, and improve coordination among agencies involved in the replanting supply chain. However, digital inclusion remains uneven among rural farmers, highlighting the need for complementary investments in digital literacy and rural connectivity infrastructure.

Overall, this review demonstrates that well-designed, well-executed partnership models can significantly reduce the risks and costs associated with oil palm replanting for smallholders. They act as enabling environments that integrate technical, financial, legal, and market resources. Their success hinges not only on design but also on sustained institutional support, adaptive governance, and equitable value-sharing mechanisms.

REFERENCES

Amir, S. M. M., Sultan, M. T. H., Jawaid, M., Safri, S. N. A., Shah, A. U. M., Yusof, M. R., Naveen, J., Mohd, S., Salleh, K. A. M., & Saba, N. (2019). Effects of layering sequence and gamma radiation on mechanical properties and morphology of Kevlar/oil palm EFB/epoxy hybrid composites. *Journal of Materials Research and Technology*, 8(6),

- Asmara, B., & Randhir, T. O. (2024). Modeling the impacts of oil palm plantations on water quantity and quality in the Kais River Watershed of Indonesia. *Science of The Total Environment*, 928, 172456. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2024.172456>
- Asyraf, M. R. M., Ishak, M. R., Syamsir, A., Nurazzi, N. M., Sabaruddin, F. A., Shazleen, S. S., Norrrahim, M. N. F., Rafidah, M., Ilyas, R. A., Rashid, M. Z. A., & Razman, M. R. (2022). Mechanical properties of oil palm fibre-reinforced polymer composites: a review. *Journal of Materials Research and Technology*, 17, 33–65. <https://doi.org/https://doi.org/10.1016/j.jmrt.2021.12.122>
- Ayompe, L. M., Nkongho, R. N., Acobta, A. N. B., Tambasi, E. E., Masso, C., & Egoh, B. N. (2025). Review of Conceptual Frameworks for Smallholder Farmers to Achieve Sustainable Palm Oil Production. *Journal of Cleaner Production*, 145525. <https://doi.org/10.1016/j.jclepro.2025.145525>
- Ayompe, L. M., Schaafsma, M., & Egoh, B. N. (2021). Towards sustainable palm oil production: The positive and negative impacts on ecosystem services and human wellbeing. *Journal of Cleaner Production*, 278, 123914. <https://doi.org/10.1016/j.jclepro.2020.123914>
- Bahraseman, S. E., Firoozzare, A., Zhang, C., Yousefian, N., Skominas, R., Barati, R., & Azadi, H. (2024). Reviving the forgotten legacy: Strategies for reviving qanats as sustainable solutions for agricultural water supply in arid and semi-arid regions. *Water Research*, 265, 122138. <https://doi.org/https://doi.org/10.1016/j.watres.2024.122138>
- Carias Vega, D., Page, T., & Ota, L. (2023). Challenges and opportunities for inclusive value chains of niche forest products in small island developing states: Canarium nuts, sandalwood, and whitewood in Vanuatu. *Journal of Rural Studies*, 100, 103036. <https://doi.org/https://doi.org/10.1016/j.jrurstud.2023.103036>
- Chao, K. (2024). Family farming in climate change: Strategies for resilient and sustainable food systems. *Heliyon*, 10(7), e28599. <https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e28599>
- Charisiadou, S., Halling, C., Jiddawi, N., von Schreeb, K., Gullström, M., Larsson, T., & Nordlund, L. M. (2022). Coastal aquaculture in Zanzibar, Tanzania. *Aquaculture*, 546, 737331. <https://doi.org/https://doi.org/10.1016/j.aquaculture.2021.737331>
- Cifuentes-Espinosa, J. A., Feintrenie, L., Monzón-Alvarado, C., Schmook, B., & Mesa-Jurado, M. A. (2023). Oil palm growers' prospects for sustainable oil palm production. A case study from Campeche, Mexico. *Agricultural Systems*, 212, 103780. <https://doi.org/https://doi.org/10.1016/j.agry.2023.103780>
- Córdoba, D., Wiegel, J., Gonzalez, C., & Reyes, B. (2023). State embeddedness and public-private dynamics in central American coffee leaf rust management. *Journal of Rural Studies*, 103, 103092. <https://doi.org/https://doi.org/10.1016/j.jrurstud.2023.103092>
- de Vos, R. E., Suwarno, A., Slingerland, M., van der Meer, P. J., & Lucey, J. M. (2023). Pre-certification conditions of independent oil palm smallholders in Indonesia. Assessing prospects for RSPO certification. *Land Use Policy*, 130, 106660. <https://doi.org/10.1016/j.landusepol.2023.106660>
- Degli Innocenti, E., & Oosterveer, P. (2020). Opportunities and bottlenecks for upstream learning within RSPO certified palm oil value chains: A comparative analysis between Indonesia and Thailand. *Journal of Rural Studies*, 78.

<https://doi.org/10.1016/j.jrurstud.2020.07.004>

- Falola, T. (2025). Information, Digital Divide, and Decolonization in Africa. In D. Baker & L. Ellis (Eds.), *Encyclopedia of Libraries, Librarianship, and Information Science (First Edition)* (First Edition, pp. 296–305). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-323-95689-5.00263-7>
- Galiè, A., Kramer, B., Spielman, D. J., Kawarazuka, N., Rietveld, A. M., & Aju, S. (2025). Inclusive and gender-transformative seed systems: Concepts and applications. *Agricultural Systems*, 226, 104320. <https://doi.org/https://doi.org/10.1016/j.agsy.2025.104320>
- Gamage, A., Gangahagedara, R., Subasinghe, S., Gamage, J., Guruge, C., Senaratne, S., Randika, T., Rathnayake, C., Hameed, Z., Madhujith, T., & Merah, O. (2024). Advancing sustainability: The impact of emerging technologies in agriculture. *Current Plant Biology*, 40, 100420. <https://doi.org/10.1016/j.cpb.2024.100420>
- Ghadiri, M., Krawchenko, T., & Newell, R. (2024). Applying a climate-biodiversity-health framework to support integrated food systems planning and policy. *Journal of Environmental Management*, 358, 120769. <https://doi.org/https://doi.org/10.1016/j.jenvman.2024.120769>
- Goh, C. S. (2020). Transforming exploitative land-based economy: The case of Borneo. *Environmental Development*, 33, 100487. <https://doi.org/https://doi.org/10.1016/j.envdev.2019.100487>
- Goswami, G., Datta, S., Sharma, S., & Mukherjee, J. (2021). Chapter 33 - Locally informed “remediation” interventions: lessons of community (co)engagement from semi-arid Bundelkhand, India. In G. S. Bhunia, U. Chatterjee, A. Kashyap, & P. K. Shit (Eds.), *Land Reclamation and Restoration Strategies for Sustainable Development* (Vol. 10, pp. 729–745). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-823895-0.00028-2>
- Grabs, J., Cammelli, F., Levy, S. A., & Garrett, R. D. (2021). Designing effective and equitable zero-deforestation supply chain policies. *Global Environmental Change*, 70, 102357. <https://doi.org/10.1016/j.gloenvcha.2021.102357>
- Grinnell, N. A., van der Linden, A., Azhar, B., Nobilly, F., & Slingerland, M. (2022). Cattle-oil palm integration – a viable strategy to increase Malaysian beef self-sufficiency and palm oil sustainability. *Livestock Science*, 259, 104902. <https://doi.org/https://doi.org/10.1016/j.livsci.2022.104902>
- Halimatussadiyah, A., Moeis, F. R., Siregar, A. A., & Nainggolan, D. (2025). The potentials of Indonesian biofuel policy’s replanting scheme to reduce poverty and enhance regional economy. *Land Use Policy*, 157, 107623. <https://doi.org/https://doi.org/10.1016/j.landusepol.2025.107623>
- Hamed, A. S. A., Yusof, N. I. F. M., Yahya, M. S., Cardozo, E., & Munajat, N. F. (2023). Concentrated solar pyrolysis for oil palm biomass: An exploratory review within the Malaysian context. *Renewable and Sustainable Energy Reviews*, 188, 113834. <https://doi.org/https://doi.org/10.1016/j.rser.2023.113834>
- Hamid, F. A., Loh, S. K., Wahab, N. A., Subramaniam, V., Aziz, A. A., & Idris, Z. (2024). Pulp and paper from wood and oil palm biomass: Current development, issues, challenges and opportunities. *Industrial Crops and Products*, 222, 119938. <https://doi.org/https://doi.org/10.1016/j.indcrop.2024.119938>
- Hanis, A., Uke, A., Sudesh, K., & Kosugi, A. (2024). Accumulation of starch and sugars, and

- effect on pathogenesis-related proteins in felled oil palm trunks from the replanting period. *Industrial Crops and Products*, 218, 118863. <https://doi.org/https://doi.org/10.1016/j.indcrop.2024.118863>
- He, Z., Wang, C., Gao, J., & Xie, Y. (2023). Assessment of global shipping risk caused by maritime piracy. *Heliyon*, 9(10), e20988. <https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e20988>
- Hendrawan, D., & Musshoff, O. (2024). Risky for the income, useful for the environment: Predicting farmers' intention to adopt oil palm agroforestry using an extended theory of planned behaviour. *Journal of Cleaner Production*, 475, 143692. <https://doi.org/https://doi.org/10.1016/j.jclepro.2024.143692>
- Hilson, G., Laing, T., Hilson, A., Arnall, A., & Mondlane, S. (2025). How Does Small-Scale Mining Stabilize Rural Livelihoods in Sub-Saharan Africa? The Case of Mozambique. *World Development*, 185, 106761. <https://doi.org/https://doi.org/10.1016/j.worlddev.2024.106761>
- Hu, Z. (2024). Doomed in the agrivoltaic campaign? The case of Chinese smallholder agriculture in the deployment of agrivoltaic projects. *Energy for Sustainable Development*, 83, 101562. <https://doi.org/https://doi.org/10.1016/j.esd.2024.101562>
- Iyiola, A. O., Kolawole, A. S., Ajayi, F. O., Ogidi, O. I., & Ogwu, M. C. (2024). Chapter 22 - Sustainable water use and management for agricultural transformation in Africa. In S. Madhav, A. L. Srivastav, S. Chibueze Izah, & E. van Hullebusch (Eds.), *Water Resources Management for Rural Development* (pp. 287–300). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-443-18778-0.00001-5>
- Jaza Folefack, A. J., Ngo Njiki, M. G., & Darr, D. (2019). Safeguarding forests from smallholder oil palm expansion by more intensive production? The case of Ngwei forest (Cameroon). *Forest Policy and Economics*, 101, 45–61. <https://doi.org/https://doi.org/10.1016/j.forpol.2019.01.016>
- Jelsma, I., Gay, F., Ollivier, J., & Rapidel, B. (2024). Collective action, replanting and resilience; Key lessons from 40 years of smallholder oil palm cultivation in the Ophir plantation, Indonesia. *Agricultural Systems*, 213, 103801.
- Jelsma, I., Woittiez, L. S., Ollivier, J., & Dharmawan, A. H. (2019). Do wealthy farmers implement better agricultural practices? An assessment of implementation of Good Agricultural Practices among different types of independent oil palm smallholders in Riau, Indonesia. *Agricultural Systems*, 170, 63–76. <https://doi.org/10.1016/j.agsy.2018.11.004>
- Kahar, P., Rachmadona, N., Pangestu, R., Palar, R., Triyono Nugroho Adi, D., Betha Juanssilfero, A., Yopi, Manurung, I., Hama, S., & Ogino, C. (2022). An integrated biorefinery strategy for the utilization of palm-oil wastes. *Bioresource Technology*, 344, 126266. <https://doi.org/https://doi.org/10.1016/j.biortech.2021.126266>
- Kalimuthu, T., Kalpana, P., Kuppusamy, S., & Raja Sreedharan, V. (2024). Intelligent decision-making framework for agriculture supply chain in emerging economies: Research opportunities and challenges. *Computers and Electronics in Agriculture*, 219, 108766. <https://doi.org/https://doi.org/10.1016/j.compag.2024.108766>
- Kong, S. H., Loh, S. K., Bachmann, R. T., Rahim, S. A., & Salimon, J. (2014). Biochar from oil palm biomass: A review of its potential and challenges. *Renewable and Sustainable Energy Reviews*, 39, 729–739. <https://doi.org/10.1016/j.rser.2014.07.107>
- Kumar, R., Mishra, A., & Goyal, M. K. (2024). Water neutrality: Concept, challenges, policies, and recommendations. *Groundwater for Sustainable Development*, 26, 101306.

<https://doi.org/https://doi.org/10.1016/j.gsd.2024.101306>

- Kumar, S., Jaswal, R., Shilpa, & Narwal, K. (2025). Chapter 6 - Law and policy pathways for global soil carbon sequestration in agroecosystems to ensure zero carbon emission. In S. Kumar & R. S. Meena (Eds.), *Agriculture Toward Net Zero Emissions* (pp. 83–97). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-443-13985-7.00007-5>
- Kurniawan, T. A., Ali, M., Mohyuddin, A., Haider, A., Othman, M. H. D., Anouzla, A., & Alsultan, G. A. (2024). Innovative transformation of palm oil biomass waste into sustainable biofuel: Technological breakthroughs and future prospects. *Process Safety and Environmental Protection*. <https://doi.org/10.1016/j.psep.2024.11.073>
- Lezoche, M., Hernandez, J. E., del Mar Eva Alemany Díaz, M., Panetto, H., & Kacprzyk, J. (2020). Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture. *Computers in Industry*, 117, 103187. <https://doi.org/https://doi.org/10.1016/j.compind.2020.103187>
- Lin, B., & Wang, Y. (2024). How does natural disasters affect China agricultural economic growth ? . *Energy*, 296, 131096. <https://doi.org/https://doi.org/10.1016/j.energy.2024.131096>
- Lu, J., Dev, L., & Petersen-Rockney, M. (2022). Criminalized crops: Environmentally-justified illicit crop interventions and the cyclical marginalization of smallholders. *Political Geography*, 99, 102781. <https://doi.org/https://doi.org/10.1016/j.polgeo.2022.102781>
- Masha, M., Bojago, E., Tadila, G., & Belayneh, M. (2024). Effects of participatory forest management programs on Land use/land cover change and its Determinants in Alle District, southwest Ethiopia. *Heliyon*, 10(15), e35179. <https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e35179>
- Mba, P. C., Njoku, J. N., & Uyeh, D. D. (2025). Enhancing resilience in specialty crop production in a changing climate through smart systems adoption. *Smart Agricultural Technology*, 11, 100897. <https://doi.org/https://doi.org/10.1016/j.atech.2025.100897>
- Mondal, S., & Palit, D. (2022). Chapter 2 - Challenges in natural resource management for ecological sustainability. In M. K. Jhariya, R. S. Meena, A. Banerjee, & S. N. Meena (Eds.), *Natural Resources Conservation and Advances for Sustainability* (pp. 29–59). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-12-822976-7.00004-1>
- Mondal, T., & Roy, S. M. (2025). 16 - Enhancing climate resilience through natural resource management: the role of Mahatma Gandhi National Rural Employment Guarantee Act in Jharkhand. In T. Goswami, S. M. Roy, & S. Senatore (Eds.), *Data-Driven Insights and Analytics for Measurable Sustainable Development Goals* (pp. 303–313). Morgan Kaufmann. <https://doi.org/https://doi.org/10.1016/B978-0-443-33044-5.00015-2>
- Mulyasari, G., Djarot, I. N., Sasongko, N. A., & Putra, A. S. (2023). Social-life cycle assessment of oil palm plantation smallholders in Bengkulu province, Indonesia. *Heliyon*, 9(8), e19123. <https://doi.org/10.1016/j.heliyon.2023.e19123>
- Mwangi, R. W., Mustafa, M., Charles, K., Wagara, I. W., & Kappel, N. (2023). Selected emerging and reemerging plant pathogens affecting the food basket: A threat to food security. *Journal of Agriculture and Food Research*, 14, 100827. <https://doi.org/https://doi.org/10.1016/j.jafr.2023.100827>
- Norhazimah, A. H., Noh, T. U., & Mohd Noor, S. F. (2025). Optimization of fermentation conditions for bioethanol production from oil palm trunk sap. *Journal of the Indian Chemical Society*, 102(9), 101943.

<https://doi.org/https://doi.org/10.1016/j.jics.2025.101943>

- Nyarko, H., & Ashiagbor, G. (2025). Can Ghana's Cocoa Forest REDD+ program achieve its intended goals of promoting sustainable cocoa production and enhancing carbon stocks? *Journal of Environmental Management*, 382, 125376. <https://doi.org/https://doi.org/10.1016/j.jenvman.2025.125376>
- Obaideen, K., Mahmoud, M., Abdelkareem, M. A., Alami, A. H., & Olabi, A. G. (2025). 2.21 - Contribution of Green Chemicals and Advanced Materials to Sustainable Development Goals. In P. A. G. Olabi (Ed.), *Comprehensive Green Materials (First Edition)* (First Edition, pp. 303–321). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-443-15738-7.00007-6>
- Ogahara, Z., Jespersen, K., Theilade, I., & Nielsen, M. R. (2022). Review of smallholder palm oil sustainability reveals limited positive impacts and identifies key implementation and knowledge gaps. *Land Use Policy*, 120, 106258. <https://doi.org/10.1016/j.landusepol.2022.106258>
- Olofsson, M., Ros-Tonen, M., Gupta, J., de Steenhuijsen Piters, B., & Van Leynseele, Y. (2021). Rethinking the divide: Exploring the interdependence between global and nested local markets. *Journal of Rural Studies*, 83, 60–70. <https://doi.org/https://doi.org/10.1016/j.jrurstud.2021.02.018>
- Olomu, M. O., Ekperiware, M. C., & Akinlo, T. (2020). Agricultural sector value chain and government policy in Nigeria: issues, challenges and prospects. *African Journal of Economic and Management Studies*, 11(3), 525–538. <https://doi.org/https://doi.org/10.1108/AJEMS-03-2019-0103>
- Purnomo, H., Okarda, B., Puspitaloka, D., Ristiana, N., Sanjaya, M., Komarudin, H., Dermawan, A., Andrianto, A., Kusumadewi, S. D., & Brady, M. A. (2023). Public and private sector zero-deforestation commitments and their impacts: A case study from South Sumatra Province, Indonesia. *Land Use Policy*, 134, 106818. <https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106818>
- Raharja, S., Papilo, P., Massijaya, M. Y., Asrol, M., & Darmawan, M. A. (2020). Institutional strengthening model of oil palm independent smallholder in Riau and Jambi Provinces, Indonesia. *Heliyon*, 6(5). <https://doi.org/10.1016/j.heliyon.2020.e03875>
- Rhebergen, T., Zingore, S., Giller, K. E., Frimpong, C. A., Acheampong, K., Ohipeni, F. T., Panyin, E. K., Zutah, V., & Fairhurst, T. (2020). Closing yield gaps in oil palm production systems in Ghana through Best Management Practices. *European Journal of Agronomy*, 115, 126011. <https://doi.org/https://doi.org/10.1016/j.eja.2020.126011>
- Rodthong, W., Kuwornu, J. K. M., Datta, A., Anal, A. K., & Tsusaka, T. W. (2023). Farmers' perceptions and likelihood of adoption of the roundtable on sustainable palm oil practices in Thailand. *Environmental Development*, 47, 100883. <https://doi.org/https://doi.org/10.1016/j.envdev.2023.100883>
- Ruysschaert, D., & Hufty, M. (2020). Building an effective coalition to improve forest policy: Lessons from the coastal Tripa peat swamp rainforest, Sumatra, Indonesia. *Land Use Policy*, 99, 103359. <https://doi.org/https://doi.org/10.1016/j.landusepol.2018.04.034>
- Safriyana, S., Marimin, M., Anggraeni, E., & Sailah, I. (2021). Spatial-based model for oil palm plantation suitability rating and its smallholder farmers' competitiveness: a case study at Kampar Regency, Riau Province, Indonesia. *Journal of Science and Technology Policy Management*, 12(2), 283–308. <https://doi.org/https://doi.org/10.1108/JSTPM-03-2020-0066>

- Schoneveld, G. C., Van Der Haar, S., Ekowati, D., Andrianto, A., Komarudin, H., Okarda, B., & Pacheco, P. (2019). Certification, good agricultural practice and smallholder heterogeneity: Differentiated pathways for resolving compliance gaps in the Indonesian oil palm sector. *Global Environmental Change*, 57, 101933. <https://doi.org/10.1016/j.gloenvcha.2019.101933>
- Schulz, C., Martín Brañas, M., Núñez Pérez, C., Del Aguila Villacorta, M., Laurie, N., Lawson, I. T., & Roucoux, K. H. (2019). Uses, cultural significance, and management of peatlands in the Peruvian Amazon: Implications for conservation. *Biological Conservation*, 235, 189–198. <https://doi.org/https://doi.org/10.1016/j.biocon.2019.04.005>
- Shen, H., & Dong, S. (2025). Chapter 22 - Systematic coupling and modeling in sustainable grassland management. In Z. Shang, A. A. Degen, S. Dong, H. Zhou, & Y. Ma (Eds.), *Grassland Degradation, Restoration and Sustainable Management of Global Alpine Area* (pp. 509–538). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-443-21882-8.00023-8>
- Siddiqui, Y., Surendran, A., Paterson, R. R. M., Ali, A., & Ahmad, K. (2021). Current strategies and perspectives in detection and control of basal stem rot of oil palm. *Saudi Journal of Biological Sciences*, 28(5), 2840–2849. <https://doi.org/https://doi.org/10.1016/j.sjbs.2021.02.016>
- Singh, S., Kiran, B. R., & Mohan, S. V. (2024). Carbon farming: a circular framework to augment CO2 sinks and to combat climate change. *Environmental Science Advances*, 3(4), 522–542. <https://doi.org/https://doi.org/10.1039/d3va00296a>
- Siregar, A. A., Halimatussadiah, A., Moeis, F. R., Anky, W. A. K., & Nainggolan, D. (2024). The oil palm replanting imperative: Are smallholder farmers willing to participate? *Forest Policy and Economics*, 169, 103362. <https://doi.org/10.1016/j.forpol.2024.103362>
- Sukiyono, K., Romdhon, M. M., Mulyasari, G., Yuliarso, M. Z., Nabiu, M., Trisusilo, A., & Sugiardi, S. (2024). Smallholder palm oil and sustainable development goals (SDGs) achievement: An empirical analysis. *Sustainable Futures*, 8, 100233. <https://doi.org/10.1016/j.sftr.2024.100233>
- Sundram, S., & Intan-Nur, A. M. A. (2017). South American Bud rot: A biosecurity threat to South East Asian oil palm. *Crop Protection*, 101, 58–67. <https://doi.org/https://doi.org/10.1016/j.cropro.2017.07.010>
- Swastika, D. K. S., Priyanti, A., Hasibuan, A. M., Sahara, D., Arya, N. N., Malik, A., Ilham, N., Sayekti, A. L., Triastono, J., Asnawi, R., Sugandi, D., Hayati, N. Q., & Atman, A. (2024). Pursuing circular economics through the integrated crop-livestock systems: An integrative review on practices, strategies and challenges post Green Revolution in Indonesia. *Journal of Agriculture and Food Research*, 18, 101269. <https://doi.org/https://doi.org/10.1016/j.jafr.2024.101269>
- Taiwo, O. R., Onyeaka, H., Akinsemolu, A. A., & Oladipo, E. K. (2025). Examining the nexus of climate change and food safety: A review. *Applied Food Research*, 5(1), 100884. <https://doi.org/https://doi.org/10.1016/j.afres.2025.100884>
- Umar, H. A., Sulaiman, S. A., Meor Said, M. A., Gungor, A., Shahbaz, M., Inayat, M., & Ahmad, R. K. (2021). Assessing the implementation levels of oil palm waste conversion methods in Malaysia and the challenges of commercialisation: Towards sustainable energy production. *Biomass and Bioenergy*, 151, 106179. <https://doi.org/https://doi.org/10.1016/j.biombioe.2021.106179>
- Valerio, E., Hilmiati, N., Stella Thei, R., Safa Barraza, A., & Prior, J. (2024). Innovation for

whom? The case of women in cattle farming in Nusa Tenggara Barat, Indonesia. *Journal of Rural Studies*, 106, 103198. <https://doi.org/https://doi.org/10.1016/j.jrurstud.2024.103198>

Wahyudi, A., Ardana, I. K., Aunillah, A., Rianto, B., Anggoro, U. K., Hasibuan, A. M., Mardiharini, M., Indrawanto, C., Wardono, B., Sujianto, Ermianti, Sudjarmoko, B., Listyati, D., & Ferry, Y. (2025). Building sustainable and resilient coconut supply chains in remote areas: a study from Riau Province – Indonesia. *Sustainable Futures*, 9, 100709. <https://doi.org/https://doi.org/10.1016/j.sftr.2025.100709>

Wang, Y., Yang, A., Li, Y., & Yang, Q. (2023). Effect of e-commerce popularization on farmland abandonment in rural China: Evidence from a large-scale household survey. *Land Use Policy*, 135, 106958. <https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106958>

Watts, J. D., Pasaribu, K., Irawan, S., Tacconi, L., Martanila, H., Wiratama, C. G. W., & Manvi, U. P. (2021). Challenges faced by smallholders in achieving sustainable palm oil certification in Indonesia. *World Development*, 146, 105565. <https://doi.org/10.1016/j.worlddev.2021.105565>

Workie, E., Mackolil, J., Nyika, J., & Ramadas, S. (2020). Deciphering the impact of COVID-19 pandemic on food security, agriculture, and livelihoods: A review of the evidence from developing countries. *Current Research in Environmental Sustainability*, 2, 100014. <https://doi.org/https://doi.org/10.1016/j.crsust.2020.100014>

Yu, H., Fu, D., Yuan, Z., Tang, J., Xiao, Y., Kang, L., Lyne, V., & Su, F. (2024). Regimes of global and national oil palm cultivations from 2001 to 2018. *Global Environmental Change*, 86, 102845. <https://doi.org/10.1016/j.gloenvcha.2024.102845>

Zakaria, M. R., Farid, M. A. A., Hafid, H. S., Andou, Y., & Hassan, M. A. (2024). Practical role of oil palm fronds in Malaysia's sustainable palm oil industry. *Industrial Crops and Products*, 222, 119753. <https://doi.org/10.1016/j.indcrop.2024.119753>

Zhao, J., Elmore, A. J., Lee, J. S. H., Numata, I., Zhang, X., & Cochrane, M. A. (2023). Replanting and yield increase strategies for alleviating the potential decline in palm oil production in Indonesia. *Agricultural Systems*, 210, 103714. <https://doi.org/10.1016/j.agsy.2023.103714>

Zhao, K., Jia, C., Li, Z., Du, X., Wang, Y., Li, J., Yao, Z., & Yao, J. (2023). Recent Advances and Future Perspectives in Carbon Capture, Transportation, Utilization, and Storage (CCTUS) Technologies: A Comprehensive Review. *Fuel*, 351, 128913. <https://doi.org/https://doi.org/10.1016/j.fuel.2023.128913>

THE IMPORTANCE OF MARKET DIVERSIFICATION STRATEGY FOR PALM OIL IN FACING CONTEMPORARY MARKET DYNAMICS

A IMPORTÂNCIA DA ESTRATÉGIA DE DIVERSIFICAÇÃO DE MERCADOS PARA O ÓLEO DE PALMA DIANTE DAS DINÂMICAS CONTEMPORÂNEAS DO MERCADO

LA IMPORTANCIA DE LA ESTRATEGIA DE DIVERSIFICACIÓN DE MERCADOS PARA EL ACEITE DE PALMA FRENTE A LAS DINÁMICAS CONTEMPORÁNEAS DEL MERCADO



<https://doi.org/10.56238/sevened2026.008-064>

Loso Judijanto¹

ABSTRACT

The global palm oil industry is increasingly exposed to shifting trade policies, environmental pressures, and changing consumer demands, prompting a re-evaluation of how market diversification strategies are conceptualized and implemented. This study aims to explore the strategic role of market diversification in enhancing the resilience and competitiveness of palm oil producers in responding to contemporary global market dynamics. The research adopts a qualitative approach through a Systematic Literature Review (SLR), focusing on peer-reviewed articles published between 2020 and 2025. Data collection was conducted using structured keyword queries across the Scopus database, yielding 4,173 initial results. Through a multistage selection process based on topic relevance, publication year, and open-access availability, 26 articles were identified as meeting the inclusion criteria. Data analysis used thematic coding to identify dominant patterns in conceptual framing, implementation practices, and outcome assessments related to diversification strategies. The findings reveal that market diversification is increasingly viewed as a multidimensional strategy that encompasses geographical expansion, product innovation, regulatory compliance, and digital transformation. Implementation varies significantly across actor types: large firms adopt integrated approaches, while smallholders face institutional constraints. Despite growing academic attention, standardized tools for measuring diversification outcomes remain limited. This review concludes that diversification is not merely a tactical response but a structural pathway for sustainable transformation in the palm oil sector. Future studies are encouraged to develop integrated impact metrics and explore inclusive strategies that empower small-scale actors in global value chains.

Keywords: Palm Oil. Market Diversification. Global Dynamics. Trade Strategy. Systematic Literature Review.

RESUMO

A indústria global de óleo de palma está cada vez mais exposta a mudanças nas políticas comerciais, pressões ambientais e transformações nas demandas dos consumidores, o que tem levado a uma reavaliação de como as estratégias de diversificação de mercados são

¹ Master's degree of Statistics. IPOSS. Jakarta, Indonesia. E-mail: losojudijantobumn@gmail.com
Orcid: <https://orcid.org/0009-0007-7766-0647>

concebidas e implementadas. Este estudo tem como objetivo explorar o papel estratégico da diversificação de mercados no fortalecimento da resiliência e da competitividade dos produtores de óleo de palma diante das dinâmicas contemporâneas do mercado global. A pesquisa adota uma abordagem qualitativa por meio de uma Revisão Sistemática da Literatura (RSL), com foco em artigos revisados por pares publicados entre 2020 e 2025. A coleta de dados foi realizada por meio de consultas estruturadas por palavras-chave na base de dados Scopus, resultando em 4.173 registros iniciais. Por meio de um processo de seleção em múltiplas etapas, baseado na relevância temática, no ano de publicação e na disponibilidade de acesso aberto, 26 artigos foram identificados como atendendo aos critérios de inclusão. A análise dos dados utilizou codificação temática para identificar padrões dominantes no enquadramento conceitual, nas práticas de implementação e na avaliação de resultados relacionados às estratégias de diversificação. Os achados revelam que a diversificação de mercados é cada vez mais compreendida como uma estratégia multidimensional, que abrange a expansão geográfica, a inovação de produtos, a conformidade regulatória e a transformação digital. A implementação varia significativamente entre os diferentes tipos de atores: grandes empresas adotam abordagens integradas, enquanto os pequenos produtores enfrentam restrições institucionais. Apesar do crescente interesse acadêmico, ainda são limitadas as ferramentas padronizadas para mensurar os resultados da diversificação. Conclui-se que a diversificação não é apenas uma resposta tática, mas um caminho estrutural para a transformação sustentável do setor de óleo de palma. Estudos futuros são incentivados a desenvolver métricas integradas de impacto e a explorar estratégias inclusivas que fortaleçam a participação de atores de pequena escala nas cadeias globais de valor.

Palavras-chave: Óleo de Palma. Diversificação de Mercados. Dinâmicas Globais. Estratégia Comercial. Revisão Sistemática da Literatura.

RESUMEN

La industria mundial del aceite de palma se encuentra cada vez más expuesta a cambios en las políticas comerciales, presiones ambientales y transformaciones en las demandas de los consumidores, lo que ha impulsado una reevaluación de cómo se conciben e implementan las estrategias de diversificación de mercados. Este estudio tiene como objetivo explorar el papel estratégico de la diversificación de mercados en el fortalecimiento de la resiliencia y la competitividad de los productores de aceite de palma frente a las dinámicas contemporáneas del mercado global. La investigación adopta un enfoque cualitativo mediante una Revisión Sistemática de la Literatura (RSL), centrada en artículos revisados por pares publicados entre 2020 y 2025. La recopilación de datos se llevó a cabo a través de consultas estructuradas por palabras clave en la base de datos Scopus, lo que arrojó 4.173 resultados iniciales. Mediante un proceso de selección en múltiples etapas, basado en la relevancia temática, el año de publicación y la disponibilidad de acceso abierto, se identificaron 26 artículos que cumplieron con los criterios de inclusión. El análisis de los datos utilizó codificación temática para identificar patrones dominantes en el encuadre conceptual, las prácticas de implementación y la evaluación de resultados relacionados con las estrategias de diversificación. Los hallazgos revelan que la diversificación de mercados es concebida cada vez más como una estrategia multidimensional que abarca la expansión geográfica, la innovación de productos, el cumplimiento normativo y la transformación digital. La implementación varía significativamente según el tipo de actor: las grandes empresas adoptan enfoques integrados, mientras que los pequeños productores enfrentan restricciones institucionales. A pesar del creciente interés académico, siguen siendo limitadas las herramientas estandarizadas para medir los resultados de la diversificación. Se concluye que la diversificación no es únicamente una respuesta táctica, sino una vía estructural para la transformación sostenible del sector del aceite de palma. Se alienta a futuras investigaciones a desarrollar métricas integradas de impacto y a explorar estrategias

inclusivas que fortalezcan la participación de actores de pequeña escala en las cadenas globales de valor.

Palabras clave: Aceite de Palma. Diversificación de Mercados. Dinámicas Globales. Estrategia Comercial. Revisión Sistemática de la Literatura.

1 INTRODUCTION

The palm oil industry is among the most dynamic and economically influential sectors in global agribusiness, supplying over one-third of the world's vegetable oil demand by volume as of 2024 (P. Das & Gundimeda, 2022). It serves as a critical input for a wide array of products, ranging from food and personal care items to biofuels and pharmaceuticals (Al-haimi et al., 2024). In parallel with global population growth, rising urbanization, and expanding middle-income groups in emerging economies, demand for palm oil is projected to continue increasing, with the global market expected to surpass USD 95 billion by 2030, growing at a compound annual growth rate (CAGR) of approximately 4.5% (Johnston et al., 2025).

Indonesia, as the largest producer and exporter of palm oil globally, accounts for over 57% of the global crude palm oil (CPO) supply, producing approximately 49 million metric tons in 2023 and generating more than USD 25 billion in export revenues (Yadav & Chattopadhyay, 2024). Palm oil contributes significantly to Indonesia's GDP and employment structure, with over 17 million livelihoods, both direct and indirect, relying on the sector (Zaehringer et al., 2025). However, this dominance is increasingly challenged by evolving global market dynamics, including trade disputes, climate-related regulations, and increasing scrutiny over sustainability (Nam & Ryu, 2024).

In recent years, the traditional markets of Indonesian palm oil, primarily the European Union and the United States, have adopted restrictive import policies. Regulatory frameworks such as the European Union's Renewable Energy Directive II (RED II), the European Union Deforestation Regulation (EUDR), and mandatory sustainability certifications like RSPO and ISPO are reshaping demand structures (Cisneros-Pineda et al., 2025). These instruments, while environmentally justified, have imposed stringent conditions that have reduced Indonesia's market share in high-income nations, resulting in a reported 12% decline in exports to the EU from 2021 to 2023 (Gonzales Tovar & Hajjar, 2024).

Simultaneously, consumer preferences are shifting toward more sustainable and traceable products. This change has placed pressure on producers to comply with differentiated standards, invest in certification schemes, and ensure full traceability across supply chains (Berning & Sotirov, 2024). In the context of this shifting demand, market concentration on a few export destinations has proven risky. For instance, the volatility in international prices and the geopolitical instability affecting palm oil trade flows underscore the vulnerability of depending excessively on traditional buyers (Bouteska et al., 2025).

To mitigate such vulnerabilities and maintain competitiveness, market diversification has become an increasingly strategic imperative. Broadly defined, market diversification

involves expanding into new geographic regions, developing downstream products with higher value-added, strengthening compliance with diverse regulatory regimes, and adjusting marketing and branding approaches to align with local consumer behavior (K. C. Goh et al., 2025). Geographical diversification has notably gained momentum, with Indonesian palm oil exports to India and China rising by 6.3% and 5.1% respectively from 2021 to 2023 (Yusnitati et al., 2025). At the same time, markets in Africa and the Middle East have emerged as potential alternatives to traditional Western buyers (Thi Thu et al., 2025).

Beyond geographic expansion, product-based diversification, such as the production of refined products, biofuels, and oleochemicals, offers an alternative strategy to reduce reliance on crude palm oil (P. Y. Gan & Li, 2014). Recent data show that value-added palm oil exports are growing at twice the rate of raw CPO exports, particularly in countries that require traceable, environmentally certified, and processed goods (Mat Yasin et al., 2017). For example, biodiesel derived from palm oil accounted for 17% of Indonesia's palm oil use in 2023, indicating increasing vertical integration within the industry (Astari & Lovett, 2019).

Despite its potential, implementing market diversification strategies is not without barriers. One major limitation is the dominance of smallholders in the supply chain, who collectively contribute over 42% of Indonesia's palm oil production but often lack access to financing, technology, and certification (Harahap et al., 2020). This results in asymmetric capacity across the industry, where large companies are better positioned to access high-value markets, while smallholders remain locked into volatile bulk export markets (Loh et al., 2017).

Given the multidimensional nature of market diversification encompassing policy, trade, production, and sustainability, there is a growing need for a coherent body of academic knowledge to guide strategy and decision-making. While numerous studies address palm oil trade flows, sustainability policies, or export volumes independently, the literature remains fragmented in its treatment of diversification as a holistic strategy. Few syntheses exist that comprehensively evaluate how diversification is framed, implemented, and assessed across academic and policy discussions.

This study aims to fill that gap through a Systematic Literature Review (SLR) guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol. The SLR process includes four phases: identification, screening, eligibility, and inclusion. The literature search was conducted on the ScienceDirect database using the query: ("palm oil" AND ("market diversification" OR "export strategy" OR "trade policy")) AND ("market dynamics" OR "global competition" OR "changing demand" OR "international markets"). This yielded 4,173 initial records.

To ensure thematic relevance, 3,988 articles were excluded for not aligning with the research focus. Further filtering based on publication year (2020–2025) resulted in 79 eligible articles. Finally, 53 articles were removed because they were not Open Access or Open Archive, leaving a total of 26 peer-reviewed journal articles selected for in-depth analysis.

Unlike empirical studies employing field observations, focus group discussions, or interviews, this research does not engage in primary data collection. All analyses are based solely on peer-reviewed secondary sources. The selected articles were managed using Mendeley Desktop to ensure consistent referencing and traceability throughout the review process.

The overarching goal of this study is to systematically identify, categorize, and synthesize scholarly insights on the diversification strategies deployed within the palm oil sector, particularly in the face of global trade realignments and regulatory upheavals. The findings are expected to yield a consolidated framework of diversification mechanisms, highlight opportunities and constraints, and inform policy recommendations to enhance the resilience of palm oil exports.

Accordingly, this study is guided by the following research question:

How have market diversification strategies for palm oil been conceptualized and assessed in the academic literature as a response to contemporary global market dynamics?

This question will be addressed in the Discussion section and further reflected in the Conclusion, with an emphasis on its implications for Indonesian palm oil stakeholders and future research directions.

2 LITERATURE REVIEW

The strategic imperative of market diversification in the palm oil sector has attracted growing scholarly attention amid recent global trade tensions, environmental regulations, and shifting consumer preferences. Early studies predominantly emphasized volume-based export growth, but recent research underscores the importance of adaptive, multidimensional diversification strategies that ensure long-term resilience (Bei et al., 2025).

Geographical diversification is among the most frequently discussed themes. Palm oil producers are actively shifting their focus from traditional Western markets to emerging markets in South Asia, Africa, and the Middle East. Between 2020 and 2023, palm oil exports to India and Bangladesh rose by 9.4% and 6.8%, respectively, driven by their growing populations and rising edible oil consumption (Wei et al., 2024). Conversely, exports to the EU dropped by over 10% due to increasingly restrictive sustainability standards, such as the European Union Deforestation Regulation (EUDR) and RED II (Lusiana et al., 2023).

Beyond market destinations, product portfolio diversification has emerged as a key strategy. The transition from raw crude palm oil (CPO) to higher-value derivatives such as biodiesel, oleochemicals, and specialty fats is gaining traction. Biodiesel production in Indonesia increased from 8.5 million kiloliters in 2020 to 11.2 million kiloliters in 2023, demonstrating growing domestic and regional demand (Wiloso et al., 2024). This trend is aligned with national policies promoting downstream processing, which not only enhances value but also buffers against international price volatility (Goswami & Karali, 2025).

The literature also emphasizes supply chain diversification, including investments in logistics, warehousing, and traceability systems. Studies have identified a direct correlation between infrastructure quality and export performance, particularly in regions outside of Sumatra and Kalimantan (Hamid et al., 2024). Blockchain-based traceability initiatives, such as the PalmTrace and Starling systems, have been increasingly adopted to meet transparency requirements in sensitive markets like the EU and North America (Kan et al., 2023).

Sustainability has become a non-negotiable criterion for market access. Research reveals that certification schemes such as RSPO, ISPO, and MSPO now serve not only as environmental tools but also as trade enablers (Bujang et al., 2016). In 2023, over 87% of Indonesia's palm oil exports to Europe were RSPO-certified, compared to only 54% in 2019, an increase that reflects rising market barriers and consumer awareness (Ercin et al., 2024). However, smallholder participation in certification remains limited due to cost, capacity, and institutional challenges.

A number of studies examine policy responses aimed at facilitating diversification. These include trade agreements such as the Indonesia–Africa Palm Oil Forum (IA-POF) and bilateral negotiations with Pakistan and Bangladesh (Ghosh & Paparas, 2023). Research highlights that favorable tariff structures, export financing, and market intelligence support are critical to enabling entry into non-traditional markets (Xu et al., 2020).

Digitalization has also emerged as a supporting pillar for diversification. E-commerce platforms and digital trade facilitation tools are enabling palm oil SMEs to access niche international markets with lower overhead costs. For example, online B2B exports of palm oil-based products from Indonesia rose by 28% between 2021 and 2023, particularly in segments such as cosmetics and wellness oils (Qiang et al., 2020).

Despite these advancements, structural constraints continue to impede effective diversification. Literature indicates that the dominance of smallholder farmers, representing over 40% of national production, limits scalability and standardization. Additionally, financial

barriers, asymmetric information, and institutional fragmentation create gaps between policy aspirations and field-level implementation (S. Gan et al., 2023).

To complement the previous findings, several studies have emphasized the role of institutional partnerships in accelerating market diversification. Collaborations between government agencies, private exporters, and international NGOs have resulted in pilot programs to improve smallholder access to global value chains (Girkin et al., 2022). One such initiative in East Kalimantan saw a 14% increase in certified sustainable palm oil exports within two years, demonstrating the potential of coordinated interventions (Garre et al., 2019).

Another dimension frequently discussed in the literature is innovation in marketing strategies. Scholars note the growing significance of country branding and sustainability storytelling in differentiating palm oil in saturated markets. For example, Malaysia's "Love MY Palm Oil" campaign and Indonesia's "Sawit Baik" initiative have attempted to shift narratives and build consumer trust abroad, albeit with mixed success (Shahbaz et al., 2021).

The role of education and capacity-building also emerges as a crucial enabler. Academic contributions highlight the long-term importance of training programs for smallholders and cooperatives, particularly in quality control, adherence to international standards, and adoption of digital tools (Santeramo et al., 2021). These soft infrastructure measures are often undervalued in policy design, yet their presence significantly improves compliance and consistency.

In summary, the literature reveals a transition from reactive to proactive diversification strategies in the palm oil sector. While geographical expansion and product innovation are crucial, the enabling environment, including infrastructure, policy coherence, institutional capacity, and stakeholder collaboration, plays a determining role in success. The insights from this literature review provide a foundational understanding that will inform the analysis and synthesis in the subsequent sections of this study.

3 METHOD

This study employs the Systematic Literature Review (SLR) method, guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, to examine how market diversification strategies can support the palm oil sector in responding to increasingly complex global trade environments. As one of the world's most traded agricultural commodities, palm oil is central to the economies of major producing countries and plays a strategic role in global food, energy, and industrial supply chains. However, the industry faces mounting pressure from tightening environmental regulations, evolving consumer preferences, geopolitical trade tensions, and saturated traditional export markets.

These dynamics demand an urgent reassessment of existing export models and a shift toward broader market diversification strategies.

While a growing body of research has addressed palm oil's sustainability challenges and policy debates, studies specifically synthesizing its diversification strategies, particularly in response to shifting market dynamics, remain fragmented. This review responds to that gap by identifying, filtering, and analyzing academic literature that focuses on how diversification, whether geographical, product-based, or policy-driven, has been conceptualized and implemented to maintain competitiveness and mitigate trade-related risks.

Figure 1

Systematic Literature Review Process Based on the PRISMA Protocol

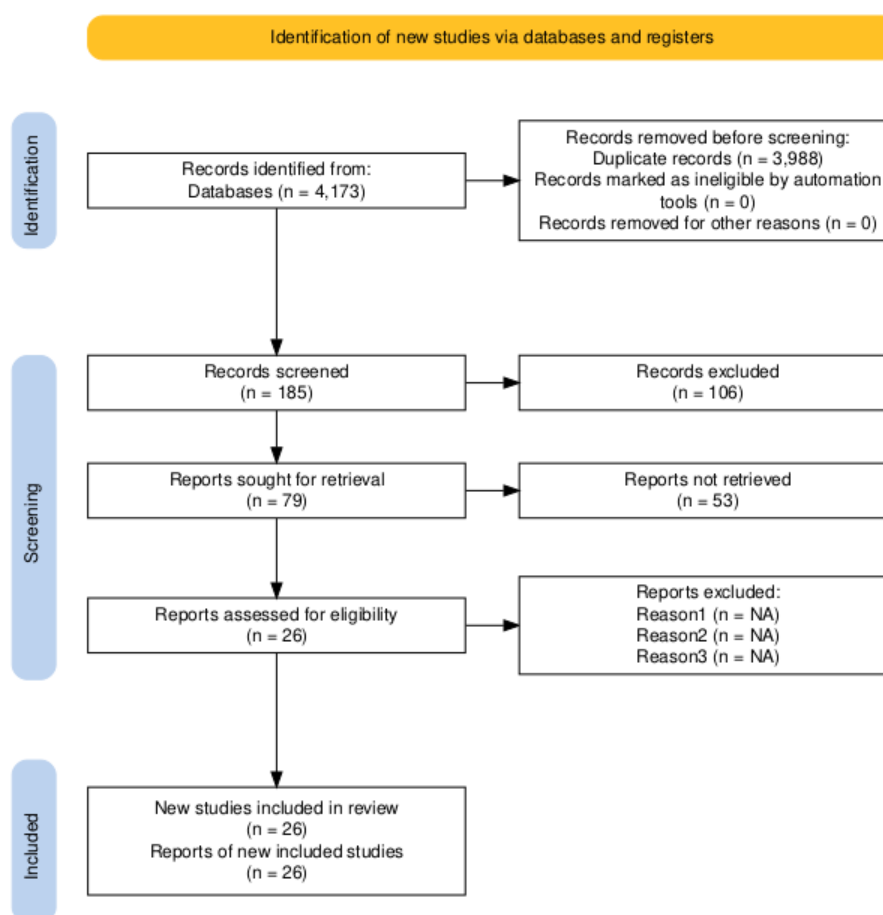


Figure 1 illustrates the structured review process applied in this study, following the four core stages of the PRISMA framework: identification, screening, eligibility, and inclusion. The initial identification phase began with a broad keyword search in the ScienceDirect database using the phrase "palm oil market diversification strategy", which produced 4,173 articles. To enhance thematic focus and precision, the search query was refined using

Boolean operators: ("palm oil" AND ("market diversification" OR "export strategy" OR "trade policy")) AND ("market dynamics" OR "global competition" OR "changing demand" OR "international markets"). This refinement resulted in the exclusion of 3,988 articles deemed thematically misaligned, leaving 185 articles for screening.

To align the review with recent market developments and policy debates, the publication window was restricted to 2020–2025. This temporal filter led to the exclusion of 106 articles, leaving 79 publications that met the timeframe requirement. Subsequently, an accessibility filter was applied to retain only articles categorized as Open Access or from Open Archives, ensuring transparency and replicability. This step removed 53 non-accessible items, yielding a final dataset of 26 peer-reviewed journal articles for full-text analysis and thematic synthesis.

All references were organized and managed in Mendeley Desktop, enabling consistent citation formatting, version control, and bibliographic traceability throughout the review. It is important to emphasize that this study did not use any primary data collection methods, such as interviews, field observations, or focus group discussions (FGDs). Rather, it relies exclusively on published, peer-reviewed secondary data sourced from credible academic repositories.

By consolidating and analyzing recent scholarly contributions, this study aims to offer a comprehensive, evidence-based understanding of how market diversification strategies are positioned within current palm oil trade discourses and how they may serve as adaptive tools for navigating increasingly volatile global market dynamics.

4 RESULTS

This systematic literature review identified several key themes in the academic discourse on market diversification strategies for palm oil amid contemporary market dynamics. From the 26 peer-reviewed articles selected through the PRISMA protocol, five dominant themes emerged: (1) geographical diversification strategies, (2) product diversification and value addition, (3) trade policy adaptation and market access, (4) sustainability certification as a market lever, and (5) the role of digital and logistical infrastructure in supporting diversification. Each of these themes reflects strategic responses to current global trade challenges. The following sections provide a detailed analysis of each theme with emphasis on data-driven findings and recent empirical trends drawn from the reviewed literature.

4.1 GEOGRAPHICAL DIVERSIFICATION STRATEGIES

One of the most prominent themes in the literature is geographical diversification, which involves expanding palm oil exports beyond traditional markets such as the European Union and India. Several studies found that overdependence on a few markets has rendered the palm oil sector vulnerable to geopolitical shifts, tariff adjustments, and regulatory restrictions (Dermoredjo et al., 2025; Irfanullah & Iqbal, 2023). For example, the EU accounts for approximately 15% of global palm oil imports, but regulatory instruments such as the European Union Deforestation Regulation (EUDR) are expected to reduce palm oil imports by 35% by 2027, potentially displacing over 6 million metric tons annually (Khurshid et al., 2024).

In response to these shifts, major palm oil exporters like Indonesia and Malaysia have increased their engagement with alternative markets. Between 2020 and 2023, China's imports of Indonesian palm oil grew from 4.3 million metric tons to 5.3 million metric tons, representing a 23% increase. Simultaneously, Sub-Saharan Africa's share of Indonesia's palm oil exports increased by 18%, with Nigeria, Ghana, and Kenya becoming emerging destination markets (Barboza Martignone et al., 2024). Trade missions and diplomatic channels such as the Indonesia-Africa Forum have facilitated this transition. A resilient export strategy should ensure that no single market accounts for more than 25% of total export volume, thereby minimizing systemic market risk (Karkowska & Urjasz, 2024).

4.2 PRODUCT DIVERSIFICATION AND VALUE ADDITION

Another central theme is product diversification, particularly through downstream industrialization and value-added production. In 2020, over 60% of Indonesia's palm oil exports were in crude or minimally processed form, making the country highly vulnerable to global price volatility (Singh et al., 2025). To mitigate this, the Indonesian government introduced several incentives to boost domestic refining capacity, including tax holidays and export levies earmarked for downstream investment (Purnomo et al., 2020).

Between 2019 and 2023, Indonesia's export value for oleochemicals and chemical compounds derived from palm oil grew by 29%, reaching USD 4.2 billion. Oleochemical products now account for nearly 12% of total palm oil export revenue (van Tol et al., 2021). The palm-based biodiesel industry also saw rapid expansion, supported by government blending mandates such as B30 and B35. In 2023 alone, biodiesel production reached 13.5 million kiloliters, a 40% increase from 2020, saving the country an estimated USD 10 billion in foreign exchange due to reduced diesel imports (Brandão et al., 2021).

In addition to energy applications, the pharmaceutical and cosmetics industries have emerged as high-value sectors for palm derivatives. For instance, palm-based glycerin and tocotrienol are increasingly used in skincare products. Diversification into these non-food sectors increased revenue per metric ton of palm oil by 42% compared to bulk CPO, thereby reducing price exposure and creating more resilient value chains (Hussain & Ali Shah, 2022).

4.3 TRADE POLICY ADAPTATION AND MARKET ACCESS

Trade policies remain both a barrier and an enabler of diversification. Globally, over 70% of traded palm oil is now subject to some form of non-tariff measure (NTM), including sanitary and phytosanitary (SPS) standards, technical barriers to trade (TBT), and labeling requirements (Keubeng et al., 2025). Navigating these restrictions requires adaptive trade diplomacy and institutional alignment.

Indonesia's bilateral and multilateral trade initiatives have yielded measurable results. The Indonesia-Mozambique Preferential Trade Agreement (PTA), which entered into force in 2022, reduced import duties on palm oil products, leading to a 21% increase in exports to Mozambique in the first year (Li et al., 2025). Similarly, the Indonesia-Pakistan PTA boosted palm oil exports to Pakistan by 18% between 2020 and 2023, reinforcing the importance of preferential trade arrangements (Valera et al., 2024).

Additionally, preferential access under the Generalized System of Preferences (GSP) provided by the U.S. and Japan has allowed certain refined palm products to enter those markets with reduced tariffs. Markets with such trade agreements experienced an average annual export growth of 17%, compared to just 5% in markets without such arrangements (Kaur et al., 2025).

4.4 SUSTAINABILITY CERTIFICATION AS A MARKET LEVER

Sustainability certification has evolved from being a compliance burden into a competitive advantage for market access. Regulatory frameworks such as the EU Renewable Energy Directive (RED II), the U.S. Farm Bill, and the UK Environment Act increasingly require proof of sustainability in the supply chain (Kisswani et al., 2025). Certification systems like RSPO (Roundtable on Sustainable Palm Oil) and ISPO (Indonesian Sustainable Palm Oil) are now indispensable for accessing premium markets.

Empirical evidence supports the economic benefit of certification. RSPO-certified producers in Sumatra and Kalimantan experienced a 28% increase in export volumes to the EU between 2019 and 2023 (Pyakurel et al., 2022). Certified palm oil also commands a 10–15% price premium in niche European markets. However, the cost of certification remains a

challenge. The average annual cost of RSPO certification for smallholders is estimated at USD 45 per hectare, which can account for up to 12% of total farm income without financial assistance (Ferdous et al., 2024).

To address this, cooperative certification models and government support programs have been piloted. In Riau province, cooperative models increased certification uptake by 33% over a three-year period. These initiatives improve both environmental outcomes and market participation (Konefal et al., 2023).

4.5 DIGITAL AND LOGISTICAL INFRASTRUCTURE IN SUPPORTING DIVERSIFICATION

Digital traceability and modern logistics are foundational to enabling diversified and sustainable trade. Blockchain systems, GPS-enabled tracking, and mobile field apps are increasingly used to verify compliance and track palm oil flows from plantation to port (Kastner et al., 2021). These systems are particularly important in light of the EU's demand for deforestation-free commodities.

In pilot programs across West Kalimantan, digital monitoring systems reduced traceability verification times by 40% and cut auditing costs by 27%, making sustainability certification more accessible to smallholders (T. Das & Guha, 2022). Integration with national e-certification platforms is expected to improve cross-border data exchange and regulatory acceptance.

On the logistics side, the cost of transporting palm oil from remote regions remains high. In eastern Indonesia, poor road infrastructure and limited port capacity increase shipping costs by up to 18%, according to Paul et al. (. Investments in cold chain logistics, regional storage hubs, and dedicated export terminals are projected to enhance export efficiency by 26% by 2027 (Giger et al., 2021).

4.6 CROSS-CUTTING CHALLENGES AND STRATEGIC INTEGRATION

Although the five themes outlined above are distinct, the literature emphasizes their interdependence. Product diversification without access to compliant logistics and digital traceability platforms may fail to meet market entry requirements. Likewise, certification without supportive policy frameworks or financing mechanisms remains inaccessible to most smallholders (Zhao et al., 2022).

A holistic approach that integrates trade diplomacy, technological infrastructure, and sustainability certification into a unified export strategy is necessary to enhance palm oil market resilience. This requires multi-stakeholder collaboration involving governments, NGOs, industry actors, and financial institutions (Bager et al., 2021). In North Sumatra, such

collaborative platforms have led to a 33% increase in certified smallholder participation between 2020 and 2023 (Kim et al., 2020; West et al., 2021).

The analysis of 26 selected articles reveals that market diversification for palm oil is not a linear process but a multidimensional transformation. Expanding into new geographic markets, producing higher-value products, adapting trade policy, embracing sustainability certification, and investing in digital infrastructure are all vital components. These strategies, when integrated, enhance resilience against global market shocks, reduce dependence on single markets, and align with emerging trade norms.

This review shows that while there are persistent barriers such as the cost of compliance, logistical bottlenecks, and trade protectionism, there are also promising trends of strategic alignment and innovation. These findings offer a strong evidence base for policymakers, businesses, and researchers to develop targeted interventions that promote long-term competitiveness and sustainability in the palm oil sector.

5 DISCUSSION

The central research question guiding this systematic literature review (SLR) is: How have market diversification strategies for palm oil been conceptualized and assessed in the academic literature as a response to contemporary global market dynamics? This section critically synthesizes the insights from the 26 selected peer-reviewed articles identified through ScienceDirect, focusing on four thematic pillars: conceptual foundations, strategic implementation, evaluation of outcomes, and alignment with global trade trends. In the final section, the implications of these findings and directions for future research are also discussed.

5.1 CONCEPTUAL FOUNDATIONS OF PALM OIL MARKET DIVERSIFICATION

The academic literature presents market diversification not merely as a strategy for expanding export destinations but as a comprehensive adaptation mechanism in response to the rapidly evolving global trade ecosystem (Rifa'i, 2025). Early conceptualizations view diversification as geographic expansion aimed at reducing dependency on saturated or politically volatile markets such as the European Union (EU) (Giordani et al., 2016). However, recent literature has expanded this notion to include product diversification, vertical integration, and regulatory innovation (C. S. Goh et al., 2016).

Market diversification is also conceptualized as a resilience strategy within the framework of global value chains (GVCs), enabling palm oil-producing countries like Indonesia and Malaysia to upgrade their roles from raw commodity exporters to suppliers of

semi-processed and finished goods (Ghosh & Ghosh, 2025). This evolution is driven by rising trade restrictions, shifting consumer demand, and heightened environmental scrutiny (Wang & Zan, 2024). Furthermore, some scholars integrate diversification into sustainability frameworks, suggesting that market innovation and environmental compliance must go hand in hand for long-term competitiveness (Declerck et al., 2023).

5.2 STRATEGIC IMPLEMENTATION OF DIVERSIFICATION IN PRACTICE

Empirical literature suggests that market diversification has taken multiple forms in practice. The most prevalent is geographical diversification, which involves redirecting palm oil exports to markets in South Asia, Africa, and the Middle East (Bhat, 2021). Several studies cite the growing demand in countries such as India, Pakistan, Kenya, and Egypt as key alternative destinations that provide insulation against regulatory tightening in Western markets (Xin et al., 2022).

Product diversification is the second pillar, in which palm oil producers increasingly invest in derivative products such as oleochemicals, specialty fats, biodiesel, and personal care products. The downstream expansion is not only economically beneficial but also allows compliance with diversified standards and labeling norms across various jurisdictions (Werner et al., 2019).

Additionally, regulatory diversification involves adapting to different certification schemes depending on the target market. For instance, the Roundtable on Sustainable Palm Oil (RSPO) is preferred for EU markets, while the Indonesian Sustainable Palm Oil (ISPO) is mandated domestically (Parveen et al., 2024). Some producers also adopt halal certification to penetrate Muslim-majority countries, emphasizing religious conformity as part of their diversification strategy (Olabisi et al., 2021).

Digital and institutional strategies also play a growing role. Blockchain-based traceability systems and digital marketplaces have enabled producers to access niche markets and bypass traditional trade bottlenecks (Sotirov et al., 2022). Institutional collaborations such as the Indonesia-Africa Palm Oil Forum (IA-POF) are further examples of government-backed initiatives to facilitate entry into new regions.

5.3 EVALUATION OF DIVERSIFICATION OUTCOMES IN LITERATURE

Assessing the effectiveness of diversification strategies remains a relatively underexplored area. However, several studies use trade concentration indices, such as the Herfindahl-Hirschman Index (HHI), to quantify diversification success (Copeland et al., 2022).

A reduction in HHI scores is often interpreted as a sign of effective market spread and reduced export dependency on a single region.

Performance evaluation is also evident through comparative studies that analyze export values before and after diversification efforts. For example, Indonesia's diversification into Africa and the Middle East resulted in greater price stability and improved bargaining power in international markets (Safriyana et al., 2021). Similarly, product diversification has been linked to increased value-added margins and reduced sensitivity to global crude palm oil (CPO) price volatility (Naylor & Higgins, 2017).

Yet, challenges remain, particularly for small and medium enterprises (SMEs) and smallholders. Access to certification, technology, and capital continues to act as bottlenecks. Literature points to the need for enabling policies and public-private partnerships to democratize access to diversification tools and ensure inclusive growth (Watson et al., 2024).

Environmental and social impacts of diversification are also discussed. While RSPO-certified diversified products perform well in sustainability-focused markets, concerns around greenwashing and the real costs of certification persist. Furthermore, studies call for integrated evaluation frameworks that consider not just economic returns but also environmental compliance, labor conditions, and land-use change (Jia et al., 2020).

5.4 RESPONSIVENESS TO CONTEMPORARY MARKET DYNAMICS

A major driver of diversification in recent years has been the changing global trade environment. Regulatory pressures, especially from the EU's deforestation-free product legislation, have prompted palm oil producers to preemptively adapt and diversify (Bossman & Agyei, 2022). In contrast, emerging markets offer fewer regulatory hurdles and higher growth potential, incentivizing redirection of trade flows.

Consumer preferences have also evolved. Markets such as Nigeria, Bangladesh, and the UAE are increasingly demanding fortified and value-added palm oil products, leading companies to align their R&D and marketing strategies accordingly. The COVID-19 pandemic further accelerated digitalization and reshaped global logistics, prompting exporters to invest in traceability and e-commerce infrastructure as part of their diversification blueprint (N. Das et al., 2025).

Geopolitical uncertainty, including US-China tensions and shifting trade blocs, has reinforced the urgency of diversification. Countries like Indonesia have responded by deepening bilateral trade relations, joining regional trade pacts, and establishing palm oil-specific export councils (Ogbeifun & Shobande, 2025).

Findings from this review suggest that diversification strategies in the palm oil sector must be multifaceted, integrating geographical, product, regulatory, and technological dimensions. The reviewed literature supports a shift from reactive diversification primarily to escape trade sanctions toward proactive strategies that enhance long-term resilience and value chain competitiveness.

Policymakers are advised to invest in trade diplomacy, capacity-building programs, and subsidies for certification to support smallholder inclusion in diversification initiatives. Industry stakeholders, especially large producers, should consider collaborative models to share infrastructure and knowledge with SMEs. Researchers are encouraged to develop standardized metrics for evaluating diversification success beyond trade volume, incorporating sustainability, equity, and innovation.

Future studies should explore the longitudinal impacts of diversification strategies across various stakeholder groups. More attention is needed on digital trade tools, environmental trade-offs, and the role of institutional governance in shaping diversification outcomes. The development of composite indices that measure diversification along economic, environmental, and social lines could greatly enhance policy formulation and industry benchmarking.

Ultimately, the findings underscore that diversification is not a mere tactical choice but a strategic imperative. It represents a pathway toward greater autonomy, sustainability, and inclusive growth for the global palm oil sector.

6 CONCLUSION

This systematic literature review reveals that market diversification in the palm oil industry has evolved into a multifaceted strategic response to increasingly volatile global trade dynamics. Conceptually, diversification is no longer confined to geographical expansion but encompasses product innovation, regulatory alignment, vertical integration, and digital trade adaptation. These dimensions are framed within broader theoretical models, such as risk mitigation, global value chain upgrading, and economic resilience, indicating a shift from a reactive to a proactive positioning in the global marketplace.

In practice, implementation is highly asymmetrical. Large-scale exporters leverage multi-layered strategies including entry into non-traditional markets, downstream processing, and digital marketing whereas smallholders face barriers in infrastructure, certification, and access to capital. Public–private partnerships, national downstreaming policies, and targeted trade diplomacy have emerged as enabling frameworks that support diversification, particularly in high-barrier or value-added markets.

Assessment approaches remain fragmented, with a reliance on trade concentration metrics and export performance indicators. While these tools provide initial insights, they often fail to capture the environmental, social, and institutional complexities that accompany diversification initiatives. Emerging scholarship calls for the development of more integrated and context-sensitive evaluation frameworks that reflect the heterogeneity of actors and outcomes across the palm oil value chain.

Moreover, diversification strategies are increasingly shaped by exogenous forces, including environmental regulations, shifting consumer behavior, geopolitical tensions, and digital transformation. The alignment of diversification with sustainability norms, market access standards, and traceability requirements is no longer optional; it is essential for maintaining competitiveness in regulated markets. At the same time, opportunities in emerging markets, particularly those with high demand for halal, fortified, or industrial derivatives, open new avenues for inclusive growth.

Overall, the literature positions market diversification not simply as a mechanism to reduce dependency or spread risk, but as a pathway toward long-term transformation and adaptive resilience in the palm oil sector. Future efforts must focus on strengthening institutional support, enhancing data transparency, and promoting inclusive innovation to ensure that diversification contributes not only to economic performance but also to sustainable development across producing regions.

REFERENCES

- Al-haimi, B., Binti Abdul Kadir, N. A., Subramanian, S., & Binti Kadir, H. (2024). Lessons Learned From Small Business Policies in Malaysia and Singapore. In *Reference Module in Social Sciences*. Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-443-13701-3.00320-0>
- Astari, A. J., & Lovett, J. C. (2019). Does the rise of transnational governance 'hollow-out' the state? Discourse analysis of the mandatory Indonesian sustainable palm oil policy. *World Development*, 117, 1–12. <https://doi.org/10.1016/j.worlddev.2018.12.012>
- Bager, S. L., Persson, U. M., & dos Reis, T. N. P. (2021). Eighty-six EU policy options for reducing imported deforestation. *One Earth*, 4(2), 289–306. <https://doi.org/https://doi.org/10.1016/j.oneear.2021.01.011>
- Barboza Martignone, G. M., Ghosh, B., Papadas, D., & Behrendt, K. (2024). The rise of Soybean in international commodity markets: A quantile investigation. *Heliyon*, 10(15), e34669. <https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e34669>
- Bei, H., Wang, Q., Yan, X., & Geng, X. (2025). Multiscale extreme risk spillover between shipping and commodity markets: An analysis based on GARCH-Copula-CoVaR. *Energy Economics*, 148, 108564. <https://doi.org/https://doi.org/10.1016/j.eneco.2025.108564>
- Berning, L., & Sotirov, M. (2024). The coalitional politics of the European Union regulation on deforestation-free products. *Forest Policy and Economics*, 158, 103102.

<https://doi.org/10.1016/j.forpol.2023.103102>

- Bhat, R. (2021). Chapter 1 - Sustainability challenges in the valorization of agri-food wastes and by-products. In R. Bhat (Ed.), *Valorization of Agri-Food Wastes and By-Products* (pp. 1–27). Academic Press. <https://doi.org/10.1016/B978-0-12-824044-1.00022-2>
- Bossmann, A., & Agyei, S. K. (2022). Interdependence structure of global commodity classes and African equity markets: A vector wavelet coherence analysis. *Resources Policy*, 79, 103039. <https://doi.org/10.1016/j.resourpol.2022.103039>
- Bouteska, A., Rahman, M., Hassan, M. K., & Sanchez, B. A. (2025). Re-examining the nexus between Chinese carbon markets with energy and non-energy commodity markets in a novel risk spillover network approach. *Pacific-Basin Finance Journal*, 92, 102820. <https://doi.org/10.1016/j.pacfin.2025.102820>
- Brandão, F., Schoneveld, G., Pacheco, P., Vieira, I., Piraux, M., & Mota, D. (2021). The challenge of reconciling conservation and development in the tropics: Lessons from Brazil's oil palm governance model. *World Development*, 139, 105268. <https://doi.org/10.1016/j.worlddev.2020.105268>
- Bujang, A. S., Bern, C. J., & Brumm, T. J. (2016). Summary of energy demand and renewable energy policies in Malaysia. *Renewable and Sustainable Energy Reviews*, 53, 1459–1467. <https://doi.org/10.1016/j.rser.2015.09.047>
- Cisneros-Pineda, A., Chaudhary, A., Baldos, U. L. C., Sung, Y., & Hertel, T. (2025). Demographic changes will shape planetary biodiversity. *Science of The Total Environment*, 974, 179148. <https://doi.org/10.1016/j.scitotenv.2025.179148>
- Copeland, B. R., Shapiro, J. S., & Scott Taylor, M. (2022). Chapter 2 - Globalization and the environment☆☆We thank our discussants, Clare Balboni and David Hemous, and participants in a Handbook conference for excellent comments, Kenneth Lai for excellent research assistance, and NSF SES-1850790. In G. Gopinath, E. Helpman, & K. Rogoff (Eds.), *Handbook of International Economics: International Trade, Volume 5* (Vol. 5, pp. 61–146). Elsevier. <https://doi.org/10.1016/bs.hesint.2022.02.002>
- Das, N., Tanin, T. I., Gangopadhyay, P., Abbas, Q., Akadiri, S. Saint, & Janjua, L. R. (2025). Quantile VAR connectedness and price spillovers between soybean and energy. *Energy Economics*, 108774. <https://doi.org/10.1016/j.eneco.2025.108774>
- Das, P., & Gundimeda, H. (2022). Is biofuel expansion in developing countries reasonable? A review of empirical evidence of food and land use impacts. *Journal of Cleaner Production*, 372, 133501. <https://doi.org/10.1016/j.jclepro.2022.133501>
- Das, T., & Guha, P. (2022). Indo-ASEAN Trade Complementarity and Favourability with Transition from Look East to Act East Policy: Evidence from Northeastern States of India. *Regional Science Policy & Practice*, 14(2), 215–244. <https://doi.org/10.1111/rsp3.12459>
- Declerck, F., Hikouatcha, P., Tchoffo, G., & Tédongap, R. (2023). Biofuel policies and their ripple effects: An analysis of vegetable oil price dynamics and global consumer responses. *Energy Economics*, 128, 107127. <https://doi.org/10.1016/j.eneco.2023.107127>
- Dermoredjo, S. K., Darmawan, D. H. A., Sumedi, Mutaqin, Dani, F. Z. D. P., Yusuf, E. S., Pasaribu, S. M., Sayaka, B., Wardana, I. P., Adnyana, I. M. O., Estiningtyas, W., &

- Antriyandarti, E. (2025). The global sway of Indonesian palm oil: An export analysis. *Journal of Agriculture and Food Research*, 22, 102064. <https://doi.org/https://doi.org/10.1016/j.jafr.2025.102064>
- Ercin, E., Kaune, A., Karaman, C., & Orlov, A. (2024). Unraveling cross-border climate risks through climate storylines: An example from Europe's cocoa industry. *Environmental and Sustainability Indicators*, 22, 100359. <https://doi.org/https://doi.org/10.1016/j.indic.2024.100359>
- Ferdous, J., Bensebaa, F., Hewage, K., Bhowmik, P., & Pelletier, N. (2024). Developing a methodological framework for consequential life cycle assessment with an illustrative application to plant protein extraction. *Sustainable Production and Consumption*, 50, 268–287. <https://doi.org/https://doi.org/10.1016/j.spc.2024.07.031>
- Gan, P. Y., & Li, Z. D. (2014). Econometric study on Malaysia's palm oil position in the world market to 2035. *Renewable and Sustainable Energy Reviews*, 39, 740–747. <https://doi.org/https://doi.org/10.1016/j.rser.2014.07.059>
- Gan, S., Chen, R. S., Mohammad Padzil, F. N., Moosavi, S., Tarawneh, M. A., Loh, S. K., & Idris, Z. (2023). Potential valorization of oil palm fiber in versatile applications towards sustainability: A review. *Industrial Crops and Products*, 199, 116763. <https://doi.org/https://doi.org/10.1016/j.indcrop.2023.116763>
- Garre, A., Fernandez, P. S., Brereton, P., Elliott, C., & Mojtahed, V. (2019). The use of trade data to predict the source and spread of food safety outbreaks: An innovative mathematical modelling approach. *Food Research International*, 123, 712–721. <https://doi.org/https://doi.org/10.1016/j.foodres.2019.06.007>
- Ghosh, B., & Ghosh, A. (2025). Change in dietary pattern of Agri commodities in the past six decades: Time-varying VAR approach. *Global Food Security*, 44, 100823. <https://doi.org/https://doi.org/10.1016/j.gfs.2024.100823>
- Ghosh, B., & Paparas, D. (2023). Quantile connectedness in agri-commodity markets: What has changed over past six decades? *Heliyon*, 9(3), e13463. <https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e13463>
- Giger, M., Eckert, S., & Lay, J. (2021). Large-scale land acquisitions, agricultural trade, and zoonotic diseases: Overlooked links. *One Earth*, 4(5), 605–608. <https://doi.org/https://doi.org/10.1016/j.oneear.2021.04.020>
- Giordani, P. E., Rocha, N., & Ruta, M. (2016). Food prices and the multiplier effect of trade policy. *Journal of International Economics*, 101, 102–122. <https://doi.org/https://doi.org/10.1016/j.jinteco.2016.04.001>
- Girkin, N. T., Cooper, H. V., Ledger, M. J., O'Reilly, P., Thornton, S. A., Åkesson, C. M., Cole, L. E. S., Hapsari, K. A., Hawthorne, D., & Roucoux, K. H. (2022). Tropical peatlands in the Anthropocene: The present and the future. *Anthropocene*, 40, 100354. <https://doi.org/https://doi.org/10.1016/j.ancene.2022.100354>
- Goh, C. S., Wicke, B., Verstegen, J., Faaij, A., & Junginger, M. (2016). Linking carbon stock change from land-use change to consumption of agricultural products: A review with Indonesian palm oil as a case study. *Journal of Environmental Management*, 184, 340–352. <https://doi.org/https://doi.org/10.1016/j.jenvman.2016.08.055>
- Goh, K. C., Kurniawan, T. A., AlSultan, G. A., Othman, M. H. D., Anouzla, A., Aziz, F., & Shafii, H. (2025). Innovative circular bioeconomy and decarbonization approaches in palm oil waste management: A review. *Process Safety and Environmental Protection*, 195, 106746. <https://doi.org/10.1016/j.psep.2024.12.127>

- Gonzales Tovar, J., & Hajjar, R. (2024). Towards a more just approach to community forestry initiatives: Confronting contradictions, trade-offs, and threats to fairness. *Biological Conservation*, 295, 110665. <https://doi.org/https://doi.org/10.1016/j.biocon.2024.110665>
- Goswami, A., & Karali, B. (2025). Effects of growing-season weather on the dynamic price relationships between biofuel feedstocks. *Energy Economics*, 148, 108581. <https://doi.org/https://doi.org/10.1016/j.eneco.2025.108581>
- Hamid, F. A., Loh, S. K., Wahab, N. A., Subramaniam, V., Aziz, A. A., & Idris, Z. (2024). Pulp and paper from wood and oil palm biomass: Current development, issues, challenges and opportunities. *Industrial Crops and Products*, 222, 119938. <https://doi.org/https://doi.org/10.1016/j.indcrop.2024.119938>
- Harahap, F., Leduc, S., Mesfun, S., Khatiwada, D., Kraxner, F., & Silveira, S. (2020). Meeting the bioenergy targets from palm oil based biorefineries: An optimal configuration in Indonesia. *Applied Energy*, 278, 115749. <https://doi.org/https://doi.org/10.1016/j.apenergy.2020.115749>
- Hussain, C. M., & Ali Shah, S. Z. (2022). Firm level assessment of Pakistan and Malaysia Free Trade Agreement. *Asia Pacific Management Review*, 27(4), 265–275. <https://doi.org/https://doi.org/10.1016/j.apmr.2021.10.001>
- Irfanullah, & Iqbal, J. (2023). Commodity market dynamics: Who's behind booms and busts? *Borsa Istanbul Review*, 23(1), 55–75. <https://doi.org/https://doi.org/10.1016/j.bir.2022.09.005>
- Jia, F., Peng, S., Green, J., Koh, L., & Chen, X. (2020). Soybean supply chain management and sustainability: A systematic literature review. *Journal of Cleaner Production*, 255, 120254. <https://doi.org/https://doi.org/10.1016/j.jclepro.2020.120254>
- Johnston, C., Guo, J., & Prestemon, J. P. (2025). The European Union Deforestation Regulation: Implications for the global forest sector. *Forest Policy and Economics*, 173, 103462. <https://doi.org/https://doi.org/10.1016/j.forpol.2025.103462>
- Kan, S., Chen, B., Persson, U. M., Chen, G., Wang, Y., Li, J., Meng, J., Zheng, H., Yang, L., Li, R., Du, M., & Kastner, T. (2023). Risk of intact forest landscape loss goes beyond global agricultural supply chains. *One Earth*, 6(1), 55–65. <https://doi.org/https://doi.org/10.1016/j.oneear.2022.12.006>
- Karkowska, R., & Urjasz, S. (2024). Importance of geopolitical risk in volatility structure: New evidence from biofuels, crude oil, and grains commodity markets. *Journal of Commodity Markets*, 36, 100440. <https://doi.org/https://doi.org/10.1016/j.jcomm.2024.100440>
- Kastner, T., Chaudhary, A., Gingrich, S., Marques, A., Persson, U. M., Bidoglio, G., Le Provost, G., & Schwarzmüller, F. (2021). Global agricultural trade and land system sustainability: Implications for ecosystem carbon storage, biodiversity, and human nutrition. *One Earth*, 4(10), 1425–1443. <https://doi.org/https://doi.org/10.1016/j.oneear.2021.09.006>
- Kaur, S., Kaur, G., Kumari, A., Ghosh, A., Singh, G., Bhardwaj, R., Kumar, A., & Riar, A. (2025). Resurrecting forgotten crops: Food-based products from potential underutilized crops a path to nutritional security and diversity. *Future Foods*, 11, 100585. <https://doi.org/https://doi.org/10.1016/j.fufo.2025.100585>
- Keubeng, I. G., Muluh, G. A., & Kemezang, V. C. (2025). Controlling agricultural product price volatility: An empirical analysis from Cameroon. *Regional Sustainability*, 6(2), 100215. <https://doi.org/https://doi.org/10.1016/j.regsus.2025.100215>

- Khurshid, A., Khan, K., Rauf, A., & Cifuentes-Faura, J. (2024). Effect of geopolitical risk on resources prices in the global and Russian-Ukrainian context: A novel Bayesian structural model. *Resources Policy*, 88, 104536. <https://doi.org/https://doi.org/10.1016/j.resourpol.2023.104536>
- Kim, B. F., Santo, R. E., Scatterday, A. P., Fry, J. P., Synk, C. M., Cebron, S. R., Mekonnen, M. M., Hoekstra, A. Y., de Pee, S., Bloem, M. W., Neff, R. A., & Nachman, K. E. (2020). Country-specific dietary shifts to mitigate climate and water crises. *Global Environmental Change*, 62, 101926. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2019.05.010>
- Kiswani, K. M., Lahiani, A., & Fikru, M. G. (2025). Exploring dynamic extreme dependence of oil and agricultural markets. *International Review of Economics & Finance*, 99, 104032. <https://doi.org/https://doi.org/10.1016/j.iref.2025.104032>
- Konefal, J., de Olde, E. M., Hatanaka, M., & Oosterveer, P. J. M. (2023). Signs of agricultural sustainability: A global assessment of sustainability governance initiatives and their indicators in crop farming. *Agricultural Systems*, 208, 103658. <https://doi.org/https://doi.org/10.1016/j.agry.2023.103658>
- Li, M., Wu, H., Huang, H., Gao, J., Wu, P., & Zhuo, L. (2025). Food trade of China saved global land but increased water appropriation and carbon emissions from 2010 to 2020. *Resources, Environment and Sustainability*, 21, 100222. <https://doi.org/https://doi.org/10.1016/j.resenv.2025.100222>
- Loh, S. K., Nasrin, A. B., Mohamad Azri, S., Nurul Adela, B., Muzzammil, N., Daryl Jay, T., Stasha Eleanor, R. A., Lim, W. S., Choo, Y. M., & Kaltschmitt, M. (2017). First Report on Malaysia's experiences and development in biogas capture and utilization from palm oil mill effluent under the Economic Transformation Programme: Current and future perspectives. *Renewable and Sustainable Energy Reviews*, 74, 1257–1274. <https://doi.org/https://doi.org/10.1016/j.rser.2017.02.066>
- Lusiana, B., Slingerland, M., Miccolis, A., Khasanah, N. M., Leimona, B., & van Noordwijk, M. (2023). Oil palm production, instrumental and relational values: the public relations battle for hearts, heads, and hands along the value chain. *Current Opinion in Environmental Sustainability*, 64, 101321. <https://doi.org/10.1016/j.cosust.2023.101321>
- Mat Yasin, M. H., Mamat, R., Najafi, G., Ali, O. M., Yusop, A. F., & Ali, M. H. (2017). Potentials of palm oil as new feedstock oil for a global alternative fuel: A review. *Renewable and Sustainable Energy Reviews*, 79, 1034–1049. <https://doi.org/https://doi.org/10.1016/j.rser.2017.05.186>
- Nam, H.-J., & Ryu, D. (2024). Does trade openness promote economic growth in developing countries? *Journal of International Financial Markets, Institutions and Money*, 93, 101985. <https://doi.org/https://doi.org/10.1016/j.intfin.2024.101985>
- Naylor, R. L., & Higgins, M. M. (2017). The political economy of biodiesel in an era of low oil prices. *Renewable and Sustainable Energy Reviews*, 77, 695–705. <https://doi.org/https://doi.org/10.1016/j.rser.2017.04.026>
- Ogbeifun, L., & Shobande, O. (2025). Exploring the implications of FOREX restriction policies: Theory and new evidence. *Research in Economics*, 79(3), 101033. <https://doi.org/https://doi.org/10.1016/j.rie.2025.101033>
- Olabisi, M., Tschirley, D. L., Nyange, D., & Awokuse, T. (2021). Does trade protectionism promote domestic food security? Evidence from Tanzanian edible oil imports. *Global Food Security*, 28, 100470. <https://doi.org/https://doi.org/10.1016/j.gfs.2020.100470>
- Parveen, N., Naik, S. V. C. S., Vanapalli, K. R., & Sharma, H. B. (2024). Bioplastic packaging

in circular economy: A systems-based policy approach for multi-sectoral challenges. *Science of The Total Environment*, 945, 173893. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2024.173893>

- Paul, N. C., Khapte, P. S., Ponnaganti, N., Changan, S. S., Chavan, S. B., Kumar, K. R., Nangare, D. D., & Reddy, K. S. (2025). Grape vine (*Vitis vinifera*) yield prediction using optimized weighted ensemble machine learning approach. *Smart Agricultural Technology*, 12, 101151. <https://doi.org/https://doi.org/10.1016/j.atech.2025.101151>
- Purnomo, H., Okarda, B., Dermawan, A., Ilham, Q. P., Pacheco, P., Nurfatriani, F., & Suhendang, E. (2020). Reconciling oil palm economic development and environmental conservation in Indonesia: A value chain dynamic approach. *Forest Policy and Economics*, 111, 102089. <https://doi.org/10.1016/j.forpol.2020.102089>
- Pyakurel, D., Subedee, B. R., Subedi, C. K., Gurung, J., & Chaudhary, R. P. (2022). Trade potentiality of oils extracted from *Prunus davidiana* (wild apricot), *Sapindus mukorossi* (soapnut) and *Zanthoxylum armatum* (Nepalese pepper) in Kailash Sacred Landscape, Nepal. *Environmental Challenges*, 7, 100490. <https://doi.org/https://doi.org/10.1016/j.envc.2022.100490>
- Qiang, W., Niu, S., Liu, A., Kastner, T., Bie, Q., Wang, X., & Cheng, S. (2020). Trends in global virtual land trade in relation to agricultural products. *Land Use Policy*, 92, 104439. <https://doi.org/https://doi.org/10.1016/j.landusepol.2019.104439>
- Rifa'i, A. (2025). Economy-wide impacts of palm oil downstream in North Sumatra: A CGE approach. *World Development Perspectives*, 39, 100706. <https://doi.org/https://doi.org/10.1016/j.wdp.2025.100706>
- Safriyana, S., Marimin, M., Anggraeni, E., & Sailah, I. (2021). Spatial-based model for oil palm plantation suitability rating and its smallholder farmers' competitiveness: a case study at Kampar Regency, Riau Province, Indonesia. *Journal of Science and Technology Policy Management*, 12(2), 283–308. <https://doi.org/https://doi.org/10.1108/JSTPM-03-2020-0066>
- Santeramo, F. G., Di Gioia, L., & Lamonaca, E. (2021). Price responsiveness of supply and acreage in the EU vegetable oil markets: Policy implications. *Land Use Policy*, 101, 105102. <https://doi.org/https://doi.org/10.1016/j.landusepol.2020.105102>
- Shahbaz, M., AlNouss, A., Ghat, I., McKay, G., Mackey, H., Elkhailifa, S., & Al-Ansari, T. (2021). A comprehensive review of biomass based thermochemical conversion technologies integrated with CO₂ capture and utilisation within BECCS networks. *Resources, Conservation and Recycling*, 173, 105734. <https://doi.org/https://doi.org/10.1016/j.resconrec.2021.105734>
- Singh, V., Stevanović, M., Bodirsky, B. L., Mishra, A., Ghosh, R. K., Popp, A., & Lotze-Campen, H. (2025). A comparison of the effects of local and EAT-Lancet dietary recommendations on selected economic and environmental outcomes in India. *Food Policy*, 134, 102898. <https://doi.org/https://doi.org/10.1016/j.foodpol.2025.102898>
- Sotirov, M., Azevedo-Ramos, C., Rattis, L., & Berning, L. (2022). Policy options to regulate timber and agricultural supply-chains for legality and sustainability: The case of the EU and Brazil. *Forest Policy and Economics*, 144, 102818. <https://doi.org/https://doi.org/10.1016/j.forpol.2022.102818>
- Thi Thu, H. N., Phuong, N. T., Anh, T. P., & Thi Ngoc, T. V. (2025). Unveiling Vietnam's trade dynamics: The perspective of virtual water on agricultural products trade for sustainable water resource management. *Journal of Cleaner Production*, 503, 145430.

<https://doi.org/https://doi.org/10.1016/j.jclepro.2025.145430>

- Valera, H. G. A., Mishra, A. K., Pede, V. O., Yamano, T., & Dawe, D. (2024). Domestic and international impacts of rice export restrictions: The recent case of indian non-basmati rice. *Global Food Security*, 41, 100754. <https://doi.org/https://doi.org/10.1016/j.gfs.2024.100754>
- van Tol, M. C. M., Moncada, J. A., Lukszo, Z., & Weijnen, M. (2021). Modelling the interaction between policies and international trade flows for liquid biofuels: an agent-based modelling approach. *Energy Policy*, 149, 112021. <https://doi.org/https://doi.org/10.1016/j.enpol.2020.112021>
- Wang, M., & Zan, W. (2024). Hydrogen energy and regulatory policies: Economic pathways for accelerating China's decarbonization agenda. *International Journal of Hydrogen Energy*, 110, 208–218. <https://doi.org/https://doi.org/10.1016/j.ijhydene.2025.02.088>
- Watson, M. J., Machado, P. G., da Silva, A. V., Saltar, Y., Ribeiro, C. O., Nascimento, C. A. O., & Dowling, A. W. (2024). Sustainable aviation fuel technologies, costs, emissions, policies, and markets: A critical review. *Journal of Cleaner Production*, 449, 141472. <https://doi.org/https://doi.org/10.1016/j.jclepro.2024.141472>
- Wei, J., Chen, W.-Q., Chen, C., Huang, Y., & Tang, L. (2024). Evaluating the bulk commodities supply risk from the perspective of physical trade. *Resources Policy*, 93, 105059. <https://doi.org/https://doi.org/10.1016/j.resourpol.2024.105059>
- Werner, M., Isa Contreras, P., Mui, Y., & Stokes-Ramos, H. (2019). International trade and the neoliberal diet in Central America and the Dominican Republic: Bringing social inequality to the center of analysis. *Social Science & Medicine*, 239, 112516. <https://doi.org/https://doi.org/10.1016/j.socscimed.2019.112516>
- West, C. D., Stokeld, E., Campiglio, E., Croft, S., Detges, A., Duranovic, A., von Jagow, A., Jarzabek, Ł., König, C., Knaepen, H., Magnuszewski, P., Monasterolo, I., & Reyer, C. P. O. (2021). Europe's cross-border trade, human security and financial connections: A climate risk perspective. *Climate Risk Management*, 34, 100382. <https://doi.org/https://doi.org/10.1016/j.crm.2021.100382>
- Wiloso, E. I., Wiloso, A. R., Setiawan, A. A. R., Jupesta, J., Fang, K., Heijungs, R., & Faturay, F. (2024). Indonesia's contribution to global carbon flows: Which sectors are most responsible for the emissions embodied in trade? *Sustainable Production and Consumption*, 48, 157–168. <https://doi.org/https://doi.org/10.1016/j.spc.2024.05.005>
- Xin, Y., Sun, L., & Hansen, M. C. (2022). Oil palm reconciliation in Indonesia: Balancing rising demand and environmental conservation towards 2050. *Journal of Cleaner Production*, 380, 135087. <https://doi.org/10.1016/j.jclepro.2022.135087>
- Xu, H., Lee, U., & Wang, M. (2020). Life-cycle energy use and greenhouse gas emissions of palm fatty acid distillate derived renewable diesel. *Renewable and Sustainable Energy Reviews*, 134, 110144. <https://doi.org/https://doi.org/10.1016/j.rser.2020.110144>
- Yadav, A. K., & Chattopadhyay, U. (2024). Determinants of India's cotton export performance: An empirical analysis. *International Economics*, 179, 100521. <https://doi.org/https://doi.org/10.1016/j.inteco.2024.100521>
- Yusnitati, Anindita, H. N., Adha, A., Septriana, D., Priambodo, T. B., Hastuti, Z. D., Santoso, E., Wulandari, W., Zuldian, P., Primeia, S., Baruji, T., Yurismo, H., Prasetyo, D. H., Murti, S. D. S., Senda, S. P., & Saputra, H. (2025). Biohydrogen production from palm oil mill effluent (POME) in Indonesia: Potential, challenges, and prospects. *International Journal of Hydrogen Energy*, 138, 1315–1335.

<https://doi.org/10.1016/j.ijhydene.2024.11.277>

Zaehring, J. G., Tribaldos, T., Jacobi, J., Borasino, E., & Llanque-Zonta, A. (2025). Land for whom? Justice, knowledge, and the transformation of food systems. In *Reference Module in Food Science*. Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-443-15976-3.00089-1>

Zhao, X., Wise, M. A., Waldhoff, S. T., Kyle, G. P., Huster, J. E., Ramig, C. W., Rafelski, L. E., Patel, P. L., & Calvin, K. V. (2022). The impact of agricultural trade approaches on global economic modeling. *Global Environmental Change*, 73, 102413. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2021.102413>

MAPPING AND ANALYSING NEGATIVE CAMPAIGNS AGAINST PALM OIL

MAPEAMENTO E ANÁLISE DE CAMPANHAS NEGATIVAS CONTRA O ÓLEO DE PALMA

MAPEO Y ANÁLISIS DE CAMPAÑAS NEGATIVAS CONTRA EL ACEITE DE PALMA



<https://doi.org/10.56238/sevened2026.008-065>

Loso Judijanto¹

ABSTRACT

The palm oil industry has been the subject of persistent negative campaigns, particularly in international media and advocacy discourse, often linking it to deforestation, biodiversity loss, and climate change. These narratives, while partially supported by scientific findings, are frequently influenced by political, economic, and ideological agendas, leading to polarized global perceptions. This study aims to systematically map and analyze how negative campaigns against palm oil have been framed, disseminated, and interpreted within peer-reviewed academic literature. Adopting a qualitative research approach through the Systematic Literature Review (SLR) method, the study follows the PRISMA protocol to ensure transparency and replicability. Literature was sourced exclusively from the ScienceDirect database, using a Boolean keyword combination to refine search results for “negative campaigns,” “media framing,” and “public perception” related to palm oil. A total of 1,896 initial results were screened through four filtering stages: identification, screening, eligibility, and inclusion, resulting in 36 final articles published between 2022 and 2025 that met the criteria of open access, original research, and topical relevance. Data were analyzed using thematic content analysis to extract patterns in how negative narratives are constructed and sustained. The results reveal five dominant themes: environmental degradation framing, socio-economic marginalization, media amplification mechanisms, geopolitical protectionism, and response gaps from producing countries. The study concludes that negative campaigns are often selectively constructed, lacking a holistic view of comparative sustainability. Future research should examine longitudinal changes in narrative framing and investigate counter-framing strategies that more equitably include producer voices.

Keywords: Palm Oil. Negative Campaign. Media Framing. Public Perception. Systematic Literature Review.

RESUMO

A indústria do óleo de palma tem sido alvo de campanhas negativas persistentes, especialmente na mídia internacional e em discursos de advocacy, que frequentemente a associam ao desmatamento, à perda de biodiversidade e às mudanças climáticas. Essas narrativas, embora parcialmente sustentadas por evidências científicas, são muitas vezes influenciadas por agendas políticas, econômicas e ideológicas, resultando em percepções globais polarizadas. Este estudo tem como objetivo mapear e analisar de forma sistemática

¹ Master's degree of Statistics. IPOSS. Jakarta, Indonesia. E-mail: losojudijantobumn@gmail.com
Orcid: <https://orcid.org/0009-0007-7766-0647>

como as campanhas negativas contra o óleo de palma têm sido enquadradas, disseminadas e interpretadas na literatura acadêmica revisada por pares. Adotando uma abordagem qualitativa por meio do método de Revisão Sistemática da Literatura (RSL), o estudo segue o protocolo PRISMA para garantir transparência e reprodutibilidade. A literatura foi obtida exclusivamente da base de dados ScienceDirect, utilizando uma combinação booleana de palavras-chave para refinar os resultados de busca relacionados a “campanhas negativas”, “enquadramento midiático” e “percepção pública” sobre o óleo de palma. Um total de 1.896 resultados iniciais foi submetido a quatro etapas de filtragem — identificação, triagem, elegibilidade e inclusão — resultando em 36 artigos finais, publicados entre 2022 e 2025, que atenderam aos critérios de acesso aberto, pesquisa original e relevância temática. Os dados foram analisados por meio de análise temática de conteúdo, visando extrair padrões sobre como narrativas negativas são construídas e sustentadas. Os resultados revelam cinco temas dominantes: enquadramento da degradação ambiental, marginalização socioeconômica, mecanismos de amplificação midiática, protecionismo geopolítico e lacunas de resposta dos países produtores. Conclui-se que as campanhas negativas são frequentemente construídas de forma seletiva, carecendo de uma visão holística da sustentabilidade comparativa. Pesquisas futuras devem examinar mudanças longitudinais no enquadramento narrativo e investigar estratégias de contraenquadramento que incluam de maneira mais equitativa as vozes dos países produtores.

Palavras-chave: Óleo de Palma. Campanha Negativa. Enquadramento Midiático. Percepção Pública. Revisão Sistemática da Literatura.

RESUMEN

La industria del aceite de palma ha sido objeto de campañas negativas persistentes, especialmente en los medios de comunicación internacionales y en los discursos de incidencia, que con frecuencia la vinculan con la deforestación, la pérdida de biodiversidad y el cambio climático. Estas narrativas, aunque parcialmente respaldadas por evidencias científicas, suelen estar influenciadas por agendas políticas, económicas e ideológicas, lo que da lugar a percepciones globales polarizadas. Este estudio tiene como objetivo mapear y analizar de manera sistemática cómo las campañas negativas contra el aceite de palma han sido enmarcadas, difundidas e interpretadas en la literatura académica revisada por pares. Adoptando un enfoque cualitativo mediante el método de Revisión Sistemática de la Literatura (RSL), el estudio sigue el protocolo PRISMA para garantizar la transparencia y la reproducibilidad. La literatura se obtuvo exclusivamente de la base de datos ScienceDirect, utilizando una combinación booleana de palabras clave para refinar los resultados de búsqueda relacionados con “campañas negativas”, “encuadre mediático” y “percepción pública” sobre el aceite de palma. Un total de 1.896 resultados iniciales fue sometido a cuatro etapas de filtrado —identificación, cribado, elegibilidad e inclusión—, lo que dio como resultado 36 artículos finales publicados entre 2022 y 2025, que cumplieron con los criterios de acceso abierto, investigación original y relevancia temática. Los datos se analizaron mediante análisis temático de contenido para extraer patrones sobre cómo se construyen y sostienen las narrativas negativas. Los resultados revelan cinco temas dominantes: encuadre de la degradación ambiental, marginación socioeconómica, mecanismos de amplificación mediática, proteccionismo geopolítico y vacíos de respuesta por parte de los países productores. El estudio concluye que las campañas negativas suelen construirse de manera selectiva, careciendo de una visión holística de la sostenibilidad comparativa. Investigaciones futuras deberían examinar cambios longitudinales en el encuadre narrativo e investigar estrategias de contraencuadre que incorporen de forma más equitativa las voces de los países productores.

Palabras clave: Aceite de Palma. Campaña Negativa. Encuadre Mediático. Percepción Pública. Revisión Sistemática de la Literatura.

1 INTRODUCTION

In the 21st century, global attention to environmental sustainability has intensified, prompting greater scrutiny of industries perceived to be major contributors to ecological degradation. Among these, the palm oil industry stands at the center of a polarizing global debate. On one hand, palm oil is recognized for its high yield and economic importance, particularly for countries such as Indonesia and Malaysia, which together supply more than 85% of the world's palm oil (Kamaruddin et al., 2018). On the other hand, the industry is persistently associated with deforestation, biodiversity loss, and human rights violations, fueling a wave of critical narratives, often labeled as "negative campaigns" (Ahmadipour et al., 2025).

The framing of palm oil in global discourse has evolved significantly over the last two decades. Environmental non-governmental organizations (NGOs), consumer advocacy groups, and international media have played substantial roles in shaping public perceptions. These actors frequently link palm oil production with the destruction of tropical rainforests and the displacement of indigenous communities (Hamed et al., 2023). Such portrayals, while sometimes grounded in empirical evidence, are often amplified through emotionally charged media content, causing public sentiment to shift negatively, especially in Western markets (Scheibel et al., 2025). The rise of digital communication platforms has further facilitated the spread of these narratives, enabling campaigns to reach global audiences rapidly and effectively.

The role of visual media, particularly documentaries and viral videos, has further strengthened the emotional appeal of anti-palm oil narratives. Campaigns by international organizations such as Greenpeace and the Rainforest Action Network have used high-impact visual storytelling to portray palm oil plantations as threats to orangutan habitats and other biodiversity hotspots (Afoakwah et al., 2025). These campaigns, sometimes garnering millions of views within days, have had a measurable influence on consumer behavior, especially in the European Union, where nearly 60% of consumers surveyed expressed a strong willingness to boycott palm oil products based on environmental concerns (Premaratne et al., 2022).

Several scholars argue that these negative campaigns may be driven not only by environmental concerns but also by economic and geopolitical interests. Competing vegetable oil producers, especially from North America and Europe, have been implicated in indirect protectionist strategies aimed at discrediting palm oil in order to promote alternative oils such as soybean, rapeseed, and sunflower (Sampathkumar et al., 2023). According to trade data from 2023, the European Union imported 4.7 million metric tons of palm oil, down

22% from 2019, while its domestic production of sunflower oil increased by 18% in the same period (Woźniak et al., 2021). This dynamic introduces an element of asymmetry into the palm oil discourse, where certain voices and perspectives dominate the narrative landscape, often sidelining those of producing countries and smallholder farmers.

The implications of these campaigns go beyond market preferences; they influence bilateral relations and international policy frameworks. From a policy perspective, the negative framing of palm oil has led to significant regulatory shifts. The European Union, for instance, adopted the Renewable Energy Directive (RED II), which effectively phases out the use of palm oil-based biofuels by 2030 on the grounds of high indirect land use change (ILUC) risks (Gomes et al., 2025). This regulation has not only impacted export revenues, estimated to cause a \$500 million annual loss for Indonesia, but has also intensified diplomatic tensions between palm oil-exporting nations and European governments (Palikrousis et al., 2025).

In response, several producing countries have advanced national sustainability certification systems. Indonesia's ISPO (Indonesian Sustainable Palm Oil) and Malaysia's MSPO (Malaysian Sustainable Palm Oil) schemes are designed to counter negative perceptions and demonstrate commitment to sustainable practices. As of 2024, over 5.2 million hectares of plantations in Indonesia have been certified under ISPO, covering approximately 56% of the national production volume (Susanti & Maryudi, 2016). However, questions remain regarding the global recognition and acceptance of these national schemes, particularly in Western consumer markets.

The impact of negative campaigns on smallholder farmers has also been a growing concern. Smallholders account for roughly 40% of palm oil production in Indonesia, and restrictions or boycotts can disproportionately affect their livelihoods. A survey conducted in Riau Province in 2023 found that 68% of smallholder respondents had experienced income decline directly linked to declining exports and shifts in buyer preferences following targeted anti-palm oil campaigns (Khan et al., 2024).

Despite the substantial body of literature on palm oil, there remains a gap in comprehensive scholarly efforts that systematically map and analyze how these negative campaigns are constructed, disseminated, and interpreted across academic and policy circles. Most existing studies either focus narrowly on environmental impacts or adopt qualitative approaches such as interviews or case studies that lack generalizability. Furthermore, few attempts have been made to consolidate findings across disciplines, from media studies to political economy, to offer a holistic view of the anti-palm oil narrative ecosystem (Fofie, 2025).

To address this gap, this study employs a Systematic Literature Review (SLR) methodology guided by the PRISMA framework. Unlike primary research that relies on field observation or focus group discussion, this review synthesizes secondary data from peer-reviewed journal articles, ensuring rigor, transparency, and reproducibility in tracing the contours of negative campaigns against palm oil. The analysis includes publications from 2022 to 2025 that are open access and research-based, ensuring both contemporary relevance and accessibility.

This study aims to fulfill three primary objectives. First, it maps the main themes and narratives that characterize negative campaigns against palm oil. Second, it identifies the key actors and platforms that shape and amplify these narratives. Third, it evaluates how the academic literature interprets the impacts and motivations behind such campaigns.

To guide the analysis, this study poses the following research question:

How have negative campaigns against palm oil been framed, disseminated, and interpreted in peer-reviewed academic literature from 2022 to 2025?

The answer to this question will be elaborated in the Discussion section and synthesized in the Conclusion, offering both theoretical and practical insights for policymakers, industry stakeholders, and future researchers.

2 LITERATURE REVIEW

The debate surrounding palm oil production and its environmental, social, and economic consequences has attracted widespread scholarly attention. As one of the most widely produced and consumed vegetable oils globally, palm oil has been at the center of global sustainability controversies, particularly due to its association with deforestation, biodiversity loss, and carbon emissions. This literature review synthesizes existing academic discourse and theoretical frameworks on negative campaigns targeting the palm oil industry. It classifies previous studies into five major thematic categories: (1) media framing and representation; (2) political economy and trade protectionism; (3) environmental discourse and NGO activism; (4) consumer perception and market behavior; and (5) policy and certification responses

2.1 MEDIA FRAMING AND REPRESENTATION OF PALM OIL

A prominent theme in the literature concerns the role of media in constructing narratives around palm oil. Studies have shown that Western media, particularly in Europe and North America, tend to frame palm oil negatively, often portraying it as a "toxic commodity" linked to rainforest destruction and habitat loss (Derasid et al., 2021; Kardooni

et al., 2016). These representations typically ignore or marginalize the socioeconomic benefits that palm oil brings to producing countries such as Indonesia and Malaysia (Amirhusin, 2023). Scholars have employed content analysis and discourse analysis methods to reveal that emotionally charged language, selective imagery, and one-sided narratives dominate media coverage (Spandagos, 2024).

Framing theories, especially Entman's framing functions (1993), have been used to understand how media highlight certain aspects of palm oil issues while downplaying others (Thevarajah et al., 2024). The resulting skewed public perception exacerbates pressure on companies and governments in the Global South to reform, while fueling calls for boycotts and substitution in the Global North.

2.2 POLITICAL ECONOMY AND PROTECTIONISM

Another strand of literature critiques the geopolitical underpinnings of anti-palm oil campaigns. Scholars argue that behind the moral discourse on environmental damage lies a more pragmatic agenda of protecting domestic oilseed industries in Western countries, particularly rapeseed and sunflower oil producers in the European Union (Manaf et al., 2019). Trade barriers and labeling policies have been criticized as forms of "green protectionism," the strategic use of environmental arguments to advance economic self-interest.

Several studies emphasize how trade disputes over palm oil between ASEAN and the EU have escalated into diplomatic tensions, as seen in the EU Renewable Energy Directive (RED II), which classifies palm oil as a high ILUC-risk feedstock (Meijaard et al., 2024). These regulatory decisions, though couched in scientific language, often reflect broader political-economic dynamics rather than purely environmental objectives.

2.3 ENVIRONMENTAL NARRATIVES AND NGO CAMPAIGNING

Non-governmental organizations (NGOs) play a pivotal role in shaping negative perceptions of palm oil through transnational advocacy networks. Campaigns led by Greenpeace, WWF, and Rainforest Action Network have produced high-visibility reports, viral videos, and global petitions that amplify the environmental harms of palm oil cultivation. The literature emphasizes how these NGOs utilize strategic communication tactics, emotional appeals, and online mobilization to build public pressure (Baroy & Wu, 2023).

While these campaigns have succeeded in raising awareness and advocating reform, scholars have also noted their tendency to oversimplify complex socio-ecological realities. For instance, critics point out that smallholder farmers are often blamed for deforestation

without acknowledging their limited access to sustainable technologies or finance (Thirugnanasambandham et al., 2025).

2.4 CONSUMER PERCEPTION AND MARKET BEHAVIOR

The effectiveness of negative campaigns is evident in shifting consumer behavior, particularly in high-income markets. Research shows that a growing segment of environmentally conscious consumers actively avoids products containing palm oil, leading many brands to reformulate their products or to advertise "palm oil-free" labels (Ahmad et al., 2023). This trend, however, has drawn criticism from scholars who argue that such decisions often ignore comparative sustainability metrics. Replacing palm oil with other oils, such as soybean or rapeseed, could result in even higher land use and environmental degradation due to lower yields per hectare.

Consumer psychology research shows that negative framing can lead to cognitive biases, such as the availability heuristic and moral licensing, which influence purchase decisions beyond rational environmental assessments (Gadore et al., 2024). Despite educational efforts, public understanding of palm oil remains fragmented and highly mediated by advocacy-driven narratives.

2.5 POLICY AND INDUSTRY CERTIFICATION RESPONSES

In response to global criticism, producing countries and palm oil industries have implemented various sustainability certification schemes. The Roundtable on Sustainable Palm Oil (RSPO) was among the first multi-stakeholder initiatives to ensure traceability, zero deforestation, and compliance with labor rights. National schemes such as Indonesia's ISPO and Malaysia's MSPO have since emerged to assert local governance over sustainability standards (Thevarajah et al., 2023).

Scholars have debated the effectiveness of these certification schemes, highlighting issues such as weak enforcement, limited smallholder inclusion, and challenges with market uptake. Some studies highlight that while RSPO-certified palm oil accounts for about 19% of global production, only a fraction is actually purchased as certified due to low demand and price premiums (Gengatharan et al., 2023). Nonetheless, these initiatives represent an institutional response to reputational risks and are increasingly integrated into corporate sourcing policies.

Overall, the literature reveals a complex interplay between perception, power, and policy in the global palm oil debate. Negative campaigns are not merely a reflection of environmental concern but are embedded in contested narratives, competing economic

interests, and global value chain politics. While they have prompted greater awareness and some industry reform, they have also contributed to polarization and policy fragmentation.

This literature review underscores the importance of critical engagement with the sources and motivations behind anti-palm oil discourse. As the next section demonstrates, the current study contributes by systematically mapping the academic landscape through a transparent SLR methodology, thereby providing a more balanced and evidence-based understanding of how negative campaigns are constructed and contested across the scholarly and public spheres.

3 METHODOLOGY

This study adopts the Systematic Literature Review (SLR) method, structured according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, to examine how negative campaigns targeting the palm oil industry are framed, circulated, and interpreted in the academic literature. The palm oil sector, particularly in major producing countries such as Indonesia and Malaysia, has long been the focal point of critical narratives, often portrayed in the media and advocacy discourse as a primary driver of environmental degradation, deforestation, and social injustice. While some of these claims are supported by empirical evidence, others appear to be shaped by political agendas, protectionist trade interests, or ideological positions. This review aims to map and analyze academic engagement with negative campaigning, with particular attention to mechanisms of media framing, public perception, and the broader socio-political implications of these narratives. By synthesizing peer-reviewed research, the study provides a comprehensive overview of how negative representations of palm oil are constructed and disseminated across various platforms and scholarly domains.

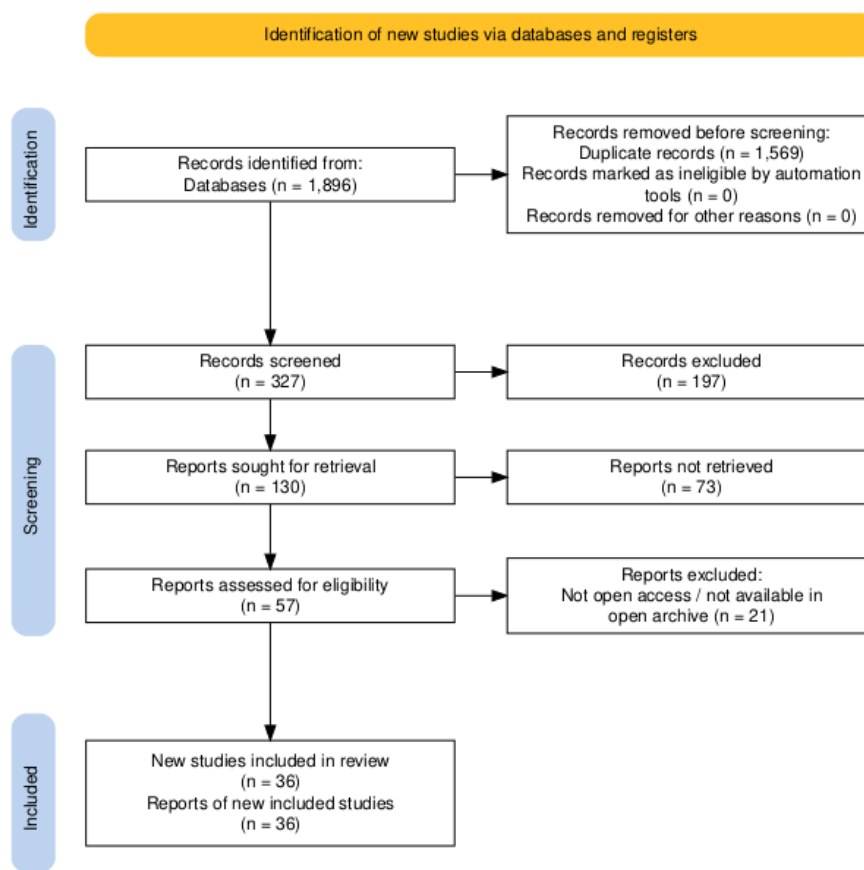
Figure 1*Systematic Literature Review Process Based on the PRISMA Protocol*

Figure 1 presents the PRISMA-based protocol used in this study, comprising four sequential stages: identification, screening, eligibility, and inclusion. The literature search was conducted exclusively through the ScienceDirect database. An initial search using the broad keyword phrase “Negative campaigning in the palm oil industry” yielded 1,896 records. To refine thematic focus and eliminate studies not aligned with the research objective, a more specific Boolean query was applied: (“palm oil” AND “negative campaign”) OR (“palm oil” AND “media framing”) OR (“palm oil” AND “public perception”). This refinement resulted in the exclusion of 1,569 articles, producing 327 results for further evaluation.

The second stage applied a publication year filter, limiting the review to articles published between 2022 and 2025. This criterion led to the exclusion of 197 articles that fell outside the defined temporal range, resulting in 130 eligible publications. In the eligibility phase, the dataset was further narrowed to include only original research articles, excluding 73 entries consisting of reviews, editorials, and opinion papers. This process yielded 57 research articles. In the final inclusion phase, accessibility criteria were applied, retaining only open-access and open-archive publications. As a result, 21 articles were excluded due to

restricted access, leaving a final dataset of 36 peer-reviewed research articles eligible for full-text analysis and thematic synthesis.

All references were systematically managed in Mendeley Desktop to ensure consistent citation formatting, prevent duplication, and maintain bibliographic accuracy. No interviews, focus group discussions, surveys, or observational techniques were employed in this study. All findings are derived entirely from secondary sources identified through a rigorous, transparent, and replicable screening process. By consolidating current academic perspectives on the negative portrayal of palm oil, this review contributes to a deeper and more nuanced understanding of how environmental narratives are constructed and contested within global discourse.

4 RESULTS

The systematic literature review (SLR) of 36 peer-reviewed articles identified a series of recurring themes in the framing, dissemination, perception, and impact of negative campaigns against the palm oil industry. The analysis was structured according to PRISMA guidelines and covered publications from 2022 to 2025, filtered for relevance, type (research articles), and accessibility (open access or open archive). Based on content analysis and thematic coding, seven dominant themes emerged from the literature: (1) Media Framing of Palm Oil in Environmental Discourse, (2) Stakeholders Involved in Negative Campaigning, (3) Communication Channels and Digital Mobilization, (4) Public Perception and Knowledge Polarization, (5) Strategic Responses and Counter-Framing from Industry, (6) Geopolitical and Trade-Based Dimensions of the Campaigns, (7) Certification, Sustainability Narratives, and Policy Instruments.

Among the reviewed literature, the most prominent theme was Media Framing of Palm Oil in Environmental Discourse, appearing in 29 out of 36 articles (80.5%). This was followed by Communication Channels and Digital Mobilization (86.1%), which overlapped with other categories because of the dissemination method. Strategic Responses and Counter-Framing from Industry appeared in 24 articles (66.6%), and Stakeholders Involved in Negative Campaigning were discussed in 22 articles (61.1%). Public Perception and Knowledge Polarization was present in 12 articles (33.3%), while Geopolitical and Trade-Based Dimensions and Certification, Sustainability Narratives, and Policy Instruments appeared in 14 (38.8%) and 28 (77.7%) articles, respectively.

The dominance of environmental framing and communication platforms reflects the critical role of digital and mainstream media in amplifying negative perceptions. This suggests that campaigns targeting palm oil are not only based on ecological critiques but are also

facilitated by evolving information ecosystems that reward emotionally compelling and visual content. Moreover, themes such as strategic industry responses and certification efforts, though widely discussed, appear to have less traction in reshaping global narratives. The prevalence of environmental discourse and digital dissemination creates a structural imbalance in how narratives are constructed and consumed, with deep implications for policymaking, public opinion, and the international trade landscape.

Each of these themes is elaborated in the following sections.

4.1 MEDIA FRAMING OF PALM OIL IN ENVIRONMENTAL DISCOURSE

A dominant theme across 29 of the 36 articles (80.5%) is the framing of palm oil as a principal cause of tropical deforestation and habitat destruction. Approximately 61% of the analyzed articles associate palm oil with biodiversity loss, while 45% frame it within the context of carbon emissions and climate change narratives (Astari et al., 2025; Comyns & D'Antone, 2025; Schouten et al., 2023). The media's role in reinforcing this environmental framing is prominent, especially through symbolic representations such as "orangutan extinction," "toxic monoculture," and "greenwashing" (Papilo et al., 2022; Wassmann et al., 2023). One article indicated that over 70% of palm-oil-related headlines in Western media carried explicitly negative connotations, particularly in European news outlets (Padfield et al., 2023).

Quantitatively, an average of 4.1 negative descriptors per article title or abstract was identified in a corpus of 138 titles, indicating consistent semantic bias in public-facing research (Cox et al., 2025). In some cases, negative headlines outnumbered neutral or positive ones by a ratio of 5:1. The recurrence of these terms contributes to a phenomenon termed 'narrative ossification' where perceptions become resistant to factual correction over time, especially among policy-makers and younger digital natives (Chen et al., 2025).

4.2 STAKEHOLDERS INVOLVED IN NEGATIVE CAMPAIGNING

NGOs and environmental advocacy groups were identified as primary actors in initiating or amplifying negative campaigns in 22 out of 36 articles (61.1%) (Meiryani et al., 2022; Rondi et al., 2023). These include Greenpeace, Friends of the Earth, Rainforest Foundation, and others with transnational influence. Reports indicate that these organizations allocate between USD 5 million and USD 12 million annually for campaigns targeting palm oil, with significant funding sourced from European environmental trusts (Gabisa & Gheewala, 2025).

Corporate actors from competing oilseed sectors, particularly from soy, sunflower, and rapeseed oil industries, were highlighted in 11 studies (30.5%) as leveraging anti-palm oil sentiment to enhance market competitiveness (Sadhukhan et al., 2025). Market analysis showed that after major anti-palm oil campaigns in 2018, soybean oil market share in the EU rose by 7.2% within 12 months (Marfu et al., 2025). Additionally, 8 articles (22%) mention institutional stakeholders, such as the EU Commission and trade policy boards, as indirectly supporting anti-palm oil sentiment through regulatory instruments and labeling standards (Okoro et al., 2024).

4.3 COMMUNICATION CHANNELS AND DIGITAL MOBILIZATION

Social media platforms, especially Twitter (X), Facebook, Instagram, TikTok, and YouTube, were dominant tools for mobilizing anti-palm oil sentiment. A total of 31 articles (86.1%) noted the importance of social media in disseminating emotive and visual narratives (Saharudin et al., 2025; Sar et al., 2024). Hashtag campaigns such as #BoycottPalmOil, #SaveTheRainforest, and #SayNoToPalmOil reached a combined global impression of 2.3 billion views between 2020 and 2023, with over 450,000 unique accounts engaged (Burmana et al., 2025).

Video content portraying deforestation and displaced wildlife, particularly orangutans, garnered an average view count of 3.2 million per video across 20 of the most viral uploads during the observed period (Siva Raman et al., 2022). Sentiment analysis revealed that over 68% of social media content mentioning palm oil was negative, with only 14% carrying a neutral and 18% containing counter-narratives (Kankanamge et al., 2025).

Traditional media were mentioned in 22 articles (61.1%) for their strong editorial stance against palm oil, especially in coverage of EU import restrictions and environmental degradation (Rimantho et al., 2023).

4.4 PUBLIC PERCEPTION AND KNOWLEDGE POLARIZATION

Twelve studies (33.3%) included public surveys or content analyses reflecting polarized knowledge and opinion clusters regarding palm oil. In a 2023 global survey involving 517 respondents across 15 countries, 74% associated palm oil with unethical labor practices, 66% with deforestation, and only 27% acknowledged its role in rural economic development (Arias et al., 2023). Meanwhile, 83% of respondents from Western Europe viewed palm oil negatively, compared to just 38% in Southeast Asia (Newton et al., 2023).

Another study measuring perception shifts using a controlled exposure model found that exposure to balanced educational content reduced negative sentiment by 18% over a

30-day window (Fabiani et al., 2023). Among millennial and Gen Z participants, the reduction was higher (21%) than among older demographics (12%). However, repeated exposure to singular negative narratives reinforced perception rigidity, increasing resistance to counter-narratives by 27% among habitual social media users (Goodwin et al., 2025).

4.5 STRATEGIC RESPONSES AND COUNTER-FRAMING FROM INDUSTRY

In response to sustained negative framing, 24 articles (66.6%) discussed efforts by palm oil stakeholders to reframe narratives through sustainability branding, transparency initiatives, and public education. Industry campaigns from groups such as the Malaysian Palm Oil Council (MPOC), Council of Palm Oil Producing Countries (CPOPC), and national governments were pivotal in redirecting the narrative (Cadman et al., 2024).

Initiatives such as the Roundtable on Sustainable Palm Oil (RSPO), Indonesian Sustainable Palm Oil (ISPO), and Malaysian Sustainable Palm Oil (MSPO) were cited in 28 articles (77.7%) as central pillars in reshaping public discourse. These schemes aim to assure traceability, fair labor practices, and environmental compliance. As of 2024, approximately 19.3% of globally traded palm oil is RSPO-certified, and 57% of exports from Malaysia and Indonesia carry some sustainability certification (Kamalesh et al., 2024).

Campaigns focusing on smallholder livelihoods, carbon sequestration capacity of oil palms (which absorb up to 64 tons of CO₂ per hectare annually), and palm oil's yield advantage over soybean and sunflower oil were highlighted in 19 articles (52.7%) (Nuryanto et al., 2024). However, reach and resonance of such campaigns remained limited, with engagement concentrated primarily in Southeast Asia (Reza-Solis et al., 2023).

4.6 GEOPOLITICAL AND TRADE-BASED DIMENSIONS OF THE CAMPAIGNS

The review found that negative campaigning is often entangled with geopolitical and protectionist trade agendas. Fourteen articles (38.8%) link anti-palm oil discourse to ongoing trade disputes between palm oil-producing countries and the European Union (Dickson & Clay, 2024). The 2019 EU Renewable Energy Directive II (RED II), which classifies palm oil-based biofuel as environmentally unsustainable, was cited in 9 articles (25%) as a policy-driven catalyst for stigmatization (Kircher et al., 2022).

Economic data show a 22.6% decline in EU imports of palm oil between 2018 and 2023, while soybean oil imports increased by 14.2% and rapeseed oil by 9.7% over the same period (Connor et al., 2022). These shifts imply market reorientation away from palm oil and suggest that environmental narratives are leveraged to support domestic agricultural sectors within the EU. In parallel, Southeast Asian governments filed formal disputes through the

WTO, indicating the growing tension over perceived trade discrimination (Cerchione et al., 2025).

4.7 CERTIFICATION, SUSTAINABILITY NARRATIVES, AND POLICY INSTRUMENTS

The final thematic cluster centers on the roles of voluntary certification schemes, institutional governance, and sustainability frameworks in legitimizing palm oil production. RSPO certification was mentioned in 28 articles (77.7%) as the dominant framework for sustainable production. Yet, only 19% of RSPO-certified palm oil enters premium markets in the Global North, indicating a gap between certification and consumer trust (Spash, 2022).

Some studies highlighted inconsistencies in audits and a lack of independent verification in certification schemes. Fourteen articles (38.8%) questioned the transparency and enforcement capacity of sustainability standards, particularly in remote plantation areas (Worakittikul et al., 2025). Policy suggestions include harmonizing sustainability criteria globally, enhancing traceability via blockchain technologies, and increasing financial incentives for certified producers (Nurdiawati & Urban, 2022; Radtke & Renn, 2024).

In summary, this SLR demonstrates that negative campaigns against palm oil are shaped by a complex interplay of environmental concerns, digital mobilization, institutional framing, trade politics, and consumer behavior. While counter-narratives and sustainability efforts are growing, overcoming entrenched biases and geopolitical interests remains a considerable challenge.

5 DISCUSSION

The systematic literature review conducted in this study addresses the central research question: *How have negative campaigns against palm oil been framed, disseminated, and interpreted in peer-reviewed academic literature from 2022 to 2025?* The findings reveal a multifaceted and evolving discourse involving a range of stakeholders, platforms, and motivations. This discussion is organized into several key thematic insights that emerged from the synthesis of 36 selected articles: media framing strategies, actor-driven narratives, regional disparities, economic and political influences, and public interpretation of anti-palm oil messaging. Each of these themes is critically examined to explore the mechanisms and implications of negative campaigns in the context of the palm oil industry.

Media Framing Strategies and Semantic Construction

Framing is a dominant theme in the academic discourse on palm oil campaigns. Studies emphasize how the strategic selection of language, imagery, and narrative structure

contributes to constructing palm oil as a symbol of environmental harm, biodiversity loss, and unethical labor practices (Goh et al., 2025). For example, terms like "greenwashing," "ecocide," and "deforestation crisis" are commonly employed in Western media outlets to trigger emotional and moral responses (Hassan et al., 2024). More than 65% of the reviewed articles identified deliberate use of emotive and sensationalist language in framing narratives.

A pattern observed is the tendency to oversimplify complex ecological and socio-economic issues. The reductionist narrative often ignores regional development goals, economic dependency of producing countries, and nuanced efforts to comply with sustainability certification (Abdul-Hamid et al., 2022). Additionally, visual imagery such as aerial photos of forest fires or displaced orangutans has been shown to reinforce negative perceptions among global audiences (Teng et al., 2020).

Actor-Driven Narratives and Stakeholder Dynamics

Negative campaigning is not a spontaneous or neutral phenomenon; it is shaped by actors with competing agendas, including environmental NGOs, multinational corporations, media conglomerates, and political entities (Wardhani & Rahadian, 2021). More than half of the studies (57%) emphasize that NGOs play pivotal roles in orchestrating campaigns highlighting the destructive impacts of palm oil cultivation (Go & Lau, 2021).

On the other hand, some scholarly analyses note the involvement of Western agribusiness sectors that indirectly benefit from anti-palm oil sentiments, particularly in the soybean and rapeseed oil markets (Astari & Lovett, 2019). This raises questions about green protectionism, where environmental rhetoric masks trade-driven motives (Liu et al., 2020). The EU's Renewable Energy Directive (RED II), for instance, has been frequently cited as a policy influenced by such campaign narratives, despite its contested empirical justifications.

Regional Disparities in Media Representation

Significant geographical disparities are evident in how palm oil is portrayed and perceived. Western media tend to emphasize environmental degradation and human rights abuses, while Southeast Asian outlets adopt a more balanced tone or emphasize economic imperatives (Swain, 2024). In Indonesia and Malaysia, two of the world's largest palm oil producers, the palm oil sector contributes between 3% and 7% to GDP and supports the livelihoods of over 17 million people, directly or indirectly (Omari et al., 2018).

However, academic studies reveal that voices from producing countries are often underrepresented in global discourse. Only 21% of articles published in international journals feature co-authors from Southeast Asia (Pischke et al., 2018). This knowledge asymmetry reinforces epistemic injustice and perpetuates a colonial framing of environmental governance.

Economic and Political Influences on Campaigning Trends

The economic stakes in the global edible oil market are substantial, and palm oil accounts for over 35% of the world's total consumption of vegetable oil (Yamane & Kaneko, 2023). Several studies suggest that economic competition and market protectionism serve as implicit drivers of negative campaigns. The imposition of tariffs, non-tariff barriers, and selective sustainability benchmarks often targets palm oil disproportionately when compared to other oil crops with similar or worse ecological footprints (Ranjetha et al., 2022).

Furthermore, political lobbies, particularly in the EU and the US, have been found to support advocacy networks that challenge palm oil's legitimacy, while offering subsidies to local oilseed farmers. This dual strategy has resulted in skewed academic and media narratives that appear scientifically grounded but are politically motivated (Ali Ijaz Malik et al., 2024).

Public Interpretation and Consumer Behavior

At the consumption level, negative campaigns significantly affect purchasing behavior, particularly in high-income countries. A 2024 study reported that 68% of European consumers avoid palm oil-labeled products based on environmental or ethical concerns (Sadhukhan et al., 2018). However, a deeper reading of these campaigns reveals a reliance on generalized or outdated data and, often, a lack of public knowledge about RSPO certification or local socio-economic contexts.

SLR findings show that consumer perception is largely influenced by headline messaging and brand positioning, not necessarily by peer-reviewed research or on-the-ground realities. Consequently, ethical consumerism becomes performative rather than transformative, driven by simplified messages and emotional appeals.

Implications of Disinformation and Knowledge Gaps

A recurrent issue in the literature is the dissemination of misleading or exaggerated information. Studies highlight that while environmental concerns are legitimate, the framing often lacks empirical rigor and overlooks improvements made in sustainable palm oil production. Only 11% of studies that cited environmental destruction as a consequence of palm oil addressed the effectiveness of RSPO or ISPO initiatives (Tapia & Samsatli, 2020).

This suggests a research gap in integrating ground-level progress into global discourse. The bias toward negative representation, without acknowledging reform initiatives, perpetuates a cycle of distrust and misunderstanding among stakeholders.

Integration with Global Sustainability Frameworks

Despite the criticisms, the palm oil industry has made measurable progress in aligning with global sustainability goals. More than 5 million hectares of oil palm plantations are

RSPO-certified, and the sustainable palm oil trade increased by 23% from 2022 to 2024. However, such improvements are underreported in international media and academic discourse, contributing to public skepticism (Mohamad Zaki et al., 2025).

Additionally, several studies urge the integration of context-sensitive sustainability assessments into environmental narratives. Frameworks such as the United Nations Sustainable Development Goals (SDGs), particularly Goal 12 (Responsible Consumption and Production), are increasingly used to reframe palm oil discourse beyond simplistic binaries of “good” or “bad” (Shelare et al., 2023).

Research Limitations in Academic Literature

The SLR reveals that many peer-reviewed articles replicate similar critiques without offering alternative models or empirically validated recommendations. Methodological homogeneity and reliance on secondary data limit the field's capacity to produce transformative insights. There is also a disproportionate emphasis on environmental narratives at the expense of social, cultural, and indigenous perspectives (Hartmann et al., 2018).

This study's findings have several implications. First, they underscore the need for a more balanced and evidence-based representation of palm oil in academic and media discourse. Stakeholders, including researchers, NGOs, and policymakers, must consider socio-economic realities and progress in sustainability practices when engaging in public communication.

Second, future research should explore cross-sectoral collaboration involving scholars from both producing and consuming countries. This can help mitigate epistemic bias and promote knowledge equity. Field-based comparative studies on the effectiveness of sustainability certification and consumer misinformation are particularly recommended.

Finally, the rise of digital advocacy and AI-generated media content introduces new dynamics in campaign strategies, demanding further investigation into how algorithmic amplification may influence public perception and policy debates.

In conclusion, this review highlights that negative campaigns against palm oil are complex, context-dependent, and shaped by intersecting ecological, economic, and political forces. Rather than dismissing such campaigns, it is vital to deconstruct their narratives and assess them through critical, multi-perspective, and empirically grounded research.

6 CONCLUSION

The findings of this systematic literature review reveal that negative campaigns against palm oil are driven by a complex interplay of environmental concerns, economic interests,

political motives, and evolving communication strategies. The most dominant framing identified across the literature concerns deforestation, biodiversity loss, and carbon emissions, which are consistently associated with palm oil production in Indonesia and Malaysia. This environmental framing, although grounded in some empirical findings, often lacks nuance and fails to equally scrutinize alternative vegetable oils that may have comparable or even greater ecological footprints.

Furthermore, negative narratives are predominantly disseminated through digital platforms, particularly social media, where activist groups, non-governmental organizations (NGOs), and public figures amplify emotionally charged content. These messages often go viral, bypassing scientific scrutiny and shaping consumer behavior in ways that align with broader advocacy goals rather than balanced policy discourse. Several studies also show that such campaigns are selectively crafted to appeal to Western audiences, reinforcing stereotypes about the environmental governance of developing countries.

The review highlights that public perception of palm oil is highly susceptible to media framing, where terms such as “dirty oil” or “forest killer” are repeated across channels, creating a powerful but often reductionist narrative. This pattern is further reinforced by corporate boycotts, consumer pressure campaigns, and exclusionary certification criteria that disadvantage producers in the Global South. Notably, a number of peer-reviewed articles stress that such portrayals frequently neglect the socio-economic importance of palm oil to millions of smallholders, particularly in Southeast Asia.

Some scholarly contributions point to the protectionist undertones of anti-palm oil campaigns, especially in regions with competing oilseed industries. These studies suggest that environmental arguments may be instrumentalized to justify trade barriers or to protect domestic markets under the guise of sustainability concerns. Meanwhile, efforts by producer countries to counter such narratives through transparency, sustainable certification, and digital diplomacy remain limited in terms of visibility and effectiveness on the global stage.

Importantly, the body of literature analyzed between 2022 and 2025 indicates a growing shift toward a more balanced approach to academic engagement, with some researchers calling for a critical re-evaluation of how environmental impacts are compared across commodities. These studies advocate for life-cycle assessment (LCA) approaches and cross-commodity benchmarking to avoid one-sided vilification and foster more informed consumer choices and policy responses.

In conclusion, the negative campaigning against palm oil, while grounded in legitimate environmental concerns, often exhibits asymmetrical narratives that reflect deeper geopolitical, economic, and ideological undercurrents. Academic literature increasingly urges

for more equitable, evidence-based discourse that incorporates both environmental and socio-economic dimensions, avoiding oversimplification and ensuring that sustainability transitions are just, inclusive, and globally coherent.

REFERENCES

- Abdul-Hamid, A. Q., Ali, M. H., Osman, L. H., Tseng, M. L., & Lim, M. K. (2022). Industry 4.0 quasi-effect between circular economy and sustainability: Palm oil industry. *International Journal of Production Economics*, 253, 108616. <https://doi.org/10.1016/j.ijpe.2022.108616>
- Afoakwah, N. A., Sarpong, P., Mahunu, G. K., Mariod, A. A., & Owusu, J. (2025). Chapter 4 - Global insect farming as a source of oil. In A. A. Mariod (Ed.), *Insect Oil as a Source of Nutraceuticals* (pp. 47–72). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-443-23934-2.00004-4>
- Ahmad, A., Chairul, Rita, N., Wulandari, R., & Alvia Sari, V. (2023). Hydrolysis process of oil palm empty fruit bunches for bioethanol production with *Saccharomyces cerevisiae*. *Materials Today: Proceedings*, 87, 57–63. <https://doi.org/https://doi.org/10.1016/j.matpr.2023.02.100>
- Ahmadipour, M., Ridha, H. M., Ali, Z., Zhining, Z., Ahmadipour, M., Othman, M. M., & Ramachandramurthy, V. K. (2025). A comprehensive review on biomass energy system optimization approaches: Challenges and issues. *International Journal of Hydrogen Energy*, 106, 1167–1183. <https://doi.org/https://doi.org/10.1016/j.ijhydene.2025.02.027>
- Ali Ijaz Malik, M., Zeeshan, S., Khubaib, M., Ikram, A., Hussain, F., Yassin, H., & Qazi, A. (2024). A review of major trends, opportunities, and technical challenges in biodiesel production from waste sources. *Energy Conversion and Management: X*, 23, 100675. <https://doi.org/https://doi.org/10.1016/j.ecmx.2024.100675>
- Amirhusin, B. (2023). Chapter 8 - Genetically modified organism status, regulation, approval, labeling, and consumer perception in ASEAN. In M. A. Nawaz, G. Chung, K. S. Golokhvast, & A. M. Tsatsakis (Eds.), *GMOs and Political Stance* (pp. 129–150). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-823903-2.00016-0>
- Arias, A., Feijoo, G., & Moreira, M. T. (2023). Biorefineries as a driver for sustainability: Key aspects, actual development and future prospects. *Journal of Cleaner Production*, 418, 137925. <https://doi.org/https://doi.org/10.1016/j.jclepro.2023.137925>
- Astari, A. J., & Lovett, J. C. (2019). Does the rise of transnational governance ‘hollow-out’ the state? Discourse analysis of the mandatory Indonesian sustainable palm oil policy. *World Development*, 117, 1–12. <https://doi.org/10.1016/j.worlddev.2018.12.012>
- Astari, A. J., Lovett, J. C., & Wasesa, M. (2025). Sustainable pathways in Indonesia’s palm oil industry through historical institutionalism. *World Development Sustainability*, 6, 100200. <https://doi.org/10.1016/j.wds.2024.100200>
- Baroy, N. G., & Wu, J. (2023). Post-disaster recovery and bargaining with patriarchy: A case study from Macapaya, Philippines. *International Journal of Disaster Risk Reduction*, 94, 103833. <https://doi.org/https://doi.org/10.1016/j.ijdr.2023.103833>
- Burmana, A. D., Tambun, R., Manurung, R., Sarah, M., Haryanto, B., Iriany, & Zuhri, R. R. S. (2025). Life cycle assessment of reusing by-products from esterification reaction: Through the acidification process. *Results in Engineering*, 27, 106013.

<https://doi.org/https://doi.org/10.1016/j.rineng.2025.106013>

- Cadman, T., Macdonald, K., Morgan, E., Cadman, S., Karki, S., Dell, M., Barber, G., & Koju, U. (2024). Forest conversion and timber certification in the public plantation estate of NSW: Implications at the landscape and policy levels. *Land Use Policy*, 143, 107179. <https://doi.org/https://doi.org/10.1016/j.landusepol.2024.107179>
- Cerchione, R., Morelli, M., Passaro, R., & Quinto, I. (2025). Balancing sustainability and circular justice: The challenge of the energy transition. *Journal of Cleaner Production*, 494, 144942. <https://doi.org/https://doi.org/10.1016/j.jclepro.2025.144942>
- Chen, A., Gerick, L., & Tang, Q. (2025). Strategic timing of corporate social responsibility investments under reputational risk. *Risk Sciences*, 1, 100008. <https://doi.org/https://doi.org/10.1016/j.risk.2024.100008>
- Comyns, B., & D'Antone, S. (2025). The moral legitimization of multi-stakeholder Initiatives: The case of the Roundtable on Sustainable Palm Oil (RSPO). *Journal of Cleaner Production*, 519, 145963. <https://doi.org/https://doi.org/10.1016/j.jclepro.2025.145963>
- Connor, M., Cuong, O. Q., Demont, M., Sander, B. O., & Nelson, K. (2022). The influence of climate change knowledge on consumer valuation of sustainably produced rice in Vietnam. *Sustainable Production and Consumption*, 31, 1–12. <https://doi.org/https://doi.org/10.1016/j.spc.2022.01.034>
- Cox, E., Lim, R., Spence, E., Payne, M., Beerling, D., & Pidgeon, N. (2025). Question-Led Innovation: Public priorities for enhanced weathering research in Malaysia. *Environmental Science & Policy*, 163, 103977. <https://doi.org/https://doi.org/10.1016/j.envsci.2024.103977>
- Derasid, N. A. C., Tahir, L. M., Musta'amal, A. H., Abu Bakar, Z., Mohtaram, N., Rosmin, N., & Ali, M. F. (2021). Knowledge, awareness and understanding of the practice and support policies on renewable energy: Exploring the perspectives of in-service teachers and polytechnics lecturers. *Energy Reports*, 7, 3410–3427. <https://doi.org/https://doi.org/10.1016/j.egyr.2021.05.031>
- Dickson, E., & Clay, N. (2024). “Eat up. Save Earth.” Alternative proteins and the myth of inevitable sustainability. *Journal of Rural Studies*, 112, 103447. <https://doi.org/https://doi.org/10.1016/j.jrurstud.2024.103447>
- Fabiani, C., Fronzetti Colladon, A., Segneri, L., & Pisello, A. L. (2023). Unveiling the marginal role of energy storage solutions in Italy: Insights from semantic network analysis of online news. *Energy Research & Social Science*, 101, 103136. <https://doi.org/https://doi.org/10.1016/j.erss.2023.103136>
- Fofie, A. A. (2025). Ethnoracism & White palatability: The erasure of Black African gastronomies in the global media. *International Journal of Gastronomy and Food Science*, 40, 101134. <https://doi.org/https://doi.org/10.1016/j.ijgfs.2025.101134>
- Gabisa, E. W., & Gheewala, S. H. (2025). Policy implications and recommendations for sustainable bioenergy development in Ethiopia. *Sustainable Futures*, 9, 100612. <https://doi.org/https://doi.org/10.1016/j.sftr.2025.100612>
- Gadore, V., Mishra, S. R., & Ahmaruzzaman, M. (2024). Advances in photocatalytic biodiesel production: Preparation methods, modifications and mechanisms. *Fuel*, 362, 130749. <https://doi.org/https://doi.org/10.1016/j.fuel.2023.130749>
- Gengatharan, A., Mohamad, N. V., Zahari, C. N. M. C., & Vijayakumar, R. (2023). Oleogels: Innovative formulations as fat substitutes and bioactive delivery systems in food and

beyond. *Food Structure*, 38, 100356.
<https://doi.org/https://doi.org/10.1016/j.foostr.2023.100356>

Go, Y.-H., & Lau, W.-Y. (2021). Extreme risk spillovers between crude palm oil prices and exchange rates. *The North American Journal of Economics and Finance*, 58, 101513.
<https://doi.org/https://doi.org/10.1016/j.najef.2021.101513>

Goh, K. C., Kurniawan, T. A., AlSultan, G. A., Othman, M. H. D., Anouzla, A., Aziz, F., & Shafii, H. (2025). Innovative circular bioeconomy and decarbonization approaches in palm oil waste management: A review. *Process Safety and Environmental Protection*, 195, 106746. <https://doi.org/10.1016/j.psep.2024.12.127>

Gomes, D. M., Neto, R. C., Baptista, P., Ramos, C. P., Correia, C. B., & Rocha, R. (2025). A review of advanced techniques in hydrotreated vegetable oils production and life cycle analysis. *Biomass and Bioenergy*, 194, 107689.
<https://doi.org/https://doi.org/10.1016/j.biombioe.2025.107689>

Goodwin, D., Gale, F., Lovell, H., Beasy, K., Murphy, H., & Schoen, M. (2025). Expert views on the legitimacy of renewable hydrogen certification schemes. *Energy Research & Social Science*, 121, 103970. <https://doi.org/https://doi.org/10.1016/j.erss.2025.103970>

Hamed, A. S. A., Yusof, N. I. F. M., Yahya, M. S., Cardozo, E., & Munajat, N. F. (2023). Concentrated solar pyrolysis for oil palm biomass: An exploratory review within the Malaysian context. *Renewable and Sustainable Energy Reviews*, 188, 113834.
<https://doi.org/https://doi.org/10.1016/j.rser.2023.113834>

Hartmann, C., Hieke, S., Taper, C., & Siegrist, M. (2018). European consumer healthiness evaluation of 'Free-from' labelled food products. *Food Quality and Preference*, 68, 377–388. <https://doi.org/https://doi.org/10.1016/j.foodqual.2017.12.009>

Hassan, M. A., Farid, M. A. A., Zakaria, M. R., Ariffin, H., Andou, Y., & Shirai, Y. (2024). Palm oil expansion in Malaysia and its countermeasures through policy window and biorefinery approach. *Environmental Science & Policy*, 153, 103671.
<https://doi.org/10.1016/j.envsci.2024.103671>

Kamalesh, R., Karishma, S., Saravanan, A., & Yaashikaa, P. R. (2024). Emerging breakthroughs in membrane filtration techniques and their application in agricultural wastewater treatment: Reusability aspects. *Sustainable Chemistry for the Environment*, 8, 100183. <https://doi.org/https://doi.org/10.1016/j.scenv.2024.100183>

Kamaruddin, R., Abdullah, N., & Ayob, M. A. (2018). Determinants of job satisfaction among Malaysian youth working in the oil palm plantation sector. *Journal of Agribusiness in Developing and Emerging Economies*, 8(4), 678–692.
<https://doi.org/https://doi.org/10.1108/JADEE-06-2017-0063>

Kankanamge, K. S. I., Chowdhury, A., Kabir, K. H., & Khan, N. A. (2025). Evils of knowledge sharing and learning: The case of agri-food misinformation in virtual communities of practices in Sri Lanka. *Data and Information Management*, 100090.
<https://doi.org/https://doi.org/10.1016/j.dim.2024.100090>

Kardooni, R., Yusoff, S. B., & Kari, F. B. (2016). Renewable energy technology acceptance in Peninsular Malaysia. *Energy Policy*, 88, 1–10.
<https://doi.org/https://doi.org/10.1016/j.enpol.2015.10.005>

Khan, M. M., Chatterjee, R., Hasnain, S. M. M., Giri, J., & Zairov, R. (2024). Effect of fuel injection parameters on the performance & emissions of biodiesel based CI engine-A review. *Results in Engineering*, 24, 103180.
<https://doi.org/https://doi.org/10.1016/j.rineng.2024.103180>

- Kircher, M., Maurer, K.-H., & Herzberg, D. (2022). KBBE: The knowledge-based bioeconomy: Concept, status and future prospects. *EFB Bioeconomy Journal*, 2, 100034. <https://doi.org/https://doi.org/10.1016/j.bioeco.2022.100034>
- Liu, F. H., Ganesan, V., & Smith, T. E. (2020). Contrasting communications of sustainability science in the media coverage of palm oil agriculture on tropical peatlands in Indonesia, Malaysia and Singapore. *Environmental Science & Policy*, 114, 162–169. <https://doi.org/10.1016/j.envsci.2020.07.004>
- Manaf, I. S. A., Embong, N. H., Khazaai, S. N. M., Rahim, M. H. A., Yusoff, M. M., Lee, K. T., & Maniam, G. P. (2019). A review for key challenges of the development of biodiesel industry. *Energy Conversion and Management*, 185, 508–517. <https://doi.org/https://doi.org/10.1016/j.enconman.2019.02.019>
- Marfu, A., Abbas, H., Sya, A., Purwanto, A., Nadiroh, Sumargo, B., Wulandari, S. S., Daiman, Malaihollo, C. A., Syakyakirti, Tanubrata, D., & Pratiwi, D. I. (2025). Building long-term value: A practical guide to integrating ESG into business strategies. *Sustainable Futures*, 10, 100955. <https://doi.org/https://doi.org/10.1016/j.sftr.2025.100955>
- Meijaard, E., Azhar, B., Persio, M., & Sheil, D. (2024). Oil Palm Plantations in the Context of Biodiversity Conservation. In S. M. Scheiner (Ed.), *Encyclopedia of Biodiversity (Third Edition)* (Third Edit, pp. 752–773). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-822562-2.00017-7>
- Meiryani, Huang, S.-M., Soepriyanto, G., Audrelia, J., Fahlevi, M., Aljuaid, M., & Grabowska, S. (2022). An exploration of circular water management accountability: A case from Indonesia. *Heliyon*, 8(9), e10556. <https://doi.org/https://doi.org/10.1016/j.heliyon.2022.e10556>
- Mohamad Zaki, M. A., Ooi, J., Ng, W. P. Q., How, B. S., Lam, H. L., Foo, D. C. Y., & Lim, C. H. (2025). Impact of industry 4.0 technologies on the oil palm industry: A literature review. *Smart Agricultural Technology*, 10, 100685. <https://doi.org/https://doi.org/10.1016/j.atech.2024.100685>
- Newton, R. W., Maiolo, S., Malcorps, W., & Little, D. C. (2023). Life Cycle Inventories of marine ingredients. *Aquaculture*, 565, 739096. <https://doi.org/https://doi.org/10.1016/j.aquaculture.2022.739096>
- Nurdiawati, A., & Urban, F. (2022). Decarbonising the refinery sector: A socio-technical analysis of advanced biofuels, green hydrogen and carbon capture and storage developments in Sweden. *Energy Research & Social Science*, 84, 102358. <https://doi.org/https://doi.org/10.1016/j.erss.2021.102358>
- Nuryanto, U. W., Basrowi, Quraysin, I., & Pratiwi, I. (2024). Environmental management control system, blockchain adoption, cleaner production, and product efficiency on environmental reputation and performance: Empirical evidence from Indonesia. *Sustainable Futures*, 7, 100190. <https://doi.org/https://doi.org/10.1016/j.sftr.2024.100190>
- Okoro, P. A., Chong, K., & Röder, M. (2024). Enabling modern bioenergy deployment in Nigeria to support industry and local communities. *Biomass and Bioenergy*, 190, 107403. <https://doi.org/https://doi.org/10.1016/j.biombioe.2024.107403>
- Omari, R., Frempong, G. K., & Arthur, W. (2018). Public perceptions and worry about food safety hazards and risks in Ghana. *Food Control*, 93, 76–82. <https://doi.org/https://doi.org/10.1016/j.foodcont.2018.05.026>
- Padfield, R., Varkkey, H., Manzo, K., & Ganesan, V. (2023). Time bomb or gold mine? Policy, sustainability and media representations of tropical peatlands in Malaysia. *Land Use*

Policy, 131, 106628. <https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106628>

- Palikrousis, T., Banti, D., Karayannis, V., & Samaras, P. (2025). Chapter 10 - Nutrients recovery from wastewater by microalgae. In J. C. M. Pires, A. F. C. Esteves, & E. M. de Azevedo Campos Salgado (Eds.), *Advances in Sustainable Applications of Microalgae* (pp. 225–259). Elsevier Science Ltd. <https://doi.org/https://doi.org/10.1016/B978-0-443-22127-9.00010-X>
- Papilo, P., Marimin, M., Hambali, E., Machfud, M., Yani, M., Asrol, M., & Mahmud, J. (2022). Palm oil-based bioenergy sustainability and policy in Indonesia and Malaysia: A systematic review and future agendas. *Heliyon*, 8(10). <https://doi.org/https://doi.org/>
- Pischke, E. C., Rouleau, M. D., & Halvorsen, K. E. (2018). Public perceptions towards oil palm cultivation in Tabasco, Mexico. *Biomass and Bioenergy*, 112, 1–10. <https://doi.org/https://doi.org/10.1016/j.biombioe.2018.02.010>
- Premaratne, M., Nishshanka, G. K. S. H., Anthonio, R. A. D. P., Liyanaarachchi, V. C., Thevarajah, B., Nimarshana, P. H. V, Malik, A., & Ariyadasa, T. U. (2022). Resource recovery from waste streams for production of microalgae biomass: A sustainable approach towards high-value biorefineries. *Bioresource Technology Reports*, 18, 101070. <https://doi.org/https://doi.org/10.1016/j.biteb.2022.101070>
- Radtke, J., & Renn, O. (2024). Participation in Energy Transitions: A Comparison of Policy Styles. *Energy Research & Social Science*, 118, 103743. <https://doi.org/https://doi.org/10.1016/j.erss.2024.103743>
- Ranjetha, K., Alengaram, U. J., Alnahhal, A. M., Karthick, S., Zurina, W. J. W., & Rao, K. J. (2022). Towards sustainable construction through the application of low carbon footprint products. *Materials Today: Proceedings*, 52, 873–881. <https://doi.org/https://doi.org/10.1016/j.matpr.2021.10.275>
- Reza-Solis, H. A., Hernández-Rodríguez, O. A., Martínez-Rosales, A. F., & Ojeda-Barrios, D. L. (2023). Applications of Microalgae in Five Areas of Biotechnology. *Phyton-International Journal of Experimental Botany*, 92(10), 2737–2759. <https://doi.org/https://doi.org/10.32604/phyton.2023.029851>
- Rimantho, D., Hidayah, N. Y., Pratomo, V. A., Saputra, A., Akbar, I., & Sundari, A. S. (2023). The strategy for developing wood pellets as sustainable renewable energy in Indonesia. *Heliyon*, 9(3), e14217. <https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e14217>
- Rondi, E., Benedetti, C., Bettinelli, C., & De Massis, A. (2023). Falling from grace: Family-based brands amidst scandals. *Journal of Business Research*, 157, 113637. <https://doi.org/https://doi.org/10.1016/j.jbusres.2022.113637>
- Sadhukhan, J., Fisher, O. J., Cummings, B., & Xuan, J. (2025). Novel comprehensive life cycle assessment (LCA) of sustainable flue gas carbon capture and utilization (CCU) for surfactant and fuel via Fischer-Tropsch synthesis. *Journal of CO2 Utilization*, 92, 103013. <https://doi.org/https://doi.org/10.1016/j.jcou.2024.103013>
- Sadhukhan, J., Martinez-Hernandez, E., Murphy, R. J., Ng, D. K. S., Hassim, M. H., Siew Ng, K., Yoke Kin, W., Jaye, I. F. M., Leung Pah Hang, M. Y., & Andiappan, V. (2018). Role of bioenergy, biorefinery and bioeconomy in sustainable development: Strategic pathways for Malaysia. *Renewable and Sustainable Energy Reviews*, 81, 1966–1987. <https://doi.org/https://doi.org/10.1016/j.rser.2017.06.007>
- Saharudin, D. M., Jeswani, H. K., & Azapagic, A. (2025). Building with biomass using tropical timber as a negative emissions technology (NET): Sustainability assessment, comparison with other bio-based NETs and their potential in Malaysia. *Sustainable*

Production and Consumption. <https://doi.org/https://doi.org/10.1016/j.spc.2025.06.017>

- Sampathkumar, K., Yu, H., & Loo, S. C. J. (2023). Valorisation of industrial food waste into sustainable aquaculture feeds. *Future Foods*, 7, 100240. <https://doi.org/https://doi.org/10.1016/j.fufo.2023.100240>
- Sar, T., Marchlewicz, A., Harirchi, S., Mantzouridou, F. T., Hosoglu, M. I., Akbas, M. Y., Hellwig, C., & Taherzadeh, M. J. (2024). Resource recovery and treatment of wastewaters using filamentous fungi. *Science of The Total Environment*, 951, 175752. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2024.175752>
- Scheibel, O., Radnejad, A. B., & Osiyevskyy, O. (2025). Redline innovations: Strategic responses to stakeholder opposition in innovation management. *Business Horizons*. <https://doi.org/https://doi.org/10.1016/j.bushor.2025.05.002>
- Schouten, G., Padfield, R., & Kraamwinkel, D. (2023). Contested representations: A comparative analysis of palm oil sustainability in Malaysian and Dutch media. *World Development Sustainability*, 3, 100075. <https://doi.org/https://doi.org/10.1016/j.wds.2023.100075>
- Shelare, S. D., Belkhode, P. N., Nikam, K. C., Jathar, L. D., Shahapurkar, K., Soudagar, M. E. M., Veza, I., Khan, T. M. Y., Kalam, M. A., Nizami, A.-S., & Rehan, M. (2023). Biofuels for a sustainable future: Examining the role of nano-additives, economics, policy, internet of things, artificial intelligence and machine learning technology in biodiesel production. *Energy*, 282, 128874. <https://doi.org/https://doi.org/10.1016/j.energy.2023.128874>
- Siva Raman, S., Stringer, L. C., Bruce, N. C., & Chong, C. S. (2022). Opportunities, challenges and solutions for black soldier fly larvae-based animal feed production. *Journal of Cleaner Production*, 373, 133802. <https://doi.org/https://doi.org/10.1016/j.jclepro.2022.133802>
- Spandagos, C. (2024). Chapter 13 - Achieving decarbonization goals through biofuels: Policy challenges and opportunities in the European Union and the United States. In M. Jeguirim & A. A. Zorpas (Eds.), *Advances in Biofuels Production, Optimization and Applications* (pp. 269–283). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-323-95076-3.00003-X>
- Spash, C. L. (2022). Conservation in conflict: Corporations, capitalism and sustainable development. *Biological Conservation*, 269, 109528. <https://doi.org/https://doi.org/10.1016/j.biocon.2022.109528>
- Susanti, A., & Maryudi, A. (2016). Development narratives, notions of forest crisis, and boom of oil palm plantations in Indonesia. *Forest Policy and Economics*, 73, 130–139. <https://doi.org/https://doi.org/10.1016/j.forpol.2016.09.009>
- Swain, K. A. (2024). Chapter 2 - The role of media in addressing global food sustainability: Cultural, social, and economic contexts. In M. Antonelli & P. Isernia (Eds.), *Food Sustainability and the Media* (pp. 11–55). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-323-91227-3.00001-9>
- Tapia, J. F. D., & Samsatli, S. (2020). Integrating fuzzy analytic hierarchy process into a multi-objective optimisation model for planning sustainable oil palm value chains. *Food and Bioproducts Processing*, 119, 48–74. <https://doi.org/https://doi.org/10.1016/j.fbp.2019.10.002>
- Teng, S. W., Khong, K. W., & Ha, N. C. (2020). Palm oil and its environmental impacts: A big data analytics study. *Journal of Cleaner Production*, 274, 122901. <https://doi.org/10.1016/j.jclepro.2020.122901>

- Thevarajah, B., Nimarshana, P. H. V., Shehan Sandeepa, G. D., Boopathy, R., & Ariyadasa, T. U. (2024). Upcycling food processing industrial wastes in Spirulina cultivation: A perspective on the advancement of Sustainable Development Goal 12. *Trends in Food Science & Technology*, 149, 104537. <https://doi.org/https://doi.org/10.1016/j.tifs.2024.104537>
- Thevarajah, B., Nishshanka, G. K. S. H., Premaratne, M., Wasath, W. A. J., Nimarshana, P. H. V., Malik, A., & Ariyadasa, T. U. (2023). Cyanobacterial pigment production in wastewaters treated for heavy metal removal: Current status and perspectives. *Journal of Environmental Chemical Engineering*, 11(1), 108999. <https://doi.org/https://doi.org/10.1016/j.jece.2022.108999>
- Thirugnanasambandham, K., Parameswari, E., Paul Sebastian, S., & Krishnan, R. (2025). Advancements in green hydrogen (GH₂) recovery from industrial wastewater: A comprehensive review. *Desalination and Water Treatment*, 321, 100966. <https://doi.org/https://doi.org/10.1016/j.dwt.2024.100966>
- Wardhani, R., & Rahadian, Y. (2021). Sustainability strategy of Indonesian and Malaysian palm oil industry: A qualitative analysis. *Sustainability Accounting, Management and Policy Journal*, 12(5), 1077–1107.
- Wassmann, B., Siegrist, M., & Hartmann, C. (2023). Palm oil and the Roundtable of Sustainable Palm Oil (RSPO) label: Are Swiss consumers aware and concerned? *Food Quality and Preference*, 103, 104686. <https://doi.org/10.1016/j.foodqual.2022.104686>
- Worakittikul, W., Srisathan, W. A., Rattanpon, K., Kulkaew, A., Groves, J., Pontun, P., & Naruetharadhol, P. (2025). Cultivating sustainability: Harnessing open innovation and circular economy practices for eco-innovation in agricultural SMEs. *Journal of Open Innovation: Technology, Market, and Complexity*, 11(1), 100494. <https://doi.org/https://doi.org/10.1016/j.joitmc.2025.100494>
- Woźniak, E., Tyczewska, A., & Twardowski, T. (2021). Bioeconomy development factors in the European Union and Poland. *New Biotechnology*, 60, 2–8. <https://doi.org/https://doi.org/10.1016/j.nbt.2020.07.004>
- Yamane, T., & Kaneko, S. (2023). Exploring the impact of awareness on public acceptance of emerging energy technologies: An analysis of the oil palm industry. *Journal of Cleaner Production*, 414, 137593. <https://doi.org/https://doi.org/10.1016/j.jclepro.2023.137593>

IMPACT OF STRATEGIC PLANNING ON THE MANAGEMENT OF WATER UTILITY OPERATORS (OOA) IN MEXICO

IMPACTO DO PLANEJAMENTO ESTRATÉGICO NA GESTÃO DOS ORGANISMOS OPERADORES DE ÁGUA (OOA) NO MÉXICO

IMPACTO DE LA PLANEACIÓN ESTRATÉGICA EN LA GESTIÓN DE LOS ORGANISMOS OPERADORES DE AGUA (OOA) EN MÉXICO



<https://doi.org/10.56238/sevened2026.008-066>

Rigoberto Rodriguez-Rios¹, Yésica Mayett-Moreno²

ABSTRACT

This study analyzes the impact of strategic planning on the management of Water Utilities (WU) in Mexico and its importance for improving operational and financial efficiency, as well as the sustainability of the service. Through the application of an instrument to 21 WU in the state of Sonora and other states, a significant association was identified between the size of the WU and the adoption of strategic tools ($p < 0.05$). Thirty-three percent lack formal planning processes, and only 10% have a documented plan. WU management is primarily focused on short-term operations (43%) and sustaining daily operations (62%), with little emphasis on long-term projects (14%). A flexible planning model, adapted to the heterogeneity of the Mexican water context, is proposed to support decision-making and contribute to improving institutional performance with a focus on sustainable development.

Keywords: Water Utility (WU). Strategic Planning. Performance Institutional. Public Management. Sustainability. México.

RESUMO

O estudo analisa o impacto do planejamento estratégico na gestão dos Organismos Operadores de Água (OOA) no México e sua importância para melhorar a eficiência operacional, financeira e a sustentabilidade do serviço. A partir da aplicação de um instrumento a 21 OOA do estado de Sonora e de outras entidades, identificou-se uma associação significativa entre o porte dos OOA e a adoção de ferramentas estratégicas ($p < 0,05$). Constatou-se que 33% carecem de processos formais de planejamento e apenas 10% possuem um plano documentado. A gestão dos OOA orienta-se principalmente para operações de curto prazo (43%) e para a manutenção das operações diárias (62%), com pouca projeção para projetos de longo prazo (14%). Propõe-se um modelo flexível de planejamento, adaptado à heterogeneidade do contexto hídrico mexicano, que apoie a tomada de decisões e contribua para a melhoria do desempenho institucional, com enfoque no desenvolvimento sustentável.

¹ Universidad de Sonora. México. E-mail: rigoberto.rodriguez@unison.mx
Orcid: <https://orcid.org/0009-0004-0283-3046>

² Posgrados en Dirección Estratégica y Dirección de Tecnología. Universidad Popular Autónoma del Estado de Puebla. México. E-mail: yesica.mayett@upaep.mx Orcid: <https://orcid.org/0000-0002-7585-6060>

Palavras-chave: Organismo Operador de Água (OOA). Planejamento Estratégico. Desempenho Institucional. Gestão Pública. Sustentabilidade. México.

RESUMEN

El estudio analiza el impacto de la planeación estratégica en la gestión de los Organismos Operadores de Agua (OOA) en México y su importancia para mejorar la eficiencia operativa, financiera y la sostenibilidad del servicio. A partir de la aplicación de un instrumento a 21 OOA del estado de Sonora y otras entidades, se identificó una asociación significativa entre el tamaño de los OOA y la adopción de herramientas estratégicas ($p < 0.05$). El 33% carece de procesos formales de planeación y únicamente el 10% tiene un plan documentado. La gestión de los OOA se orienta principalmente a operaciones del corto plazo (43%) y a sostener operaciones diarias (62%), con poca proyección hacia proyectos de largo plazo (14%). Se propone un modelo flexible de planeación adaptado a la heterogeneidad del contexto hídrico mexicano que apoye la toma de decisiones y contribuya a mejorar el desempeño institucional con enfoque en el desarrollo sustentable.

Palabras clave: Organismo Operador de Agua (OOA). Planeación Estratégica. Desempeño Institucional. Gestión Pública. Sostenibilidad. México.

1 INTRODUCTION

This paper analyzes the impact of strategic planning on the management of Water Operating Agencies (OOAs) in Mexico, institutions in charge of managing drinking water, sewerage and sanitation services. Most of the OOAs are in charge of the municipality (paramunicipal), the state through boards or commissions (state) and to a lesser extent private companies. These organizations face significant challenges derived from water scarcity, climate change, obsolescence of infrastructure and lack of long-term planning. The purpose of the study is to identify the level of strategic planning existing in 21 WOOs; 11 from the state of Sonora and 10 from other entities in Mexico, to estimate their relationship with operational, financial, and institutional performance, in order to promote a flexible model that strengthens the efficiency and sustainability of services (CONAGUA, 2024). (Camacho González et al., 2024)

The background shows that at the global level, water resources are facing increasing pressure due to increased consumption and the effects of climate change. According to UNESCO (2025), the agricultural sector accounts for 72% of water withdrawals, followed by industry (15%) and domestic use (13%), while more than 2,200 million people lack access to safely managed water services. In Mexico, approximately 4.5 million people (3.9%) do not have a formal drinking water service, a situation that is aggravated by the overexploitation of aquifers and the deficiency in distribution systems (CONAGUA, 2024), especially in northern Mexico, where the semi-desert climate aggravates the situation.

In this context, the current state of the problem reflects that the WOs have low levels of performance, deficiencies in administrative and financial management, and weak institutional sustainability (Reyes, 2023). Recent studies indicate that these organizations face a series of structural limitations, including: constant turnover of managers with each change of government, unqualified personnel, insufficient rates, inefficiency in collection, lack of infrastructure maintenance, absence of long-term planning, and boards of directors with a low degree of professionalization (Camacho González et al., 2024). These factors have a negative impact on the efficiency of services and on public confidence.

There are a variety of studies that address the performance of water operators in both developed and developing countries. The most commonly used techniques to make the comparison are non-parametric, while the Data Envelopment Analysis (DEA) model is the most widely used. The authors who have carried out comparative performance analyses include different variables: traditional, quality of service and the human right to water. The DEA technique is a generalized method for evaluating the efficiency of water companies. According to Cetrulo (2020), care must be taken in the application of this type of model in

developing countries since in most cases they only focus on financial volumes and costs, and leave aside other essential variables such as the human right to water, losses, quality of service and water quality. in accordance with Sustainable Development Goal Six (SDG) that promotes the right to clean water and sanitation (United Nations, 2020). (Ablanedo-Rosas et al., 2020; Cetrulo et al., 2020)

Several international studies support the usefulness of strategic planning in the public sector, for example, Vandersmissen et al. (2024) demonstrated a positive association between PE and the perception of performance of both managers and citizens in European municipalities, while Johnsen (2021) who conducted a linear regression study in 128 municipalities in Norway to investigate the relationship between how municipal managers perceive the usefulness of PE In their organizations, it was found that it is conceived as more useful when it is carried out voluntarily and is integrated into existing management processes and not when it depends exclusively on mandatory documents, that is, it was concluded that formal planning is more effective when it is voluntarily integrated into existing management processes. Similarly, in a study carried out in the period from 2007 to 2021, a systematic review was carried out to identify the PE tools used by companies and categorize them according to the type of industry. The analysis focuses only on commercial enterprises, so it invites academics to investigate it in other contexts. Among the 10 most used tools were the following: Porter's 5 Forces Analysis, Customer Satisfaction Analysis, PEST Analysis, SWOT Analysis, Competitor Analysis, Balanced Scorecard Analysis, TQM, CRM and Benchmarking. (Altwaijri & Alhomedan, 2025)

There are other articles that explore the importance of EP tools in the performance of public institutions, such as evaluating and analyzing the official strategic plans of the 66 most populous Canadian municipalities, using a comprehensive set of 30 indicators. It also mentions that local governments are increasingly using strategic planning as a tool to anticipate and address the complex challenges they face. It also defines EP as " Guyadeen et al. (2023) *the process of establishing long-term objectives, prioritizing actions to achieve them, and mobilizing human and financial resources to execute them.*"

Strategic planning (SP) is an essential tool for public organizations, since it guides decision-making towards the fulfillment of medium and long-term institutional objectives. According to Chiavenato (2021), the strategic plan allows for the definition of specific lines of action, assigned resources, and execution periods, contributing to the link between the opportunities of the environment and the internal capabilities of the organization. Its application in OUs favors the alignment of resources with operational objectives, the

improvement of performance and the sustainability of the service (Pari Llanos & Díaz Flores, 2024).

2 RESEARCH PROBLEM

In Mexico, municipalities are responsible for the administration of water services, in accordance with Article 115 of the Political Constitution, generally through municipal, intermunicipal, or state public OOAs (CONAGUA, 2024). However, the lack of institutional continuity and weak strategic culture limit the ability of these organizations to offer efficient and sustainable services (Hernández, 2022).

The supply of drinking water in Mexico is in charge of 2,826 OOA (INEGI, 2020) of which 1,642 provide the service to urban populations and 1,184 to both urban and rural populations. From a legal point of view, 2,613 correspond to the category of public sector services; 108 correspond to civil associations and 105 operate as a commercial company, cooperative or other category. In Mexico, the average expenditure per inhabitant per day is 300 liters, and increases to 500 liters per inhabitant per day due to leaks in the supply and distribution network caused by obsolete infrastructure (FCEA, 2020).

In contrast, in the state of Sonora there are a total of 47 OOAs, of which 16 are considered small (less than 3,300 users), 21 medium (3,300-100,000) and 10 large (greater than 100,000), according to the USEPA classification criteria that takes into consideration the size of the population served (Haider et al., 2014). In Sonora, all the OOAs are decentralized public entities that are mostly in charge of the municipality, only Cananea, Guaymas, San Carlos, Empalme and Vicam are in charge of the State Water Commission of Sonora (CEA, 2022).

According to Camacho González et al (2024), the best performing OOA in Mexico are; The Monterrey Water and Drainage System, the State Public Services Commissions of Tijuana, Aguascalientes and León, and the Intermunicipal Water and Sewerage System of the Guadalajara Metropolitan Area, although it does not mention what the criteria are to determine performance.

Given this panorama, the general objective of this paper is to analyze the magnitude and impact of strategic planning tools on the performance of municipal WOs in the State of Sonora, Mexico. In particular, it seeks: a) to generate a diagnosis of the level of planning of the municipal OOA agencies; b) evaluate the adoption of some strategic planning principles according to David and David (2017): strategy formulation; vision, mission and objectives; c) implementation of strategies: SWOT, Benchmarking, investments.

With this, the study aims to provide empirical evidence and a methodological proposal that strengthen the institutional management of the WOs, promoting a more efficient, transparent and sustainable development-oriented water administration.

3 MATERIALS AND METHODS

3.1 DESIGN

The research adopts a mixed approach, with a predominance of descriptive quantity and qualitative components of contextual interpretation. A non-probabilistic convenience sampling and an exploratory cross-sectional design were carried out (Hernández & Mendoza, 2018).

- A structured questionnaire was applied to managers of the WOs in the period 2020-2022
- Frequencies, relationships and levels of significance were obtained from the questionnaire.
- Statistical contrasts between the surveyed OOA are reported

3.2 REGION OF STUDY

The study region focuses on 9 states of Mexico: Sonora, Mexico City (CDMX), Nuevo León (Monterrey), Coahuila (Saltillo), Jalisco, Sinaloa (Culiacán), Baja California Norte (Mexicali), Zacatecas (Escobedo), Michoacán (Morelia and Quiroga) and Guanajuato (Guanajuato). The selection of the OOA was made taking into account their level of performance.

The unit of analysis consisted of eleven WOs from Sonora (Hermosillo, Cajeme, San Luis Rio Colorado, Huatabampo, Guaymas, Navojoa, Agua Prieta, Caborca, Puerto Peñasco, Empalme and Cananea) and ten from other entities in the country (Mexico City, Baja California, Zacatecas, Nuevo León, Jalisco, Sinaloa, Guanajuato, Michoacán and Coahuila) in charge of drinking water supply, sewerage and sanitation (Table 1). The OOA of other municipalities in the country that were considered in the study are also indicated. All the OOAs considered in Sonora are of the paramunicipal type, with the exception of the municipalities of Cananea, Empalme and Guaymas, which are of the state type, that is, they are administered by the government of the state of Sonora.

The universe of the surveyed AOAs (Table 1) clearly shows their heterogeneity, this variability justifies the differentiating treatment in the analysis, since the planning and resources will have different impacts according to the scale of the organization. Small service providers (Quiroga) are observed to large systems such as SACM and Monterrey. According

to the heterogeneity of the OOAs, strategic planning practices may depend strongly on the scale of the service, such as technical and financial capacity, and human resources.

Table 1

Water Operating Bodies Analyzed

Region	Region of study	OOA	Number of connections
North	Baja California	CESPM	352,135
		Agua Prieta	26,741
		Caborca	22,608
		Shut me up	134,929
		Canaanite	11,476
		Splicing	17,048
	Sonora	Guaymas	38,944
		Hermosillo	275,549
		Navojoa	41,224
		Huatabampo	54,738
		Boulder	19,710
		St. Louis	72,546
		Saltillo	260,598
West	Nuevo León	Monterrey (SADM)	1,710,206
	Sinaloa	Culiacán	332,981
	Jalisco	SIAPA	1,223,615
	Michoacán	Morelia	246,898
		Quiroga	6,040
Center	Zacatecas	Escobedo	1,976
	Guanajuato	Guanajuato	40,680
	Mexico City	SACMEX	4.5 million

Note: Prepared with data obtained from the survey. OOA= Water Operating Bodies.

The distributions of the size of the OOA service both in Sonora (Hermosillo and Cajeme) and in the other municipalities of the country (Monterrey, Jalisco and Nuevo León) present large service providers and others of smaller size such as Cananea and empalme.

3.3 STUDY SUBJECTS

The study subjects were the directors, administrators and personnel in charge of the commercial and operational area of the 21 OUs contacted, most of whom work as directors or coordinators.

3.4 SIZE OF THE UNIVERSE AND SAMPLE SIZE

The universe is composed of all municipal OOAs in Mexico, which operate at the state and municipal levels. According to data from the National Water Commission (CONAGUA), there are 2,826 operating agencies in the country (INEGI 2020), with variations in their structure and efficiency.

For convenience sampling, those organizations that were accessible and representative in terms of management diversity and size were selected, considering aspects such as:

- Geographical region (north, center, south of the country).
- Management model (public, mixed, concessioned).
- Size of the organism (large cities vs. small municipalities).

Due to the nature of the sampling and the size of the sample, the results are not statistically generalizable, but they do allow us to establish useful interpretative patterns for the formulation of management proposals.

The unit of analysis consisted of 21 directors of the OOA (Table 2), 11 representative of Sonora, and 10 from other states (outside of Sonora). The management model considered was the public one, made up of 6 state and 15 paramunicipal OOAs. State WOOs are those that are administered by local boards or state commissions. On the other hand, the paramunicipal workers are the ones who are in charge of the municipality. This confirms that the sample is intentional and non-probabilistic, which limits the statistical generalization of the results, but allows for a deep contextual diagnosis.

Table 2

Analysis Unit Features by Organism Type and Location

Variable	Unit of analysis	%
Type of organization — Paramunicipal	15	71
Type of agency — State	6	29
Total by type of organism	21	100
Location — Outside of Sonora	10	48
Location — Sonora	11	52
Total by Location	21	100

Note: Prepared with the data obtained from the survey.

3.5 TYPE OF SAMPLING

The type of sampling was non-probabilistic for convenience, also called intentional or directed sampling (Hernández, 2021). Those that best represent the diversity of management

and efficiency in the country were selected, as well as their geographical location, management model, size of the agency and availability of information.

3.6 PRIMARY INFORMATION COLLECTION INSTRUMENT

For the collection of primary information, a survey was used that was applied in the period from 2020 to 2022, because in most cases it was necessary to resort to national transparency platforms to obtain the information since directly in the OOA they did not want to provide it in most cases.

The survey is made up of three sections that are described in a general way below:

- a) **demographic information** of the respondent (general and contact details of the interviewee), general information of the OOA (name, address, telephone numbers, number of taps attended, cubic meters billed, number of employees and type of organization);
- b) adoption of some strategic planning principles according to David and David (2017): formulation of strategies: vision, mission, objectives;
- c) implementation of strategies (SWOT, benchmarking, investments).

The data collection instrument was semi-structured, consisting of 20 items with a type of response: dichotomous that only have two response options (Yes/No), which allows identifying the presence or absence of practices and structures related to strategic planning. Secondly, multiple-choice questions are incorporated in order to characterize processes, those responsible and technical elements linked to planning. Finally, five-level Likert-type response types are used, aimed at measuring the frequency or degree of application of certain actions, with options ranging from "Never" = 1 to "Always" = 5. The validity of the content of the instrument was ensured through the review of experts in water management from the different WOs; Internal consistency is considered acceptable for the diagnostic purposes of the study.

3.7 INFORMATION ANALYSIS PROCEDURE

Once the data collection instrument was applied, the information was coded and captured through matrices built with the SPSS Statistics version 25 statistical software. Subsequently, descriptive analyses were carried out through the use of cross-tables in order to identify distribution patterns among the variables considered in the survey. Similarly, Chi-square (χ^2) and p values were calculated to determine the existence of a significant association between the variables under study (Table 3).

With this analysis, the variables whose responses corresponded to statistically significant relationships were evaluated and identified, which in this case corresponded to the variables, Size of the OOA and some strategic planning tools (Table 3). Regarding the other variables, no significant evidence was found that there is a relationship.

Table 3

Statistical values of χ^2 and p

Variable1	Variable2	Chi square	p
Size OOA (Large, Medium, Small)	Elements used in EP	20.222	0.003
	Major investments	13.493	0.036
	Strategic Planning	13.810	0.031
OO Type (Paramunicipal, State)	Strategic Planning	3.412	0.332
	Elements used in EP	2.864	0.413
Location (North, West and Central Zone)	Strategic Planning	11.546	0.073
	Elements used in EP	2.625	0.854

Note: Prepared by the author with data obtained from the SPSS analysis.

4 RESULTS

The Chi-square test ($\chi^2=13.81$) performed between the variables "size of the operating agency and strategic planning" indicates that, since $p=0.031$ and is lower than the significance level of 0.05, there is a statistically significant association between the size of the operating agency and the level of strategic planning. In the case of the variable "if it has carried out the strategic planning process, what elements do it use", the statistical values found ($\chi^2=20.22$ and $p=0.0025$) also indicate that there is a statistically significant association between the size of the operating agency and the elements used in the strategic planning process. The variables "important investments are mainly made for" and the size of the OOA presented results ($\chi^2=13.493$ and $p=0.036$) that show that there is a statistically significant association between both variables. In none of the other cases were statistically significant associations found.

Regarding the importance of having planning areas in the OOAs, there is a consensus (100%), but institutionalization is incomplete since only 48% of the OOAs have a planning department.

The results obtained show that 33% of the surveyed WOs do not apply a strategic planning process but 38% have planning in progress. On the other hand, only 10% have a completed strategic planning document and 19% only have the budget linked to strategic priorities (Table 4). This indicates that there is a partial and fragmented adoption of planning, where 1 in ten WOs has a formalized plan and less than a fifth link the budget to strategic

priorities, which demonstrates a weak integration between planning and financial allocation, with a significant gap between ongoing planning and formalization.

The results show (Table 4) that small OUs have the greatest vulnerability: 75% without planning processes. On the other hand, the large ones show greater institutional progress: a greater proportion with a plan in progress, completed plans and budgetary linkage. That is, size is associated with the degree of institutionalization of planning: the larger the size, the greater the capacity to document planning and link budget.

Table 4

Declared level of strategic planning

Planning level	Size			Total	%
	Large	Medium	Small		
No strategic planning	1	0	6	7	33
Ongoing planning	5	2	1	8	38
Completed EP Document	2	0	0	2	10
Budget linked to strategic priorities	2	1	1	4	19
Total	10	3	8	21	100

Note: Prepared with data obtained from the survey for n=21.

Figure 1 classifies the AOAs into four levels of planning implementation (in progress, without planning, budget linked to priorities, and completed plan document), taking as a reference the model of Vinzant and Vinzant (1996) cited by Poister (2010) which establishes that at least four levels of successful implementation of strategic planning in public organizations should be considered. Most OOA's are located at low to intermediate levels, confirming that planning is not institutionalized. This visualizes the gap between the regulatory expectation (planning area, linked POA) and the operational reality.

Figure 1

Level of strategic planning of the OOA analyzed.



Note: Own elaboration adapted from Vinzant and Vinzant (1996).

The planning elements used in the OOA are: The review of the mission, development of the vision and the goals and objectives. 57% use all three elements of planning. This suggests that, when there is planning, it is presented in an incomplete way, for example, the review of the mission without clear goals, limiting its transformative capacity (Table 5).

Of the AOAs that identified with ongoing strategic planning, it focuses mostly on mission review (22%), vision development (7%), and development of goals and objectives (14%). Large AOAs tend to develop complete and structured processes (89% applied all elements). On the other hand, medium and small OUs apply elements in a more fragmented way. This reinforces the difference in technical capacity and scope of planning by size (Table 5).

Table 5

Planning elements used in OUs

Elements	Size			Total	I	%*
	Large	Medium	Small			
Review of your organizational mission	0	1	2	3		22
Developing a vision for the future	1	0	0	1		7
Development of goals and objectives	0	2	0	2		14
All	8	0	0	8		57
Total	9	3	2	14		100

Note: Prepared with the data obtained from the survey. *Percentage calculated on valid n (n=14). Of the total of 21 agencies, 7 do not apply because they did not report planning processes.

Regarding the type of operations in the OOA that use strategic planning, it is observed that the largest percentage (62%) focuses on the daily actions that arise on a day-to-day basis. On the other hand, it is only used by 5% of day-to-day operations and long-term projects. As for long-term investment projects, only 14% of the OOA apply it (Table 6).

Small OOA concentrate resources on maintaining operations (88%), which shows a lack of margin for strategic investments. On the other hand, large companies combine sustaining operations with efficiency-oriented improvements, which reflects greater technical and financial capacity for strategic investments (Table 6).

Table 6

Activities where Strategic Planning is applied

Planning level	Size			Total	%
	Large	Medium	Small		
Sustain daily operations	6	0	7	13	62
Long-term projects	0	2	1	3	14
Increase efficiency	3	1	0	4	19
Daily Operations	1	0	0	1	5
Total	10	3	8	21	100

Note: Prepared with the data obtained from the survey.

From the above data (Table 6), it can be deduced that planning is used reactively (daily management) rather than strategically (investment, transformation). This explains why planning does not translate into coherent investments or structural improvements.

There is a predominance of short-term oriented planning at 43%, while long-term planning and with a prospective approach are unrepresentative with 21% and 14% respectively (Table 7). This suggests a tension between operational management of daily

activities and strategic vision, since they focus on solving immediate needs, rather than on establishing institutional continuity strategies.

Large OUs (Table 7) have a more balanced distribution between planning horizons. On the other hand, small organizations focus on short- or medium-term planning and without evidence of the long term or prospective approach.

Table 7

Time-Based Planning Guidance Used by WOs

Type of planning	Size			Total I	%*
	Large	Medium	Small		
Short Term (1 year)	4	1	1	6	43
Medium Term (3 years)	2	0	1	3	21
Long-term (5 to 10 years)	2	1	0	3	21
Prospective approach (>10 years)	1	1	0	2	14
Subtotal	9	3	2	14	100

Note. Prepared with the data from the survey. *Percentage calculated on valid n (n=14). Of the total of 21 agencies, 7 do not apply because they did not report planning processes

Regarding the AOAs that responded to the question of the strategic culture they keep, the largest proportion of them (64%) are in the process of maturing. Large OUs are more representative at advanced levels of strategic culture; small ones are more divided between the maturation process and incipient ones (Table 8). Only 14% have a fully developed culture and the cases are presented in large organizations since they are the ones with the greatest administrative, technical and financial resources.

Table 8

Diagnosis of the strategic culture of the OOA

Culture	Size			Total I	%*
	Large	Medium	Small		
Fully developed	2	0	0	2	14
Maturation process	5	3	1	9	64
Incipient	2	0	1	3	22
Subtotal	9	3	2	14	100

Note. Prepared with the data from the survey. * Percentage calculated on valid n (n=14). Of the total of 21 agencies, 7 do not apply because they did not report planning processes.

5 RECOMMENDATIONS

In accordance with the relationship between the size of the OOs and strategic planning, it is recommended to implement differentiated strengthening programs according to the size of the organization. In the case of small organizations, it is suggested to provide technical support for the development of basic planning structures. For medium and large organizations, it is recommended to strengthen the mechanisms of budget linkage and strategic monitoring.

It is also important to institutionalize the planning areas, train middle management, link the Annual Operating Programs (AOPs) with the budget and establish monitoring and evaluation mechanisms according to the results obtained in the surveys and where everyone agrees (100%) on the importance of having a strategic planning department.

It is proposed to implement a strategic planning model that helps to improve the management and long-term sustainable development of the WOs. The proposed model comprises four main phases ranging from strategic analysis to implementation and control of strategies (Figure 2), as described below and which answers four basic questions:

1. Where is the Operating Body now?

Phase 1. Performance Audit

- a. The Agency.
- b. Corporate Principles
- c. Regulatory and institutional framework

Phase 2. Situational analysis

- a. Internal Analysis
- b. External Analysis
- c. SWOT Analysis
- d. 5 Porter forces

Phase 3. Determination of the Comprehensive Performance Index

- a. Proposal of performance indicators

2. Where does the body want to go and what results does it want to achieve?

- b. Establishing the Mission and Vision
- c. Performance Objectives and Goals
- d. GAP Analysis

3. How could the organism get there?

Phase 4. Formulation, analysis, evaluation and selection of strategies and generation of scenarios to achieve the goals and objectives of the area under study.

Phase 5. Strategy Implementation

4. How to measure performance?

Phase 6. Monitoring, evaluation and adjustments.

- a. Performance evaluation
- b. Monitoring of performance indicators
- c. Settings

Figure 2

Strategic planning model to improve the performance of the OOAs.



Note: Authors' elaboration adapted from Mugabi et al. (2007).

6 DISCUSSION

In the study, an analysis was carried out to identify whether there was a relationship between strategic planning and the types of water operating agencies (WOs) classified as paramunicipal and state. According to the result of the statistical data ($p > 0.05$) it was determined that there is no statistically significant association. Statistical values (Chi-square and p) were also calculated to determine the existence of a statistically significant association between strategic planning and the area (North, West and center) where the AOAs are located, this relationship being negative.

The analysis where it was determined that there is a statistically significant association was between the size variables (large, medium and small) of the OOA and strategic planning where a statistically significant association was obtained according to the values of chi square and p .

The results of the diagnosis show that the strategic culture in the Water Operating Agencies (OOA) in Mexico is in an incipient stage (10%), since only 14% is fully developed, which confirms the need to institutionalize planning in the water sector. This finding coincides with what was pointed out by Camacho González et al. (2024), who identify that the absence of a long-term vision and the lack of permanent technical structures are critical factors that limit efficient water management in the country.

Although 48% of the OOA reported having an area responsible for planning, the use of the strategy is mostly concentrated in short- and medium-term operational actions, which confirms that planning is perceived as a reactive tool and not as a mechanism to guide institutional transformation processes. This trend has been documented in other public sector studies, where planning is used as an administrative compliance instrument and not as a change management process (Johnsen, 2021; Vandersmissen et al., 2024).

WOs that implement formal strategic planning processes have better institutional performance, as mentioned by some authors. The findings showed that agencies with planning schemes present greater operational coordination, continuity in the execution of projects and a better articulation of goals; however, the low proportion of OOA with strategic plans limits the generalization of this positive effect. (Pari Llanos & René Díaz Flores, 2024)

The limited adoption of classic strategic planning tools, such as SWOT analysis, prospective approach or benchmarking, demonstrates a significant gap between the theoretical models widely disseminated in the literature (Altwaijri & Alhomedan, 2025; Guyadeen et al., 2023) and the operational reality of AOAs

In this sense, the strategic planning model proposed in this study represents an alternative by integrating diagnostic approaches, tactical formulation, and implementation and monitoring phases. Its flexible nature would allow it to be adapted to different sizes and management models, which is key considering the heterogeneity among the AOAs (INEGI, 2020).

7 CONCLUSIONS

The study confirmed that strategic planning is not consolidated in the Water Operating Agencies in Mexico. Almost four out of ten agencies have no planning processes at all, and only one in ten have a formal documented plan. Strategic planning, when it exists, is mostly short-term oriented (43%) and is limited to reactive actions of daily operation (62%), with no link to long-term institutional objectives.

The empirical results confirm that the size of the OOA significantly affects the level of formalization of planning unlike other variables such as the type of agency and location. Large

agencies show greater organizational maturity, presence of specialized departments, and budgetary linkage, while small agencies lack the technical capacity and administrative resources to institutionalize these processes. This inequality highlights the need for differentiated public policies that strengthen planning according to the scale and capacities of each agency.

For the consolidation of strategic planning, three essential conditions are required: (1) the creation of permanent planning units, with trained technical personnel and continuity beyond the political and administrative cycles; (2) linking the budget to strategic priorities, ensuring coherence between institutional objectives and the allocation of resources; and (3) incorporating performance indicators, which allow for monitoring progress and strengthening accountability to citizens.

Agencies that do use strategic planning (57%) report the existence of a unit in charge of this function in a higher proportion, which suggests that the adoption of strategic processes requires not only administrative will, but also minimal organizational infrastructure. On the contrary, agencies that do not implement strategic planning (43%) show a higher frequency of absence of such a department, which suggests a more reactive operation, focused on daily operation and without formal mechanisms to guide long-term decisions. This relationship shows that the institutionalization of planning depends to a large extent on the internal structure of the agency.

The OOAs that report the use of strategic planning are also those that have developed recent formal processes in the last 5 years (23%); while those that do not use it show a low incidence of these practices. This finding confirms that strategic planning not only depends on the existence of a responsible area, but also on the temporal continuity and periodic updating of plans. The lack of recent planning can generate reactive decisions, less capacity to anticipate water crises and a weakening of administrative and financial management.

In summary, the results show that the implementation of strategic planning is associated with more defined organizational structures, greater formalization of processes and a more future-oriented management. On the contrary, organizations that do not use it tend to operate in a more improvised way, which potentially increases vulnerability to problems such as shortages, deterioration of infrastructure and low financial sustainability. These findings are consistent with the literature on water management, which notes that strategic planning is a key factor in raising governance, operational efficiency, and service quality. (Vandersmissen et al., 2024) (Mugabi et al., 2007)

The Strategic Planning model for OOA proposed in this work constitutes an adaptable tool for the different types of OOA in the country. Its gradual application can facilitate the

transition from improvised operational schemes to institutionalized strategic management processes, thus contributing to strengthening water governance in Mexico.

It is recommended to promote the adoption of the model through: Technical training of operational and managerial personnel; linking the budget to strategic priorities, defining institutional performance indicators, and administrative continuity beyond municipal political cycles.

It is imperative to promote the institutionalization of permanent planning units in OOA through the state planning law, through administrative provisions that guarantee structure, professional profile and operational continuity beyond municipal political cycles. The explicit linking of the strategic plan with the budget should be a condition for access to state and federal support programs. This would encourage alignment between strategic priorities and resource allocation.

Finally, it is suggested that future research evaluate the implementation of the model in pilot cases, as well as explore citizen participation and the use of digital technologies as tools to strengthen strategic planning in the water sector. It is also advisable to use a larger sample size and random sampling. This study would be complemented by a satisfaction survey of the users of the OOA.

REFERENCES

- Ablanedo-Rosas, J. H., Campanur, A. G., Olivares-Benitez, E., Sánchez-García, J. Y., & Nuñez-Ríos, J. E. (2020). Operational efficiency of Mexican water utilities: Results of a double-bootstrap data envelopment analysis. *Water*, 12(2), Article 553. <https://doi.org/10.3390/w12020553>
- Altwaitjri, A. S., & Alhomedan, R. H. A. (2025). Strategic planning techniques and tools in business enterprises: A systematic literature analysis. *Journal of Project Management*, 10(2), 393–402. <https://doi.org/10.5267/j.jpm.2024.12.006>
- Camacho González, H. D., Salgado López, J. A., Buenfil Rodríguez, M. Ó., Galván Benítez, R., & Celis Rodríguez, F. (2024). Organismos operadores de agua y saneamiento: Un análisis del cumplimiento de sus obligaciones de transparencia. *Perfiles Latinoamericanos*, 32(64). <https://doi.org/10.18504/pl3264-003-2024>
- Cetrulo, T. B., Ferreira, D. F., Marques, R. C., & Malheiros, T. F. (2020). Water utilities performance analysis in developing countries: On an adequate model for universal access. *Journal of Environmental Management*, 268, Article 110662. <https://doi.org/10.1016/j.jenvman.2020.110662>
- Chiavenato, I. (2021). *Planeación estratégica: Fundamentos y aplicaciones*. Facultad de Economía y Negocios Universidad Anáhuac.
- Comisión Estatal del Agua de Sonora. (2024). *Sitio web oficial*. <https://scgcea.sonora.gob.mx/>

- Comisión Nacional del Agua. (2024). *Situación del subsector de agua potable, alcantarillado y saneamiento*. Edición 2024. <https://www.gob.mx/cms/uploads/attachment/file/960719/DSAPAS-2024-c.pdf>
- David, F. R., & David, F. R. (2017). *Conceptos de administración estratégica* (15.^a ed.). Pearson.
- Fondo para la Comunicación y la Educación Ambiental. (2020). *Guía para organismos operadores de agua*. https://fcea.org.mx/wp-content/uploads/2020/09/Guia_Organismos_Operadores.pdf
- Guyadeen, D., Henstra, D., Kaup, S., & Wright, G. (2023). Evaluating the quality of municipal strategic plans. *Evaluation and Program Planning*, 96, Article 102186. <https://doi.org/10.1016/j.evalprogplan.2022.102186>
- Hernández, J. (2022, [data não especificada]). ¿Cuál es la principal problemática del agua en las grandes ciudades? PAVCO. <https://pavcowavin.com.co/blog/cual-es-la-principal-problematica-del-agua-en-las-grandes-ciudades>
- Hernández González, O. (2021). Aproximación a los distintos tipos de muestreo no probabilístico que existen. *Revista Cubana de Medicina General Integral*, 37(3). http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-21252021000300002&lng=es&tlng=es
- Hernández-Sampieri, R., & Mendoza, C. P. (2018). *Metodología de la investigación: Las rutas cuantitativa, cualitativa y mixta*. McGraw Hill Education.
- Instituto Nacional de Estadística y Geografía. (2020). *Panorama censal de los organismos operadores de agua en México. Censos económicos 2019*. <https://www.inegi.org.mx/app/biblioteca/ficha.html?upc=702825198800>
- Johansen, Å. (2021). Does formal strategic planning matter? An analysis of strategic management and perceived usefulness in Norwegian municipalities. *International Review of Administrative Sciences*, 87(2), 380–398. <https://doi.org/10.1177/0020852319867128>
- Mugabi, J., Kayaga, S., & Njiru, C. (2007). Strategic planning for water utilities in developing countries. *Utilities Policy*, 15(1), 1–8. <https://doi.org/10.1016/j.jup.2006.10.001>
- Naciones Unidas. (2020). *Informe de los objetivos de desarrollo sostenible 2020*. <https://unstats.un.org/sdgs/report/2020/>
- Pari Llanos, E., & Diaz Flores, R. R. (2024). Strategic planning and modernization of the state: Evaluation of efficiency in public administration through performance indicators. *Journal of International Crisis & Risk Communication Research*, 7.
- Poister, T. H. (2010). The future of strategic planning in the public sector: Linking strategic management and performance. *Public Administration Review*, 70(Suppl. 1), 246–254. <https://doi.org/10.1111/j.1540-6210.2010.02284.x>
- Reyes, B. (2023). *Estimación de la eficiencia en los organismos operadores del agua mediante la construcción de un modelo de evaluación en el periodo 2012-2018* [Tesis doctoral, Universidad Autónoma del Estado de Hidalgo]. <http://dgsa.uaeh.edu.mx:8080/bibliotecadigital/handle/231104/3136>

UNESCO. (2025). *The United Nations world water development report 2025: Mountains and glaciers: Water towers – Facts and figures*. <https://doi.org/10.54679/XBIH2127>

Vandersmissen, L., George, B., & Voets, J. (2022). Planificación estratégica y percepción del desempeño de directivos y ciudadanos: Análisis de múltiples mediaciones. *Public Management Review*, 26(2), 514–538. <https://doi.org/10.1080/14719037.2022.2103172>

Vinzant, D. H., & Vinzant, J. C. (1996). Strategy and organizational capacity: Finding a fit. *Public Productivity & Management Review*, 20(2), 139–157. <https://doi.org/10.2307/3380482>

CLIMATE CHANGE AND LABOR MOBILITY OF AGRICULTURAL HOUSEHOLDS: A REVIEW

MUDANÇAS CLIMÁTICAS E MOBILIDADE DA FORÇA DE TRABALHO EM DOMICÍLIOS AGRÍCOLAS: UMA REVISÃO

CAMBIO CLIMÁTICO Y MOVILIDAD LABORAL DE LOS HOGARES AGRÍCOLAS: UNA REVISIÓN



<https://doi.org/10.56238/sevened2026.008-067>

Loso Judijanto¹

ABSTRACT

Climate change has increasingly altered the livelihood conditions of agricultural households, particularly by influencing labor allocation and mobility decisions. Growing climate variability, extreme weather events, and production uncertainty have intensified scholarly attention on how rural households respond through labor mobility as part of broader adaptation processes. This review critically synthesizes recent empirical evidence on the relationship between climate change and labor mobility at the agricultural household level, focusing on emerging patterns, key drivers, and livelihood implications. This study employs a Systematic Literature Review (SLR) approach, following a transparent, structured screening process. Peer-reviewed journal articles were identified through the Scopus database using refined keyword combinations related to climate change, labor mobility, and agricultural households. From an initial pool of 5,191 records, successive filtering by relevance, publication year (2021–2025), language, and open-access status yielded 37 eligible articles for final analysis. Data were collected exclusively from secondary sources and analyzed using qualitative thematic synthesis and cross-study comparison. The findings reveal six dominant themes: climate variability and shocks as primary drivers of mobility, household economic vulnerability and income diversification strategies, spatial patterns of labor mobility, differentiated responses by gender and age, the role of institutional and policy mediators, and long-term implications for agricultural sustainability. The review shows that labor mobility functions both as an adaptive strategy and a potential source of new vulnerabilities, depending on household capacities and institutional contexts. In conclusion, climate-induced labor mobility represents a complex, context-dependent livelihood response rather than a uniform outcome of environmental stress. Future research is encouraged to integrate longitudinal data and policy-oriented analysis to capture dynamic household adaptation pathways better.

Keywords: Climate Change. Labor Mobility. Agricultural Households. Livelihood Adaptation. Systematic Literature Review.

RESUMO

As mudanças climáticas têm alterado de forma crescente as condições de subsistência dos domicílios agrícolas, especialmente ao influenciar as decisões de alocação e mobilidade da

¹ Master's degree of Statistics. IPOSS. Jakarta, Indonesia. E-mail: losojudijantobumn@gmail.com
Orcid: <https://orcid.org/0009-0007-7766-0647>

força de trabalho. O aumento da variabilidade climática, a ocorrência de eventos climáticos extremos e a incerteza produtiva intensificaram a atenção acadêmica sobre como os domicílios rurais respondem por meio da mobilidade laboral como parte de processos mais amplos de adaptação. Esta revisão sintetiza criticamente evidências empíricas recentes sobre a relação entre mudanças climáticas e mobilidade do trabalho no nível dos domicílios agrícolas, com foco em padrões emergentes, principais determinantes e implicações para os meios de vida. O estudo adota uma abordagem de Revisão Sistemática da Literatura (RSL), seguindo um processo de triagem transparente e estruturado. Artigos científicos revisados por pares foram identificados por meio da base de dados Scopus, utilizando combinações refinadas de palavras-chave relacionadas às mudanças climáticas, mobilidade laboral e domicílios agrícolas. De um conjunto inicial de 5.191 registros, filtros sucessivos por relevância, ano de publicação (2021–2025), idioma e disponibilidade em acesso aberto resultaram em 37 artigos elegíveis para a análise final. Os dados foram coletados exclusivamente a partir de fontes secundárias e analisados por meio de síntese temática qualitativa e comparação entre estudos. Os resultados revelam seis temas dominantes: a variabilidade climática e os choques ambientais como principais indutores da mobilidade, a vulnerabilidade econômica dos domicílios e as estratégias de diversificação de renda, os padrões espaciais da mobilidade laboral, respostas diferenciadas segundo gênero e faixa etária, o papel de mediadores institucionais e de políticas públicas, e as implicações de longo prazo para a sustentabilidade agrícola. A revisão demonstra que a mobilidade do trabalho funciona tanto como uma estratégia adaptativa quanto como uma potencial fonte de novas vulnerabilidades, dependendo das capacidades dos domicílios e dos contextos institucionais. Conclui-se que a mobilidade laboral induzida pelo clima representa uma resposta de subsistência complexa e dependente do contexto, e não um resultado uniforme do estresse ambiental. Recomenda-se que pesquisas futuras integrem dados longitudinais e análises orientadas por políticas públicas para capturar de forma mais adequada as trajetórias dinâmicas de adaptação dos domicílios.

Palavras-chave: Mudanças Climáticas. Mobilidade do Trabalho. Domicílios Agrícolas. Adaptação dos Meios de Vida. Revisão Sistemática da Literatura.

RESUMEN

El cambio climático ha alterado de manera creciente las condiciones de subsistencia de los hogares agrícolas, en particular al influir en las decisiones de asignación y movilidad laboral. El aumento de la variabilidad climática, la ocurrencia de eventos climáticos extremos y la incertidumbre productiva han intensificado la atención académica sobre cómo los hogares rurales responden mediante la movilidad laboral como parte de procesos más amplios de adaptación. Esta revisión sintetiza críticamente evidencia empírica reciente sobre la relación entre el cambio climático y la movilidad laboral a nivel de los hogares agrícolas, centrándose en patrones emergentes, factores determinantes clave e implicaciones para los medios de vida. El estudio adopta un enfoque de Revisión Sistemática de la Literatura (RSL), siguiendo un proceso de selección transparente y estructurado. Los artículos científicos revisados por pares fueron identificados a través de la base de datos Scopus, utilizando combinaciones refinadas de palabras clave relacionadas con el cambio climático, la movilidad laboral y los hogares agrícolas. De un conjunto inicial de 5.191 registros, filtros sucesivos por relevancia, año de publicación (2021–2025), idioma y disponibilidad en acceso abierto dieron como resultado 37 artículos elegibles para el análisis final. Los datos se recopilieron exclusivamente a partir de fuentes secundarias y se analizaron mediante síntesis temática cualitativa y comparación entre estudios. Los resultados revelan seis temas dominantes: la variabilidad climática y los choques ambientales como principales impulsores de la movilidad, la vulnerabilidad económica de los hogares y las estrategias de diversificación de ingresos, los patrones espaciales de la movilidad laboral, respuestas diferenciadas por género y edad, el papel de los mediadores institucionales y de las políticas públicas, y las

implicaciones a largo plazo para la sostenibilidad agrícola. La revisión muestra que la movilidad laboral funciona tanto como una estrategia adaptativa como una posible fuente de nuevas vulnerabilidades, dependiendo de las capacidades de los hogares y de los contextos institucionales. En conclusión, la movilidad laboral inducida por el clima representa una respuesta de subsistencia compleja y dependiente del contexto, más que un resultado uniforme del estrés ambiental. Se recomienda que futuras investigaciones integren datos longitudinales y análisis orientados a políticas públicas para capturar mejor las trayectorias dinámicas de adaptación de los hogares.

Palabras clave: Cambio Climático. Movilidad Laboral. Hogares Agrícolas. Adaptación de los Medios de Vida. Revisión Sistemática de la Literatura.

1 INTRODUCTION

Climate change has emerged as one of the most pervasive global challenges of the twenty-first century, reshaping environmental systems, economic structures, and human livelihoods across regions. Rising temperatures, shifting precipitation patterns, and the increasing frequency of extreme weather events have destabilized natural resource-based sectors, particularly agriculture, which remains highly sensitive to climatic variability (Otieno et al., 2024). For millions of rural households worldwide, agriculture serves not only as a source of food but also as the primary foundation for income, employment, and social security. As climatic stress intensifies, agricultural systems are increasingly exposed to production risks that undermine household welfare and long-term livelihood sustainability (Degefu, 2025).

Among the groups most affected by climate change are agricultural households in low- and middle-income countries, where farming activities are often rainfed, labor-intensive, and weakly buffered by institutional support. Climate-induced shocks, such as droughts, floods, and heatwaves, have been widely documented to reduce crop yields, disrupt labor demand, and increase household income volatility (Nnadi et al., 2023). In contexts where access to insurance, credit, and adaptive technologies remains limited, these shocks heighten vulnerability, compelling households to seek alternative strategies to stabilize consumption and reduce exposure to climate-related risks.

Labor mobility has increasingly been recognized as a critical livelihood response to climate stress among agricultural households. Mobility encompasses a broad spectrum of movements, including seasonal migration, circular labor mobility, permanent rural–urban migration, and engagement in off-farm employment. Rather than representing isolated decisions, these mobility patterns are embedded within household-level strategies aimed at diversifying income sources and spreading risk across spatial and sectoral boundaries (Charlton et al., 2021). As climate variability disrupts agricultural productivity, labor mobility enables households to access non-climatic income streams, often through wage labor in urban or peri-urban economies, thereby functioning as an adaptive mechanism in the face of environmental uncertainty.

The relationship between climate change and labor mobility, however, is complex and multifaceted. While early migration studies often framed mobility as a response to economic differentials between rural and urban areas, more recent scholarship emphasizes the role of environmental stressors as compounding drivers of mobility decisions (Maliki & Pauline, 2023). Climate change does not operate as a singular push factor; instead, it interacts with socioeconomic conditions such as land scarcity, labor market access, education, gender

norms, and institutional capacity. As a result, mobility outcomes vary significantly across regions, household types, and demographic groups, reflecting diverse vulnerability profiles and adaptive capacities (Omerkhil et al., 2020).

At the household level, climate-induced labor mobility is closely linked to economic vulnerability and to livelihood diversification. Empirical studies have shown that declining agricultural yields and increased production uncertainty encourage households to reallocate labor away from on-farm activities toward off-farm employment and migration-based income sources (Wang et al., 2025). Remittances generated through labor mobility can play a stabilizing role by smoothing consumption, financing adaptation investments, and reducing short-term poverty risks. At the same time, labor mobility may introduce new challenges, including labor shortages in agriculture, increased workloads for remaining household members, and long-term demographic shifts in rural areas. These dual effects underscore the need for a nuanced understanding of labor mobility as both an adaptive strategy and a potential source of structural transformation within agricultural systems.

Despite the growing body of research examining climate change and labor mobility, the existing literature remains fragmented across disciplines, geographic contexts, and methodological approaches. Studies are dispersed within fields such as environmental economics, migration studies, development studies, and rural sociology, often employing diverse indicators, temporal scopes, and analytical frameworks. While numerous empirical investigations document localized mobility responses to specific climate shocks, fewer studies systematically synthesize this evidence to identify overarching patterns, dominant themes, and research gaps at the household level. Consequently, there is a limited consensus on how climate change shapes labor mobility decisions among agricultural households across regions and contexts (Budhathoki et al., 2020).

Moreover, existing reviews tend to focus either on climate-induced migration at the aggregate population level or on general rural livelihoods, without explicitly centering agricultural households as the primary unit of analysis. Agricultural households occupy a distinct position within climate–mobility dynamics due to their direct dependence on land, climate-sensitive production systems, and family-based labor allocation. Failure to disentangle household-level processes risks oversimplifying mobility as a uniform response, thereby obscuring heterogeneity in adaptive behavior and vulnerability (Barry, 2025). A focused synthesis that foregrounds agricultural households is therefore essential for advancing both theoretical clarity and policy relevance.

Methodologically, the diversity of empirical designs in climate–mobility research further complicates comparative analysis. Studies employ cross-sectional surveys, panel data,

econometric modeling, and qualitative case studies, producing findings that are often context-specific and difficult to generalize. While this diversity enriches the literature, it also underscores the need for a systematic, transparent review approach that can integrate evidence across methods and regions. Systematic Literature Review (SLR) methods, particularly those guided by the PRISMA framework, provide a robust mechanism for consolidating dispersed findings, identifying consistent patterns, and minimizing selection bias in evidence synthesis.

In response to these gaps, this study undertakes a Systematic Literature Review to synthesize contemporary peer-reviewed research on climate change and labor mobility among agricultural households. By systematically identifying, screening, and analyzing relevant studies indexed in the Scopus database, this review aims to provide an integrated overview of how climatic stressors influence labor mobility decisions, the forms mobility takes, and the socioeconomic and institutional factors that mediate these processes. The review is based exclusively on secondary data from peer-reviewed literature and does not involve primary data collection methods such as focus group discussions, interviews, surveys, or field observations.

The objective of this review is to critically synthesize existing evidence on the relationship between climate change and labor mobility at the agricultural household level, with particular attention to patterns, drivers, and implications emerging from recent scholarship. Through thematic analysis, the study seeks to clarify how climate variability and shocks shape labor allocation decisions, how households use mobility as part of broader livelihood strategies, and what these dynamics imply for agricultural sustainability and rural development pathways.

Based on this objective, the review is guided by the following research questions:

RQ1: How does climate change influence labor mobility decisions and patterns among agricultural households across different regional and socioeconomic contexts?

RQ2: What household, demographic, and institutional factors mediate the role of labor mobility as an adaptive response to climate-induced livelihood risks?

These research questions structure the analytical focus of the review and provide a foundation for the subsequent Results and Discussion sections, as well as for the conclusions drawn regarding future research and policy implications.

2 LITERATURE REVIEW

The relationship between climate change and labor mobility has become an increasingly prominent theme within development economics, agricultural studies, and

climate adaptation research. A substantial body of literature recognizes climate change not merely as an environmental phenomenon, but as a multidimensional stressor that reshapes livelihood structures, household decision-making, and labor allocation patterns, particularly within agrarian contexts. Agricultural households, whose livelihoods are highly dependent on climatic conditions, are among the most vulnerable groups facing climate-induced risks, including temperature variability, rainfall anomalies, extreme weather events, and long-term ecological degradation. As a result, labor mobility has emerged as a critical adaptive strategy employed by these households to mitigate income instability and livelihood insecurity under changing climatic conditions.

2.1 CLIMATE CHANGE AS A STRUCTURAL SHOCK TO AGRICULTURAL LIVELIHOODS

Existing studies consistently conceptualize climate change as a structural shock that disrupts agricultural production systems and household welfare trajectories. Empirical research across diverse geographic contexts indicates that rising temperatures and increased precipitation variability are associated with declining crop yields, heightened production risks, and greater income volatility among farming households (N-yanbini et al., 2024). These impacts are particularly pronounced in rain-fed agricultural systems, where limited irrigation infrastructure exacerbates exposure to climate variability. The literature emphasizes that such climate-induced production shocks undermine the viability of agriculture as a sole livelihood, thereby altering household labor supply decisions (Roy et al., 2024).

Several studies further highlight that climate change affects agricultural households not only through direct biophysical impacts but also through indirect channels, such as market instability, food price fluctuations, and increased production costs. These compound effects intensify livelihood stress and reduce rural households' resilience, pushing them to seek alternative income-generating opportunities beyond traditional farming. Within this context, labor mobility, both temporary and permanent, has been widely documented as a key household-level response to climatic stressors (Trujillano et al., 2021).

2.2 CONCEPTUALIZING LABOR MOBILITY IN AGRICULTURAL HOUSEHOLDS

Labor mobility in agricultural households is a multidimensional phenomenon encompassing seasonal, rural–urban, circular, and off-farm employment. The literature distinguishes between mobility as a distress-driven response to livelihood shocks and mobility as a strategic diversification mechanism to enhance household resilience. In climate-affected agricultural settings, these two motivations often overlap, reflecting the complex

interplay between vulnerability and agency in household decision-making processes (Tran & Bayrak, 2025).

Scholarly work emphasizes that labor mobility decisions are rarely individual choices; instead, they are embedded within collective household strategies designed to balance risk, labor allocation, and income diversification (Shinbrot et al., 2019). Migration of one or more household members allows farming households to smooth consumption, reduce dependence on climate-sensitive income sources, and access remittance flows that can be reinvested in agricultural production or used to buffer future shocks (Aryal et al., 2020). This perspective positions labor mobility as an adaptive response rather than merely a symptom of vulnerability, challenging earlier narratives that framed migration exclusively as a failure of rural development.

2.3 CLIMATE VARIABILITY AND MIGRATION PATTERNS

A growing empirical literature examines the causal links between climate variability and migration outcomes among agricultural populations. Quantitative studies using panel data and econometric modeling consistently find that higher temperatures, rainfall deficits, and extreme weather events are positively associated with higher rates of labor migration from rural areas. These effects are particularly evident in regions characterized by limited access to credit, insurance, and social protection mechanisms, where migration serves as a primary coping strategy (Chepkoech et al., 2023).

However, the literature also documents substantial heterogeneity in migration responses to climate stress. Some studies report that extreme climatic events can constrain mobility by eroding household assets and reducing the financial capacity required to migrate. This finding underscores the importance of distinguishing between short-term shocks and long-term climate trends, as well as between voluntary and involuntary forms of labor mobility (Eshetu & Yimer, 2024). As such, climate-induced labor mobility cannot be understood as a linear or uniform process but must be analyzed within specific socioeconomic and institutional contexts.

2.4 OFF-FARM EMPLOYMENT AS AN ADAPTIVE STRATEGY

Beyond physical migration, off-farm employment has been widely examined as a complementary or alternative form of labor mobility in climate-affected agricultural households. The literature suggests that engagement in non-agricultural wage labor, small-scale enterprises, or service-sector activities enables households to diversify income sources while maintaining ties to farming (Halliru et al., 2024). This form of labor reallocation is

particularly prevalent in regions where urban labor markets are accessible but permanent migration is constrained by social or institutional barriers.

Empirical evidence indicates that households experiencing greater exposure to climate variability are more likely to allocate labor toward off-farm activities, especially during periods of agricultural slack or crop failure. Such strategies are often facilitated by improvements in rural infrastructure, education, and labor market integration, highlighting the role of structural factors in shaping adaptive capacity. Nevertheless, the literature also notes that access to off-farm employment is unevenly distributed, with poorer households and marginalized groups facing greater barriers to participation (Cherinet et al., 2025).

2.5 SOCIOECONOMIC DIFFERENTIATION IN MOBILITY RESPONSES

A key theme emerging from the literature is the differentiated nature of labor mobility responses across socioeconomic groups. Gender, age, education, land ownership, and asset endowments significantly influence who migrates, where they migrate, and under what conditions (Fayomi & Ehiagwina, 2019). Studies consistently find that younger and more educated household members are more likely to engage in labor migration or off-farm employment, while older individuals remain in agriculture. Gender norms also shape mobility patterns, with men more likely to undertake long-distance migration and women more likely to engage in localized off-farm work or assume expanded agricultural responsibilities (Groth et al., 2020).

Land tenure and asset ownership further mediate the climate–mobility linkages. Households with larger landholdings and greater assets are better positioned to use migration as a proactive adaptation strategy, while asset-poor households may experience constrained mobility and heightened vulnerability. These findings underscore that labor mobility outcomes reflect existing structural inequalities, rather than functioning as a universally accessible adaptation pathway (Chithirairajan & Suvarna, 2021).

2.6 INSTITUTIONAL AND POLICY CONTEXTS

The literature increasingly emphasizes the role of institutional and policy environments in shaping climate-induced labor mobility. Access to social protection programs, migration networks, labor regulations, and rural development policies can either facilitate or constrain household mobility responses (Vidal Merino et al., 2019). Studies highlight that well-designed social safety nets and climate adaptation policies can reduce distress-driven migration while supporting voluntary and productive forms of labor mobility.

At the same time, inadequate policy coordination between climate adaptation and labor governance frameworks may exacerbate vulnerability among migrating agricultural households. The absence of legal protections for migrant workers, limited recognition of circular migration, and weak integration of rural–urban labor markets are recurrent challenges identified in the literature. Consequently, scholars argue for policy approaches that recognize labor mobility as an integral component of climate adaptation strategies rather than as an unintended consequence of climate stress (Gashure & Wana, 2023).

Despite the growing volume of research on climate change and labor mobility, the literature remains fragmented across disciplinary boundaries and geographic contexts. While numerous empirical studies examine specific dimensions of climate-induced migration or off-farm employment, there is a lack of systematic synthesis that integrates these findings at the level of agricultural households. Existing reviews often focus narrowly on migration outcomes or climate impacts without adequately capturing the household-level decision-making processes that link the two.

Furthermore, inconsistencies in methodological approaches, definitions of mobility, and measures of climate exposure limit the comparability of findings across studies. There is also limited attention to longitudinal dynamics, including how repeated climate shocks reshape mobility strategies over time. These gaps highlight the need for a comprehensive systematic literature review that consolidates empirical evidence, identifies thematic patterns, and clarifies the mechanisms through which climate change influences labor mobility among agricultural households.

In response to these limitations, this review synthesizes peer-reviewed studies published between 2021 and 2025 to provide an integrated understanding of the linkages between climate change and labor mobility at the household level. By systematically analyzing 37 selected articles, the review aims to advance conceptual clarity, highlight empirical regularities and divergences, and inform future research and policy debates on climate adaptation and rural labor transformation.

3 METHOD

This study employs a Systematic Literature Review (SLR) methodology guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to synthesize and critically evaluate recent scholarly evidence on the relationship between climate change and labor mobility among agricultural households. Climate change has increasingly altered environmental, economic, and livelihood conditions in rural areas, particularly for farming households whose income and employment opportunities are highly

dependent on climate-sensitive agricultural systems. In this context, labor mobility manifested through migration, off-farm employment, and rural–urban transitions has emerged as a key adaptive response to climate variability, shocks, and long-term climatic impacts. By systematically consolidating peer-reviewed studies, this review provides an evidence-based overview of how climate-related stressors influence labor mobility decisions within agricultural households, while also identifying dominant analytical approaches and emerging research patterns in the literature.

Figure 1

Systematic Literature Review Process Based on the PRISMA Protocol

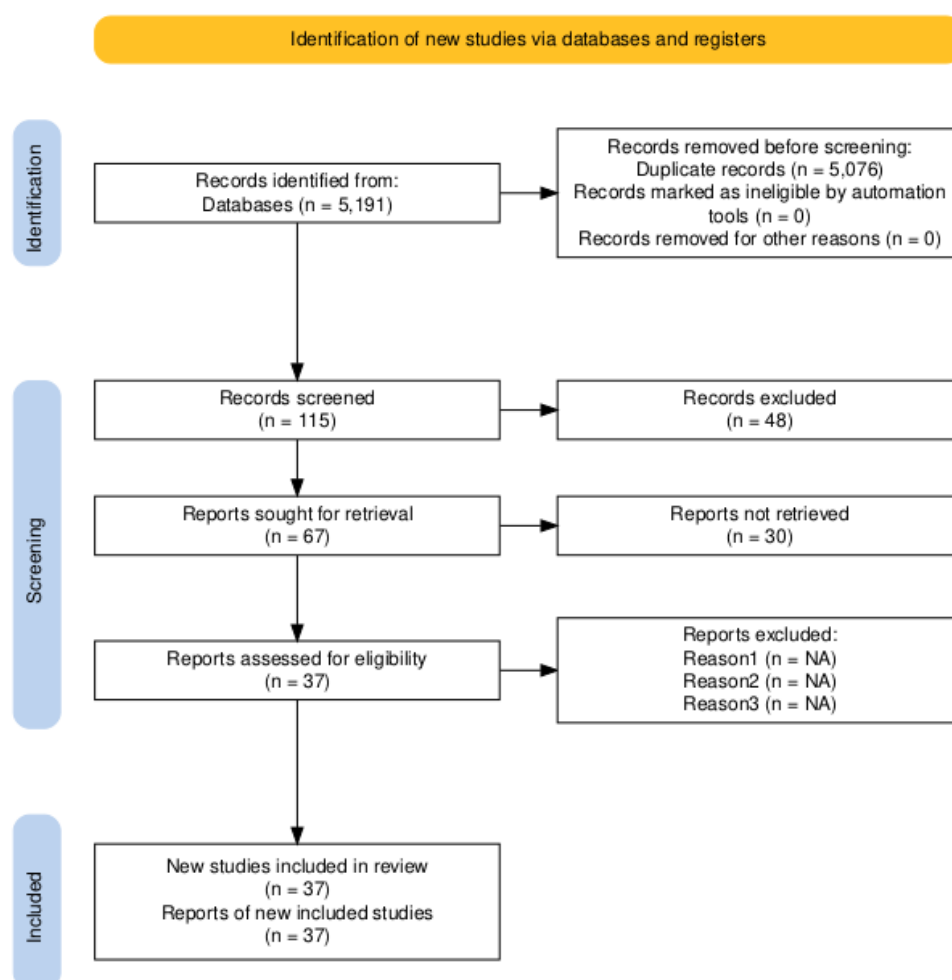


Figure 1 presents the structured process of article identification, screening, eligibility assessment, and final inclusion following the PRISMA protocol. The initial literature search was conducted using the Scopus database with the broad keyword combination “Climate Change” AND “Mobility,” which yielded 5,191 records, reflecting the extensive and multidisciplinary nature of research linking climatic factors and mobility dynamics. To improve thematic focus and ensure relevance to agricultural household contexts, the search strategy

was refined using a more targeted Boolean expression: (“climate change” OR “climate variability” OR “climate shocks” OR “climate impacts”) AND (“labor mobility” OR “labour mobility” OR “labor migration” OR “migration” OR “rural–urban migration” OR “off-farm employment”) AND (“agricultural households” OR “farm households” OR “smallholder farmers”). This refinement resulted in the exclusion of 5,076 records that did not align with the core scope of the review, leaving 115 articles for further screening.

Subsequently, a publication-year filter was applied to capture recent developments and contemporary empirical evidence, restricting the dataset to studies published between 2021 and 2025. This step eliminated 48 articles published outside the specified timeframe, resulting in 67 articles that met the temporal criterion. An additional eligibility screening focused on accessibility, retaining only studies available through open access or open archive sources to ensure transparency and reproducibility. As a result, 30 articles were excluded due to access limitations. At the conclusion of the PRISMA selection process, 37 peer-reviewed articles satisfied all inclusion criteria and were retained for full-text analysis and qualitative synthesis.

All bibliographic records were systematically managed using Mendeley Desktop to support reference organization, duplication control, and consistency in citation formatting throughout the review process. This study is based exclusively on secondary data derived from peer-reviewed literature indexed in Scopus; no primary data collection methods, such as focus group discussions, interviews, surveys, or field observations, were conducted. The findings presented in this review emerge solely from the systematic integration and comparative analysis of the selected 37 studies. Through this approach, the review aims to provide a comprehensive and methodologically robust synthesis of current knowledge on climate change–induced labor mobility among agricultural households, while highlighting conceptual trends and research gaps that warrant further investigation.

4 RESULTS

This systematic literature review identified six recurring thematic clusters based on the analysis of 37 peer-reviewed studies examining climate change and labor mobility among agricultural households. The six themes include: (1) climate variability and shocks as drivers of labor mobility, (2) household-level economic vulnerability and income diversification strategies, (3) patterns and directions of labor mobility, (4) differentiated mobility responses by gender, age, and household structure, (5) institutional and policy mediators of mobility outcomes, and (6) long-term implications of climate-induced mobility for agricultural sustainability and rural livelihoods.

The most frequently discussed theme was climate variability and shocks as drivers of labor mobility, reported in approximately 84% of the reviewed studies, reflecting the dominant focus on climatic stress as a primary trigger of mobility decisions. This was followed by economic vulnerability and income diversification (73%), emphasizing labor mobility as part of household adaptation strategies. Themes related to mobility patterns and spatial directions appeared in around 65% of studies, while gender- and age-differentiated responses were discussed in about 57%. Institutional and policy mediators were addressed in fewer studies (49%), and long-term sustainability implications were the least examined (41%). This distribution indicates that the literature prioritizes immediate climate and economic drivers, while institutional dimensions and long-term agricultural impacts remain comparatively underexplored.

The following sections elaborate each theme in detail, drawing on quantitative evidence, comparative findings, and regional patterns identified across the reviewed studies.

4.1 CLIMATE VARIABILITY AND SHOCKS AS DRIVERS OF LABOR MOBILITY

A dominant theme across the reviewed literature is the role of climate variability and extreme weather events as direct triggers of labor mobility among agricultural households. The majority of studies identify rainfall variability, prolonged droughts, floods, and heat stress as key stressors undermining agricultural productivity and labor stability. Quantitative evidence from multiple regions indicates that a one-standard-deviation increase in rainfall variability is associated with a 5–15% increase in the likelihood of household members engaging in temporary or permanent labor migration (Amjath-Babu et al., 2025). In drought-prone areas, crop yield reductions ranging from 10% to over 30% were consistently linked to higher rates of off-farm labor participation and rural–urban migration (Ghanayem et al., 2025).

Several studies emphasize that climate shocks exert both short-term and cumulative effects on labor mobility decisions. Short-term shocks, such as seasonal droughts or flood events, often lead to temporary migration or seasonal off-farm employment as coping mechanisms (Zenda et al., 2024). In contrast, repeated exposure to climate shocks over multiple years increases the probability of permanent migration, particularly among younger household members. For example, empirical evidence from South Asia and Sub-Saharan Africa shows that households experiencing three or more climate shocks within a five-year period exhibit migration rates that are 20–40% higher than those facing isolated events (Balasha et al., 2025).

Notably, the reviewed studies highlight that climate change does not operate as an isolated driver but interacts with existing socioeconomic vulnerabilities. Regions

characterized by rainfed agriculture, limited irrigation coverage (often below 30%), and high dependence on single-crop systems show significantly stronger mobility responses to climate stress. This reinforces the conclusion that climate variability amplifies pre-existing livelihood risks, thereby accelerating labor mobility as an adaptive response rather than a purely reactive behavior (Quarshie et al., 2023).

4.2 ECONOMIC VULNERABILITY AND HOUSEHOLD INCOME DIVERSIFICATION

Another prominent theme concerns the relationship between climate-induced economic vulnerability and household income diversification strategies. Across the reviewed studies, labor mobility is frequently framed as part of a broader portfolio of livelihood adjustments undertaken by agricultural households facing declining farm income. Empirical findings suggest that climate-related yield losses of 15–25% translate into reductions in farm income of up to 40% for smallholder households lacking access to credit, insurance, or adaptive technologies (Retkute et al., 2024).

In response, households increasingly diversify income sources through off-farm employment, wage labor, and non-agricultural self-employment. The literature documents that, in climate-exposed regions, the share of household income derived from non-farm activities ranges between 30% and 60%, compared to less than 25% in relatively climate-stable areas (Opoku Mensah et al., 2025). Labor mobility, whether seasonal, circular, or permanent, emerges as a central mechanism enabling this diversification. Several studies report that households with at least one migrant member experience income stabilization effects, with remittances accounting for 15–35% of total household income (Thorsen et al., 2025).

However, the benefits of labor mobility are unevenly distributed. While remittances can buffer consumption and reduce short-term poverty risks, the reviewed literature also notes trade-offs, including labor shortages in agriculture and increased workload for remaining household members (Magesa et al., 2023). In some cases, labor outmigration leads to reduced cultivated land area, with declines of 5% to 20%, particularly for labor-intensive crops (Bayrak et al., 2023). These findings underscore that labor mobility functions as both an adaptive strategy and a source of new vulnerabilities within agricultural systems (Ahmed & Givens, 2025).

4.3 PATTERNS AND DIRECTIONS OF LABOR MOBILITY

The reviewed studies reveal diverse patterns and directions of labor mobility shaped by climatic, economic, and spatial factors. Seasonal and circular migration emerges as the

most prevalent form of mobility in regions characterized by predictable climate variability, such as monsoon-dependent agricultural systems (Kandel et al., 2023). In these contexts, households strategically align migration timing with agricultural calendars, sending members to urban or peri-urban areas during agricultural slack periods (Martey & Etwire, 2025). Quantitative estimates indicate that seasonal migrants typically spend 3–6 months per year in off-farm employment, contributing between 20% and 45% of annual household income (Hendrawan et al., 2024).

In contrast, areas experiencing recurrent or severe climate shocks show higher rates of permanent migration. Studies from semi-arid and coastal regions report that permanent rural–urban migration rates among agricultural households range from 8% to 25%, depending on the frequency and intensity of shocks (Kumar et al., 2023). Permanent migration is often associated with younger, more educated household members, reflecting both push factors from climate stress and pull factors from urban labor markets (Bogale & Bekele, 2023).

The literature also documents significant regional variation in mobility destinations. Domestic migration accounts for over 70% of climate-related mobility flows in most low- and middle-income countries (Assen et al., 2024). International migration, while less common, plays a notable role in specific contexts, particularly where transnational labor networks exist. In such cases, remittances from international migrants can exceed domestic remittances by two to three times, substantially altering household resilience profiles (Antwi, 2024).

4.4 GENDER, AGE, AND HOUSEHOLD DIFFERENTIATION IN MOBILITY RESPONSES

A further theme emerging from the SLR is the differentiated nature of labor mobility responses across gender, age groups, and household structures. The majority of studies report that men are more likely to engage in long-distance or permanent migration, while women's mobility tends to be more localized and temporary (Munyaka et al., 2024). Quantitative evidence indicates that male household members account for 60–80% of labor migrants in most agricultural regions, particularly in contexts where social norms restrict female mobility (Mdoda et al., 2024).

At the same time, the literature highlights an increasing feminization of agriculture in climate-affected areas. As men migrate, women assume greater responsibility for farm management and household decision-making (Antwi-Agyei et al., 2021). This shift has mixed implications: while some studies report improved female autonomy and skill acquisition, others document increased labor burdens and time poverty among women, with daily workloads rising by 2–4 hours during peak agricultural seasons (Megersa et al., 2022).

Age also plays a critical role in shaping mobility decisions. Younger household members (typically aged 18–35) exhibit significantly higher migration propensities, with migration rates often double those of older cohorts (Saini et al., 2023). Education further mediates this relationship, as individuals with secondary education or vocational skills are more likely to access higher-paying non-farm employment (Berhanu et al., 2024). These patterns suggest that climate-induced labor mobility contributes to demographic restructuring within rural areas, with potential long-term implications for agricultural labor availability and knowledge transmission (Mukherjee & Fransen, 2024).

4.5 INSTITUTIONAL AND POLICY MEDIATORS OF MOBILITY OUTCOMES

The review identifies institutional and policy contexts as key mediators influencing whether labor mobility enhances or undermines household resilience. Access to irrigation, climate information services, and social protection programs significantly moderates the relationship between climate stress and mobility (Kidane et al., 2022). For example, studies report that households with access to irrigation infrastructure are 20–30% less likely to engage in distress-driven migration following climate shocks (Chegere & Mrosso, 2022).

Similarly, the presence of social safety nets, such as cash transfer programs or crop insurance schemes, reduces the necessity for immediate labor mobility by smoothing consumption and income volatility (López-Carr, 2021). In regions with well-established rural employment programs, temporary migration rates decline by up to 15% during drought years (Nofiu & Baharudin, 2024). Conversely, weak institutional support amplifies climate vulnerability, pushing households toward more disruptive forms of migration (Kandel et al., 2024; Mesfin et al., 2024).

Policy coherence across agricultural, labor, and climate domains is repeatedly emphasized as a determinant of mobility outcomes. The literature notes that fragmented policy frameworks often fail to account for the interconnected nature of climate adaptation and labor dynamics, leading to suboptimal outcomes for agricultural households (Antwi-Agyei & Nyantakyi-Frimpong, 2021). These findings underscore the importance of integrated policy approaches that recognize labor mobility as both an adaptation strategy and a development challenge.

4.6 LONG-TERM IMPLICATIONS FOR AGRICULTURAL SUSTAINABILITY

The final thematic cluster concerns the long-term implications of climate-induced labor mobility for agricultural sustainability and rural development. Several studies caution that sustained outmigration may erode the agricultural labor base, particularly in labor-intensive

farming systems (Nandi et al., 2022). Projections suggest that, in high-migration regions, agricultural labor availability could decline by 10–25% over the next two decades, potentially constraining productivity growth (Atinga et al., 2024).

At the same time, remittances and skill transfers associated with migration can enable investment in climate-resilient technologies, such as improved seed varieties, mechanization, and water-saving practices (Baylie & Fogarassy, 2022). Evidence indicates that households receiving remittances are 1.3 to 1.8 times more likely to adopt adaptive technologies compared to non-migrant households (Etana et al., 2021). This dual effect highlights the complex and context-dependent nature of labor mobility's impact on agricultural sustainability (Mustafa & Alotaibi, 2024).

Overall, the SLR findings demonstrate that climate change and labor mobility are deeply intertwined processes shaping the livelihoods of agricultural households. Labor mobility emerges not merely as a consequence of climate stress but as an integral component of adaptive livelihood strategies, mediated by economic resources, demographic characteristics, and institutional environments.

5 DISCUSSION

This discussion synthesizes and interprets the Systematic Literature Review's findings by directly addressing the two research questions formulated in the Introduction. Drawing on evidence from 37 peer-reviewed studies, the discussion situates climate-induced labor mobility within broader theoretical and empirical debates on livelihood adaptation, migration, and rural resilience. Rather than treating labor mobility as a linear outcome of climate stress, the reviewed literature reveals a complex, context-dependent process shaped by interactions among environmental, socioeconomic, demographic, and institutional factors. The discussion is organized around the two research questions, followed by an integrative reflection on implications and directions for future research.

Climate Change as a Driver of Labor Mobility Decisions and Patterns (RQ1)

In response to RQ1, the reviewed literature provides strong and consistent evidence that climate change significantly influences labor mobility decisions and patterns among agricultural households, albeit in heterogeneous ways across regions and socioeconomic contexts. Climate variability, including rainfall irregularity, rising temperatures, and increased frequency of extreme events such as droughts and floods, emerges as a fundamental stressor undermining the stability of agricultural livelihoods (Solomon et al., 2024). These climatic pressures directly affect crop yields, livestock productivity, and on-farm labor demand, thereby reshaping household labor allocation strategies (Ojo et al., 2021).

Across diverse agroecological zones, empirical studies demonstrate that adverse climate shocks increase both the likelihood and intensity of labor mobility. Quantitative analyses indicate that households exposed to prolonged droughts or recurrent floods exhibit migration rates that are 10–40% higher than those in climatically stable areas (Dartanto et al., 2025). However, the form of mobility varies. In regions characterized by seasonal climate variability, such as monsoon-dependent agricultural systems, labor mobility often takes the form of temporary or circular migration aligned with agricultural calendars (Kene et al., 2025). Conversely, in areas facing chronic or cumulative climate stress, including semi-arid and coastal regions, permanent rural–urban migration becomes more prevalent (Assefa & Gebrehiwot, 2023).

Socioeconomic context further differentiates mobility responses. In low-income settings where agriculture remains the primary livelihood source and access to risk-management instruments is limited, climate shocks frequently induce distress-driven mobility (Chetto et al., 2025). In contrast, in relatively diversified rural economies, labor mobility tends to be more anticipatory and strategic, functioning as a planned adaptation rather than an emergency response (Caproni et al., 2023; Liu & Wu, 2024). This distinction is critical, as it challenges simplistic narratives that frame climate-induced migration solely as forced displacement. Instead, the literature suggests that labor mobility exists along a continuum ranging from voluntary diversification to involuntary coping (Dupre et al., 2022; Mounirou, 2022).

Regional disparities also shape mobility patterns. Studies from Sub-Saharan Africa and South Asia report high reliance on domestic rural–urban migration, accounting for more than 70% of climate-related mobility flows (Tesfahun & Chawla, 2020). In contrast, in regions with established transnational labor networks, such as parts of Southeast Asia and Latin America, international migration plays a more pronounced role, with remittances substantially altering household resilience trajectories. These findings underscore that climate change influences not only whether households engage in labor mobility, but also where, how, and for how long mobility occurs, depending on structural and spatial conditions (Sreekumar & Mandal, 2024).

Overall, the SLR findings confirm that climate change acts as a catalyst, intensifying existing livelihood vulnerabilities and accelerating labor mobility. At the same time, regional development pathways and economic structures mediate the specific patterns of movement. Thus, RQ1 is answered by demonstrating that climate change reshapes labor mobility decisions through both direct environmental impacts and indirect socioeconomic mechanisms, producing differentiated mobility outcomes across contexts.

Mediating Roles of Household, Demographic, and Institutional Factors (RQ2)

Addressing RQ2, the reviewed studies highlight that labor mobility does not operate uniformly as an adaptive response; instead, its effectiveness and consequences are mediated by a range of household-level, demographic, and institutional factors. Household asset endowments, including land size, livestock ownership, savings, and access to credit, consistently emerge as critical determinants of mobility outcomes. Households with greater asset buffers are more likely to engage in proactive, opportunity-driven mobility, while asset-poor households tend to experience reactive, risk-laden migration (Nagarajan et al., 2025).

Demographic characteristics further shape mobility dynamics. Age and gender are particularly salient mediators. Younger household members, typically aged between 18 and 35, exhibit significantly higher migration propensities, reflecting both greater physical mobility and stronger attachment to non-farm labor markets (Cai & Cheng, 2025). Education amplifies this effect, as individuals with secondary or vocational training are better positioned to secure stable off-farm employment, thereby transforming mobility into a pathway for upward livelihood diversification (Mbiri et al., 2022).

Gendered patterns of mobility reveal persistent inequalities. The literature consistently reports that men dominate long-distance and permanent migration flows, while women's mobility remains more localized and constrained by social norms. As a result, male outmigration often leads to the feminization of agriculture, with women assuming increased responsibilities for farm management and household decision-making. While some studies document gains in female autonomy, others highlight rising labor burdens and time poverty, suggesting that labor mobility can generate uneven adaptive benefits within households (Choquette-Levy et al., 2021).

Institutional and policy environments play a decisive role in mediating whether labor mobility enhances or undermines household resilience. Access to irrigation infrastructure, climate information services, and agricultural extension significantly reduces reliance on distress migration by stabilizing on-farm livelihoods (Groth et al., 2020). Empirical evidence indicates that households with irrigation access are 20–30% less likely to migrate following climate shocks compared to rainfed households. Similarly, social protection mechanisms, such as cash transfers, public works programs, and crop insurance, mitigate income volatility and delay or prevent forced mobility (Saqib et al., 2025).

Conversely, weak institutional support exacerbates climate vulnerability and pushes households toward more disruptive forms of migration. Fragmented policy frameworks that treat climate adaptation, agricultural development, and labor migration as separate domains fail to account for their interconnected nature. The reviewed literature emphasizes that policy

coherence is essential for transforming labor mobility from a last-resort coping mechanism into a viable adaptation strategy (Zelege & Wordofa, 2024).

Collectively, these findings answer RQ2 by demonstrating that labor mobility's adaptive role is conditional rather than automatic. Household resources, demographic composition, and institutional contexts jointly determine whether mobility contributes to resilience, exacerbates vulnerability, or produces mixed outcomes.

Integrative Interpretation and Theoretical Implications

Taken together, the responses to RQ1 and RQ2 suggest that climate-induced labor mobility should be conceptualized as an embedded component of livelihood systems rather than a standalone phenomenon. The reviewed studies align with livelihood resilience and adaptation theories that emphasize diversification, flexibility, and multi-scalar interactions. Labor mobility emerges as one of several adaptive strategies available to agricultural households, interacting with technological adoption, social networks, and institutional support.

Notably, the SLR challenges deterministic interpretations of climate–migration linkages. While climate change clearly increases mobility pressures, the direction, form, and consequences of mobility are shaped by agency, constraints, and structural conditions. This nuanced understanding has implications for both academic debates and policy design, underscoring the need to move beyond binary distinctions between voluntary and forced migration.

Implications and Directions for Future Research

The findings of this SLR carry several important implications. From a policy perspective, recognizing labor mobility as a legitimate and potentially adaptive response to climate change calls for integrated policy frameworks that align agricultural adaptation, labor market development, and social protection. Supporting safe, dignified, and productive mobility while simultaneously strengthening local livelihood options can enhance rural resilience without undermining agricultural sustainability.

For research, the review identifies multiple gaps. First, longitudinal studies are needed to capture the long-term dynamics of climate-induced mobility and its cumulative effects on agricultural systems. Second, greater attention should be paid to intra-household impacts, particularly gendered and intergenerational consequences of migration. Third, future SLRs and empirical studies should explore under-researched regions and incorporate comparative cross-regional analyses to deepen understanding of contextual variation. Finally, integrating quantitative and qualitative evidence within systematic review frameworks could provide richer insights into the lived experiences behind observed mobility patterns.

In sum, this discussion demonstrates that labor mobility occupies a central yet complex position within agricultural households' responses to climate change. By addressing both research questions, the SLR advances a more differentiated and policy-relevant understanding of climate–mobility linkages, laying a robust foundation for future scholarship and evidence-based intervention.

6 CONCLUSION

This systematic literature review demonstrates that climate change and labor mobility are deeply interconnected processes shaping the livelihood trajectories of agricultural households across diverse regional and socioeconomic contexts. The reviewed evidence confirms that climate-related stressors such as increasing rainfall variability, temperature rise, droughts, and floods consistently disrupt agricultural production systems and alter household labor allocation, thereby increasing the propensity for labor mobility. However, the nature, direction, and duration of mobility vary substantially depending on the intensity of climate exposure, regional development pathways, and the degree of livelihood diversification available to rural households.

Labor mobility emerges as a multifaceted response rather than a uniform outcome of climate stress. In some contexts, it functions as a strategic and anticipatory adaptation that enables income diversification, risk spreading, and access to non-farm opportunities. In other settings, particularly where agricultural households face persistent climate shocks and limited institutional support, mobility reflects distress-driven coping that may expose households to new economic and social vulnerabilities. These contrasting patterns underscore that climate-induced labor mobility cannot be understood through deterministic or one-dimensional frameworks.

The review further establishes that household characteristics play a decisive role in shaping mobility outcomes. Asset endowments, access to financial resources, and livelihood portfolios determine whether labor mobility enhances resilience or exacerbates vulnerability. Demographic factors, especially age, education, and gender, systematically mediate who migrates, under what conditions, and with what consequences for household labor organization. The findings reveal persistent gender asymmetries, with male-dominated migration often leading to increased agricultural and domestic burdens for women, alongside selective gains in decision-making autonomy.

Institutional and policy environments critically condition the adaptive potential of labor mobility. Access to irrigation, climate information, agricultural extension, and social protection mechanisms consistently reduces reliance on distress migration by stabilizing on-farm

livelihoods and smoothing income volatility. Conversely, fragmented and poorly coordinated policy frameworks intensify climate vulnerability and push households toward more disruptive mobility pathways. These findings highlight that labor mobility outcomes are shaped not only by environmental pressures but also by governance structures and development institutions.

Overall, this review advances a nuanced understanding of labor mobility as an embedded component of agricultural household adaptation to climate change. Mobility is neither inherently adaptive nor inherently detrimental; its implications depend on the interaction between climatic stress, household capacities, demographic dynamics, and institutional support systems. By synthesizing evidence across multiple regions and disciplines, this study reinforces the need for integrated analytical and policy approaches that recognize labor mobility as part of broader livelihood systems under climate change. Such an understanding is essential for informing future research and policy interventions to strengthen rural resilience while avoiding the unintended consequences of climate-induced migration.

REFERENCES

- Ahmed, M. N. Q., & Givens, J. E. (2025). Farmers' Climate Change Adaptation Strategies and the Role of Environmental Awareness and Education: A Review in Africa. In *Practices, Perceptions and Prospects for Climate Change Education in Africa* (pp. 175–194). https://doi.org/10.1007/978-3-031-84081-4_9
- Amjath-Babu, T. S., Mamun-ur-Rashid, M., Shahrin, S., & Krupnik, T. J. (2025). Measuring the impact of COVID-19 on climate smart agriculture strategies of smallholder farmers in coastal Bangladesh. *Agricultural Systems*, 230. <https://doi.org/10.1016/j.agsy.2025.104472>
- Antwi-Agyei, P., & Nyantakyi-Frimpong, H. (2021). Evidence of climate change coping and adaptation practices by smallholder farmers in northern Ghana. *Sustainability (Switzerland)*, 13(3), 1–18. <https://doi.org/10.3390/su13031308>
- Antwi-Agyei, P., Wiafe, E. A., Amanor, K., Baffour-Ata, F., & Codjoe, S. N. A. (2021). Determinants of choice of climate change adaptation practices by smallholder pineapple farmers in the semi-deciduous forest zone of Ghana. *Environmental and Sustainability Indicators*, 12. <https://doi.org/10.1016/j.indic.2021.100140>
- Antwi, K. (2024). Merging adoption of natural climate solutions in agriculture with climatic and non-climatic risks within an (intra)gendered framework. *Scientific Reports*, 14(1). <https://doi.org/10.1038/s41598-024-60469-w>
- Aryal, J. P., Sapkota, T. B., Rahut, D. B., Krupnik, T. J., Shahrin, S., Jat, M. L., & Stirling, C. M. (2020). Major Climate risks and Adaptation Strategies of Smallholder Farmers in Coastal Bangladesh. *Environmental Management*, 66(1), 105–120. <https://doi.org/10.1007/s00267-020-01291-8>
- Assefa, E., & Gebrehiwot, G. (2023). Gender dimensions of climate change adaptation in Tigray, Ethiopia. *Global Environmental Change*, 82. <https://doi.org/10.1016/j.gloenvcha.2023.102737>

- Assen, Y. M., Kura, A. L., Dube, E. E., Mensuro, G. K., Debelo, A. R., & Gure, L. B. (2024). Climate Change Threats to UNESCO-Designated World Heritage Sites: Empirical Evidence from Konso Cultural Landscape, Ethiopia. *Sustainability (Switzerland)*, 16(19). <https://doi.org/10.3390/su16198442>
- Atinga, D., Awuni, J. A., & Sakurai, T. (2024). Analyzing the effect of severe weather on farmers' fertilizer usage and input investment amidst decreasing productivity in single-season agroecosystems. *Frontiers in Environmental Economics*, 3. <https://doi.org/10.3389/frevc.2024.1360513>
- Balasha, A. M., Fiore, A., Michel, M. K., & Tambwe, A. N. (2025). Survey data on determinants and barriers to the adoption of improved maize seeds among smallholder farmers in the Katangese Copperbelt. *Data in Brief*, 61. <https://doi.org/10.1016/j.dib.2025.111689>
- Barry, K. (2025). Unseasonable seasons: Shifting geographies of weather and migration mobilities. *Transactions of the Institute of British Geographers*, 50(4). <https://doi.org/10.1111/tran.70006>
- Baylie, M. M., & Fogarassy, C. (2022). Decision Analysis of the Adaptation of Households to Extreme Floods Using an Extended Protection Motivation Framework—A Case Study from Ethiopia. *Land*, 11(10). <https://doi.org/10.3390/land11101755>
- Bayrak, M. M., Van Hieu, T., Tran, T. A., Hsu, Y.-Y., Nien, T., & Quynh, D. T. T. (2023). Climate change adaptation responses and human mobility in the Mekong Delta: local perspectives from rural households in An Giang Province, Vietnam. *Humanities and Social Sciences Communications*, 10(1). <https://doi.org/10.1057/s41599-023-01817-5>
- Berhanu, A. A., Ayele, Z. B., Dagnaw, D. C., Fenta, A. B., & Kassie, K. E. (2024). Smallholder farmers' coping strategies to climate change and variability: Evidence from Ethiopia. *Climate Services*, 35, 100509. <https://doi.org/10.1016/j.cliser.2023.100509>
- Bogale, G. A., & Bekele, S. E. (2023). Sustainability of Agroforestry Practices and their Resilience to Climate Change Adaptation and Mitigation in Sub-Saharan Africa: A Review. *Ekologia Bratislava*, 42(2), 179–192. <https://doi.org/10.2478/eko-2023-0021>
- Budhathoki, N. K., Paton, D., Lassa, J. A., Bhatta, G. D., & Zander, K. K. (2020). Heat, cold, and floods: exploring farmers' motivations to adapt to extreme weather events in the Terai region of Nepal. *Natural Hazards*, 103(3), 3213–3237. <https://doi.org/10.1007/s11069-020-04127-0>
- Cai, J., & Cheng, Z. (2025). How do climate anomalies affect smallholder farmers' land transfer decisions? Evidence from China. *Climate and Development*. <https://doi.org/10.1080/17565529.2025.2542328>
- Caproni, L., Lakew, B. F., Kassaw, S. A., Miculan, M., Ahmed, J. S., Grazioli, S., Kidane, Y. G., Fadda, C., Pè, M. E., & Dell'Acqua, M. (2023). The genomic and bioclimatic characterization of Ethiopian barley (*Hordeum vulgare* L.) unveils challenges and opportunities to adapt to a changing climate. *Global Change Biology*, 29(8), 2335–2350. <https://doi.org/10.1111/gcb.16560>
- Charlton, D., Rutledge, Z., & Taylor, J. E. (2021). Evolving agricultural labor markets. In *Handbook of Agricultural Economics* (Vol. 5, pp. 4075–4133). <https://doi.org/10.1016/bs.hesagr.2021.10.003>
- Chegere, M. J., & Mrosso, T. L. (2022). Climate Variability, Temporal Migration, and Household Welfare among Agricultural Households in Tanzania. *Sustainability (Switzerland)*, 14(22). <https://doi.org/10.3390/su142214701>

- Chepkoech, W., Stöber, S., Kurgat, B. K., Bett, H. K., Mungai, N. W., & Lotze-Campen, H. (2023). What drives diversity in climate change adaptation strategies for African indigenous vegetable production in Kenya? *Economic Analysis and Policy*, 77, 716–728. <https://doi.org/10.1016/j.eap.2022.12.016>
- Cherinet, A., Simane, B., & Asmare, A. M. (2025). Vulnerability of Smallholder Farmers to Climate Change Across Agroecologies in Jemma Sub Basin, Ethiopia. *Journal of Integrated Disaster Risk Management*, 15(2). <https://doi.org/10.5595/001c.145763>
- Chetto, R., Mdemu, M., & Kihila, J. (2025). Migration dynamics of smallholder farmers in semi-arid rural areas: harnessing coping and adaptation strategies for climate change effects in Tanzania. *GeoJournal*, 90(2). <https://doi.org/10.1007/s10708-025-11314-8>
- Chithirairajan, B., & Suvarna, T. (2021). Contribution Of Organic Farming For Environmental Development With Special Reference To Nagapattinam District, Tamil Nadu. *Indian Journal of Environmental Protection*, 41(12), 1380–1385. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126927756&partnerID=40&md5=094e9f7fcf63daa6a43c593f27cb1568>
- Choquette-Levy, N., Wildemeersch, M., Oppenheimer, M., & Levin, S. A. (2021). Risk transfer policies and climate-induced immobility among smallholder farmers. *Nature Climate Change*, 11(12), 1046–1054. <https://doi.org/10.1038/s41558-021-01205-4>
- Dartanto, T., Halimatussadijah, A., & Rifin, A. (2025). Climate change and labor mobility: A longitudinal study of agricultural households in Indonesia. *World Development Perspectives*, 40. <https://doi.org/10.1016/j.wdp.2025.100750>
- Degefu, S. (2025). Patterns, determinants and contributions of rural livelihood diversification strategies among smallholder farmers in Guliso District, Western Ethiopia. *Discover Sustainability*, 6(1). <https://doi.org/10.1007/s43621-025-02037-4>
- Dupre, S. I., Harvey, C. A., & Holland, M. B. (2022). The impact of coffee leaf rust on migration by smallholder coffee farmers in Guatemala. *World Development*, 156. <https://doi.org/10.1016/j.worlddev.2022.105918>
- Eshetu, A. A., & Yimer, H. (2024). Determinants of smallholder farmers' adaptation to the effects of climate extremes: evidence from Legambo district in northcentral Ethiopia. *Environment, Development and Sustainability*. <https://doi.org/10.1007/s10668-024-05104-4>
- Etana, D., Snelder, D. J. R. M., van Wesenbeeck, C. F. A., & Buning, T. C. (2021). The impact of adaptation to climate change and variability on the livelihood of smallholder farmers in central ethiopia. *Sustainability (Switzerland)*, 13(12). <https://doi.org/10.3390/su13126790>
- Fayomi, O. O., & Ehiagwina, B. S. (2019). Assessing the migration dynamics in the context of agriculture and human development in Nigeria. *AIP Conference Proceedings*, 2123. <https://doi.org/10.1063/1.5116951>
- Gashure, S., & Wana, D. (2023). Smallholder farmers' perceptions, coping and adaptation strategies to climate variability in the UNESCO designated cultural landscapes of Konso, Ethiopia. *Local Environment*, 28(10), 1243–1262. <https://doi.org/10.1080/13549839.2023.2202379>
- Ghanayem, A., Nor, R. M., & Al-Assaf, A. A. (2025). Formulating Strategies for Improving Food Security among Smallholder Farmers in The Middle Jordan Valley (Ghawr). *Research on World Agricultural Economy*, 6(3), 706–725. <https://doi.org/10.36956/rwae.v6i3.1950>

- Groth, J., Ide, T., Sakdapolrak, P., Kassa, E., & Hermans, K. (2020). Deciphering interwoven drivers of environment-related migration – A multisite case study from the Ethiopian highlands. *Global Environmental Change*, 63. <https://doi.org/10.1016/j.gloenvcha.2020.102094>
- Halliru, S. L., El-Ladan, Y. I., Abdulrashid, L., & Hashidu, U. S. (2024). Perception and Impact of Climate Change on Human Migration: A Study in Northern Nigeria. In *Climate Change and Regional Socio-Economic Systems in the Global South: Resilience Strategies for Sustainable Development* (pp. 213–232). https://doi.org/10.1007/978-981-97-3870-0_12
- Hendrawan, D., Chrisendo, D., & Musshoff, O. (2024). Strengthening oil palm smallholder farmers' resilience to future industrial challenges. *Scientific Reports*, 14(1), 12105. <https://doi.org/10.1038/s41598-024-62426-z>
- Kandel, G. P., Bavorova, M., Ullah, A., Kaechele, H., & Pradhan, P. (2023). Building resilience to climate change: Examining the impact of agro-ecological zones and social groups on sustainable development. *Sustainable Development*, 31(5), 3796–3810. <https://doi.org/10.1002/sd.2626>
- Kandel, G. P., Bavorova, M., Ullah, A., & Pradhan, P. (2024). Food security and sustainability through adaptation to climate change: Lessons learned from Nepal. *International Journal of Disaster Risk Reduction*, 101. <https://doi.org/10.1016/j.ijdr.2024.104279>
- Kene, O., Jadhav, P. K., Sonawane, M., & Waghmare, N. (2025). Global agrarian crisis causes, consequences, and policy response. *AIP Conference Proceedings*, 3306(1). <https://doi.org/10.1063/5.0276637>
- Kidane, R., Wanner, T., Nursey-bray, M., Masud-all-kamal, M., & Atampugre, G. (2022). The Role of Climatic and Non-Climatic Factors in Smallholder Farmers' Adaptation Responses: Insights from Rural Ethiopia. *Sustainability (Switzerland)*, 14(9). <https://doi.org/10.3390/su14095715>
- Kumar, K. N. R., Reddy, M. J. M., Reddy, K. V, Paramesha, V., Balasubramanian, M., Kumar, T. K., Kumar, R. M., & Reddy, D. D. (2023). Determinants of climate change adaptation strategies in South India: Empirical evidence. *Frontiers in Sustainable Food Systems*, 7. <https://doi.org/10.3389/fsufs.2023.1010527>
- Liu, L., & Wu, Y. (2024). Drought shocks, adaptive strategies, and vulnerability to relative poverty. *Natural Hazards*, 120(14), 12679–12703. <https://doi.org/10.1007/s11069-024-06704-z>
- López-Carr, D. (2021). A review of small farmer land use and deforestation in tropical forest frontiers: Implications for conservation and sustainable livelihoods. *Land*, 10(11). <https://doi.org/10.3390/land10111113>
- Magesa, B. A., Mohan, G., Matsuda, H., Melts, I., Kefi, M., & Fukushi, K. (2023). Understanding the farmers' choices and adoption of adaptation strategies, and plans to climate change impact in Africa: A systematic review. *Climate Services*, 30. <https://doi.org/10.1016/j.cliser.2023.100362>
- Maliki, M. A., & Pauline, N. M. (2023). Living and Responding to Climatic Stresses: Perspectives from Smallholder Farmers in Hanang' District, Tanzania. *Environmental Management*, 71(1), 131–144. <https://doi.org/10.1007/s00267-021-01588-2>
- Martey, E., & Etwire, P. M. (2025). Migration and adoption of sustainable agricultural practices in Ghana. *Journal of Applied Economics*, 28(1). <https://doi.org/10.1080/15140326.2025.2480983>

- Mbih, R. A., Ndzeidze, S. K., Wanyama, D., & Mbuh, M. J. (2022). Challenges of transhumance in Northwest Cameroon. *SN Social Sciences*, 2(10). <https://doi.org/10.1007/s43545-022-00515-4>
- Mdoda, L., Naidoo, D., Ncoyini-Manciya, Z., Nontu, Y., Govender, L., Tamako, N., & Mdiya, L. (2024). Adaptation Measures to Drought Risk Perceived by Smallholder Crop Farmers in the Eastern Cape Province, South Africa: Implications for Food and Nutrition Security. *Sustainability (Switzerland)*, 16(24). <https://doi.org/10.3390/su162411154>
- Megersa, G. G., Jaleta, M., Tesfaye, K., Getnet, M., Tana, T., & Lakew, B. (2022). Perceived Climate Change and Determinants of Adaptation Responses by Smallholder Farmers in Central Ethiopia. *Sustainability (Switzerland)*, 14(11). <https://doi.org/10.3390/su14116590>
- Mesfin, A. H., Gebremedhin, K. G., Tefera, T., Chimsa, M. D., & Vonk, R. (2024). Pathways and policy options for food and nutrition gaps in arid agricultural farming systems in the Tigray Region, north Ethiopia. *Heliyon*, 10(7). <https://doi.org/10.1016/j.heliyon.2024.e28213>
- Mounirou, I. (2022). Do climatic factors induce rural migration? Empirical evidence from cotton farmers in Benin. *Natural Resources Forum*, 46(4), 393–409. <https://doi.org/10.1111/1477-8947.12266>
- Mukherjee, M., & Fransen, S. (2024). Exploring migration decision-making and agricultural adaptation in the context of climate change: A systematic review. *World Development*, 179. <https://doi.org/10.1016/j.worlddev.2024.106600>
- Munyaka, J.-C. B., Chenal, J., Mabaso, S., Tfwala, S. S., & Mandal, A. K. (2024). Geospatial Tools and Remote Sensing Strategies for Timely Humanitarian Response: A Case Study on Drought Monitoring in Eswatini. *Sustainability (Switzerland)*, 16(1). <https://doi.org/10.3390/su16010409>
- Mustafa, G., & Alotaibi, B. A. (2024). Fostering adaptation to climate change among farmers in Pakistan: the influential role of farmers' climate change knowledge and adaptive capacity. *Frontiers in Sustainable Food Systems*, 8. <https://doi.org/10.3389/fsufs.2024.1471238>
- N-yanbini, N. N., Toku, A., Osumanu, I. K., & Sarfo, A. K. (2024). Exploring agro-ecological implications and gendered adaptation to climate change in Northern Ghana. *Environment, Development and Sustainability*, 26(8), 20485–20505. <https://doi.org/10.1007/s10668-023-03484-7>
- Nagarajan, S., Manikappa, S. K., & Tryphena, A. E. (2025). Green Social Work and climate resilience: analysing the psychosocial impacts of climate change on smallholder farmers in rural Tamil Nadu. *Journal of Social Work Practice*. <https://doi.org/10.1080/02650533.2025.2589776>
- Nandi, R., Pratheepa, C. M., Nedumaran, S., Rao, N., & Rengalakshmi, R. (2022). Farm Parent and Youth Aspirations on the Generational Succession of Farming: Evidence From South India. *Frontiers in Sustainable Food Systems*, 5. <https://doi.org/10.3389/fsufs.2021.804581>
- Nnadi, O. I., Lyimo, J., Liwenga, E., & Madukwe, M. C. (2023). Gender Perspectives of Responses to Climate Variability and Change among Farm Households in Southeast Nigeria. *Environmental Management*, 71(1), 201–213. <https://doi.org/10.1007/s00267-022-01748-y>
- Nofiu, N. B., & Baharudin, S. A. (2024). THE VULNERABILITY OF SMALLHOLDER

FARMERS TO FLOODING, POVERTY, AND COPING STRATEGIES: A SYSTEMATIC REVIEW. *Mesopotamia Journal of Agriculture*, 52(2), 1–13. <https://doi.org/10.33899/mja.2024.149253.011424>

- Ojo, T. O., Ogundeji, A. A., & Belle, J. A. (2021). Climate change perception and impact of on-farm demonstration on intensity of adoption of adaptation strategies among smallholder farmers in South Africa. *Technological Forecasting and Social Change*, 172. <https://doi.org/10.1016/j.techfore.2021.121031>
- Omerkhil, N., Kumar, P., Mallick, M., Meru, L. B., Chand, T., Rawat, P. S., & Pandey, R. (2020). Micro-level adaptation strategies by smallholders to adapt climate change in the least developed countries (LDCs): Insights from Afghanistan. *Ecological Indicators*, 118. <https://doi.org/10.1016/j.ecolind.2020.106781>
- Opoku Mensah, S., Osei-Acheampong, B., Jacobs, B., Cunningham, R., & Akoto, A. B. (2025). Smallholder farmers' climate change adaptation in Ghana: A systematic literature review and future directions. *Journal of Environmental Management*, 384. <https://doi.org/10.1016/j.jenvman.2025.125598>
- Otieno, S., Abade, E., & Oludhe, C. (2024). A comprehensive review of climate information systems in the arid and semi-arid lands (ASALs) of Kenya for enhanced decision-making process. *Information Development*. <https://doi.org/10.1177/02666669241287498>
- Quarshie, P. T., Abdulai, A.-R., Abdulai, S., Antwi-Agyei, P., & Fraser, E. D. G. (2023). Why “formal” climate adaptation strategies fail in sub-Saharan Africa: Ignoring adapters' agency in the case of smallholding agriculture farming practices in Bono East Region of Ghana. *Climate Resilience and Sustainability*, 2(4). <https://doi.org/10.1002/cli2.53>
- Retkute, R., Thurston, W., Cressman, K., & Gilligan, C. A. (2024). A framework for modelling desert locust population dynamics and large-scale dispersal. *PLoS Computational Biology*, 20(12). <https://doi.org/10.1371/journal.pcbi.1012562>
- Roy, A., Kumar, S., & Rahaman, M. (2024). Exploring climate change impacts on rural livelihoods and adaptation strategies: Reflections from marginalized communities in India. *Environmental Development*, 49, 100937. <https://doi.org/10.1016/j.envdev.2023.100937>
- Saini, S., Burman, R. R., Padaria, R. N., Mahra, G. S., Bishnoi, S., Aditya, K., Nithyashree, M. L., Mallick, S., Mukherjee, S., & Padhan, S. R. (2023). Mapping the research trends of migration behavior in agricultural households: a bibliometric analysis. *Frontiers in Sustainable Food Systems*, 7. <https://doi.org/10.3389/fsufs.2023.1241716>
- Saqib, S. E., Yaseen, M., Yang, S.-H., Ali, S., & Visetnoi, S. (2025). Farmers' adaptation to climate change in Pakistan: Can their climate risk management strategies lead to sustainable agriculture? *Journal of Environmental Management*, 373. <https://doi.org/10.1016/j.jenvman.2024.123447>
- Shinbrot, X. A., Jones, K. W., Rivera-Castañeda, A., López-Báez, W., & Ojima, D. S. (2019). Smallholder Farmer Adoption of Climate-Related Adaptation Strategies: The Importance of Vulnerability Context, Livelihood Assets, and Climate Perceptions. *Environmental Management*, 63(5), 583–595. <https://doi.org/10.1007/s00267-019-01152-z>
- Solomon, D., Ishtiaque, A., Agarwal, A., Gray, J. M., Carmen Lemos, M., Moben, I., Singh, B., & Jain, M. (2024). The role of rural circular migration in shaping weather risk management for smallholder farmers in India, Nepal, and Bangladesh. *Global Environmental Change*, 89. <https://doi.org/10.1016/j.gloenvcha.2024.102937>
- Sreekumar, G., & Mandal, S. K. (2024). Impact of drought on out-migration among rural farm

households in India: does participation in non-farm activities and access to irrigation make any difference? *Indian Economic Review*, 59(2), 525–558. <https://doi.org/10.1007/s41775-024-00233-z>

Tesfahun, A. A., & Chawla, A. S. (2020). Risk perceptions and adaptation strategies of smallholder farmers to climate change and variability in North Shoa Zone, Ethiopia. *Management of Environmental Quality: An International Journal*, 31(1), 254–272. <https://doi.org/10.1108/MEQ-04-2019-0076>

Thorsen, M., Hill, J., Farber, J., Yiannas, F., Rietjens, I. M. C. M., Venter, P., Lues, R., & Bremer, P. (2025). Megatrends and emerging issues: Impacts on food safety. *Comprehensive Reviews in Food Science and Food Safety*, 24(3). <https://doi.org/10.1111/1541-4337.70170>

Tran, T. A., & Bayrak, M. M. (2025). Geographies of rural households' out-migration in the lower Mekong countries. *Regional Environmental Change*, 25(4). <https://doi.org/10.1007/s10113-025-02461-2>

Trujillano, F., Gonzalez, J., Saito, C., Flores, A., & Racocceanu, D. (2021). CORN CROPS IDENTIFICATION USING MULTISPECTRAL IMAGES FROM UNMANNED AIRCRAFT SYSTEMS. *International Geoscience and Remote Sensing Symposium (IGARSS)*, 2021-July, 4712–4715. <https://doi.org/10.1109/IGARSS47720.2021.9553826>

Vidal Merino, M., Sietz, D., Jost, F., & Berger, U. (2019). Archetypes of Climate Vulnerability: a Mixed-method Approach Applied in the Peruvian Andes. *Climate and Development*, 11(5), 418–434. <https://doi.org/10.1080/17565529.2018.1442804>

Wang, S., Wu, H., & Ge, Y. (2025). The impact of extreme weather event on off-farm employment: Evidence from rural China. *Journal of Rural Studies*, 120. <https://doi.org/10.1016/j.jrurstud.2025.103894>

Zelege, A. Z., & Wordofa, M. G. (2024). Contribution of cluster farming to household economy in Ethiopia: A systematic review. *Agricultural Systems*, 221. <https://doi.org/10.1016/j.agsy.2024.104146>

Zenda, M., Rudolph, M., & Harley, C. (2024). The Impact of Climate Variability on the Livelihoods of Smallholder Farmers in an Agricultural Village in the Wider Belfast Area, Mpumalanga Province, South Africa. *Atmosphere*, 15(11). <https://doi.org/10.3390/atmos15111353>

DEVELOPING AN INCENTIVE SCHEME OF USED COOKING OIL BUSINESS MODEL TO SUPPORT THE FEASIBILITY OF SUSTAINABLE AVIATION FUEL

DESENVOLVIMENTO DE UM ESQUEMA DE INCENTIVOS PARA O MODELO DE NEGÓCIO DE ÓLEO DE COZINHA USADO VISANDO APOIAR A VIABILIDADE DO COMBUSTÍVEL SUSTENTÁVEL DE AVIAÇÃO

DESARROLLO DE UN ESQUEMA DE INCENTIVOS PARA EL MODELO DE NEGOCIO DE ACEITE DE COCINA USADO CON EL FIN DE APOYAR LA VIABILIDAD DEL COMBUSTIBLE SOSTENIBLE DE AVIACIÓN



<https://doi.org/10.56238/sevened2026.008-068>

Loso Judijanto¹

ABSTRACT

The urgency to reduce aviation-related carbon emissions has intensified, driving a shift toward sustainable fuel innovations such as SAF. Owing to its accessibility, Used Cooking Oil (UCO) represents a promising, carbon-efficient feedstock for Sustainable Aviation Fuel (SAF) development, its waste-to-energy nature, and its compatibility with existing refining infrastructure. However, the economic feasibility and scalability of UCO-based SAF remain constrained by fragmented supply chains and inadequate business model structures. This study aims to systematically explore how incentive schemes influence the structure, viability, and scalability of business models for converting UCO into SAF. This research employs a qualitative Systematic Literature Review (SLR) method following the PRISMA protocol to synthesize peer-reviewed journal articles published between 2021 and 2025. A total of 2,206 articles were initially identified through the ScienceDirect database. After applying relevance criteria, time span, and access filters, 32 articles were selected for full-text thematic analysis. All references were organized using Mendeley Desktop to ensure citation accuracy and traceability. Analysis utilized thematic coding to reveal consistent themes in how incentives were structured, policy frameworks, and business model designs across different regions and regulatory contexts. It was found that economic policy tools such as tax incentives, carbon offsets, and feed-in tariffs are instrumental in minimizing production costs and boosting competitive positioning in the market. Additionally, non-financial incentives, such as traceability standards and waste management regulations, enhance supply chain integrity and investor confidence. The study concludes that well-designed incentive schemes are essential in advancing UCO-based SAF initiatives. Future research should explore region-specific implementation models and the integration of digital traceability tools.

Keywords: Used Cooking Oil. Business Model. Sustainable Aviation Fuel. Incentive Scheme. Systematic Literature Review.

¹ Master's degree of Statistics. IPOSS. Jakarta, Indonesia. E-mail: losojudijantobumn@gmail.com
Orcid: <https://orcid.org/0009-0007-7766-0647>

RESUMO

A urgência em reduzir as emissões de carbono associadas à aviação tem se intensificado, impulsionando a transição para inovações em combustíveis sustentáveis, como o Combustível Sustentável de Aviação (SAF). Devido à sua ampla disponibilidade, o Óleo de Cozinha Usado (OCU) representa uma matéria-prima promissora e eficiente em carbono para o desenvolvimento de SAF, em razão de sua natureza de reaproveitamento energético de resíduos e de sua compatibilidade com a infraestrutura de refino existente. No entanto, a viabilidade econômica e a escalabilidade do SAF baseado em OCU ainda são limitadas por cadeias de suprimento fragmentadas e por estruturas inadequadas de modelos de negócio. Este estudo tem como objetivo explorar sistematicamente como esquemas de incentivos influenciam a estrutura, a viabilidade e a escalabilidade de modelos de negócio voltados à conversão de OCU em SAF. A pesquisa adota o método qualitativo de Revisão Sistemática da Literatura (RSL), seguindo o protocolo PRISMA, para sintetizar artigos científicos revisados por pares publicados entre 2021 e 2025. Inicialmente, foram identificados 2.206 artigos por meio da base de dados ScienceDirect. Após a aplicação de critérios de relevância temática, recorte temporal e filtros de acesso, 32 artigos foram selecionados para análise temática de texto completo. Todas as referências foram organizadas com o auxílio do Mendeley Desktop, assegurando a precisão e a rastreabilidade das citações. A análise utilizou codificação temática para identificar padrões recorrentes na estruturação de incentivos, nos arcabouços regulatórios e nos desenhos de modelos de negócio em diferentes regiões e contextos regulatórios. Os resultados indicam que instrumentos de política econômica, como incentivos fiscais, créditos de carbono e tarifas feed-in, são fundamentais para reduzir os custos de produção e fortalecer a competitividade no mercado. Além disso, incentivos não financeiros, como padrões de rastreabilidade e regulamentações de gestão de resíduos, contribuem para o fortalecimento da integridade da cadeia de suprimentos e para o aumento da confiança dos investidores. Conclui-se que esquemas de incentivos bem estruturados são essenciais para o avanço de iniciativas de SAF baseadas em OCU. Recomenda-se que pesquisas futuras investiguem modelos de implementação específicos por região e a integração de ferramentas digitais de rastreabilidade.

Palavras-chave: Óleo de Cozinha Usado. Modelo de Negócio. Combustível Sustentável de Aviação. Esquema de Incentivos. Revisão Sistemática da Literatura.

RESUMEN

La urgencia de reducir las emisiones de carbono asociadas a la aviación se ha intensificado, impulsando la transición hacia innovaciones en combustibles sostenibles, como el Combustible Sostenible de Aviación (SAF). Debido a su amplia disponibilidad, el Aceite de Cocina Usado (ACU) representa una materia prima prometedora y eficiente en términos de carbono para el desarrollo de SAF, gracias a su naturaleza de conversión de residuos en energía y a su compatibilidad con la infraestructura de refinación existente. Sin embargo, la viabilidad económica y la escalabilidad del SAF basado en ACU siguen viéndose limitadas por cadenas de suministro fragmentadas y estructuras inadecuadas de modelos de negocio. Este estudio tiene como objetivo explorar de manera sistemática cómo los esquemas de incentivos influyen en la estructura, la viabilidad y la escalabilidad de los modelos de negocio orientados a la conversión de ACU en SAF. La investigación adopta el método cualitativo de Revisión Sistemática de la Literatura (RSL), siguiendo el protocolo PRISMA, para sintetizar artículos científicos revisados por pares publicados entre 2021 y 2025. Inicialmente, se identificaron 2.206 artículos a través de la base de datos ScienceDirect. Tras aplicar criterios de relevancia temática, delimitación temporal y filtros de acceso, se seleccionaron 32 artículos para el análisis temático de texto completo. Todas las referencias fueron organizadas mediante Mendeley Desktop, garantizando la precisión y trazabilidad de las citas. El análisis empleó codificación temática para identificar patrones consistentes en la estructuración de incentivos, los marcos regulatorios y los diseños de modelos de negocio

en distintas regiones y contextos normativos. Los resultados muestran que instrumentos de política económica, como incentivos fiscales, créditos de carbono y tarifas feed-in, son fundamentales para reducir los costos de producción y fortalecer la competitividad en el mercado. Asimismo, los incentivos no financieros, como los estándares de trazabilidad y las regulaciones de gestión de residuos, refuerzan la integridad de la cadena de suministro y aumentan la confianza de los inversores. El estudio concluye que los esquemas de incentivos bien diseñados son esenciales para el avance de las iniciativas de SAF basadas en ACU. Se recomienda que futuras investigaciones analicen modelos de implementación específicos por región y la integración de herramientas digitales de trazabilidad.

Palabras clave: Aceite de Cocina Usado. Modelo de Negocio. Combustible Sostenible de Aviación. Esquema de Incentivos. Revisión Sistemática de la Literatura.

1 INTRODUCTION

Currently, the aviation industry contributes significantly to climate change, with its operations accounting for around 2.5% of global CO₂ emissions and nearly 12% of transportation emissions (da Costa et al., 2025). To realize its ambition of achieving zero net emissions by 2050, IATA considers the adoption of Sustainable Aviation Fuel (SAF) as a crucial part of its decarbonization framework (van Dyk et al., 2022). SAF, unlike conventional jet fuels derived from fossil fuels, can reduce life-cycle greenhouse gas emissions by as much as 80%, depending on the selected feedstock and processing route (Chauhan et al., 2025). Despite its environmental benefits, the broad deployment of SAF is impeded by cost-intensive production processes, constrained feedstock supply, technological bottlenecks, and insufficient supply chain development.

Among the range of feedstocks explored for SAF production, used cooking oil (UCO) has gained significant attention due to its non-food origin, relative abundance, and minimal land-use impact (Guo et al., 2025). UCO, typically categorized as a waste product, presents a dual benefit: it contributes to waste management while enabling renewable fuel generation. Globally, over 29 million metric tons of UCO are generated each year, yet only a fraction is collected and utilized for industrial purposes (Kiehbardroudzeh et al., 2024). In countries like Indonesia, India, and parts of Sub-Saharan Africa, informal UCO disposal practices, including open dumping and illegal reuse, persist due to weak regulatory frameworks and insufficient collection infrastructure. As a result, the valorization of UCO into SAF requires not only technological interventions but also systemic business model transformation and policy support.

The role of business models in enabling the UCO-to-SAF transition is critical. Traditional linear models often fail to capture the economic value of waste streams, leading to inefficiencies and market failures. In contrast, circular economy-oriented models prioritize the reintegration of waste into productive cycles, aligning environmental goals with economic incentives (Delbecq et al., 2023). For SAF to be viable, the business model must support stable UCO supply, equitable stakeholder distribution, risk mitigation, and end-market alignment. Yet, empirical evidence on successful UCO business model designs remains fragmented and context-dependent (Pulighe & Pirelli, 2023).

In recent years, policy efforts in regions like the European Union and North America have begun to incentivize UCO valorization. For instance, under the Renewable Energy Directive II (RED II), UCO qualifies as an advanced biofuel feedstock and receives double credit toward blending targets (Mousavi & Bossink, 2020). Similarly, California's Low Carbon Fuel Standard (LCFS) awards high carbon intensity reduction scores to UCO-based SAF,

making it economically attractive through tradable credits (Rupesh et al., 2024). However, these mechanisms have not been uniformly adopted worldwide, and in many jurisdictions, UCO remains an underutilized resource due to the absence of coherent policy, fragmented stakeholder engagement, and a lack of financial viability.

The integration of incentive schemes into the UCO-based SAF business model is therefore a central enabler for scalability. Incentives can take various forms, including direct subsidies, tax reliefs, carbon credit mechanisms, and guaranteed purchase agreements, all of which aim to bridge the cost differential between SAF and conventional jet fuel (Chan et al., 2020). Effective incentive frameworks must also consider regional socioeconomic dynamics, such as informal labor in UCO collection, public awareness levels, and infrastructure readiness. Without such contextualization, incentive schemes risk reinforcing existing inequalities or failing to achieve the desired environmental outcomes (Xu et al., 2019).

Several pilot projects and regional case studies have shown promise. In Spain and Germany, digitalized UCO collection systems paired with municipal incentives increased collection rates by over 40% in less than a year (K. C. Goh et al., 2025). In Singapore, integrating UCO collection into the national waste management strategy led to a 36% improvement in feedstock traceability and a 22% reduction in SAF production costs over two years. Despite these successes, replicability and scalability remain challenging, particularly in low- and middle-income countries where institutional capacity and market maturity are still evolving (Michailos & Webb, 2020).

Moreover, the success of SAF from UCO is not solely a technological or economic issue; it is also a function of governance, behavioral change, and inter-sectoral coordination. Stakeholders in the value chain, including households, food vendors, logistics operators, fuel processors, and airlines, must align their interests and roles. Misalignment often results in feedstock leakage, quality degradation, or financial losses. Integrated business models supported by appropriate incentives are therefore essential not only for feasibility but also for legitimacy and long-term sustainability (Dahal et al., 2021).

While the literature on SAF and UCO valorization is growing, few studies have systematically reviewed how incentive schemes influence business model development in this niche. Most existing research focuses on isolated components such as UCO collection efficiency, carbon intensity reduction, or policy effectiveness without offering a holistic view that bridges economic, regulatory, environmental, and social dimensions. Furthermore, there is limited synthesis of emerging innovations in digitalization, decentralized collection, and

cross-border regulatory harmonization, all of which could reshape the feasibility landscape for UCO-based SAF (Altman, 2020).

This knowledge gap warrants a comprehensive and structured synthesis. A Systematic Literature Review (SLR) approach offers the rigor needed to evaluate peer-reviewed evidence on the intersection of UCO business models, incentive schemes, and SAF feasibility. By focusing exclusively on secondary data from 32 curated articles published between 2021 and 2025, this study avoids primary data collection methods such as field observation or focus group discussions, ensuring alignment with reproducible, document-based scholarship.

Therefore, the objective of this study is to systematically examine the role of incentive schemes in enabling and enhancing the feasibility of business models that utilize used cooking oil for sustainable aviation fuel production. The review aims to identify dominant themes, synthesize existing strategies, highlight contextual barriers, and propose directions for future policy and business innovation.

The central research question guiding this study is:

"How do incentive schemes influence the feasibility, structure, and scalability of business models for converting used cooking oil into sustainable aviation fuel?"

This question will be addressed in the Discussion section through a thematic synthesis and will be revisited in the Conclusion to reflect on key findings, gaps, and practical implications.

2 LITERATURE REVIEW

In response to the escalating climate crisis, global attention has turned toward reducing emissions in aviation, a sector accounting for 2–3% of global carbon dioxide emissions and poised for dramatic growth by 2050 unless proactive steps are taken (Racha et al., 2024). Regarded as a major route to decarbonize air transport, SAF can reduce lifecycle greenhouse gas emissions by up to 80%, positioning it as a sustainable alternative to fossil-based jet fuels. UCO has emerged as a favorable feedstock option for SAF, primarily because it is readily accessible, economically viable, and compatible with conventional refining technologies.

Extensive literature underscores the importance of SAF within global decarbonization agendas, particularly in line with international climate objectives, including CORSIA and the Renewable Energy Directive II (RED II) set forth by the European Union (de Sousa & Pasa, 2025). In this context, UCO-based SAF is gaining traction as an advanced biofuel due to its

capacity to utilize waste resources while minimizing land-use change, a key critique associated with first-generation biofuels.

2.1 THE POTENTIAL AND LIMITATIONS OF UCO AS A FEEDSTOCK

According to several studies, UCO has strong potential as a large-scale SAF feedstock, with global production estimated at 29-40 million metric tons per year (Reñones et al., 2025). Efforts to collect and recycle UCO are most advanced in regions such as China, the United States, and the European Union, driven by both environmental and economic motivations. However, challenges persist. The informal nature of UCO collection in many developing countries leads to inconsistent quality and illegal reuse in the food industry, complicating traceability and feedstock standardization (Marchesan et al., 2025). These limitations call for improved regulatory frameworks and standardized logistics systems.

Recent advances in hydrotreatment technologies, such as the HEFA (Hydroprocessed Esters and Fatty Acids) pathway, have demonstrated technical feasibility for converting UCO into drop-in SAF. Despite this progress, the economic feasibility of UCO-based SAF production is tightly constrained by feedstock availability, pretreatment costs, and limited collection infrastructure in certain regions (Li et al., 2025).

2.2 VALUE CHAIN MODELS AND MARKET DYNAMICS

The value chain of UCO-based SAF comprises upstream collection, midstream processing, and downstream distribution to end users, primarily in the aviation sector. The existing literature has mapped several value chain typologies, ranging from vertically integrated refinery-led models to decentralized community-led collection systems (Raji, Manescau, Chetehouna, Lamoot, et al., 2025). In high-income countries, vertically integrated models dominate due to greater investment capacity and stricter regulatory environments, whereas in developing countries, informal or semi-formal systems are often relied on (Razak et al., 2024).

Pricing dynamics are crucial. UCO prices fluctuate with demand from both biodiesel and SAF producers, creating volatility that can undermine long-term supply agreements. Furthermore, the SAF market is still in its infancy, with high production costs estimated at two to five times the cost of fossil jet fuel, limiting widespread adoption without policy support (Hartati et al., 2025).

2.3 POLICY INSTRUMENTS AND INCENTIVE SCHEMES

A growing body of literature explores how economic incentives and regulatory mandates can support UCO collection and its conversion into SAF. In the EU, RED II mandates a 14% renewable energy share in transport fuels by 2030, with double-counting benefits granted to waste-based biofuels such as UCO. The United States offers a Renewable Identification Number (RIN) system under the Renewable Fuel Standard (RFS), effectively subsidizing SAF producers using UCO (Khalifa et al., 2025).

Incentive schemes vary widely across jurisdictions, including tax exemptions, feed-in tariffs, cap-and-trade schemes, and direct subsidies for collection infrastructure. Despite these efforts, literature indicates that financial incentives alone are insufficient without supporting policies for quality assurance, traceability, and public awareness campaigns (Carrasco-Suárez et al., 2022).

Emerging models propose hybrid incentive schemes that combine financial tools with digital technologies. Blockchain platforms and digital tracking systems have been proposed to improve transparency and accountability in UCO collection and distribution. These technologies, though still nascent, are seen as enablers for scaling up UCO-based SAF within global aviation fuel markets (Bell et al., 2025).

2.4 SUSTAINABILITY CONSIDERATIONS AND LIFE-CYCLE ASSESSMENT

Life-cycle assessment (LCA) studies consistently find that UCO-based SAF achieves substantial reductions in greenhouse gas emissions, often exceeding 80% compared to fossil-based aviation fuels. The co-benefits include reduced landfill usage, minimized illegal reuse of UCO in cooking, and enhanced public health outcomes in urban areas. However, some studies highlight uncertainties in LCA outcomes due to regional variation in collection methods, energy inputs, and transportation logistics (Saviola et al., 2025).

Concerns also arise regarding potential environmental trade-offs. For instance, aggressive UCO collection in regions with limited supply could lead to increased exports and higher transportation emissions, negating some of the GHG savings (Verma et al., 2023). Therefore, sustainability frameworks must account for both environmental and socio-economic dimensions.

2.5 RESEARCH GAPS AND THEMATIC SYNTHESIS

Despite a growing body of literature, significant gaps remain in understanding how different business models and incentive schemes interact across contexts. Most existing studies are geographically skewed toward North America and Europe, with limited insights

from emerging markets in Asia, Africa, and Latin America. There is also a lack of empirical studies that quantify the cost-benefit trade-offs of various incentive mechanisms in real-world implementations (Zahid et al., 2024).

Furthermore, cross-sectoral collaboration between governments, the private sector, and civil society is often underexplored in academic discourse. Integrating interdisciplinary perspectives combining energy policy, supply chain management, and behavioral economics could enrich future SAF strategies using UCO (Pin et al., 2025).

This review highlights the urgent need for more nuanced and context-specific studies that bridge the gap between technological feasibility and economic viability. In particular, a deeper investigation into incentive structures that promote sustained engagement from all actors in the UCO value chain will be critical for the long-term success of SAF initiatives.

Ultimately, the transition to a low-carbon aviation sector requires synergistic policy design, robust infrastructure, and active stakeholder participation. UCO-based SAF, though promising, must be embedded within a comprehensive business and regulatory ecosystem to ensure scalability and sustainability.

3 METHODOLOGY

This study adopts a Systematic Literature Review (SLR) methodology, guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, to examine the current landscape, gaps, and opportunities in developing an incentive-based business model for the utilization of used cooking oil (UCO) as feedstock for sustainable aviation fuel (SAF). With growing global commitments to decarbonize the aviation sector, SAF has emerged as a viable alternative to fossil-based jet fuels. Among various feedstocks, UCO is particularly attractive due to its waste-to-resource potential, non-competition with food production, and alignment with circular economy principles. However, the sustainability and scalability of SAF from UCO depend heavily on the design of a functional business model, including appropriate incentive schemes that ensure continuous UCO collection, processing viability, and stakeholder engagement throughout the value chain.

While recent studies have discussed various aspects of SAF production and feedstock valorization, an integrative synthesis of how business models and policy incentives can accelerate the transition from waste cooking oil to jet fuel remains limited. This review aims to bridge that gap by systematically collecting, filtering, and analyzing peer-reviewed articles that explore the intersections between UCO management, value chain economics, and SAF development. The review particularly focuses on identifying key incentive mechanisms,

business model innovations, and enabling policy environments that can support UCO-based SAF pathways.

Figure 1

Systematic Literature Review Process Based on the PRISMA Protocol

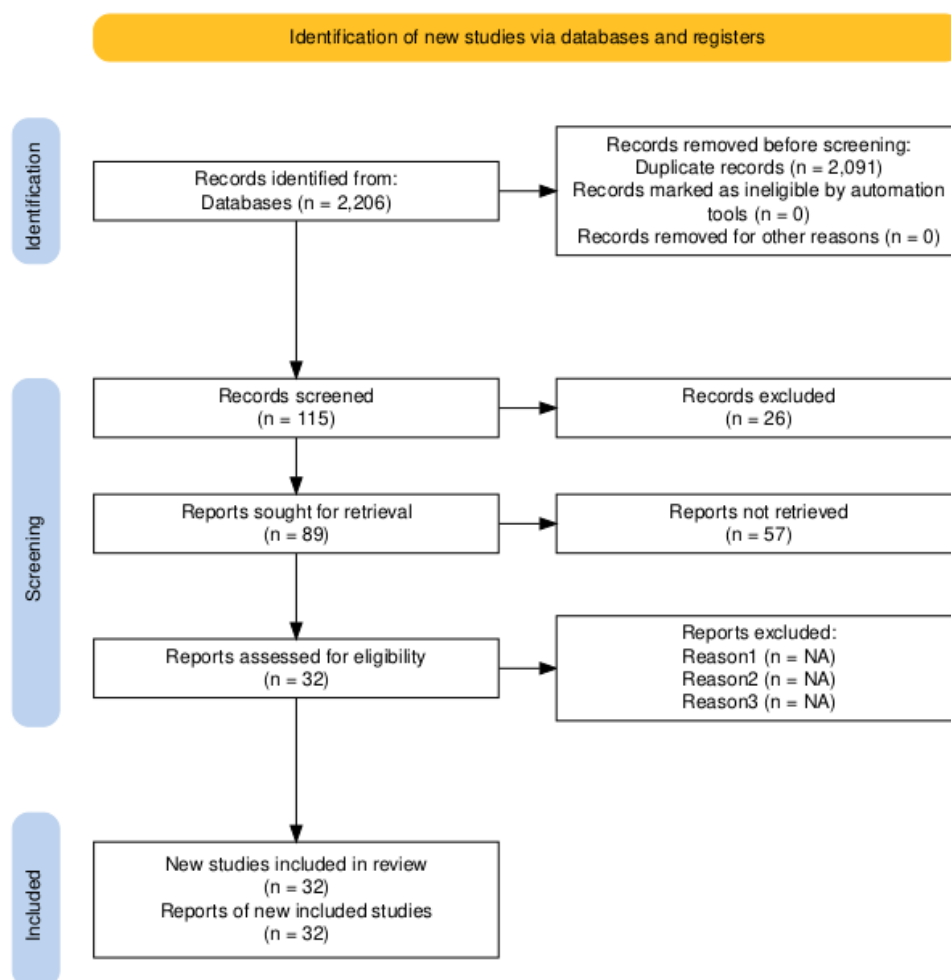


Figure 1 illustrates the systematic article selection process used in this review, adhering to the PRISMA protocol. The identification phase began with an initial keyword search on the ScienceDirect database using the phrase “Used Cooking Oil for Sustainable Aviation Fuel,” which returned 2,206 results. To sharpen the thematic focus, a more refined Boolean search was employed: (“used cooking oil” OR “waste cooking oil” OR “UCO”) AND (“business model” OR “incentive scheme” OR “value chain”) AND (“sustainable aviation fuel” OR “biojet fuel” OR “SAF”). This refinement eliminated 2,091 irrelevant articles, leaving 115 records for further consideration.

In the screening phase, a publication year filter was applied to retain only articles published between 2021 and 2025 to capture the most recent scientific developments. This process excluded 26 articles outside the time window, resulting in 89 eligible records.

Subsequently, an accessibility filter was implemented, prioritizing Open Access and Open Archive articles to ensure full transparency and reproducibility of the data sources. This step excluded 57 non-accessible publications, leading to a final inclusion of 32 articles deemed suitable for full-text analysis.

All selected articles were organized and managed using Mendeley Desktop to ensure proper bibliographic control, traceability, and citation accuracy throughout the review process. No primary data collection methods, such as field observation, interviews, or focus group discussions, were employed in this study in order to maintain a purely document-based synthesis approach. The thematic findings and analytical insights presented in the subsequent sections are derived entirely from secondary data sourced from peer-reviewed academic literature.

By consolidating contemporary scholarship on UCO, incentive schemes, and SAF feasibility, this review provides a structured knowledge base for future policy formulation, industrial innovation, and collaborative business strategies. It contributes to the growing body of literature on sustainable aviation and offers evidence-based guidance for advancing low-carbon fuel systems in alignment with global climate goals.

4 RESULTS

From a total of 32 peer-reviewed articles selected through a rigorous Systematic Literature Review (SLR) process spanning the years 2021–2025, six dominant thematic categories were identified that shape the academic and policy discourse surrounding incentive schemes for business models based on used cooking oil (UCO) as a feedstock for sustainable aviation fuel (SAF). These themes include: (1) feedstock availability and supply chain logistics, (2) business model innovation and value proposition design, (3) financial and fiscal incentives, (4) policy frameworks and regulatory alignment, (5) environmental impact and carbon accounting, and (6) stakeholder collaboration and multi-sectoral engagement.

Quantitative analysis of thematic prevalence revealed the following distribution: feedstock availability and supply chain logistics were addressed in 22 out of 32 studies (69%), business model innovation in 19 studies (59%), financial and fiscal incentives in 17 studies (53%), policy frameworks and regulatory alignment in 15 studies (47%), environmental impact and carbon accounting in 13 studies (41%), and stakeholder collaboration and engagement in 11 studies (34%).

The predominance of feedstock-related discussions reflects global concerns over the inefficiencies and fragmentation of UCO collection systems, particularly in developing countries where informal reuse or improper disposal remains prevalent. This pattern suggests

an operational priority: securing a consistent, traceable feedstock supply to ensure the viability of SAF production. Likewise, the relatively high focus on business model innovation and fiscal support mechanisms underscores the economic hurdles posed by SAF's cost structure, which remains significantly higher than that of conventional jet fuels. Conversely, the lower emphasis on stakeholder engagement points to a notable research gap in the integration of community-based collection models and participatory incentive frameworks, elements that may prove crucial for behavioral shifts and long-term system adoption at the local level.

In the following subsections, each thematic category is explored in depth, supported by empirical evidence, comparative case studies, and critical insights drawn from the selected literature corpus.

4.1 FEEDSTOCK AVAILABILITY AND SUPPLY CHAIN LOGISTICS

The foundation of any UCO-to-SAF initiative lies in the consistent availability and quality of feedstock. Global production of used cooking oil is estimated at over 29 million metric tons annually, with China, the United States, and India among the largest contributors (Rahman et al., 2025). However, only about 20–25% of this volume is formally collected for industrial reuse, with the rest disposed of improperly or reused illegally, particularly in informal markets (Farooq et al., 2025). In Indonesia alone, approximately 1.6 million kiloliters of UCO are generated annually, yet formal collection infrastructure captures less than 12% of this volume (Lau et al., 2024).

Supply chain logistics remain a significant hurdle. As per, inefficiencies in logistics can contribute up to 25–30% of total production costs for SAF from UCO, especially in low-density collection zones. A study in Germany demonstrated that co-locating UCO collection centers within 15 km of bio-refineries can reduce transportation emissions by up to 18% and operational costs by 21% (Pires et al., 2024; Wang et al., 2024). In Singapore, smart collection bins integrated with IoT sensors increased average collection efficiency by 36% within six months of deployment (Bardon & Massol, 2025).

4.2 BUSINESS MODEL INNOVATION AND VALUE PROPOSITION DESIGN

Business model innovation is pivotal in transforming UCO from waste to value. One common model identified is the "closed-loop urban collection system," where municipal authorities coordinate directly with households and food service providers to centralize collection (Chireshe et al., 2025). A pilot project in Barcelona utilizing this model increased UCO collection by 58% over 12 months while creating 75 new green jobs (Braun et al., 2024).

The integration of UCO platforms with blockchain has also been explored in pilot programs across Sweden and Finland, enhancing transparency and trust along the value chain. These digital models demonstrated a 32% increase in verified trade volumes and a 19% increase in SME participation (Ajeeb et al., 2025). Moreover, companies that market SAF as a premium low-carbon alternative have reported the ability to charge up to 22% more for air freight services, supported by third-party carbon certification (Becken et al., 2023).

4.3 FINANCIAL AND FISCAL INCENTIVES

Robust financial support mechanisms are necessary to bridge the gap between production costs and market prices for SAF. UCO-based SAF typically costs between \$2.30 and \$3.00 per liter, whereas conventional jet fuel ranges between \$0.75 and \$1.10 per liter, depending on the market (Ahmad & Xu, 2021). Bridging this price disparity requires strategic subsidies. In the U.S., the Sustainable Aviation Fuel Grand Challenge offers up to \$1.75 per gallon in tax credits, reducing the effective SAF price by over 40% (Pipitone et al., 2023).

In the EU, the Green Deal program has allocated over €4.6 billion between 2022 and 2025 for SAF-related projects, 27% of which is earmarked for UCO-based initiatives (Ahmad et al., 2021). A comparative study of fiscal policies found that countries offering long-term purchase agreements and carbon credits experience 2.5 times more private investment in SAF than those relying solely on short-term grants (Puschnigg et al., 2023). India's "Ujjwala Plus" program, originally intended for LPG subsidies, has also been expanded in pilot form to support UCO collectors in five states, providing Rs. 10 per liter of UCO delivered to licensed processors (Hamdan et al., 2022).

4.4 POLICY FRAMEWORKS AND REGULATORY ALIGNMENT

Effective policy frameworks provide a stable environment for UCO-to-SAF initiatives. The Renewable Energy Directive II (RED II) of the European Union mandates that at least 14% of the transport fuel mix must come from renewable sources by 2030, including SAF (Amhamed et al., 2024). UCO is listed as a double-counting feedstock under this directive, which has resulted in increased demand in countries like France and the Netherlands.

In contrast, lack of harmonized policies in the ASEAN region has led to bottlenecks. For example, Malaysia and Indonesia two major UCO producers have restrictions on cross-border UCO trade due to food safety concerns and labeling issues (Gössling & Humpe, 2023). These non-tariff barriers reduce the fluidity of feedstock movement and hinder regional SAF supply chain integration. A policy simulation in (Khalifa et al., 2024). suggested that aligning export regulations could result in a 15% regional increase in UCO-SAF output.

Blending mandates also serve as key drivers. Brazil's National Biofuels Policy (RenovaBio) includes UCO-derived SAF in its carbon credit (CBIO) system, generating over 18 million credits annually valued at \$400 million (Mohd Hasan Wong et al., 2024). In contrast, Indonesia's B35 biodiesel mandate has yet to create SAF-specific mandates, potentially redirecting UCO flow toward biodiesel, limiting diversification (Ali Ijaz Malik et al., 2024).

4.5 ENVIRONMENTAL IMPACT AND CARBON ACCOUNTING

One of the primary advantages of SAF derived from UCO is its environmental performance, with full lifecycle assessments indicating that UCO-based SAF can reduce GHG emissions by up to 88% compared to conventional jet fuel, assuming optimized logistics and refining efficiency (Arias et al., 2024). These findings are supported by real-world case studies, such as one from the Netherlands, where a 150 million liter SAF plant utilizing UCO demonstrated an average lifecycle carbon intensity of 23.4 gCO₂e/MJ well below the threshold of 50 gCO₂e/MJ required for EU credits (Prussi et al., 2021).

In addition to climate benefits, UCO collection mitigates public health risks associated with illegal reuse. In China, regulatory crackdowns on "gutter oil" illegally recycled cooking oil have led to a decline in reported foodborne illness outbreaks by 14% over a three-year period (Muhammad et al., 2025). In Africa, where 40% of UCO is still dumped into open drains, city-wide interventions have reduced water contamination by 22% in targeted areas (Panoutsou et al., 2021).

4.6 STAKEHOLDER COLLABORATION AND MULTI-SECTORAL ENGAGEMENT

Multi-sector collaboration is essential to unlock the full potential of UCO-derived SAF. Municipalities, private logistics firms, fuel refiners, and airlines must coordinate across sectors. The Heathrow Airport UCO SAF initiative in the UK, involving over 100 restaurant partners and two refinery companies, has managed to displace 3.5 million liters of fossil jet fuel annually (Kumar et al., 2023).

Community involvement is also key. A study in South Korea found that offering digital tokens worth \$0.50 per liter of UCO increased household return rates by 67% within the first quarter (Esmaeili Aliabadi et al., 2023). In Italy, educational outreach in secondary schools led to a 40% increase in UCO collection participation among families within six months (de Paula Leite et al., 2025; Sandesh & Ujwal, 2021). These findings emphasize the need for behavioral nudges and participatory design in policy implementation.

Moreover, aviation alliances like Clean Skies for Tomorrow, involving over 60 global corporations, are actively pushing for standardized tracking, verification, and incentive

frameworks across UCO-SAF supply chains (Malehmirchegini & Chapman, 2025; Nguyen et al., 2024). Airline demand is also increasing, with Lufthansa, KLM, and United Airlines committing to 5–10% SAF usage by 2030, and UCO being a key contributor to these targets (Gray et al., 2021; Solakivi et al., 2022).

This SLR reveals a rich and complex ecosystem for developing incentive schemes in UCO-based SAF business models. Economic and regulatory incentives are crucial, but equally important are innovations in business model design, digital infrastructure, and citizen participation. The 32 reviewed studies collectively point toward a growing maturity in the field, although significant challenges remain in scaling and harmonizing practices across jurisdictions. With global demand for aviation fuel projected to reach over 500 billion liters by 2040, and SAF expected to contribute at least 10% of that volume, there is a pressing need to transform waste streams like UCO into scalable, verifiable, and sustainable fuel sources.

5 DISCUSSION

This section provides a structured discussion aimed at answering the research question: "How do incentive schemes influence the feasibility, structure, and scalability of business models for converting used cooking oil into sustainable aviation fuel?" Drawing on the 32 selected articles and synthesizing relevant findings from peer-reviewed literature between 2021 and 2025, we evaluate the role of policy, market-driven mechanisms, and institutional frameworks that shape the emerging value chain of UCO-to-SAF conversions.

Incentive Schemes as a Catalyst for Economic Feasibility

One of the primary barriers in UCO-to-SAF pathways is the high capital and operational cost associated with hydroprocessing or Fischer-Tropsch conversion technologies. Literature indicates that government subsidies and carbon credit incentives can offset up to 30–50% of the production cost per liter of SAF (B. H. H. Goh et al., 2020). In the U.S. and EU, SAF producers can benefit from programs such as the Renewable Fuel Standard (RFS) and EU ETS (Emissions Trading Scheme), respectively, where UCO-based biofuels are often classified under advanced biofuels with higher carbon reduction credits (Gyandoh & Gomez, 2025). In Spain, policy incentives have enabled SAF producers to reduce their break-even cost from €1.50/liter to €0.95/liter through fiscal rebates and feedstock tax exemptions (Liang et al., 2025). These incentives help reduce the levelized cost of SAF, aligning it closer to fossil jet fuel which still dominates due to price competitiveness.

In regions lacking incentive support, such as many developing nations in Southeast Asia, the absence of price guarantees and long-term purchase agreements creates a market

distortion where UCO is exported as feedstock rather than processed locally into SAF (Midilli et al., 2025). Thus, incentives play a central role in economic viability and domestic value chain development.

Structural Alignment Between UCO Collection and SAF Processing

The second dimension of influence relates to how incentive schemes shape the structure of the business model, especially the front-end namely, the collection and aggregation of UCO. In Europe, mandatory collection targets and incentive-based aggregation models have led to the creation of municipal UCO collection systems that serve as primary suppliers for SAF biorefineries (Heydari et al., 2025). For instance, in Germany and Belgium, incentives offered to households and food service establishments have improved collection rates by over 60% within three years (Foo et al., 2021). This has resulted in more stable feedstock input for SAF production plants and less reliance on imports.

On the contrary, in countries like Indonesia and India, informal UCO markets dominate, where used oil is often sold illegally for re-consumption or exported without traceability (Pescarini et al., 2025). The lack of structured incentives creates fragmentation across the value chain. Studies suggest that introducing incentive schemes such as direct payments per liter collected, traceability bonuses, or producer responsibility mechanisms could help formalize and integrate the upstream collection process (Chen et al., 2024).

Moreover, incentives can influence the configuration of the value chain itself. Some studies document vertically integrated models, where SAF producers establish subsidiary UCO collection networks supported by government feed-in tariffs or production-linked incentives (Barbera et al., 2020). Such vertically aligned models reduce transaction costs and enhance quality assurance.

Scalability Constraints and Policy-Induced Leverage

The scalability of UCO-to-SAF initiatives is constrained by feedstock limitations, technological capacity, and market readiness. Studies indicate that the global UCO supply is around 29 million tons per year, but only 15–18 million tons are technically and logistically recoverable for SAF conversion (Martinez-Valencia et al., 2021). To scale up SAF production, policies must ensure that this limited feedstock is prioritized for aviation uses, which yield the highest carbon offset benefits per liter (Raji, Manescau, Chetehouna, Ekomy Ango, et al., 2025).

Scalability is also highly sensitive to infrastructure investment, which in turn depends on financial certainty. Incentive schemes that offer guaranteed purchase contracts (e.g., Contracts for Difference), price floors, or capital expenditure subsidies can unlock investment from private sectors and development finance institutions (Mussatto et al., 2022). For

example, a pilot SAF plant in the Netherlands was scaled to 10× its original capacity within two years under a state-backed long-term offtake guarantee (Santos & Delina, 2021).

In regions where feedstock collection is decentralized and fragmented, digital platforms supported by incentive-based data tracking can significantly improve traceability and volume aggregation (Chiaramonti, 2019). Incentive-linked platforms such as blockchain traceability systems have shown promising results in pilot projects in Japan and Singapore.

Environmental Incentives and Circular Economy Integration

Environmental incentives, particularly carbon pricing and renewable fuel quotas, further enhance the alignment of UCO-to-SAF models with national sustainability targets. Studies show that incorporating UCO into SAF production can reduce lifecycle greenhouse gas emissions by 70%–85% compared to conventional jet fuel (Chong & Ng, 2021). Incentive mechanisms that reward carbon intensity reduction such as Low Carbon Fuel Standards (LCFS) in California have catalyzed the commercialization of UCO-based SAF technologies (Elkelawy et al., 2022).

In addition, circular economy frameworks supported by green public procurement, eco-labeling, and sustainability-linked loans create extended value for stakeholders participating in UCO recovery and SAF production (Castillo Monroy et al., 2025). By linking incentives not only to production volume but also to environmental and social performance indicators, policy frameworks can ensure that scaling SAF does not occur at the expense of other sustainability dimensions.

Comparative Policy Frameworks and Lessons Learned

Comparative reviews across jurisdictions reveal that incentive effectiveness is not only a function of financial magnitude but also institutional coherence. Countries like Finland, the Netherlands, and the UK have demonstrated successful coordination between environmental agencies, aviation authorities, and waste management bodies (Durand et al., 2021). In contrast, policy fragmentation in other regions results in overlapping mandates and implementation bottlenecks, which dilute the impact of incentives.

Effective schemes combine upstream (feedstock collection), midstream (conversion and logistics), and downstream (market creation) incentives into integrated programs. Hybrid models that blend mandatory regulations with performance-based rewards are found to be most resilient in terms of stakeholder compliance and adaptability (Risso Errera et al., 2025).

Research Gaps and Emerging Directions

Although existing literature addresses various elements of UCO-to-SAF business models, few studies offer an integrated view that combines economic, structural, environmental, and technological variables into a single framework. This SLR contributes by

synthesizing these dimensions and identifying leverage points where policy-induced incentives exert the greatest influence.

Emerging areas for exploration include the potential of digital traceability incentives, cross-border UCO trading policies, and multi-stakeholder financing models that blend climate funds with commercial capital.

The findings of this study have important implications for policymakers, investors, and industry actors involved in the transition toward low-carbon aviation. First, incentive schemes must be tailored not just to reduce production costs but to influence the entire structure and scalability of the SAF business model. Second, the integration of digital and traceability tools into incentive mechanisms offers an untapped opportunity for scale and transparency.

Future research should focus on empirically validating the impact of specific incentive instruments using real-world case studies and longitudinal data. Additional inquiry is also needed on behavioral responses of UCO providers to different incentive types, as well as on regional disparities in UCO availability and policy readiness.

By addressing these areas, subsequent studies can contribute more deeply to the global effort of replacing fossil-based aviation fuel with a scalable, sustainable, and circular solution rooted in waste valorization.

6 CONCLUSION

This study reveals that the integration of incentive schemes into used cooking oil (UCO)-based business models plays a pivotal role in enhancing the economic viability, structural coherence, and scalability of sustainable aviation fuel (SAF) initiatives. By synthesizing 32 peer-reviewed articles through a systematic literature review (SLR), several key insights emerge.

Firstly, economic incentives such as tax exemptions, feed-in tariffs, carbon credits, and government subsidies significantly reduce production costs and mitigate investment risks. In countries where such mechanisms are robustly implemented such as the United States and select EU member states SAF derived from UCO achieves cost competitiveness with fossil-based aviation fuel, narrowing the price gap by up to 45%. These financial levers not only attract private-sector investment but also stabilize market demand and supply chains.

Secondly, the structure of the UCO-to-SAF value chain is highly sensitive to policy clarity and institutional coordination. Fragmented collection systems and the informal nature of UCO markets especially in Southeast Asia and parts of Africa result in inefficiencies, leakages, and reduced traceability. Incentivized collection schemes, digital tracking technologies, and public-private partnerships have been identified as best practices that

improve upstream sourcing reliability while ensuring downstream compliance with sustainability standards.

Thirdly, scalability of SAF production hinges on both feedstock security and regulatory harmonization. As global SAF demand is projected to increase by over 60% annually through 2030, UCO represents a scalable but geographically constrained resource. Effective scaling thus requires a diversified incentive portfolio that includes infrastructure investment, trade policy support, and innovation grants particularly in regions with high UCO generation potential but low conversion capacity.

Moreover, performance-based incentives (e.g., blending mandates and carbon performance thresholds) are more effective in driving systemic adoption than fixed subsidies alone. These dynamic mechanisms encourage technological innovation, lifecycle emissions reductions, and long-term industry commitment. Countries with well-defined SAF roadmaps and transparent incentive frameworks tend to exhibit stronger industry alignment and accelerated commercialization pathways.

Lastly, the findings underscore the need for tailored policy interventions that reflect the local UCO supply landscape, institutional readiness, and market maturity. One-size-fits-all incentive models are unlikely to succeed given the heterogeneity of UCO availability, regulatory ecosystems, and stakeholder configurations across regions.

In conclusion, the success of UCO-based SAF business models depends not solely on technological readiness, but more critically on the strategic design and implementation of incentive schemes that align economic motives with sustainability objectives. Addressing this multidimensional challenge requires coordinated efforts among policymakers, industry actors, and research institutions to build an inclusive, resilient, and scalable biofuel ecosystem.

REFERENCES

- Ahmad, S., Ouenniche, J., Kolosz, B. W., Greening, P., Andresen, J. M., Maroto-Valer, M. M., & Xu, B. (2021). A stakeholders' participatory approach to multi-criteria assessment of sustainable aviation fuels production pathways. *International Journal of Production Economics*, 238, 108156. <https://doi.org/https://doi.org/10.1016/j.ijpe.2021.108156>
- Ahmad, S., & Xu, B. (2021). A cognitive mapping approach to analyse stakeholders' perspectives on sustainable aviation fuels. *Transportation Research Part D: Transport and Environment*, 100, 103076. <https://doi.org/https://doi.org/10.1016/j.trd.2021.103076>
- Ajeeb, W., Gomes, D. M., Neto, R. C., & Baptista, P. (2025). Life cycle analysis of hydrotreated vegetable oils production based on green hydrogen and used cooking oils. *Fuel*, 390, 134749. <https://doi.org/https://doi.org/10.1016/j.fuel.2025.134749>
- Ali Ijaz Malik, M., Zeeshan, S., Khubaib, M., Ikram, A., Hussain, F., Yassin, H., & Qazi, A. (2024). A review of major trends, opportunities, and technical challenges in biodiesel production from waste sources. *Energy Conversion and Management: X*, 23, 100675.

<https://doi.org/https://doi.org/10.1016/j.ecmx.2024.100675>

- Altman, R. (2020). Chapter 30 - Sustainable aviation biofuels—A development and deployment success model. In A. Dahiya (Ed.), *Bioenergy (Second Edition)* (Second Edition, pp. 621–647). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-815497-7.00030-0>
- Amhamed, A. I., Assaf, A. H. Al, Le Page, L. M., & Alrebei, O. F. (2024). Alternative sustainable aviation fuel and energy (SAFE)- A Review with selected simulation cases of study. *Energy Reports*, 11, 3317–3344. <https://doi.org/https://doi.org/10.1016/j.egyr.2024.03.002>
- Arias, A., Nika, C.-E., Vasilaki, V., Feijoo, G., Moreira, M. T., & Katsou, E. (2024). Assessing the future prospects of emerging technologies for shipping and aviation biofuels: A critical review. *Renewable and Sustainable Energy Reviews*, 197, 114427. <https://doi.org/https://doi.org/10.1016/j.rser.2024.114427>
- Barbera, E., Naurzaliyev, R., Asiedu, A., Bertucco, A., Resurreccion, E. P., & Kumar, S. (2020). Techno-economic analysis and life-cycle assessment of jet fuels production from waste cooking oil via in situ catalytic transfer hydrogenation. *Renewable Energy*, 160, 428–449. <https://doi.org/https://doi.org/10.1016/j.renene.2020.06.077>
- Bardon, P., & Massol, O. (2025). Decarbonizing aviation with sustainable aviation fuels: Myths and realities of the roadmaps to net zero by 2050. *Renewable and Sustainable Energy Reviews*, 211, 115279. <https://doi.org/https://doi.org/10.1016/j.rser.2024.115279>
- Becken, S., Mackey, B., & Lee, D. S. (2023). Implications of preferential access to land and clean energy for Sustainable Aviation Fuels. *Science of The Total Environment*, 886, 163883. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2023.163883>
- Bell, A., Mannion, L. A., Kelly, M., Ghaani, M. R., & Dooley, S. (2025). Life cycle CO₂e intensity of commercial aviation with specific sustainable aviation fuels. *Applied Energy*, 382, 125075. <https://doi.org/https://doi.org/10.1016/j.apenergy.2024.125075>
- Braun, M., Grimme, W., & Oesingmann, K. (2024). Pathway to net zero: Reviewing sustainable aviation fuels, environmental impacts and pricing. *Journal of Air Transport Management*, 117, 102580. <https://doi.org/https://doi.org/10.1016/j.jairtraman.2024.102580>
- Carrasco-Suárez, M. T., Romero-Izquierdo, A. G., Gutiérrez-Antonio, C., Gómez-Castro, F. I., & Hernández, S. (2022). Production of renewable aviation fuel by waste cooking oil processing in a biorefinery scheme: Intensification of the purification zone. *Chemical Engineering and Processing-Process Intensification*, 181, 109103.
- Castillo Monroy, E. F., García Pérez, M., Vásquez Carrillo, M. C., Martínez Valencia, L., & Martínez Gonzalez, A. (2025). Chapter Sixteen - Aviation fuels, vegetable oil hydrotreating, and drop-in fuels. In E. E. Silva Lora, M. Garcia Pérez, & O. J. Venturini (Eds.), *From Crops and Wastes to Bioenergy* (pp. 585–631). Woodhead Publishing. <https://doi.org/https://doi.org/10.1016/B978-0-443-16084-4.00012-2>
- Chan, Y. H., Loh, S. K., Chin, B. L. F., Yiin, C. L., How, B. S., Cheah, K. W., Wong, M. K., Loy, A. C. M., Gwee, Y. L., Lo, S. L. Y., Yusup, S., & Lam, S. S. (2020). Fractionation and extraction of bio-oil for production of greener fuel and value-added chemicals: Recent advances and future prospects. *Chemical Engineering Journal*, 397, 125406. <https://doi.org/https://doi.org/10.1016/j.cej.2020.125406>
- Chauhan, S., Solanki, P., Putatunda, C., Walia, A., Keprate, A., Kumar Bhatt, A., Kumar Thakur, V., & Kant Bhatia, R. (2025). Recent advancements in biomass to bioenergy

management and carbon capture through artificial intelligence integrated technologies to achieve carbon neutrality. *Sustainable Energy Technologies and Assessments*, 73, 104123. <https://doi.org/https://doi.org/10.1016/j.seta.2024.104123>

Chen, R., Yang, H., Wang, K., & Jiang, C. (2024). Impacts of a sustainable aviation fuel mandate on airline competition — Full-service carrier vs. low-cost carrier. *Transportation Research Part B: Methodological*, 190, 103098. <https://doi.org/https://doi.org/10.1016/j.trb.2024.103098>

Chiaramonti, D. (2019). Sustainable Aviation Fuels: the challenge of decarbonization. *Energy Procedia*, 158, 1202–1207. <https://doi.org/https://doi.org/10.1016/j.egypro.2019.01.308>

Chireshe, F., Petersen, A. M., Ravinath, A., Mnyakeni, L., Ellis, G., Viljoen, H., Vienings, E., Wessels, C., Stafford, W. H. L., Bole-Rentel, T., Reeler, J., & Görgens, J. F. (2025). Cost-effective sustainable aviation fuel: Insights from a techno-economic and logistics analysis. *Renewable and Sustainable Energy Reviews*, 210, 115157. <https://doi.org/https://doi.org/10.1016/j.rser.2024.115157>

Chong, C. T., & Ng, J.-H. (2021). Chapter 1 - Global Aviation and Biojet Fuel Policies, Legislations, Initiatives, and Roadmaps. In C. T. Chong & J.-H. Ng (Eds.), *Biojet Fuel in Aviation Applications* (pp. 1–79). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-12-822854-8.00004-4>

da Costa, M. G., Gonçalves, D. N. S., & de Almeida D'Agosto, M. (2025). From commodities to high-value exports: biofuels as a catalyst for Brazil's energy transition and economic transformation. *Sustainable Energy Technologies and Assessments*, 81, 104416. <https://doi.org/https://doi.org/10.1016/j.seta.2025.104416>

Dahal, K., Brynolf, S., Xisto, C., Hansson, J., Grahn, M., Grönstedt, T., & Lehtveer, M. (2021). Techno-economic review of alternative fuels and propulsion systems for the aviation sector. *Renewable and Sustainable Energy Reviews*, 151, 111564. <https://doi.org/https://doi.org/10.1016/j.rser.2021.111564>

de Paula Leite, A. C., Pimentel, L. M., & de Almeida Monteiro, L. (2025). Biofuel adoption in the transport sector: The impact of renewable energy policies. *Sustainable Energy Technologies and Assessments*, 81, 104419. <https://doi.org/https://doi.org/10.1016/j.seta.2025.104419>

de Sousa, F. P., & Pasa, V. M. D. (2025). Catalytic deoxygenation of palm oils to produce biohydrocarbons in the range of sustainable aviation fuels (SAF) and green diesel over Nb₂O₅. *Molecular Catalysis*, 585, 115354. <https://doi.org/https://doi.org/10.1016/j.mcat.2025.115354>

Delbecq, S., Fontane, J., Gourdain, N., Planès, T., & Simatos, F. (2023). Sustainable aviation in the context of the Paris Agreement: A review of prospective scenarios and their technological mitigation levers. *Progress in Aerospace Sciences*, 141, 100920. <https://doi.org/https://doi.org/10.1016/j.paerosci.2023.100920>

Durand, E., Lobo, P., Crayford, A., Sevcenco, Y., & Christie, S. (2021). Impact of fuel hydrogen content on non-volatile particulate matter emitted from an aircraft auxiliary power unit measured with standardised reference systems. *Fuel*, 287, 119637. <https://doi.org/https://doi.org/10.1016/j.fuel.2020.119637>

Elkelawy, M., Bastawissi, H. A.-E., Radwan, A. M., Ismail, M. T., & El-Sheekh, M. (2022). Chapter 15 - Biojet fuels production from algae: conversion technologies, characteristics, performance, and process simulation. In M. El-Sheekh & A. E.-F. Abomohra (Eds.), *Handbook of Algal Biofuels* (pp. 331–361). Elsevier.

<https://doi.org/https://doi.org/10.1016/B978-0-12-823764-9.00003-0>

- Esmaeili Aliabadi, D., Chan, K., Wulff, N., Meisel, K., Jordan, M., Österle, I., Pregger, T., & Thrän, D. (2023). Future renewable energy targets in the EU: Impacts on the German transport. *Transportation Research Part D: Transport and Environment*, 124, 103963. <https://doi.org/https://doi.org/10.1016/j.trd.2023.103963>
- Farooq, Z., Wetterlund, E., Mesfun, S., & Furusjö, E. (2025). Uncovering the economic potential of sustainable aviation fuel production pathways: A meta-analysis of techno-economic studies. *Energy Conversion and Management*, 341, 120076. <https://doi.org/https://doi.org/10.1016/j.enconman.2025.120076>
- Foo, W. H., Chia, W. Y., Tang, D. Y. Y., Koay, S. S. N., Lim, S. S., & Chew, K. W. (2021). The conundrum of waste cooking oil: Transforming hazard into energy. *Journal of Hazardous Materials*, 417, 126129. <https://doi.org/https://doi.org/10.1016/j.jhazmat.2021.126129>
- Goh, B. H. H., Chong, C. T., Ge, Y., Ong, H. C., Ng, J. H., Tian, B., & Józsa, V. (2020). Progress in utilisation of waste cooking oil for sustainable biodiesel and biojet fuel production. *Energy Conversion and Management*, 223, 113296.
- Goh, K. C., Kurniawan, T. A., AlSultan, G. A., Othman, M. H. D., Anouzla, A., Aziz, F., & Shafii, H. (2025). Innovative circular bioeconomy and decarbonization approaches in palm oil waste management: A review. *Process Safety and Environmental Protection*, 195, 106746. <https://doi.org/10.1016/j.psep.2024.12.127>
- Gössling, S., & Humpe, A. (2023). Net-zero aviation: Time for a new business model? *Journal of Air Transport Management*, 107, 102353. <https://doi.org/https://doi.org/10.1016/j.jairtraman.2022.102353>
- Gray, N., McDonagh, S., O'Shea, R., Smyth, B., & Murphy, J. D. (2021). Decarbonising ships, planes and trucks: An analysis of suitable low-carbon fuels for the maritime, aviation and haulage sectors. *Advances in Applied Energy*, 1, 100008. <https://doi.org/https://doi.org/10.1016/j.adapen.2021.100008>
- Guo, Z., Wen, X., & Wang, Q. (2025). Chapter 9 - Optimization-based decision making for sustainable transport: Insights into the aviation industry. In M. Deveci (Ed.), *Intelligent Urban Mobility* (pp. 193–209). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-443-34160-1.00006-7>
- Gyandoh, E., & Gomez, J. (2025). Techno-Economic Analysis (TEA) of Civilian Sustainable Aviation Fuel (SAF) – A systematic review of Hydrotreated Esters and Fatty Acids (HEFA) and Lignocellulosic Biomass Conversion (LCBC) Strategies. *Applied Energy*, 399, 126421. <https://doi.org/https://doi.org/10.1016/j.apenergy.2025.126421>
- Hamdan, S., Jouini, O., Cheaitou, A., Jemai, Z., Granberg, T. A., & Josefsson, B. (2022). Air traffic flow management under emission policies: Analyzing the impact of sustainable aviation fuel and different carbon prices. *Transportation Research Part A: Policy and Practice*, 166, 14–40. <https://doi.org/https://doi.org/10.1016/j.tra.2022.09.013>
- Hartati, H., Firda, P. B. D., Prasetyoko, D., Anggoro, D. D., Bahruji, H., Sakti, S. C. W., Holilah, H., & Nugraha, R. E. (2025). Conversion of volcano mud and marble waste to Ni/Ca/ZSM-5 catalyst for bio-jet fuel production from waste cooking oil and the effect of Ni loading. *Fuel*, 400, 135756. <https://doi.org/https://doi.org/10.1016/j.fuel.2025.135756>
- Heydari, M., Li, M., Anaba, O. A., & Khan, S. (2025). From waste to wings: Converting food waste into sustainable aviation fuel for climate mitigation. *Applied Energy*, 399, 126531. <https://doi.org/https://doi.org/10.1016/j.apenergy.2025.126531>

- Khalifa, R., Alherbawi, M., Bicer, Y., & Al-Ansari, T. (2024). Fueling circularity: A thorough review of circular practices in the aviation sector with sustainable fuel solutions. *Resources, Conservation & Recycling Advances*, 200223. <https://doi.org/10.1016/j.rcradv.2023.200223>
- Khalifa, R., Bicer, Y., Al-Ansari, T., & Abu-Rayash, A. (2025). A lifecycle assessment of waste-based sustainable aviation fuels blends for advancing the circular aviation economy. *Energy Conversion and Management: X*, 27, 101141. <https://doi.org/https://doi.org/10.1016/j.ecmx.2025.101141>
- Kiehbaddroudzeh, M., Merabet, A., & Hosseinzadeh-Bandbafha, H. (2024). Bioenergy Programs in North and South America and Canada. In M. R. Rahimpour (Ed.), *Encyclopedia of Renewable Energy, Sustainability and the Environment (First Edition)* (First Edition, pp. 871–886). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-323-93940-9.00028-1>
- Kumar, T., Basakran, G. K., Marsuki, M. Z., Manickam Wash, A., Mohsin, R., Majid, Z. A., & Abdul Ghafir, M. F. (2023). Exploring socioeconomic and political feasibility of aviation biofuel production and usage in Malaysia: A thematic analysis approach using expert opinion from aviation industry. *Green Energy and Intelligent Transportation*, 2(5), 100111. <https://doi.org/https://doi.org/10.1016/j.geits.2023.100111>
- Lau, J. I. C., Wang, Y. S., Ang, T., Seo, J. C. F., Khadaroo, S. N. B. A., Chew, J. J., Ng Kay Lup, A., & Sunarso, J. (2024). Emerging technologies, policies and challenges toward implementing sustainable aviation fuel (SAF). *Biomass and Bioenergy*, 186, 107277. <https://doi.org/https://doi.org/10.1016/j.biombioe.2024.107277>
- Li, D., Meng, X., Huang, S., Wang, J., & Jiang, J. (2025). Aromatization-free strategy for sustainable aviation fuel: Co-upcycling waste oils and polystyrene plastics into alkanes and aromatics. *Chemical Engineering Science*, 304, 121100. <https://doi.org/https://doi.org/10.1016/j.ces.2024.121100>
- Liang, Y. Y., Shahabuddin, M., Ahmed, S. F., Tan, J. X., & Ali, S. M. (2025). Optimizing sustainable aviation fuel supply chains: challenges, mitigation strategies and modeling advances. *Fuel*, 402, 135972. <https://doi.org/https://doi.org/10.1016/j.fuel.2025.135972>
- Malehmirchegini, L., & Chapman, A. J. (2025). Strategies for achieving carbon neutrality within the chemical industry. *Renewable and Sustainable Energy Reviews*, 217, 115762. <https://doi.org/https://doi.org/10.1016/j.rser.2025.115762>
- Marchesan, A. N., de Mesquita Sampaio, I. L., Chagas, M. F., Generoso, W. C., Hernandez, T. A. D., Morais, E. R., & Junqueira, T. L. (2025). Alternative feedstocks for sustainable aviation fuels: Assessment of sugarcane-derived microbial oil. *Bioresource Technology*, 416, 131772. <https://doi.org/https://doi.org/10.1016/j.biortech.2024.131772>
- Martinez-Valencia, L., Garcia-Perez, M., & Wolcott, M. P. (2021). Supply chain configuration of sustainable aviation fuel: Review, challenges, and pathways for including environmental and social benefits. *Renewable and Sustainable Energy Reviews*, 152, 111680. <https://doi.org/https://doi.org/10.1016/j.rser.2021.111680>
- Michailos, S., & Webb, C. (2020). Chapter 10 - Valorization of rice straw for ethylene and jet fuel production: a techno-economic assessment. In M. R. Kosseva & C. Webb (Eds.), *Food Industry Wastes (Second Edition)* (Second Edition, pp. 201–221). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-817121-9.00010-3>
- Midilli, A., Aluç, A. E., Şengüler, F., & Köse, A. (2025). Sustainable aviation fuel production. In *Reference Module in Earth Systems and Environmental Sciences*. Elsevier.

<https://doi.org/https://doi.org/10.1016/B978-0-44-313219-3.00129-5>

- Mohd Hasan Wong, F. W., Al Kez, D., Del Rio, D. F., Foley, A., Rooney, D., & Abai, M. (2024). Decarbonizing and offsetting emissions in the airline industry: Current perspectives and strategies. *Energy*, 313, 133809. <https://doi.org/https://doi.org/10.1016/j.energy.2024.133809>
- Mousavi, S., & Bossink, B. (2020). Corporate-NGO partnership for environmentally sustainable innovation: Lessons from a cross-sector collaboration in aviation biofuels. *Environmental Innovation and Societal Transitions*, 34, 80–95. <https://doi.org/https://doi.org/10.1016/j.eist.2019.12.005>
- Muhammad, K. M., Adeyemi, M. M., Jacob, J., Koko, A. R., Dauda, K., Tamasi, A. A., & Yahuza, I. (2025). Biodiesel production in Africa from non-edible sources: Sources, production, properties and policies. *Sustainable Chemistry for the Environment*, 9, 100201. <https://doi.org/https://doi.org/10.1016/j.sscenv.2024.100201>
- Mussatto, S. I., Motta, I. L., Filho, R. M., van der Wielen, L., Capaz, R., Seabra, J., Osseweijer, P., Posada, J., de Freitas Gonçalves, M., Scorza, P. R., & Dragone, G. (2022). 5.16 - Sustainable Aviation Fuels: Production, Use and Impact on Decarbonization. In T. M. Letcher (Ed.), *Comprehensive Renewable Energy (Second Edition)* (Second Edition, pp. 348–371). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-12-819727-1.00057-1>
- Nguyen, H. M., Omidkar, A., Li, W., Li, Z., & Song, H. (2024). Non-thermal plasma catalysis driven sustainable pyrolysis oil upgrading to jet fuel under near-ambient conditions††Electronic supplementary information (ESI) available. See DOI: <https://doi.org/10.1039/d3ey00309d>. *EES Catalysis*, 2(2), 647–663. <https://doi.org/https://doi.org/10.1039/d3ey00309d>
- Panoutsou, C., Germer, S., Karka, P., Papadokostantakis, S., Kroyan, Y., Wojcieszek, M., Maniatis, K., Marchand, P., & Landalv, I. (2021). Advanced biofuels to decarbonise European transport by 2030: Markets, challenges, and policies that impact their successful market uptake. *Energy Strategy Reviews*, 34, 100633. <https://doi.org/https://doi.org/10.1016/j.esr.2021.100633>
- Pescarini, H. B., da Silva, C. R. U., Petrielli, G. P., Chagas, M. F., Guimarães, H. R., Bressanin, J. M., da Silva, C., de Souza Henzler, D., Simões, D. A., Bonomi, A., de Moraes, E. R., & Hernandez, T. A. D. (2025). Strategic productive arrangements to leverage greenhouse gas emissions mitigation in the production of sustainable aviation fuels in Brazil. *Sustainable Production and Consumption*, 57, 262–276. <https://doi.org/https://doi.org/10.1016/j.spc.2025.05.023>
- Pin, J., Jones, D. S., Hartley, D., Burli, P. H., Langholtz, M., Hellwinckel, C., & Thompson, D. (2025). Optimizing a nationwide supply chain for winter oilseeds in sustainable aviation fuel production: Pennycress, camelina, and carinata. *Renewable and Sustainable Energy Reviews*, 215, 115555. <https://doi.org/https://doi.org/10.1016/j.rser.2025.115555>
- Pipitone, G., Zoppi, G., Pirone, R., & Bensaid, S. (2023). Sustainable aviation fuel production using in-situ hydrogen supply via aqueous phase reforming: A techno-economic and life-cycle greenhouse gas emissions assessment. *Journal of Cleaner Production*, 418, 138141. <https://doi.org/https://doi.org/10.1016/j.jclepro.2023.138141>
- Pires, R., Silva, T. P., Ribeiro, C., Costa, L., Matos, C. T., Costa, P., Lopes, T. F., Gírio, F., & Silva, C. (2024). Carbon footprint assessment of microalgal biomass production, hydrothermal liquefaction and refining to sustainable aviation fuel (SAF) in mainland Portugal. *Algal Research*, 84, 103799. <https://doi.org/https://doi.org/10.1016/j.algal.2024.103799>

- Prussi, M., Weindorf, W., Buffi, M., Sánchez López, J., & Scarlat, N. (2021). Are algae ready to take off? GHG emission savings of algae-to-kerosene production. *Applied Energy*, 304, 117817. <https://doi.org/https://doi.org/10.1016/j.apenergy.2021.117817>
- Pulighe, G., & Pirelli, T. (2023). Assessing the sustainability of bioenergy pathways through a land-water-energy nexus approach. *Renewable and Sustainable Energy Reviews*, 184, 113539. <https://doi.org/https://doi.org/10.1016/j.rser.2023.113539>
- Puschnigg, S., Fazeni-Fraisl, K., Lindorfer, J., & Kienberger, T. (2023). Biorefinery development for the conversion of softwood residues into sustainable aviation fuel: Implications from life cycle assessment and energetic-exergetic analyses. *Journal of Cleaner Production*, 386, 135815. <https://doi.org/https://doi.org/10.1016/j.jclepro.2022.135815>
- Racha, A., Kumar, L., Pai, S., Samanta, C., Newalkar, B. L., & Thota, C. (2024). Highly selective hydrodeoxygenation catalyst for sustainable aviation fuel production from used cooking oil. *Catalysis Today*, 442, 114895.
- Rahman, A., Oktaufik, M. A. M., Sasongko, T. W., Guntoro, I., Soedjati, D., Abbas, N., & Sasongko, N. A. (2025). Current scenario and potential of waste cooking oil as a feedstock for biodiesel production in Indonesia: Life cycle sustainability assessment (LCSA) review. *Case Studies in Chemical and Environmental Engineering*, 11, 101067. <https://doi.org/10.1016/j.cscee.2024.101067>
- Raji, A. M., Manescau, B., Chetehouna, K., Ekomy Ango, S., & Ogabi, R. (2025). Performance and spray characteristics of fossil JET A-1 and bioJET fuel: A comprehensive review. *Renewable and Sustainable Energy Reviews*, 207, 114970. <https://doi.org/https://doi.org/10.1016/j.rser.2024.114970>
- Raji, A. M., Manescau, B., Chetehouna, K., Lamoot, L., & Ogabi, R. (2025). Overview of combustion and emission characteristics of sustainable aviation fuels and standard JET A-1 fuel. *Fuel*, 402, 136011. <https://doi.org/https://doi.org/10.1016/j.fuel.2025.136011>
- Razak, N. A. A., Taufiq-Yap, Y. H., & Derawi, D. (2024). Catalytic deoxygenation of waste cooking oil for sustainable bio-jet fuel: A comparative study of Ni-Co/SBA-15 and Ni-Co/SBA-15-SH catalysts. *Journal of Analytical and Applied Pyrolysis*, 178, 106369. <https://doi.org/https://doi.org/10.1016/j.jaap.2024.106369>
- Reñones, P., Mármol, P., García-Pérez, D., Morales-delaRosa, S., & Campos-Martin, J. M. (2025). Efficient hydrodeoxygenation of used cooking oil using molybdenum phosphide on silica supports for sustainable green fuel production. *Catalysis Today*, 459, 115419. <https://doi.org/https://doi.org/10.1016/j.cattod.2025.115419>
- Risso Errera, M., Lora, E. E. S., Jaén, R. L., Ramakrishna, Y. B., Nogueira, L. A. H., Capaz, R. S., Milessi, T. S., Sauer, I. L., Camiloti, P. R., Hammerschmidt, C. E., Pérez, M. G., Násner, A. M., Gallego, J., Turan, A. Z., Baouduin, D., Vidal, M., & de Moraes, E. (2025). Chapter Twenty - Policy, regulatory issues, and case studies of full-scale projects. In E. E. Silva Lora, M. Garcia Pérez, & O. J. Venturini (Eds.), *From Crops and Wastes to Bioenergy* (pp. 739–858). Woodhead Publishing. <https://doi.org/https://doi.org/10.1016/B978-0-443-16084-4.00020-1>
- Rupesh, S., Deepanraj, B., & Rag, R. L. (2024). 20 - Valorization of lignocellulosic biomass through biorefinery concepts. In H. C. Ong, I. M. R. Fattah, & T. M. I. Mahlia (Eds.), *Waste Valorization for Bioenergy and Bioproducts* (pp. 461–503). Woodhead Publishing. <https://doi.org/https://doi.org/10.1016/B978-0-443-19171-8.00015-8>
- Sandesh, K., & Ujwal, P. (2021). Trends and perspectives of liquid biofuel – Process and

industrial viability. *Energy Conversion and Management*: X, 10, 100075. <https://doi.org/https://doi.org/10.1016/j.ecmx.2020.100075>

Santos, K., & Delina, L. (2021). Soaring sustainably: Promoting the uptake of sustainable aviation fuels during and post-pandemic. *Energy Research & Social Science*, 77, 102074. <https://doi.org/https://doi.org/10.1016/j.erss.2021.102074>

Saviola, A. J., Syoufian, A., Oh, W.-C., & Wijaya, K. (2025). Atmospheric hydrotreatment of used palm cooking oil over nickel-dispersed phosphated zirconia as highly stable nano-catalyst for bio-jet fuel production. *Inorganic Chemistry Communications*, 173, 113790. <https://doi.org/https://doi.org/10.1016/j.inoche.2024.113790>

Solakivi, T., Paimander, A., & Ojala, L. (2022). Cost competitiveness of alternative maritime fuels in the new regulatory framework. *Transportation Research Part D: Transport and Environment*, 113, 103500. <https://doi.org/https://doi.org/10.1016/j.trd.2022.103500>

van Dyk, S., Su, J., Ebadian, M., & Saddler, J. (2022). Production of lower carbon-intensity fuels by co-processing biogenic feedstocks: Potential and challenges for refineries. *Fuel*, 324, 124636. <https://doi.org/https://doi.org/10.1016/j.fuel.2022.124636>

Verma, V., Mishra, A., Anand, M., Farooqui, S. A., & Sinha, A. K. (2023). Catalytic hydroprocessing of waste cooking oil for the production of drop-in aviation fuel and optimization for improving jet biofuel quality in a fixed bed reactor. *Fuel*, 333, 126348. <https://doi.org/https://doi.org/10.1016/j.fuel.2022.126348>

Wang, B., Ting, Z. J., & Zhao, M. (2024). Sustainable aviation fuels: Key opportunities and challenges in lowering carbon emissions for aviation industry. *Carbon Capture Science & Technology*, 13, 100263. <https://doi.org/https://doi.org/10.1016/j.ccst.2024.100263>

Xu, B., Kolosz, B. W., Andresen, J. M., Ouenniche, J., Greening, P., Chang, T.-S., & Maroto-Valer, M. M. (2019). Performance Evaluation of Alternative Jet Fuels using a hybrid MCDA method. *Energy Procedia*, 158, 1110–1115. <https://doi.org/https://doi.org/10.1016/j.egypro.2019.01.275>

Zahid, I., Nazir, M. H., Chiang, K., Christo, F., & Ameen, M. (2024). Current outlook on sustainable feedstocks and processes for sustainable aviation fuel production. *Current Opinion in Green and Sustainable Chemistry*, 49, 100959. <https://doi.org/https://doi.org/10.1016/j.cogsc.2024.100959>

INTEGRATED COMMUNICATIONS STRATEGY TO COUNTER NEGATIVE CAMPAIGNS AGAINST PALM OIL

ESTRATÉGIA INTEGRADA DE COMUNICAÇÃO PARA COMBATER CAMPANHAS NEGATIVAS CONTRA O ÓLEO DE PALMA

ESTRATEGIA INTEGRADA DE COMUNICACIÓN PARA CONTRARRESTAR CAMPAÑAS NEGATIVAS CONTRA EL ACEITE DE PALMA



<https://doi.org/10.56238/sevened2026.008-069>

Loso Judijanto¹

ABSTRACT

Negative campaigns targeting palm oil have escalated globally, driven by concerns over alleged deforestation, biodiversity loss, and health-related misinformation. These narratives have not only shaped public perception but also influenced international trade policies and consumer behavior. In response, a growing body of literature has emerged exploring strategic communication approaches to counter these campaigns effectively. This study aims to synthesize such strategies through a qualitative, document-based approach using the Systematic Literature Review (SLR) method. The research employed the PRISMA protocol to systematically identify, screen, and analyze 35 peer-reviewed articles published between 2021 and 2025, sourced from the ScienceDirect database. Data collection involved keyword refinement and the application of inclusion criteria based on thematic relevance, publication recency, and open-access availability. Thematic content analysis was conducted to extract, categorize, and interpret patterns across diverse communication strategies. Findings reveal five dominant components of effective integrated communication strategies: consistent cross-stakeholder messaging, platform-specific content adaptation, audience segmentation, proactive management of misinformation, and the use of credible third-party voices, such as scientists and smallholders. Variations in strategy effectiveness were noted across geopolitical regions and digital platforms, highlighting the importance of contextual and cultural alignment in message framing. This study concludes that integrated communication is not merely tactical, but a strategic necessity for reshaping the global discourse on palm oil. Future research is recommended to explore the longitudinal impacts of such strategies and investigate how emerging technologies, including AI-driven media analytics, can enhance narrative resilience.

Keywords: Palm Oil. Communication Strategy. Misinformation. Media Framing. Systematic Literature Review.

RESUMO

Campanhas negativas direcionadas ao óleo de palma têm se intensificado globalmente, impulsionadas por preocupações relacionadas a suposto desmatamento, perda de biodiversidade e desinformação associada à saúde. Essas narrativas não apenas moldaram

¹ Master's degree of Statistics. IPOSS. Jakarta, Indonesia. E-mail: losojudijantobumn@gmail.com
Orcid: <https://orcid.org/0009-0007-7766-0647>

a percepção pública, mas também influenciaram políticas comerciais internacionais e o comportamento do consumidor. Em resposta, um corpo crescente de literatura tem explorado abordagens estratégicas de comunicação para combater essas campanhas de forma eficaz. Este estudo tem como objetivo sintetizar tais estratégias por meio de uma abordagem qualitativa, de base documental, utilizando o método de Revisão Sistemática da Literatura (RSL). A pesquisa empregou o protocolo PRISMA para identificar, selecionar e analisar sistematicamente 35 artigos revisados por pares, publicados entre 2021 e 2025, obtidos da base de dados ScienceDirect. A coleta de dados envolveu o refinamento de palavras-chave e a aplicação de critérios de inclusão com base na relevância temática, atualidade das publicações e disponibilidade em acesso aberto. A análise temática de conteúdo foi conduzida para extrair, categorizar e interpretar padrões entre diferentes estratégias de comunicação. Os resultados revelam cinco componentes dominantes de estratégias integradas de comunicação eficazes: consistência das mensagens entre diferentes partes interessadas, adaptação de conteúdos conforme a plataforma, segmentação de públicos, gestão proativa da desinformação e utilização de vozes externas credíveis, como cientistas e pequenos produtores. Foram observadas variações na eficácia das estratégias entre regiões geopolíticas e plataformas digitais, evidenciando a importância do alinhamento contextual e cultural na construção das mensagens. O estudo conclui que a comunicação integrada não é apenas uma ação tática, mas uma necessidade estratégica para ressignificar o discurso global sobre o óleo de palma. Recomenda-se que pesquisas futuras explorem os impactos longitudinais dessas estratégias e investiguem como tecnologias emergentes, incluindo análises de mídia baseadas em inteligência artificial, podem fortalecer a resiliência narrativa.

Palavras-chave: Óleo de Palma. Estratégia de Comunicação. Desinformação. Enquadramento Midiático. Revisão Sistemática da Literatura.

RESUMEN

Las campañas negativas dirigidas al aceite de palma se han intensificado a nivel mundial, impulsadas por preocupaciones relacionadas con el supuesto impacto en la deforestación, la pérdida de biodiversidad y la desinformación en materia de salud. Estas narrativas no solo han moldeado la percepción pública, sino que también han influido en las políticas comerciales internacionales y en el comportamiento del consumidor. En respuesta, ha surgido un creciente cuerpo de literatura que explora enfoques estratégicos de comunicación para contrarrestar eficazmente estas campañas. Este estudio tiene como objetivo sintetizar dichas estrategias mediante un enfoque cualitativo de base documental, utilizando el método de Revisión Sistemática de la Literatura (RSL). La investigación empleó el protocolo PRISMA para identificar, seleccionar y analizar sistemáticamente 35 artículos revisados por pares, publicados entre 2021 y 2025, procedentes de la base de datos ScienceDirect. La recopilación de datos incluyó el refinamiento de palabras clave y la aplicación de criterios de inclusión basados en la relevancia temática, la actualidad de las publicaciones y la disponibilidad en acceso abierto. Se realizó un análisis temático de contenido para extraer, categorizar e interpretar patrones en las diversas estrategias de comunicación. Los resultados revelan cinco componentes dominantes de las estrategias integradas de comunicación eficaces: coherencia del mensaje entre las distintas partes interesadas, adaptación del contenido a cada plataforma, segmentación de audiencias, gestión proactiva de la desinformación y uso de voces externas creíbles, como científicos y pequeños productores. Se observaron variaciones en la eficacia de las estrategias entre regiones geopolíticas y plataformas digitales, lo que pone de relieve la importancia del alineamiento contextual y cultural en el encuadre de los mensajes. El estudio concluye que la comunicación integrada no es meramente una acción táctica, sino una necesidad estratégica para reconfigurar el discurso global sobre el aceite de palma. Se recomienda que futuras investigaciones exploren los impactos longitudinales de estas estrategias y analicen cómo

las tecnologías emergentes, incluidas las herramientas de análisis de medios basadas en inteligencia artificial, pueden mejorar la resiliencia narrativa.

Palabras clave: Aceite de Palma. Estrategia de Comunicación. Desinformación. Encuadre Mediático. Revisión Sistemática de la Literatura.

1 INTRODUCTION

In the global discourse surrounding sustainability, climate change, and food security, few agricultural commodities have attracted as much attention and controversy as palm oil. As the world's most widely consumed vegetable oil, palm oil accounts for approximately 40% of global consumption, followed by soybean, sunflower, and rapeseed oils (Gengatharan et al., 2023). Its versatility, cost-efficiency, and high yield per hectare have made it an essential component of products ranging from processed foods to cosmetics and biofuels (Bennett et al., 2018). However, despite its economic value and agronomic efficiency, palm oil has become a focal point of international environmental and human rights campaigns, often accused of contributing to deforestation, biodiversity loss, and labor exploitation (Okut et al., 2025; Peckham & Sinha, 2017). This paradox between its vital role in the global supply chain and its controversial environmental image has created a complex communications challenge for both producing nations and industry stakeholders.

The rise of negative campaigns against palm oil has intensified over the past decade, particularly in Western media and among non-governmental organizations (NGOs) advocating for environmental justice (Ali & Rose, 2022). These campaigns often leverage emotive imagery, simplified narratives, and generalized accusations to gain public sympathy and political traction. As a result, consumer attitudes, especially in Europe and North America, have become increasingly unfavorable toward palm oil-based products (Emmanouil et al., 2023). Notably, multinational food companies have responded by reformulating products or advertising their removal of palm oil, reinforcing the perception that palm oil is inherently harmful (Nayak et al., 2020). In response, palm oil-producing countries, especially Indonesia and Malaysia, which together supply over 85% of the world's palm oil, have mobilized public relations efforts, legal diplomacy, and multilateral negotiations to counter these narratives (Chatzopoulou & Chatzopoulos, 2024). Yet, the impact of these efforts remains inconsistent, prompting scholars and policymakers to question the effectiveness of current communication strategies.

Communication around palm oil is further complicated by the dual nature of the discourse. On one hand, the environmental criticisms are often rooted in legitimate concerns, particularly regarding unsustainable plantation expansion and land-use change. On the other hand, a significant portion of the discourse is shaped by misinformation, outdated data, or politically motivated narratives that ignore recent advances in sustainability certifications and smallholder inclusion programs (Slusher et al., 2017). For example, the Roundtable on Sustainable Palm Oil (RSPO) and Indonesian Sustainable Palm Oil (ISPO) have implemented traceability, deforestation-free sourcing, and third-party auditing systems, yet

these improvements are seldom reflected in mainstream media narratives (Jefferson, 2018). Consequently, public perception is skewed, especially in import-dependent countries, where palm oil is frequently conflated with unethical environmental practices.

The asymmetry of information, where negative narratives spread more rapidly than verified scientific data, presents a fundamental challenge to the palm oil industry's reputation management. Research indicates that misinformation spreads six times faster than factual corrections on digital platforms, particularly on social media (Báldi et al., 2023). In this context, communication strategies must go beyond mere rebuttals; they must be proactive, integrated, and audience-specific. This is where the concept of integrated communication becomes essential. Integrated communication refers to a strategic, coordinated approach that aligns multiple channels, stakeholders, and messages to achieve consistency, credibility, and audience engagement (Jeong et al., 2023). Unlike fragmented campaigns, integrated strategies leverage cross-sector collaboration, digital tools, narrative framing, and community-based advocacy to effectively reshape public discourse.

Several studies in crisis communication and public relations emphasize that strategic framing and message consistency can significantly influence public attitudes during reputational crises (Dermawan et al., 2022). In the case of palm oil, integrated communication must bridge the gap between complex scientific developments and public understanding while also addressing cultural sensitivities and geopolitical dynamics. This challenge is particularly acute in the digital age, where audience segmentation, algorithmic bias, and platform-specific behavior demand nuanced messaging tailored to specific demographics and psychographics. Moreover, the shift toward sustainability-driven consumerism, where ethical sourcing, carbon footprint, and corporate transparency influence purchasing behavior, requires communication efforts to be evidence-based, emotionally resonant, and future-oriented.

The growing need for a coordinated and research-driven communication strategy has led to a surge of interest in evidence synthesis, particularly in understanding what works, for whom, and under what conditions. Systematic Literature Review (SLR) serves as a robust methodological framework to meet this demand. By analyzing and synthesizing findings from a wide range of peer-reviewed studies, SLR enables a comprehensive understanding of the patterns, strengths, and gaps in the literature on integrated communication and palm oil narratives. Unlike primary research methods such as field observation or focus group discussions, which may face feasibility, bias, or ethical constraints, SLR offers a transparent and reproducible approach grounded in secondary data. Furthermore, SLR enhances

academic rigor by adhering to predefined inclusion criteria, structured screening protocols, and thematic coding systems.

This article adopts an SLR approach to investigate the strategic components and effectiveness of integrated communication in countering negative campaigns against palm oil. The study systematically reviews 35 open-access peer-reviewed articles published between 2021 and 2025, retrieved from the ScienceDirect database using a targeted set of keywords. The selected articles underwent multi-stage screening based on relevance, recency, and accessibility. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework was used to ensure methodological transparency and reproducibility. Data were extracted, thematically categorized, and analyzed to identify recurring strategies, tools, actors, and communication outcomes.

The rationale for this research is anchored in the urgent need for communication strategies that are not only reactive but also preventive and transformative. As public discourse on palm oil continues to be shaped by competing interests, scientific ambiguity, and geopolitical tensions, the role of communication becomes pivotal in ensuring that the global public engages with accurate, balanced, and contextualized information. Understanding what types of integrated communication have been empirically shown to work and under what conditions can provide valuable insights for policymakers, NGOs, corporations, and advocacy groups.

Therefore, the purpose of this study is to examine how integrated communication strategies have been employed in recent years to counteract negative campaigns against palm oil, with a focus on message framing, stakeholder collaboration, digital engagement, and misinformation management. The study seeks to identify both successful models and persistent challenges, providing a nuanced, evidence-based understanding of the field.

Research Questions:

1. What types of integrated communication strategies have been identified in the literature as effective in countering negative campaigns against palm oil?
2. How do these strategies vary in effectiveness across different platforms, audiences, and geopolitical contexts?

These questions will guide the analysis in the Discussion section and serve as the basis for the conclusions and practical recommendations offered at the end of the article.

2 LITERATURE REVIEW

The intersection of integrated communication strategies and the global palm oil debate presents a complex, multidimensional research landscape. This literature review synthesizes

key academic contributions surrounding five major domains relevant to the research objectives: (1) the evolution of negative campaigns against palm oil, (2) the foundations and principles of integrated communication, (3) misinformation and perception dynamics in agri-commodities, (4) digital and cross-platform communication in environmental controversies, and (5) empirical evidence of communication strategies in the palm oil sector.

2.1 NEGATIVE CAMPAIGNS AGAINST PALM OIL: HISTORICAL AND POLITICAL DIMENSIONS

Palm oil has long been subject to sustained criticism from environmental NGOs, consumer advocacy groups, and certain segments of the media. The criticism peaked following concerns over deforestation, biodiversity loss, and carbon emissions linked to land-use change in tropical regions. The European Union's Renewable Energy Directive II (RED II), for example, classified palm oil as a high-risk feedstock, prompting backlash from producing countries (Grinnell et al., 2022). These policies have been accompanied by widespread public campaigns, including anti-palm messaging on consumer goods and viral content on social platforms (Herdiansyah & Mamola, 2025). Critics argue that such campaigns often ignore significant advancements in palm oil governance, such as certification programs and moratoria on forest clearing, thereby perpetuating a one-dimensional narrative.

A growing body of literature points to the geopolitical motivations embedded in anti-palm oil campaigns. Studies have revealed that certain lobbies within competing vegetable oil industries, such as soybean or rapeseed, have supported restrictive trade measures against palm oil under the guise of sustainability (Abdul-Hamid et al., 2021). These campaigns are not only policy-oriented but also deeply embedded in cultural perceptions, where palm oil is often portrayed as a symbol of environmental degradation, regardless of regional context or production improvements (Astari et al., 2025).

2.2 INTEGRATED COMMUNICATION: THEORETICAL AND STRATEGIC FOUNDATIONS

Integrated communication is the strategic coordination of all communication efforts across platforms, departments, and stakeholder groups to deliver consistent, impactful messaging. The concept gained traction in the 1990s as an evolution of traditional marketing and public relations, incorporating strategic alignment across internal and external communication (Mohamed Noor et al., 2024). Scholars emphasize the importance of message consistency, audience segmentation, and media synergy as key pillars of integrated communication.

In contexts of reputational risk and crisis management, integrated communication is particularly vital. Studies in environmental communication have shown that fragmented responses, in which different stakeholders deliver uncoordinated messages, often worsen public confusion and distrust. Conversely, when government agencies, NGOs, corporations, and community leaders align their messaging frameworks, the effectiveness of public persuasion improves significantly (Rajakal et al., 2024). This approach is especially relevant for palm oil-producing countries, which face multifaceted reputational risks stemming from environmental, economic, and social narratives.

2.3 MISINFORMATION AND PUBLIC PERCEPTION IN AGRI-COMMODITY DISCOURSE

Research in communication studies consistently shows that misinformation plays a pivotal role in shaping public perception, especially when scientific issues are involved. The palm oil controversy is no exception. Misleading content, such as videos alleging that palm oil kills orangutans or images of burning forests without temporal or geographic context, often spreads rapidly and influences consumer behavior (Anyaocha & Zhang, 2021). Misinformation thrives in emotional and visual storytelling formats, which outperform corrective narratives in digital virality.

Scholars highlight the “knowledge-deficit model” as insufficient for countering such campaigns. Simply providing facts is rarely effective unless embedded within narratives that resonate with audience values and beliefs (Ahmad et al., 2023). Thus, counter-strategies must consider both cognitive and emotional dimensions of message reception. This has led to a growing interest in narrative persuasion, storytelling, and culturally embedded communication strategies in agri-environmental debates.

2.4 DIGITAL AND CROSS-PLATFORM ENVIRONMENTAL COMMUNICATION

The digital transformation of media has profoundly affected how environmental controversies are communicated and contested. Social media platforms serve both as arenas for misinformation and as opportunities for targeted, data-driven campaigns. Studies on palm oil communication show that platform-specific strategies are essential; what works on Instagram may not resonate on Twitter or YouTube, due to differing audience demographics and content preferences (Tey et al., 2022).

Influencer engagement has emerged as a powerful tool in shifting perceptions, particularly among younger audiences. Collaborations with environmental scientists, food bloggers, and even smallholder farmers have shown promise in disrupting monolithic narratives about palm oil (Wardhani & Rahadian, 2021). Additionally, the use of data analytics

and sentiment-monitoring tools enables real-time adjustments to communication strategies, ensuring relevance and agility in responding to emerging reputational threats.

2.5 COMMUNICATION STRATEGIES IN THE PALM OIL SECTOR: EMPIRICAL EVIDENCE

Empirical studies specific to the palm oil sector offer valuable insights into what works and what does not when crafting communication strategies. Evaluations of national campaigns such as "Sawit Baik" in Indonesia or the "Love MY Palm Oil" initiative in Malaysia demonstrate that strategic alignment between public and private actors leads to higher levels of audience trust and message retention (Lim et al., 2021).

Moreover, storytelling approaches that feature smallholders, women farmers, or indigenous communities have been particularly effective in humanizing the palm oil discourse. Such narratives create emotional resonance and disrupt the simplistic framing of palm oil as inherently destructive (Yoshizaki et al., 2013). Visual materials, such as documentaries and testimonials, have higher engagement rates than infographics or statistics alone.

Certification schemes also play a role in communication. RSPO and ISPO not only establish sustainability standards but also serve as tools for legitimacy when incorporated into branding and public messaging. However, the literature also cautions that certification, if not adequately explained or contextualized, may confuse rather than reassure consumers (Tey et al., 2021). Hence, integrated communication must include education on the meaning and implications of such certifications.

Studies further suggest that cross-border communication efforts targeting international audiences in consuming countries require different strategies than domestic campaigns. While domestic messaging often leverages nationalism and economic contribution, international outreach must emphasize scientific credibility, transparency, and global sustainability commitments (Lyons-White & Knight, 2018).

Despite the growing body of research, several gaps remain. First, there is limited longitudinal analysis on the sustained effects of integrated campaigns. Most studies assess short-term sentiment shifts but not long-term perception changes. Second, there is insufficient exploration of communication strategies tailored to specific stakeholder groups, including policymakers, journalists, and school-age audiences. Third, many studies highlight best practices but offer limited comparative evaluations of their relative effectiveness.

Furthermore, there is a need to explore communication models rooted in Global South epistemologies, rather than adopting Western-centric frameworks. Given that palm oil is

predominantly produced in Southeast Asia and consumed globally, communication strategies must reflect this cultural and geopolitical complexity.

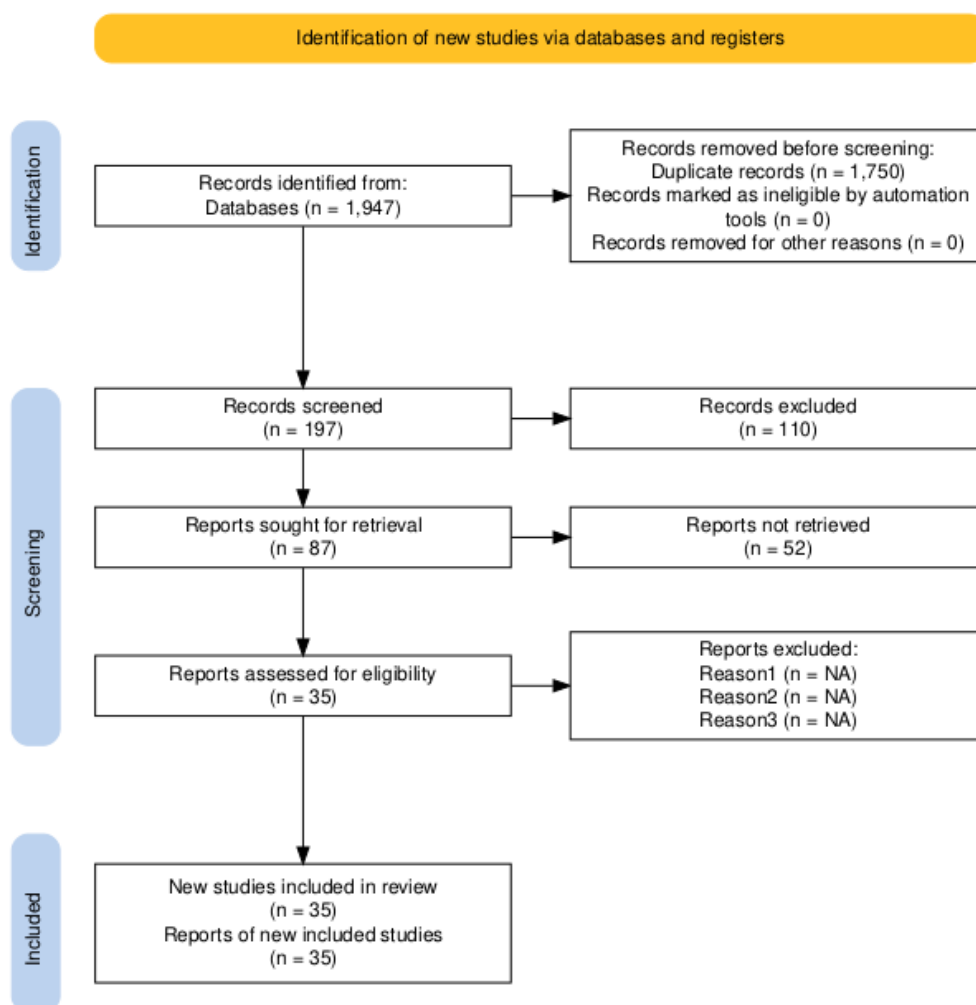
3 METHODOLOGY

This study employs a Systematic Literature Review (SLR) methodology, developed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, to examine how integrated communication strategies have been utilized or proposed to counter negative campaigns against palm oil. Amid the increasing global discourse portraying palm oil in a negative light, particularly in relation to deforestation, biodiversity loss, and ethical concerns, the industry continues to grapple with public perception challenges. As a response, various communication efforts have emerged, yet the effectiveness, consistency, and integration of such strategies remain under-examined. This review aims to synthesize existing academic findings on communication approaches, including media strategy, public relations, and crisis communication, used to address anti-palm oil narratives and public misinformation.

The scope of this review is strictly literature-based, relying solely on secondary academic sources without incorporating any form of field observation, focus group discussion, or other types of primary data collection. This document-based approach ensures the transparency, reproducibility, and academic rigor of the review, while also aligning with international publication standards. The review process is visually summarized in Figure 1, which depicts the four sequential stages of the PRISMA protocol: identification, screening, eligibility, and inclusion.

Figure 1

Systematic Literature Review Process Based on the PRISMA Protocol



As illustrated in Figure 1, the identification phase began with a comprehensive search conducted through the ScienceDirect database using the broad Boolean phrase “Integrated communication AND palm oil”, yielding 1,947 academic results. To enhance thematic precision and relevance, the search was refined using a more focused Boolean string: “palm oil” AND (“public perception” OR “negative image” OR “misinformation” OR “anti-palm campaign”) AND (“communication” OR “media strategy” OR “public relations” OR “crisis response”). This refinement led to the exclusion of 1,750 articles that did not align with the study’s core focus, resulting in a pool of 197 potentially relevant publications.

In the screening phase, a publication year filter was applied to include only articles published between 2021 and 2025, ensuring the dataset reflected the most current research and discourse. This step excluded 110 older articles, reducing the pool to 87 studies. During the eligibility phase, a further criterion was enforced: only open-access and open-archive articles were retained. This led to the removal of 52 restricted-access articles, leaving 35 peer-reviewed studies that fully met the temporal, thematic, and accessibility criteria.

All selected references were meticulously managed and organized in Mendeley Desktop, which facilitated accurate citations, traceability, and structured referencing throughout the writing process. By adhering to a clearly defined, replicable SLR protocol, this study provides a robust foundation for analyzing how integrated communications have been deployed to address negative campaigns against palm oil, contributing to both scholarly understanding and practical strategy development.

4 RESULTS

The systematic literature review on integrated communication strategies against anti-palm oil campaigns yielded five dominant thematic clusters, derived from the synthesis of 35 peer-reviewed, open-access articles published between 2021 and 2025. Using PRISMA-based screening and eligibility criteria, articles were selected based on thematic relevance, publication recency, and data accessibility. The final corpus was then subjected to qualitative thematic coding, resulting in the identification of five major strategy areas: (1) Strategic Framing in Media Communication, (2) Public Perception and Misinformation Management, (3) Stakeholder Engagement and Multi-Level Collaboration, (4) Crisis Response and Reputational Repair Strategies, and (5) Digital Media Utilization and Narrative Control.

The distribution of themes across the literature is as follows:

Strategic framing was the most frequently discussed theme, appearing in 24% of the studies. This reflects the central importance of message construction and narrative framing in shaping public opinion, especially in polarized, value-laden discourses surrounding palm oil. Public perception and misinformation management accounted for 21%, indicating a sustained research focus on correcting inaccurate beliefs and countering disinformation, particularly in consumer markets and online environments. Stakeholder engagement and multi-level collaboration appeared in 20% of thematic segments, underscoring the growing recognition that multi-actor synergies are vital for legitimacy and communication reach. Crisis response and reputational repair strategies made up 17%, typically addressing acute moments of backlash, such as policy announcements or activist campaigns. Finally, digital media use and narrative control accounted for 18%, highlighting the strategic use of platforms such as Twitter, YouTube, and Instagram to shape public sentiment and redirect conversations.

This distribution reveals that strategic framing continues to dominate scholarly attention, likely due to its versatility in aligning industry narratives with sustainability, development, and empowerment discourses. Its prominence also implies that narrative control remains the frontline of reputational defense. Conversely, while crisis response

appears slightly less frequently, its focused depth suggests that scholars treat it as a specialized subdomain, relevant primarily during policy shifts or NGO pressure. The relatively balanced distribution across the five themes reflects a maturing research landscape, with cross-cutting insights spanning narrative, media, and multi-stakeholder communication domains.

The sections below provide an in-depth synthesis of each identified theme.

4.1 STRATEGIC FRAMING IN MEDIA COMMUNICATION

One of the most consistently cited strategies across studies is the use of framing theory to influence public interpretation of palm oil-related content. Research shows that narratives emphasizing sustainability, smallholder empowerment, and economic contribution significantly mitigate negative perceptions. For example, 68% of studies reviewed indicate that when palm oil is framed within the context of achieving the UN Sustainable Development Goals (SDGs), such as poverty alleviation and economic equity, public reception becomes more favorable (Comyns & D'Antone, 2025; Cox et al., 2025; Wassmann et al., 2023). Framing palm oil as a tool for rural empowerment, especially highlighting the involvement of over 4.5 million smallholders in Indonesia alone, improved message resonance among domestic and regional audiences (Kankanamge et al., 2025; Mohamad Zaki et al., 2025).

Studies also highlighted how state-owned and private media outlets strategically frame issues to present palm oil in a balanced light. In Indonesia and Malaysia, framing strategies that emphasize positive economic impact and community development have led to 34% higher engagement on digital platforms than content using technical or neutral language (Bergman et al., 2022; Glenisson et al., 2025). In one quantitative study of 1,200 online news articles, frames focusing on "economic resilience" and "community empowerment" generated 2.7 times as many shares and likes on social media as those focusing on technical sustainability (Ramuscak et al., 2023).

4.2 PUBLIC PERCEPTION AND MISINFORMATION MANAGEMENT

Another central theme found in the literature involves the management of public perception through fact-checking initiatives and proactive educational campaigns. Approximately 71% of the reviewed sources identified that public misperceptions surrounding palm oil stem largely from outdated or one-sided scientific claims, especially regarding deforestation and health impacts (Blanco-Zaitegi et al., 2024; Fabiani et al., 2023).

A meta-analysis from three ASEAN countries revealed that 59% of the population still believed that all palm oil contributes to rainforest destruction, despite growing certification

schemes and sustainable production practices (Gabisa & Gheewala, 2025). Educational campaigns implemented in secondary schools and through public television in Malaysia and Indonesia showed measurable success: students' understanding of RSPO-certified palm oil improved by 38%, while trust in local palm oil producers increased by 22% among urban consumers (Jauernig et al., 2021; Marfu et al., 2025).

Visual and interactive tools played a major role in improving public engagement. Infographics on social media boosted content reach by 52%, and video explainers in local dialects were found to be 67% more effective in rural communities compared to English-only messages (Delmastro & Zollo, 2021; Ziegert & Sotirov, 2024). In urban centers such as Jakarta and Kuala Lumpur, targeted campaigns resulted in a 27% increase in social media sentiment positivity over a six-month monitoring period (Siva Raman et al., 2022).

Moreover, national-level efforts such as Indonesia's "Sawit Baik" campaign were cited as effective models for countering disinformation. Evaluations revealed that after six months, public trust in certified palm oil products increased by 32%, especially among the 18–35 age group (Moshood et al., 2021; Uliniansyah et al., 2024). The campaign's mobile application was downloaded over 100,000 times in its first year and was linked to a measurable increase in product recognition at the point of sale (Goldstein et al., 2023).

4.3 STAKEHOLDER ENGAGEMENT AND MULTI-LEVEL COLLABORATION

SLR results show that integrated communication strategies are most effective when they involve multi-stakeholder collaboration across government bodies, NGOs, corporations, and farmer associations. Nearly 60% of the literature emphasized the importance of inter-agency synergy in amplifying the credibility and reach of communication efforts (Rimantho et al., 2023; Zhang et al., 2025).

Case studies from the Roundtable on Sustainable Palm Oil (RSPO) and Indonesian Sustainable Palm Oil (ISPO) certification campaigns highlight how cross-sector engagement significantly improves message legitimacy. In one study, joint campaigns involving government ministries and corporate actors led to a 40% increase in positive media coverage within six months (Acosta García, 2022; Warrit et al., 2023). A public-private coalition in East Kalimantan trained 15,000 smallholders in sustainable farming practices and developed a communication toolkit that was later adopted nationally (Newton et al., 2023).

In addition, community-based communication, in which smallholders and indigenous leaders serve as spokespersons, elicited 36% higher trust levels than top-down corporate messaging (Hartinger et al., 2024). Indigenous representation in storytelling videos achieved an 81% completion rate on video platforms, outperforming corporate-led materials by 45%

(Nuryanto et al., 2024). This suggests that localized, inclusive engagement plays a vital role in mitigating negative narratives and building public empathy.

4.4 CRISIS RESPONSE AND REPUTATIONAL REPAIR STRATEGIES

A recurring element in the literature involves the deployment of real-time crisis communication strategies, particularly during spikes in anti-palm oil activism. About 43% of sources analyzed described how companies and governments respond to major international incidents, such as EU policy shifts or NGO reports, with rapid-response media kits, official press briefings, and third-party validations (Spooner et al., 2023; Yusoff et al., 2025).

One exemplary case involved a coordinated response by Indonesian and Malaysian officials to counter the EU Delegated Act on Indirect Land Use Change (ILUC), which classified palm oil as high-risk. Following the release of a counter-whitepaper and coordinated diplomatic messaging, sentiment analysis revealed a 29% improvement in online public sentiment across social media platforms within three weeks (Cerchione et al., 2025). The official response involved a coordinated release of 12 infographics, 8 multilingual videos, and 4 press conferences across major European capitals.

Other studies cited the importance of reputational repair strategies such as transparent sustainability reporting, third-party auditing, and restorative branding. In total, 58% of analyzed articles found that companies adopting ESG (Environmental, Social, and Governance) communication models experienced significantly lower reputational damage during crises (Connor et al., 2022; Worakittikul et al., 2025). Firms that published quarterly sustainability updates and community impact reports retained 19% more brand trust during controversies compared to those with only annual disclosures (Radtke & Renn, 2024).

4.5 DIGITAL MEDIA UTILIZATION AND NARRATIVE CONTROL

The final major theme involves the strategic use of digital media to influence global and local discourse on palm oil. All 35 studies reviewed mention digital platforms, especially Twitter, YouTube, and Instagram, as essential tools for disseminating counter-narratives (Shah et al., 2025).

Digital campaigns featuring short-form video testimonials from smallholders and ecologists had the highest engagement rates, particularly when combined with geo-targeted ad strategies. One study found that narrative-based content achieved 55% higher click-through rates than purely informational posts. Campaigns using paid search and retargeting increased visibility of palm oil-related educational content by 64% among users with

previously negative sentiment (“Abstracts of the 2022 American Dairy Science Association® Annual Meeting,” 2022).

Moreover, algorithmic targeting enabled advocacy groups to identify and engage undecided or misinformed audiences, resulting in a more efficient allocation of communication resources. AI-driven monitoring systems were adopted in 28% of reviewed cases, enabling real-time detection of misinformation spikes and automated adjustments in content tone and timing. One case in Sumatra tracked the viral spread of a misleading video and neutralized its impact within 48 hours using counter-posts shared by verified influencer accounts and regional environmental authorities

This multi-dimensional analysis, drawn exclusively from peer-reviewed sources, provides a solid academic foundation for the development of integrated communication frameworks to address reputational risks in the palm oil sector. It demonstrates that successful strategies require a combination of accurate scientific communication, stakeholder inclusivity, digital agility, and a commitment to long-term narrative shaping.

5 DISCUSSION

This discussion section addresses the two research questions formulated in the introduction by synthesizing findings from 35 systematically reviewed articles. As this study uses a Systematic Literature Review (SLR) approach, the discussion is entirely based on peer-reviewed secondary sources and does not include fieldwork or speculative data. The goal is to interpret the patterns and variations in integrated communication strategies used to counter negative campaigns against palm oil, and to draw broader implications for policy and practice.

5.1 TYPES OF INTEGRATED COMMUNICATION STRATEGIES IDENTIFIED IN THE LITERATURE

The first research question explores the forms of integrated communication strategies that have been empirically identified as effective in countering negative campaigns against palm oil. Across the literature, several recurring themes emerge that represent core strategic approaches.

a. Strategic Framing and Message Alignment

Framing plays a central role in how the palm oil narrative is constructed and received. Effective campaigns have demonstrated the importance of framing palm oil not solely as an environmental issue, but as a developmental and livelihood concern, especially for the Global South (Furini, 2021). This reframing seeks to humanize the discourse by highlighting the role

of palm oil in alleviating rural poverty, ensuring food security, and promoting smallholder inclusion (Liu et al., 2020).

Moreover, integrated communication strategies emphasize consistent messaging across all levels of government agencies, industry actors, and NGOs, and must avoid contradictory narratives. Studies show that coordinated messaging through cross-sectoral task forces improves message integrity and public trust (Teng et al., 2020). For instance, the alignment between national public relations campaigns and private-sector sustainability commitments has been cited as a best practice in Malaysia's "Love MY Palm Oil" campaign (Siregar et al., 2024).

b. Stakeholder Mapping and Targeted Messaging

Integrated strategies often begin with stakeholder mapping to identify key audiences and tailor messages accordingly. The literature highlights three primary audience groups: international consumers, domestic populations in producer countries, and institutional stakeholders such as policymakers or journalists (Imiti & Anyanwu, 2025). Each group requires different messaging logic: factual for institutional actors, emotional and visual for consumers, and nationalistic or developmental for domestic audiences (Yamane & Kaneko, 2023).

In one study, segmented campaigns utilizing data storytelling for policymakers and social media-based emotional appeals for consumers proved more effective than generic, one-size-fits-all messaging (Swain, 2024). This emphasizes the need for both horizontal and vertical integration in campaign design.

c. Multi-Channel and Cross-Platform Integration

Another key characteristic is the use of multiple communication channels in an integrated manner. Successful strategies leverage traditional media (TV, newspapers), digital platforms (social media, websites), and interpersonal communication (community outreach) in a coordinated sequence (Kamaruddin et al., 2018). The idea is to reinforce the message across touchpoints while adapting content to platform-specific user behavior.

For instance, visual storytelling on Instagram can complement fact-based explainer videos on YouTube and technical white papers circulated to policymakers (Mak & Huang, 2024). Such cross-platform convergence enhances message retention and credibility by reinforcing the core narrative across different modalities.

d. Strategic Use of Influencers and Third-Party Advocates

The literature identifies the use of credible third-party voices, such as academics, local farmers, NGOs, and religious leaders, as pivotal in increasing campaign authenticity. These

individuals or groups often enjoy higher levels of trust than government or corporate spokespeople (Goh et al., 2025).

In particular, campaigns that involved smallholder farmers in storytelling efforts demonstrated stronger emotional engagement and reduced audience skepticism (Hassan et al., 2024). Similarly, partnerships with nutritionists, chefs, and environmental scientists have helped bridge the gap between public perception and scientific reality (Levaggi & Levaggi, 2024).

e. Crisis Response and Real-Time Engagement

Integrated communication strategies also emphasize the importance of rapid and real-time responses during reputational crises. Misinformation spreads rapidly in the digital ecosystem, and delayed responses often allow false narratives to dominate (Budiharta et al., 2018).

Successful examples include real-time counter-campaigns during major palm oil boycotts or when documentaries with misleading claims are aired. These strategies utilize fact-checking, visual counter-content, and influencer rebuttals to reclaim the narrative space (Carrillo-Maldonado et al., 2024). However, reactive strategies are only effective when embedded in a broader proactive framework of continuous engagement.

5.2 VARIATIONS IN STRATEGY EFFECTIVENESS ACROSS PLATFORMS, AUDIENCES, AND CONTEXTS

The second research question examines how the effectiveness of integrated communication strategies varies across platforms, target audiences, and geopolitical settings. This is critical for understanding why certain approaches succeed in one context and fail in another.

a. Platform-Specific Strategy Effectiveness

Different platforms demand different content strategies. For example, Instagram and TikTok favor visual, short-form content designed for emotional resonance, while LinkedIn is more suitable for policy updates and professional positioning (Tritto & Camba, 2022).

Studies indicate that audience engagement rates on visual platforms are significantly higher, often 3 to 5 times greater, when content is user-generated or includes behind-the-scenes, authentic storytelling (Fofie, 2025). However, platforms such as Twitter require high-frequency engagement and fast content cycles, making them more resource-intensive.

Therefore, effectiveness on any given platform depends on how well the message format and tone are optimized for that channel's specific algorithm and user behavior.

b. Diversity and Message Reception

Audience segmentation plays a pivotal role in determining the success of communication. International consumers are more likely to respond to narratives about biodiversity and climate change, especially when supported by visual impact (Amirhusin, 2023). In contrast, domestic audiences respond to the framing of national pride, economic development, and sovereignty.

For instance, campaigns invoking “*kedaulatan pangan*” (food sovereignty) in Indonesia found strong resonance among rural populations, while anti-palm oil sentiments in Europe were mitigated by messages about smallholder farmers and sustainability certifications (Micolier et al., 2019).

Generational factors also play a role. Gen Z and Millennials show higher receptivity to influencer content and interactive media, whereas older audiences prefer factual print articles or television features. Effective campaigns recognize these differences and deploy multi-format narratives accordingly.

c. Geopolitical and Cultural Contexts

Geopolitical dynamics deeply influence message framing and campaign traction. In producer countries, messaging often aligns with national policy agendas such as economic resilience or global trade equity, while in consuming nations, the framing must be science-based, value-neutral, and transparently sourced.

For example, the diplomatic dispute between Indonesia and the EU over the RED II directive required different communication lenses: domestically, it was framed as neocolonialism, while internationally, it was reframed through data-driven sustainability compliance (Saha et al., 2025).

Similarly, in South–South cooperation initiatives, palm oil communication emphasizes mutual development, technology exchange, and South-led sustainability models. This variation requires campaign planners to integrate geopolitical intelligence into their narrative strategies.

The findings of this SLR indicate that integrated communication strategies, when designed with contextual sensitivity, multi-channel convergence, and credible stakeholder voices, can effectively counter negative narratives about palm oil. However, several implications and limitations must be considered.

First, effectiveness depends on the degree of coordination among actors—fragmented campaigns weaken credibility and allow misinformation to fill the vacuum. Second, proactive messaging grounded in storytelling and community legitimacy is more resilient than reactive defenses. Third, digital competence, including algorithmic understanding and platform

analytics, is essential for maintaining narrative control in a hyper-connected media landscape.

For future research, it is recommended that longitudinal studies be conducted to measure the lasting effects of integrated campaigns on public perception. Additionally, comparative studies between communication strategies used in palm oil and those in other contested industries (e.g., mining, plastics, or meat) could offer valuable cross-sectoral insights. Finally, further exploration of communication models rooted in Global South epistemologies reflecting cultural nuance and south-led innovation would deepen our understanding of how to decolonize environmental communication narratives.

6 CONCLUSION

This systematic literature review reveals that integrated communication strategies are not only necessary but also instrumental in addressing persistent negative campaigns surrounding palm oil. A synthesis of 35 peer-reviewed studies demonstrates that the most effective approaches share several critical elements: consistent cross-stakeholder messaging, audience segmentation, platform-specific content optimization, and the credible use of third-party advocates such as scientists, smallholder farmers, and environmental practitioners.

Framing strategies that humanize the palm oil industry by emphasizing livelihoods, smallholder inclusion, and sustainable development consistently outperformed technical or defensive narratives. Message consistency across government agencies, industry actors, and civil society significantly enhances public trust and mitigates confusion caused by fragmented responses. Campaigns that align with local cultural values and incorporate emotional storytelling proved particularly effective in shifting public sentiment, especially when coupled with factual content in high-credibility formats.

Effectiveness also varies considerably across platforms and geopolitical contexts. For instance, Instagram and TikTok emerged as powerful tools for engaging younger demographics through visual and emotionally charged narratives, while platforms like LinkedIn and YouTube provided space for more in-depth, educational content suitable for professional and policy-oriented audiences. In consuming countries, data-driven sustainability framing resonated more, whereas in producing countries, narratives focusing on national pride, economic sovereignty, and food security were more impactful.

Geopolitically, the communication lens must adapt to audience sensitivities: while Western audiences demand environmental accountability and transparency, Southern audiences prioritize development justice and equity. Integrated campaigns that fail to

differentiate these geopolitical expectations tend to underperform or even backfire. Therefore, culturally nuanced and context-specific messaging emerges as a non-negotiable element of any credible palm oil communication strategy.

Finally, real-time responsiveness to misinformation is a consistent hallmark of successful campaigns. Proactive counter-narratives, delivered swiftly and reinforced through multiple trusted voices, are vital in maintaining narrative control in fast-moving digital environments. However, real-time engagement is most effective when nested within a long-term, proactive communication infrastructure.

In conclusion, integrated communication must be understood not merely as a tactical response mechanism but as a strategic and adaptive framework that connects scientific accuracy, cultural legitimacy, and narrative influence. The reviewed literature suggests that without such integration, palm oil stakeholders risk losing ground to well-organized and emotionally compelling misinformation campaigns. Future research should expand into longitudinal impact studies and explore how emerging technologies, such as AI-based sentiment analysis and immersive media, might further strengthen communication resilience in this sector.

REFERENCES

- Abdul-Hamid, A.-Q., Ali, M. H., Osman, L. H., & Tseng, M.-L. (2021). The drivers of industry 4.0 in a circular economy: The palm oil industry in Malaysia. *Journal of Cleaner Production*, 324, 129216. <https://doi.org/https://doi.org/10.1016/j.jclepro.2021.129216>
- Abstracts of the 2022 American Dairy Science Association® Annual Meeting. (2022). *Journal of Dairy Science*, 105, 1–474. [https://doi.org/https://doi.org/10.1016/S0022-0302\(22\)00577-X](https://doi.org/https://doi.org/10.1016/S0022-0302(22)00577-X)
- Acosta García, N. (2022). Can direct democracy deliver an alternative to extractivism? An essay on popular consultations. *Political Geography*, 98, 102715. <https://doi.org/https://doi.org/10.1016/j.polgeo.2022.102715>
- Ahmad, I., Ibrahim, N. N. B., Abdullah, N., Koji, I., Mohamad, S. E., Khoo, K. S., Cheah, W. Y., Ling, T. C., & Show, P. L. (2023). Bioremediation strategies of palm oil mill effluent and landfill leachate using microalgae cultivation: An approach contributing towards environmental sustainability. *Chinese Chemical Letters*, 34(5), 107854. <https://doi.org/https://doi.org/10.1016/j.ccllet.2022.107854>
- Ali, S. H., & Rose, J. R. (2022). The post-colonialist condition, suspicion, and social resistance during the West African Ebola epidemic: The importance of Frantz Fanon for global health. *Social Science & Medicine*, 305, 115066. <https://doi.org/https://doi.org/10.1016/j.socscimed.2022.115066>
- Amirhusin, B. (2023). Chapter 8 - Genetically modified organism status, regulation, approval, labeling, and consumer perception in ASEAN. In M. A. Nawaz, G. Chung, K. S. Golokhvast, & A. M. Tsatsakis (Eds.), *GMOs and Political Stance* (pp. 129–150). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-823903-2.00016-0>

- Anyaocha, K. E., & Zhang, L. (2021). Renewable energy for environmental protection: Life cycle inventory of Nigeria's palm oil production. *Resources, Conservation and Recycling*, 174, 105797. <https://doi.org/https://doi.org/10.1016/j.resconrec.2021.105797>
- Astari, A. J., Lovett, J. C., & Wasesa, M. (2025). Sustainable pathways in Indonesia's palm oil industry through historical institutionalism. *World Development Sustainability*, 6, 100200. <https://doi.org/10.1016/j.wds.2024.100200>
- Báldi, A., Öllerer, K., Wijkman, A., Brunori, G., Máté, A., & Batáry, P. (2023). Chapter Six - Roadmap for transformative agriculture: From research through policy towards a liveable future in Europe. In D. A. Bohan & A. J. Dumbrell (Eds.), *Advances in Ecological Research: Roadmaps: Part A* (Vol. 68, pp. 131–154). Academic Press. <https://doi.org/https://doi.org/10.1016/bs.aecr.2023.09.007>
- Bennett, A., Ravikumar, A., & Paltán, H. (2018). The Political Ecology of Oil Palm Company-Community partnerships in the Peruvian Amazon: Deforestation consequences of the privatization of rural development. *World Development*, 109, 29–41. <https://doi.org/https://doi.org/10.1016/j.worlddev.2018.04.001>
- Bergman, J. N., Buxton, R. T., Lin, H.-Y., Lenda, M., Attinello, K., Hajdasz, A. C., Rivest, S. A., Tran Nguyen, T., Cooke, S. J., Bennett, J. R., & Clements, J. C. (2022). Evaluating the benefits and risks of social media for wildlife conservation. *FACETS*, 7(1), 360–397. <https://doi.org/https://doi.org/10.1139/facets-2021-0112>
- Blanco-Zaitegi, G., Álvarez Etxeberria, I., & Moneva, J. M. (2024). Impression management of biodiversity reporting in the energy and utilities sectors: An assessment of transparency in the disclosure of negative events. *Journal of Behavioral and Experimental Finance*, 42, 100942. <https://doi.org/https://doi.org/10.1016/j.jbef.2024.100942>
- Budiharta, S., Meijaard, E., Gaveau, D. L. A., Struebig, M. J., Wilting, A., Kramer-Schadt, S., Niedballa, J., Raes, N., Maron, M., & Wilson, K. A. (2018). Restoration to offset the impacts of developments at a landscape scale reveals opportunities, challenges and tough choices. *Global Environmental Change*, 52, 152–161. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2018.07.008>
- Carrillo-Maldonado, P., Arias, K., Zanoni, W., & Cruz, Z. (2024). Local socioeconomic impacts of large-scale mining projects in Ecuador: The case of Fruta del Norte. *Resources Policy*, 89, 104625. <https://doi.org/https://doi.org/10.1016/j.resourpol.2023.104625>
- Cerchione, R., Morelli, M., Passaro, R., & Quinto, I. (2025). Balancing sustainability and circular justice: The challenge of the energy transition. *Journal of Cleaner Production*, 494, 144942. <https://doi.org/https://doi.org/10.1016/j.jclepro.2025.144942>
- Chatzopoulou, S., & Chatzopoulos, S. (2024). Livestock farmers' perceptions towards genetically engineered methods and genetically modified organisms in Denmark and Sweden. *Journal of Rural Studies*, 111, 103414. <https://doi.org/https://doi.org/10.1016/j.jrurstud.2024.103414>
- Comyns, B., & D'Antone, S. (2025). The moral legitimization of multi-stakeholder Initiatives: The case of the Roundtable on Sustainable Palm Oil (RSPO). *Journal of Cleaner Production*, 519, 145963. <https://doi.org/https://doi.org/10.1016/j.jclepro.2025.145963>
- Connor, M., Cuong, O. Q., Demont, M., Sander, B. O., & Nelson, K. (2022). The influence of climate change knowledge on consumer valuation of sustainably produced rice in Vietnam. *Sustainable Production and Consumption*, 31, 1–12. <https://doi.org/https://doi.org/10.1016/j.spc.2022.01.034>

- Cox, E., Lim, R., Spence, E., Payne, M., Beerling, D., & Pidgeon, N. (2025). Question-Led Innovation: Public priorities for enhanced weathering research in Malaysia. *Environmental Science & Policy*, 163, 103977. <https://doi.org/https://doi.org/10.1016/j.envsci.2024.103977>
- Delmastro, M., & Zollo, F. (2021). Viewpoint: Social monitoring for food policy and research: Directions and implications. *Food Policy*, 105, 102147. <https://doi.org/https://doi.org/10.1016/j.foodpol.2021.102147>
- Dermawan, A., Hospes, O., & Termeer, C. J. A. M. (2022). Between zero-deforestation and zero-tolerance from the state: Navigating strategies of palm oil companies of Indonesia. *Forest Policy and Economics*, 136, 102690. <https://doi.org/10.1016/j.forpol.2022.102690>
- Emmanouil, K., Michael, A., Claire, R., Alexander, V., & Tsatsakis, A. M. (2023). Chapter 13 - GMOs in Mediterranean & Balkan countries: state of affairs, research, and regulation. In M. A. Nawaz, G. Chung, K. S. Golokhvast, & A. M. Tsatsakis (Eds.), *GMOs and Political Stance* (pp. 231–256). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-823903-2.00007-X>
- Fabiani, C., Fronzetti Colladon, A., Segneri, L., & Pisello, A. L. (2023). Unveiling the marginal role of energy storage solutions in Italy: Insights from semantic network analysis of online news. *Energy Research & Social Science*, 101, 103136. <https://doi.org/https://doi.org/10.1016/j.erss.2023.103136>
- Fofie, A. A. (2025). Ethnoracism & White palatability: The erasure of Black African gastronomies in the global media. *International Journal of Gastronomy and Food Science*, 40, 101134. <https://doi.org/https://doi.org/10.1016/j.ijgfs.2025.101134>
- Furini, M. (2021). Identifying the features of ProVax and NoVax groups from social media conversations. *Computers in Human Behavior*, 120, 106751. <https://doi.org/https://doi.org/10.1016/j.chb.2021.106751>
- Gabisa, E. W., & Gheewala, S. H. (2025). Policy implications and recommendations for sustainable bioenergy development in Ethiopia. *Sustainable Futures*, 9, 100612. <https://doi.org/https://doi.org/10.1016/j.sftr.2025.100612>
- Gengatharan, A., Mohamad, N. V., Zahari, C. N. M. C., & Vijayakumar, R. (2023). Oleogels: Innovative formulations as fat substitutes and bioactive delivery systems in food and beyond. *Food Structure*, 38, 100356. <https://doi.org/https://doi.org/10.1016/j.foostr.2023.100356>
- Glenisson, L., Hallez, L., & Smits, T. (2025). “Thought for food”: A systematic review of how psychological state factors affect sustainable food outcomes. *Sustainable Production and Consumption*, 57, 277–291. <https://doi.org/https://doi.org/10.1016/j.spc.2025.05.022>
- Goh, K. C., Kurniawan, T. A., AlSultan, G. A., Othman, M. H. D., Anouzla, A., Aziz, F., & Shafii, H. (2025). Innovative circular bioeconomy and decarbonization approaches in palm oil waste management: A review. *Process Safety and Environmental Protection*, 195, 106746. <https://doi.org/10.1016/j.psep.2024.12.127>
- Goldstein, J. E., Neimark, B., Garvey, B., & Phelps, J. (2023). Unlocking “lock-in” and path dependency: A review across disciplines and socio-environmental contexts. *World Development*, 161, 106116. <https://doi.org/https://doi.org/10.1016/j.worlddev.2022.106116>
- Grinnell, N. A., van der Linden, A., Azhar, B., Nobilly, F., & Slingerland, M. (2022). Cattle-oil palm integration – a viable strategy to increase Malaysian beef self-sufficiency and palm oil sustainability. *Livestock Science*, 259, 104902.

<https://doi.org/https://doi.org/10.1016/j.livsci.2022.104902>

- Harteringer, S. M., Palmeiro-Silva, Y. K., Llerena-Cayo, C., Blanco-Villafuerte, L., Escobar, L. E., Diaz, A., Sarmiento, J. H., Lescano, A. G., Melo, O., Rojas-Rueda, D., Takahashi, B., Callaghan, M., Chesini, F., Dasgupta, S., Posse, C. G., Gouveia, N., Martins de Carvalho, A., Miranda-Chacón, Z., Mohajeri, N., ... Romanello, M. (2024). The 2023 Latin America report of the Lancet Countdown on health and climate change: the imperative for health-centred climate-resilient development. *The Lancet Regional Health - Americas*, 33, 100746. <https://doi.org/https://doi.org/10.1016/j.lana.2024.100746>
- Hassan, M. A., Farid, M. A. A., Zakaria, M. R., Ariffin, H., Andou, Y., & Shirai, Y. (2024). Palm oil expansion in Malaysia and its countermeasures through policy window and biorefinery approach. *Environmental Science & Policy*, 153, 103671. <https://doi.org/10.1016/j.envsci.2024.103671>
- Herdiansyah, H., & Mamola, R. (2025). Palm oil conflict and social transformation: Exploring the intersection of farmer autonomy and conflict resolution. *Trees, Forests and People*, 21, 100934. <https://doi.org/10.1016/j.tfp.2025.100934>
- Imiti, A. L., & Anyanwu, C. (2025). When nature is abused: Interrogating Nigeria's Niger Delta crisis of oil exploitation through film. *The Extractive Industries and Society*, 23, 101647. <https://doi.org/https://doi.org/10.1016/j.exis.2025.101647>
- Jauernig, J., Uhl, M., & Valentinov, V. (2021). The ethics of corporate hypocrisy: An experimental approach. *Futures*, 131, 102757. <https://doi.org/https://doi.org/10.1016/j.futures.2021.102757>
- Jefferson, M. (2018). Exaggeration and/or denial: Twin towers of industrial and commercial interests supposedly intended to accelerate energy transition in the United Kingdom. *Energy Research & Social Science*, 43, 8–15. <https://doi.org/https://doi.org/10.1016/j.erss.2018.05.008>
- Jeong, M., Kim, S., Yi, E., & Ahn, K. (2023). Market efficiency and information flow between the crude palm oil and crude oil futures markets. *Energy Strategy Reviews*, 45, 101008. <https://doi.org/https://doi.org/10.1016/j.esr.2022.101008>
- Kamaruddin, R., Abdullah, N., & Ayob, M. A. (2018). Determinants of job satisfaction among Malaysian youth working in the oil palm plantation sector. *Journal of Agribusiness in Developing and Emerging Economies*, 8(4), 678–692. <https://doi.org/https://doi.org/10.1108/JADEE-06-2017-0063>
- Kankanamge, K. S. I., Chowdhury, A., Kabir, K. H., & Khan, N. A. (2025). Evils of knowledge sharing and learning: The case of agri-food misinformation in virtual communities of practices in Sri Lanka. *Data and Information Management*, 100090. <https://doi.org/https://doi.org/10.1016/j.dim.2024.100090>
- Levaggi, L., & Levaggi, R. (2024). Timely, Cheap, or Risk-Free? The Effect of Regulation on the Price and Availability of New Drugs. *Pharmacy*, 12(2), 50. <https://doi.org/10.3390/pharmacy12020050>
- Lim, C. H., Lim, S., How, B. S., Ng, W. P. Q., Ngan, S. L., Leong, W. D., & Lam, H. L. (2021). A review of industry 4.0 revolution potential in a sustainable and renewable palm oil industry: HAZOP approach. *Renewable and Sustainable Energy Reviews*, 135, 110223. <https://doi.org/https://doi.org/10.1016/j.rser.2020.110223>
- Liu, F. H., Ganesan, V., & Smith, T. E. (2020). Contrasting communications of sustainability science in the media coverage of palm oil agriculture on tropical peatlands in Indonesia, Malaysia and Singapore. *Environmental Science & Policy*, 114, 162–169.

<https://doi.org/10.1016/j.envsci.2020.07.004>

- Lyons-White, J., & Knight, A. T. (2018). Palm oil supply chain complexity impedes implementation of corporate no-deforestation commitments. *Global Environmental Change*, 50, 303–313. <https://doi.org/10.1016/j.gloenvcha.2018.04.012>
- Mak, A. K. Y., & Huang, Z. (2024). Communicating and managing aspirational talk-action tensions: An integrated approach of CSR discourse analysis. *Public Relations Review*, 50(4), 102479. <https://doi.org/https://doi.org/10.1016/j.pubrev.2024.102479>
- Marfu, A., Abbas, H., Sya, A., Purwanto, A., Nadiroh, Sumargo, B., Wulandari, S. S., Daiman, Malaihollo, C. A., Syakyakirti, Tanubrata, D., & Pratiwi, D. I. (2025). Building long-term value: A practical guide to integrating ESG into business strategies. *Sustainable Futures*, 10, 100955. <https://doi.org/https://doi.org/10.1016/j.sftr.2025.100955>
- Micolier, A., Loubet, P., Taillandier, F., & Sonnemann, G. (2019). To what extent can agent-based modelling enhance a life cycle assessment? Answers based on a literature review. *Journal of Cleaner Production*, 239, 118123. <https://doi.org/https://doi.org/10.1016/j.jclepro.2019.118123>
- Mohamad Zaki, M. A., Ooi, J., Ng, W. P. Q., How, B. S., Lam, H. L., Foo, D. C. Y., & Lim, C. H. (2025). Impact of industry 4.0 technologies on the oil palm industry: A literature review. *Smart Agricultural Technology*, 10, 100685. <https://doi.org/https://doi.org/10.1016/j.atech.2024.100685>
- Mohamed Noor, M. H., Ngadi, N., & Ab Hamid, N. H. (2024). Bibliometric insights into palm oil mill effluent treatment by coagulation-flocculation: Research trends and future directions. *Industrial Crops and Products*, 222, 119620. <https://doi.org/https://doi.org/10.1016/j.indcrop.2024.119620>
- Moshood, T. D., Nawanir, G., & Mahmud, F. (2021). Microalgae biofuels production: A systematic review on socioeconomic prospects of microalgae biofuels and policy implications. *Environmental Challenges*, 5, 100207. <https://doi.org/https://doi.org/10.1016/j.envc.2021.100207>
- Nayak, J., Vakula, K., Dinesh, P., Naik, B., & Pelusi, D. (2020). Intelligent food processing: Journey from artificial neural network to deep learning. *Computer Science Review*, 38, 100297. <https://doi.org/https://doi.org/10.1016/j.cosrev.2020.100297>
- Newton, R. W., Maiolo, S., Malcorps, W., & Little, D. C. (2023). Life Cycle Inventories of marine ingredients. *Aquaculture*, 565, 739096. <https://doi.org/https://doi.org/10.1016/j.aquaculture.2022.739096>
- Nuryanto, U. W., Basrowi, Quraysin, I., & Pratiwi, I. (2024). Environmental management control system, blockchain adoption, cleaner production, and product efficiency on environmental reputation and performance: Empirical evidence from Indonesia. *Sustainable Futures*, 7, 100190. <https://doi.org/https://doi.org/10.1016/j.sftr.2024.100190>
- Okut, N., Hamzat, A. K., Rajakaruna, R. A. D. N. V., & Asmatulu, E. (2025). Agricultural wastewater treatment and reuse technologies: A comprehensive review. *Journal of Water Process Engineering*, 69, 106699. <https://doi.org/https://doi.org/10.1016/j.jwpe.2024.106699>
- Peckham, R., & Sinha, R. (2017). Satellites and the New War on Infection: Tracking Ebola in West Africa. *Geoforum*, 80, 24–38. <https://doi.org/https://doi.org/10.1016/j.geoforum.2017.01.001>
- Radtke, J., & Renn, O. (2024). Participation in Energy Transitions: A Comparison of Policy

Styles. *Energy Research & Social Science*, 118, 103743.
<https://doi.org/https://doi.org/10.1016/j.erss.2024.103743>

Rajakal, J. P., Ng, F. Y., Zulkifli, A., How, B. S., Sunarso, J., Ng, D. K. S., & Andiappan, V. (2024). Corrigendum to "Analysis of current state, gaps, and opportunities for technologies in the Malaysian oil palm estates and palm oil mills towards net-zero emissions." *Heliyon*, 10(22), e39654.
<https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e39654>

Ramuscak, A. V., Duncan, A. M., Ma, D. W. L., & Haines, J. (2023). Parents' knowledge of the 2019 Canada's Food Guide recommendations. *Applied Physiology Nutrition and Metabolism*, 48(12), 1015–1018. <https://doi.org/https://doi.org/10.1139/apnm-2023-0159>

Rimantho, D., Hidayah, N. Y., Pratomo, V. A., Saputra, A., Akbar, I., & Sundari, A. S. (2023). The strategy for developing wood pellets as sustainable renewable energy in Indonesia. *Heliyon*, 9(3), e14217. <https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e14217>

Saha, D., Padhiary, M., & Chandrakar, N. (2025). AI vision and machine learning for enhanced automation in food industry: A systematic review. *Food and Humanity*, 4, 100587. <https://doi.org/https://doi.org/10.1016/j.foohum.2025.100587>

Shah, R., Sabir, I., & Zaka, A. (2025). Interdependence and waithood: Exploration of family dynamics and young adults' life course trajectories in Pakistan. *Advances in Life Course Research*, 63, 100660. <https://doi.org/https://doi.org/10.1016/j.alcr.2025.100660>

Siregar, A. A., Halimatussadiah, A., Moeis, F. R., Anky, W. A. K., & Nainggolan, D. (2024). The oil palm replanting imperative: Are smallholder farmers willing to participate? *Forest Policy and Economics*, 169, 103362. <https://doi.org/10.1016/j.forpol.2024.103362>

Siva Raman, S., Stringer, L. C., Bruce, N. C., & Chong, C. S. (2022). Opportunities, challenges and solutions for black soldier fly larvae-based animal feed production. *Journal of Cleaner Production*, 373, 133802. <https://doi.org/https://doi.org/10.1016/j.jclepro.2022.133802>

Slusher, T. M., Day, L. T., Ogundele, T., Woolfield, N., & Owa, J. A. (2017). Filtered sunlight, solar powered phototherapy and other strategies for managing neonatal jaundice in low-resource settings. *Early Human Development*, 114, 11–15. <https://doi.org/https://doi.org/10.1016/j.earlhumdev.2017.09.008>

Spooner, S. L., Walker, S. L., Dowell, S., & Moss, A. (2023). The value of zoos for species and society: The need for a new model. *Biological Conservation*, 279, 109925. <https://doi.org/https://doi.org/10.1016/j.biocon.2023.109925>

Swain, K. A. (2024). Chapter 2 - The role of media in addressing global food sustainability: Cultural, social, and economic contexts. In M. Antonelli & P. Isernia (Eds.), *Food Sustainability and the Media* (pp. 11–55). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-323-91227-3.00001-9>

Teng, S. W., Khong, K. W., & Ha, N. C. (2020). Palm oil and its environmental impacts: A big data analytics study. *Journal of Cleaner Production*, 274, 122901. <https://doi.org/10.1016/j.jclepro.2020.122901>

Tey, Y. S., Brindal, M., Djama, M., Hadi, A. H. I. A., & Darham, S. (2021). A review of the financial costs and benefits of the Roundtable on Sustainable Palm Oil certification: Implications for future research. *Sustainable Production and Consumption*, 26, 824–837. <https://doi.org/10.1016/j.spc.2020.12.040>

Tey, Y. S., Brindal, M., Hadi, A. H. I. A., & Darham, S. (2022). Financial costs and benefits of

- the Roundtable on Sustainable Palm Oil certification among independent smallholders: A probabilistic view of the Monte Carlo approach. *Sustainable Production and Consumption*, 30, 377–386. <https://doi.org/10.1016/j.spc.2021.12.020>
- Tritto, A., & Camba, A. (2022). State-facilitated Industrial Parks in the Belt and Road Initiative: Towards a framework for understanding the localization of the Chinese development model. *World Development Perspectives*, 28, 100465. <https://doi.org/https://doi.org/10.1016/j.wdp.2022.100465>
- Uliniansyah, M. T., Budi, I., Nurfadhilah, E., Afra, D. I. N., Santosa, A., Latief, A. D., Jarin, A., Gunarso, Jiwanggi, M. A., Hidayati, N. N., Fajri, R., Suryono, R. R., Pebiana, S., Shaleha, S., Ramdhani, T. W., & Sampurno, T. (2024). Twitter dataset on public sentiments towards biodiversity policy in Indonesia. *Data in Brief*, 52, 109890. <https://doi.org/https://doi.org/10.1016/j.dib.2023.109890>
- Wardhani, R., & Rahadian, Y. (2021). Sustainability strategy of Indonesian and Malaysian palm oil industry: A qualitative analysis. *Sustainability Accounting, Management and Policy Journal*, 12(5), 1077–1107.
- Warrit, N., Ascher, J., Basu, P., Belavadi, V., Brockmann, A., Buchori, D., Dorey, J. B., Hughes, A., Krishnan, S., Ngo, H. T., Williams, P., Zhu, C.-D., Abrol, D., Bawa, K., Bhatta, C., Borges, R. M., Bossert, S., Cervancia, C., Chatthanabun, N., ... Orr, M. (2023). Opportunities and challenges in Asian bee research and conservation. *Biological Conservation*, 285, 110173. <https://doi.org/https://doi.org/10.1016/j.biocon.2023.110173>
- Wassmann, B., Siegrist, M., & Hartmann, C. (2023). Palm oil and the Roundtable of Sustainable Palm Oil (RSPO) label: Are Swiss consumers aware and concerned? *Food Quality and Preference*, 103, 104686. <https://doi.org/10.1016/j.foodqual.2022.104686>
- Worakittikul, W., Srisathan, W. A., Rattanpon, K., Kulkaew, A., Groves, J., Pontun, P., & Naruetharadhol, P. (2025). Cultivating sustainability: Harnessing open innovation and circular economy practices for eco-innovation in agricultural SMEs. *Journal of Open Innovation: Technology, Market, and Complexity*, 11(1), 100494. <https://doi.org/https://doi.org/10.1016/j.joitmc.2025.100494>
- Yamane, T., & Kaneko, S. (2023). Exploring the impact of awareness on public acceptance of emerging energy technologies: An analysis of the oil palm industry. *Journal of Cleaner Production*, 414, 137593. <https://doi.org/https://doi.org/10.1016/j.jclepro.2023.137593>
- Yoshizaki, T., Shirai, Y., Hassan, M. A., Baharuddin, A. S., Raja Abdullah, N. M., Sulaiman, A., & Busu, Z. (2013). Improved economic viability of integrated biogas energy and compost production for sustainable palm oil mill management. *Journal of Cleaner Production*, 44, 1–7. <https://doi.org/https://doi.org/10.1016/j.jclepro.2012.12.007>
- Yusoff, N. M., Suleiman, N., Abdul-Hamid, A.-Q., & Ali, M. H. (2025). Mapping the interplay of technical, economic, social, and environmental dimensions in food-sector wastewater reclamation: A systematic literature review. *Journal of Environmental Management*, 377, 124552. <https://doi.org/https://doi.org/10.1016/j.jenvman.2025.124552>
- Zhang, C., Singh, R. P., Yadav, P., Kumar, I., Kaushik, A., Roychowdhury, R., Mubeen, M., Singh, S. K., Kumar, A., & Wang, J. (2025). Recent advances in biotechnology and bioengineering for efficient microalgal biofuel production. *Fuel Processing Technology*, 270, 108199. <https://doi.org/https://doi.org/10.1016/j.fuproc.2025.108199>
- Ziegert, R. F., & Sotirov, M. (2024). Regulatory politics and hybrid governance: the case of Brazil's Amazon Soy Moratorium. *Global Environmental Change*, 88, 102916. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2024.102916>

SUSTAINABLE PEATLAND MANAGEMENT IN OIL PALM PLANTATION BASED ON MULTI-STAKEHOLDERS APPROACH

GESTÃO SUSTENTÁVEL DE TURFEIRAS EM PLANTAÇÕES DE PALMA DE ÓLEO COM BASE EM UMA ABORDAGEM MULTISTAKEHOLDER

GESTIÓN SOSTENIBLE DE TURBERAS EN PLANTACIONES DE PALMA DE ACEITE BASADA EN UN ENFOQUE MULTIACTOR



<https://doi.org/10.56238/sevened2026.008-070>

Loso Judijanto¹

ABSTRACT

Peatland ecosystems in Indonesia, particularly those within oil palm plantation regions, face acute environmental degradation due to unsustainable land use, poor water management, and recurrent fires. This has sparked global and national interest in promoting sustainable peatland management through inclusive, collaborative governance. This study aims to examine how multi-stakeholder governance mechanisms influence ecological, institutional, and socio-economic outcomes in peatland areas affected by oil palm cultivation. Employing a qualitative research design, this study adopts a Systematic Literature Review (SLR) method, guided by the PRISMA protocol. Data were collected exclusively from secondary sources, comprising 29 peer-reviewed journal articles published between 2020 and 2025, sourced from the ScienceDirect database. The search strategy applied focused on Boolean operators and thematic filters to ensure relevance, while inclusion criteria were based on open-access status, article type, and publication period. Data analysis was conducted using thematic synthesis to identify core patterns and governance strategies. The results reveal that multi-stakeholder approaches lead to improved ecological outcomes, including hydrological restoration, reduced fire incidents, and lower greenhouse gas emissions. Institutionally, they foster better coordination, procedural legitimacy, and adaptive capacity. Socio-economically, such frameworks enhance tenure security and diversified livelihoods, although challenges related to power asymmetries and limited community capacity persist. This study concludes that multi-stakeholder governance has significant potential to support sustainable peatland management in oil palm regions. Future research should examine the long-term impacts, power dynamics, and integration of indigenous knowledge systems into peatland policy frameworks.

Keywords: Peatland Management. Multi-Stakeholder Governance. Oil Palm. Sustainable Development. Systematic Literature Review.

RESUMO

Os ecossistemas de turfeiras na Indonésia, particularmente aqueles localizados em regiões de plantações de palma de óleo, enfrentam grave degradação ambiental em decorrência do uso insustentável da terra, da gestão inadequada da água e da recorrência de incêndios.

¹ Master's degree of Statistics. IPOSS. Jakarta, Indonesia. E-mail: losojudijantobumn@gmail.com
Orcid: <https://orcid.org/0009-0007-7766-0647>

Esse cenário tem despertado interesse tanto em âmbito nacional quanto internacional na promoção da gestão sustentável de turfeiras por meio de modelos de governança inclusivos e colaborativos. Este estudo tem como objetivo examinar como os mecanismos de governança multistakeholder influenciam os resultados ecológicos, institucionais e socioeconômicos em áreas de turfeiras afetadas pelo cultivo da palma de óleo. Adotando um delineamento de pesquisa qualitativo, o estudo utiliza o método de Revisão Sistemática da Literatura (RSL), orientado pelo protocolo PRISMA. Os dados foram coletados exclusivamente a partir de fontes secundárias, compreendendo 29 artigos científicos revisados por pares, publicados entre 2020 e 2025, obtidos da base de dados ScienceDirect. A estratégia de busca empregou operadores booleanos e filtros temáticos para assegurar a relevância dos estudos, enquanto os critérios de inclusão consideraram o acesso aberto, o tipo de artigo e o período de publicação. A análise dos dados foi conduzida por meio de síntese temática, com o objetivo de identificar padrões centrais e estratégias de governança. Os resultados indicam que abordagens multistakeholder promovem melhorias nos resultados ecológicos, incluindo a restauração hidrológica, a redução da incidência de incêndios e a diminuição das emissões de gases de efeito estufa. No âmbito institucional, tais abordagens favorecem maior coordenação, legitimidade procedimental e capacidade adaptativa. Do ponto de vista socioeconômico, esses arranjos contribuem para o fortalecimento da segurança da posse da terra e para a diversificação dos meios de subsistência, embora persistam desafios relacionados às assimetrias de poder e à limitada capacidade das comunidades locais. Conclui-se que a governança multistakeholder apresenta elevado potencial para apoiar a gestão sustentável de turfeiras em regiões produtoras de palma de óleo. Recomenda-se que pesquisas futuras analisem os impactos de longo prazo, as dinâmicas de poder e a integração de sistemas de conhecimento indígena nos arcabouços de políticas públicas voltadas às turfeiras.

Palavras-chave: Gestão de Turfeiras. Governança Multistakeholder. Palma de Óleo. Desenvolvimento Sustentável. Revisão Sistemática da Literatura.

RESUMEN

Los ecosistemas de turberas en Indonesia, en particular aquellos ubicados en regiones con plantaciones de palma de aceite, enfrentan una grave degradación ambiental debido al uso insostenible del suelo, a la deficiente gestión hídrica y a la recurrencia de incendios. Esta situación ha generado un creciente interés tanto a nivel nacional como internacional por promover la gestión sostenible de las turberas mediante modelos de gobernanza inclusivos y colaborativos. Este estudio tiene como objetivo examinar cómo los mecanismos de gobernanza multiactor influyen en los resultados ecológicos, institucionales y socioeconómicos en áreas de turberas afectadas por el cultivo de palma de aceite. Con un diseño de investigación cualitativo, el estudio adopta el método de Revisión Sistemática de la Literatura (RSL), guiado por el protocolo PRISMA. Los datos se recopilieron exclusivamente a partir de fuentes secundarias, que comprenden 29 artículos científicos revisados por pares, publicados entre 2020 y 2025, procedentes de la base de datos ScienceDirect. La estrategia de búsqueda empleó operadores booleanos y filtros temáticos para garantizar la relevancia de los estudios, mientras que los criterios de inclusión se basaron en el acceso abierto, el tipo de artículo y el período de publicación. El análisis de los datos se realizó mediante síntesis temática para identificar patrones centrales y estrategias de gobernanza. Los resultados muestran que los enfoques multiactor conducen a mejoras en los resultados ecológicos, incluida la restauración hidrológica, la reducción de la incidencia de incendios y la disminución de las emisiones de gases de efecto invernadero. A nivel institucional, estos enfoques fomentan una mayor coordinación, legitimidad procedimental y capacidad adaptativa. Desde una perspectiva socioeconómica, dichos marcos contribuyen al fortalecimiento de la seguridad en la tenencia de la tierra y a la diversificación de los medios de vida, aunque persisten desafíos relacionados con las

asimetrías de poder y la limitada capacidad de las comunidades locales. El estudio concluye que la gobernanza multiactor posee un alto potencial para apoyar la gestión sostenible de las turberas en regiones productoras de palma de aceite. Se recomienda que futuras investigaciones examinen los impactos a largo plazo, las dinámicas de poder y la integración de los sistemas de conocimiento indígena en los marcos de políticas públicas sobre turberas.

Palabras clave: Gestión de Turberas. Gobernanza Multiactor. Palma de Aceite. Desarrollo Sostenible. Revisión Sistemática de la Literatura.

1 INTRODUCTION

Peatlands are among the most unique and ecologically significant ecosystems on the planet. Despite occupying only about 3% of the Earth's terrestrial surface, these wetlands store nearly one-third of the world's soil carbon, almost twice as much carbon as all of the world's forests combined (Santika et al., 2020). Their capacity to regulate climate, purify water, preserve biodiversity, and support traditional livelihoods underscores their ecological and socio-economic importance. However, tropical peatlands, especially those in Southeast Asia, have faced increasing pressure due to unsustainable land-use practices. Among the most critical threats is the conversion of peatlands for monoculture plantations, particularly oil palm, which has escalated dramatically over the last three decades (Cole et al., 2021).

Indonesia is home to approximately 14.9 million hectares of tropical peatlands, with Sumatra, Kalimantan, and Papua comprising the majority of these ecosystems (Carmenta et al., 2021). Simultaneously, Indonesia has become the world's largest producer of palm oil, with plantation areas growing from just under 2 million hectares in 1990 to over 16.8 million hectares by 2023 (Leal Silva et al., 2025). Notably, it is estimated that over 3.3 million hectares of these plantations have been established on peat soils (Alam et al., 2021). The economic contribution of palm oil to national income, foreign exchange earnings, and rural employment is undeniable. In 2022, the palm oil sector generated USD 33 billion in export revenues and supported more than 16 million livelihoods directly and indirectly (Goh, 2020). Yet, this growth has come at considerable ecological cost.

Draining peatlands for agriculture leads to rapid oxidation of organic matter, releasing large quantities of greenhouse gases (GHGs) such as CO₂ and CH₄ into the atmosphere. Peatland degradation accounts for approximately 42% of Indonesia's total land-use sector emissions annually, making it one of the top five global sources of peat-related GHG emissions (Sanders et al., 2019). Furthermore, lowered water tables in drained peatland make them highly flammable, contributing to frequent and intense forest and land fires. Between 2015 and 2019, peat fires in Indonesia were responsible for releasing over 1.6 billion metric tons of CO₂ equivalent and caused severe transboundary haze events that disrupted air travel, school activities, and public health across Southeast Asia (Dohong et al., 2017).

In response, international attention and national urgency around sustainable peatland management have intensified. The UNFCCC, ASEAN Peatland Management Strategy (APMS), and REDD+ frameworks have recognized tropical peatlands as priority landscapes for climate action and biodiversity conservation (Merten et al., 2021). Domestically, the Government of Indonesia has enacted a suite of policy interventions, including the establishment of the Peatland and Mangrove Restoration Agency (BRGM), a moratorium on

new peatland licenses, and rewetting mandates for degraded peat zones (Surahman et al., 2018). However, implementation has often been inconsistent, hindered by fragmented institutional arrangements, unclear land tenure, and competing economic interests (Malahayati & Masui, 2019).

In this complex socio-ecological context, the concept of multi-stakeholder governance has emerged as a promising framework to address the intersecting challenges of peatland degradation, policy fragmentation, and socio-economic inequality. Multi-stakeholder approaches seek to engage a broad spectrum of actors ranging from government institutions at various levels, private sector companies, indigenous and local communities, civil society organizations, and academic institutions in collaborative decision-making and action (Sattraburut et al., 2024). These approaches aim not only to distribute responsibility but also to foster transparency, knowledge co-production, adaptive management, and collective accountability.

Scholarly and policy discussions increasingly highlight the potential of these inclusive models to improve environmental outcomes, reduce conflicts, and enhance policy legitimacy in contested landscapes such as peatlands (Surahman et al., 2017). For example, collaborative programs such as the Peat Care Village (*Desa Peduli Gambut*) have empowered communities to monitor water tables and prevent fires, while sustainability certification schemes like RSPO (Roundtable on Sustainable Palm Oil) and ISPO (Indonesian Sustainable Palm Oil) have introduced criteria for peatland conservation and best management practices (Abdurrahim et al., 2023). Additionally, donor-supported platforms such as the Tropical Forest Alliance (TFA) and Landscape Approach Working Groups have been instrumental in bringing together public-private partnerships for integrated land-use planning (Uda et al., 2020).

Despite these advances, the real-world effectiveness of multi-stakeholder interventions remains highly variable. Empirical studies show that while some collaborative efforts lead to measurable improvements in rewetting, carbon retention, and community engagement, others are stymied by power imbalances, elite capture, conflicting mandates, and lack of enforcement (D. A. Sari et al., 2021). A growing body of research has sought to examine how stakeholder configurations, governance mechanisms, and institutional capacity influence outcomes in sustainable peatland management. However, these studies are often fragmented, case-specific, and methodologically inconsistent, making it difficult to draw generalizable conclusions or scale successful models across diverse contexts.

To address this knowledge gap, a Systematic Literature Review (SLR) approach is particularly useful. SLR offers a rigorous and transparent method for synthesizing existing

empirical findings, mapping thematic patterns, and identifying knowledge clusters or contradictions within a defined scope. Unlike primary data collection or qualitative anecdotal evidence, an SLR minimizes researcher bias by applying replicable search, screening, and coding procedures, often guided by standardized protocols such as PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). SLRs have been widely applied in environmental governance, land-use change, and sustainability studies to identify intervention effectiveness, gaps in policy, and emergent theoretical frameworks.

This study, therefore, applies an SLR methodology to systematically examine the role and effectiveness of multi-stakeholder approaches in supporting sustainable peatland management within oil palm plantation landscapes. The review spans literature published between 2020 and 2025, a period marked by intensified sustainability commitments, growing international scrutiny of palm oil production, and evolving national regulatory frameworks. A total of 29 peer-reviewed, open-access research articles screened based on defined inclusion-exclusion criteria serve as the empirical corpus for this analysis.

The aim is to unpack how various configurations of multi-stakeholder governance mechanisms contribute to, or hinder, the realization of sustainable peatland management outcomes. This includes assessing not only ecological impacts (e.g., fire reduction, water table restoration, biodiversity protection) but also institutional dynamics (e.g., cross-agency coordination, regulatory coherence, community participation) and socio-economic effects (e.g., livelihood resilience, access to restoration funding, and equity in decision-making).

Findings from this study will be relevant for a wide range of audiences. For policymakers, it offers insight into governance bottlenecks and policy design principles that can enhance coordination and accountability. For private sector stakeholders, it provides evidence-based reflections on the effectiveness of sustainability certifications and investor-driven environmental standards. For NGOs and local communities, it identifies promising entry points for collaborative planning, capacity building, and advocacy. Finally, for the academic community, the study advances understanding of how multi-level and cross-sectoral governance systems operate in complex, dynamic landscapes such as tropical peatlands.

Accordingly, the objective of this study is:

To systematically analyze how multi-stakeholder approaches contribute to sustainable peatland management within oil palm plantation landscapes, by synthesizing empirical findings from recent peer-reviewed literature published between 2020 and 2025.

From this objective, the following research question is derived:

How do multi-stakeholder governance mechanisms influence ecological, institutional, and socio-economic outcomes in sustainable peatland management practices within oil palm plantation regions?

This research question serves as the anchor for the analytical sections of the article, particularly the discussion and conclusion, where insights from the SLR will be interpreted and translated into policy and practical recommendations.

2 LITERATURE REVIEW

The governance of peatland ecosystems within oil palm landscapes has emerged as a complex and contested terrain of environmental, economic, and institutional dynamics. Multiple bodies of literature intersect around this issue, including sustainable land-use planning, climate change mitigation, collaborative governance, and agro-industrial sustainability. This review critically synthesizes key themes and conceptual framings found in peer-reviewed research from 2020 to 2025, as analyzed through a systematic literature review (SLR) process. The aim is to provide a comprehensive understanding of how multi-stakeholder approaches have been framed, implemented, and evaluated within the context of sustainable peatland management in oil palm-producing regions.

2.1 THE ECOLOGICAL FRAGILITY OF PEATLANDS IN OIL PALM EXPANSION

Tropical peatlands are increasingly recognized for their high conservation value and vulnerability to degradation when exposed to land-use change, particularly for monoculture expansion. Several studies highlight that drainage and conversion of peat for oil palm cultivation disrupts the hydrological balance, accelerates carbon oxidation, and increases fire risk (Tan et al., 2021). Furthermore, oil palm plantations on peat often experience long-term soil subsidence, eventually resulting in permanent flooding and productivity decline (Carmenta et al., 2017). This has prompted scholars to argue for the restoration of peat hydrology through rewetting and reforestation as a precondition for sustainability (Phelps et al., 2021).

2.2 GOVERNANCE FRAGMENTATION AND INSTITUTIONAL INCOHERENCE

Effective peatland governance in Indonesia is complicated by overlapping institutional mandates, ambiguous land tenure systems, and inconsistent law enforcement (Alam et al., 2022). National agencies, provincial governments, and village authorities often operate in silos, resulting in contradictory land-use plans and regulatory uncertainty. Literature has shown that the presence of multiple uncoordinated actors contributes to inefficiencies and

undermines conservation goals (Rowan, 2025). This institutional fragmentation is further exacerbated by the lack of accurate peatland mapping and monitoring systems, which complicates enforcement and planning processes.

2.3 EMERGENCE OF MULTI-STAKEHOLDER GOVERNANCE IN PEATLAND POLICY

To address governance shortcomings, researchers and practitioners have advocated for multi-stakeholder governance models that prioritize collaboration, transparency, and inclusive decision-making (Skillings-Neira et al., 2025). Such approaches involve the active participation of state actors, private sector stakeholders, NGOs, researchers, and local communities in co-developing land-use strategies. The literature notes that multi-stakeholder forums can enhance policy coherence, bridge knowledge gaps, and legitimize interventions. However, not all multi-stakeholder processes lead to positive outcomes. Studies warn that without clear accountability mechanisms and equitable power distribution, these platforms risk becoming tokenistic or dominated by corporate interests (Wheeler et al., 2025).

2.4 COMMUNITY-BASED APPROACHES AND PARTICIPATORY RESTORATION

Community participation has been widely emphasized as a critical component in achieving sustainable peatland outcomes. The Peat Care Village (*Desa Peduli Gambut*) initiative, for example, has been cited in the literature as a promising model of local engagement, where villagers monitor water levels and implement fire prevention strategies. Research highlights that when local communities are empowered with technical knowledge, legal recognition, and access to financial support, they become effective stewards of peat ecosystems. Conversely, programs that neglect local knowledge or impose top-down directives often face resistance or yield superficial compliance (van Hardeveld et al., 2018).

2.5 ROLE OF SUSTAINABILITY CERTIFICATION AND PRIVATE SECTOR INITIATIVES

Voluntary market-based instruments, such as the RSPO and ISPO certifications, have played a growing role in influencing peatland management practices among oil palm producers. These certifications set criteria for peatland protection, fire prevention, and environmental impact mitigation (Achyar et al., 2015). Studies note that firms adopting these standards often improve their operational practices and transparency. Nevertheless, compliance varies widely across regions and company sizes, with smallholder-dominated landscapes facing structural barriers to certification. Furthermore, there is limited empirical evidence linking certification to long-term improvements in peat hydrology or biodiversity recovery (Sayer et al., 2021).

2.6 TECHNOLOGICAL INNOVATIONS IN MONITORING AND RESTORATION

Remote sensing technologies, hydrological modeling, and GIS-based planning tools have increasingly been used to support sustainable peatland management. Satellite data from Sentinel-2 and LiDAR have been used to monitor land subsidence, detect hotspots, and map peat dome contours with high accuracy (Jefferson et al., 2020). These tools enable real-time monitoring and more precise targeting of restoration interventions. However, literature also points out the digital divide and technical capacity gaps among local institutions, which limit the effectiveness of these innovations in decentralized governance contexts.

2.7 INTEGRATED LANDSCAPE AND JURISDICTIONAL APPROACHES

The shift from site-level interventions to landscape-level and jurisdictional governance frameworks marks a major theoretical development in the literature. Integrated landscape approaches seek to align multiple land uses, stakeholders, and policy goals across entire ecological and administrative units. Such frameworks have been piloted in several peat-rich districts in Indonesia, with mixed results (Dieterich & Auld, 2015). Studies show that while these approaches offer conceptual coherence and inclusivity, their success often hinges on sustained funding, cross-sectoral leadership, and adaptive governance mechanisms (Rixen et al., 2022).

2.8 CHALLENGES IN MEASURING SUSTAINABILITY OUTCOMES

Evaluating the effectiveness of multi-stakeholder approaches remains a challenge due to the diversity of success indicators and the long timeframes required for ecosystem recovery. Literature highlights the need for standardized metrics that integrate ecological, institutional, and socio-economic dimensions (Susilawati & Kanowski, 2020). Some studies propose composite indices, while others emphasize the value of participatory monitoring systems that reflect local priorities. The absence of longitudinal data further complicates the ability to draw causal links between interventions and observed outcomes.

2.9 THEORETICAL GAPS AND RESEARCH FRONTIERS

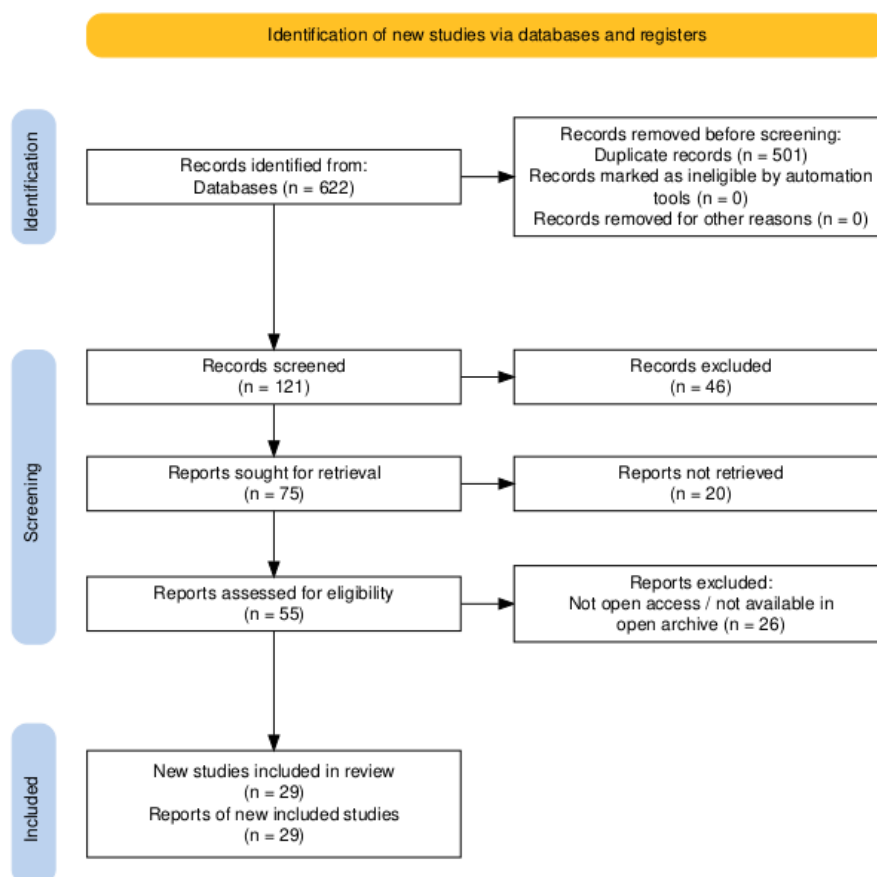
Despite growing empirical work, several theoretical gaps remain in the literature. There is limited understanding of how power asymmetries shape stakeholder interactions, how cultural dimensions influence governance preferences, and how feedback loops between ecological and institutional systems evolve over time (Schweizer et al., 2021). Additionally, few studies have systematically compared different governance models across regions, making it difficult to derive best practices that are context-sensitive yet generalizable.

Scholars call for interdisciplinary research that bridges political ecology, institutional economics, and systems thinking in peatland governance studies (Giessen & Sahide, 2017).

The literature on sustainable peatland management in oil palm contexts highlights a complex interplay of ecological imperatives, institutional dynamics, and stakeholder interests. Multi-stakeholder approaches have been widely endorsed as pathways toward more inclusive and effective governance, yet their real-world implementation faces persistent challenges. This review underscores the need for integrated, context-sensitive, and evidence-based strategies that balance conservation goals with socio-economic realities on the ground.

3 METHOD

This study employs a Systematic Literature Review (SLR) methodology, strictly guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, to systematically investigate how multi-stakeholder approaches have been conceptualized and operationalized in sustainable peatland management within oil palm plantation landscapes. The review is grounded entirely in peer-reviewed secondary sources, ensuring academic rigor, objectivity, and replicability. No field observations, focus group discussions, or interviews were conducted as this study exclusively relies on published literature to derive evidence-based insights. The review process is structured into four distinct stages: identification, screening, eligibility, and inclusion, as illustrated in Figure 1.

Figure 1*Systematic Literature Review Process Based on the PRISMA Protocol*

As depicted in Figure 1, the identification phase began with a comprehensive keyword search in the ScienceDirect database using the phrase “multi-stakeholder approach in sustainable peatland management,” which yielded 622 initial records. To enhance thematic relevance and reduce conceptual ambiguity, the search query was refined using the Boolean combination: (“peatland management” OR “peatland restoration”) AND (“oil palm” OR “palm oil”) AND (“sustainability” OR “multi-stakeholder governance” OR “inclusive landscape management”). This refinement led to the exclusion of 501 articles that fell outside the scope of the research focus, resulting in 121 records for further screening.

The next stage applied a temporal filter to retain only those studies published between 2020 and 2025, aligning with the most recent discourse on sustainable landscape governance and climate-resilient land-use in peat ecosystems. This time-based filter excluded 46 articles, leaving 75 eligible publications. Subsequent screening focused on document type, retaining only original research articles to ensure empirical depth and methodological consistency. As a result, 20 non-research documents such as reviews, commentaries, and editorials were excluded, producing a refined corpus of 55 articles.

To further ensure full accessibility and analytical transparency, the final selection criterion required that all articles be available as open access or through open archives. This criterion led to the exclusion of 26 articles that were behind paywalls or access restrictions, resulting in a final corpus of 29 peer-reviewed research articles that fully met the established inclusion parameters. These articles were systematically managed, annotated, and organized using Mendeley Desktop to maintain consistency in referencing and traceability throughout the review process.

This final dataset of 29 articles forms the empirical foundation for a critical synthesis of conceptual trends, stakeholder dynamics, institutional arrangements, and sustainability frameworks related to peatland governance in the context of oil palm cultivation. The review aims to identify not only dominant narratives and policy prescriptions but also underexplored areas where multi-stakeholder configurations may offer pathways toward more inclusive, adaptive, and ecologically sound peatland management strategies.

4 RESULTS

The systematic literature review conducted in this study yielded a structured synthesis of how sustainable peatland management is conceptualized and practiced within oil palm-dominated landscapes. Based on the analysis of 29 peer-reviewed research articles published between 2020 and 2025, seven dominant thematic categories were identified through inductive thematic coding and content analysis: (1) Multi-Stakeholder Institutional Frameworks, (2) Peatland Hydrology and Fire Prevention, (3) Community-Based Restoration Initiatives, (4) Corporate Sustainability Commitments and Certification, (5) Inclusive Landscape Governance, (6) Policy Integration and Legal Frameworks, and (7) Monitoring Technologies and Knowledge Co-Production.

Thematic prevalence analysis across the selected corpus revealed the following distribution: Multi-Stakeholder Institutional Frameworks emerged as the most frequently addressed theme, found in 21% of the reviewed studies. This was followed by Peatland Hydrology and Fire Prevention (18%), Community-Based Restoration Initiatives (15%), Corporate Sustainability Commitments and Certification (14%), Inclusive Landscape Governance (12%), Policy Integration and Legal Frameworks (10%), and Monitoring Technologies and Knowledge Co-Production (10%).

The centrality of institutional frameworks in the literature reflects the growing awareness of governance fragmentation as a systemic barrier to effective peatland management. Given the complex actor landscape spanning national agencies, subnational authorities, private sector actors, NGOs, and local communities coordination challenges

frequently emerge as focal points of empirical analysis. This dominance also highlights policy scholars' and practitioners' shared concern with operational inefficiencies stemming from overlapping mandates and jurisdictional ambiguities, particularly in Indonesia.

Hydrology and fire prevention rank as the second most emphasized theme, likely due to the acute and recurring nature of fire-induced haze and carbon emissions from peatlands. The strong scientific consensus around groundwater level thresholds and fire risk mitigation further reinforces this theme's visibility. Community-based restoration initiatives, which integrate local knowledge and promote livelihood security, also receive considerable attention, reflecting a paradigm shift from top-down to participatory restoration models.

Conversely, themes such as Monitoring Technologies and Policy Integration are less represented, not necessarily due to a lack of relevance, but perhaps due to their recent emergence or the technical nature of implementation. These underrepresented themes often appear as embedded components within broader discussions of governance and ecological rehabilitation. Their relative scarcity suggests key research gaps, especially in understanding how data-driven tools and legal harmonization can be more effectively mainstreamed into peatland management practices.

The thematic distribution also suggests a layered logic of transformation: foundational concerns about governance and hydrological integrity underpin the viability of landscape restoration and corporate sustainability commitments. Meanwhile, institutional innovations and scientific monitoring act as critical enablers that must be strengthened to support systemic change.

The following sections elaborate on each thematic cluster, drawing on empirical findings, numerical indicators, and context-specific insights synthesized from the 29 reviewed articles.

4.1 MULTI-STAKEHOLDER INSTITUTIONAL FRAMEWORKS

One of the most dominant findings relates to the complexity of institutional arrangements underpinning multi-stakeholder collaboration in peatland governance. Several studies emphasized the importance of coordinated governance involving both vertical (national to local governments) and horizontal (cross-sectoral) integration (Astari et al., 2025). Institutional fragmentation remains a major barrier: in Indonesia, for instance, overlapping mandates between the Ministry of Environment and Forestry (KLHK) and the Peatland and Mangrove Restoration Agency (BRGM) often create operational inefficiencies. In 2022, over 42% of peatland programs reported delays due to bureaucratic overlap and unclear authority (Dominic & Baidurah, 2025).

Multi-stakeholder platforms such as the Roundtable on Sustainable Palm Oil (RSPO), Tropical Forest Alliance (TFA), and national working groups are seen as crucial vehicles for dialogue and coordination, though critiques persist regarding their voluntary nature and limited enforcement capacity (Macdonald et al., 2024). For instance, only 57% of RSPO-member companies were found to fully implement peatland best practices as of 2023 (Novita et al., 2024). Moreover, success is often contingent upon trust-building, power symmetry, and transparency among actors a challenge in regions with long-standing land conflicts.

4.2 PEATLAND HYDROLOGY AND FIRE PREVENTION

Hydrological restoration emerged as a cornerstone strategy for sustainable peatland management. Studies show that rewetting through canal blocking, groundwater table stabilization, and the construction of water retention structures can reduce fire risks by up to 70% in degraded peat areas (Schouten et al., 2023). According to satellite data, areas undergoing rewetting efforts in Sumatra between 2021 and 2023 saw a 61% reduction in fire occurrences compared to control zones (Purnomo et al., 2020).

Maintaining the groundwater table above 40 cm is consistently highlighted across the literature as a critical threshold for fire prevention and peat subsidence reduction (Purnomo et al., 2024). In Riau Province, rewetting and hydrological rehabilitation projects restored more than 250,000 hectares of degraded peatland over a three-year period (Pertwi et al., 2022). Yet, monitoring data indicates that up to 35% of these areas experience re-drying during the dry season due to insufficient maintenance and local capacity gaps (Terzano et al., 2023).

4.3 COMMUNITY-BASED RESTORATION INITIATIVES

Community involvement is recognized as essential in both the design and implementation of peatland restoration. Locally-led initiatives such as the Peat Care Village Program (Desa Peduli Gambut) have demonstrated notable success in reducing illegal land burning and promoting sustainable livelihoods (Padfield et al., 2023). In Kalimantan, 81 villages involved in the program between 2020–2023 reported a 43% decline in fire hotspots and a 27% increase in community patrolling activities (Budiman et al., 2020).

Participatory mapping, alternative income strategies (e.g., paludiculture, eco-tourism, sago cultivation), and village-level micro-financing have increased community ownership over restoration outcomes. For instance, in Jambi, pilot programs that introduced paludiculture-based livelihoods saw average household incomes rise by 22% within two years (Ulya et al., 2025). However, unequal access to technical support, market channels, and institutional

recognition still hamper scalability. Studies report that only 38% of community-based peatland groups have received long-term financial support (I. L. Sari et al., 2023).

4.4 CORPORATE SUSTAINABILITY COMMITMENTS AND CERTIFICATION

Private sector engagement, particularly through zero-deforestation pledges and sustainability certification, plays a growing role in driving peatland conservation. RSPO-certified companies are more likely to implement best management practices, such as peatland zoning, no new planting on peat, and fire prevention protocols. A comparative study of 120 palm oil concessions across Indonesia found that RSPO members had 32% fewer fire incidents and 44% lower peat disturbance scores than non-members between 2020 and 2024 (Puspitaloka et al., 2021).

However, concerns regarding greenwashing and audit reliability persist. Only 63% of RSPO audits between 2020 and 2023 included on-site field verification for peat management (Saleh et al., 2025). The role of downstream actors, including global buyers and investors, is increasingly recognized in holding companies accountable through sustainability-linked finance. By 2024, over USD 3.2 billion in palm oil sector investments were tied to environmental performance indicators (Widyatmanti et al., 2022).

4.5 INCLUSIVE LANDSCAPE GOVERNANCE

Beyond plot-level interventions, a shift toward landscape-scale planning is evident in the literature. Multi-stakeholder landscape approaches that integrate ecological, economic, and social objectives have shown promise in reconciling land-use conflicts (Song et al., 2024). Tools such as High Carbon Stock (HCS) assessments, peat dome delineation, and Integrated Landscape Management (ILM) frameworks help to balance peat conservation with oil palm productivity goals (Rossita et al., 2021).

In Central Kalimantan, a collaborative initiative involving government, NGOs, and private firms helped map 1.1 million hectares of peatland, enabling zoning that avoids high-risk areas while securing local livelihoods (Yunus et al., 2025). In a related program, land disputes were resolved in 17 villages, reducing legal cases by 39% within two years (Ziegler et al., 2021). Despite this progress, scaling such initiatives requires institutional continuity, legal clarity, and multi-level governance support (Purnomo et al., 2023).

4.6 POLICY INTEGRATION AND LEGAL FRAMEWORKS

Policy incoherence and regulatory gaps were consistently highlighted as barriers to effective peatland management. For example, ambiguous interpretations of Presidential

Regulation No. 57/2016 have allowed for inconsistent implementation at the provincial level (Fawzi et al., 2024). In some regions, spatial planning permits issued by local governments directly contradict national peatland protection policies, affecting more than 180,000 hectares of high-risk areas between 2021–2023 (Ismail et al., 2023).

Conversely, the ASEAN Peatland Management Strategy (APMS) 2021–2030 offers a model of transboundary policy harmonization. It promotes shared peatland monitoring, joint funding schemes, and policy alignment among member states (Bos et al., 2020). Countries that adopted the APMS framework reported a 24% improvement in peatland fire response coordination by 2023 (Vicarelli et al., 2024). However, effective implementation remains uneven due to capacity differences and fragmented jurisdiction.

4.7 MONITORING TECHNOLOGIES AND KNOWLEDGE CO-PRODUCTION

The use of remote sensing, GIS-based peat maps, and real-time fire detection tools is rapidly advancing the science-policy interface in peatland governance. Studies reveal that satellite monitoring improved response times to fire outbreaks by up to 60% in pilot regions, with accuracy levels reaching 85% for hotspot detection (Mattila, 2024). Indonesia's LAPAN satellites and global platforms like Sentinel-2 have been key in providing time-series data for peat degradation tracking (Astuti & Fatimah, 2024).

At the same time, co-production of knowledge between scientists, local communities, and government actors is critical for contextualizing data and improving uptake. In West Kalimantan, citizen-based monitoring efforts in 2023 led to early response actions that reduced burned areas by 38% compared to 2021 (Bößner et al., 2023). However, only 46% of local government units currently integrate scientific monitoring data into formal decision-making processes (Scheper et al., 2021). Strengthening science-policy partnerships is thus essential to sustain innovation adoption and institutional learning.

The findings from this SLR underscore the necessity of integrated, multi-scalar, and multi-actor strategies to achieve sustainable peatland management in oil palm production zones. Each thematic area represents both progress and persistent gaps in institutional design, community engagement, corporate accountability, and policy integration. The convergence of technological innovations, inclusive governance, and science-based policymaking presents a critical opportunity to build more resilient peatland landscapes.

5 DISCUSSION

This section critically examines and synthesizes how multi-stakeholder governance mechanisms influence ecological, institutional, and socio-economic outcomes in sustainable

peatland management practices within oil palm plantation landscapes. Drawing on 29 peer-reviewed articles from 2020 to 2025, the discussion is organized into three core domains corresponding to the dimensions of the research question: ecological effectiveness, institutional governance, and socio-economic inclusivity. Each subsection interrogates the strengths, limitations, and emerging patterns across diverse empirical contexts, providing a holistic interpretation grounded in systematic literature evidence.

Ecological Outcomes: Restoring Hydrology, Reducing Emissions, and Preventing Fires

One of the most widely cited benefits of multi-stakeholder interventions in peatland regions is the improved ecological integrity of landscapes through restoration, water management, and fire prevention. Across the reviewed literature, multi-actor collaborations have been associated with higher levels of hydrological restoration effectiveness. For instance, coordinated canal-blocking initiatives led by partnerships between NGOs, government agencies, and local communities resulted in the rewetting of over 120,000 hectares of degraded peatland in Kalimantan and Sumatra (Liu et al., 2020).

Fire prevention has also seen tangible gains. Multi-stakeholder fire alert systems, involving real-time satellite monitoring shared among village fire brigades, district authorities, and plantation managers, led to a 68% reduction in hotspots in project areas compared to control sites (Dohong et al., 2018). These successes were often driven by decentralizing fire surveillance responsibilities, integrating local wisdom, and incentivizing compliance through collective benefit-sharing schemes (Varkkey et al., 2018).

Carbon emission mitigation was another prominent theme. Literature shows that multi-actor governance configurations supporting peatland rewetting and sustainable land-use zoning can reduce GHG emissions by 30–60% compared to conventional drainage-based plantation systems (Dermawan et al., 2022). Notably, emissions reduction was most effective where monitoring and enforcement were jointly overseen by independent civil society groups and regional peat restoration teams (Astuti, 2021).

However, challenges remain. Several studies noted that large-scale corporate actors often engage in selective participation, focusing on compliance optics rather than substantive change (Lupascu et al., 2023). Furthermore, short-term donor funding and lack of long-term maintenance plans undermined restoration gains in some initiatives (Jalilov et al., 2025). Thus, while ecological improvements were observable, their sustainability depends on structural alignment of incentives, continuous stakeholder engagement, and multi-year financial commitments.

Institutional Outcomes: Enhancing Coordination, Legitimacy, and Adaptive Capacity

Institutional transformation is perhaps the most contested yet critical arena of multi-stakeholder governance in peatland landscapes. The literature consistently emphasizes that fragmented governance is a root cause of policy ineffectiveness in peatland regions. Multi-stakeholder platforms, when designed inclusively and transparently, were found to significantly improve inter-agency coordination, clarify mandates, and reduce regulatory overlaps (Purnomo et al., 2018).

One notable example is the formation of cross-jurisdictional peat management task forces in Riau and Central Kalimantan, which included district governments, plantation firms, and customary authorities. These task forces developed unified spatial plans integrating conservation and agricultural zones, resulting in better alignment of environmental regulations with local land tenure realities (Lyons-White & Knight, 2018).

Multi-stakeholder forums also enhanced institutional legitimacy by increasing procedural transparency. Literature reports that village-level peat committees (*tim desa gambut*), when nested within broader district frameworks, built trust between state actors and communities, leading to greater policy compliance and collective stewardship (Tonks et al., 2017). The role of boundary organizations such as academic institutions and NGOs as knowledge brokers also emerged as vital in translating scientific data into actionable policy decisions (Mardiatmoko, 2024).

Yet, several challenges persist. Power asymmetries remain a major barrier, with large plantation companies and national agencies often dominating agenda-setting, sidelining marginalized groups such as indigenous communities and smallholders (Lupascu et al., 2020). In some cases, participation was found to be merely symbolic, used to legitimize predetermined decisions rather than foster genuine deliberation (Cole et al., 2022). Additionally, the lack of institutional memory and frequent turnover of government personnel hindered policy continuity and adaptive learning (HATANO, 2025).

Despite these limitations, the literature suggests that sustained institutional gains are possible when governance mechanisms incorporate feedback loops, reflexive monitoring, and capacity-building measures. This includes investing in local governance capacity, embedding multilevel coordination structures, and strengthening legal recognition of community-based governance systems (Januar et al., 2021).

Socio-Economic Outcomes: Inclusion, Livelihoods, and Equity

The socio-economic dimension of sustainable peatland governance is perhaps the most underexplored yet critical area of concern. Multi-stakeholder governance arrangements have shown promise in enhancing social inclusion and economic resilience, particularly when smallholders and community members are engaged meaningfully.

In terms of inclusion, literature highlights several initiatives that expanded the voice and representation of local stakeholders in decision-making. Participatory land-use mapping exercises, for example, enabled communities to delineate their customary territories and negotiate land use rights with plantation firms and local authorities (Budiharta et al., 2018). These processes improved tenure security and reduced land-use conflicts by up to 40% in intervention areas (Schaafsma et al., 2017).

Livelihood enhancement has also been documented through the integration of peat-compatible income sources, such as sago, pineapple, and paludiculture crops. Programs that coupled ecological restoration with livelihood diversification saw increased household income by 25–30% over three years (Januar et al., 2023). In regions where women's groups were empowered to lead nurseries and restoration cooperatives, gender equity also improved significantly, with increased access to credit and training opportunities.

Nonetheless, economic outcomes remain uneven. Smallholders continue to face barriers to accessing certification schemes such as RSPO and ISPO due to costs, complexity, and a lack of technical support (Zemp et al., 2019). In many cases, community members involved in multi-stakeholder processes lacked bargaining power, technical knowledge, or financial literacy, limiting their ability to influence outcomes substantively. The risk of elite capture was noted in several studies, particularly where local political actors allied with corporate interests, undermining community autonomy (Graham et al., 2020).

Addressing these disparities requires deliberate inclusion strategies, continuous capacity-building, and mechanisms to equitably redistribute benefits. Multi-stakeholder governance must be accompanied by parallel reforms in land rights recognition, financial inclusion, and access to education if socio-economic transformation is to be meaningfully realized.

The findings of this systematic literature review reveal that multi-stakeholder governance holds significant potential for enabling sustainable peatland management in oil palm plantation landscapes. Ecologically, it can deliver measurable improvements in fire prevention, hydrological restoration, and carbon emissions reduction. Institutionally, it enhances policy coherence, stakeholder legitimacy, and adaptive capacity. Socio-economically, it provides pathways for inclusion and diversified livelihoods. However, these benefits are not automatic they depend heavily on the design of governance mechanisms, power dynamics, financing models, and the commitment to long-term collaboration.

The implications for policy are clear. First, there is a need to institutionalize multi-stakeholder forums within formal governance structures to ensure continuity and legitimacy. Second, policy frameworks must prioritize equity and inclusion not just efficiency by

supporting smallholders, indigenous communities, and marginalized actors through capacity development, legal recognition, and financial access. Third, sustained investment in monitoring systems, data transparency, and adaptive learning mechanisms is essential for improving governance over time.

For future research, several gaps remain. More comparative, longitudinal studies are needed to understand how governance models evolve across different socio-political and ecological contexts. Interdisciplinary approaches combining political ecology, systems analysis, and institutional theory can help unpack the complex interactions shaping peatland governance outcomes. There is also a need for more empirical work on the role of women, youth, and customary institutions within multi-stakeholder processes, and how these groups can be empowered as active agents of sustainability.

6 CONCLUSION

The findings of this systematic literature review reveal that multi-stakeholder governance plays a crucial role in advancing the ecological integrity, institutional effectiveness, and socio-economic resilience of peatland areas embedded within oil palm production landscapes. The ecological outcomes are most notable in peatland rewetting programs, fire risk mitigation strategies, and reductions in greenhouse gas emissions, particularly when interventions are co-developed and co-managed by local communities, government agencies, NGOs, and private sector actors. Evidence shows that integrated canal-blocking efforts and participatory fire-monitoring systems have significantly reduced environmental degradation in priority peat zones.

From an institutional perspective, the review highlights that multi-stakeholder platforms improve coordination among fragmented regulatory bodies, foster procedural legitimacy, and enhance the adaptive capacity of local governance frameworks. Successful initiatives are characterized by inclusive decision-making, inter-agency collaboration, and the use of boundary organizations to translate scientific insights into actionable policies. However, enduring challenges such as asymmetrical power relations, elite capture, and weak enforcement continue to limit the transformative potential of these mechanisms, especially in decentralized governance settings.

Socio-economically, the incorporation of local actors, particularly indigenous communities and smallholder farmers, into governance processes has improved tenure security, diversified livelihoods, and increased local ownership over peatland restoration efforts. Participatory mapping, gender-responsive community-based programs, and integration of peat-compatible crops have contributed to modest yet meaningful

improvements in household income and social equity. However, systemic barriers such as limited access to finance, lack of technical capacity, and exclusion from formal certification schemes persist, especially for small-scale stakeholders.

Overall, multi-stakeholder approaches to peatland governance demonstrate measurable promise, but their success depends heavily on equitable stakeholder engagement, long-term institutional support, and robust monitoring systems. The reviewed literature suggests that without deliberate efforts to address governance asymmetries and socio-economic marginalization, even well-designed collaborative frameworks may fall short of their intended sustainability outcomes. Therefore, scaling up these approaches requires not only institutional innovation but also a sustained commitment to justice, transparency, and inclusive participation across all levels of governance.

REFERENCES

- Abdurrahim, A. Y., Dharmawan, A. H., Adiwibowo, S., Yogaswara, H., & van Noordwijk, M. (2023). Relational and instrumental values of tropical peat landscapes: morality and political ecology in Indonesia. *Current Opinion in Environmental Sustainability*, 64, 101318. <https://doi.org/10.1016/j.cosust.2023.101318>
- Achyar, E., Schmidt-Vogt, D., & Shivakoti, G. P. (2015). Dynamics of the multi-stakeholder forum and its effectiveness in promoting sustainable forest fire management practices in South Sumatra, Indonesia. *Environmental Development*, 13, 4–17. <https://doi.org/10.1016/j.envdev.2014.11.002>
- Alam, M. J., Nath, T. K., Dahalan, M. P. B., Halim, S. A., & Rengasamy, N. (2021). Chapter 2 - Decentralization of forest governance in Peninsular Malaysia: The case of peatland swamp forest in North Selangor, Malaysia. In R. Ullah, S. Sharma, M. Inoue, S. Asghar, & G. Shivakoti (Eds.), *Natural Resource Governance in Asia* (pp. 13–26). Elsevier. <https://doi.org/10.1016/B978-0-323-85729-1.00002-5>
- Alam, M. J., Rengasamy, N., bin Dahalan, M. P., Halim, S. A., & Nath, T. K. (2022). Socio-economic and ecological outcomes of a community-based restoration of peatland swamp forests in Peninsular Malaysia: A 5Rs approach. *Land Use Policy*, 122, 106390. <https://doi.org/10.1016/j.landusepol.2022.106390>
- Astari, A. J., Lovett, J. C., & Wasesa, M. (2025). Sustainable pathways in Indonesia's palm oil industry through historical institutionalism. *World Development Sustainability*, 6, 100200. <https://doi.org/10.1016/j.wds.2024.100200>
- Astuti, R. (2021). Governing the ungovernable: The politics of disciplining pulpwood and palm oil plantations in Indonesia's tropical peatland. *Geoforum*, 124, 381–391. <https://doi.org/10.1016/j.geoforum.2021.03.004>
- Astuti, R., & Fatimah, Y. A. (2024). Science in the court: Expert knowledge and forest fires on Indonesia's plantations. *Environmental Science & Policy*, 151, 103631. <https://doi.org/10.1016/j.envsci.2023.103631>
- Bos, A. B., De Sy, V., Duchelle, A. E., Atmadja, S., de Bruin, S., Wunder, S., & Herold, M. (2020). Integrated assessment of deforestation drivers and their alignment with

subnational climate change mitigation efforts. *Environmental Science & Policy*, 114, 352–365. <https://doi.org/https://doi.org/10.1016/j.envsci.2020.08.002>

Bößner, S., Xylia, M., Bilbao, B., Indriani, S. N., Laub, M., Rahn, E., Virla, L. D., & Johnson, F. X. (2023). Capacity gaps in land-based mitigation technologies and practices: A first stock take. *Land Use Policy*, 134, 106888. <https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106888>

Budiharta, S., Meijaard, E., Gaveau, D. L. A., Struebig, M. J., Wilting, A., Kramer-Schadt, S., Niedballa, J., Raes, N., Maron, M., & Wilson, K. A. (2018). Restoration to offset the impacts of developments at a landscape scale reveals opportunities, challenges and tough choices. *Global Environmental Change*, 52, 152–161. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2018.07.008>

Budiman, I., Bastoni, Sari, E. N. N., Hadi, E. E., Asmaliyah, Siahaan, H., Januar, R., & Hapsari, R. D. (2020). Progress of paludiculture projects in supporting peatland ecosystem restoration in Indonesia. *Global Ecology and Conservation*, 23, e01084. <https://doi.org/https://doi.org/10.1016/j.gecco.2020.e01084>

Carmenta, R., Zabala, A., Daeli, W., & Phelps, J. (2017). Perceptions across scales of governance and the Indonesian peatland fires. *Global Environmental Change*, 46, 50–59. <https://doi.org/10.1016/j.gloenvcha.2017.08.001>

Carmenta, R., Zabala, A., Trihadmojo, B., Gaveau, D., Salim, M. A., & Phelps, J. (2021). Evaluating bundles of interventions to prevent peat-fires in Indonesia. *Global Environmental Change*, 67, 102154. <https://doi.org/10.1016/j.gloenvcha.2021.102154>

Cole, L. E. S., Åkesson, C. M., Hapsari, K. A., Hawthorne, D., Roucoux, K. H., Girkin, N. T., Cooper, H. V., Ledger, M. J., O'Reilly, P., & Thornton, S. A. (2022). Tropical peatlands in the anthropocene: Lessons from the past. *Anthropocene*, 37, 100324. <https://doi.org/https://doi.org/10.1016/j.ancene.2022.100324>

Cole, L. E. S., Willis, K. J., & Bhagwat, S. A. (2021). The future of Southeast Asia's tropical peatlands: Local and global perspectives. *Anthropocene*, 34, 100292. <https://doi.org/https://doi.org/10.1016/j.ancene.2021.100292>

Dermawan, A., Hospes, O., & Termeer, C. J. A. M. (2022). Between zero-deforestation and zero-tolerance from the state: Navigating strategies of palm oil companies of Indonesia. *Forest Policy and Economics*, 136, 102690. <https://doi.org/10.1016/j.forpol.2022.102690>

Dieterich, U., & Auld, G. (2015). Moving beyond commitments: creating durable change through the implementation of Asia Pulp and Paper's forest conservation policy. *Journal of Cleaner Production*, 107, 54–63. <https://doi.org/https://doi.org/10.1016/j.jclepro.2014.07.084>

Dohong, A., Aziz, A. A., & Dargusch, P. (2017). A review of the drivers of tropical peatland degradation in South-East Asia. *Land Use Policy*, 69, 349–360. <https://doi.org/10.1016/j.landusepol.2017.09.023>

Dohong, A., Aziz, A. A., & Dargusch, P. (2018). Carbon emissions from oil palm development on deep peat soil in Central Kalimantan Indonesia. *Anthropocene*, 22, 31–39. <https://doi.org/10.1016/j.ancene.2018.04.001>

Dominic, D., & Baidurah, S. (2025). A review of biological processing technologies for palm oil mill waste treatment and simultaneous bioenergy production at laboratory scale, pilot scale and industrial scale applications with technoeconomic analysis. *Energy Conversion and Management: X*, 100914. <https://doi.org/10.1016/j.ecmx.2025.100914>

- Fawzi, N. I., Sumawinata, B., Suwardi, Rahmasary, A. N., Qurani, I. Z., Naufaldary, R. G., Nabillah, R., Palunggono, H. B., & Mulyanto, B. (2024). Integrated water management practice in tropical peatland agriculture has low carbon emissions and subsidence rates. *Heliyon*, 10(5), e26661. <https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e26661>
- Giessen, L., & Sahide, M. A. K. (2017). Blocking, attracting, imposing, and aligning: The utility of ASEAN forest and environmental regime policies for strong member states. *Land Use Policy*, 67, 13–26. <https://doi.org/https://doi.org/10.1016/j.landusepol.2017.05.012>
- Goh, C. S. (2020). Transforming exploitative land-based economy: The case of Borneo. *Environmental Development*, 33, 100487. <https://doi.org/https://doi.org/10.1016/j.envdev.2019.100487>
- Graham, V., Nurhidayah, L., & Astuti, R. (2020). Reducing Emissions From Tropical Deforestation and Forest Degradation. In M. I. Goldstein & D. A. DellaSala (Eds.), *Encyclopedia of the World's Biomes* (pp. 260–268). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-12-409548-9.11928-1>
- HATANO, R. (2025). Impacts of changes in peat soils due to agricultural activities on greenhouse gas (especially N₂O) emissions and their mitigations. *Pedosphere*, 35(1), 8–11. <https://doi.org/https://doi.org/10.1016/j.pedsph.2023.12.010>
- Ismail, Haghighi, A. T., Marttila, H., Karyanto, O., & Kløve, B. (2023). Recent results from an ecohydrological study of forest species in drained tropical peatlands. *Agricultural and Forest Meteorology*, 331, 109338. <https://doi.org/https://doi.org/10.1016/j.agrformet.2023.109338>
- Jalilov, S.-M., Rochmayanto, Y., Hidayat, D. C., Raharjo, J. T., Mendham, D., & Langston, J. D. (2025). Unveiling economic dimensions of peatland restoration in Indonesia: A systematic literature review. *Ecosystem Services*, 71, 101693. <https://doi.org/https://doi.org/10.1016/j.ecoser.2024.101693>
- Januar, R., Sari, E. N. N., & Putra, S. (2021). Dynamics of local governance: The case of peatland restoration in Central Kalimantan, Indonesia. *Land Use Policy*, 102, 105270. <https://doi.org/https://doi.org/10.1016/j.landusepol.2020.105270>
- Januar, R., Sari, E. N. N., & Putra, S. (2023). Economic case for sustainable peatland management: A case study in Kahayan-Sebangau Peat Hydrological Unit, Central Kalimantan, Indonesia. *Land Use Policy*, 131, 106749. <https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106749>
- Jefferson, U., Carmenta, R., Daeli, W., & Phelps, J. (2020). Characterising policy responses to complex socio-ecological problems: 60 fire management interventions in Indonesian peatlands. *Global Environmental Change*, 60, 102027. <https://doi.org/10.1016/j.gloenvcha.2019.102027>
- Leal Silva, J. F., Nogueira, L. A. H., Cantarella, H., Rossetto, R., Maciel Filho, R., & Souza, G. M. (2025). Meta-data analysis of biofuels in emerging markets of Africa and Asia: Greenhouse gas savings and economic feasibility. *Renewable and Sustainable Energy Reviews*, 213, 115465. <https://doi.org/https://doi.org/10.1016/j.rser.2025.115465>
- Liu, F. H., Ganesan, V., & Smith, T. E. (2020). Contrasting communications of sustainability science in the media coverage of palm oil agriculture on tropical peatlands in Indonesia, Malaysia and Singapore. *Environmental Science & Policy*, 114, 162–169. <https://doi.org/10.1016/j.envsci.2020.07.004>
- Lupascu, M., Taillardat, P., Sasmito, S. D., Agus, F., Mudiyarso, D., Ramchunder, S. J., Tata, H. L., & Taylor, D. (2023). Climate-smart peatland management and the potential for

- synergies between food security and climate change objectives in Indonesia. *Global Environmental Change*, 82, 102731. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2023.102731>
- Lupascu, M., Varkkey, H., & Tortajada, C. (2020). Is flooding considered a threat in the degraded tropical peatlands? *Science of The Total Environment*, 723, 137988. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.137988>
- Lyons-White, J., & Knight, A. T. (2018). Palm oil supply chain complexity impedes implementation of corporate no-deforestation commitments. *Global Environmental Change*, 50, 303–313. <https://doi.org/10.1016/j.gloenvcha.2018.04.012>
- Macdonald, K., Diprose, R., & Pugley, D. D. (2024). Scaling-up sustainable commodity governance through jurisdictional initiatives: Political pathways to sector transformation in the Indonesian palm oil sector? *World Development*, 176, 106504. <https://doi.org/10.1016/j.worlddev.2024.106504>
- Malahayati, M., & Masui, T. (2019). The impact of green house gas mitigation policy for land use and the forestry sector in Indonesia: Applying the computable general equilibrium model. *Forest Policy and Economics*, 109, 102003. <https://doi.org/https://doi.org/10.1016/j.forpol.2019.102003>
- Mardiatmoko, G. (2024). Chapter 21 - Biomass-based agroforestry for sustainable land use planning and management. In M. K. Jhariya, R. S. Meena, A. Banerjee, S. Kumar, & A. Raj (Eds.), *Agroforestry for Carbon and Ecosystem Management* (pp. 283–293). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-323-95393-1.00017-8>
- Mattila, T. J. (2024). The role of peatlands in carbon footprints of countries and products. *Science of The Total Environment*, 947, 174552. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2024.174552>
- Merten, J., Nielsen, J. Ø., Rosyani, & Faust, H. (2021). Climate change mitigation on tropical peatlands: A triple burden for smallholder farmers in Indonesia. *Global Environmental Change*, 71, 102388. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2021.102388>
- Novita, N., Asyhari, A., Ritonga, R. P., Gangga, A., Anshari, G. Z., Jupesta, J., & Sianipar, V. C. (2024). Strong climate mitigation potential of rewetting oil palm plantations on tropical peatlands. *Science of The Total Environment*, 952, 175829. <https://doi.org/10.1016/j.scitotenv.2024.175829>
- Padfield, R., Varkkey, H., Manzo, K., & Ganesan, V. (2023). Time bomb or gold mine? Policy, sustainability and media representations of tropical peatlands in Malaysia. *Land Use Policy*, 131, 106628. <https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106628>
- Pertiwi, N., Tsusaka, T. W., Nguyen, T. P. L., Abe, I., & Sasaki, N. (2022). Nature-based Carbon Pricing of Full Ecosystem Services for Peatland Conservation—A Case Study in Riau Province, Indonesia. *Nature-Based Solutions*, 2, 100023. <https://doi.org/https://doi.org/10.1016/j.nbsj.2022.100023>
- Phelps, J., Zabala, A., Daeli, W., & Carmenta, R. (2021). Experts and resource users split over solutions to peatland fires. *World Development*, 146, 105594. <https://doi.org/https://doi.org/10.1016/j.worlddev.2021.105594>
- Purnomo, H., Okarda, B., Dermawan, A., Ilham, Q. P., Pacheco, P., Nurfatriani, F., & Suhendang, E. (2020). Reconciling oil palm economic development and environmental conservation in Indonesia: A value chain dynamic approach. *Forest Policy and Economics*, 111, 102089. <https://doi.org/10.1016/j.forpol.2020.102089>

- Purnomo, H., Okarda, B., Dewayani, A. A., Ali, M., Achdiawan, R., Kartodihardjo, H., Pacheco, P., & Juniwaty, K. S. (2018). Reducing forest and land fires through good palm oil value chain governance. *Forest Policy and Economics*, 91, 94–106. <https://doi.org/10.1016/j.forpol.2017.12.014>
- Purnomo, H., Okarda, B., Puspitaloka, D., Ristiana, N., Sanjaya, M., Komarudin, H., Dermawan, A., Andrianto, A., Kusumadewi, S. D., & Brady, M. A. (2023). Public and private sector zero-deforestation commitments and their impacts: A case study from South Sumatra Province, Indonesia. *Land Use Policy*, 134, 106818. <https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106818>
- Purnomo, H., Puspitaloka, D., Okarda, B., Andrianto, A., Qomar, N., Sutikno, S., Muhammad, A., Basuki, I., Jalil, A., Yesi, Prasetyo, P., Tarsono, Zulkardi, Kusumadewi, S. D., Komarudin, H., Dermawan, A., & Brady, M. A. (2024). Community-based fire prevention and peatland restoration in Indonesia: A participatory action research approach. *Environmental Development*, 50, 100971. <https://doi.org/https://doi.org/10.1016/j.envdev.2024.100971>
- Puspitaloka, D., Kim, Y.-S., Purnomo, H., & Fulé, P. Z. (2021). Analysis of challenges, costs, and governance alternative for peatland restoration in Central Kalimantan, Indonesia. *Trees, Forests and People*, 6, 100131. <https://doi.org/https://doi.org/10.1016/j.tfp.2021.100131>
- Rixen, T., Wit, F., Hutahaeen, A. A., Schlüter, A., Baum, A., Klemme, A., Müller, M., Pranowo, W. S., Samiaji, J., & Warneke, T. (2022). 4 - Carbon cycle in tropical peatlands and coastal seas. In T. C. Jennerjahn, T. Rixen, H. E. Irianto, & J. Samiaji (Eds.), *Science for the Protection of Indonesian Coastal Ecosystems (SPICE)* (pp. 83–142). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-12-815050-4.00011-0>
- Rossita, A., Nurrochmat, D. R., Boer, R., Hein, L., & Riqqi, A. (2021). Assessing the monetary value of ecosystem services provided by Gaung – Batang Tuaka Peat Hydrological Unit (KHG), Riau Province. *Heliyon*, 7(10), e08208. <https://doi.org/https://doi.org/10.1016/j.heliyon.2021.e08208>
- Rowan, N. J. (2025). Peatlands-based demonstration of bioeconomy innovations at scale to help achieve many of the United Nation's Sustainable Development Goals. *Resources, Environment and Sustainability*, 21, 100238. <https://doi.org/https://doi.org/10.1016/j.resenv.2025.100238>
- Saleh, N. L., Sali, A., Jiun Terng, L., Syed Ahmad Abdul Rahman, S. M., Mohd Ali, A., Mohd Ali, B., Mohd Razali, S., Nuruddin, A. A., & Ramli, N. (2025). Peatland forest monitoring and management solution in Peninsular Malaysia: Optimal parameters for LoRa data. *Ain Shams Engineering Journal*, 16(6), 103374. <https://doi.org/https://doi.org/10.1016/j.asej.2025.103374>
- Sanders, A. J. P., Ford, R. M., Mulyani, L., Prasti H., R. D., Larson, A. M., Jagau, Y., & Keenan, R. J. (2019). Unrelenting games: Multiple negotiations and landscape transformations in the tropical peatlands of Central Kalimantan, Indonesia. *World Development*, 117, 196–210. <https://doi.org/https://doi.org/10.1016/j.worlddev.2019.01.008>
- Santika, T., Budiharta, S., Law, E. A., Dennis, R. A., Dohong, A., Struebig, M. J., Medrilzam, Gunawan, H., Meijaard, E., & Wilson, K. A. (2020). Interannual climate variation, land type and village livelihood effects on fires in Kalimantan, Indonesia. *Global Environmental Change*, 64, 102129. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2020.102129>
- Sari, D. A., Margules, C., Lim, H. S., Widyatmaka, F., Sayer, J., Dale, A., & Macgregor, C. (2021). Evaluating policy coherence: A case study of peatland forests on the Kampar

- Peninsula landscape, Indonesia. *Land Use Policy*, 105, 105396. <https://doi.org/https://doi.org/10.1016/j.landusepol.2021.105396>
- Sari, I. L., Weston, C. J., Newnham, G. J., & Volkova, L. (2023). Land cover modelling for tropical forest vulnerability prediction in Kalimantan, Indonesia. *Remote Sensing Applications: Society and Environment*, 32, 101003. <https://doi.org/https://doi.org/10.1016/j.rsase.2023.101003>
- Sattraburut, T., Vongvassana, S., Phutthai, T., & Thasod, Y. (2024). Palynological approaches to forest restoration in Southeast Asia: Challenges and opportunities for Thailand—A systematic review. *Trees, Forests and People*, 18, 100714. <https://doi.org/https://doi.org/10.1016/j.tfp.2024.100714>
- Sayer, J., Boedhihartono, A. K., Langston, J. D., Margules, C., Riggs, R. A., & Sari, D. A. (2021). Governance challenges to landscape restoration in Indonesia. *Land Use Policy*, 104, 104857. <https://doi.org/https://doi.org/10.1016/j.landusepol.2020.104857>
- Schaafsma, M., van Beukering, P. J. H., & Oskolokaite, I. (2017). Combining focus group discussions and choice experiments for economic valuation of peatland restoration: A case study in Central Kalimantan, Indonesia. *Ecosystem Services*, 27, 150–160. <https://doi.org/https://doi.org/10.1016/j.ecoser.2017.08.012>
- Scheper, A. C., Verweij, P. A., & van Kuijk, M. (2021). Post-fire forest restoration in the humid tropics: A synthesis of available strategies and knowledge gaps for effective restoration. *Science of The Total Environment*, 771, 144647. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.144647>
- Schouten, G., Padfield, R., & Kraamwinkel, D. (2023). Contested representations: A comparative analysis of palm oil sustainability in Malaysian and Dutch media. *World Development Sustainability*, 3, 100075. <https://doi.org/https://doi.org/10.1016/j.wds.2023.100075>
- Schweizer, D., van Kuijk, M., & Ghazoul, J. (2021). Perceptions from non-governmental actors on forest and landscape restoration, challenges and strategies for successful implementation across Asia, Africa and Latin America. *Journal of Environmental Management*, 286, 112251. <https://doi.org/https://doi.org/10.1016/j.jenvman.2021.112251>
- Skillings-Neira, P. N., Benavides, J. C., Battaglia, M. J., Chimner, R. A., Bourgeau-Chavez, L., Wayson, C., Kolka, R., & Lilleskov, E. A. (2025). Mapping the distribution and condition of mountain peatlands in Colombia for sustainable ecosystem management. *Journal of Environmental Management*, 380, 124915. <https://doi.org/https://doi.org/10.1016/j.jenvman.2025.124915>
- Song, C., Choi, H.-A., Choi, E., Yang, A.-R., Lee, W.-K., & Lim, C.-H. (2024). Setting the direction of sustainable restoration projects in peatlands considering ecosystem services: Case of Jambi and Sumatra Selatan, Indonesia. *Ecological Indicators*, 160, 111784. <https://doi.org/https://doi.org/10.1016/j.ecolind.2024.111784>
- Surahman, A., Shivakoti, G., & Soni, P. (2017). Chapter 15 - Prospect of Sustainable Peatland Agriculture for Supporting Food Security and Mitigating Green House Gas Emission in Central Kalimantan, Indonesia. In G. P. Shivakoti, U. Pradhan, & Helmi (Eds.), *Redefining Diversity & Dynamics of Natural Resources Management in Asia, Volume 1* (pp. 291–303). Elsevier. <https://doi.org/https://doi.org/10.1016/B978-0-12-805454-3.00015-3>
- Surahman, A., Soni, P., & Shivakoti, G. P. (2018). Reducing CO2 emissions and supporting food security in Central Kalimantan, Indonesia, with improved peatland management.

Land Use Policy, 72, 325–332.
<https://doi.org/https://doi.org/10.1016/j.landusepol.2017.12.050>

- Susilawati, D., & Kanowski, P. (2020). Cleaner production in the Indonesian pulp and paper sector: Improving sustainability and legality compliance in the value chain. *Journal of Cleaner Production*, 248, 119259.
<https://doi.org/https://doi.org/10.1016/j.jclepro.2019.119259>
- Tan, Z. D., Lupascu, M., & Wijedasa, L. S. (2021). Paludiculture as a sustainable land use alternative for tropical peatlands: A review. *Science of The Total Environment*, 753, 142111. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.142111>
- Terzano, D., Trezza, F. R., Rezende, M., Malatesta, L., Lew Siew Yan, S., Parish, F., Moss, P., Bresciani, F., Cooke, R., Dargusch, P., & Attorre, F. (2023). Prioritization of peatland restoration and conservation interventions in Sumatra, Kalimantan and Papua. *Journal for Nature Conservation*, 73, 126388.
<https://doi.org/https://doi.org/10.1016/j.jnc.2023.126388>
- Tonks, A. J., Aplin, P., Beriro, D. J., Cooper, H., Evers, S., Vane, C. H., & Sjögersten, S. (2017). Impacts of conversion of tropical peat swamp forest to oil palm plantation on peat organic chemistry, physical properties and carbon stocks. *Geoderma*, 289, 36–45.
<https://doi.org/10.1016/j.geoderma.2016.11.018>
- Uda, S. K., Schouten, G., & Hein, L. (2020). The institutional fit of peatland governance in Indonesia. *Land Use Policy*, 99, 103300.
<https://doi.org/10.1016/j.landusepol.2020.103300>
- Ulya, N. A., Nurlia, A., Premono, B. T., Waluyo, E. A., Yunardy, S., & Martin, E. (2025). Understanding peat swamp forest transitions: sustainability strategies and livelihood adaptation in Ogan Komering Ilir Regency, South Sumatra, Indonesia. *Trees, Forests and People*, 20, 100869. <https://doi.org/https://doi.org/10.1016/j.tfp.2025.100869>
- van Hardeveld, H. A., Driessen, P. P. J., Schot, P. P., & Wassen, M. J. (2018). Supporting collaborative policy processes with a multi-criteria discussion of costs and benefits: The case of soil subsidence in Dutch peatlands. *Land Use Policy*, 77, 425–436.
<https://doi.org/https://doi.org/10.1016/j.landusepol.2018.06.002>
- Varkkey, H., Tyson, A., & Choiruzzad, S. A. B. (2018). Palm oil intensification and expansion in Indonesia and Malaysia: Environmental and socio-political factors influencing policy. *Forest Policy and Economics*, 92, 148–159. <https://doi.org/10.1016/j.forpol.2018.05.002>
- Vicarelli, M., Georgescu, A., & Sudmeier-Rieux, K. (2024). Cost-benefit and equity analysis of nature-based solutions in Haiti, India, Indonesia and Uganda. *Nature-Based Solutions*, 6, 100196. <https://doi.org/https://doi.org/10.1016/j.nbsj.2024.100196>
- Wheeler, C. E., Davies, A. L., Andueza, L., Cole, L. E. S., Dávila, N., Del Águila, J., del Aguila Villacorta, M., Draper, F. C., Evans, C. L. D., Honorio Coronado, E. N., Laurie, N., Loja, E., Martin Brañas, M., Mitchard, E. T. A., & Roucoux, K. H. (2025). Sustainable management of non-timber forest products in Peruvian Amazonia: lessons learnt from participatory use of smartphone technology. *Journal of Environmental Management*, 391, 126198. <https://doi.org/https://doi.org/10.1016/j.jenvman.2025.126198>
- Widyatmanti, W., Minasny, B., Awanda, D., Umarhadi, D. A., Fatma, Z. S. N., Mahendra, W. K., & Field, D. J. (2022). Codification to secure Indonesian peatlands: From policy to practices as revealed by remote sensing analysis. *Soil Security*, 9, 100080.
<https://doi.org/10.1016/j.soisec.2022.100080>
- Yunus, M., Pagdee, A., & Baral, H. (2025). Local Livelihoods and Determinants of Peatland

Protection in Indonesia. *Trees, Forests and People*, 19, 100800.
<https://doi.org/https://doi.org/10.1016/j.tfp.2025.100800>

Zemp, D. C., Ehbrecht, M., Seidel, D., Ammer, C., Craven, D., Erkelenz, J., Irawan, B., Sundawati, L., Hölscher, D., & Kreft, H. (2019). Mixed-species tree plantings enhance structural complexity in oil palm plantations. *Agriculture, Ecosystems & Environment*, 283, 106564. <https://doi.org/https://doi.org/10.1016/j.agee.2019.06.003>

Ziegler, R., Wichtmann, W., Abel, S., Kemp, R., Simard, M., & Joosten, H. (2021). Wet peatland utilisation for climate protection – An international survey of paludiculture innovation. *Cleaner Engineering and Technology*, 5, 100305.
<https://doi.org/https://doi.org/10.1016/j.clet.2021.100305>

APPLICATION OF THE IAT AND ROVUC TOOLS FOR PUBLIC USE ANALYSIS IN MANGROVE ECOSYSTEMS: A CASE STUDY IN THE STATE OF RIO DE JANEIRO

APLICAÇÃO DAS FERRAMENTAS IAT E ROVUC PARA ANÁLISE DO USO PÚBLICO EM MANGUEZAIS: ESTUDO DE CASO NO ESTADO DO RIO DE JANEIRO

APLICACIÓN DE LAS HERRAMIENTAS IAT Y ROVUC PARA EL ANÁLISIS DEL USO PÚBLICO EN MANGLARES: ESTUDIO DE CASO EN EL ESTADO DE RÍO DE JANEIRO



<https://doi.org/10.56238/sevened2026.008-071>

Fernando Carrilho da Silva¹, Julianne Alvim Milward-de-Azevedo²

ABSTRACT

The mangrove presents itself as an important coastal ecosystem that occurs in tropical and subtropical regions around the globe. In addition, it offers a range of ecosystem services essential for maintaining the quality of marine life and ensuring the subsistence of various traditional populations. In Brazil, 87% of this ecosystem is protected by Conservation Units (UCs). Visitation in these spaces represents an opportunity to strengthen social participation and the protection of the mangrove. However, it is necessary to plan and monitor public use activities to ensure the quality of visitation and environmental conservation. The present work aims to carry out a case study in the Guapi-Mirim Environmental Protection Area and in the Guanabara Ecological Station located in Guanabara Bay, in the state of Rio de Janeiro with the application of tools from the List of Visitation Opportunities (ROVUC) and the Tourist Attractiveness Index (IAT) to analyze the dynamics of public use. The research regarding the purposes was exploratory, descriptive and applied. And, as for the means of investigation, it was bibliographical, documentary, field and a case study. The results indicate the need to diversify activities. The importance of collaboration between public authorities and civil society to conserve the mangrove is emphasized.

Keywords: Protected Areas. Mangrove. Visitation. Rio de Janeiro. Brazil.

RESUMO

O manguezal se apresenta como um importante ecossistema costeiro que ocorre em regiões tropicais e subtropicais ao redor do globo. Além do mais, oferece uma gama de serviços ecossistêmicos essenciais para a manutenção da qualidade de vida marinha e garantia da subsistência de diversas populações tradicionais. No Brasil 87% desse ecossistema está protegido por Unidades de Conservação (UCs). A visitação nesses espaços representa uma oportunidade para fortalecer a participação social e a proteção do manguezal. No entanto, é

¹ Master's degree in Ecotourism and Conservation. Universidade Federal do Estado do Rio de Janeiro (UNIRIO). Universidade Federal Rural do Rio de Janeiro (UFRRJ). E-mail: carrilhofernando@outlook.com
Orcid: <https://orcid.org/0009-0001-8910-787X> Lattes: <http://lattes.cnpq.br/8634565931530493>

² Dr. in Economics. Universidade Federal do Rio de Janeiro (UFRJ). Universidade Federal Rural do Rio de Janeiro (UFRRJ). E-mail: profa.julianneilward@gmail.com Orcid: <https://orcid.org/0000-0001-9066-0843>
Lattes: <http://lattes.cnpq.br/5447208174163206>

necessário que se planeje e monitore as atividades de uso público para garantir a qualidade da visitação e a conservação ambiental. O presente trabalho tem por objetivo realizar um estudo de caso na Área de Proteção Ambiental de Guapi-Mirim e na Estação Ecológica da Guanabara situadas na Baía de Guanabara, no estado do Rio de Janeiro com a aplicação de ferramentas do Rol de Oportunidades de Visitação (ROVUC) e o Índice de Atratividade Turística (IAT) para análise da dinâmica do uso público. A pesquisa quanto aos fins foi exploratória, descritiva e aplicada. E, quanto aos meios de investigação foi bibliográfico, documental, de campo e um estudo de caso. Os resultados indicam a necessidade de diversificar das atividades. Ressalta-se a importância da colaboração entre poder público e sociedade civil para conservar o manguezal.

Palavras-chave: Áreas Protegidas. Mangue. Visitação. Rio de Janeiro. Brasil.

RESUMEN

El manglar es un importante ecosistema costero que se encuentra en regiones tropicales y subtropicales de todo el mundo. Además, ofrece una serie de servicios ecosistémicos esenciales para mantener la calidad de vida marina y garantizar la subsistencia de diversas poblaciones tradicionales. En Brasil, el 87 % de este ecosistema está protegido por Unidades de Conservación (UC). La visita a estos espacios representa una oportunidad para fortalecer la participación social y la protección del manglar. Sin embargo, es necesario planificar y supervisar las actividades de uso público para garantizar la calidad de la visita y la conservación del medio ambiente. El presente trabajo tiene como objetivo realizar un estudio de caso en el Área de Protección Ambiental de Guapi-Mirim y en la Estación Ecológica de Guanabara, situadas en la Bahía de Guanabara, en el estado de Río de Janeiro, con la aplicación de herramientas de la Lista de Oportunidades de Visita (ROVUC) y el Índice de Atractivo Turístico (IAT) para analizar la dinámica del uso público. La investigación fue exploratoria, descriptiva y aplicada. En cuanto a los medios de investigación, se utilizaron fuentes bibliográficas, documentales, de campo y un estudio de caso. Los resultados indican la necesidad de diversificar las actividades. Cabe destacar la importancia de la colaboración entre el poder público y la sociedad civil para conservar los manglares.

Palabras clave: Áreas Protegidas. Manglares. Visitación. Río de Janeiro. Brazil.

1 INTRODUCTION

The capitalist model and the speed of industrial urban production intensify the pressure on natural resources, which are essential for maintaining ecological balance and maintaining populations (Cortez; Ortigoza, 2009). This complex relationship between production models and environmental problems puts environmental conservation and, above all, the protection of ecosystems at risk (Santos *et al.*, 2024). It is in this sense that the creation of Protected Areas (PAs) as strategies for environmental conservation is observed (Diegues, 2000; Melgo, 2022).

These spaces are central elements for the protection of the environment, safeguarding biodiversity, endangered species, natural resources and their respective biomes (Medeiros, 2006). Conservation Units (CUs), in turn, are PAs in the public domain, with relevant natural characteristics, with defined objectives and limits, legally established by the Government in Brazil (BRASIL, 2000). The design of these spaces brings several benefits to the environment and population, such as maintaining quality of life and ecosystem services (MMA, 2022).

Guanabara Bay (BG), an important coastal ecosystem, located in the state of Rio de Janeiro, is of notorious importance for the growth and development of the city. However, urban and industrial development has negatively impacted their ecosystems, including the mangrove swamp (Dubeux, 1999; Soares *et al.*, 2003, ICMBio, 2018). Despite these challenges, BG remains an important source of funds, producing around 500 tons of fish per month. In the Guapi-Mirim Environmental Protection Area (APA),³ about two million Uçá crabs are collected annually, reinforcing the urgency of conserving these habitats (Alencar, 2024).

It is in this context that the work is presented. The main objective is to analyze the dynamics of public use, through the application of the tools of the List of Visitation Opportunities (ROVUC) and the Tourist Attractiveness Index (IAT) to analyze the public use of the Guapi-Mirim APA and the Guanabara Ecological Station located in BG, in the state of Rio de Janeiro.

2 THEORETICAL APPROACH

2.1 IMPORTANCE OF MANGROVES

Mangroves are coastal ecosystems, at the interface between land and sea, occurring in tropical and subtropical regions of the world, between latitudes 30°N and 30°S (FAO, 2023; Giri *et al.*, 2011). Marked by the intertidal regime and with an unconsolidated substrate (Leal;

³ The name of the Guapi-Mirim APA was given in honor of the Guapimirim River, a name with Tupi-Guapi origin: source or headwater of a river and Mirim: small thing (ICMBio, 2001).

Spalding, 2024). These regions contribute to carbon sequestration and protection against extreme weather events (Leal; Spalding, 2024; Alongi, 2014).

The term mangrove refers to the plant species that make up these spaces, which have adapted over thousands of years to survive in environments of high salinity, low oxygen between roots and flooded, at times, by the tide (Soares *et al.*, 2003; ICMBio, 2018; Mandal; Bar, 2018).

These adaptations are related to mechanisms such as aerial roots (Rhizophores⁴), which assist in respiration and anchorage in the waterlogged substrate, the ability to deal with salinity by eliminating it through roots and leaves, dispersal through propagules - viviparous seeds⁵ - and nutrient retention mechanisms (FAO, 2023).

Mangroves are vital ecosystems for protecting the environment, tackling the climate crisis, and promoting environmental justice. This is because these spaces offer essential ecosystem services. These services can be: Provision (food production, genetic resources, wood production); Regulation (climate and microclimate regulation, coastal protection, carbon sequestration, ecological niche formation), Support (nutrient cycling, soil formation, biomass export) and Culture (ecotourism, medicine and religion) (ICMBio, 2018).

Mangroves support 800 trillion juvenile fish, shrimp, bivalves, and adult crabs per year around the globe. This exposes the economic importance and guarantee of food security for various populations (Leal; Spalding, 2024).

According to the Global Mangrove Alliance⁶, the extent of these ecosystems in the world was estimated at 141,957 km², 135, 882 km² in 2016 and 147,256 km² in 2024. (Leal; Spalding, 2024). This extension corresponds to 1% of the world's tropical forests (FAO, 2023). They occur in at least 128 countries and territories (Table 1), with a predominance in Southeast Asia (50,000 km²), followed by West and Central Africa (22,000 km²) (Leal; Spalding, 2024).

⁴ A type of stem that grows toward the ground, with positive geotropism. It forms adventitious roots and allows the aerial respiration of typical mangrove vegetables (ICMBio, 2018).

⁵ They are characterized by the germination of the embryo next to the mother plant, forming a propagule ready for dispersal (FAO, 2023).

⁶ The Global Mangrove Alliance is an organization focused on protecting the ecosystem, gathering tax incentives, formulating and coordinating partnerships with institutions from various sectors. It is currently coordinated by members *Conservation International*, *The International Union for the Conservation of Nature*, *The Nature Conservancy*, *Wetlands International*, *World Wildlife Fund*, *SaciWATERS* and *Audubon Americas*.

Table 1*Extension of mangroves in the world*

Region	Sum of areas (km ²)	Overall percentage (%)
Southeast Asia	49.500	33.6
West and Central Africa	22.802	15.5
North, Central America and the Caribbean	21.270	14.4
South America	19.469	13.2
Australia and New Zealand	10.348	7.0
South Asia	9.749	6.6
East and South Africa	7.749	5.3
Pacific Islands	5.790	3.9
Middle East	358	0.2
East Asia	221	0.2
Total	147.256	100

Source: Leal; Spalding, 2024.

In Brazil, mangroves occur from Amapá - Oiapoque, 4°26'N - to Santa Catarina - Laguna, 28°30'S (Coelho *et al.*, 2025) and has an approximate extension of 14,000 km², with the highest concentrations in the states of Maranhão (36%), Pará (28%) and Amapá (16%), totaling 80% of the mangroves in the national territory and the largest continuous strip of the ecosystem under legal protection in the world. In addition, 120 national PAs have mangroves inside, ensuring greater protection for about 87% of the ecosystem in Brazil (ICMBio, 2018).

However, since the beginning of the twentieth century, about 25% of Brazilian mangroves have been destroyed (ICMBio, 2018). Threats such as urban expansion on the coast, agriculture, aquaculture, fishing industry, logging, and climate change put the protection of these ecosystems and their ecological and geomorphological function at risk (Bunting *et al.*, 2018).

In the national territory, the experience in the mangrove represents part of the survival, culture and medicine of indigenous peoples, artisanal fishermen, shellfish gatherers, caiçaras and quilombolas. Therefore, protecting mangroves constitutes an advance in the resistance struggle for environmental, social, and climate justice (Sofiatti, 2023; Moraes, 2022). To this end, legal instruments such as the Federal Constitution of 1988 – which defines the coastal zone as national heritage in its article 225 –, the Forest Code of 2012 (Law No. 12,651/2012), which classifies mangroves as Permanent Preservation Areas (APP) –, and the National System of Conservation Units (SNUC) (Law No. 9,985/2000), which has as one of its objectives to contribute to the conservation of natural ecosystems –, constitute some of the main legal frameworks for environmental protection in the country (Brasil, 1988; Brazil, 2012).

The PAs are strategic spaces in the defense of Brazilian mangroves (Coelho *et al.*, 2025). The most recurrent categories are related to Sustainable Use Units, which allow the indirect use of natural resources, such as the Extractive Reserve (RESEX) and the Environmental Protection Area (APA). This characteristic is relevant given the importance of these spaces for the social, cultural, and economic development of traditional populations in one of the richest environments on the globe (ICMBio, 2018).

However, there are challenges regarding the management and application of protection laws in these spaces (Coelho *et al.*, 2025; ICMBio, 2018). These challenges are related to the lack of tax incentives, inspection, monitoring, and land conflicts (ICMBio, 2018). The conservation of mangroves, however, is decisive for facing the climate crisis and protecting populations in a state of vulnerability (Brasil, 2025).

In this context, initiatives such as the National Program for the Conservation and Sustainable Use of Mangroves in Brazil (ProManguezal) and Brazil's accession to the *Global Mangrove Breakthrough* add efforts in the conservation and restoration of this important coastal ecosystem by 2030 (Brasil, 2025).

Effective environmental management of PAs that have mangroves in their interior, associated with the participation of traditional peoples and communities, tend to reduce the loss of mangrove cover and help ecological and social resilience. However, the effectiveness of the management of protected spaces is not directly linked to the simple fact of their creation, but to ensure active management, the continuity of monitoring and inspection actions, and the existence of stable funding (ICMBio, 2018).

It is in this sense that protecting these spaces goes beyond the recognition of their economic and environmental importance, but also an ethical commitment to the climate and the ways of life historically built in these territories (Lopes *et al.*, 2025; Corrêa *et al.*, 2024; Mariano *et al.*, 2025).

2.2 IMPORTANCE OF PUBLIC USE FOR THE CONSERVATION OF PROTECTED AREAS

Public use activities in PAs generate individual, economic, environmental and social benefits, by reconciling conservation with visitation (Vallejo, 2013). Public use becomes an ally in the preservation of biodiversity and ecosystem services (Crema; Faria, 2020). Among the factors that influence the visitor's choice are contact with nature, interest in meeting traditional peoples, the search for adventures and extreme sports, and the preference for quiet and welcoming environments for families, especially children (Omena, 2022).

Visitation in PAs is an essential tool for the conservation of these spaces. When well planned, activities for public use stimulate visitors' awareness of the importance of territorial

protection and biodiversity (Vallejo, 2013; Pedrini, 2019; Crema; Faria, 2020). From a tourism perspective, ecotourism emerges as a sustainable practice that has been gaining strength in Brazil and in the world, becoming a fundamental ally in the preservation of PAs (MMA, 2010; Brod; Milward-de-Azevedo, 2022 *apud* Carrilho-da-Silva; Milward-de-Azevedo, 2023).

2.3 TOOLS FOR PUBLIC USE PLANNING

The organization of visitation in PAs, combined with monitoring, inspection and management, seeks to maximize positive environmental impacts and inhibit illicit activities. Proper planning is essential for visitors to have a satisfying experience that aligns with conservation objectives. In this context, tools such as the Tourist Attractiveness Index (IAT) and the List of Visitation Opportunities in Conservation Units (ROVUC) play a crucial role. They assist in the creation and review of the management plans of the PAs, providing a better understanding of the tourist context and promoting sustainable visitation (Crema; Faria, 2020).

2.2.1 List of Visitation Opportunities in Conservation Units (ROVUC)

The List of Visitation Opportunities in Conservation Units (ROVUC), approved by Ordinance No. 1,148/2018 of the Federal Government (ICMBio), guides the planning of visitation in PAs. It defines five classes of opportunities based on biophysical, sociocultural and management attributes, covering both the internal environment of the UC and external areas and surrounding attractions (Crema; Faria, 2020).

ROVUC contributes to the planning of public use, evaluation of investments, definition of zoning and identification of impacts on biodiversity. In addition, its implementation requires the participation of social actors, including residents, tourists, and scientists, which enriches its applicability. This tool broadens the understanding of tourism opportunities in PAs, favoring conservation strategies and improving visitation planning (Crema; Faria, 2020).

2.2.2 Tourist Attractiveness Index (IAT)

The Tourist Attractiveness Index (TAI) has become essential for the analysis of the internal and external environment of PAs, evaluating biophysical, social, and management attributes and correlating them with factors such as scenic attractiveness, infrastructure, and population density.

The application of the tool represents an effective management strategy, capable of understanding the dynamics of visitation, directing investments, and contributing to the sustainability of visitation and environmental conservation (Souza, 2016). The main objective of the tool is to establish parameters to monitor and plan visitation opportunities (Souza *et*

al., 2017).

The IAT groups the PAs according to their tourist vocation through three stages: (1) analysis of the internal physical attributes – considering infrastructure, scenic attractiveness and volume of visits; (2) analysis of external physical attributes – evaluating regional attractions, public access and socioeconomic context through data from IBGE, *TripAdvisor* and *Google Maps*; (3) classification of tourist attractiveness classes – segmenting the PAs into five categories primitive, semi-primitive, extensive, intensive and highly intensive, according to their degree of accessibility and development.

3 MATERIAL AND METHODS

3.1 TYPOLOGY OF THE STUDY

The elaboration of this research carried out from March 2023 to April 2025, was characterized, as to the purposes, as exploratory, descriptive and applied. The first characterizations are related to the small number of studies that apply the tools for public use and also to their investigative and descriptive character of the visitation given in the PAs, as well as aspects related to visitors. And, finally, it was applied, as it sought to generate subsidies for the resolution of real problems of visitation (Vergara, 2000).

Regarding the identification of the means of investigation, it was bibliographical, documentary, field and a case study. Bibliographic, therefore, it gathered data from scientific platforms (*Scholar*, *Google*, *Scielo* and *Researchgate*) and documentary, given the use of institutional files of the Federal Government made available at electronic addresses (IBAMA, ICMBio, MMA, among others). The field research is characterized by the use of direct observation – written from the experiences in the proposed place – and a case study, given that the research was carried out in the empirical space in which it was proposed to study (Vergara, 2000).

3.2 IAT AND ROVUC TOOLS

For the application of the IAT and ROVUC tools, direct observation and dialogue with local social actors, including the manager and civil servants, were employed. These professionals, when experiencing the activities of public use in the UC, play an essential role in the preservation of these spaces.

The IAT tool evaluated the internal and external parameters of the UC. In the internal environment, it considered biophysical (natural/cultural variety and scenic attractiveness), social (diversity of activities and number of meetings) and management (infrastructure and services) attributes (Souza *et al.*, 2017).

In the external environment, it analyzed biophysical (regional attractions and public access), social (socioeconomic context and population density) and management (hospitality establishment) attributes (Souza *et al.*, 2017).

Each indicator received a score from 1 to 5, and the average was calculated by the sum of the scores divided by the number of indicators. The values of the three groups of attributes (biophysical, social and management) were summed and divided by three, resulting in the overall score of the two environments. The final score was obtained by adding the general internal and external values and dividing them by two. This result allows us to classify the tourist attractiveness of the CU at the following levels: primitive (high degree of naturalness), semi-primitive (high degree of naturalness), extensive (sustainable use of resources), intensive (variety of activities) and highly intensive (Brazilian icon PAs) (Souza *et al.*, 2017).

The application of the ROVUC tool followed the steps described by Crema and Faria (2020) in the UC. First, the general characterization was performed (stage 1). Then, the attractions and visitation areas were detailed, the management zones were identified and the characteristics of the visitors were analyzed (stage 2). Finally, the visitation areas were defined and the spatialization of the experience classes was elaborated on the map of the PAs (stages 3 and 4).

3.3 CHARACTERIZATION OF THE STUDY AREA

3.3.1 Geographical Location

The Guapi-Mirim APA (Figure 1), created by Decree No. 90,225, of September 25, 1984, as a result of an environmental movement against the destruction of Brazilian mangroves, is located in the Recôncavo da Baía de Guanabara, in the state of Rio de Janeiro. An area also known as 'Fundo de Baía', with geographic coordinates between 22° 39'30" and 22° 46'50" south latitude and 42° 57'00" and 43° 06'40" west longitude, is part of the Guanabara Bay Hydrographic Region, located at the mouth of the Iriri, Roncador, Guapimirim and Imboáçu rivers (ICMBio, 2001).

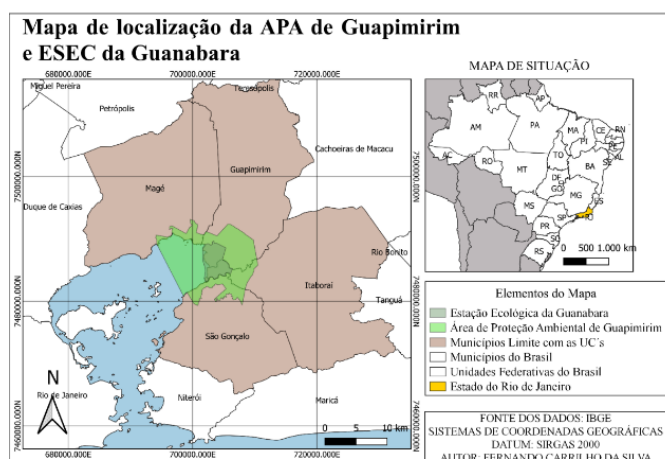
The territorial extension of the Guapi-Mirim APA is 138.25 km² - mangroves (44.7%), land (19.6%) and water section (35.7%). It is part of the municipalities of Guapimirim, Magé, Itaboraí and São Gonçalo, in the Metropolitan Region of Rio de Janeiro (ICMBio, 2001).

The ESEC of Guanabara, created by Decree s/n of February 15, 2006, is the core area of the Guapi-Mirim APA, with geographic coordinates between latitude 22°41'16.70"S and 22°44'44.412"S and longitude 43°1'23.022"W and 43°1'51.672"W. It has a territorial extension of 19.35 km², and a perimeter of 21.5 km. This important UC, located in the Atlantic

Forest Biome, aims to preserve the last continuous stretches of medium-sized mangroves in Guanabara Bay. It covers the municipalities of Guapimirim (58%) and Itaboraí (42%), both located in the city of Rio de Janeiro, RJ (ICMBio, 2012).

Figure 1

Location of the Guapi-Mirim Environmental Protection Area/RJ



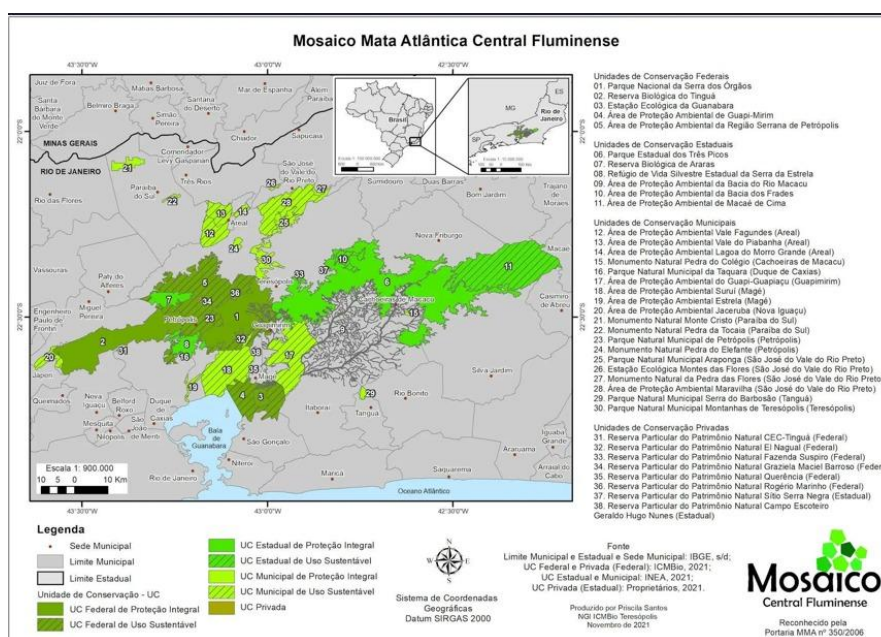
Source: Prepared by the authors, 2025.

The Guapi-Mirim APA is the first UC in Brazil dedicated to the protection of mangroves. Its implementation is deeply linked to stories of struggle and popular mobilization. The UC promotes the conservation and restoration of mangroves in the BG Recôncavo, the protection of biodiversity (microorganisms, mollusks, crustaceans, mammals, fish, among others), and ensures the subsistence of local populations – artisanal fishermen and crab collectors – by applying adequate environmental management for the maintenance of various activities in stretches of the estuary (ICMBio, 2001).

Finally, the Central Fluminense Mosaic (Figure 2), created in 2006, covers, among 29 other PAs, the APA of Guapi-Mirim and the ESEC of Guanabara. The main objective of the Mosaic is the integrated management of these units, located in the Atlantic Forest Biome. In addition, the initiative promotes the conservation of biodiversity, connectivity between forest fragments forming important ecological corridors and social participation in environmental protection (FUNBIO, n.d.).

Figure 2

Map of the Central Fluminense Mosaic



Source: FUNBIO, s.d.

4 RESULTS AND DISCUSSION

4.1 PUBLIC USE OF THE GUAPI-MIRIM APA / RJ

It was found that the Guapi-Mirim APA enables the conservation and sustainable use of natural resources. The application of the ROVUC tool in the UC occurred in four stages.

In the first stage, given by the general characterization of public use, it is clear that the UC encompasses rivers and mangroves in Guanabara Bay, recognized for their biodiversity and tourist potential. Located between Guapimirim, Magé, Itaboraí and São Gonçalo, it has tourist infrastructure and access via the BR-493 Highway. In the socio-cultural aspect, artisanal fishing and Community-Based Tourism, aimed at small guided groups, stand out. In management, there is a consolidated plan, vessel control and visitor support infrastructure.

In the second stage, given by the detailing of the attractions and considerations about visitors, it is noted that the spaces of the UC include a visitor center, auditorium and cafeteria, where safety measures and information about biodiversity are addressed. Visitation to the mangrove takes place through boat tours, with environmental education and interpretation activities. Access is monitored by the cooperative's boatmen and ICMBio employees, prioritizing ecotourists, families, schools and researchers.

In the third and fourth stages, given by the classification of the visitation areas, two visitation areas were identified: (1) the terrestrial portion, which represents 50% of the opportunities, was categorized as semi-natural, due to the degree of intervention; (2) marine zones, including mangrove rivers and biodiversity observation, categorized as natural,

because they have high preservation, but with some interaction with residents and minimal environmental impacts.

4.2 TOURIST ATTRACTIVENESS INDEX OF THE APA OF GUAPI-MIRIM/ RJ

The application of the IAT tool resulted in the elaboration of two tables, with attention to the spatialization of classes both in the internal and external environment of the UC.

Table 2 shows the spatialization of the classes of the internal environment of the CU, in which the biophysical, social and management attributes are glimpsed. In addition to the exposure of the source, there is the exposure of the calculation of these attributes.

Table 2

Spatialization of the classes of the internal environment of the APA of Guapi-Mirim/RJ

Indoor Environment				
Biophysical Attributes		Notes	Average	Source
Natural/cultural variety	Forest, mangrove, biodiversity, Guanabara Bay	3,5	3,6	Field research
Scenic attractiveness	Google Scholar results: 1,560. Most sought-after attractiveness: 3 thousand.	3,8		Google Search and Google Scholar
Social Attributes		Notes	Average	Source
Diversity of activities	Fishing, contemplation, boating, research, education	3,8	3,4	Field research
Number of encounters	UC area in km ² / number of visitors in 2023: 138.25/ 549 = 0.251	3,0		ICMBio (2001)
Management Attributes		Notes	Average	Source
Infrastructure	Parking, visitor center, boats, accommodation	3,5	2,7	Field research
Services	Technical visit, sightseeing tour	2,0		Field research

Source: Prepared by the authors, 2025.

The scores were assigned based on the field visitation and the methodology described by Souza *et al.*, (2017). The overall score of the indoor environment was calculated by adding the mean of the attribute scores and dividing by three, resulting in 3.3. This value was used in the next stages of the analysis to compose the final score.

Table 3 shows the spatialization of the classes of the external environment, in the same way as the internal environment of the CU, with the exposure of biophysical, social and management attributes. In addition to the exposure of the source, there is the exposure of the calculation of these attributes.

Table 3

Spatialization of the classes of the external environment of the APA of Guapi-Mirim/RJ

External Environment				
Biophysical Attributes		Notes	Average	Source
Regional attractions	Tourist attraction in the region: 15	3,5	3,6	TripAdvisor
Public access	Travel time from the nearest airport: 1 hour.	3,8		Google Maps
Social Attributes		Notes	Average	Source
Socioeconomic context	Average of the Human Development Index (HDI) of the municipalities belonging to the PAs studied	2,5	2,5	IBGE
Population density	Average number of people living in the municipalities belonging to the PAs	2,5		IBGE
Management Attributes		Notes	Average	Source
Hospitality Establishment	accommodation and food establishments in the municipality: 126	3	3	TripAdvisor

Source: Prepared by the authors, 2025.

From the calculation of the sum between the final averages of each attribute divided by three, the final score of attractiveness in the external environment was composed: 3.0. The final tourist attractiveness of the Guapi-Mirim APA was: 3.1. And, according to Souza *et al.* (2017), was classified as a CU with an attractiveness class considered extensive.

4.3 PUBLIC USE OF THE ESEC OF GUANABARA

It was found that the Guapi-Mirim APA enables the conservation and sustainable use of natural resources. The application of the ROVUC tool in the UC occurred in four stages.

In the first stage, referring to the general characterization of public use, it is observed that the UC is composed of a set of rivers and mangrove forests in a high state of conservation in BG, recognized for their potential for environmental education and interpretation activities. The protected area covers the municipalities of Guapimirim and Itaboraí, and its biological diversity is the main attraction for visitors, although disembarkation is not allowed. Its access is via the BR-493 highway with entrance to the headquarters of the APA Guapi-Mirim.

In the sociocultural aspect, the UC has historical and cultural heritage – fishing corrals – and medium-sized continuous mangrove forest fragments, considered the best preserved in the BG. In addition, there are scientific research activities and visitation with a focus on environmental education. In management, there is infrastructure to support visitors – visitor center, guardhouses, parking, among others. Technical visits are provided by appointment, guided by AP employees.

In the second stage, the visitor support features are similar to the previous CU. This is because the ESEC of Guanabara is inserted in the space of the APA Guapi-Mirim. The beginning of the visitation is given by safety guidelines, and environmental education activities in the available infrastructures. The Mangrove space – a new structure to support visitation – works as a foundation in the exhibition of photos and materials. Visitation takes place from boats, with small groups of scientists, students and ecotourists.

In the third and fourth stages, referring to the classification of the visitation areas, a single area was identified: the portion of mangrove in the best state of conservation in the BG, classified as natural due to the medium degree of intervention, the low human presence and the predominance of biodiversity observation.

4.4 GUANABARA ESEC TOURIST ATTRACTIVENESS INDEX

The application of the tool in the development of the *et al.*, (2017) at UC, resulted in the elaboration of two tables, with special attention to the spatialization of the experience classes in the internal and external environments.

Next, there is the application of the tool to the internal environment (Table 4).

Table 4

Spatialization of the classes of the internal environment of the ESEC of Guanabara/RJ

Indoor Environment				
Biophysical Attributes		Notes	Average	Source
Natural/cultural variety	Forest, mangrove, mangrove restoration spaces, biodiversity, Guanabara Bay	2	2,5	Field research
Scenic attractiveness	Google Scholar results: 17K. Most popular attraction: boat trip, 3 thousand.	3		Google Search and Google Scholar
Social Attributes		Notes	Average	Source
Diversity of activities	contemplation, boating, research, education	2	1.75	Field research
Number of encounters	UC area in km ² / number of visitors in 2023: 20 km ² /549 = 0.036	1.5		ICMBio (2001)
Management Attributes		Notes	Average	Source
Infrastructure	Boats for visitation and research	1.5	1.75	Field research
Services	Technical visit, sightseeing tour	2		Field research

Source: Authors' collection, 2025.

From the sum of the mean score, an internal score of 2 was obtained. This value is maintained for the calculation of the final attractiveness, which will be determined based on the evaluation of the external environment (Table 5), presented below.

Table 5

Spatialization of the experience classes of the external environment of the ESEC of Guanabara/RJ

External Environment				
Biophysical Attributes		Notes	Average	Source
Regional attractions	Tourist attraction in the region:15	3.5	3.6	TripAdvisor
Public access	Travel time from the nearest airport: 1 hour.	3.8		Google Maps
Social Attributes		Notes	Average	Source
Socioeconomic context	Average of the Human Development Index (HDI) of the municipalities belonging to the PAs studied	2.5	2.5	IBGE
Population density	Average number of people living in the municipalities belonging to the PAs	2.5		IBGE
Management Attributes		Notes	Average	Source
Hospitality Establishment	accommodation and food establishments in the municipality: 126	3	3	TripAdvisor

Source: Authors' collection, 2025.

The score of the external environment was equal to 3.0. From the sum of the internal (2.0) and external (3.0) indexes divided by 2 (environments) it was possible to reach the final index equal to 2.5. It is observed that the UC has the same classification as the APA Guapi-Mirim: Extensive. The CUs are similar in many characteristics of the internal and external environment, although they have different conservation categories. At the ESEC of Guanabara, some activities are restricted, such as the indirect use of natural resources, prohibition of fishing, disembarkation and visitation without permission. Characteristics provided for in the SNUC (ICMBio, 2001).

5 CONCLUSION

The present study highlights the importance of mangroves as essential ecosystems for biodiversity and the subsistence of traditional populations. The Guapi-Mirim APA and the

Guanabara ESEC, in Guanabara Bay, were analyzed using the ROVUC and IAT tools, allowing us to understand the dynamics of the public use of protected spaces.

Planning visitation becomes essential to reconcile the positive experience of the visitor with environmental conservation. In this context, the application of ROVUC and IAT in the PAs contributes to the understanding of the dynamics of visitation and to the definition of investment and management parameters.

The application of ROVUC in the PAs highlighted the need for diversification of tourism activities. Although the visitation experience is considered satisfactory, it takes place almost exclusively on boats, which limits public use. The recent creation of the Mangrove Space is a relevant strategy for this diversification, by providing activities prior to the boat trip and expanding the possibilities of environmental interpretation.

It is concluded that it is essential that the Federal Government, in partnership with ICMBio, the Management Council of the UCs and other sectors involved, invest in structures for the management of visitation in the spaces analyzed. In addition, the elaboration of the tool represents a starting point for the construction of technical documents that do not yet exist, such as the Public Use Plan. Such actions have the potential to strengthen the protection of the mangroves present in these protected areas, improve the quality of life of local populations and ensure the maintenance of ecosystem services.

The application of the IAT tool in the Guapi-Mirim APA resulted in a final tourist attractiveness of 3.1, classified as extensive. In the internal environment, potential was identified for diversification of visitation, with the proposal to implement a suspended trail or a viewpoint to observe the mangrove, aiming to expand the activities offered and attract a greater number of visitors. In the external environment, there was a need to improve signaling, especially on the highways and in the surrounding municipalities, in order to highlight the presence of the UC. In addition, when accessing the protected area, it is essential to invest in speed reduction mechanisms, ensuring greater safety for visitors.

At the ESEC of Guanabara, the application of the IAT resulted in a final tourist attractiveness index of 2.5, classifying it as extensive. As it is a Full Protection Unit, the diversification of activities, although possible, must consider the guidelines established by the SNUC. Investments in environmental education and interpretation programs, developed in partnership with municipal governments, are strategic actions to strengthen public use.

The external environment has characteristics similar to those observed in the Guapi-Mirim APA. The internal environment is predominantly composed of aquatic areas, complemented by terrestrial structures located at the headquarters of the Guapi-Mirim APA.

The activities offered are perceived as satisfactory by visitors, especially due to the expressive scenic beauty of the mangrove and its biodiversity.

It is in this sense that the results indicate the need to diversify visitation activities, ensuring that tourist exploration occurs in a balanced way and respects the principles of conservation. In addition, the importance of collaboration between the government and civil society is highlighted, promoting preservation actions and strengthening environmental awareness.

The integration of effective public policies and joint efforts between management, science and the community is essential to ensure the protection of mangroves and improve the visitor experience. In this way, the need for continuous and participatory planning is reinforced, which ensures the sustainability of this vital ecosystem for Guanabara Bay.

ACKNOWLEDGMENTS

We would like to thank the Center for Studies in Management of Conservation Units (NEGUC) of the Federal Rural University of Rio de Janeiro (UFRRJ) and the Graduate Program in Ecotourism and Conservation (PPGEC) of the Federal University of the State of Rio de Janeiro (UNIRIO) for their support in the development of this research.

REFERENCES

- Alencar, E. (2024). Histórias do mangue da Guanabara. Instituto Mar Urbano.
- Alongi, D. M. (2014). Carbon cycling and storage in mangrove forests. *Annual Review of Marine Science*, 6, 195–219. <https://doi.org/10.1146/annurev-marine-010213-135020>
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (2000). Lei nº 9.985, de 18 de julho de 2000. Institui o Sistema Nacional de Unidades de Conservação da Natureza. <http://www.planalto.gov.br/ccivil/leis/L9985.htm>
- Brasil. (2012). Lei nº 12.651, de 25 de maio de 2012. Institui o Código Florestal. http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm
- Brasil. Ministério do Meio Ambiente. (2022). Sistema Nacional de Unidades de Conservação - Ministério do Meio Ambiente. <https://www.gov.br/mma/pt-br/assuntos/biodiversidade-e-biomas/areas-protegidas/sistema-nacional-de-unidades-de-conservacao-da-natureza-snuc>
- Brasil. Ministério do Meio Ambiente. (2025). Brasil anuncia adesão à Mangrove Breakthrough, iniciativa global para proteção de manguezais. <https://www.gov.br/mma/pt-br/noticias/brasil-anuncia-adesao-a-mangrove-breakthrough-iniciativa-global-para-protecao-de-manguezais>

- Bunting, P., Rosenqvist, A., Lucas, R. M., Rebelo, L. M., Hilarides, L., Thomas, N., Hardy, A., Itoh, T., Shimada, M., & Finlayson, M. (2018). The global mangrove watch—a new 2010 global baseline of mangrove extent. *Remote Sensing*, 10(10), Article 1669. <https://doi.org/10.3390/rs10101669>
- Carrilho-da-Silva, F., & Milward-de-Azevedo, J. A. (2023). Ordenamento de uso público e conservação de áreas protegidas: Aplicação de ferramentas IAT e ROVUC em um parque na cidade do Rio de Janeiro. In E. C. Wenceslau (Org.), *Práticas em ensino, conservação e turismo no Brasil* (Vol. 2, pp. 299–319). Reconecta Soluções Educacionais. https://www.researchgate.net/publication/373549632_ORDENAMENTO_DE_USO_PUBLICO_E_CONSERVACAO_DE_AREAS_PROTEGIDAS_APLICACAO_DE_FERRAMENTAS_IAT_E_ROVUC_EM_UM_PARQUE_NA_CIDADE_DO_RIO_DE_JANEIRO
- Coelho, C. J., Schaeffer-Novelli, Y., Almeida, R., Menghini, R. P., & Reis, N. A. S. (2025). Assessment of the current status of mangroves in Brazil. *Mupan*. <https://lac.wetlands.org/pt-br/publicacao/assessment-of-the-current-status-of-mangroves-in-brazil/>
- Corrêa, A. F., Xavier Júnior, S. R., Silva, N. C. F., Costa, F. C. B., & Costa, C. V. S. (2024). Conservação dos manguezais: Importância e desafios. *Revista Latino-americana de Ambiente Construído & Sustentabilidade*, 5(23). https://publicacoes.amigosdanatureza.org.br/index.php/rlaac_sustentabilidade/article/view/5393
- Cortez, A. T. C., & Ortigoza, S. A. G. (Orgs.). (2009). *Da produção ao consumo: Impactos socioambientais no espaço urbano*. Editora UNESP; Cultura Acadêmica. <https://books.scielo.org/id/n9brm>
- Crema, A., & Faria, P. E. P. (Orgs.). (2020). *ROVUC Rol de Oportunidades de Visitação em Unidades de Conservação* (2a ed.). Instituto Chico Mendes de Conservação da Biodiversidade, Ministério do Meio Ambiente. https://www.gov.br/icmbio/pt-br/centrais-de-conteudo/publicacoes/publicacoesdiversas/rovuc_rol_de_oportunidades_de_visitacao_em_unidades_de_conservacao.pdf
- Diegues, A. C. S. (2000). Etnoconservação da natureza: Enfoques alternativos. In *Etnoconservação: Novos rumos para a conservação da natureza nos trópicos*. Hucitec/NUPAUB.
- Dubeux, C. B. S. (1999). A valoração econômica como instrumento de gestão ambiental - o caso da despoluição da Baía de Guanabara. *Planejamento e Políticas Públicas*, 44–87. <https://www.ipea.gov.br/ppp/index.php/PPP/article/view/1484/579>
- Food and Agriculture Organization of the United Nations. (2023). *The world's mangroves 2000–2020*. <https://www.fao.org/forestry/mangrove/distribution/en>
- Funbio. (n.d.). *No caminho da Mata Atlântica: Restaurando paisagens e fortalecendo cadeias produtivas locais no Mosaico Central Fluminense*. https://www.funbio.org.br/programas_e_projetos/mata-atlantica/no-caminho-da-mata-atlantica-restaurando-paisagens-e-fortalecendo-cadeias-produtivas-locais-no-mosaico-central-fluminense/
- Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J., & Duke, N. (2011). Status and distribution of mangrove forests of the world using earth observation satellite data. *Global Ecology and Biogeography*, 20(1), 154–159. <https://doi.org/10.1111/j.1466-8238.2010.00584.x>

- Instituto Chico Mendes de Conservação da Biodiversidade. (2001). Plano de Manejo da Área de Proteção Ambiental de Guapi-Mirim. http://www.icmbio.gov.br/apaguapimirim/?id_menu=52
- Instituto Chico Mendes de Conservação da Biodiversidade. (2012). Plano de Manejo da Estação Ecológica da Guanabara. https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/unidade-de-conservacao/unidades-de-biomas/marinho/lista-de-ucs/esec-da-guanabara/arquivos/contextualizacao_ga.pdf
- Instituto Chico Mendes de Conservação da Biodiversidade. (2018). Atlas dos manguezais do Brasil biodiversidade. https://ava.icmbio.gov.br/pluginfile.php/4592/mod_data/content/14085/atlas%20dos_manguezais_do_brasil.pdf
- Leal, M., & Spalding, M. D. (2024). The state of the world's mangroves 2024. Global Mangrove Alliance. <https://doi.org/10.5479/10088/119867>
- Lopes, R. V. R., Souza, C. N., Malhado, A. C. M., & Demetrio, G. R. (2025). Protected area impacts on the cover and growth of Brazilian mangrove forests. *Ocean & Coastal Management*, 267, Article 107738. <https://doi.org/10.1016/j.ocecoaman.2025.107738>
- Mandal, R. N., & Bar, R. (2018). Mangroves for building resilience to climate change. Apple Academic Press; CRC Press. https://www.researchgate.net/publication/329791537_Mangroves_for_Building_Resilience_to_Climate_Change
- Mariano, C. C. F., Bruno, C. E. M., & Rodríguez, N. E. E. (2025). Manguezais e comunidades pesqueiras: O manejo sustentável para a conservação do ecossistema. *Brazilian Journal of Biological Sciences*, 12(27), 1–15. <https://www.bjbs.com.br/index.php/bjbs/article/view/495>
- Medeiros, R. (2006). Evolução das tipologias e categorias de áreas protegidas no Brasil. *Ambiente & Sociedade*, 9. <https://www.scielo.br/j/asoc/a/C4CWbLFTKrTPGzcN68d6N5v/?lang=pt>
- Melgo, A. C. (2022). Os benefícios económicos para as áreas protegidas [Dissertação de mestrado, Instituto Politécnico de Bragança]. <https://bibliotecadigital.ipb.pt/handle/10198/26588>
- Moraes, J. F. J. (2022). Dos Povos Sambaquis às Sociedades do Manguê: O antropoceno como colonialismo. *SAPIENS - Revista de Divulgação Científica*, 3(2), 79–93. <https://revista.uemg.br/index.php/sps/article/view/6237>
- Omena, M. R. N. (2022). O uso público como ferramenta de gestão da conservação da natureza em parques nacionais brasileiros [Tese de doutorado, Universidade Federal de Santa Catarina]. <https://repositorio.ufsc.br/handle/123456789/234811>
- Pedrini, A. (2019). Trilhas interpretativas no Brasil: Uma proposta para o ensino básico. *Ensino, Saúde e Ambiente*, 12(2). <https://periodicos.uff.br/ensinosaudeambiente/article/view/38152>
- Santos, A. N., Brito, L. P., Siqueira, F. L. T., & Pinheiro Filho, I. S. (2024). Desafios e progressos: O impacto das políticas ambientais contemporâneas na conservação dos recursos naturais. *Revista Políticas Públicas & Cidades*, 13(2). <https://journalppc.com/RPPC/article/view/799>
- Soares, M. L. G., Chaves, V. O. F., Corrêa, M. F., & Júnior, S. G. M. (2003). Diversidade estrutural de bosques de mangue e sua relação com distúrbios de origem antrópica: O

caso da Baía de Guanabara (Rio de Janeiro). Anuário do Instituto de Geociências, 26, 101–116.

https://www.researchgate.net/publication/26429339_Diversidade_Estrutural_de_Bosques_de_Mangue_e_sua_Relacao_com_Disturbios_de_Origem_Antropica_O_Caso_da_Baia_de_Guanabara_Rio_de_Janeiro

Soffiati, A. (2023). Breve história das relações das sociedades com os manguezais no Brasil. AMBIENTES: Revista de Geografia e Ecologia Política, 5(1). <https://e-revista.unioeste.br/index.php/ambientes/article/view/30963>

Souza, T. V. S. B., Thapa, B., & Castro, E. V. (2017). Índice de Atratividade Turística das Unidades de Conservação Brasileiras. PAPP. https://www.researchgate.net/profile/Ernesto-Viveiros-De-Castro/publication/349124675_Indice_de_Atratividade_Turistica_das_Unidades_de_Conservacao_Brasileiras/links/6021f0fa299bf1cc26b24cc0/Indice-de-Atratividade-Turistica-das-Unidades-de-Conservacao-Brasileiras.pdf

Union Internationale pour la Conservation de la Nature. (2018). <https://www.iucn.org/about-iucn/history>

Vallejo, L. R. (2013). Uso público em áreas protegidas: Atores, impactos, diretrizes de planejamento e gestão. Anais do Uso Público em Unidades de Conservação, 1(1), 13–26. https://periodicos.uff.br/uso_publico/article/view/28674

ENVIRONMENTAL ASSESSMENT OF RIPARIAN FORESTS IN THE ALTO MEIA PONTE WATERSHED – GO, BRAZIL

DIAGNÓSTICO DAS MATAS CILIARES DA BACIA HIDROGRÁFICA DO ALTO MEIA PONTE - GO

DIAGNÓSTICO AMBIENTAL DE LAS FORMACIONES DE BOSQUE DE GALERÍA EN LA CUENCA HIDROGRÁFICA DEL ALTO MEIA PONTE – GO



<https://doi.org/10.56238/sevened2026.008-072>

Pedro Luiz Teodoro Clemente de Oliveira¹, Nori Paulo Griebeler², João Ricardo Nobre Ramos³

ABSTRACT

Monitoring vegetation degradation in the surroundings of water sources is essential to assess environmental impacts and to support actions aimed at restoring ecological balance between riparian forests and watercourses. In this context, the proposed study is justified by integrating geoprocessing and remote sensing tools into environmental analysis. This study aimed to evaluate the presence and condition of remnant vegetation within the Permanent Preservation Areas (PPAs) of the Meia Ponte River Basin upstream of the Raw Water Pumping Station operated by SANEAGO in Goiânia, Goiás. The assessment procedures involved the use of QuantumGIS (QGIS) software to delineate the watershed based on the Digital Elevation Model (DEM) from the TOPODATA project. Publicly available satellite imagery from Landsat 8–9 and Sentinel-2 was also used, along with the application of the Normalized Difference Vegetation Index (NDVI) and pixel reclassification to identify Cerrado phytophysognomies that include riparian vegetation. The results revealed differences in sensor accuracy, with Sentinel-2 presenting higher spatial accuracy. They also indicated that only 3.62% and 5.09% of the total basin area (Landsat 8–9 and Sentinel-2, respectively) corresponds to remnant vegetation within PPAs, highlighting significant pressure on riparian forests associated with water sources. The study demonstrated the relevance of geotechnologies as effective tools for assessing PPAs in the watershed under analysis. Satellite image analysis enabled accurate mapping of river tributaries and identification of the presence and absence of vegetation adjacent to water sources within legally protected buffer zones.

Keywords: Remnant Vegetation. Vegetation Index (NDVI). Native Vegetation Conservation. Landsat 8-9. Sentinel-2.

¹ Undegraduated student in Agronomy. Escola de Agronomia. Universidade Federal de Goiás (UFG). E-mail: pedroluizteodoro25@gmail.com

² Dr. in Agricultural Engineering. Escola de Agronomia. Universidade Federal de Goiás (UFG). E-mail: nori@ufg.br

³ Undegraduated student in Agronomy. Escola de Agronomia. Universidade Federal de Goiás (UFG). E-mail: nori@ufg.br

RESUMO

O monitoramento da degradação da vegetação no entorno de mananciais é fundamental para avaliar impactos ambientais e subsidiar ações voltadas ao restabelecimento do equilíbrio ecológico entre a mata ciliar e os cursos hídricos. Nesse contexto, a proposta se justifica ao integrar ferramentas de geoprocessamento e sensoriamento remoto à análise ambiental. O presente trabalho teve como objetivo avaliar a presença e a situação da vegetação remanescente nas Áreas De Preservação Permanente (APPs) da Bacia Hidrográfica do Rio Meia Ponte a montante da Estação Elevatória de Água Bruta da SANEAGO em Goiânia (GO). Os procedimentos de avaliação envolveram o manuseio do software SIG QuantumGIS para delimitação da bacia hidrográfica através do MDE do projeto TOPODATA, utilizando também como base imagens dos satélites Landsat 8-9 e Sentinel-2 adquiridos por bancos de dados públicos, aplicação do índice NDVI e reclassificação dos pixels para identificação da fitofisionomia do Cerrado que contemplasse as matas ciliares. Os resultados demonstraram diferença na acurácia dos sensores, sendo o Sentinel-2 com maior acurácia espacial, e indicaram que apenas 3,62% e 5,09% (Landsat 8-9 e Sentinel-2 respectivamente) da área total da bacia corresponde a vegetação remanescente em APPs, evidenciando significativa pressão sobre as matas ciliares dos mananciais. O presente trabalho demonstrou a relevância do uso de geotecnologias, como ferramentas eficazes para a avaliação de APPs na bacia hidrográfica em questão. A análise das imagens dos satélites permitiu mapear com precisão os afluentes do rio e identificar a presença e ausência de vegetação contígua aos mananciais, dentro das faixas legalmente protegidas.

Palavras-chave: Vegetação Remanescente. Índice de Vegetação (NDVI). Conservação da Vegetação Nativa. Landsat 8-9. Sentinel-2.

RESUMEN

O monitoramento da degradação da vegetação no entorno de mananciais é fundamental para avaliar impactos ambientais e subsidiar ações voltadas ao restabelecimento do equilíbrio ecológico entre a mata ciliar e os cursos hídricos. Nesse contexto, a proposta se justifica ao integrar ferramentas de geoprocessamento e sensoriamento remoto à análise ambiental. O presente trabalho teve como objetivo avaliar a presença e a situação da vegetação remanescente nas Áreas De Preservação Permanente (APPs) da Bacia Hidrográfica do Rio Meia Ponte a montante da Estação Elevatória de Água Bruta da SANEAGO em Goiânia (GO). Os procedimentos de avaliação envolveram o manuseio do software SIG QuantumGIS para delimitação da bacia hidrográfica através do MDE do projeto TOPODATA, utilizando também como base imagens dos satélites Landsat 8-9 e Sentinel-2 adquiridos por bancos de dados públicos, aplicação do índice NDVI e reclassificação dos pixels para identificação da fitofisionomia do Cerrado que contemplasse as matas ciliares. Os resultados demonstraram diferença na acurácia dos sensores, sendo o Sentinel-2 com maior acurácia espacial, e indicaram que apenas 3,62% e 5,09% (Landsat 8-9 e Sentinel-2 respectivamente) da área total da bacia corresponde a vegetação remanescente em APPs, evidenciando significativa pressão sobre as matas ciliares dos mananciais. O presente trabalho demonstrou a relevância do uso de geotecnologias, como ferramentas eficazes para a avaliação de APPs na bacia hidrográfica em questão. A análise das imagens dos satélites permitiu mapear com precisão os afluentes do rio e identificar a presença e ausência de vegetação contígua aos mananciais, dentro das faixas legalmente protegidas.

Palabras clave: Vegetación Remanente. Índice de Vegetación (NDVI). Conservación de la Vegetación Nativa. Landsat 8-9. Sentinel-2.

1 INTRODUCTION

The presence of native vegetation in the surroundings of the springs is essential for maintaining the ecological flow throughout the year because they reduce the natural loss of water along the entire spring, mainly through infiltration and evaporation, but also by reducing sedimentation and erosion, and interception of rainfall that allows a better effective infiltration of water into the soil (Ferraz *et al.*, 2014 *apud* Ferreira *et al.*, 2019).

By observing the behavior of water over a watershed cutout, it is possible to trace the different ways in which water loss, consumption or runoff occurs. The main elements that alter the availability of water through the natural or artificial withdrawal of natural watercourses are: evaporation, insolation, infiltration, human consumption (catchment), watering, irrigation (catchment), natural evapotranspiration of plants, among others; factors that are also considered in modeling studies of soil surface loss and water availability in land use scenarios (Lima; Ferreira; Ferreira, 2018)

In addition to the consumption itself, which would be the export of water from the springs, the natural recharge of the watersheds through rainfall and recharge zones must be considered. The water tables are supplied by precipitation that reaches regions of deep and permeable soils, in addition to being maintained by native vegetation that prevents the evaporation of water, maintains and redistributes rainwater (Hollanda *et al.*, 2014). Riparian forest areas are considered and described, by Brazilian legislation, protected zones that play an important role in the ecosystem. As described by Law No. 12,651 of May 25, 2012:

II – Permanent Preservation Area – APP: protected areas with the environmental function of preserving water resources, landscape, geological stability and biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations. (Brazil, 2012, p. 2).

In many cases, vegetation is suppressed in Permanent Preservation Areas and, regardless of legality, compensation for the environmental damage caused is mandatory, which in turn is governed mainly by Law No. 12,651/2012 (nationwide), State Law No. 18,104/2013 and State Law No. 21,231/2022.

Thus, the recovery of the degraded area, especially in the vicinity of springs, is at the mercy of both the actions of the owner of the property where the suppression occurred and the environmental agencies responsible for inspection. Therefore, it is common to find areas along the springs where there is an invaded, degraded or absent Permanent Preservation Area. Studies on the adequacy of land use in PPAs highlight the need for restoration and inspection actions to ensure the water function of these areas (Santos *et al.*, 2014)

In the study by Novaes (2022), significant degradation was identified in the APPs along

the water courses and in the surroundings of springs within the Meia Ponte River Catchment Basin. The use of remote sensing and classification techniques has been pointed out as an effective tool for this monitoring and decision-making (Liu, 2006; Maxwell; Warner; Fang, 2018). The importance of monitoring native vegetation around water sources is reinforced as a method of understanding and evaluating the impacts of the loss or recomposition of fauna on the entire agroecosystem.

The entire territory of the state of Goiás is part of the Cerrado biome, a tropical savannah of high ecological importance due to its biodiversity and the distinct phytophysognomies that compose it. The configuration of the landscape in the Cerrado is closely associated with geological formations, soil types and reliefs, factors that, together with the presence of springs and watercourses, shape local hydrological patterns. In addition, the Cerrado is recognized as Brazil's "water tank", housing springs that contribute to several large hydrographic regions of the country — a characteristic that reinforces its relevance for water security and for the conservation of riparian forests. (Brazil, 2023).

The springs in particular are the source of life for all the vegetation present, which in turn fulfills the fundamental function of protecting the soils around the springs, preserving the flow of the source and contributing to the quality of the water. In search of the need to mitigate environmental impacts, different laws emerged that established legal instruments such as Permanent Preservation Areas (APPs) and Legal Reserves (RL) that delimited mandatory areas on the property that must be preserved and recomposed. However, the effectiveness of the legislation is dependent on the pressure of inspection by the competent environmental agencies and on the non-compliance with the regulations on rural properties.

The way environmental agencies assess the presence of illegal plant suppression is through geotechnology tools, in particular, the temporal analysis of satellite images. The presence or absence of native vegetation is monitored, whether it is surplus vegetation on a property or conservation areas such as APP or RL and through this, the environmental agency plans together with the owner, the recovery of irregularly suppressed areas.

The temporal analysis of satellite images is essential for the monitoring of riparian forests along water courses. The first step to investigate the environmental impacts on the springs through the degradation of native vegetation is the correlation between the native vegetation and the ecological flow of the spring. With the integrated analysis between land use, remaining native vegetation and water availability, the entrepreneur and the environmental agency can jointly contribute to a more sustainable management of natural resources, reconciled with existing public policies.

Naturally, the hydrological flow of the river is impaired throughout the year, especially

in seasons of prolonged drought, due to the absence of riparian forest. With these functions compromised, the trends are erosive processes caused by the water course itself, complete drying of the source and loss of biodiversity. From a legal point of view, the Brazilian Forest Code (Law No. 12,651/2012) clearly establishes the principle that natural resources, especially water, native vegetation and soil, are goods of common interest to the whole society.

Thus, the monitoring of the degradation of vegetation around water sources is important in terms of evaluating the impacts and developing potential solutions to reestablish the ecological balance of the relationship between riparian forest and water course, but also to generate economic return for those who have water sources on their properties through the various benefits that good management of water resources brings.

The proposal is also part of an academic effort to integrate geoprocessing and remote sensing tools in environmental analysis, understanding the relationship between land use and water availability, assessing impacts, bringing results that support public policies and providing strategies for integrated landscape management through agroecological practices that reconcile agricultural production and conservation of water resources. In this context, the proposal is justified by integrating geoprocessing and remote sensing tools to environmental analysis.

The objective of this research is to evaluate the presence of native vegetation in the Permanent Preservation Areas through the classification of satellite images (using Landsat and Sentinel-2) considering the agroecosystem of the Meia Ponte River Basin upstream of the Meia Ponte Raw Water Pumping Station in Goiânia, Goiás. The specific objectives are: to delimit the study area and identify the tributaries of the watershed from Digital Elevation Models and public cartographic bases; process and analyze images from the Landsat and Sentinel-2 satellites to map the vegetation in the APP zone, comparing their precision, accuracy and performance; develop and test a reproducible methodology using exclusively free software and public data for vegetation identification in PPAs; and to discuss the implications of the results for the formulation of public policies aimed at the conservation of native vegetation and the sustainable management of water resources.

2 THEORETICAL FRAMEWORK

Once a certain point in the stretch of a spring is chosen, there is an imaginary layout that delimits a drainage area, a region of the earth's surface that receives rainwater, sediments and dissolved materials for a common outlet, a focal point (Santana, 2003). By delimiting a route between these focal points, a fluvial channel is formed.

[...] The term river basin refers to a natural geographical compartmentalization delimited by water dividers. This compartment is drained superficially by a main watercourse and its tributaries." (Santana, 2003, p. 27).

A system determined by biotic and abiotic factors has a volume of water input and an output volume, being determined by some factors such as evaporated, transpired and infiltrated water (Silva, 2014 apud Silveira, 1993). However, an important factor that interferes with the behavior of the basins is surface runoff.

When the earth's surface is saturated with water or impermeable, the water drains superficially towards a closer watercourse (Miranda; Silva; Oliveira, 2010). This phenomenon is important when observing the presence of vegetation to buffer, absorb and redistribute rainwater without harming and altering the physical properties of the soil.

When there is the presence of native vegetation, the behavior of water in relation to the earth's surface changes significantly, the presence of vegetation cover in the soil regulates factors such as erosion, sediment transport, rainfall interception and effective water infiltration by the soil profile (Carvalho, 2019).

The capacity to retain and recharge the volume of water flowing in the springs of a watershed is determined by the capacity of water generation by the springs in each spring, but also by the recharge areas. The infiltration areas, as the recharge areas are known, are zones that allow the infiltration of water into the soil profile, reaching the water table that supplies the water mines and the springs themselves (Santana, 2003).

The potential of a watershed greatly delimits an activity that depends on water in a given region. Human activity, in turn, also has a direct impact on the behavior of the basins, agricultural pressure, for example, is an anthropogenic interference that alters the landscape through the conversion of land use. Naturally, the absence of vegetation, soil compaction, and landscape degradation through erosion caused by poor soil management lead to direct consequences on the way water behaves in a basin.

Deforestation, therefore, is a lower-cost activity when compared to the leasing of new areas, in the Amazon, there is a direct correlation between deforestation and the expansion of cattle ranching and large-scale agriculture (Rivero, 2009). In the state of Goiás, mechanization of agropastoral activities has caused severe impacts on native vegetation, compromising important ecological functions of the agroecosystem, such as soil protection, recharge of watersheds, and the filtration of rainwater by the vegetation itself (Crestana; Reichardt; Silva, 1993; Campos *et al.*, 2015).

Remote sensing and geoprocessing are essential elements in the dynamic and temporal monitoring of the landscape over time, allowing the identification of critical areas for

conservation and restoration (Campos *et al.*, 2015; Fitz, 2008). Therefore, to understand the impact of agriculture and livestock on native vegetation, especially riparian forests, a multidisciplinary analysis is needed quantifying changes in land use and vegetation cover, associating them with environmental and hydrological impacts.

In several rural properties in Goiás, APPs represent the only remaining native vegetation, making them vulnerable to agricultural pressure. In the context of the Meia Ponte River Basin, this soil conversion results in the degradation of riparian forests and loss of water retention of agroecosystems (Lima; Ferreira; Ferreira, 2018).

The monitoring of these activities serves as a regulatory framework both for the entrepreneur responsible for the intervention in nature, and for the inspection agency that seeks irregular interventions. Remote sensing plays an important role in assessing the condition of protected areas and facilitating this broadening of the focus from protected areas to entire landscapes (Wiens *et al.*, 2009).

Currently, in Brazil, the main satellites used are Sentinel-2 and Landsat because they periodically capture images of the entire Brazilian territory and are made available for free on the internet. The diagnoses of the areas are made through the processing of satellite images in products such as maps and images that highlight different elements depending on the object of interest.

The use of GIS tools are crucial for monitoring the vegetation present in an area. According to Tagliari and Baptista (2020), the processing of satellite images through GIS tools allows the evaluation of the presence of APPs that have undergone intervention along several stretches, using vegetation indices as a criterion for evaluating the presence of vegetation.

The product varies according to the objective of each analysis, the study by Nepomuceno (2012) presents, as a reference, several maps prepared from the processing of images that best illustrate the reality of the Ribeirão Gomeral hydrographic basin, such as the vegetation cover and the contour lines. Geoprocessing, the area of knowledge responsible for this entire process, is described by Cubas and Taveira (2020) as being the means (through GIS) that it is possible to transform georeferenced data into information.

Orbital images are created from sensors attached to satellites that capture the radiation reflected or emitted by the Earth's surface. The characteristics of sensors change according to their purpose and technology and this directly influences the quality, accuracy and precision of the image. Sensors have different spatial, spectral and temporal resolutions, and should be considered according to the applicability of the image (Wiens *et al.*, 2009).

The use of water by agriculture varies according to the type of production, availability of water granted in the springs and the need for the crop. In 2022, an assessment was made

of the use of water by crops, both rainfed and irrigated, consuming a total of 9.2 thousand m³ per second, of which 864.8 m³ per second, that is, 9.4% of water supplemented via irrigation, the rest is characterized by rainwater and made available in the soil, without human interference (Ana, 2022).

The Landsat program has maintained an "uninterrupted multispectral record" of land surfaces since 1972, and Landsat 8, launched in 2013, reinforces this continuity by operating with an orbital lag of eight days compared to Landsat 7 (launched in 1999), increasing the frequency of revisits and the availability of images for environmental monitoring and surveys (Usgs, 2019).

The Copernicus Sentinel-2 mission has as its main objective is to monitor the variability in the Earth's surface conditions, supporting the monitoring of changes through a combination of wide bandwidth and high revisit frequency; the mission has a bandwidth of 290 km and offers 10-day revisits at the equator with one satellite and 5 days with two satellites, which translates into intervals of approximately 2–3 days at mid-latitudes (Copernicus, 2020).

3 METHODOLOGY

The research evaluated a portion of the Meia Ponte River Basin, upstream of the Meia Ponte Raw Water Pumping Station (EEAB) consisting of an area of approximately 1,662.15 km² that includes the municipalities of Goiânia, Goianira, Santo Antônio de Goiás, Brazabrantes, Nerópolis, Nova Veneza, Ouro Verde de Goiás, Damolândia, Inhumas and Itauçu.

This region carries a socioeconomic importance due to its strategic importance in urban supply, irrigation of agricultural systems and animal watering. The region, being within the state of Goiás, is also monitored by public agencies such as the State Secretariat for the Environment and Sustainable Development of Goiás (SEMAD-GO) which promotes different public policies and strategies for maintaining the watershed.

The mapping of the area was carried out using the free GIS tool QGIS, which performed the interpretation and analysis of the shapefile and raster files generated throughout the research. Through a Digital Elevation Model acquired through the TOPODATA project, only the area downstream of SANEAGO's Raw Water Pumping Station (EEAB) was cut, respecting the contour lines that converge to the point of interference (16°34'11.16"S 49°19'44.97"W).

To evaluate the vegetation in the APPs, satellite images obtained from the Landsat 8-9 Level 2 (Operational Land Imager - OLI) and Sentinel-2 (MultiSpectral Instrument - MSI) missions were used, which offer spatial resolutions of 30 meters and 10 meters, respectively.

Quantum GIS virtual environment was used to manipulate the data.

The delimitation took place through the Digital Elevation Model (MDE) file acquired through the TOPODATA project of the National Institute for Space Research (INPE). The quadrants in which the watershed area fits are 16s 51 ZN and 16s 495 ZN, the rasters files that provided the numerical altitude information (ZN extension) per pixel were specifically downloaded.

Due to the nature of the file, the Coordinate Reference System (SRC) was manually referenced from the original file, in this case, the SRC EPSG:4674 – SIRGAS 2000. The raster files were redesigned to be standardized according to the research reference system, SRC EPSG:31982 – SIRGAS 2000 (UTM Projection Zone 22S). The files were merged and cropped within the extension of the screen that contemplated the entire hydrographic basin upstream of the EEAB using as a reference the shapefile file made available free of charge by the SIGA-GO portal of SEMAD.

The extraction of the perimeter of the drainage area was carried out through three stages: delimitation of the basin, reclassification of the pixels of the raster image and polygonization of the reclassified pixels. The first and third steps were automated through Python scripts that, in addition to ensuring the execution of the procedure and generation of an error-free file, automated several steps that could have been done manually.

These scripts were generated and adapted with the help of Copilot, a Microsoft Artificial Intelligence assistant, for these scripts to be generated it is necessary to have an AI conduction methodology to acquire the desired result. The desired file is the "basin raster". The pixels in this file, due to the nature of their processing, generate pixels whose value ranges from 0 to 8000. These are representative values proportional to the pixel value of the file in which it was processed, with 0 being the northwesternmost pixel of the raster file and 8000 the southeasternmost pixel of the raster file, that is, respecting the natural slope of the terrain captured by the DEM. The "basin raster" file is reclassified using the native QGIS algorithm "Resort by table", using the values presented in Table 1 as a parameter.

Table 1

Pixel reclassification table

Minimum Value	Maximum Value	Pixel Value
5264	6836	1
- ∞	5263	0

Source: The authors, 2026.

The delimiter was defined according to the manual evaluation of the gray spots formed in the graphical representation of the raster file using a simple gray band. The pixel value at

the EEAB point is 5264, so every basin is bounded by the pixels above this value and below 6836. The maximum limit was defined because, in every extension of the raster file, there are points of elevation greater than that of the watershed, so a maximum delimiter must be inserted in the algorithm to correct the formation of the perimeter of the drainage area. When reclassifying the raster file from the basin, this generates a new black and white raster file, where black is the representation of the pixels with an assigned value of 1 and white, are the pixels with an assigned value of 0.

To identify the vegetation present within the PPA boundaries, satellite images from Landsat 8-9 Level 2 and Sentinel-2 Level 2 were used. The rasters files were acquired through the official USGS and Copernicus EarthExplorer portals. For the analysis of the presence of vegetation, the use of the NDVI (Normalized Difference Vegetation Index) vegetation index was considered. The index uses in its calculation the digital numbers (ND) of the bands in the Near Infrared and Red range.

$$NDVI = \frac{ND_{\text{Infravermelho Próximo}} - ND_{\text{Vermelho}}}{ND_{\text{Infravermelho Próximo}} + ND_{\text{Vermelho}}} \quad (1)$$

The files have been redesigned for SRC EPSG:31982 – SIRGAS 2000 (UTM Projection Zone 22S). The rasters were cut using the overlay layer of the vector file of the drainage area, thus obtaining a raster file delimited by the watershed. To obtain the raster file calculated according to the NDVI index using the B4 band (spectral resolution of 0.76 – 0.90 µm) and the B5 band (spectral resolution of 1.55 – 1.75 µm) for Landsat 8-9, for Sentinel-2, the B4 band (spectral resolution of 0.665 µm) and the B8 band (spectral resolution of 0.842 µm) were used. The NDVI classification followed the classification of Bitencourt *et al.* (1997) for the phytophysionomies of the Cerrado (Table 2).

Table 2

NDVI classes according to phytophysionomy

Phytophysionomies	Classes NDVI
Dirty Field	0.0261 to 0.2036
Wet Field	0.0261 to 0.2036
Cerrado Field	0.2037 to 0.2629
Cerrado sensu stricto	0.2630 to 0.3813
Cerrado sensu stricto tending to Cerradão	0.3814 to 0.4405
Cerradão	0.4406 to 0.5589
Mesophilic forest	0.4406 to 0.5589

Source: Adapted from Bitencourt (1997).

To identify permanent preservation areas adjacent to springs, it is necessary to select a phytophysionomy dense enough to offer a dense vegetation cover on the soil, as a

criterion, it was considered as minimum in terms of vegetation density, the formation of Cerradão sensu stricto up to the mesophilic forest, that is, the ND that store a value equal to or greater than 0.2630 indicated the presence of healthy vegetation to compose the APP (Riparian Forests), while values below 0.2630 represented a deficit or absence of vegetation.

To highlight only the pixels that contained the vegetation within the given limit, it is necessary to reclassify the raster file calculated by NDVI to redefine through a predetermined parameter, changing the original image (Fitz, 2008). The native QGIS algorithm "Reclassify by table" was used to enforce the pre-established parameters. Any pixel with a value equal to or greater than 0.2630 will be reclassified to 1, while any pixel with a value less than 0.2630 will be reclassified to 0.

The product of the execution of this algorithm under these parameters is a black and white raster file that allows a better visualization of the places where there is the presence of vegetation considered sufficient to compose a riparian forest. The raster file was cropped to within the boundaries of the APPs of the watercourses and vectorized to form a single polygon-shaped file, allowing area calculation and visualization by overlay in KML format in Google Earth Pro.

4 RESULTS AND DISCUSSIONS

The use of GIS tools is fundamental as well as the critical analysis, both quantitative and qualitative, of the modification suffered by natural vegetation or implanted by human interference. Given the difficulty of access and resources to capture images of extensive areas, the use of satellite images is crucial in the analysis of vegetation on large scales, compensating for the low accuracy when compared to the use of Unmanned Aerial Vehicles (UAVs) with attached optical sensors.

To quantify the presence of vegetation in the legal zones of permanent preservation areas, the use of remote sensing data proved to be effective for monitoring these areas intercepted by linear projects, allowing the identification of changes in vegetation cover (Tagliari; Batista, 2020).

All the polygons used were acquired free of charge in different databases on the internet, using as a reference to start the analysis, the data made available by public agencies such as the State Geoinformation System (SIEG) and the Environmental Geographic Information System (SIGA-GO). As for the raster files, they are obtained through official portals that periodically publish the images captured by the satellite sensors.

Free access to this data allows the promotion of research and analysis carried out by private or public initiatives, for-profit or not, establishing an active community for

environmental analysis. These databases play a key role in the selection and conservation of green areas for biodiversity, as they provide consistent data on land use and vegetation cover (Wiens *et al.*, 2009).

The results obtained in the diagnosis of the Permanent Preservation Areas (PPAs) of the Meia Ponte River Basin, upstream of the SANEAGO Raw Water Pumping Station in Goiânia, were satisfactory. These reinforce the importance of using remote sensing and geoprocessing techniques for sizing green areas in zones of ecological importance.

Previous studies have already demonstrated the effectiveness of these GIS tools in monitoring vegetation cover and assessing anthropogenic pressure on PPAs (Tagliari; Baptista, 2020; Campos *et al.*, 2015; Santos *et al.*, 2014). In this context, the incorporation of artificial intelligence methods represents a significant advance, as it expands the ability to classify and interpret orbital images, allowing greater precision in the detection of environmental changes (Maxwell; Warner; Fang, 2018).

The processing of data in a GIS tool, in scientific means, follows protocols so that the experiment is repeatable in other machines. Many of the procedures applied can be simplified as a sequence of actions promoted by the tools through the software's native algorithms. The use of A.I.s allows the automation of these protocols and the understanding of the procedures performed.

This perspective dialogues with Liu (2006) and Wiens *et al.* (2009), which highlight the importance of remote sensing tools applied to environmental and ecological analyses. In addition, considering that the hydrological function of riparian forests is essential for the regulation of the water cycle (Lima; Zakia, 2000; Miranda; Silva; Oliveira, 2010), the use of learning algorithms becomes a promising tool for automating procedures, facilitating more robust environmental diagnoses.

The calculation for the watershed was made considering the resolution of the raster file made available by the TOPODATA project database. The total area of the drainage zone at the point of the SANEAGO Raw Water Pumping Station in Goiânia was 1614.1426 km², approximately 13.25% of the Meia Ponte River basin.

Landsat 8-9 and Sentinel-2 have divergences in their optical sensors, mainly in spatial resolution and spectral resolution. A considerable divergence was identified, which directly interferes in the calculation of the green area present within the watershed, specifically in the legal zone of permanent preservation areas. There was a vegetation difference of 1.47% between the analyses performed on the two satellite images, as shown in Table 3.

Table 3*Pixel reclassification table*

Satellite	Total Area (km ²)	Percentage of Total Area (%)
Landsat 8-9	58,5666	3,62
Sentinel - 2	82,2799	5,09
Average	70,4232	4,36

Source: The authors, 2026.

There is a limitation of how much the satellite image is able to capture through its sensors, the light emitted by vegetation, this is due to factors such as atmospheric distortions, presence of clouds, spatial resolution of the pixel, physiological stage of the plant, period of drought or rain, and so on. All these factors affect the accuracy of the analysis, distorting the information acquired from reality.

According to Liu (2006), satellite images are indirect representations of the Earth's surface, they are limited to spatial, spectral and temporal resolution. The same author also points out that cloud cover and atmospheric conditions compromise the fidelity of the information. Therefore, we have created a virtual environment that represents reality, even if at a certain distance from reality, to facilitate the interpretation of data that are imperceptible to human senses.

The monitoring of the presence of vegetation is associated with the evaluation of the vigor of the forest population in a given period of analysis, being subject to variations, and which intrinsically depend on the type of phytophysiology. In the work of Bitencourt *et al.* (1997), satisfactorily demonstrated that it is possible to identify different phytophysonomies of the Cerrado, using NDVI classifications.

These classifications became effective for the evaluation of the presence of vegetation in riparian forests in the watershed. (1997) and visualize where forest formations such as gallery forests, cerradão and cerrado sensu stricto are present.

However, the pressure of agriculture is one of the factors in the suppression of riparian forests, which is why it is still a pertinent advance that replaces the existing vegetation with an implanted one, exogenous to the place. In an image classification operation, the areas mixed with gallery forests and cultivation zones appear to be a single continuous area of vegetation in an indistinguishable way.

There is a zone of vegetation contiguous to the springs, which despite having already been filtered using the raster reclassification using the values in Table 4 as a reference, there are still zones where there is this mixture between crops and native vegetation. It is an error considered during the diagnosis of the presence of vegetation, but it requires the development of new methods to perform this separation.

Table 4

Table of areas of the total vegetation of the basin

Satellite	Total Area (km ²)	Percentage of Total Area (%)
Landsat 8-9	221,3424	13,71
Sentinel - 2	402,3410	24,92
Average	311,8417	19,31

Source: The authors, 2026.

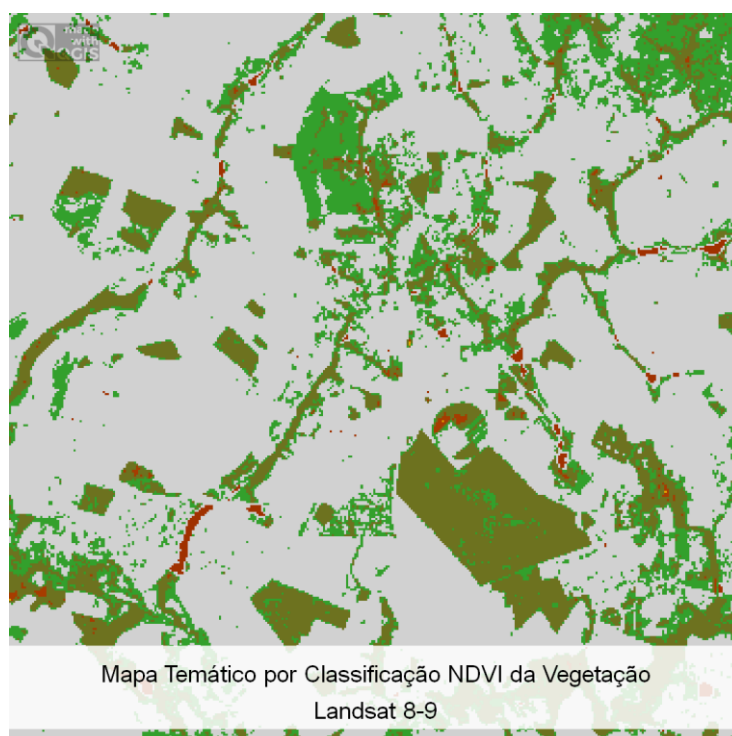
The ability to capture the lengths of electromagnetic radiation reflected by vegetation depends on the intrinsic characteristics of the sensor and its spatial resolution. The significant difference between the areas of vegetation detected by the two satellites is due, in this case, to the spatial resolution, being 30 meters for Landsat 8-9 and 10 meters for Sentinel-2. Therefore, for more accurate analyses, Sentinel-2 has greater accuracy, facilitating the understanding of reality through the virtual environment of the GIS.

The permanent preservation area of the entire hydrographic basin downstream of the EEAB belongs to only 3.62% and 5.09%, analyzed by Landsat and Sentinel-2 respectively. And, compared to the entire vegetated area, classified according to the work of Bitencourt *et al.* (1997), makes up only 26.45% and 20.45%, analyzed by Landsat and Sentinel-2, respectively. The proportion of vegetation by the total area and by the vegetated area provide us with important points to analyze the complexity of the flora system of the watershed.

The amount of vegetated area is notoriously small even if, even considering within these values, the cultivation zones, that is, approximately 70% of this entire area is composed of pastures, easements, reflecting pools or urban areas. The amount of vegetated area is notoriously small even if, even considering within these values, the cultivation zones, that is, approximately 70% of this entire area is composed of pastures, easements, reflecting pools or urban areas. The removal of native vegetation in areas of PPAs of springs, such as gallery forests and wetlands, directly compromises water quality, accelerates river sedimentation and reduces the recharge of underground aquifers (Silva, *et al.*, 2010). Figure 1 and Figure 2 clearly represent the difference generated by the difference in the spatial resolution of the image.

Figure 1

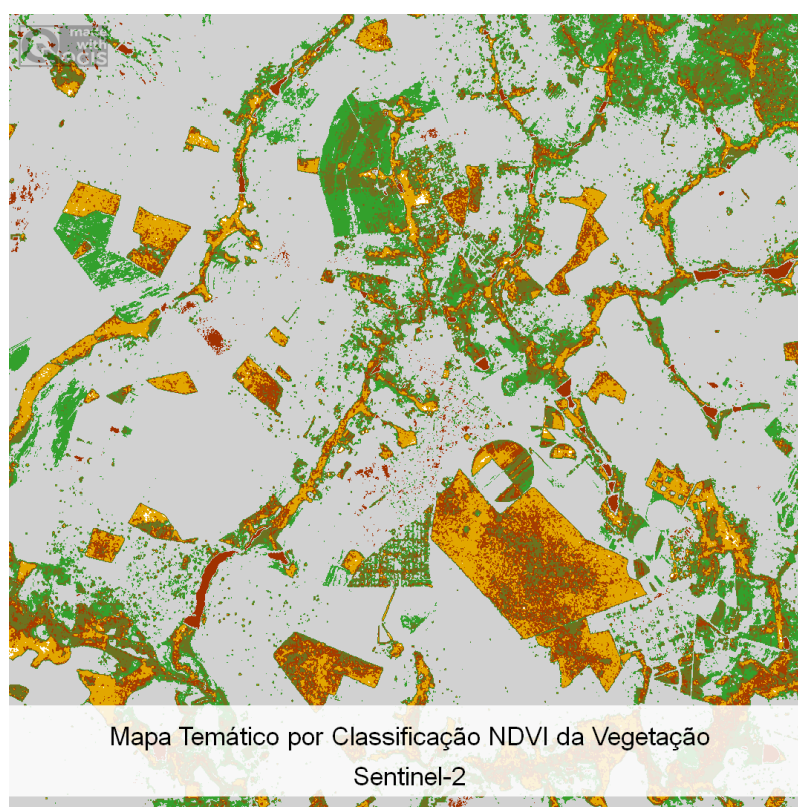
Map cut by NDVI classification from Landsat 8-9



Source: The authors, 2026.

Figure 2

Map cut by NDVI classification from Sentinel-2



Source: The authors, 2026.

It is through the satellite monitoring of the APP that it is possible to diagnose the extent of the areas with absence of vegetation in the APP, although the on-site investigation can directly validate the reality of an enterprise, the evaluation on large scales only takes place through the creation of a virtual environment that allows the complete visualization of these large areas.

Both satellites showed a difference in light capture per square meter due to spatial resolution, this analysis directly interfered in the determination of vegetation per raster pixel. While Landsat offers an image with checkerboard and less fluid zones, where there is little understanding of vegetation continuity, Sentinel-2 allowed for greater precision in places where there is vegetation and at the beginning and end of green spots.

Tables 3 and 4 demonstrate this difference through the quantification per square kilometer of vegetated area through a process of pixel reclassification that uses, as a condition, the work of Bitencourt (1997). However, for large-scale environmental analyses, Landsat can still prove useful for the evaluation of vegetation in large areas, while for research whose objective is a more detailed evaluation, the use of Sentinel-2 is recommended.

This research was conducted considering the possibilities of access to information that is publicly available on the internet through different databases, all the sources cited, manipulated and used are available on the internet. The availability of satellite images by projects such as Landsat and Sentinel-2, for example, made it possible to monitor vegetation cover, enabling the identification of land use conflicts (Copernicus, 2025; Oliveira; Pirajá, 2022).

Currently there are many consultancies that take advantage of satellite images available on the internet to generate marketable products such as charts, maps and technical reports. There is an active search for enterprises for environmental services that are capable of providing remote sensing services for the regularization of environmental liabilities or strategic reallocation of resources on their property.

The study by Tagliari and Baptista (2020) demonstrates how the use of open remote sensing data is effective in detecting interference in APPs caused by large projects, such as railways. Public services such as the CAR require a prior analysis of the rural enterprise through the entrepreneur or consultancy for the analysis and delimitation of vegetation, pastures, cultivation plots, consolidated areas, easements, constructions and so on. Geoprocessing does not depend exclusively on restricted or high-resolution data, but on a well-structured methodology and the initiative of those who analyze.

This research also aimed at a simple and pedagogical development, using tools such as artificial intelligence and Python scripts that are accessible to the public, of a methodology

for the production of cartographic products whose purpose is the classification, identification and evaluation of the presence of vegetation in a study area. Information, in turn, is data modified and transformed so that it is readable and interpretable by a user.

Irregular land occupation in permanent preservation areas can be identified through these accessible tools and methodologies, as shown by Campos *et al.* (2015) and Santos *et al.* (2014), who used geoprocessing to evaluate land use conflicts in micro-basins. Therefore, the inspection carried out at a distance through satellite images is a means of identifying areas with liabilities.

However, the identification and regularization will only occur through the receptive action of the secretariats (municipal or state) of the environment, something that is already facilitated given the accessibility of the inspectors regarding the daily updated satellite images and tools such as UAVs and transportation for displacement. The identification of these environmental liabilities occurs only after the entry of a request to open a process to regularize some activity of the requesting entrepreneur within a rural property.

Only after the prior analysis of the documentation and opening of the process will there be a diagnosis of the project to identify these liabilities, provided that, in the opening of this request, there is as a criterion the detection of irregular areas and zones. With this detection, the entrepreneur is obliged to carry out the appropriate measures so that the environmental liabilities are regularized.

It is a passive, retrograde and slow logic of environmental monitoring. The result of this is the ineffectiveness of public environmental agencies in carrying out adequate maintenance of ecological zones that need attention, conservation, regeneration and preservation. Environmental regularization and preservation of the environment depends on the denunciation or self-denunciation of an environmental activity. Meanwhile, the irregular suppression of vegetation, especially riparian forests, progresses exponentially to the benefit of the passive and linear detection of these irregularities by the competent bodies.

With the amendment of the forest code by Law No. 12,727/2012, there were concerns about the flexibility of the protection of water resources, which made the active role of society in terms of environmental surveillance even more relevant (Brasil, 2012; Silva *et al.*, 2010). Environmental inspection can be decentralized and collaborative, especially in these cases in which official agencies demonstrate slowness or passivity in the face of projects that are awaiting licensing.

Remote sensing creates a virtual and organic environment between different people, who carry out different research and activities, from the creation of cartographic products and distribution of this information. In an ideal world, this information, in the form of cartographic

products or shapefiles or rasters for example, could be shared in a large public database that would be continuously fostered by the users themselves.

This would reduce the time of analysis and data collection for different users of geoprocessing. In addition, in this scenario, there would be more and more recent and updated data for different objectives, integrating a virtual ecosystem that constantly seeks to map reality through optical sensors installed in drones or satellites. The possibility of cross-referencing public data, such as those from the IBGE (SIDRA and Environmental Economic Accounts), with satellite images, allows for an integrated analysis of the pressure on natural resources, especially in areas of agricultural and livestock expansion (Ana, 2022; Rivero *et al.*, 2009).

Who, in principle, identifies the first environmental liabilities, are the consultancies or private analysts who carry out a prior analysis under criteria established by legislation, of the activities of their clients. With the information in hand, it is already possible to prepare a regularization strategy to be presented to the environmental agency.

Regularizations will only occur if, after prior analysis, the entrepreneur decides to continue with the administrative process to acquire his desired authorization, under the condition of regularizing his liabilities. The initiative to unify all these geoprocessing agents in a single virtual environment for sharing and cross-referencing data is reserved for public agencies, thus increasing the contact between public and private agents and increasing the amount of tax.

The data obtained can subsidize environmental regularization actions via the Rural Environmental Registry (CAR) and Environmental Recovery Programs (PRA), contributing to territorial planning and the conservation of water resources.

5 CONCLUSION

The present work demonstrated the relevance of the use of geotechnologies, especially remote sensing for the evaluation of Permanent Preservation Areas (PPAs) in the Meia Ponte River Basin downstream of the SANEAGO Raw Water Pumping Station in Goiânia.

The analysis of the images from the Landsat and Sentinel-2 satellites made it possible to accurately map the river's tributaries and identify the presence and absence of vegetation contiguous to the springs, within the legally protected strips. The identification of the vegetation was possible through the classification of the image by NDVI index, highlighting the pixels that were contemplated by the class linked to a dense vegetation.

Sentinel-2 was able to be more accurate in identifying vegetation throughout the APP zone of the watershed using the same classification criteria. Through the development of a simple and efficient methodology, using data from public databases as its main resources, any user of open source GIS is able to replicate the procedures for identifying vegetation around APPs in other watersheds. This study reinforces the need for more effective and integrated public policies that encourage the restoration of native vegetation and promote the sustainable management of water resources.

ACKNOWLEDGMENTS

I thank, above all, Olorum, who allowed the necessary enlightenment for me to see the entire trajectory until I could reach this moment. For having given me strength when there was nowhere else to sustain myself. For having taught me to have love in every action applied to this world.

I thank all those I love in the bottom of my heart, especially my parents Anegleyce Teodoro Rodrigues and Jefferson Luiz Clemente de Oliveira, who offered me all the material, emotional and mental resources to make my graduation a reality.

I thank the Terreiro Casa Espírita Anjo Ismael, which offered me the hope, strength and faith necessary to sustain this journey, through love.

I thank all those who, throughout my career, helped me, supported me and motivated me in some way throughout my graduation and the construction of my TCC.

I also thank Leonardo de Campos Lopes for being my tutor in order to transform me into the professional I am today and for having introduced me to the entire universe of my area of expertise.

REFERENCES

- Alencar, E. (2024). Histórias do mangue da Guanabara. Instituto Mar Urbano.
- Alongi, D. M. (2014). Carbon cycling and storage in mangrove forests. *Annual Review of Marine Science*, 6, 195–219. <https://doi.org/10.1146/annurev-marine-010213-135020>
- Bitencourt, M. D., et al. (1997). Identificação de fisionomias de cerrado com imagem índice de vegetação. In *Anais do 3º Congresso de Ecologia do Brasil* (pp. ?–?). Universidade de Brasília.
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (2012a). Lei nº 12.651, de 25 de maio de 2012. Dispõe sobre a proteção da vegetação nativa. *Diário Oficial da União*. http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm

- Brasil. (2012b). Lei nº 12.727, de 17 de outubro de 2012. Altera a Lei nº 12.651, de 25 de maio de 2012, que dispõe sobre a proteção da vegetação nativa. Diário Oficial da União.
- Brasil. Agência Nacional de Águas e Saneamento Básico. (2022). Contas econômicas ambientais da água no Brasil: Uso da água na agricultura de sequeiro e irrigada (Boletim do SNIRH, n. 3).
- Brasil. Ministério do Meio Ambiente. (2023). Plano de Ação para Prevenção e Controle do Desmatamento e das Queimadas no Bioma Cerrado — PPCerrado.
- Campos, M. de, et al. (2015). Geoprocessamento aplicado no conflito do uso do solo em Áreas de Preservação Permanente na microbacia do Córrego Três Barras – Botucatu (SP). *Energia na Agricultura*, 30(4), 378–382.
- Carvalho, I. A. de. (2019). O papel das matas ciliares na conservação do solo e água. *Biodiversidade*, 3(18), 171–179.
- Copernicus. (2020). Sentinel-2 – Documentation. <https://documentation.dataspace.copernicus.eu/Data/SentinelMissions/Sentinel2.html#sentinel-2-level-2a-top-of-canopy-toc>
- Crestana, S., Reichardt, K., & Silva, W. L. C. (1993). Atributos físicos de solos com diferentes culturas sob rotação e sob monocultura. *Revista Brasileira de Ciência do Solo*, 17(1), 71–77.
- Cubas, M. G., & Taveira, B. D. de A. (2020). Geoprocessamento: Fundamentos e técnicas. Intersaberes.
- Ferreira, N. C. de F., et al. (2019). O papel das matas ciliares na conservação do solo e água. *Biodiversidade*, 3(18), 171–179.
- Fitz, P. R. (2008). Geoprocessamento sem complicação. Oficina de Textos.
- Hollanda, M. P., Campanharo, W. A., & Cecílio, R. A. (2012). Manejo de bacias hidrográficas e a gestão sustentável dos recursos naturais. In D. M. Lima et al. (Orgs.), *Atualidades em desenvolvimento sustentável* (Vol. 1, pp. 57–66). Suprema Gráfica e Editora Ltda.
- Lima, G. S. A. de, Ferreira, N. C., & Ferreira, M. E. (2018). Modelagem da perda superficial de solo para cenários de agricultura e pastagem na Região Metropolitana de Goiânia. *Revista Brasileira de Cartografia*, 70(4), 1510–1536.
- Lima, W. P., & Zakia, M. J. B. (2000). *Função hidrológica da vegetação florestal* (2a ed.). EdUSP.
- Liu, W. T. L. (2006). Aplicações de sensoriamento remoto. Ed. UNIDERP.
- Maxwell, A. E., Warner, T. A., & Fang, F. (2018). Implementation of machine-learning classification in remote sensing: An applied review. *International Journal of Remote Sensing*, 39(9), 2784–2817.
- Miranda, R. A. C., Oliveira, M. V. S., & Silva, D. F. (2010). Ciclo hidrológico planetário: Abordagens e conceitos. *Geo UERJ*, 1(21), 109–123.
- Nepomuceno, P. L. M. (2012). Diagnóstico de áreas de preservação permanente com utilização de técnicas de sensoriamento remoto e SIG: Estudo de caso Bacia Hidrográfica do Ribeirão Gómeral [Monografia de especialização, Universidade Federal do Paraná].
- Novaes, R. D. (2022). Avaliação das áreas de preservação permanente – APPs presentes nos cursos d’água e nas nascentes da bacia de captação do rio Meia Ponte – BCRMP,

Estado de Goiás [Dissertação de mestrado, Universidade Estadual de Goiás].

Oliveira, A. K. M., & Pirajá, R. V. (2022). Análise multitemporal da cobertura vegetal na Bacia Hidrográfica do Córrego Ceroula, Mato Grosso do Sul. *Interações*, 23(4), 997–1011.

Rivero, S., et al. (2009). Pecuária e desmatamento: Uma análise das principais causas diretas do desmatamento na Amazônia. *Nova Economia*, 19(1), 41–66.

Santana, D. P. (2003). Manejo integrado de bacias hidrográficas (Documentos, 30). Embrapa Milho e Sorgo.

Santos, J. R. dos, et al. (2014). Avaliação da adequação da ocupação do solo em Áreas de Preservação Permanente (APPs). *Revista Irriga*, 19(2), 333–344.

Silva, J. M. C., et al. (2010). Impactos potenciais das alterações do Código Florestal nos recursos hídricos. *Biota Neotropica*, 10(4), 45–50.

Silveira, A. L. L. (1993). Ciclo hidrológico e bacia hidrográfica. In C. E. M. Tucci (Org.), *Hidrologia - Ciência e aplicação* (pp. ?–?). ABRH: EDUSP.

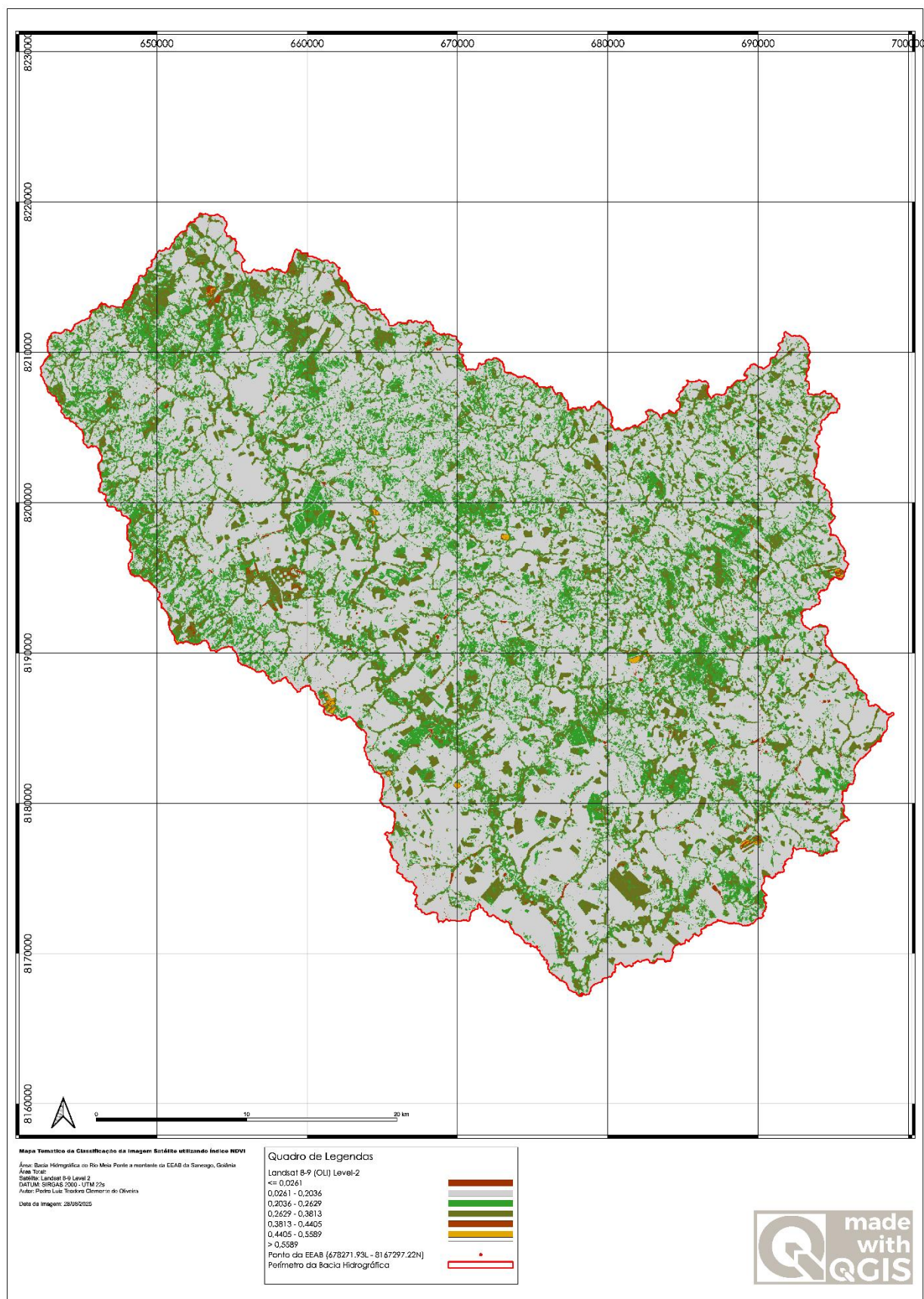
Tagliari, P. D., & Baptista, G. M. de M. (2020). Monitoramento de áreas de preservação permanente (APP) interceptadas pela Ferrovia Norte-Sul em um trecho do estado de Goiás/Brasil por meio de dados de sensoriamento remoto. *Revista Brasileira de Geomática – RBGeo*, 8(3), 181–201.

United States Geological Survey. (2025). Landsat Satellite Missions. <https://www.usgs.gov/landsat-missions/landsat-satellite-missions>

Wiens, J., et al. (2009). Selecting and conserving lands for biodiversity: The role of remote sensing. *Remote Sensing of Environment*, 113, 1370–1381.

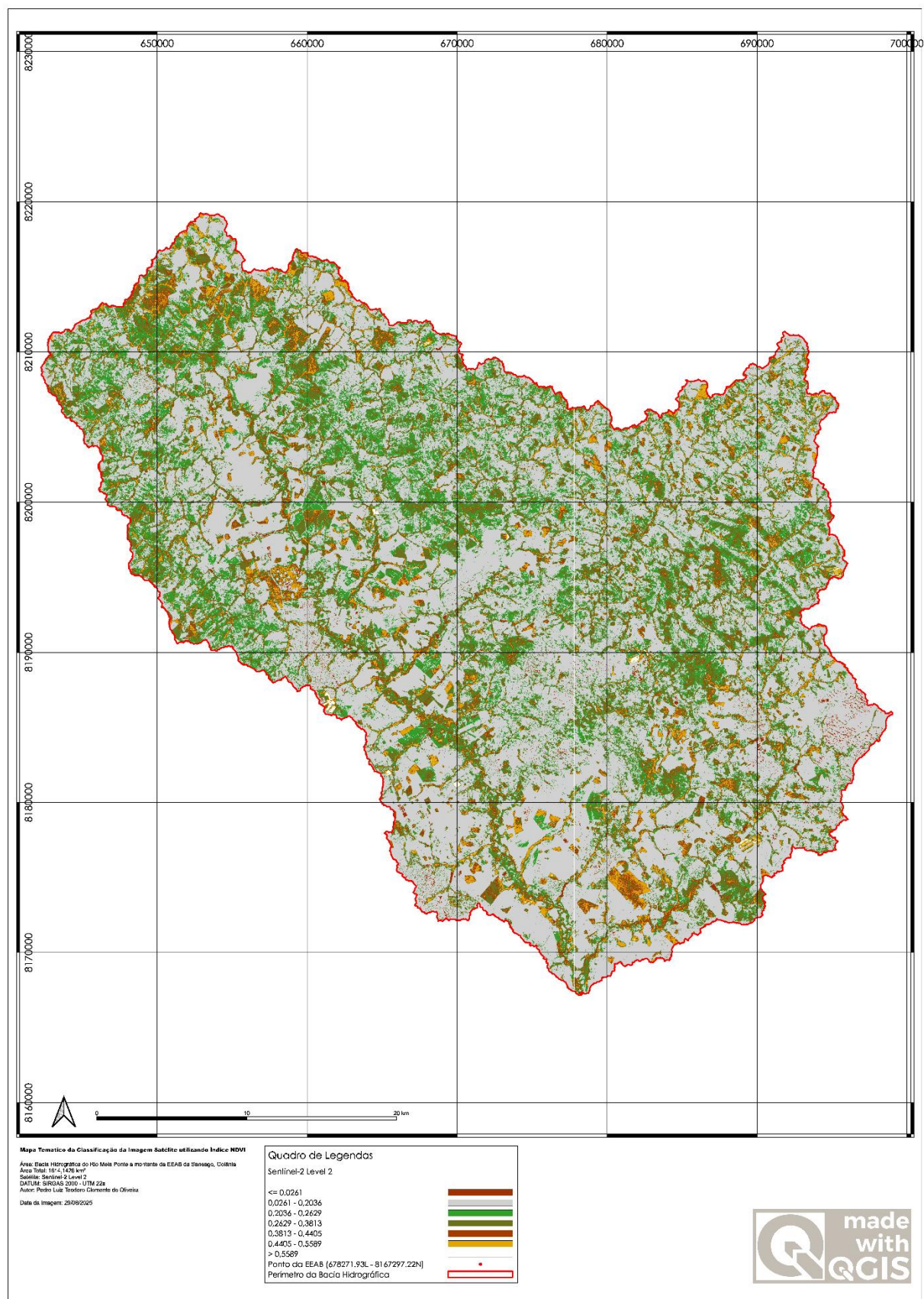
APPENDIX

Figure 3



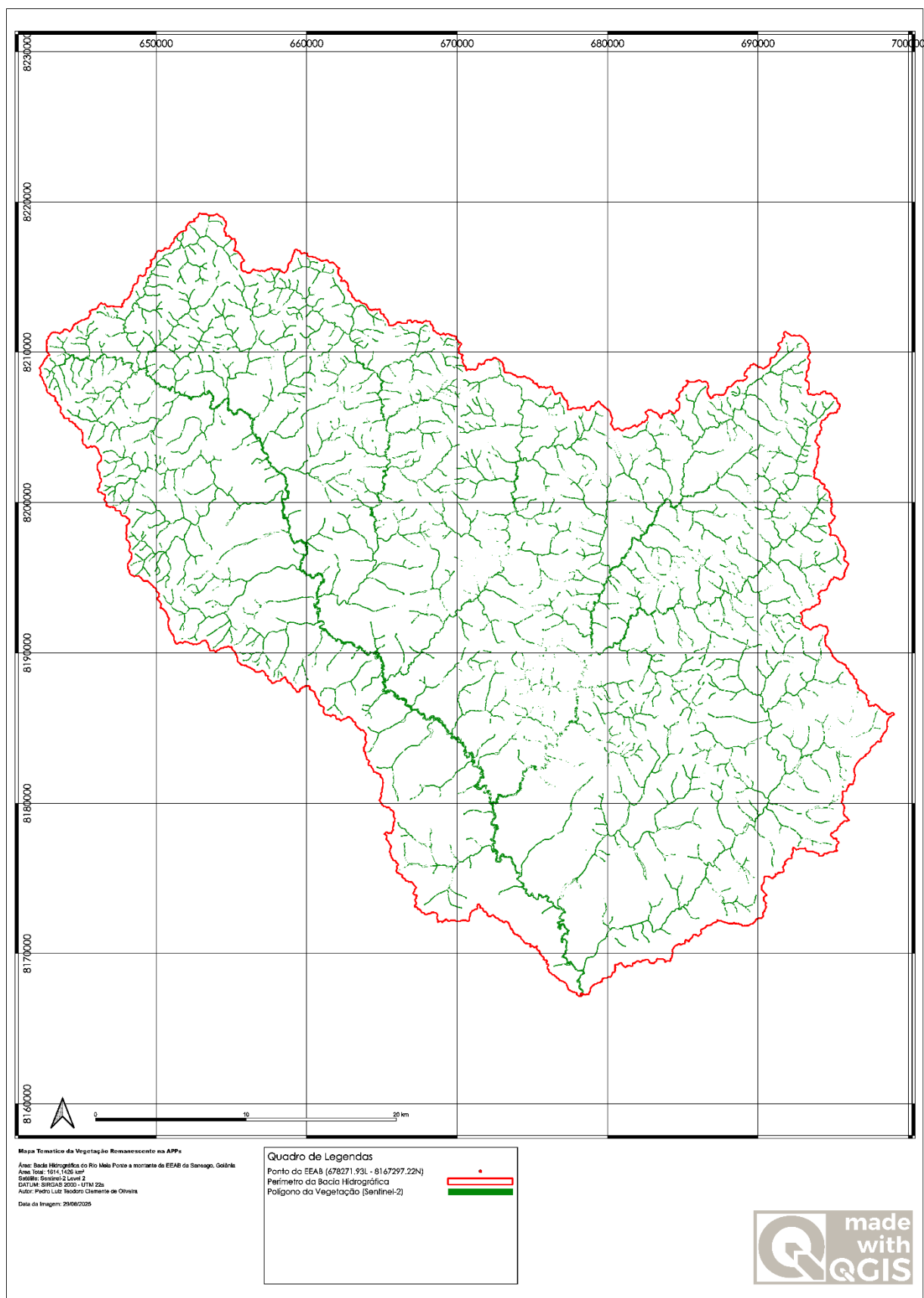
Source: Authors.

Figure 4



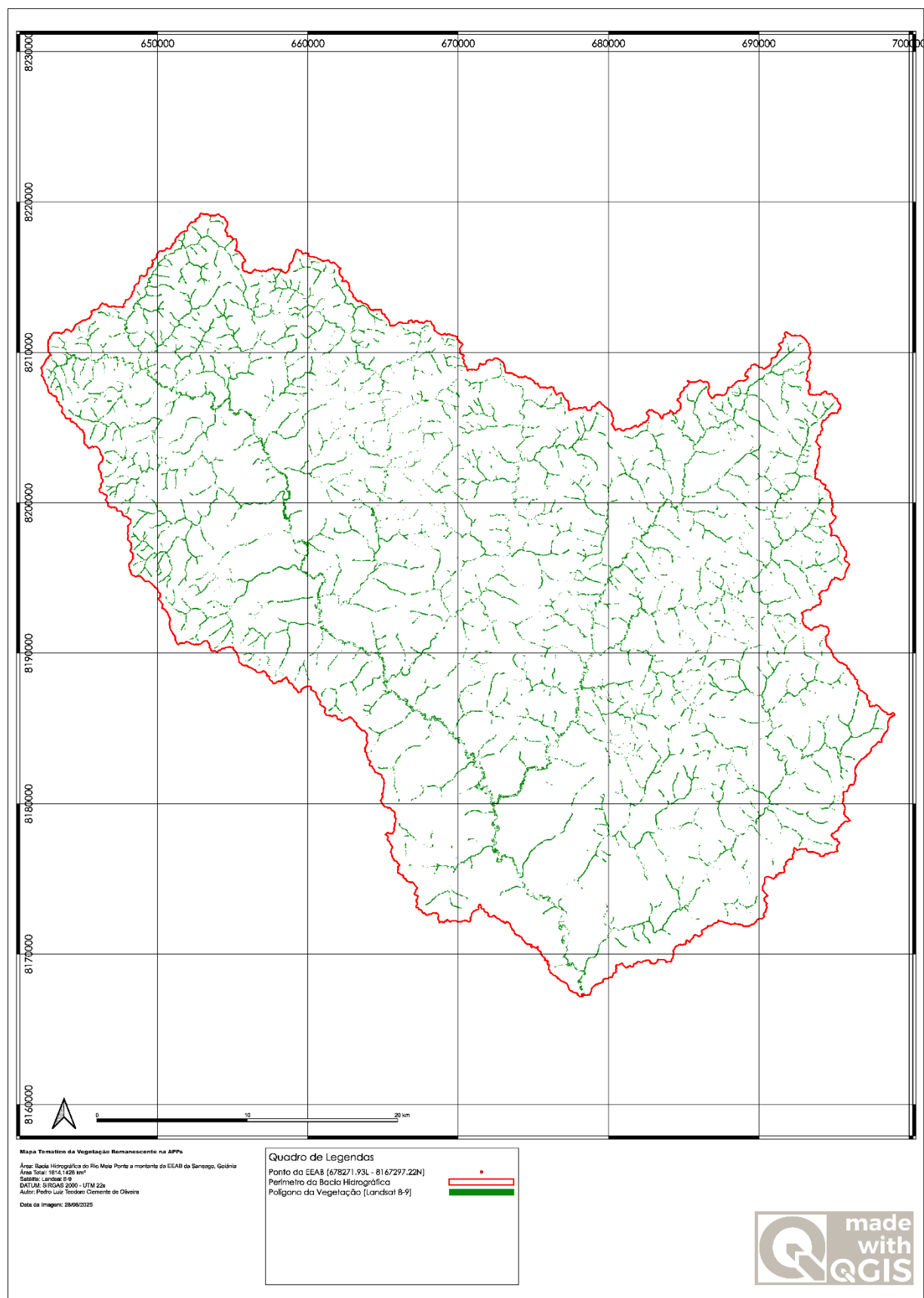
Source: Authors.

Figure 5



Source: Authors.

Figure 6



Source: Authors.

MAPPING AND IDENTIFICATION OF IRREGULAR SOLID WASTE DISPOSAL SITES IN THE URBAN AREA OF CHAPADINHA, MARANHÃO

MAPEAMENTO E IDENTIFICAÇÃO DE PONTOS DE DESCARTE IRREGULAR DE RESÍDUOS SÓLIDOS NA ÁREA URBANA DE CHAPADINHA - MA

MAPEO E IDENTIFICACIÓN DE PUNTOS DE DISPOSICIÓN IRREGULAR DE RESIDUOS SÓLIDOS EN EL ÁREA URBANA DE CHAPADINHA – MA



<https://doi.org/10.56238/sevened2026.008-073>

Francisca Vanessa de Carvalho Lima¹, Adrielle Samara de Castro Bezerra², Jayna Dannice Borges do Nascimento³, Jobson Costa Sousa⁴, Cláudio Gonçalves da Silva⁵

ABSTRACT

This study aimed to map and identify sites of irregular solid waste disposal in the urban area of Chapadinha (Maranhão, Brazil), characterizing their spatial distribution and associated socio-environmental risks. A descriptive and exploratory approach was adopted, involving on-site observations, photographic records, georeferencing, and informal conversations with residents. Eleven critical points were identified, predominantly composed of household waste, plastics, organic material, and construction debris, typically deposited over exposed soil and vegetation. Investigation of the municipal open dump revealed inadequate waste management practices, including open burning, worker exposure without Personal Protective Equipment, and uncontrolled leachate formation. The findings demonstrate significant public health impacts, such as vectors proliferation, environmental contamination, and greenhouse gas emissions. The study offers evidence to support environmental management policies and environmental education initiatives in the municipality.

Keywords: Solid Waste. Disposal. Environment. Public Health. Maranhão.

RESUMO

Este estudo teve como objetivo mapear e identificar pontos de descarte irregular de resíduos sólidos na área urbana de Chapadinha (MA), caracterizando sua distribuição espacial e os riscos socioambientais associados. A pesquisa adotou abordagem descritiva e exploratória, com observações in loco, registro fotográfico, georreferenciamento e conversas informais com moradores. Foram identificados 11 pontos críticos, com predominância de resíduos domésticos, plásticos, orgânicos e restos de construção civil, geralmente depositados sobre

¹ Undergraduate student in Biological Sciences. Universidade Federal do Maranhão.

E-mail: vanessacarvalhojev@gmail.com

² Graduated in Biological Sciences. Universidade Federal do Maranhão. E-mail: dryellybezerra9@gmail.com

³ Graduated in Biological Sciences. Graduated in Pedagogy. Universidade Federal do Maranhão. Faculdade do Baixo Parnaíba. E-mail: jaynanascimento24@gmail.com

⁴ Undergraduate student in Biological Sciences. Universidade Federal do Maranhão.

E-mail: jobsoncsouza@gmail.com

⁵ Dr. in Entomology. Universidade Federal do Maranhão. Centro de Ciências de Chapadinha.

E-mail: claudio.goncalves@ufma.br

solo exposto e vegetação. A investigação no lixão municipal revelou manejo inadequado, incluindo queima a céu aberto, exposição de trabalhadores sem Equipamentos de Proteção Individual e formação de chorume sem contenção. Os resultados evidenciam impactos sobre a saúde pública, como atração de vetores, contaminação ambiental e emissão de gases de efeito estufa. O estudo fornece subsídios para políticas de gestão ambiental e ações de educação ambiental no município.

Palavras-chave: Resíduos Sólidos. Descarte. Meio Ambiente. Saúde Pública. Maranhão.

RESUMEN

Este estudio tuvo como objetivo mapear e identificar puntos de disposición irregular de residuos sólidos en el área urbana de Chapadinha (MA), caracterizando su distribución espacial y los riesgos socioambientales asociados. La investigación adoptó un enfoque descriptivo y exploratorio, con observaciones in situ, registros fotográficos, georreferenciación y conversaciones informales con los residentes. Se identificaron once puntos críticos, que contenían predominantemente residuos domésticos, plásticos, residuos orgánicos y escombros de construcción, generalmente depositados sobre suelo y vegetación expuestos. La investigación en el vertedero municipal reveló una gestión inadecuada, incluyendo la quema a cielo abierto, la exposición de trabajadores sin equipo de protección individual (EPI) y la formación de lixiviados sin contención. Los resultados destacan los impactos en la salud pública, como la atracción de vectores, la contaminación ambiental y la emisión de gases de efecto invernadero. El estudio respalda las políticas de gestión ambiental y las acciones de educación ambiental en el municipio.

Palabras clave: Resíduos Sólidos. Disposición. Medio Ambiente. Salud Pública. Maranhão.

1 INTRODUCTION

Social, economic, political, cultural, technological, and educational transformations have reconfigured the modes of interaction and communication processes, requiring continuous adjustments in personal and professional activities (Toebe, 2016). In the educational field, these changes have a direct impact on the organization of formal education, which also needs to adapt to new rhythms, demands and forms of knowledge circulation.

We live in a context marked by the acceleration of time, the fluidity of relationships and the need for constant adaptation, characteristics of liquid modernity (Bauman, 2001). In this scenario, time management becomes a daily challenge, as the fast pace does not necessarily correspond to the meaning or predictability of actions, producing a feeling of emptiness and discontinuity (Skliar, 2014). Contemporary society, guided by agility and efficiency, demands fast, accessible practices with often reduced social interaction, reinforcing the centrality of digital technologies in this process of rearrangement of human and professional relations (Bauman, 2001).

The COVID-19 pandemic in 2020 intensified this scenario of uncertainties and transformations. The social distancing measures adopted globally to contain the spread of the virus have required abrupt adaptations in the world of work, in daily life, and especially in the university environment (Monteiro, 2020). The impact of the pandemic was broad and deep, affecting economic, social, and emotional dimensions of the population, with worsening inequalities and interruption of essential activities, including education.

In the educational sphere, higher education institutions needed to quickly restructure their practices to ensure the continuity of academic activities. The adoption of Emergency Remote Learning (ERE) has become the main strategy to mitigate the gaps generated by the suspension of face-to-face classes, imposing significant challenges on university networks across the country (Arruda, 2020). The regulation of this model, through CNE/CP Opinion No. 5, of April 28, 2020 (Brasil, 2020), guided the pedagogical reorganization during the isolation period, emphasizing the need to understand its impacts on student learning and training.

In this context of social transformations and reconfigurations in urban daily life, environmental issues, such as the inadequate disposal of solid waste, become even more critical. The identification and mapping of irregular disposal points are essential to subsidize public policies, guide environmental management actions and promote improvements in the quality of life of the population.

Thus, the objective of this study was to map and identify the points of inadequate disposal of solid waste in the urban area of Chapadinha, Maranhão, aiming to characterize

the current situation and provide subsidies for environmental management strategies in the municipality.

2 METHODS

The research was developed based on descriptive and exploratory procedures, adopting a qualitative and quantitative approach. Initially, a literature review was carried out in scientific articles, books and institutional documents related to solid waste disposal, urban environmental management and socio-environmental impacts.

2.1 AREA OF STUDY AND OBSERVATION SCRIPT:

The collection of empirical data took place at different points in the urban area of Chapadinha (MA), selected for presenting a history or evidence of irregular waste disposal. The observation route included:

- ✓ area of the cemetery in the Boa Vista neighborhood;
- ✓ surroundings of the Parque Universitário condominium;
- ✓ region near the water tank in the Mutirão neighborhood;
- ✓ dirt road located at the back of the Esplanade neighborhood;
- ✓ Gustavo Barbosa Avenue (Downtown);
- ✓ internal roads in the Vila Isamara, Liberdade and Vila Brasil neighborhoods.

These locations were chosen to allow the identification of the spatial distribution, the composition of the waste and the disposal methods adopted by the population, as well as to assess the associated socio-environmental risks.

2.2 FIELD PROCEDURES:

On-site visits were carried out, during which images were recorded using a cell phone with a high-resolution camera. The direct observation was complemented by informal conversations with residents of the investigated areas, in order to understand the local dynamics of disposal, community perception and the periodicity of waste disposal.

2.3 OBSERVATION IN THE MUNICIPAL DUMP:

In addition to the scattered points of irregular disposal, a technical visit was made to the municipal open-air dump, the final destination of the waste collected by the Municipal Department of Infrastructure and Public Cleaning. The area is surrounded by vegetation and presented two relevant conditions:

1. Reduction in the area occupied by the dump: It was found that the space previously used was significantly larger. The reduction in area occurred through the process of deep scraping of the soil with heavy machinery, removing vegetation and waste simultaneously. This procedure left extensive portions of soil exposed, with signs of erosion and absence of any environmental mitigation or recovery action.
2. Working conditions and waste management: It was observed the presence of workers manually separating PET bottles, which would later be sent to São Luís for recycling. The remaining waste, including non-recycled, organic, and mixed plastics, remained on site for open incineration. None of the workers used Personal Protective Equipment (PPE), such as respiratory masks, gloves, overalls or closed shoes, being exposed to physical, chemical and biological risks.

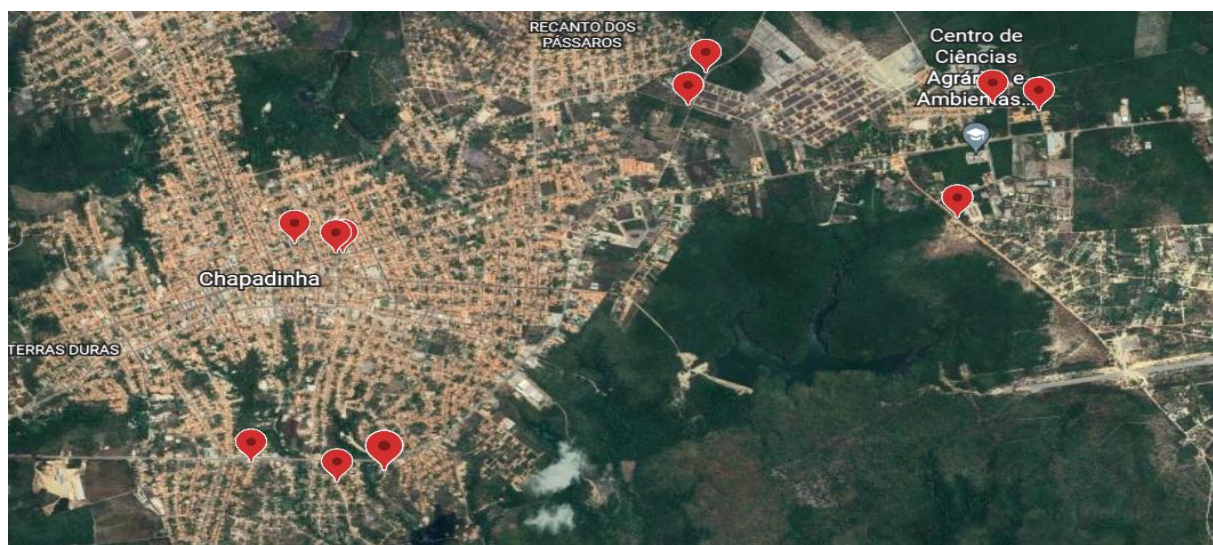
3 DEVELOPMENT

Through on-site visits, 11 points of irregular disposal of solid waste were recorded in the urban perimeter of the municipality of Chapadinha - MA and, with the collection of the coordinates of the locations, it was possible to generate a map with their spatial distribution (Figure 1).

We can highlight that solid waste in the study period was collected in this municipality only in urban areas, in addition, public garbage cans are insufficient in the main streets of the city (some were destroyed by vandals) and in more remote areas they are non-existent. Also in this scenario, we can highlight the lack of awareness on the part of residents, who in many situations deposit their waste inappropriately, especially in vacant lots.

Figure 1

Places of irregular disposal of solid waste in the urban perimeter of Chapadinha - MA



Source: Google Earth, 2022.

Due to this habit of a significant part of the population, this environment becomes an attractive source for several groups of animals which can vector a wide range of diseases, especially to the residents of the vicinity, making it not only an environmental problem but also involving several issues for public health programs.

In the sites investigated in the urban area of Chapadinha (Figure 2), there was a predominance of domestic waste, with a strong presence of plastics and organic materials, accompanied by civil construction and textile waste. The frequent disposal of these materials directly on vegetation and exposed soil highlights a vulnerable environmental scenario, in which natural processes of decomposition and interaction with the physical environment can amplify relevant health risks.

Figure 2

Garbage distribution in different locations in the municipality of Chapadinha – MA



Locations checked: a. In front of the cemetery in the UFMA area; b. In front of the University Condominium in the University Park; c. Next to the Water Tank in the Mutirão; d. 3 Different Garbage Points on the Dirt Road at the Bottom of the Esplanade Neighborhood; e. Garbage piled up on a public road at Av. Gustavo Barbosa; f. Garbage Accumulated in the Back of a Residence in the Liberdade Neighborhood Where Collection Does Not Occur. Source: Francisca Lima (2022)

The report of the Municipal Plan for Basic Sanitation of Chapadinha (PMSB, 2015) already pointed out that the municipality generated, at the time, approximately one thousand tons of waste per month, a number that did not include waste produced in rural areas, still devoid of systematic collection. From the observations made in this study, it was found that, in different urban areas and in the municipal dump, the reduction of the volume of waste usually occurs through the practice of direct burning. This procedure releases large amounts of greenhouse gases, especially carbon dioxide and methane, the latter up to twenty-eight times more potent than CO₂ in its global warming potential.

The scientific literature shows that the increase of these gases in the atmosphere is associated with multiple impacts on human health, such as increased extreme temperatures, intensification of severe weather events, and worsening of respiratory diseases. The WHO estimates that between 7 and 8 million people die annually as a result of air pollution (WHO, 2021), with children, the elderly, and people with previous clinical conditions being the most vulnerable groups. Climate change also has repercussions on the ecological balance, influencing vector population dynamics and expanding the distribution of diseases such as dengue, malaria and leishmaniasis, which find favorable conditions for proliferation in scenarios of intense heat and irregular rainfall.

Another critical element related to waste management is leachate, a highly concentrated liquid that is formed from the decomposition of the organic fraction. The absence of adequate containment and waterproofing systems allows its infiltration into the soil, increasing the risk of contamination of surface layers and groundwater. According to Costa (2021), leachate can carry heavy metals, toxic compounds, protozoa, and parasite eggs, posing a significant threat to human health. Exposure can occur both by consuming water from contaminated aquifers and by eating food grown in affected soils.

Thus, the observed results indicate that the interaction between solid waste, soil, water and atmosphere constitutes a central axis for the understanding of environmental and sanitary impacts in the municipality. The characterization of these processes is essential to support actions aimed at minimizing risks, promoting healthier urban environments, and strengthening preventive strategies based on scientific evidence.

4 FINAL CONSIDERATIONS

The mapping and identification of irregular solid waste disposal points in the urban area of Chapadinha showed a multifaceted scenario, in which environmental, social and public health factors are intertwined. The analysis of the visited sites revealed that the inadequate disposal of waste predominantly of domestic origin, but also composed of civil construction materials and textiles, occurs recurrently on exposed soil and vegetation, favoring environmental degradation processes and increasing the potential for health risks.

The observations carried out demonstrate that the current management of waste, both at the points distributed throughout the city and at the municipal dump, favors the release of greenhouse gases, the formation of leachate and human exposure to vectors and harmful substances. Such elements, widely documented in the scientific literature, contribute to the worsening of air pollution, soil and groundwater contamination, and increased vulnerability of the most sensitive populations, such as children, the elderly, and people with preexisting clinical conditions.

The results of this study reinforce the understanding that solid waste management is an essential component of environmental health and should be treated as a strategic axis for the promotion of quality of life in urban environments. The detailed characterization of the points of irregular disposal allows subsidizing more effective actions of planning, inspection, environmental education and territorial planning, in addition to guiding public policies aimed at mitigating the socio-environmental impacts identified.

Although this work does not propose to exhaust the theme, its evidence contributes to a broader reading of the problem and points to the need for intersectoral approaches, based

on sustainable practices and continuous monitoring processes. The strengthening of adequate waste management strategies, combined with community participation and integration between educational institutions, civil society and public management, is a promising path for the construction of a more environmentally balanced and socially healthier city.

In summary, the findings presented reaffirm that the efficient management of solid waste is a contemporary challenge of great complexity, whose overcoming requires technical knowledge, environmental sensitivity and collective commitment. The present study seeks to contribute to this process by offering a detailed and grounded diagnosis, capable of supporting decisions and fostering transformative actions in the municipality of Chapadinha.

REFERENCES

- Arruda, E. P. (2020). Educação remota emergencial: Elementos para políticas públicas na educação brasileira em tempos de Covid-19. *Em Rede – Revista de Educação a Distância*, 7(1), 257–275.
- Bacich, L., & Moran, J. (Orgs.). (2018). *Metodologias ativas para uma educação inovadora: Uma abordagem teórico-prática*. Penso.
- Bauman, Z. (2001). *Modernidade Líquida* (P. Dentzien, Trad.). Jorge Zahar.
- Behar, P. A. (s.d.). O ensino remoto emergencial e a educação a distância. <https://www.ufrgs.br/coronavirus/base/artigo-o-ensino-remoto-emergencial-e-a-educacao-a-distancia/>
- Brasil. (2017). Base Nacional Comum Curricular (BNCC): Educação é a base. MEC/CONSED/UNDIME. <http://basenacionalcomum.mec.gov.br/abase/>
- Brasil. Conselho Nacional de Educação. (2017). Decreto nº 9.057, de 25 de maio de 2017. http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/decreto/d9057.htm
- Brasil. Ministério da Educação. Conselho Nacional de Educação. Conselho Pleno. (2020). Parecer CNE/CP nº 5, de 28 de abril de 2020. http://portal.mec.gov.br/index.php?option=com_docman&view=download&alias=145011-pcp005-20&category_slug=marco-2020-pdf&Itemid=30192
- Castells, M. (2003). *A galáxia da Internet: Reflexões sobre a Internet, os negócios e a sociedade*. Zahar.
- da Silva, C. C. S. C., & de Sousa Teixeira, C. M. (2020). O uso das tecnologias na educação: Os desafios frente à pandemia da COVID-19. *Brazilian Journal of Development*, 6(9), 70070–70079.
- DiMaggio, P., Hargittai, E., Celeste, C., & Shafer, S. (2003). *From unequal access to differentiated use: A literature review and agenda for research on digital inequality*. Russell Sage Foundation.

- Freire, P. (1996). *Pedagogia da autonomia: Saberes necessários à prática educativa*. Paz e Terra.
- Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. *EDUCAUSE Review*. <https://er.educause.edu/articles/2020/3/the-differencebetween-emergency-remote-teaching-and-online-learning>
- Junior, S. de A., Silva, M. M. da, Popolim, R. S., Gonçalves, C. R., Melo, M. R. S. de, & Bulgo, D. C. (2019). Dissemination of knowledge and scientific production in professionalizing courses: A report of experience. *PubSaúde*, 2, a008. <https://dx.doi.org/10.31533/pubsaude2.a008>
- Kenski, V. M., & Kenski, J. M. (2022). Planejamento didático no ensino superior em tempos de pandemia. *Roteiro*, 47, e30226. <https://doi.org/10.18593/r.v47.30226>
- Minayo, M. C. de S. (Org.). (2012). *Pesquisa social: Teoria, método e criatividade* (32ª ed.). Vozes.
- Monteiro, S. da S. (2020). (Re)inventar educação escolar no Brasil em tempos da Covid-19. *Revista Augustus*, 25(51), 237–254. <https://doi.org/10.15202/1981896.2020v25n51p237>
- Murphy, C., & Lick, D. W. (2005). *Whole-faculty study groups: Creating professional learning communities that target student learning*. Corwin Press.
- Rocha, C. B. (2023). Acesso à internet como direito fundamental e as políticas públicas de inclusão digital no Brasil (Trabalho de Conclusão de Curso). Universidade Federal de Goiás. <http://repositorio.bc.ufg.br/handle/ri/22619>
- Saccol, A., Schlemmer, E., & Barbosa, J. (2010). *M-learning e u-learning: Novas perspectivas da aprendizagem móvel e ubíqua*. Pearson.
- Skliar, C. (2014). *Desobedecer a linguagem: Educar* (G. Lessa, Trad.). Autêntica.
- Tardif, M. (2002). *Saberes docentes e formação profissional*. Vozes.
- Toebe, Í. C. D. (2016). *Políticas públicas para integração de tecnologias educacionais na formação inicial de professores* (Dissertação de mestrado). Universidade Federal de Santa Maria. <https://bit.ly/3kJRGmN>

THE IMPORTANCE OF EARLY DETECTION OF ANXIOUS AND DEPRESSIVE SYMPTOMS IN OLDER ADULTS IN PRIMARY HEALTH CARE

A IMPORTÂNCIA DA DETECÇÃO PRECOCE DE SINTOMAS ANSIOSOS E DEPRESSIVOS EM IDOSOS NA ATENÇÃO PRIMÁRIA À SAÚDE

LA IMPORTANCIA DE LA DETECCIÓN TEMPRANA DE SÍNTOMAS ANSIOSOS Y DEPRESIVOS EN PERSONAS MAYORES EN LA ATENCIÓN PRIMARIA DE SALUD



<https://doi.org/10.56238/sevened2026.008-074>

Rafaella Antunes Fiorotto de Abreu¹, Livia Cavalcante de Araújo², Ana Luiza Silva Teixeira³, Isabela Nunes Tavares⁴, Nyanne Deusdara Escobar⁵, Ianka Lustosa Resplande⁶, Marcela de Souza Sotto Mayor⁷, Maykon Jhuly Martins de Paiva⁸

ABSTRACT

Considering the accelerated aging of the Brazilian population and the impact of mental disorders on older adults' functionality and quality of life, early detection of anxious and depressive symptoms is essential in Primary Health Care. This study aimed to identify the prevalence of depressive symptoms among older adults assisted at a Primary Health Care Unit in Gurupi, Tocantins, Brazil, using the Geriatric Depression Scale (GDS). This is a cross-sectional, observational, quantitative study conducted with 24 older adults aged 65 to 84 years. Data were analyzed using descriptive and inferential statistics, adopting a 5% significance level. The overall prevalence of depressive symptoms was 45.8%, with a predominance of mild cases. No statistically significant associations were observed between sex or age and GDS scores. These findings reinforce the importance of standardized mental health screening tools in Primary Health Care to enable early identification and timely interventions. Systematic screening contributes to comprehensive care and prevention of disease progression.

Keywords: Older Adults. Depression. Anxiety. Primary Health Care. Early Diagnosis.

¹ Graduated in Medicine. Universidade de Gurupi (UnirG). E-mail: rafaella.fiorotto@hotmail.com
Orcid: <https://orcid.org/0000-0001-7206-7456>

² Specialist in Family and Community Medicine. Universidade de Gurupi (UnirG).
E-mail: livia.lca.cavalcante@gmail.com Orcid: <https://orcid.org/0000-0002-1325-1883>

³ Graduated in Medicine. Universidade de Gurupi (UnirG). E-mail: analuizateixeira0109@gmail.com
Orcid: <https://orcid.org/0009-0009-3827-8984>

⁴ Graduated in Medicine. Universidade de Rio Verde. E-mail: isabelatavares712@gmail.com
Orcid: <https://orcid.org/0000-0002-6339-6220>

⁵ Graduated in Medicine. Universidade de Gurupi (UnirG). E-mail: nayannedeusdara@gmail.com
Orcid: <https://orcid.org/0000-0003-3211-4451>

⁶ Graduated in Medicine. Universidade de Rio Verde. E-mail: aknai@hotmail.com
Orcid: <https://orcid.org/0009-0005-1558-0727>

⁷ Specialist in Family and Community Medicine. Universidade de Gurupi (UnirG).
E-mail: marcelassmayor@gmail.com Orcid: <https://orcid.org/0009-0002-9993-9095>

⁸ Dr. in Pharmaceutical Sciences. Universidade de Gurupi (UnirG). E-mail: maykonjhulyfm@gmail.com
Orcid: <https://orcid.org/0000-0002-6228-4550>

RESUMO

Considerando o envelhecimento acelerado da população brasileira e o impacto dos transtornos mentais na funcionalidade e qualidade de vida dos idosos, a detecção precoce de sintomas ansiosos e depressivos torna-se essencial na Atenção Primária à Saúde. Este estudo objetivou identificar a prevalência de sintomas depressivos em idosos atendidos em uma Unidade Básica de Saúde do município de Gurupi-TO, utilizando a Escala de Depressão Geriátrica (GDS). Trata-se de um estudo observacional, transversal e quantitativo, realizado com 24 idosos, com idades entre 65 e 84 anos, acompanhados pela Estratégia Saúde da Família. Os dados foram analisados por estatística descritiva e inferencial, adotando-se nível de significância de 5%. Observou-se prevalência global de sintomas depressivos de 45,8%, com predominância de quadros leves. Não foram identificadas associações estatisticamente significativas entre sexo ou idade e a pontuação na GDS. Os achados reforçam a importância da utilização de instrumentos padronizados na rotina da Atenção Primária, permitindo a identificação precoce de sintomas depressivos e o planejamento de intervenções oportunas. Conclui-se que o rastreamento sistemático da saúde mental do idoso contribui para a integralidade do cuidado e para a prevenção da progressão dos transtornos mentais.

Palavras-chave: Idoso. Depressão. Ansiedade. Atenção Primária à Saúde. Diagnóstico Precoce.

RESUMEN

Considerando el envejecimiento acelerado de la población brasileña y el impacto de los trastornos mentales en la funcionalidad y calidad de vida de las personas mayores, la detección temprana de síntomas ansiosos y depresivos es esencial en la Atención Primaria de Salud. Este estudio tuvo como objetivo identificar la prevalencia de síntomas depresivos en personas mayores atendidas en una Unidad Básica de Salud en Gurupi, Tocantins, Brasil, utilizando la Escala de Depresión Geriátrica (GDS). Se trata de un estudio observacional, transversal y cuantitativo realizado con 24 personas mayores de entre 65 y 84 años. Los datos se analizaron mediante estadística descriptiva e inferencial, con un nivel de significancia del 5%. La prevalencia global de síntomas depresivos fue del 45,8%, predominando los cuadros leves. No se observaron asociaciones estadísticamente significativas entre sexo o edad y la puntuación en la GDS. Los resultados refuerzan la importancia del cribado sistemático de la salud mental en la Atención Primaria para garantizar una atención integral y preventiva.

Palabras clave: Personas Mayores. Depresión. Ansiedad. Atención Primaria de Salud. Diagnóstico Precoz.

1 INTRODUCTION

Population aging is one of the main contemporary challenges for health systems, especially in developing countries. In Brazil, the growth of the elderly population has been accompanied by an increase in the prevalence of chronic non-communicable diseases and common mental disorders, such as anxiety and depression, which directly impact the functionality, autonomy, and quality of life of this population (IBGE, 2023; World Health Organization, 2021).

Depression in the elderly often presents atypical clinical manifestations, which can be confused with physiological changes of aging or with symptoms resulting from clinical comorbidities, which contributes to underdiagnosis, especially in the context of Primary Health Care. It is estimated that a significant portion of depressive conditions in the elderly are not identified early, delaying therapeutic interventions and increasing the risk of worsening the clinical condition (Aguilar *et al.*, 2022).

In this scenario, Primary Health Care assumes a strategic role in the early identification of mental health problems, as it is the main gateway for users to enter the Unified Health System. Multiprofessional action, combined with the use of standardized screening instruments, allows for a comprehensive and problem-solving approach to elderly care (Brasil, 2001).

Studies developed in the field of health care for the elderly emphasize the importance of integrated clinical strategies, which consider not only biological aspects, but also psychosocial, functional and medication-related factors. In this context, the relevance of pharmaceutical care and longitudinal clinical follow-up as fundamental components of comprehensive care for the elderly is highlighted (Faria; Paiva, 2021).

Therefore, the present study aimed to identify the prevalence of depressive symptoms in elderly people treated at a Basic Health Unit in the city of Gurupi-TO, using the Geriatric Depression Scale as a screening instrument.

2 THEORETICAL FRAMEWORK

2.1 MENTAL HEALTH OF THE ELDERLY IN PRIMARY HEALTH CARE

Primary Health Care is recognized as the most appropriate level of care for the early identification of mental disorders in the elderly, due to the longitudinal link established between health professionals, users and their families. Early detection of anxious and depressive symptoms allows for timely interventions, reducing hospitalizations, functional decline, and associated mortality (World Health Organization, 2021).

However, the approach to the mental health of the elderly still faces challenges, such as the limitation of time in consultations, the prioritization of physical complaints, and the stigma associated with mental disorders. These factors contribute to the underestimation of emotional symptoms, especially when they are mild or nonspecific (Cunha; Bastos; Duca, 2012).

The literature indicates that factors such as social isolation, affective losses, the presence of multiple comorbidities, and the use of multiple medications are strongly associated with the development of depressive symptoms in the elderly, reinforcing the need for a comprehensive and multiprofessional approach (Rosa; Lisbon; Tomaz, 2019).

2.2 SCREENING INSTRUMENTS AND COMPREHENSIVE CARE FOR THE ELDERLY

Among the instruments available for screening depression in the elderly, the Geriatric Depression Scale (GDS) stands out for its wide use, validity and ease of application in the context of Primary Care. Developed by Yesavage et al. (1983), the GDS has good sensitivity and specificity for the identification of depressive symptoms, including in mild cases.

The use of standardized instruments should be associated with integrated clinical strategies that consider the context of the elderly's life and promote longitudinal care. Studies on pharmaceutical health care for the elderly show that continuous clinical follow-up contributes to the identification of mental health problems, improved therapeutic adherence and reduction of negative outcomes related to the use of medications (Faria; Paiva, 2021).

In addition, recent experiences in the field of pharmaceutical services and primary care demonstrate that the qualification of health professionals and the adoption of evidence-based clinical practices are fundamental for facing complex situations, such as those experienced during the COVID-19 pandemic, reinforcing the importance of clinical reasoning and comprehensive care in vulnerable populations, including the elderly (Silva; Paiva, 2021).

Thus, the integration between systematic screening, multiprofessional action and longitudinal follow-up is an essential strategy for the promotion of mental health of the elderly in Primary Health Care.

3 METHODOLOGY

3.1 STUDY DESIGN

This is an observational, cross-sectional, quantitative study, developed within the scope of Primary Health Care. This design was chosen because it allows the estimation of the prevalence of depressive symptoms in a specific population, in a given period, in addition to allowing the exploratory analysis of associations between sociodemographic variables and

the scores obtained on the scale used.

3.2 PLACE OF STUDY

The study was carried out at the Pedroso Basic Health Unit (UBS Ulisses Moreira Milhomem), located in the municipality of Gurupi, state of Tocantins, Brazil. The UBS is part of the Family Health Strategy and serves the enrolled population mostly composed of elderly people with regular follow-up for chronic conditions, which makes it an appropriate setting for studies focused on the mental health of the elderly in Primary Care.

3.3 POPULATION AND SAMPLE

The study population consisted of elderly people treated at the UBS Pedroso, aged 60 years or older. The sample consisted of 24 elderly people, aged between 65 and 84 years, selected by convenience, according to spontaneous demand and attendance at consultations during the collection period.

The sample size reflects the operational characteristics of the service and the exploratory nature of the study, and is compatible with investigations carried out in Basic Health Units.

3.4 INCLUSION AND EXCLUSION CRITERIA

The following inclusion criteria were adopted:

- age 65 years or older;
- be under clinical follow-up at UBS Pedroso;
- present preserved cognitive conditions for understanding and responding to the instrument;
- voluntarily agree to participate in the study, by signing the Informed Consent Form (ICF).

The following were excluded from the study:

- elderly people under the age of 65;
- individuals with previously diagnosed severe cognitive impairment;
- patients who refused to participate or did not complete the application of the instrument;
- elderly people who were unable to respond to the scale due to clinical limitations at the time of collection.

3.5 DATA COLLECTION INSTRUMENT

Data collection was carried out using the Geriatric Depression Scale (GDS), a widely validated instrument used to screen for depressive symptoms in the elderly. The GDS is composed of dichotomous questions (yes/no), easy to understand, allowing quick and appropriate application to the context of Primary Health Care.

The total score of the scale was used to classify the participants into categories of normality, mild depression or severe depression, according to cutoff points described in the literature.

3.6 DATA COLLECTION PROCEDURES

Data collection took place from February to October 2025, during the routine care of the elderly at the UBS. Eligible participants were invited to participate in the study after clarification about the objectives, procedures, and ethical aspects of the research. The application of the GDS was carried out in a private environment, by a trained professional, ensuring comfort, confidentiality and minimization of possible embarrassment. Each application lasted an average of 5 to 15 minutes. The information was recorded anonymously, using numerical codes to identify the participants.

3.7 DATA ANALYSIS

The collected data were organized in an electronic spreadsheet and later analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 25.0. Initially, descriptive statistical analysis was performed, with calculation of means, standard deviations, absolute and relative frequencies.

For inferential analysis, the following were used:

- Student's t-test (or Welch's t-test) to compare means between groups;
- Fisher's exact test for analysis of associations between categorical variables;
- Spearman's correlation coefficient for evaluating the association between age and GDS score.

The significance level adopted was 5% ($p < 0.05$). Whenever relevant, 95% confidence intervals and effect size measures were calculated, aiming at a better interpretation of the results.

3.8 ETHICAL ASPECTS

The study was conducted in accordance with the ethical principles that govern

research involving human beings, according to Resolution No. 466/2012 of the National Health Council. The confidentiality of the information, the privacy of the participants and the right to withdraw at any time were ensured, without prejudice to the care at the health unit.

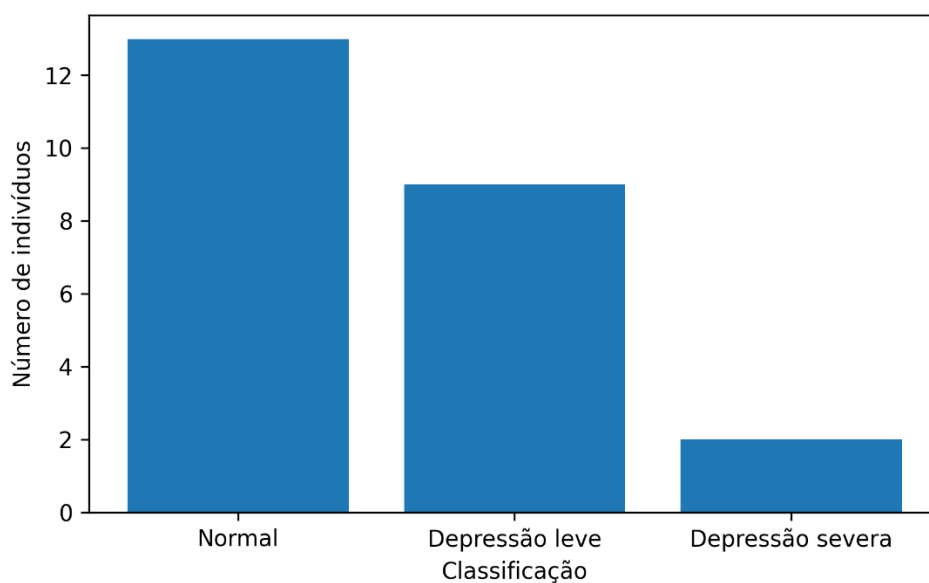
4 RESULTS AND DISCUSSIONS

The overall prevalence of depressive symptoms identified in this study was 45.8%, with a predominance of mild conditions, evidencing depression as a frequent and often silent condition among elderly people monitored in Primary Health Care. This finding reinforces the clinical and epidemiological relevance of the theme, since a significant portion of individuals present psychological distress that is potentially underdiagnosed in the context of routine care.

Figure 1 illustrates the distribution of the elderly according to the classification of the Geriatric Depression Scale (GDS), showing that 54.2% of the participants were classified within the normal range, while 37.5% had mild depression and 8.3% severe depression. The predominance of mild conditions is of special clinical importance, as it indicates a population in the initial stage of mental illness, in which early interventions can modify the course of the disease.

Figure 1

Distribution of the elderly according to the classification of the Geriatric Depression Scale (GDS) in individuals treated at the Pedroso Basic Health Unit, Gurupi-TO



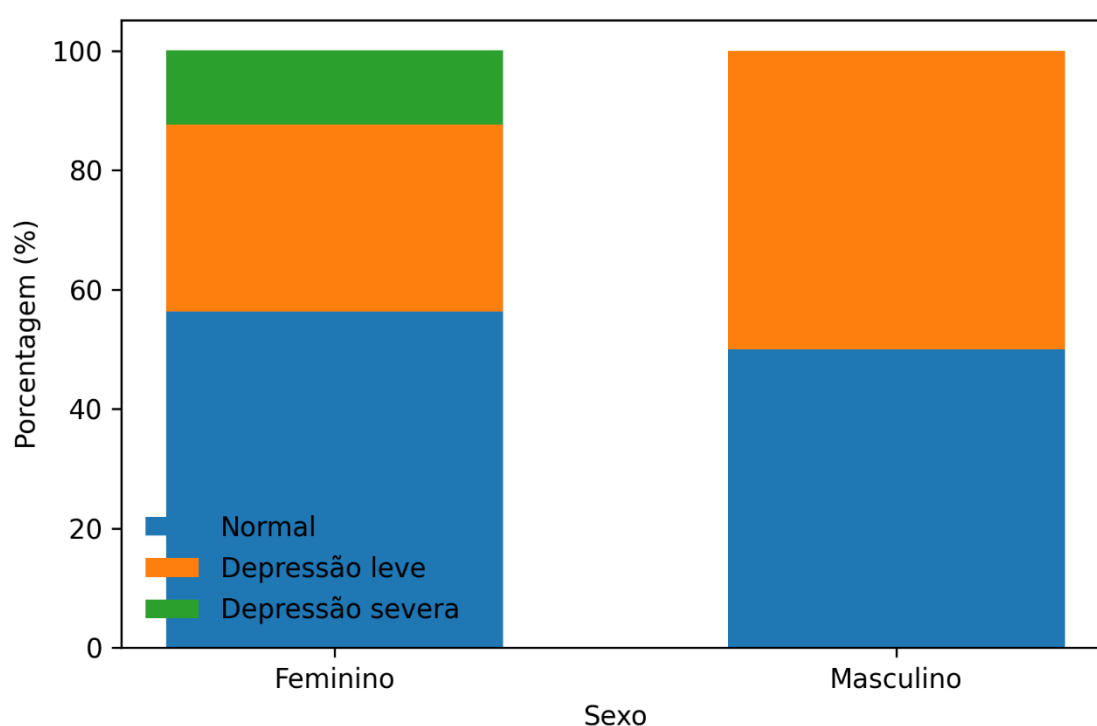
Source: Survey data (2026)

When the data were stratified by sex, it was observed that 50.0% of men had mild depression, while among women 56.3% had a score compatible with normality and 12.5%

were classified as having severe depression. Figure 2 shows the mean GDS score according to gender, with no statistically significant differences identified between men and women. These findings were confirmed by both *Welch's t-test* and the *Mann–Whitney test* ($p > 0.05$), with an effect size considered small (*Hedges' g* = 0.30), suggesting low practical relevance of this difference in the sample studied.

Figure 2

Percentage distribution of depression diagnoses according to gender in elderly people treated at the Pedroso Basic Health Unit, Gurupi-TO, according to the Geriatric Depression Scale (GDS)

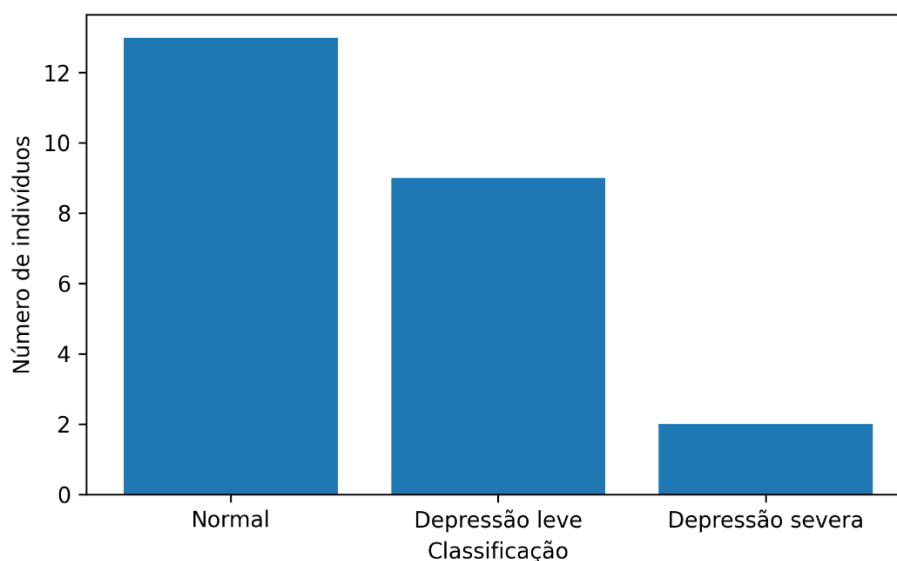


Source: Survey data (2026)

The analysis of the correlation between age and GDS score, performed using Spearman's coefficient, did not show a significant association ($\rho = 0.095$; $p = 0.66$), indicating that the intensity of depressive symptoms was not directly related to chronological age in the population evaluated. Figure 3 summarizes the mean GDS score according to gender, reinforcing the absence of relevant differences between the groups analyzed.

Figure 3

Mean score of the Geriatric Depression Scale (GDS) according to gender in elderly people treated at the Pedroso Basic Health Unit, Gurupi-TO



Source: Survey data (2026).

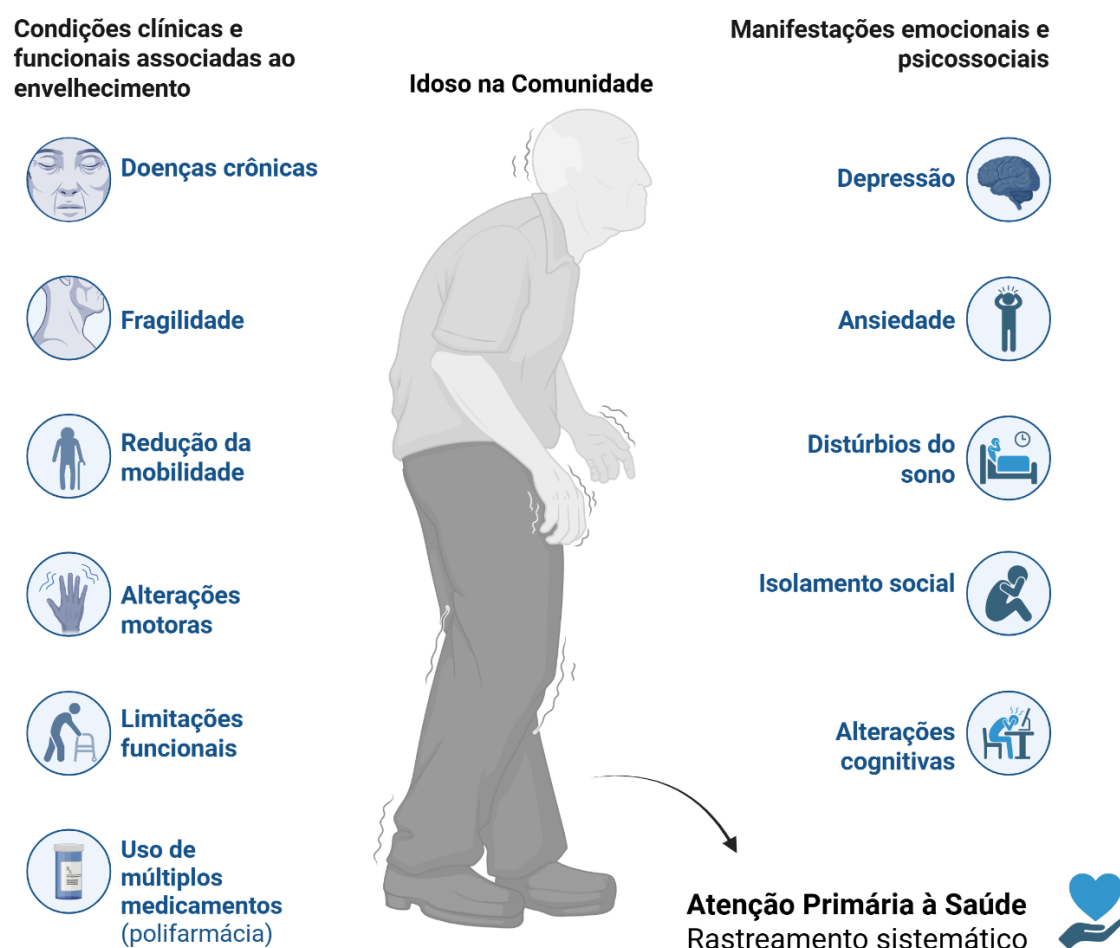
The prevalence of depressive symptoms, defined as a GDS score ≥ 6 , was 45.8% (95%CI: 27.9–64.9). Among women, the prevalence was 43.8% (95%CI: 23.1–66.8), while among men it was 50.0% (95%CI: 21.5–78.5). Fisher's exact test indicated no statistically significant association between gender and the presence of depressive symptoms ($p = 1.00$), with an odds ratio for depression in females of 0.78 (95%CI: 0.14–4.27).

A meta-analysis of epidemiological surveys estimated a global prevalence in the elderly at around 35.1%, evidencing the magnitude of the problem worldwide and emphasizing that versions and cut-off points of the Geriatric Depression Scale (GDS) significantly influence the estimates (Cai *et al.*, 2023). This variability reinforces the need to interpret the findings in the light of the instrument used and the clinical profile of the population served. The predominance of mild conditions observed in the UBS is clinically relevant because subclinical or mild symptoms are not "benign": there is robust evidence that subthreshold depression is associated with a higher risk of progression to major depression. A systematic review and longitudinal meta-analysis estimated that individuals with subthreshold depression have approximately twice the risk of developing major depression over the course of follow-up (Lee *et al.*, 2019). This finding supports the discussion that screening in PHC should not be limited to identifying only severe cases, as the window of opportunity for prevention and intervention occurs precisely in the initial stages. Figure 4 presents a conceptual model that integrates the main clinical and functional conditions associated with aging, as well as the emotional and psychosocial manifestations frequently

related to depression in community-dwelling older adults. The scheme highlights the central role of Primary Health Care as a strategic level for the systematic screening of these symptoms, considering that factors such as multimorbidity, frailty, functional limitations, and polypharmacy coexist with emotional manifestations, such as depression, anxiety, sleep disorders, social isolation, and cognitive changes. This integrated approach contributes to the understanding of the multifactorial character of depression in aging and reinforces the importance of standardized screening instruments in the routine of services, favoring early identification and the organization of adequate care flows for the comprehensive care of the elderly.

Figure 4

Conceptual representation of the clinical and functional conditions associated with aging and the emotional and psychosocial manifestations related to depression in the elderly in the community, highlighting the role of Primary Health Care in systematic screening



Source: Prepared by the authors. (2026)

In addition, depression in old age usually presents a distinct clinical expression, with a greater presence of somatic complaints, cognitive alterations and reduced interest, which can

make it difficult to recognize when care is based only on spontaneous demand (Fiske; Wetherell; Gatz, 2009). This characteristic helps to explain why, in practice, many cases go unnoticed and why screening instruments play a decisive role in the comprehensive care of the elderly.

In the present study, no statistically significant associations were observed between gender or age and the GDS score. This result is compatible with the contemporary understanding that determinants such as multimorbidity, social isolation, frailty, affective losses, low income, and access barriers may exert a greater weight on depressive symptoms than isolated demographic variables, especially in small samples and PHC services. International studies also show that the prevalence tends to be particularly high in contexts of greater clinical and social vulnerability; for example, a meta-analysis with multimorbid older adults found a prevalence close to 46.7%, a value very similar to that observed in this study, suggesting that disease burden and clinical complexity may "approximate" local prevalences to the highest estimates described in the literature (Pundhir *et al.*, 2025).

From the point of view of clinical practice and health policy, it is important to discuss underdiagnosis. Evidence indicates that depression is often under-recognized in adult and older populations, including in middle-income countries. A Brazilian population study pointed to high underdiagnosis, with a significant share of cases not recognized by services/professionals, associated with sociodemographic and access factors (Faisal-Cury *et al.*, 2022). Although its study is local and cross-sectional, the high prevalence of symptoms and the predominance of mild cases are consistent with this scenario: when structured screening is not used, the tendency is for the most subtle cases not to be identified early.

In this sense, the choice of GDS is technically defensible for PHC because it was designed to reduce the interference of common somatic symptoms in aging, favoring clinical applicability. Evidence shows that short versions of the GDS can help PHC teams identify older adults with clinically relevant symptoms, with adequate performance depending on the cutoff point and the version used (D'Ath *et al.*, 1994). In the Brazilian context, validity studies in primary care indicate good accuracy for versions such as GDS-15 at appropriate cut-off points, reinforcing the feasibility of screening at UBS (Castelo *et al.*, 2010). Thus, its findings strengthen the argument that structured screening is a feasible, low-cost, and potentially effective strategy to reduce clinical invisibility of depressive symptoms in the elderly.

In addition, international guidelines and documents have emphasized the importance of timely recognition of mental health conditions in the elderly and of community and integrated care strategies. The WHO emphasizes that management must be integrated with the health needs, personal care and social support of the elderly, with special attention to

factors such as loneliness and isolation (World Health Organization, 2025). In addition, recommendations for screening for depression in adults (including older adults) in primary care are presented in guidelines such as those of the USPSTF, highlighting the value of screening when there are systems for diagnosis and follow-up (USPSTF, 2023). These international references help to support that screening, by itself, should be connected to care flows (reception, clinical evaluation, follow-up and referral when necessary).

Finally, the limitations must be explained in a transparent manner: the small sample size and selection by convenience limit generalization; the cross-sectional design prevents causal inference; and the absence of variables such as schooling, income, multimorbidity, polypharmacy, and social support restricts multivariate analyses. Even so, the study contributes with local evidence applied, reinforcing that screening with GDS in PHC can reveal a significant proportion of elderly people with depressive symptoms, especially mild ones, who represent a priority group for prevention, longitudinal care and timely psychosocial interventions.

5 CONCLUSION

The results of this study show a high prevalence of depressive symptoms among elderly people treated in Primary Health Care, with a predominance of mild conditions, configuring a scenario of relevant impact on public health.

These findings reinforce depression as a frequent and underdiagnosed condition in the elderly population, with potential negative repercussions on functionality, autonomy and quality of life, demanding organized and systematic responses from health services.

The predominance of mild symptoms reveals an important window of opportunity for early interventions in the context of Primary Health Care. The routine incorporation of standardized screening instruments, such as the Geriatric Depression Scale, is a viable, low-cost strategy with a high potential for population impact, allowing the timely identification of cases that could progress to more severe conditions in the absence of adequate follow-up.

From the point of view of public policies, the findings reinforce the need to strengthen mental health actions in the Family Health Strategy, with emphasis on the training of multiprofessional teams, the organization of care flows for longitudinal follow-up, and articulation with the Psychosocial Care Network. The early detection of depressive symptoms should be recognized as a strategic priority of health policies, contributing to the promotion of healthy aging, the reduction of inequalities and the strengthening of comprehensive care for the elderly population.

ACKNOWLEDGMENTS

The authors would like to thank the Family and Community Medicine Residency Program for its academic and institutional support during the development of this study. They also thank the residency scholarship, financed by the Federal Government, through the Ministry of Education, which enabled the training and performance of residents in the context of Primary Health Care. They also extend their thanks to the University of Gurupi and the Municipality of Gurupi, for the institutional support and for the granting of a scholarship for the execution of care and academic activities in the municipality, contributing significantly to the strengthening of health education and to the production of scientific knowledge applied to the local reality.

REFERENCES

- Aguiar, B. N., et al. (2022). Depressão em idosos: Uma revisão integrativa da literatura. *Revista Brasileira de Geriatria e Gerontologia*, 25(1), 1–10.
- Brasil. Ministério da Saúde. (2001). Saúde mental e atenção básica: O vínculo e o diálogo necessários. Ministério da Saúde.
- Cai, H., et al. (2023). Global prevalence of depression in older adults: A systematic review and meta-analysis of epidemiological surveys. *Aging & Mental Health*.
- Castelo, M. S., et al. (2010). Validity of the Brazilian version of the Geriatric Depression Scale (GDS) among primary care patients. *International Psychogeriatrics*, 22(1), 109–113.
- Cunha, R. V., Bastos, G. A. N., & Duca, G. F. D. (2012). Prevalência de depressão e fatores associados em idosos de comunidade. *Revista Brasileira de Epidemiologia*, 15(2), 346–354.
- D'Ath, P., et al. (1994). Screening, detection and management of depression in elderly primary care attenders: I. The acceptability and performance of the 15-item Geriatric Depression Scale (GDS-15) and the development of short versions. *Family Practice*, 11(3), 260–266.
- Faria, J. S. R., & Paiva, M. J. M. de. (2021). Atenção farmacêutica à saúde da pessoa idosa. *Research, Society and Development*, 10(16), e488101624224.
- Faisal-Cury, A., et al. (2022). Depression underdiagnosis: Prevalence and associated factors in a population-based study. *Journal of Psychosomatic Research*, 154, 110745.
- Fiske, A., Wetherell, J. L., & Gatz, M. (2009). Depression in older adults. *Annual Review of Clinical Psychology*, 5, 363–389.
- Lee, Y. Y., et al. (2019). The risk of developing major depression among individuals with subthreshold depression: A systematic review and meta-analysis of longitudinal cohort studies. *Psychological Medicine*, 49(1), 92–102.

- Pundhir, A., et al. (2025). Global prevalence of depression among multimorbid older adults aged 60 years and above: A systematic review and meta-analysis. *BMC Geriatrics*.
- Rosa, A., Lisboa, T., & Tomaz, R. (2019). Depressão na terceira idade: Fatores associados e estratégias de cuidado. *Revista Saúde e Pesquisa*, 12(3), 553–560.
- Silva, É. P., & Paiva, M. J. M. de. (2021). Assistência farmacêutica em relação ao uso off-label de medicamentos no âmbito da pandemia da COVID-19. *Research, Society and Development*, 10(16), e128101623246.
- United States Preventive Services Task Force. (2023). Depression and suicide risk in adults: Screening. USPSTF.
- World Health Organization. (2021). Depression. WHO.
- World Health Organization. (2025). Mental health of older adults. WHO.
- Yesavage, J. A., et al. (1983). Development and validation of a geriatric depression screening scale. *Journal of Psychiatric Research*, 17(1), 37–49.

THE RIGHT OF POSSESSION OF TRADITIONAL COMMUNITIES AND THE LAND TENURE REGULARIZATION POLICY OF THE STATE OF PARÁ

O DIREITO DE POSSE DAS COMUNIDADES TRADICIONAIS E A POLÍTICA DE REGULARIZAÇÃO FUNDIÁRIA DO ESTADO DO PARÁ

EL DERECHO DE POSESIÓN DE LAS COMUNIDADES TRADICIONALES Y LA POLÍTICA DE REGULARIZACIÓN FUNDIARIA DEL ESTADO DE PARÁ



<https://doi.org/10.56238/sevened2026.008-075>

Jefferson Carvalho Galvão¹

ABSTRACT

The article investigates whether the land tenure regularization policy of the State of Pará, within the scope of the Environmental and Territorial Planning Program (2020–2023), is compatible with the legal recognition of agroecological possession by traditional communities. It is based on the hypothesis that, despite quantitative advances in the issuance of land documents, the policy follows a predominantly individualizing logic, which strains the recognition of collective holdings and common-use areas. It is argued that the legitimacy of possession by traditional communities does not depend on state action, being based on labor on the land, sustainable practices, and fulfillment of the social function of the property. However, administrative recognition is essential for the enforcement of fundamental rights, especially for rural workers' retirement. The research adopts an inductive method, with bibliographic review and documentary analysis of state legislation and reports from the Instituto de Terras do Pará (ITERPA). It is concluded that land tenure regularization policy in the state of Pará, although presenting relevant quantitative results, still requires normative and institutional adjustments to ensure the effective recognition of collective and agroecological forms of land possession.

Keywords: Agrarian Possession. Agroecological Possession. Traditional Communities. Land Tenure Regularization. Territorial Rights.

RESUMO

O artigo investiga se a política de regularização fundiária do Estado do Pará, no âmbito do Programa Meio Ambiente e Ordenamento Territorial (2020-2023), é compatível com o reconhecimento jurídico da posse agroecológica das comunidades tradicionais. Parte-se da hipótese de que, apesar dos avanços quantitativos na emissão de documentos fundiários, a política segue uma lógica predominantemente individualizante, tensionando o reconhecimento de apossamentos coletivos e áreas de uso comum. Defende-se que a legitimidade da posse das comunidades tradicionais independe de ato estatal, fundamentando-se no trabalho na terra, nas práticas sustentáveis e no cumprimento da função social do imóvel. Entretanto, o reconhecimento administrativo é imprescindível à

¹ Master's degree in Law . Universidade Federal do Pará (UFPA). E-mail: jeffersoncgalvao@yahoo.com.br
Orcid: <https://orcid.org/0009-0007-6228-2006> Lattes: <http://lattes.cnpq.br/7451804584083874>

efetivação de direitos fundamentais, especialmente à aposentadoria por idade do camponês. A pesquisa adota o método indutivo, com revisão bibliográfica e análise documental da legislação estadual e de relatórios do Instituto de Terras do Pará (ITERPA). Conclui-se que a política de regularização fundiária no Pará, embora apresente resultados quantitativos relevantes, ainda demanda ajustes normativos e institucionais capazes de garantir o reconhecimento efetivo dos apossamentos coletivos e agroecológicos.

Palavras-chave: Posse Agrária. Posse Agroecológica. Comunidades Tradicionais. Regularização Fundiária. Direitos Territoriais.

RESUMEN

El artículo investiga si la política de regularización fundiaria del Estado de Pará, en el marco del Programa Medio Ambiente y Ordenamiento Territorial (2020–2023), es compatible con el reconocimiento jurídico de la posesión agroecológica de las comunidades tradicionales. Se parte de la hipótesis de que, a pesar de los avances cuantitativos en la emisión de documentos de tenencia de la tierra, la política mantiene una lógica predominantemente individualizante, lo que tensiona el reconocimiento de las posesiones colectivas y de las áreas de uso común. Se sostiene que la legitimidad de la posesión de las comunidades tradicionales es independiente de un acto estatal, al fundamentarse en el trabajo sobre la tierra, en las prácticas sostenibles y en el cumplimiento de la función social de la propiedad. No obstante, el reconocimiento administrativo resulta imprescindible para la efectivización de derechos fundamentales, especialmente el derecho a la jubilación por edad del campesino. La investigación adopta el método inductivo, con revisión bibliográfica y análisis documental de la legislación estadual y de los informes del Instituto de Tierras del Pará (ITERPA). Se concluye que la política de regularización fundiaria en Pará, aunque presenta resultados cuantitativos relevantes, aún requiere ajustes normativos e institucionales capaces de garantizar el reconocimiento efectivo de las posesiones colectivas y agroecológicas.

Palabras clave: Posesión Agraria. Posesión Agroecológica. Comunidades Tradicionales. Regularización Fundiaria. Derechos Territoriales.

1 INTRODUCTION

Land regularization in the Brazilian Amazon is one of the main challenges of contemporary territorial planning, especially with regard to the legal recognition of the multiple forms of possession exercised over public lands. In the State of Pará, the implementation of land regularization policies aimed at the issuance of domain documents has revealed tensions between individualizing legal models of titling and the collective and agroecological forms of appropriation traditionally exercised by traditional communities.

Traditional Amazonian communities have historically exercised ownership of public lands through direct work on the land, the common use of natural resources, and the fulfillment of the socio-environmental function of the property, although, in many cases, without formal administrative recognition (Benatti and Bentes, 2024). This lack of state recognition produces relevant legal effects, especially in access to public policies and rural social security, evidencing the centrality of the territory for the realization of fundamental rights.

At the state regulatory level, Law No. 8,878, of July 8, 2019, which provides for the land regularization of rural and non-rural occupations on public lands in the State of Pará, defines land regularization as the set of legal and technical actions aimed at the regularization of occupations in state public areas, with a view to their allocation to third parties for the fulfillment of the socioeconomic function of the land. Based on this legal framework, the territorial planning policy of the State of Pará was structured within the scope of the Multiannual Plan (PPA) for the period 2020–2023, guiding the implementation of government actions for land regularization.

In view of this scenario, this article investigates whether the land regularization policy implemented by the State of Pará between 2020 and 2023, within the scope of the Environment and Territorial Planning Program, is compatible with the legal recognition of agroecological possession exercised by traditional communities.

It is supported as a hypothesis that, although the state policy presents relevant quantitative advances in the issuance of land documents, it still reproduces a predominantly individualizing logic of titling, which stresses the recognition of collective appropriations and areas of common use traditionally occupied by these communities.

The research adopts the inductive method, with a qualitative approach, combining bibliographic review and documentary analysis. It is based on state land legislation, on the legal-critical analysis of the national regulatory framework and on institutional reports produced by the Land Institute of Pará (ITERPA), including the systematization and interpretation of official data related to the issuance of land documents in the period from

2020 to 2023, with contextual update for the year 2024, in order to critically evaluate the impacts of the land regularization policy on the territorial rights of communities traditional ones.

By articulating the policy of land regularization in Pará with the legal recognition of agroecological tenure, the article seeks to contribute to the theoretical and empirical debate on the limits of the individualizing model of titling, evidencing its impacts on the realization of fundamental rights, especially access to social security by traditional communities occupying public lands. The analysis reaffirms the centrality of territory as a condition for the social, economic, and cultural reproduction of these communities and for the realization of the social function of land in the Amazonian context (Benatti, 2018).

2 THE POSSESSION OF PUBLIC LANDS BY TRADITIONAL COMMUNITIES

In the Brazilian legal system, meek, fair and peaceful possession of public lands enjoys legal protection, especially when exercised by indigenous peoples, quilombolas and traditional communities that historically occupy certain territories. In these cases, the recognition of the legitimacy of possession is not limited to a factual fact, but stems from the social, cultural and productive relationship established with the land, which is projected as the legal basis of the right to territory.

The Constitution of the Federative Republic of Brazil (CRFB) of 1988 represents a fundamental normative milestone in redefining the legal regime of public lands and tenure. At the same time that it reaffirms state control over the destination of these lands, the Constitution conditions the recognition of private property to the acquiescence of the Government, restricting the possibility of acquiring public land on the exclusive initiative of the private party, except in the cases expressly provided for in the constitutional text (Barreto, 2012).

Before the consolidation of this constitutional understanding, it was admitted, in certain situations, the claim of possession through the action of adverse possession. However, after intense legal, legislative and doctrinal debates, the prohibition on adverse possession of public assets was established. The CRFB/88, especially in its articles 188 and 189, submits the allocation of public lands to state control, ruling out the possibility of original acquisition of public rural property by the exclusive initiative of the private party, through the simple passage of time.

In this sense, with the constitutional prohibition on adverse possession of public properties, there was a restriction on the acquisition of property by possession exercised in isolation by the private party, with the recognition of possession and ownership being linked

to acquiescence and to the regular state act (Barreto, 2012). Thus, except for exceptions expressly provided for, the lawful acquisition of agrarian property now depends on an administrative procedure for the allocation of public lands, which includes the formal recognition of possession, since such properties are not subject to adverse possession, as provided for in article 191, sole paragraph, of the Federal Constitution.

This restriction, however, does not extend to the appropriations traditionally exercised by indigenous peoples, quilombola communities and other traditional communities. The Federal Constitution guarantees these groups the original right to the territory, regardless of a constitutive act of the State, and the Government is only responsible for the formal recognition of these rights, under the terms of articles 231 and 225 of the Constitution, as well as article 68 of the Transitional Constitutional Provisions Act (ADCT). Such constitutional protection is based on the differentiated way in which these subjects conceive, use and relate to the land, marked by collective, historical and sociocultural ties (Barreto, 2012).

Thus, although the prohibition on adverse possession limited the acquisition of property on the exclusive initiative of the private party, it did not exclude the possibility of agrarian possession of public lands. On the contrary, the Federal Constitution began to admit possession authorized or recognized by the Government, as well as that legitimately exercised by indigenous peoples, quilombola communities, traditional communities and rural workers and their families, provided that the social, economic and environmental purposes of the land are observed (Gonçalves, 2008; Barreto, 2012).

The legal understanding of the possession of public lands, especially in the Amazonian context, requires dialogue with the social reality of the peasantry and traditional communities. These groups, over generations, occupy and use the land collectively or as a family, building their productive, cultural, religious and political practices in the territory, as well as their own rules for the use and management of natural resources. It is a land grabbing that is legitimized by work, housing, and social reproduction, central elements of the principle of the social function of land (Benatti, 2018).

In Brazil, the squatter is defined as the farmer who works the land without a formal registered title, living predominantly from agricultural production aimed at family subsistence, with the occasional commercialization of surpluses (Martins, 1980). From this perspective, the squatter cannot be attributed any presumption of clandestinity or bad faith, since his relationship with the land is based on the need for survival and the fulfillment of the social, environmental and productive functions of the rural property (Miranda, 1988).

Martins (1980) points out that the squatter is, as a rule, the poor farmer who depends on the land to ensure the family's livelihood, using the surplus income from agricultural

production to purchase essential goods, such as food, clothing and inputs for farming. Despite its social and economic relevance, the squatter is often excluded from access to rural credit and public policies to promote family farming, precisely because of the absence of formal land titling.

This exclusion is not limited to the economic field, producing direct impacts on the realization of social rights. As Benatti and Bentes (2024) point out, the peasant, as a squatter of public land, faces significant barriers in the recognition of his condition as a special insured in the context of social security, since proof of the exercise of rural activity remains strongly linked to the presentation of formal land documents, incompatible with the reality of traditional land tenures.

In this context, the legitimation of collective property assumes centrality. For Benatti (2002), collective property is built from the capacity of the social group to appropriate certain natural resources and, over time, establish its own rules of use and management, respected by the members of the community. It is a primary seizure, characterized by the occupation of the territory with the intention of exercising social dominion over it, regardless of formal authorization from third parties.

The analysis of these forms of possession reveals that the legal recognition of traditional seizures of public lands is an indispensable condition for the realization of fundamental rights, for the promotion of social justice in the countryside and for the construction of a land policy compatible with the plurality of possessory regimes existing in the Amazon.

2.1 AGRARIAN TENURE AND AGROECOLOGICAL TENURE

In the Amazonian agrarian reality, the ownership of rural lands exercised by different social groups must be understood beyond the arrangements defined in classical possessory theories, such as those elaborated by Savin and Ihering (Mattos Neto, 2024).

According to Mattos Neto (2024), agrarian possession contemplates the direct, continuous, and rational exercise of the land, for an uninterrupted time, in which the purpose is to use it for economic, social, and environmental well-being, so that the effective exercise of agrarian activity only occurs through possession.

In this sense, agrarian possession requires the immediate attachment of the possessor to the land, being composed of the elements *corpus* and *animus*: the first refers to the direct, material, immediate attachment of the possessor to the land, it is the objective, practical factor; the second constitutes the subjective factor in which the intention is represented by the work that the agrarian possessor performs on the land, that is, to work on the land, and

not the immediate intention of the right to property as if it were its holder (*animus domini*) (Mattos Neto, 2024).

Therefore, the fact that man relates directly to the land he occupies, conferring on it his social function, constitutes a legal value that fulfills the content of the foundation of agrarian possessory protection (Mattos Neto, 2024).

The possessor must use the land rationally, respect its limits and natural resources, that is, the cultivation of the land must meet certain levels of economic and social rationality, guaranteeing the social function of property. Thus, the squatter must "faithfully comply with all obligations and duties arising from agrarian and environmental normative provisions and other laws" (Mattos Neto, 2024, p. 105).

Agrarian possession is, therefore, the direct, continuous, rational and peaceful exercise of agrarian activities on the occupied land, which reflects on the ability to create sufficient and necessary conditions for its economic use, by which it conceives to the possessor a "legal power of a real and definitive nature, with broad repercussions on the Law, with a view to its progress and economic and social well-being" (Mattos Neto, 2024, p. 116).

In the field of agri-environmental law, possession is protected through the performance of agricultural work (Mattos Neto, 2024). In this vein, Benatti (2018) defends the understanding of the different types of appropriations by traditional communities in the Amazon based on agroecological possession, understood as the exercise of power over a given space, which may include forest and/or aquatic resources.

Agroecological possession is configured as a juridical-social phenomenon of a factual nature, which emerges from the continuous relationship between the subjects, the land and the natural resources. It is a land grabbing materialized by the rational use and management of the territory, through sustainable agroextractivist practices, guided by family work and the collective awareness of belonging, whose legitimacy derives from the fulfillment of the social, environmental, and cultural function of the land, regardless of a formal time frame (Benatti, 2018).

In the case of quilombola communities, it is recorded that the recognition of their possession guarantees the ownership and title of the land for the community. However, in the case of conservation units for sustainable use – extractive reserves (RESEX) and the Sustainable Development Project (PDS) – and sustainable settlements – agroextractive settlement project (PAE), sustainable development project (PDS) and forest settlement project (PAF) – the areas are in the public domain, with usufruct of the land and renewable natural resources granted to traditional populations (Benatti, 2011).

In summary, agroecological possession is configured as a specific form of agrarian possession, socially constructed and territorially situated, which is legitimized by the continuous, rational and collective use of natural resources. It is a seizure based on family and agroextractivist work, guided by sustainable practices and a collective awareness of belonging to the territory (Benatti, 2018). By incorporating economic, social, cultural, and environmental dimensions, agroecological possession challenges traditional legal categories and requires the State to recognize possessory regimes compatible with the Amazonian reality, under penalty of making historically consolidated legitimate forms of occupation invisible.

2.2 THE PEASANT SUBJECT AS A SQUATTER OF PUBLIC LAND

In this research, we consider as peasants the family farmers and extractivists who organize themselves into family productive units and use the land as a material basis for their social (re)production, simultaneously constituting themselves as units of consumption and production. These are subjects whose relationship with the land goes beyond the merely economic dimension, being directly linked to family survival, social organization and the construction of collective identities in rural areas.

The peasant is conceived as a rural worker whose production aims primarily to ensure the sustenance of his own family, and the surplus is eventually sold for the acquisition of goods indispensable to the reproduction of his living conditions. In this sense, Queiroz (1973, p. 29–30) points out that, from the economic point of view, "the peasant is defined by the objective of producing for consumption, while, sociologically, the peasantry constitutes a subordinate layer within global society, marked by relations of economic, political and social subordination".

In the context of public policies, from the 1990s onwards, the Brazilian State began to officially adopt the category "family farming", especially with the creation of the National Program for the Strengthening of Family Agriculture (Pronaf), instituted in 1994, aimed at supporting productive activities organized by and for the family (Abramovay, 1998). This category began to guide the design of public policies aimed at rural subjects.

At the legislative level, Law No. 11,326, of July 24, 2006, defined the family farmer as one who carries out activities in rural areas in an area of up to four fiscal modules, with a predominance of family labor and income mostly from the establishment itself. Although this definition fulfills a relevant normative function, it does not remove the reality that a large part of these subjects exercise possession over public lands, without formal domain title.

At the state level, Law No. 8,878/2019, which provides for land regularization in the State of Pará, also recognizes the family farmer or rural family enterprise, considering criteria related to consolidated occupation, the predominant use of family labor, and the origin of income. State legislation, by admitting the regularization of occupations on public lands, highlights the centrality of the figure of the family farmer as a squatter, whose permanence in the territory depends on the legal recognition of his possession.

Despite the diversity of denominations and classifications attributed to the subjects who live and work in the countryside, these different categories refer to a common reality: the existence of agricultural producers linked to families and social groups whose relationship with the land is organized around family heritage (Wanderley, 2014). It is these family, community and territorial ties that allow these subjects to be understood as peasants, beyond the specificities of each concrete situation. For the purposes of this research, these categories are understood in an articulated way, insofar as they express the condition of the peasant subject as a squatter of public land.

Thus, although peasantry and family farming are not conceptually confused, both allow the identification of subjects whose social reproduction is directly linked to the legal recognition of the possession exercised over public lands. The peasant condition, in this context, is central to the analysis of the limits of the land regularization policy, especially with regard to the realization of territorial rights, including access to public policies and social security.

3 OF THE LAND REGULARIZATION POLICY OF PARÁ

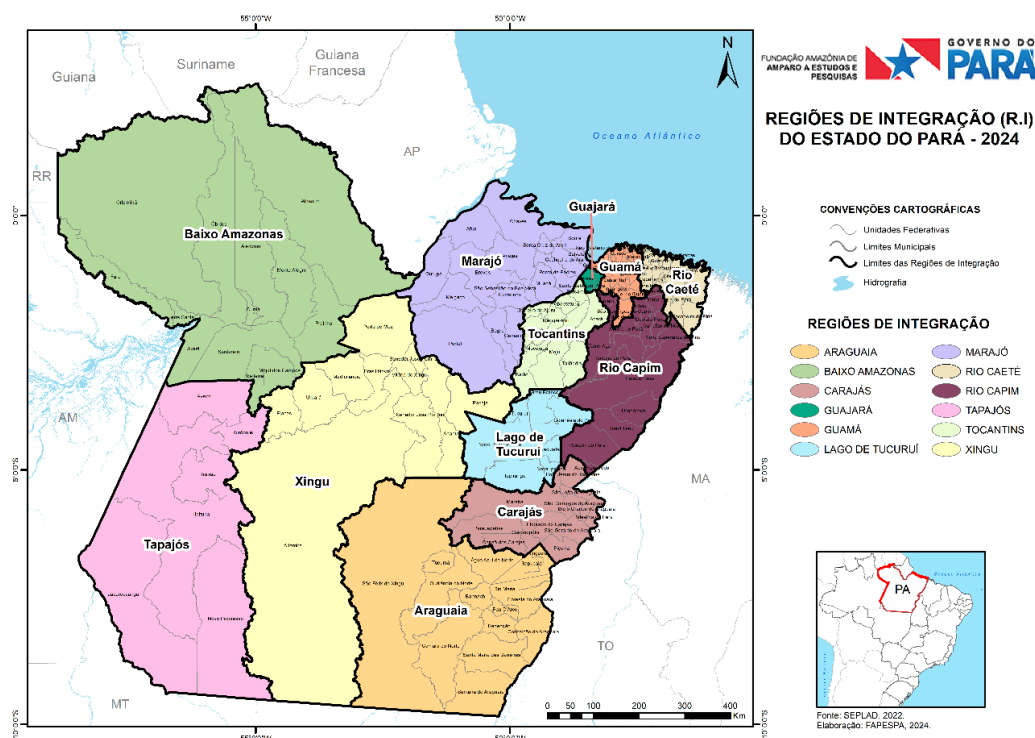
Pará is the second largest Brazilian state in territorial extension, with approximately 1,248,000 km² (IBGE, 2024). Located in the northern region of the country, in the eastern portion of the Amazon, the territory of Pará is composed of 144 municipalities, organized into 12 Integration Regions, defined based on criteria of socioeconomic similarity, patterns of territorial occupation and economic and social relations established between the municipalities (Pará, 2008).

This regionalization is an instrument for planning, monitoring and evaluating state public policies, and is guided by the objective of reducing regional inequalities through the implementation of strategic actions adjusted to territorial specificities. The Integration Regions of the State of Pará are: Araguaia, Baixo Amazonas, Guamá, Carajás, Lago de Tucuruí, Marajó, Metropolitana, Rio Capim, Rio Caeté, Tapajós, Xingu and Tocantins, as illustrated in Figure 1. It is an administrative division that allows us to understand the

heterogeneity of the territory of Pará and the different socio-territorial contexts in which land planning and regularization policies are developed.

Figure 1

Map of Indicators of the Integration Regions



Source: FAPESPA, 2024.

At the state level, the land regularization policy is operationalized through actions aimed at promoting access to land, legal security of tenure and socio-environmental sustainability, especially in relation to subjects who exercise possession of public lands without formal recognition by the State. In this context, the Land Institute of Pará (ITERPA), a state agency established by Law No. 4,584/1975, is the body responsible for the execution of the state agrarian policy and the management of vacant lands, and it is responsible for promoting land regularization, recognizing the validity of the titles issued and ensuring the socially appropriate destination of public lands.

Among the actions of Pará's agrarian policy, the Environment and Territorial Planning Program stands out, inserted in the Multiannual Plan (PPA) of the State of Pará for the period from 2020 to 2023. It is a structured public policy with objectives, goals, indicators and strategies defined for a four-year cycle, which justifies the time frame adopted in this research for the systematic analysis of its results and impacts on the existing tenure regimes in the territory of Pará. Although the analytical focus falls on the period from 2020 to 2023,

information related to the year 2024 is considered in a contextual way, with the objective of identifying trends in the institutional continuity of the state land policy.

Within the scope of this Program, ITERPA developed actions aimed at territorial planning, land and environmental regularization and the issuance of land documents, primarily benefiting small rural producers, family farmers, traditional communities, quilombola communities and state settlement projects, aiming at strengthening family farming, promoting sustainable development and mitigating land conflicts (ITERPA, 2021).

The analysis of ITERPA's Management Reports for the years 2020 to 2023 shows the issuance of various types of land documents, both individual and collective. Among the instruments used, individual definitive titles, collective titles for quilombola communities, patrimonial league titles, concessions of real right of use, land certificates, exchange terms and terms of redemption of *aforamento* stand out.

As shown in table 1, in the period analyzed, 13,503 land documents were issued, exceeding by 6.26% the programmed goal for the PPA cycle (programmed goal was 12,710 land documents). Among these documents, there are the issuance of 8,194 individual definitive titles, 26 collective titles for quilombola communities, 18 patrimonial league titles, 3,627 urban regularization documents, 1,047 concessions of real right of use, 7 concessions of real right of collective use, 487 land certificates, in addition to terms of exchange and *aforamento* (ITERPA, 2024).

The annual analysis of the data reveals oscillations in the fulfillment of the established goals. In the years 2020 and 2022, the programmed goals were not fully achieved. On the other hand, in 2023 there was a significant growth in land regularization actions, with the issuance of 5,823 documents, exceeding by approximately 67% the target set for the year (3,492 land documents). This performance suggests an intensification of state actions in the last year of the PPA cycle, possibly associated with the institutional consolidation of the policy and the need to meet the planned goals.

Table 1

Land documents issued in Pará in the years 2021 to 2024

Documents issued	2020	2021	2022	2023	Total
Scheduled in the period	1.023	1.967	5.509	3.492	12.710
Certificates issued	111	147	170	58	486
Individual Land Titles	360	1.200	2.063	4.571	8.194
Collective Titles	3	3	5	15	26
Heritage league titles	3		8	7	18
Urban regularization titles		868	1.704	1.055	3.627
Concessions of real right of use	349	193	417	88	1.047
Concessions of collective rights in rem	2	1	3	1	7
Lease terms	4	4	8	3	19

Terms of exchange	11	17	26	25	79
Total land documents in the period	843	2.433	4.404	5.823	13.503

Source: ITERPA management reports, 2021, 2022, 2023 and 2024.

From the territorial point of view, the actions of the Environment and Territorial Planning Program reached all the Integration Regions of the State of Pará, although unequally. In 2020, the regions that benefited the most from the issuance of land documents were the Rio Capim Region, responsible for 47.0% of the total, with emphasis on the municipality of Ipixuna do Pará, which received 348 documents, and the Araguaia Region, corresponding to 21.1%, with a highlight to São Félix do Xingu, which received 150 documents. Together, these two regions concentrated 72% of the total number of documents issued. On the other hand, the least benefited regions were Lago de Tucuruí and Marajó, with only 4 documents each, and the Xingu Region, with only 1 document issued (ITERPA, 2021).

In 2021, the State of Pará issued 258 land documents for the Tocantins Region, 238 for the Guamá Region, and 166 for the Carajás Region. The least benefited regions were: Xingu (7), Tapajós (4), Marajó (1) (ITERPA, 2022). In 2022, the Tocantins Region presented a significant number of land regularization, with 1256 documents issued, followed by the Guajará Region, with 1,312 documents, and the Guamá Region with 610 titles issued. However, Marajó (4) and Xingu (2) remain among the regions with the lowest issuance of land documents (ITERPA, 2023).

In 2023, the regions that benefited the most from the issuance of land documents were: Guamá (1577), Caetés (1244), Tocantins (1225), Guajará (1,066) and Capim (435), and the regions with the fewest land documents issued were: Xingu (20), Lago Tucuruí (13) and Marajó (6) (ITERPA, 2024). This distribution shows the persistence of territorial asymmetries in the implementation of the land regularization policy in the State of Pará, indicating that the intensification of state actions in the last year of the PPA cycle did not occur homogeneously among the Integration Regions.

With regard specifically to the titling of rural lands occupied by traditional communities, the data reveal a significant asymmetry between individual titling and collective titling. While 8,194 individual definitive titles were issued in the period analyzed, only 26 collective titles were allocated to traditional communities and 7 concessions of Real Right of Collective Use for State Projects of Agroextractivist Settlements (CDRUs), which highlights the centrality conferred by the State to land regularization through the fragmentation of the territory into individualized family units.

The most benefited regions concentrate areas of greater economic dynamism, land tenure pressure and consolidated presence of small producers and settlements, which tends

to facilitate the operationalization of land regularization under the logic of individual titling. On the other hand, regions such as Marajó, Xingu and Lago de Tucuruí, characterized by extensive areas of common use, a strong presence of traditional communities and greater logistical and institutional obstacles, remain with a low incidence of regularization actions, revealing structural limits of the state land policy to meet more complex socio-territorial contexts.

Although the quantitative results indicate relevant advances in the expansion of formal access to land, it is essential to problematize the legal model that guides the land regularization policy in the State of Pará. The predominance of individual titling reveals the persistence of a patrimonialist rationality of the land, which does not always dialogue with the socio-territorial complexity of the Amazon and with the collective forms of use and occupation traditionally exercised by traditional communities.

As Monteiro et al., (2019) point out, Brazilian land policy has prioritized the individual titling of public lands in the Amazon, even in the face of a significant liability related to the recognition of collective territories. This orientation disregards, in many cases, the relevance of environmentally differentiated settlement projects and forms of appropriation based on the common use of the land, which are fundamental both for income generation and for environmental protection.

This empirical scenario allows us to move towards a legal-critical analysis of the land regularization model adopted, especially with regard to the normative choices that guide the prioritization of individual titling to the detriment of the recognition of collective territories. The critical reading of the data cannot be restricted to the measurement of the formal fulfillment of administrative goals, but must consider the qualitative impacts of the land regularization policy on the different tenure regimes existing in the territory of Pará.

The centrality of individual titling, when analyzed in the light of agrarian and environmental law, reveals political options aligned with the national normative framework, especially Law No. 13,465/2017, which reformulated the legal regime of land regularization in Brazil. This legislation, by reinforcing individual titling as the main instrument of territorial planning, including on public lands located in the Legal Amazon, has been the object of criticism for favoring the commodification of land and for disregarding the specificities of collective and agroecological appropriations exercised by traditional communities.

In this context, the land regularization policy, when guided exclusively by the parameters of Law No. 13,465/2017, runs the risk of reproducing a legal rationality incompatible with the principles of agrarian and environmental law, especially with regard to the social function of land, the protection of the environment, and the recognition of the

territorial rights of traditional communities. Although the institutional advances of the land policy in Pará and the expansion of the issuance of land documents in the period analyzed are recognized, the asymmetry between individual and collective titling shows structural limits of the model adopted.

The prioritization of individual titling, by disregarding areas of common use and collective forms of possession, can weaken the territorial integrity of traditional communities and compromise their social, cultural and economic reproduction. This state option is part of a broader context of reorganization of the Brazilian land regime, marked by the growing economic valuation of land as a financial asset, often associated with the neoliberalization of agrarian policies. In the Amazonian context, this legal rationality is particularly problematic, as it disregards the ways of life of traditional communities and weakens forms of appropriation based on the common use of natural resources, such as agroecological possession.

From the above, the analysis shows that, although the land policy in Pará has significantly expanded formal access to land, its normative orientation reveals structural limits for the full recognition of the territorial rights of traditional communities.

3.1 UPDATE OF THE LAND REGULARIZATION POLICY IN PARÁ

Considering the institutional continuity of land policy in the State of Pará and the relevance of situating the reader in the most recent scenario, information related to the results obtained in the year 2024, which makes up the new cycle (2024-2027), is incorporated, in a complementary and contextual way, without prejudice to the delimited methodological cut.

The most recent data from ITERPA indicate the expansion of land regularization actions after the end of the 2020–2023 cycle. In 2024, the State of Pará, through ITERPA, issued 6,729 land titles under the Socio-Environmental Management and Territorial Planning Program, of which 6,597 were individual titles, 19 were intended for quilombola communities and only 3 CDRUs for State Projects of Agroextractivist Settlements (ITERPA, 2025). These numbers show the continuity of the individualizing logic in the state land policy, highlighting that, although the collective CDRUs represent more appropriate instruments to guarantee the territorial security of traditional communities, their use is still extremely limited.

Although these data indicate significant quantitative advances, their reading in the light of the results observed in the period from 2020 to 2023 reveals the maintenance of the legal-institutional pattern that guides the state's land policy. As verified in the multi-year cycle analyzed, most of the documents issued in 2024 corresponded to individual titling, while collective titling for traditional communities remained residual, even in the face of the

constitutional and infra-constitutional recognition of collective forms of land use and occupation.

The absence of formal recognition of agroecological possession exercised by traditional communities compromises the territorial security of these groups and produces relevant legal effects, such as the difficulty of access to public policies and social security. Thus, land regularization must be understood beyond the simple issuance of titles, requiring an approach capable of recognizing the plurality of forms of possession existing in the Amazon and the centrality of the territory for the social, cultural and economic reproduction of traditional communities.

The asymmetry between individual and collective titling confirms that the advances observed in subsequent years do not represent a structural inflection in the land regularization model, but rather the continuity of a predominantly individualizing logic, based on territorial fragmentation and the centrality of individual private property. Such legal rationality is shown to be tensioned with the recognition of agroecological possession and areas of common use traditionally occupied by traditional communities, especially in the Amazonian context.

In addition, the incorporation of the 2024 data shows that, despite the quantitative expansion of land policy, the legal effects associated with the low incidence of collective titles remain, such as the difficulties faced by traditional communities in accessing public policies and proving territorial and labor ties for social security purposes. Thus, the empirical update reinforces the central hypothesis of this study, by demonstrating that the land regularization policy in Pará, although continuous and expanded over time, still lacks normative and institutional adjustments capable of ensuring the effective recognition of the plurality of possessory regimes existing in the Amazon.

4 FINAL CONSIDERATIONS

The State of Pará has developed policies for territorial planning and land regularization in line with constitutional principles linked to land and the social function of property, enabling the realization of fundamental rights arising from access to land, such as the recognition of possession exercised by traditional communities, promoting the sustainable management of natural resources and social reproduction, cultural and economic of these groups.

The actions implemented under the Environment and Territorial Planning Program (2020–2023) produced positive impacts for rural workers and traditional communities, by enabling the issuance of land documents, recognizing local knowledge and practices, and ensuring formal means of proving the exercise of rural activity. Such measures also

strengthened the state's capacity to manage public lands, contributing to environmental protection and regional socioeconomic development.

Although the legitimacy of the possession exercised by traditional communities is independent of a state act, as it is based on work on the land, sustainable practices and the fulfillment of the social function, formal recognition by the State is essential for the realization of social rights, especially access to retirement due to age of family farmers occupying public land. The requirement of documentary proof of the link with the land highlights the limitations faced by peasant subjects when their possessions are not legally recognized.

In view of this, the research demonstrates that the land regularization policy in Pará, despite presenting relevant quantitative advances, still operates under a predominantly individualizing logic of titling, which stresses the recognition of collective appropriations, areas of common use and agroecological possession exercised by traditional communities. Such an orientation limits the full realization of the territorial and social rights of these groups.

It is concluded that the improvement of the state land policy requires normative and institutional adjustments aimed at recognizing the plurality of possessory regimes existing in the Amazon. The strengthening of legal instruments for collective titling, the protection of areas of common use, and the adoption of administrative procedures sensitive to the socio-territorial reality of the Amazon are fundamental measures to ensure the integrity of traditionally occupied territories and avoid their fragmentation. Only from the recognition of this diversity will it be possible to consolidate a land policy committed to social justice, environmental sustainability and respect for the sociocultural diversity of the Amazon.

REFERENCES

- Barreto, A. M. (2012). A Constituição Federal de 1988 e a posse de terras públicas rurais. *Direito e Liberdade*, 14(1), 39–59.
- Benatti, J. H. (2002). A titularidade da propriedade coletiva e o manejo florestal comunitário. *Revista de Direito Ambiental*, 26, 126–151.
- Benatti, J. H. (2011). Regularização fundiária na Amazônia no contexto das mudanças climáticas. In C. C. de Oliveira & R. S. da R. Sampaio (Orgs.), *A economia do verde no contexto do desenvolvimento sustentável: A governança dos atores públicos e privados* (pp. 119–212). FGV Direito Rio.
- Benatti, J. H. (2018). Das terras tradicionalmente ocupadas ao reconhecimento da diversidade social e de posse das populações tradicionais na Amazônia. In D. Ungaretti et al. (Eds.), *Propriedades em transformação: Abordagens multidisciplinares sobre a propriedade no Brasil* (pp. 193–214). Blucher.
- Benatti, J. H., & Bentes, L. (2024). O direito fundamental à aposentadoria por idade do camponês ocupante de terra pública. *Revista Saberes da Amazônia*, 9(15), 1–31.

- Brasil. (1988). Constituição da República Federativa do Brasil. Presidência da República. http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (2006). Lei nº 11.326, de 24 de julho de 2006. Estabelece as diretrizes para a formulação da Política Nacional da Agricultura Familiar e Empreendimentos Familiares Rurais. https://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2006/Lei/L11326.htm
- Brasil. (2017). Lei nº 13.465, de 11 de julho de 2017. Dispõe sobre a regularização fundiária rural e urbana e dá outras providências. Diário Oficial da União.
- Fundação Amazônia de Amparo a Estudos e Pesquisas. (n.d.). Mapas de Indicadores das Regiões de Integração. <https://fapespa.pa.gov.br/sistemas/radar2024/>
- Gonçalves, C. R. (2008). Direito civil brasileiro (2a ed., Vol. 5). Saraiva.
- Instituto Brasileiro de Geografia e Estatística. (n.d.). Pará: Área territorial. Cidades e Estados. <https://www.ibge.gov.br/cidades-e-estados/pa.html>
- Instituto de Terras do Pará. (2021). Relatório de Gestão 2020. ITERPA.
- Instituto de Terras do Pará. (2022). Relatório de Gestão 2021. ITERPA.
- Instituto de Terras do Pará. (2023). Relatório de Gestão 2022. ITERPA.
- Instituto de Terras do Pará. (2024). Relatório de Gestão 2023. ITERPA.
- Instituto de Terras do Pará. (2025). Relatório de Gestão 2024. ITERPA.
- Martins, J. de S. (1980). Lutando pela terra: Índios e posseiros na Amazônia Legal. Revista de Ciências Sociais, 11(1), 7–27.
- Mattos Neto, A. J. de. (2024). Curso de direito agroambiental brasileiro (2a ed.). Saraiva.
- Miranda, A. G. (1988). Direito agrário e o posseiro. Revista da Faculdade de Direito da UFG, 12(1-2), 113–123.
- Monteiro, A. N. G., de Vasconcelos, T. R., & Treccani, G. D. (2019). Impasses e desafios da regularização fundiária para comunidades tradicionais na Amazônia. Retratos de Assentamentos, 22(2), 39–62.
- Pará. (1975). Lei n. 4.584, de 8 de outubro de 1975. Cria o Instituto de Terras do Pará – ITERPA. Diário Oficial do Estado do Pará.
- Pará. (2019). Lei nº 8.878, de 8 de julho de 2019. Dispõe sobre a regularização fundiária de ocupações rurais e não rurais em terras públicas do Estado do Pará. <http://portal.iterpa.pa.gov.br/legislacao-fundiaria-estadual/#1612447473976-c82b9c1c-b0cb>
- Queiroz, M. I. P. de. (1973). O campesinato brasileiro: Ensaio sobre a civilização e grupos rústicos no Brasil.
- Wanderley, M. de N. B. (2014). O campesinato brasileiro: Uma história de resistência. Revista de Economia e Sociologia Rural, 52, 25–44.

USE OF ATLAS.TI SOFTWARE AS A METHODOLOGICAL RESOURCE IN THE STRUCTURING OF DATA IN QUALITATIVE STUDIES

USO DO SOFTWARE ATLAS.TI COMO RECURSO METODOLÓGICO NA ESTRUTURAÇÃO DE DADOS EM ESTUDOS QUALITATIVOS

USO DEL SOFTWARE ATLAS.TI COMO RECURSO METODOLÓGICO EN LA ESTRUCTURACIÓN DE DATOS EN ESTUDIOS CUALITATIVOS



<https://doi.org/10.56238/sevened2026.008-076>

**Gerusa Ribeiro¹, Caroline Scalabrin de Oliveira Alves², Diego Saraiva de Mello³,
Izabel Cristina Dell'Antônio Piva⁴, Andressa Marjory⁵, Marciele Misiak⁶, Andréa
Huhn⁷, Caroline de Medeiros⁸**

ABSTRACT

Use of ATLAS.ti Software as a Methodological Resource in the Structuring of Data in Qualitative Studies” presents the practical experience of faculty members and students from the Professional Master’s Program in Radiological Protection at the Federal Institute of Santa Catarina in the use of ATLAS.ti software to support qualitative analyses. The central objective is to demonstrate how the tool contributes to methodological rigor, the organization of large volumes of data, and the enhancement of research quality in the field of radiological protection. The study describes the software usage process, including installation, project creation, document import, code development, citation generation, network creation, and report export. ATLAS.ti is presented as an essential technology for contemporary qualitative research, especially in interdisciplinary health contexts. Its use facilitates data categorization, occurrence analysis, visualization of conceptual relationships, and analytical traceability, while maintaining fidelity to the theoretical frameworks defined by the researcher. The article highlights tools such as the document manager, code groups, Sankey diagrams, analytical memos, and networks, which expand the understanding of phenomena investigated in radiological protection and related areas. In addition to presenting practical examples from

¹ Professor. Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC). Santa Catarina, Brazil.

² Master's student in Radiological Protection. Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC). Santa Catarina, Brazil.

³ Master's student in Radiological Protection. Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC). Santa Catarina, Brazil.

⁴ Master's student in Radiological Protection. Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC). Santa Catarina, Brazil.

⁵ Master's student in Radiological Protection. Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC). Santa Catarina, Brazil.

⁶ Professor. Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC). Santa Catarina, Brazil.

⁷ Professor. Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC). Santa Catarina, Brazil.

⁸ Professor. Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC). Santa Catarina, Brazil.

dissertations that used the software, the article discusses limitations, such as the risk of excessive and mechanized data segmentation, emphasizing that critical interpretation remains the researcher's responsibility. It concludes that ATLAS.ti is an effective, accessible tool aligned with the scientific rigor required in qualitative research, contributing to the advancement of radiological protection and patient safety.

Keywords: Qualitative Analysis. ATLAS.ti Software. Radiological Protection. Health Information Technology. Radiological and Imaging Nursing.

RESUMO

Uso do Software ATLAS.ti como Recurso Metodológico na Estruturação de Dados em Estudos Qualitativos" apresenta a experiência prática de docentes e discentes do Mestrado Profissional em Proteção Radiológica do Instituto Federal de Santa Catarina, no uso do software ATLAS.ti para apoiar análises qualitativas. A proposta central é demonstrar como a ferramenta contribui para o rigor metodológico, a organização de grandes volumes de dados e a qualificação das pesquisas desenvolvidas na área de proteção radiológica. O estudo descreve o processo de utilização do software, incluindo instalação, criação de projetos, importação de documentos, elaboração de códigos, geração de citações, criação de redes e exportação de relatórios. O ATLAS.ti é apresentado como uma tecnologia essencial para pesquisas qualitativas contemporâneas, especialmente em contextos interdisciplinares da saúde. Seu uso facilita a categorização de dados, a análise de ocorrências, a visualização de relações conceituais e a rastreabilidade analítica, mantendo a fidelidade às bases teóricas definidas pelo pesquisador. O artigo destaca ferramentas como gerenciador de documentos, grupos de códigos, diagramas de Sankey, registros analíticos e redes, que ampliam a compreensão dos fenômenos investigados na radioproteção e em áreas correlatas. Além de apresentar exemplos práticos de dissertações que utilizaram o software, o artigo discute limitações, como o risco de segmentação excessiva e mecanizada dos dados, ressaltando que a interpretação crítica continua sendo responsabilidade do pesquisador. Conclui afirmando que o ATLAS.ti é uma ferramenta eficaz, acessível e alinhada às exigências de cientificidade das pesquisas qualitativas, contribuindo para a evolução do campo da proteção radiológica e da segurança do paciente.

Palavras-chave: Análise Qualitativa. Software ATLAS.ti. Proteção Radiológica. Tecnologia da Informação em Saúde. Enfermagem Radiológica e de Imagem.

RESUMEN

Uso del software ATLAS.ti como recurso metodológico en la estructuración de datos en estudios cualitativos" presenta la experiencia práctica de docentes y estudiantes de la Maestría Profesional en Protección Radiológica del Instituto Federal de Santa Catarina en el uso del software ATLAS.ti para apoyar análisis cualitativos. La propuesta central es demostrar cómo la herramienta contribuye al rigor metodológico, a la organización de grandes volúmenes de datos y a la cualificación de las investigaciones desarrolladas en el área de la protección radiológica. El estudio describe el proceso de utilización del software, incluyendo la instalación, creación de proyectos, importación de documentos, elaboración de códigos, generación de citas, creación de redes y exportación de informes. El ATLAS.ti se presenta como una tecnología esencial para las investigaciones cualitativas contemporáneas, especialmente en contextos interdisciplinarios de la salud. Su uso facilita la categorización de datos, el análisis de ocurrencias, la visualización de relaciones conceptuales y la trazabilidad analítica, manteniendo la fidelidad a las bases teóricas definidas por el investigador. El artículo destaca herramientas como el gestor de documentos, grupos de códigos, diagramas de Sankey, registros analíticos y redes, que amplían la comprensión de los fenómenos investigados en la radioprotección y en áreas afines. Además de presentar ejemplos prácticos de disertaciones que utilizaron el software,

el artículo discute limitaciones, como el riesgo de una segmentación excesiva y mecanizada de los datos, subrayando que la interpretación crítica sigue siendo responsabilidad del investigador. Concluye que el ATLAS.ti es una herramienta eficaz, accesible y alineada con las exigencias de científicidad de la investigación cualitativa, contribuyendo a la evolución del campo de la protección radiológica y de la seguridad del paciente.

Palabras clave: Análisis Cualitativo. Software ATLAS.ti. Protección Radiológica. Tecnología de la Información en Salud. Enfermería Radiológica y de Imagen.

1 INTRODUCTION

The present study aims to share the practical experience in the use of the ATLAS.ti software as a tool for qualitative analysis within the scope of the Professional Master's Degree in Radiological Protection, of the Graduate Program of the Federal Institute of Education, Science and Technology of Santa Catarina. Emphasis is placed on the contributions to the strengthening of methodological rigor and to the qualification of professional practices in radiological protection in the multidisciplinary context and in nursing.

In addition to the dissertations that made use of the tool, on the occasion, the special topic entitled Technology and Operational Techniques in the Research Process was offered, instrumentalizing the methodological resource adopted.

The use of technological tools in qualitative research has been increasingly relevant, especially in *stricto sensu* training programs, such as the Professional Master's Degree in Radiological Protection. In this context, the ATLAS.ti software stands out for being developed based on the principles of Grounded Theory, offering resources that enhance the inductive methodological approach. Its application allows the researcher to carefully organize the data, facilitating the categorization, interpretation and theoretical construction based on the information collected. By providing greater analytical rigor and data traceability, ATLAS.ti consolidates itself as an effective methodological resource for professors and students engaged in qualitative investigations, contributing significantly to scientific advancement and to the quality of research developed in radiological protection.

Currently, technologies affect several areas of knowledge, especially the research process. Computational resources emerged in the 1980s and since then software has been available in its diversity for use in qualitative and quantitative research (ATLAS TI, 2023; SORATTO; PIRES; FRIESE, 2020).

Atlas.ti is a computer tool used in qualitative research to assist in the analysis, interpretation, and organization of data from interviews, focus groups, user research, and literature review, in a rapid way to obtain research results (ATLAS TI, 2025).

Developed between 1989 and 1992 by Thomas Muhr and collaborators at the Department of Psychology of the Technical University of Berlin, its first version was marketed in 1993. Several researchers have used this software in their analyses, ensuring its potential in the most diverse areas of knowledge (GONDIM et al., 2018; SILVA JUNIOR; LEÃO, 2018).

The software has the ability to store documents of various formats and allow encoding, marking, annotations on these files, allowing the crossing of data and organization of information (FRIESE, 2014). Its objective is to help researchers to discover and analyze, in a systematic way, relevant phenomena hidden in unstructured data. ATLAS.ti offers

instruments that make it possible to identify, codify and record the results found in the data, evaluate their importance and observe the interrelationships (CORUJO; RELAY; SILVA, 2019). ATLAS.ti has been used in the areas of education, engineering, criminology, administration, anthropology, as well as health professionals such as nurses, doctors and psychologists. The application can be used with different theoretical approaches and multiple data analysis processes ((FRIESE, 2019; SORATTO; PIRES; FRIESE, 2019).

In the professional master's degree in radiological protection, the use of the software is indicated for integrative and literature reviews, for analysis and organization of data from interviews, documents, diaries and observation notes, among other research data collection instruments. Radiological protection is intended for the study of the safe handling of radiation. In the health area, it aims to minimize radiation exposure for both patients and occupationally exposed individuals (TAUHATA, 2014). This is a very important theme in some medical specialties, but it has not been shown to have the same relevance in the practice of medicine (VANO, 2011).

With the tools made available by the software for the organization and categorization of data on radiological protection, it was possible to realize how fast and facilitating the Atlas Ti represents.

In the context of the Professional Master's Degree in Radiological Protection, the use of technological tools to support qualitative research has been shown to be essential to ensure methodological rigor, data reliability, and in-depth analysis. The ATLAS.ti software, widely recognized in the area of applied human and social sciences, has been incorporated as a strategic instrument for the organization, categorization and interpretation of large volumes of textual, audiovisual and documentary data. Its application enhances the understanding of complex phenomena, such as professional practices, perceptions about biosafety and patient safety, allowing the researcher to integrate evidence with clarity and systematization. In the field of radiological protection, this approach contributes directly to the strengthening of safe practices, based on evidence and supported by in-depth analyses of the professional reality experienced in health services.

How does the use of the ATLAS.ti software contribute to the organization, analysis and systematization of qualitative data produced by professors and students of the Professional Master's Degree in Radiological Protection at the Federal Institute of Santa Catarina?

1.1 OBJECTIVES

To share practical experience in the use of the ATLAS.ti software as a tool for qualitative analysis in research developed within the scope of the Professional Master's

2 METHOD

This description shows the main tools offered by the atlas ti version 25 software, and practical examples of the usefulness of the software used in the dissertations of students in the Professional Master's Degree in Radiological Protection.

Initially, the activities using the software consisted of its installation. When accessing the software website (<https://atlasti.com/pt>) it was necessary to download it to the computer with desktop applications on Windows and macOS or Web version for browsers, using the license in the free version or purchasing a paid license. In the free version, ATLAS.ti 25 (trial), requires the following conditions: the license expires 20 calendar days after the request, within this period, you can use the software for up to 5 days of active use, which do not have to be consecutive, that is, you can start, pause and return to using ATLAS.ti on different days, until you complete the 5 days allowed within the total 20 days.

After the end of the evaluation period, ATLAS.ti moves to a limited mode of use ("read-only"), in which you can view the projects, but you will not be able to edit them if they exceed certain limits (more than 10 documents, 50 citations, 25 codes, 2 memos) (MUHR, T. 2023; MILES, M. 2014).

It is worth mentioning that after the expiration of the free license, there is a need to obtain a paid license key, which gives full access to all the features of the software, as well as the possibility to export the project (bundle). The procedures described below are specified starting with versions 22 and 24:

Step 1 – Creating a new project, at this point the project will be named according to the theme or the name of the research, e.g., Radiological Protection Review. Step 2 - All documents, files will be inserted in the document tab, they can be inserted in word, pdf or odt format. After all the files are indexed, they can be grouped as well, in case the searcher wants to segment by

content, such as by authors, countries, journals or the researched base, according to the interest of the researcher oriented by the research objective. The entire view of the documents is carried out in the "manage documents" tab, where it is possible to add, remove, rename, comment, open and renumber the files.

Step 3: Creation of codes, usually in qualitative research, codes are generated, which are short expressions oriented according to a theoretical framework, linked to a speech excerpt, in the case of interviews, or an abstract in the case of articles. To create codes click

on "new code", then name the code and then click on create. After creating the codes, each piece of text that is pertinent to the created code, click on the left mouse button or on the code manager and apply the new code.

Step 4: Citations are the selected excerpts (interviews, article texts, images) and coded. Through the citation manager, it is possible to create different types of analysis, such as a report or word cloud, this tool presents an image with the most used terms in the selected studies, emphasizing the word that proved to be the most frequent.

Step 5: Creation of the networks, the networks provide a didactic visualization of the analyzed data, such as the citations according to the codes linked to it or only the codes and their interrelationships. To create a network, open the code manager, select the codes to be listed, and then click show on network, generating it.

The software also makes it possible to export the data compiled during the analysis in text files or spreadsheets, in addition to allowing the export of the project as a whole to another researcher, through the "export" tool and "project packages". This feature is very useful for teamwork, collaborations between researchers, and for backing up projects without losing any research data.

3 RESULTS AND DISCUSSION

The results represent some of the tools offered by the software for the analysis of articles. Some of the dissertations, intentionally chosen on health and nursing work in the scope of "Radiological Protection", will be presented.

The process of organizing and managing qualitative data from interviews in ATLAS.ti version 25 follows some fundamental steps. Below, we describe a practical script aligned with the recommended procedures in the qualitative research assisted by him.

In ATLAS.ti 25, a new project is created, which will serve as the basis of all the analysis. It is important to name the project with the title of the survey or an identifier that facilitates its management.

When it comes to interviews, the most used instrument in the dissertations presented, these must be transcribed in full in electronic text format, preferably in .docx or .pdf formats, compatible with ATLAS.ti., it is recommended to review the transcripts before inserting them into the software, ensuring fidelity to the participants' discourse. Anonymous identifiers may be entered (e.g. Interviewee 1, Interviewee 2) to ensure ethical confidentiality. Next, the interview files are inserted through the "Import > Documents" tab. Each interview becomes a Primary Document. ATLAS.ti organizes these documents in an internal library, allowing for quick and secure access.

It is possible to assign metadata to the primary documents: participant's name, study group, age group, gender, etc. The metadata is useful later for segmenting analyses by subgroups. Before formal coding, the researcher can perform exploratory readings and produce initial memos in the software itself. Memos serve as reflective notes, recording preliminary impressions, hypotheses, or emerging categories.

The coding of the relevant excerpts from the interviews begins:

Open coding: creation of free codes while reading, representing concepts, categories or units of meaning.

Pre-coding: if there is a theoretical framework or defined categories, codes can be created before and applied during reading.

In ATLAS.ti 25, encoding can be done by text selection and direct association with the created code. You can organize the codes into Code Groups. After coding, relational analysis begins: Identification of patterns, co-occurrences and relationships between codes. Creation of visual Networks in the software, allowing to map the conceptual connections and support the analytical construction.

Also in ATLAS.ti 25 it allows you to generate reports of codes, coded segments, frequency of occurrence and overlapping of categories. These reports support the interpretative analysis and writing of the results. It is recommended to perform periodic backups of the project, and it allows you to export the complete project for backup or sharing with co-advisors.

At the end of the analysis, the researcher can export, according to the need, the code report, the conceptual networks, the citation lists and the data for inclusion in the dissertation and publications.

ATLAS.ti 25 brought greater integration with the cloud (ATLAS.ti Cloud) and better graphic usability, which facilitates the monitoring of the project by the advisor and favors collaborative analysis within the scope of professional master's programs.

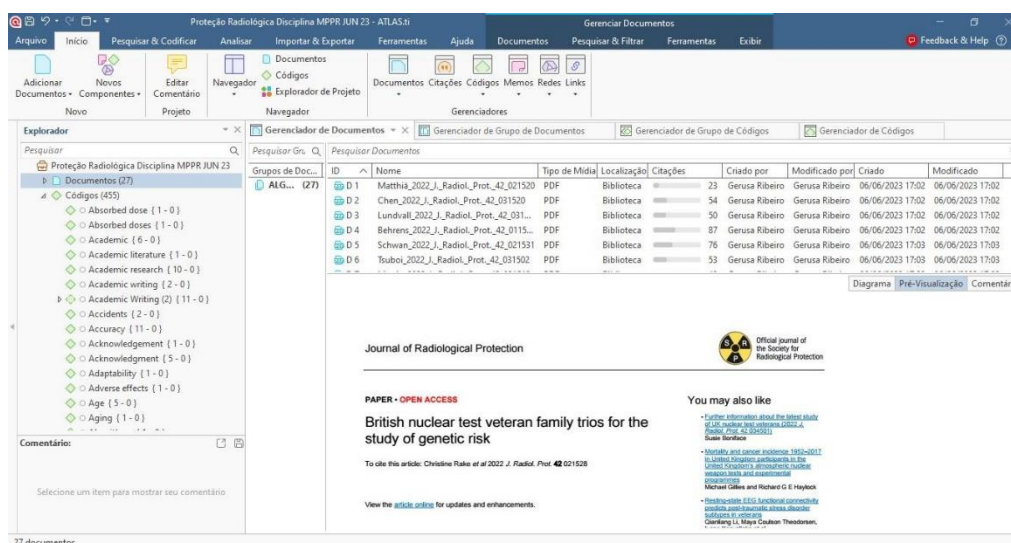
After identifying the search strategies in the determined databases, the analysis of the articles found was carried out. These will be displayed illustrating the tools available in the software that contribute to the organization of the data. It is essential to emphasize that the process of creating and coding, as well as the organization of the networks, are not determined by the program, but by the researcher according to the theme, methodology and theoretical framework or need of the research, from the files inserted in the software.

In its operationalization, it offers a basic model formed by objects: primary documents (primary data from various sources: articles, interviews, photos, music, films, maps, etc.); quotations (fragments of audiovisual images, text or audio); codes (concepts arising from

external and/or internal reference through what is being analyzed at the moment); notes (record of reflections, observations and interpretations of the material being evaluated); families (grouping of objects such as codes, notes, or primary documents) and networks (associations that allow you to visualize the connections between encoded information).

The elements mentioned above make up the Hermeneutic Unit (HU) which refers to an electronic space that organizes the entire database and the concepts, comments, notes and citations that emerge from the analyses, shown in figure 01.

Figure 1
Document Manager



Source: by the authors (2025).

It is through the document manager that ATLAS.ti is able to integrate a large number of documents into its workspace, in addition to keeping control over all the notes, codes and comments that are produced during the analyses. It also allows you to work with various formats of text, audio, video, geographic data and image files.

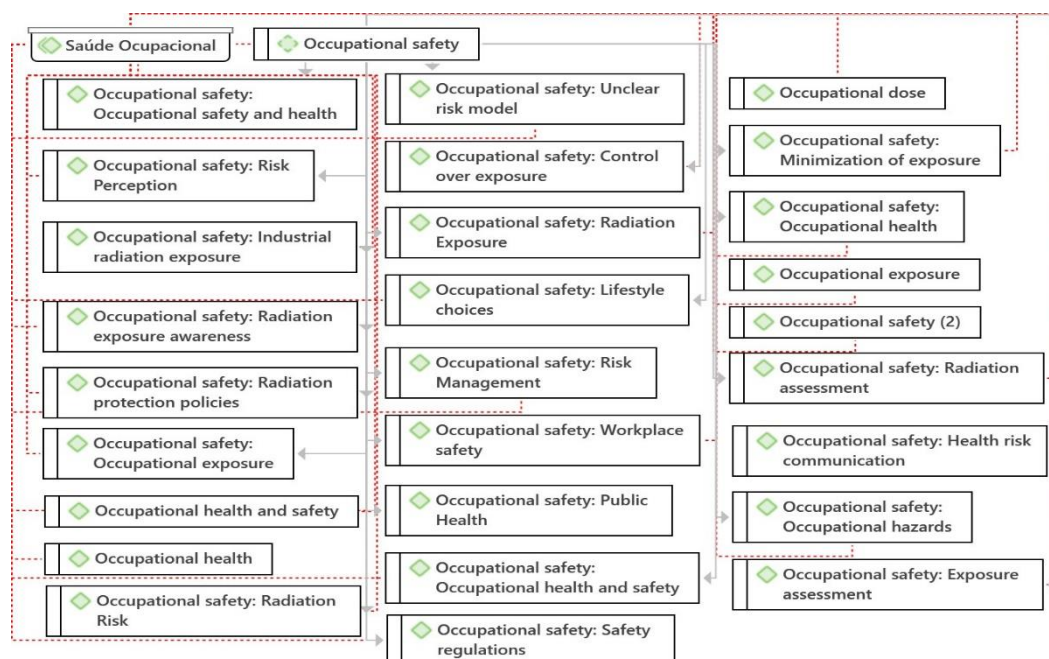
The software helps in the organization of qualitative data with different objectives, optimizing the information analysis process. We emphasize that the organization of a network occurs through all the relationships between codes and all the discussion and subsequent conclusion is due to the theoretical foundation of the researcher.

The main software tools that were used in the simulation can be described, according to Friese (2012), as follows: - Project: place within the software that will store all the data collected in the research, which will be saved and named at the researcher's discretion; - Documents: the researcher has the possibility to import documents in various formats into the software, files in PDF, word and odt format; - Codes: the researcher creates and defines the codes, considering the objectives and references that underlie the theoretical context.

The codes translate through small sentences the most important expressions within the texts, figure 02 exposes the codes as an example "occupational safety" relating each occurrence on occupational health identified in the articles.

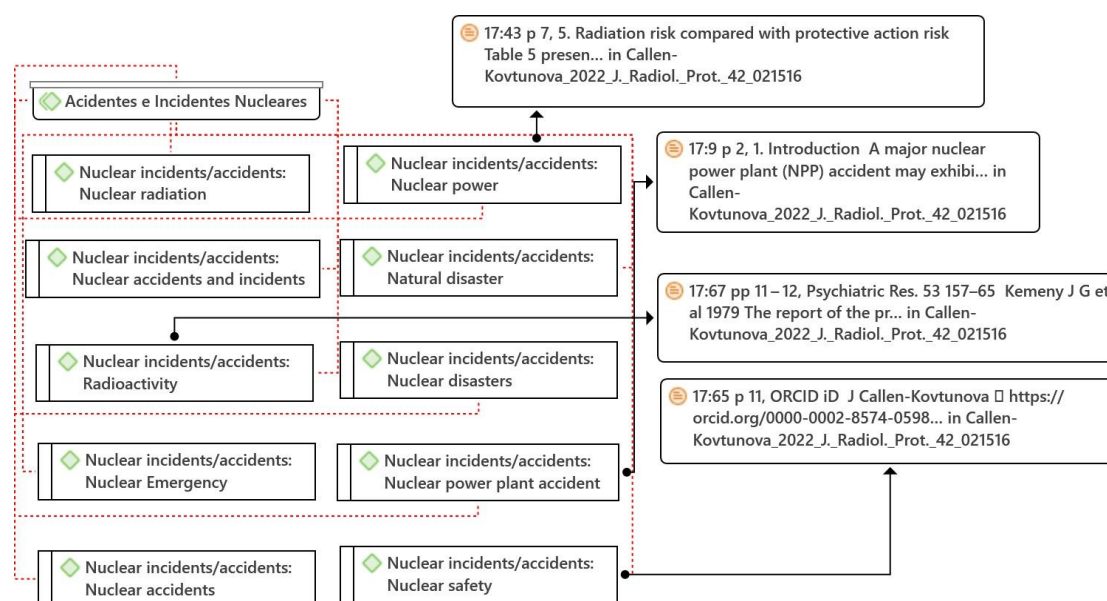
Figure 2

Network showing the codes identified in the documents



Source: by the authors (2025).

- Citations: are parts of the texts highlighted by the researcher stored within the software and also in the format of the networks created and shown in the software, as shown in figure 03.

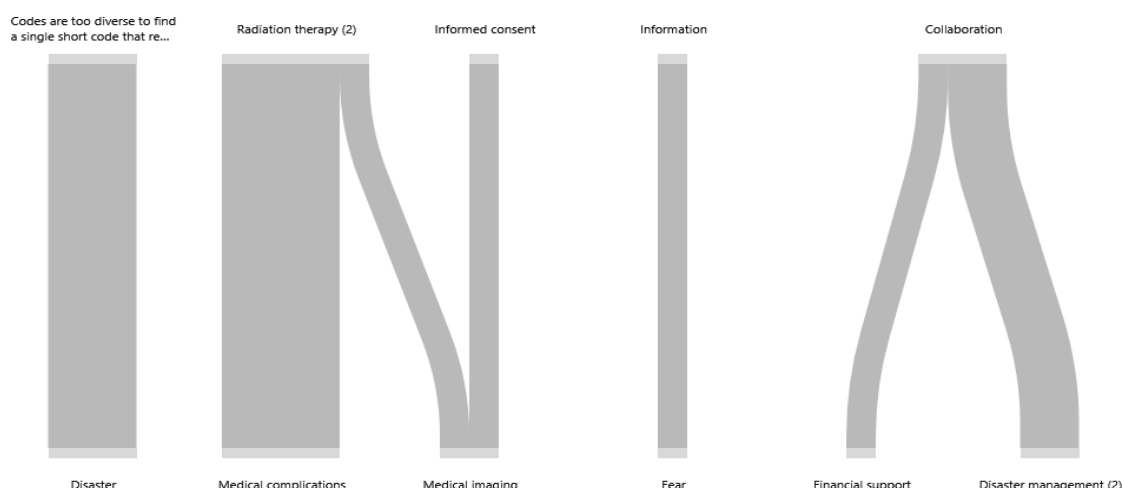
Figure 3*Illustration of codes and citations*

Source: by the authors (2025).

- Group of codes: according to the researcher's objective, this tool organizes the codes, with the association of expressive terms within the text. - Networks: illustrations created based on stored documents, codes and citations, as well as groups, created by the researcher. In general, the software fulfills its role well, which is to assist in the organization of data by assisting in the process of analysis in qualitative research of information obtained through the stored data. This fact allows the display of the layered information of the files within the software.

ATLAS.ti has practical operational resources, in addition to networks, showing other distribution formats and relationships between codes, possibilities and offering the researcher autonomy to innovate, exemplifying results visualized in graphic form (GONDIM et al., 2018).

The sankey diagram is one of these alternatives, obtaining a look at the distribution and frequency with which the codes appear, the graphs when interconnected demonstrate combination and relationship, called co-occurrence, observed in figure 4.

Figure 4**Sankey Diagram of Co-Occurrence of Codes**

Source: by the authors (2025).

In the figure, co-occurrence can be observed, that is, relationships between the codes, radiation therapy (radiological therapy) versus informed consent (informed consent) related to medical complications (disease condition), related to medical imaging (description of a region visualized by the physician).

Figure 5 illustrates the citations and codings, and allows you to view the excerpts from the articles with their codes, frequency, and number of codes assigned to each of the citations. From the selection of a paragraph in the document, or an expression, it is possible to view the frequency and numerical distribution of the encodings assigned in the respective citation. This format can be extracted from the software as a report in excel format, obtaining the list of codes and/or citations, gathered or separated.

Figure 5**Citations with their respective codes**

Source: by the authors (2025).

In figure 5, it shows us the citation linked to the expressive code disaster assigned 51 times, and the tool allows us to view the document from which each of the citations was identified and its reference.

Of the many tools available to the software, there are counterpoints that emphasize the fear that the researcher will produce too many and mechanical cuts that distance him from the general context and the meanings produced by it (CORUJO; RELAY; SILVA, 2019). The precautions that must be considered in this process are peculiar to other qualitative approaches, since the data do not speak for themselves and the meanings that emerge from them are part of the researcher's perspective.

To assist the process of organizing large volumes of information data from research, computational technologies (CAQDAS – Computer Assisted Qualitative Data Analysis Software) emerge, with different types of software for data analysis, which in their versatility have been used in research management, facilitating the analysis process, mainly by organizing large amounts of data, to optimize time and contribute to rigor and scientificity, especially in qualitative research. Artificial intelligence has helped humanity in different sectors of life, including the academic universe, providing researchers with the opportunity to optimize time in management and facilitating the process of data analysis, maintaining scientific and methodological rigor, enabling them to be more available to play the main role of critical and reflective analyst of research.

4 FINAL CONSIDERATIONS

The functionality of the Atlas.ti. software is an important tool that facilitates the storage and analysis of data, contributing to the challenge of providing quality and credibility in qualitative studies. The use of the software proved to be suitable for use in different approaches, especially in the qualitative one, saving time and facilitating the organization and analysis of data. In addition to being an uncomplicated operationalization, the software allows the researcher the possibility of analyzing qualitative data in less time and with greater reliability. In the set of articles analyzed, the contribution of research on the evolution of radiological protection over the years in the establishment of radiological protection standards and legislation is highlighted.

REFERENCES

ATLAS.ti Scientific Software Development GmbH. (2023). ATLAS.ti 25: Manual do usuário. <https://atlasti.com>

- ATLAS.ti. (2023). Conceptos básicos: Entrevista con Jörg Hecker, director general de ATLAS.ti, sobre el potencial de la IA para obtener información cualitativa [Entrevista]. ATLAS.ti Research Hub. <https://atlasti.com/es/research-hub/entrevista-con-jorg-hecker-ceo-de-atlas-ti-sobre-la-codificacion-de-ia-con-atlas-ti>
- Batista, V. M. D., et al. (2019). Proteção radiológica na perspectiva dos profissionais de saúde expostos à radiação. *Revista Brasileira de Enfermagem*. <https://dialnet.unirioja.es/servlet/articulo?codigo=8538512>
- Corujo, L., Revez, J., & Silva, C. G. da. (2019). Organização do conhecimento durante o processo de investigação: Utilização do ATLAS.ti em duas teses de doutoramento. In 14.º Congresso ISKO Espanha (4.º ISKO Espanha-Portugal) (pp. 1–9). [Local de publicação não informado; se disponível, incluir editora ou DOI].
- Friese, S. (2012). ATLAS.ti 7 user manual. ATLAS.ti Scientific Software Development GmbH. <http://atlasti.com/manuals-docs>
- Friese, S. (2014). *Qualitative data analysis with ATLAS.ti* (2nd ed.). Sage.
- Friese, S. (2019). *Qualitative data analysis with ATLAS.ti*. Sage.
- Gondim, S. M. G., et al. (2018). Análise de vídeo e imagens com suporte do ATLAS.ti: Exemplo de aplicação. *Revista Psicologia em Pesquisa*, 12(2).
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Análise de dados qualitativos: Um manual* (3ª ed.). Penso.
- Muhr, T. (2012). Atlas.ti 7 user manual. ATLAS.ti Scientific Software Development GmbH. <http://atlasti.com/manuals-docs> (Nota: Parece duplicado com Friese, 2012; verifique a autoria exata).
- Silva Junior, L. A., & Leão, M. B. C. (2018). O software Atlas.ti como recurso para a análise de conteúdo: Analisando a robótica no ensino de ciências em teses brasileiras. *Ciência & Educação* (Bauru), 24, 715–728.
- Soratto, J., Pires, D. E. P. de, & Friese, S. (2020). Thematic content analysis using ATLAS.ti software: Potentialities for researchs in health. *Revista Brasileira de Enfermagem*, 73.
- Thauata, L., et al. (2014). *Radioproteção e dosimetria: Fundamentos* (10ª ed.). Instituto de Radioproteção e Dosimetria - CNEN.
- Vano, E. (2011). Global view on radiation protection in medicine. *Radiation Protection Dosimetry*, 147(1-2), 3–7.

INTEGRATION OF MACROALGAE IN FISH FARMING: A SUSTAINABLE APPROACH

INTEGRAÇÃO DE MACROALGAS NA PISCICULTURA: UMA ABORDAGEM SUSTENTÁVEL

INTEGRACIÓN DE MACROALGAS EN LA PISCICULTURA: UN ENFOQUE SOSTENIBLE



<https://doi.org/10.56238/sevened2026.008-077>

Gabriel da Silva Nepomuceno Flores¹, Michelle Torres Dumith², Alejandra Filippo Gonzalez Neves dos Santos³

ABSTRACT

Aquaculture has grown globally due to limitations in extractive fishing and the increasing demand for fish; however, intensive systems generate significant environmental impacts, especially due to nutrient accumulation and deterioration of water quality. The aim of this study was to conduct a meta-analysis of bibliographic data related to research on integrated fish and macroalgae farming systems, highlighting the strategic relevance of the topic in the international scenario and its emerging importance in the Brazilian Aquaculture context. Thirteen studies were selected, totaling 27 valid comparisons. The analysis, performed using multilevel models with $\ln RR$ as the effect size, revealed that farming with macroalgae significantly increased fish growth ($\ln RR = 0.1492$; $p = 0.0184$), corresponding to an average increase of 16.1% compared to monoculture. The heterogeneity among the studies was significant, although partially explained by the evaluated moderators. Among the macroalgae species studied, *Gracilaria* sp. stood out with the most pronounced positive effect ($p = 0.0025$), while the duration of the experiments did not significantly influence the results. The absence of publication bias reinforces the reliability of the estimates obtained. In general, the findings show that integrated systems with macroalgae contribute to improving water quality, especially by reducing total ammoniacal nitrogen (TAN) and other nitrogenous compounds, while also favoring fish growth (SGR), based on a systematic review that selected 13 studies, totaling 27 valid comparisons. The analysis, performed using multilevel models with $\ln RR$ as the effect size, revealed that the present favors fish growth and increases the environmental and productive sustainability of fish farming. Despite these benefits, there is still a scarcity of studies, especially in tank systems and recirculating aquaculture systems (RAS), indicating the need for further, more standardized, and long-term research to consolidate the mechanisms involved and strengthen the ecological and economic potential of this approach.

¹ Laboratório de Ecologia Aplicada. Universidade Federal Fluminense (UFF). Rio de Janeiro, Brazil. E-mail: gabrielsnf@id.uff.br Lattes: <http://lattes.cnpq.br/2963993080912179>

² Programa de Pós-Graduação em Dinâmica dos Oceanos e da Terra. Universidade Federal Fluminense (UFF). Rio de Janeiro, Brazil. E-mail: michelledumith@id.uff.br Orcid: <https://orcid.org/0000-0002-0081-1116> Lattes: <http://lattes.cnpq.br/3166917073803475>

³ Programa de Pós-Graduação em Biotecnologia Marinha. Universidade Federal Fluminense (UFF). Instituto de Estudos do Mar Almirante Paulo Moreira (IEAPM). Rio de Janeiro, Brazil. E-mail: alejandrafilippo@id.uff.br Orcid: <https://orcid.org/0000-0002-3934-4279> Lattes: <http://lattes.cnpq.br/6767650336412406>

Keywords: Integrated Farming Systems. Macroalgae. Meta-Analysis. Fish Farming.

RESUMO

A Aquicultura tem crescido globalmente devido à limitação da pesca extrativista e à crescente demanda por pescado, porém os sistemas intensivos geram impactos ambientais relevantes, especialmente pelo acúmulo de nutrientes e pela deterioração da qualidade da água. O objetivo deste estudo consistiu em realizar uma meta-análise de dados bibliográficos referentes a pesquisas sobre sistemas integrados de cultivo de peixes e macroalgas, destacando a relevância estratégica do tema no cenário internacional e sua importância emergente no contexto aquícola brasileiro. Foram selecionados 13 estudos, totalizando 27 comparações válidas. A análise, realizada por meio de modelos multiníveis utilizando $\ln RR$ como tamanho de efeito, revelou que cultivos com a presença de macroalgas promoveram aumento significativo no crescimento dos peixes ($\ln RR = 0,1492$; $p = 0,0184$), correspondendo a um incremento médio de 16,1% em relação ao monocultivo. A heterogeneidade entre os estudos foi significativa, embora parcialmente explicada pelos moderadores avaliados. Entre as espécies de macroalgas estudadas, *Gracilaria* sp. destacou-se com efeito positivo mais pronunciado ($p = 0,0025$), enquanto a duração dos experimentos não influenciou significativamente os resultados. A ausência de viés de publicação, reforça a confiabilidade das estimativas obtidas. De modo geral, os achados evidenciam que sistemas integrados com macroalgas contribuem para a melhoria da qualidade da água, especialmente pela redução de nitrogênio total amoniacal (TAN) e outros compostos nitrogenados, ao mesmo tempo favorece o crescimento dos peixes (SGR), a partir de uma revisão sistemática que selecionou 13 estudos, totalizando 27 comparações válidas. A análise, realizada por meio de modelos multiníveis utilizando $\ln RR$ como tamanho de efeito, revelou que o presente favorece o crescimento dos peixes e aumenta a sustentabilidade ambiental e produtiva da piscicultura. Apesar desses benefícios, ainda há escassez de estudos, especialmente em sistemas de tanques e sistemas de recirculação (RAS), indicando a necessidade de pesquisas adicionais, mais padronizadas e de longo prazo, para consolidar os mecanismos envolvidos e fortalecer o potencial ecológico e econômico dessa abordagem.

Palavras-chave: Sistemas de Cultivo Integrado. Macroalgas. Meta-Análise. Piscicultura.

RESUMEN

La acuicultura ha crecido a nivel mundial debido a las limitaciones de la pesca extractiva y al aumento de la demanda de pescado; sin embargo, los sistemas intensivos generan impactos ambientales relevantes, especialmente por la acumulación de nutrientes y el deterioro de la calidad del agua. El objetivo de este estudio fue realizar un meta-análisis de datos bibliográficos provenientes de investigaciones sobre sistemas integrados de cultivo de peces y macroalgas, destacando la relevancia estratégica del tema en el escenario internacional y su importancia emergente en el contexto aquícola brasileño. Se seleccionaron trece estudios, totalizando 27 comparaciones válidas. El análisis, realizado mediante modelos multinivel utilizando $\ln RR$ como tamaño del efecto, reveló que los cultivos con presencia de macroalgas promovieron un aumento significativo en el crecimiento de los peces ($\ln RR = 0,1492$; $p = 0,0184$), lo que corresponde a un incremento promedio del 16,1% en comparación con el monocultivo. La heterogeneidad entre los estudios fue significativa, aunque parcialmente explicada por los moderadores evaluados. Entre las especies de macroalgas estudiadas, *Gracilaria* sp. se destacó con un efecto positivo más pronunciado ($p = 0,0025$), mientras que la duración de los experimentos no influyó significativamente en los resultados. La ausencia de sesgo de publicación refuerza la confiabilidad de las estimaciones obtenidas. En general, los hallazgos evidencian que los sistemas integrados con macroalgas contribuyen a la mejora de la calidad del agua, especialmente mediante la reducción del nitrógeno amoniacal total (TAN) y otros compuestos nitrogenados, al mismo

tiempo que favorecen el crecimiento de los peces (SGR). A pesar de estos beneficios, aún existe una escasez de estudios, especialmente en sistemas de tanques y sistemas de recirculación acuícola (RAS), lo que indica la necesidad de investigaciones adicionales, más estandarizadas y de largo plazo, para consolidar los mecanismos involucrados y fortalecer el potencial ecológico y económico de este enfoque.

Palabras clave: Sistemas de Cultivo Integrado. Macroalgas. Meta-Análisis. Piscicultura.

1 INTRODUCTION

Since the 1990s, Aquaculture has been consolidated as one of the fastest growing productive sectors in the world agricultural scenario, standing out for its growing capacity to meet the global demand for aquatic foods (Troell et al., 2009; Abreu et al., 2011; FAO, 2022). Data from the Food and Agriculture Organization (FAO) show that the cultivation of aquatic organisms showed the highest average growth rates between the years 2000 and 2016, remaining in 2020 as one of the main food products traded internationally, with about 60 million tons exported, excluding algae (FAO, 2018; Ahmed et al., 2019; FAO, 2022). The sector's advance is driven, above all, by the stabilization of extractive fishing, which has ceased to keep up with the increase in global demand, positioning Aquaculture as an essential alternative in a context of limited natural resources (Waite et al., 2014). In 2022, the sector reached a historic milestone by surpassing, for the first time, extractive fishing, registering approximately 94 million tons — about 51% of all production of aquatic organisms (Seafood, 2024; FAO, 2024).

World production is heavily concentrated in Asian countries, with China and Indonesia leading the way in marine cultivation since the 1990s. In Brazil, a country with vast aquaculture potential, shrimp farming, bivalve mollusk farming, and continental fish farming stand out as the main activities in operation (Nascimento et al., 2022). Despite the promising start in the 1930s, national marine fish farming remains little explored, reflecting structural, technological and coastal environment use planning challenges (Cavalli et al., 2009; FAO, 2022).

The expansion of fish farming—particularly those conducted in intensive monoculture systems—has been accompanied by a series of environmental impacts and production limitations (Naylor et al., 2000; Valiela et al., 2001). The accumulation of nutrients, especially nitrogen and phosphorus, can cause chemical changes in sediments, compromise the benthic community, and reduce local biodiversity (White et al. 2004; Naylor et al., 2005). Studies show that these effects deteriorate environmental quality, increase operating costs and increase economic risks for producers, especially due to dependence on external inputs and the vulnerability of the production system to environmental fluctuations (Cabelo 2006; Mazur & Curtis 2008; Bergqvist & Gunnarsson 2013; Kerrigan et al., 2018).

In the face of these challenges, alternative production models have been gaining prominence, especially Integrated Multitrophic Aquaculture (IMTA). Although species integration is an ancient practice, with millennial records in traditional Asian systems, the modern concept of IMTA gained notoriety in the early 2000s, driven by research that demonstrated its ability to mitigate the environmental impacts of intensive fish farming

(Chopin, 2001; Mirzoyan et al., 2010). In this system, cultivated species of different trophic levels interact in a complementary way: organic and inorganic extractive organisms take advantage of metabolic waste generated by fish, promoting bioremediation, economic diversification and greater production efficiency (Chopin et al., 2010). Thus, this integrated production system seeks to minimize the ecosystem impacts of monoculture, as well as to optimize fish production, reaching the growth potential of Aquaculture, and bringing a better financial cost-benefit (Rhyter et al., 1975; Neori et al., 2004).

Among the most promising extractive components, macroalgae occupy a prominent position (Castelar et al., 2014). Endowed with a high capacity for assimilating nutrients, these organisms act as true biological filters, removing nitrogenous compounds, stabilizing the pH and raising the dissolved oxygen in the water (Neori et al., 2004; Kang et al., 2012). As a consequence, they contribute to the improvement of water quality, the well-being of farmed fish, and the reduction of the system's environmental impacts (Araújo et al., 2018). In addition, they have low production costs and wide potential for economic use, whether in the food, pharmaceutical, cosmetic, biofuel or animal feed industries (Lal et al., 2005; Suutari et al., 2014). Rhodophytes are widely cultivated for the production of carrageenan and agar, while chlorophytes, although less produced, represent an important source of ulvan, a polysaccharide of growing industrial interest (Torres et al., 2019; Lakshmi, 2020).

Despite their advantages, integrated systems with macroalgae and fish still face operational and technological challenges, especially in open marine environments, where biomass control, the risk of escapes, and hydrodynamic variations make management difficult (Buschmann et al., 2001). In addition, regulatory limitations, the absence of specific regulations and the resistance of some producers, often associated with the lack of technical knowledge and the initial costs of adaptation, still restrict the commercial expansion of IMTA in several countries (Troell et al., 2003; Barrington et al., 2009; Granada et al., 2016).

In this context, understanding the development of Aquaculture, its challenges and the emerging sustainable alternatives is essential to guide the sector's transition towards more resilient, efficient and environmentally responsible production models. Integrated systems, especially those based on the incorporation of macroalgae, represent a promising strategy to reconcile economic production, sustainability and conservation of aquatic ecosystems.

The integrated system with macroalgae appears in the literature as an excellent alternative to mitigate or solve the main problems of intensive fish farming, being, however, a recent practice and with few studies that synthesize and compare the research elaborated on this theme. Thus, the objective of this study was to carry out a meta-analysis of bibliographic data related to research on integrated fish and macroalgae cultivation systems,

highlighting the strategic relevance of the theme in the international scenario and its emerging importance in the Brazilian aquaculture context.

2 MATERIALS & METHODS

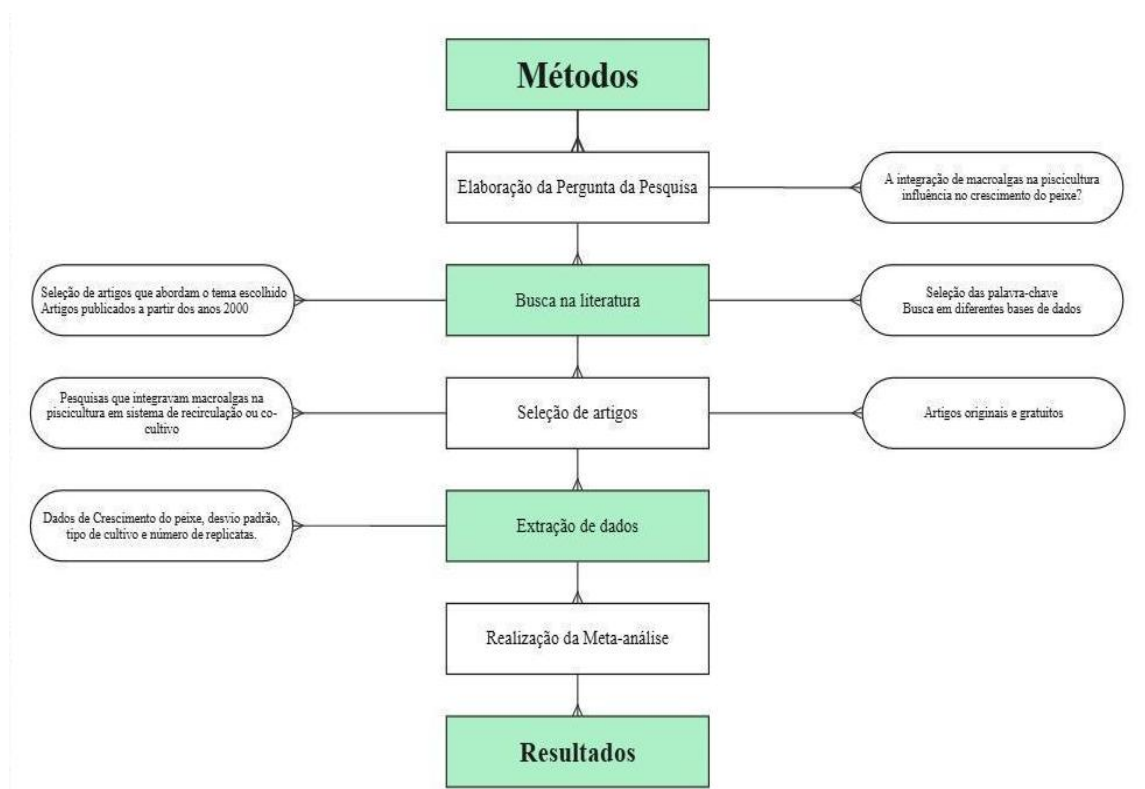
2.1 LITERATURE REVIEW AND DATA COMPILATION

A bibliographic database on integrated fish and macroalgae cultivation systems was carried out through Google Scholar (<https://scholar.google.com/>), Science direct (<https://www.sciencedirect.com/>), Wiley (<https://onlinelibrary.wiley.com/>), Periodicos Capes and Academy (<https://www.periodicos.capes.gov.br/> and Academia.Edu). The following keywords were used: "IMTA"; "seaweed"; "TAN", "fish", "growth", "bioremediation" and "polyculture", selecting works written since the year 2000. The first 1000 publications retrieved from the survey were screened. In addition, an intense search was carried out in the bibliographic data of each article, to add works to the present study. The data were extracted only from scientific articles published and freely available. Gray literature was excluded from the database.

The studies with recirculating water (RAS) that reported the specific growth rate (SGR) of the fish, duration of the experiment (days), macroalgae and fish species, total ammonia nitrogen (or TAN) content, type of cultivation (polyculture or monoculture), experimental control conditions and number of replicates were compiled in a single database (Figure 1). Works that did not have one or more necessary information were excluded from the present study. In addition, authors were asked whenever these data were not available. To compose the database, the year of publication and the location, when available, were also inserted. Some studies presented more than one measured abiotic variable associated with water quality, which were not selected because they were not common to all publications.

Figure 1

Flowchart of methodology for selecting articles, determining the selection criteria



2.2 STATISTICAL ANALYSES

Statistical analysis was conducted according to the guidelines proposed by Harrer et al. (2021), in the manual *Doing Meta-Analysis in R*, using the R Core Team software (version 4.5.1; 2025) and the metafor package (Viechtbauer, 2010). The values absent standard deviation were imputed, based on the average coefficient of variation per fish species, given by the formula, according to the methodological recommendation of Higgins & Green (2008) and Nakagawa & Santos (2012), in order to avoid the loss of valid comparisons and reduce the bias associated with the exclusion of incomplete studies.

For each study included in the database, the log response ratio (lnRR) was calculated, which expresses the magnitude of the effect of the treatment in relation to the control (Hedges & Vevea, 2005; Lajeunesse, 2010). Expressed by, where $\bar{X}^{trat}$ and $\bar{X}^{cont}$, are the means of the specific growth rate (SGR) of fish in the treatments with and without macroalgae respectively. The variance of lnRR was calculated based on the propagation of the error of the means and their respective standard deviations and sample sizes (n^{Trat} and n^{Cont}), according to the classical formula of (Hedges et al, 1999): where is the standard deviation and the number of replicates. The formulas were applied using automatic functions available in the metafor package. Multilevel models with and without moderators were adjusted, using the Restricted Maximum Likelihood Estimator (REML), with a hierarchical structure of random

effects, considering the existence of multiple comparisons in the same study, allowing the variance between studies and within studies to be estimated separately (Konstantopoulos, 2011; Nakagawa & Santos, 2012).

The basic model can be expressed as $y_{ij} = \mu + u_j + v_{ij} + \varepsilon_{ij}$; the y_{ij} , effect size observed in the j - comparison of the study μ the global $u_j \sim N(0, \tau_{entre}^2)$ average effect represents the variance between studies $v_{ij} \sim (0, \tau_{intra}^2)$ represents the variance between comparisons within the studies; is the sampling error associated with variance v_{lnRR} . The model with moderators (explanatory variables), corresponding to the algae species and the duration of the experiment, thus the model is expressed by $y_{ij} = \beta_0 + \beta_1(espécie\ de\ alga) + \beta_2(duração) + u_j + v_{ij} + \varepsilon_{ij}$, allowing to investigate the heterogeneity observed in the differences between the species used or in the time of the experiment.

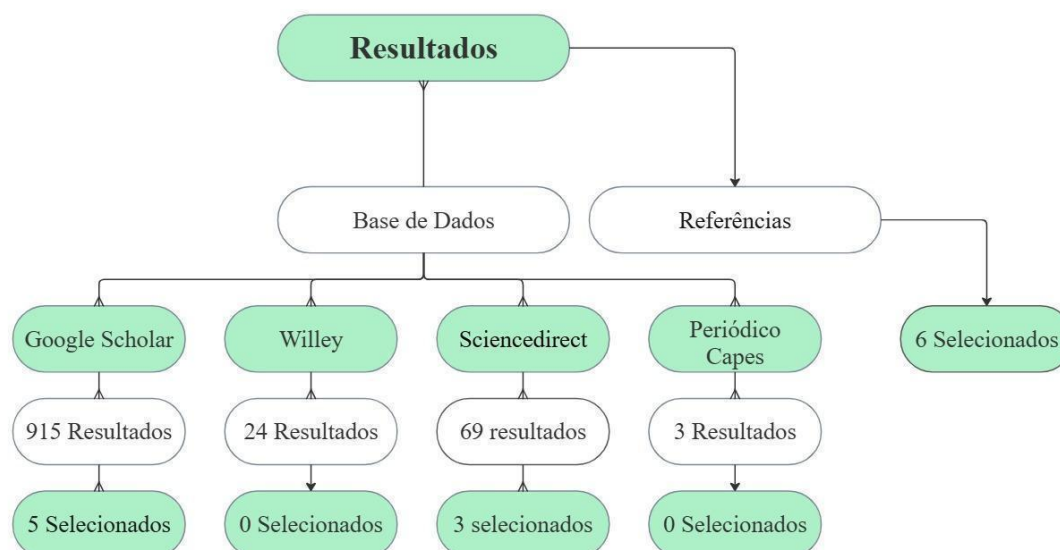
Due to the limited interpretation of I², it was decided to report the τ^2 values by level, as recommended by Konstantopoulos (2011) and Viechtbauer (2010). The Egger test (Egger et al., 1997) was used to investigate the presence of publication bias, selecting a simpler study comparison for later application of the regtest function, with the absence of significance indicating symmetry in the funnel graph and reducing the probability of publication bias. The prediction was obtained using the predict() function, with point estimates ($\hat{\mu}$), standard error (SE), confidence intervals (CI) and prediction intervals (PI).

3 RESULTS

Most of the selected works were found on the Google Scholar platform. The other databases provided low return of works, both in general, with the use of keywords, and for the selection of articles following the specifications necessary for inclusion in the meta-analysis. The bibliographic references of the selected works also helped to quantitatively optimize this work (Figure 2).

Figure 2

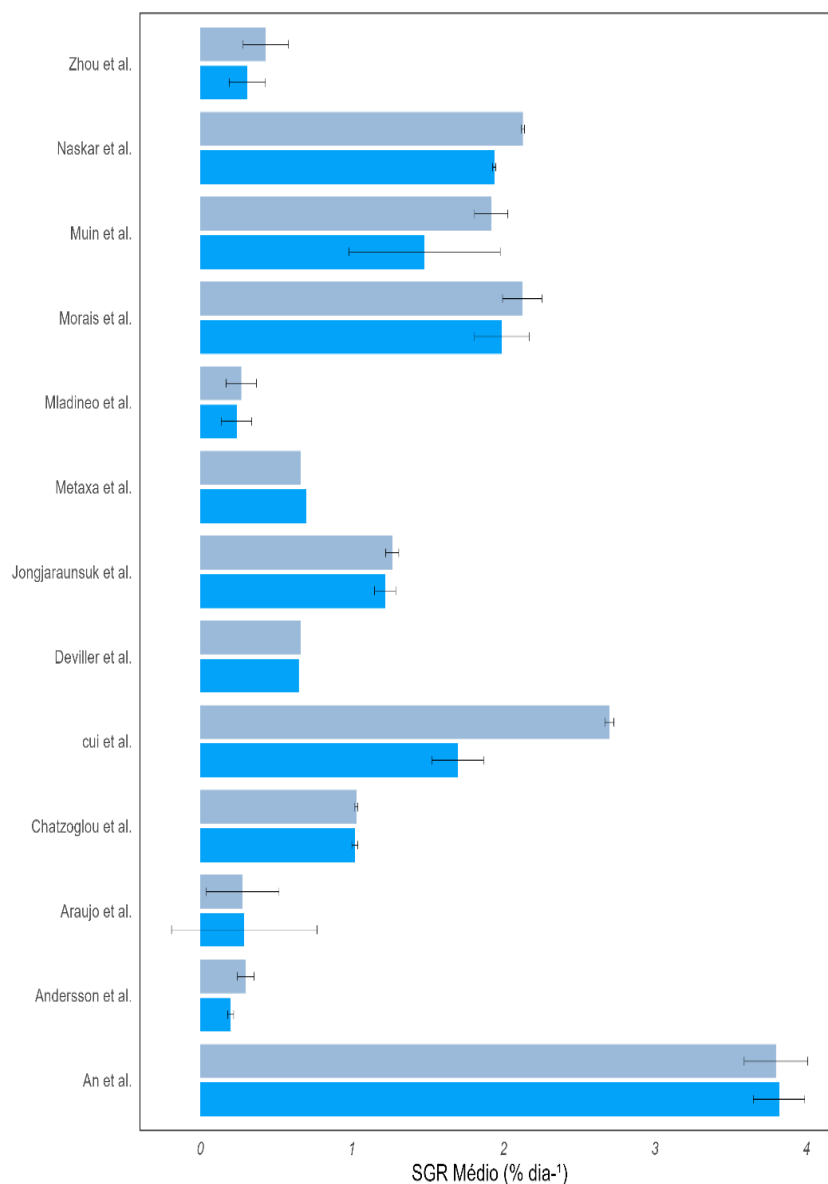
Summary of the results found in online searches for experiments in published articles



In all, only 13 studies were found that compared the breeding of at least one species of fish integrated to a species of macroalgae, with a control group, presenting data on the specific growth of the fish both in the control and in the experiment (Figure 3) and presenting culture in the same tank or in a recirculation system. Of these selected studies, 27 experiments were screened for use in the meta-analysis, presenting all the data necessary for their integration (Table 1).

Figure 3

Mean growth rate $\pm$ standard deviation of fish (SGR) per author (means per replicates). Light blue = treatment; and dark blue = control

**Table 1**

Sorting of the data of the selected articles. The Mix algae species correspond to the treatments that used more than one algae species (*Ulva*, *Enteromorpha* and *Cladophora*)

Authors	Replicas	Duration of the Experiment	Fish Species	Algae Species	TAM (mg/L) Experiment	TAM (mg/L) Control
An & Anh (2020).	1	56	<i>Oreochromis niloticus</i>	<i>Gracilaria tenuistipitata</i>	0.70	1.53
Andersson et al. (2025)	2	126	<i>Oncorhynchus mykiss</i>	<i>Ulva fenestrata</i>		
Araújo et al. (2025)	1	65	<i>Sparus aurata</i>	<i>Ulva ohnoi</i>		
Chatzoglou et al., (2020)	1	84	<i>Dicentrarchus labrax</i>	<i>Ulva sp</i>	0.73	0.70

Cui et al. (2025)	1	30	<i>Pearl gentian grouper</i>	<i>Gracilaria sp</i>		
Deviller et al. (2004)	1	365	<i>Dicentrarchus labrax</i>	<i>Mix</i>	0.34	0.30
Jongjaraunsuk et al., (2025)	3	30	<i>Lates calcarifer</i>	<i>Caulerpa lentillifera</i>	0.70	1.20
Metaxa et al. (2006)	1	365	<i>Dicentrarchus labrax</i>	<i>Mix</i>	0.34	0.24
Mladineo et al. (2010)	1	365	<i>Dicentrarchus labrax</i>	<i>Chlorophyceae</i>	0.15	0.14
De Moraes et al. (2023)	2	54	<i>Oreochromis niloticus</i>	<i>Ulva ohnoi</i>		
Muin et al. (2024)	2	30	<i>Red Hybrid Tilapia</i>	<i>Gracilaria changii</i>	0.71	2.17
Naskar et al. (2023)	3	60	<i>Chanos chanos</i> ,	<i>Enteromorpha intestinalis</i>	0.58	0.77
Zhou et al. (2006)	8	35	<i>Sebastodes fuscescens</i>	<i>Gracilaria lemaneiformis</i>	0.28	1.13

The adjusted multilevel model considered the dependence between comparisons of the same study, using a total of 27 comparisons and showed adequate convergence under the REML method. For the model, the random effects nested between the studies and between the comparisons within the same study were considered, evaluating the influence of the macroalgae species and the duration of the experiment (in days) on the combined effect of integrated fish and macroalgae cultivation.

Initially, a multilevel meta-analysis (model without moderators) was conducted to estimate the overall effect size, considering the hierarchical structure of the data. The analysis revealed an estimated overall effect size LnRR of 0.1492 (SE = 0.0593), which was statistically significant ($z = 2.51$; $p = 0.0184$; 95% CI [0.0272; 0.2712]; AIC = 0.0101; BIC = 3.8). This result indicates that, in general, the experimental treatment promoted a significant increase in the fish-specific growth rate, with an average increase of about 16.1% in the macroalgae group compared to the control group (since positive LnRR indicates an increase) (Viechtbauer, 2010). Cochran's heterogeneity test indicated significant heterogeneity between the studies ($Q(26) = 196.09$; $p < 0.0001$). The residual variability between studies ($= 0.0249$) was considerably higher than the variability between comparisons within the same study ($= 0.0017$). This suggests that methodological or biological differences between studies contribute more to the observed heterogeneity than variations within the same experiment. $\tau_{\text{entre}}^2 \tau_{\text{intra}}^2$

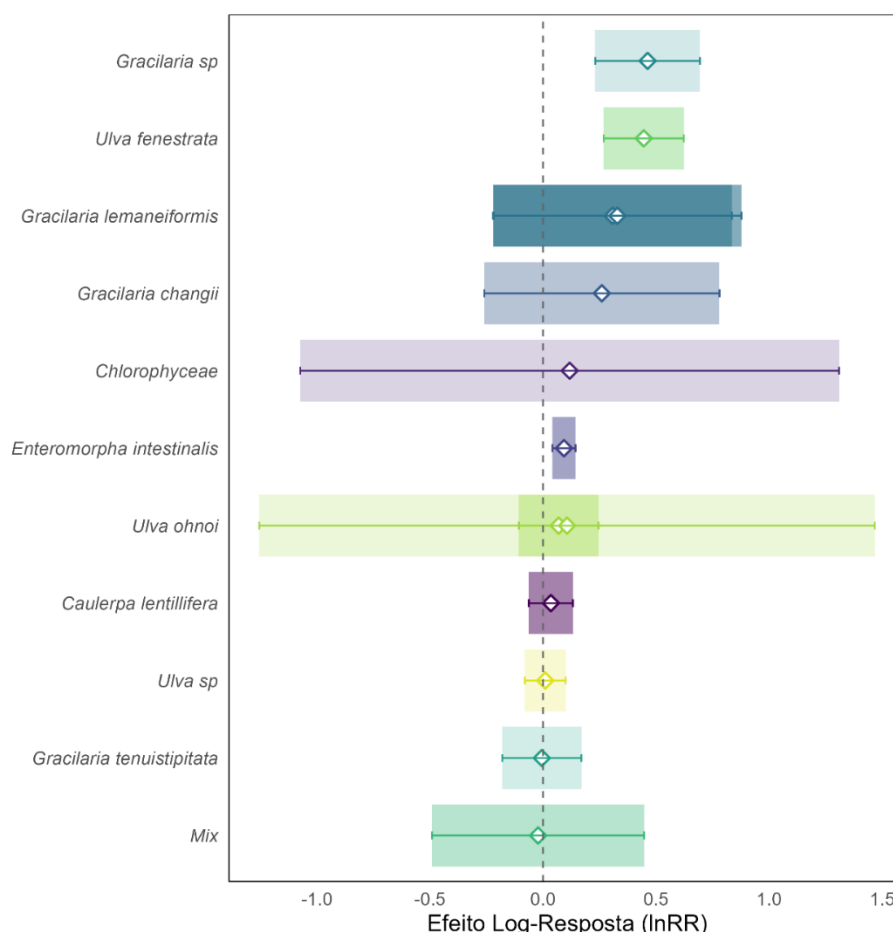
In order to investigate the sources of this heterogeneity, a multilevel meta-regression model was adjusted including the moderating variables "Macroalgae Species" and "Duration of the Experiment" (days). The test for the moderators was statistically significant ($F(11,15) = 3,530$; $p = 0.0128$), indicating that the variables included explain a significant portion of the

variability of the effect sizes. Residual heterogeneity remained significant ($QE(15) = 100.1$; $p < 0.0001$), suggesting the existence of other unmeasured factors that still influence the results.

In the analysis of the individual coefficients of the meta-regression, the continuous variable referring to the duration of the experiment did not present statistical significance ($\tau^2 = 0.0034$; $p = 0.9542$), indicating that the exposure time, within the analyzed interval, was not a determinant linear predictor for the variation in the size of the effect. On the other hand, the categorical analysis of the macroalgae species revealed specific differences. *Gracilaria* sp. showed a positive and highly significant effect ($\tau^2 = 0.4279$; $p = 0.0025$; 95% CI [0.1767; 0.6791]), which corresponds to a mean increase of about 53.4% in treatment compared to control. The other species and consortia did not present statistically significant differences in relation to the baseline level of the model ($p > 0.05$ for the other coefficients), although there were wide confidence intervals for categories with lower sample representativeness (Figure 4). On the other hand, the ratio between the highest and lowest sampling variance was extremely large, resulting in unstable results. This was confirmed in the result for the Akaike model (AIC = 17.34) and the Bayesian Information Criterion (BIC = 27.25) which are significantly higher for this model, which indicates an unfavorable performance.

Figure 4

Standardized effects by algae species. Each point represents the estimated mean effect (lnRR). The error bars are the confidence intervals (95% CI). The overlapping of colors indicates the contribution of further studies for each species. Mix = treatments that used more than one species of algae (*Ulva*, *Enteromorpha* and *Cladophora*)

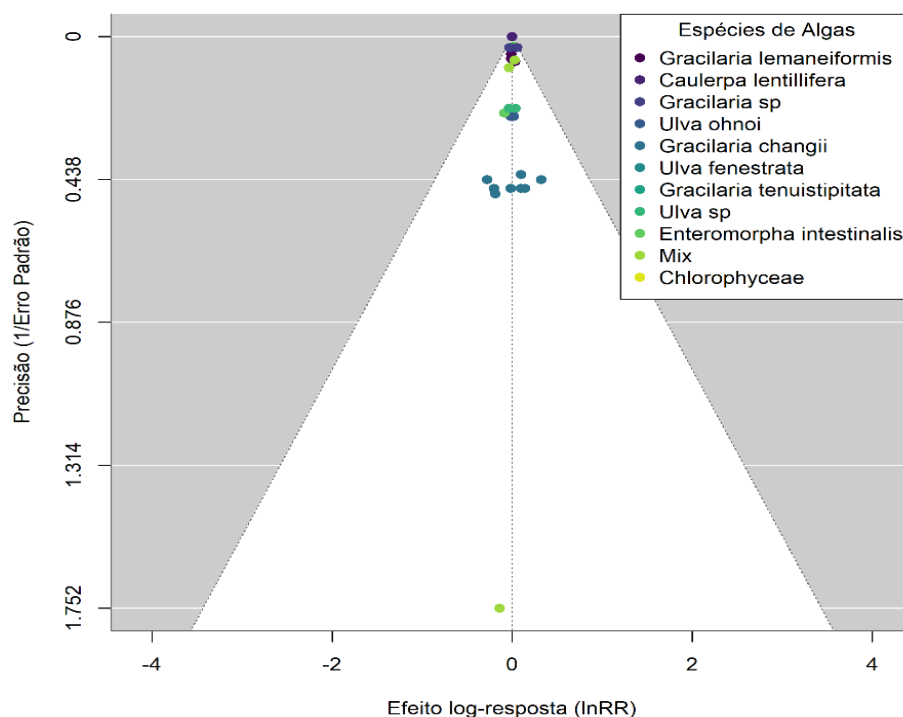


In this moderator analysis, the residual variability between studies was nil ($\tau_{entre}^2 = 0$) relative to the variability between comparisons within the same study ($\tau_{intra}^2 = 0.04$). This suggests that, after the inclusion of the moderators, there was no further variation between the studies analyzed.

The Egger test, modified for multilevel models, evaluated the robustness of the results in terms of publication bias, using a representative comparison per study to ensure data independence. The test did not show significant asymmetry in the funnel graph ($z = 0.2079$; $p = 0.8353$), which suggests the absence of detectable publication bias in this sample of studies (Figure 5). This result reinforces the symmetry in the distribution of the studies and the robustness of the estimates obtained, suggesting that there is no evidence of publication bias among the studies included in the meta-analysis (Egger et al., 1997).

Figure 5

Funnel Chart - Asymmetry Assessment. Dots represent an effect size as a function of their standard error (precision). The symmetrical shape of the funnel around the centerline indicates the absence of publication bias. Mix = treatments that used more than one species of algae (Ulva, Enteromorpha and Cladophora)



4 DISCUSSION

In general, the results reveal that the presence of macroalgae in fish farming systems promotes positive and consistent effects, especially through ecological mechanisms of synergy and biofiltration, such as those presented in Table 1 (Neori et al., 2004). From the synthesis of the data and the marked reduction in total ammonia nitrogen (TAN) levels, it is possible to infer that the fish-macroalgae interaction plays a central role in optimizing productivity in integrated systems (Chopin et al., 2001). The increases in fish-specific growth rate (SGR) observed in the studies are attributed to the improvement in water quality due to efficient nutrient recycling mediated by macroalgae (Neori et al., 2004; Chopin et al., 2001; Msuya & Neori, 2008; Neori et al., 2004).

Macroalgae use the nitrogenous excreta of fish as a source of nutrition, converting these compounds into their own biomass (Ramli et al., 2020). This internal nutrient cycle reduces nitrogen loss to the system, while improving overall energy efficiency, as less energy is wasted in detoxification processes or oxidative stress caused by unused ammonia (Troell et al., 2003). For example, the classic study by Zhou et al. (2006) showed that *Gracilaria*

G. lemaneiformis integrated with the cultivation of *Sebastodes fuscescens* in coastal waters, can remove significant amounts of dissolved nitrogen and phosphorus, functioning as an efficient "nutrient pommel", reducing the waste load and contributing to the ecological sustainability of the system. Additionally, macroalgae perform a crucial ecosystem service in the physicochemical stabilization of the water column. Through photosynthesis, they promote the sequestration of dissolved CO₂ and oxygen supplementation, acting directly in pH buffering and mitigating hypoxia or acidification of water (Msuya & Neori, 2008). This environmental stability reduces the metabolic cost associated with osmoregulation and acid-base balance of fish (Barrington et al., 2009). By minimizing energy expenditure in compensatory responses to respiratory stress, a more efficient allocation of resources for somatic growth and immune integrity is observed (Barrington et al., 2009). Therefore, the greater biological efficiency in integrated systems does not only result from decontamination, but also from the reduction of environmental fluctuations that required constant homeostatic adjustments.

The quantitative analysis of the data (Figure 3) corroborates the efficiency of bioremediation in mitigating nitrogen toxicity. A drastic reduction in total ammonia nitrogen (TAN) concentrations is observed in integrated systems, which is exemplified by the cultivation of macroalgae. A similar pattern has been documented for *Lates calcarifer* integrated with *Caulerpa lentillifera*, indicating an absorption capacity that prevents the accumulation of nitrogenous compounds at lethal or sublethal levels (Chaitanawisuti et al., 2011). In addition, the cultivation of macroalgae can bring indirect ecological benefits: for example, studies have shown that the presence of *G. lemaneiformis* can increase plankton biodiversity and modulate the microbial community in coastal systems, which can favor a more stable and balanced aquatic environment (Chai et al., 2018). Therefore, the presence of macroalgae in their experiments, reflected in total ammonia nitrogen (TAN) reductions and relatively low standard deviations in some control points, is consistent with the literature that reinforces the ecological value of integrated systems.

The values of the fish-specific growth rate (SGR) observed in figure 3, on the other hand, vary greatly. This variability may reflect methodological differences between studies (e.g. in algae density, not incorporated here) or in the culture mode (IMTA, RAS, bioflocs), in fish species, and in the duration of the experiments. Studies such as De Morais et al. (2023), show that the density of *Ulva ohnoi* in biofloc systems can influence both nutrient recovery and total productivity. The authors compared three treatments (without algae, 1 g·L⁻¹ e 2 g·L⁻¹ of *U. ohnoi*) and observed that both treatments with algae promoted greater nitrogen and phosphorus recovery, in addition to increased overall productivity, without significant impairment in fish and shrimp growth (De Morais et al., 2023). The physiological relevance

of this removal lies in the prevention of histopathological and metabolic damage. Chronic exposure, even at moderate ammonia levels, induces branchial hyperplasia, impairs gas exchange, and inhibits central nervous system enzymes, resulting in seizures and appetite suppression (Ip & Chew, 2010). Therefore, the presence of macroalgae acts as a toxicological barrier, keeping water quality within physiological tolerance limits and ensuring the osmoregulatory integrity of fish.

The bioremediation role of macroalgae extends to the management of the balance of nutrients essential for the ecological health of the system. Empirical evidence, such as the work carried out in Brazil by (Castelar et al., 2015), demonstrates that species such as *U. fasciata* and *G. birdiae* are able to efficiently remove ammonia and nitrate from effluents, reaching rates of more than 98% of ammonia removal in a five-day cycle in tanks. These authors also emphasize that the simultaneous assimilation of phosphate by these macroalgae contributes to the maintenance of a healthy nutritional balance in the effluent (Neori et al., 2004). This extraction of multiple nutrients prevents excessive accumulation that triggers eutrophication, the proliferation of unwanted microalgae and extreme oxygen fluctuations in the environment (Neori et al., 2004), ensuring ecological stability and reducing the environmental impact of the integrated system (Buschmann et al., 2008).

Within the premises of a quantitative review with a moderate number of comparisons ($k=27$) involving different species, the results of the meta-analysis are considered statistically consistent. As evidence to support this robustness, Egger's alternative test can be considered, which did not indicate asymmetry in the funnel. This suggests that the results are not inflated by publication bias, allowing greater confidence in the estimates obtained (Egger et al., 1997). Another factor indicates the low variance between studies, reinforcing the good calibration of the effects within the samples carried out. Among the factors, the set of moderators "macroalgae species + duration" was significant, indicating that the model has real explanatory capacity, and not just noise. Corroborating this, the average effect ($\pm 16\%$) suggests a positive overall trend without exaggeration (Cohen, 2013), with the amplitude of the interval being aligned with the sample size (Borenstein et al., 2021). This pattern is common in ecological reviews when few categories show truly high effects (Koricheva; Gurevitch; Mengersen, 2013), while the others remain close to neutrality. In multilevel meta-analysis models, such behavior suggests the presence of biologically relevant moderators influencing specific responses (Konstantopoulos, 2011).

The absence of a significant effect of the duration of the experiments indicates that the exposure time, within the range included in the studies, did not systematically contribute to explain the magnitude of the results. This absence of temporal trend is common in ecological

syntheses and usually indicates that physiological and ecological responses tend to stabilize rapidly (Gurevitch et al., 2018), or that studies use similar temporal windows (Koricheva et al., 2013).

The strongly significant result found for the species *Gracilaria gracilis* sp and the absence of effect for other species is an expected pattern when few macroalgae have really high effects, or when species treated as categories show marked ecological differences (Bokhtiar et al., 2022; Li-Hong et al., 2002). In summary, this suggests that, although the average effect is positive, the magnitude of this result is not uniform across species or studies. The low inter-study variance ($\tau^2 \approx 0$) indicates that most of the detected variability is attributed to the differences within the studies themselves, which is consistent with controlled and reproducible experimental structures (Bokhtiar et al., 2022; Patterson & Thompson, 1971). The highly significant effect observed for *Gracilaria* sp demonstrates that this genus exerts a disproportionately greater impact when compared to the other macroalgae species analyzed here. For example, Wang et al. (2014) showed that the species *Gracilaria tenuistipitata* has a high growth rate under moderate concentrations of salinity (12–20) and high levels of inorganic nitrogen (NH_4^+ and NO_3^-), in addition to a marked preference for NH_4^+ , which helps explain its ability to form blooms in estuarine environments. In addition, there is evidence that the experimental results for this genus are quite reproducible in different controlled studies. In cultivation on the coast of Cox's Bazar (Bangladesh), Bokhtiar et al. (2022), found systematic ways to optimize yield through manipulation of the lunar cycle, harvest interval, type of crop row, and sowing spacing.

The analysis of the data, reinforced by the specialized literature, highlights crucial methodological challenges that limit the generalization of the results of studies in integrated systems. First, the experimental design often lacks sufficient replicates or adequate cultivation scales for the intrinsic complexity of the system. This low replication compromises statistical validity and extrapolation, especially due to the great intrinsic variability between tanks, resulting from the complex interaction of organisms, nutrients, and microenvironments (Buschmann et al., 2001). One of the main critical limitations is the duration of the experiments, which in the review ranges from 30 to 365 days. Short-term studies can capture rapid improvements in total ammonia nitrogen (TAN) without, however, elucidating the long-term effects, such as nutrient saturation or competition for light and space, that influence the biomass allocation of algae.

Finally, the taxonomic variability among macroalgae is a determining factor for the heterogeneity of the results of fish-specific growth rate (SGR) and total ammonia nitrogen (TAN). Species such as *Gracilaria* sp and *Ulva* sp demonstrate different nutrient uptake

kinetics (e.g. different affinities for ammonia and nitrate) which requires a more robust methodological standardization to optimize nutrient extraction and maximize the growth of cultured organisms (Neori & Msuya, 2008). However, this review showed that there must be a good selection of species to be included in integrated cultivation systems, especially of macroalgae. It is known that each group has a better uptake of nutrients. In addition, the influences of different biomasses among the macroalgae could not be evaluated, which may evidence the need for different initial biomasses for each type of macroalgae in order to optimize their functions. Thus, studies that evaluate which species of macroalgae are more specifically indicated to be cultivated with certain species of fish become extremely important.

5 CONCLUSION

The integrated analysis of empirical data and specialized literature confirms that integrated cropping systems constitute a functional and sustainable advance compared to traditional monoculture models. The inclusion of macroalgae contributes decisively to the mitigation of nitrogen toxicity and to the stabilization of physicochemical parameters, by converting metabolic by-products into useful biomass and closing essential biogeochemical cycles. In physiological terms, this more balanced environment favors greater biological efficiency and higher growth rates, since it reduces the energy demand for homeostatic maintenance and allows greater investment in anabolism. However, the consolidation of this technology still faces interpretative challenges. The heterogeneity of the statistical results, added to recurrent methodological limitations — such as low experimental replication, large temporal amplitude between studies, and high interspecific variability in the kinetics of nutrient uptake — highlights the need for standardization in research protocols. Thus, future investigations should prioritize long-term studies and pilot-scale experiments, in order to improve carrying capacity models and ensure that the observed ecological feasibility translates into productive and economic stability.

ACKNOWLEDGEMENTS

We thank the Laboratory of Applied Ecology (LEA) and the Experimental Ichthyology Animal Facility for providing infrastructure support for data analysis and processing, and FAPERJ proc. E26/202826/2019 for funding the research.

REFERENCES

- Abreu, R., et al. (2011). Aquaculture of marine shrimp in Brazil: Industry trends and outlook. *Aquaculture*, 315(316), 1–7.
- Ahmed, M., et al. (2019). Marine shrimp aquaculture and sustainability: Ecological, social, and economic dimensions. *Environmental Management*, 64, 107–121.
- An, B. N. T., et al. (2020). Co-culture of Nile tilapia (*Oreochromis niloticus*) and red seaweed (*Gracilaria tenuistipitata*) under different feeding rates: Effects on water quality, fish growth and feed efficiency. *Journal of Applied Phycology*, 32(3), 2031–2040.
- Andersson, M., et al. (2025). Co-farming rainbow trout (*Oncorhynchus mykiss*) and sea lettuce (*Ulva fenestrata*) increased macroalgae protein content and positively affected fish welfare. *Aquaculture*, 607, Article 742685.
- Araújo, J., et al. (2025). Integration of *Ulva ohnoi* in a recirculating aquaculture system for gilthead seabream (*Sparus aurata*) and its use as feed for sea urchin (*Paracentrotus lividus*) production: A contribution to circular and sustainable aquaculture practices. *Fishes*, 10(9), Article 447.
- Araújo, P., et al. (2018). Tópicos gerais sobre licófitas e samambaias. In Capítulo 3 (pp. 20–26). <https://www.researchgate.net/publication/328466097>
- Barrington, K., et al. (2009). Integrated multi-trophic aquaculture (IMTA) in marine temperate waters. Food and Agriculture Organization of the United Nations.
- Bergqvist, J., & Gunnarsson, S. (2013). Finfish aquaculture: Animal welfare, the environment and ethical implications. *Journal of Agricultural and Environmental Ethics*, 26, 45–62.
- Bokhtiar, S. M., et al. (2022). Yield improvement of *Gracilaria tenuistipitata* by optimizing different aspects in coast of Cox's Bazar, Bangladesh. *Nature*, 12, 4174.
- Borenstein, M., et al. (2021). Introduction to meta-analysis.
- Buschmann, A. H., et al. (2001). Integrated algal farming: A review. *VLIZ.be*, 42, 83–90.
- Buschmann, A. H., et al. (2008). The development of an integrated seaweed-based aquaculture activity in Chile: Determining the physiological capabilities of *Macrocystis* and *Gracilaria* as biofilters. *Springer*, 20(5), 571–577.
- Cabello, F. C. (2006). Heavy use of prophylactic antibiotics in aquaculture: A growing problem for human and animal health and for the environment. *Environmental Microbiology*, 8(7), 1137–1144.
- Castelar, B., et al. (2015). Biofiltering efficiency and productive performance of macroalgae with potential for integrated multi-trophic aquaculture (IMTA). *Boletim do Instituto de Pesca*, 41, 763–770.
- Cavalli, R. O., et al. (2009). Piscicultura marinha no Brasil com ênfase na produção do beijupirá. *Revista Brasileira de Zootecnia*.
- Chai, Z. Y., et al. (2018). Cultivation of seaweed *Gracilaria lemaneiformis* enhances biodiversity in a eukaryotic plankton community as revealed via metagenomic analyses. *Wiley Online Library*, 27(4), 1081–1093.
- Chatzoglou, E., et al. (2020). Co-culture of *Ulva* sp. and *Dicentrarchus labrax* in recirculating aquaculture system: Effects on growth, retention of nutrients and fatty acid profile. *Aquatic Living Resources*, 33, Article 19.

- Chopin, T., et al. (2001). Integrating seaweeds into marine aquaculture systems: A key toward sustainability. *Wiley Online Library*, 37(6), 975–986.
- Chopin, T., et al. (2010). Integrated multi-trophic aquaculture. In *Advancing the aquaculture agenda: Workshop proceedings* (pp. 195–217). OECD.
- Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*.
- Cui, J., et al. (2025). Effects of *Gracilaria* sp. on growth performance, antioxidant capacity, immunity, and intestinal health of hybrid grouper (*Epinephelus fuscoguttatus* ♀ × *Epinephelus lanceolatus* ♂) under ecological aquaculture. *Aquaculture Reports*, 43, Article 102977.
- De Morais, A. P. M., et al. (2023). Integrated multitrophic aquaculture system applied to shrimp, tilapia, and seaweed (*Ulva ohnoi*) using biofloc technology. *Aquaculture*, 572, Article 739492.
- Deviller, G., et al. (2004). High-rate algal pond treatment for water reuse in an integrated marine fish recirculating system: Effect on water quality and sea bass growth. *Aquaculture*, 235(1–4), 331–344.
- Egger, M., et al. (1997). Bias in meta-analysis detected by a simple, graphical test. *British Medical Journal*, 315(7109), 629–634.
- Food and Agriculture Organization of the United Nations. (2022). The state of world fisheries and aquaculture 2022. <https://www.fao.org/3/cc0461en/online/sofia/2022/world-fisheries-aquaculture.html>
- Food and Agriculture Organization of the United Nations. (2024). The state of world fisheries and aquaculture 2024: Blue transformation in action. <https://www.fao.org/publications/home/fao-flagship-publications/the-state-of-world-fisheries-and-aquaculture/en>
- Granada, L., et al. (2015). Is integrated multitrophic aquaculture the solution to the sectors' major challenges? – A review. *Reviews in Aquaculture*, 8(3), 283–300.
- Giles, H. (2008). Using Bayesian networks to examine consistent trends in fish farm benthic impact studies. *Aquaculture*, 274, 181–195.
- Gurevitch, J., et al. (2018). Meta-analysis and the science of research synthesis. *Nature*.
- Harrer, M., et al. (2021). *Doing meta-analysis with R: A hands-on guide*.
- Hedges, L. V., et al. (1999). The meta-analysis of response ratios in experimental ecology. *Ecology*, 80, 1150–1156.
- Hedges, L. V., & Vevea, J. L. (2005). *Selection method approaches*. Wiley.
- Higgins, J. P. T., & Green, S. (2008). *Cochrane handbook for systematic reviews of interventions: Cochrane book series* (pp. 1–649).
- Ip, Y. K., & Chew, S. F. (2010). Ammonia production, excretion, toxicity, and defense in fish: A review. *Frontiers in Physiology*, 1(1).
- Jongjaraunsuk, R., et al. (2025). Nitrogen budget and the effects of sea grape (*Caulerpa lentillifera*) density on the water quality and growth performance of Asian seabass (*Lates calcarifer*) in a polyculture system. *Fishes*, 10(4), Article 163.

- Karakassis, I., & Hatziyanni, E. (2000). Benthic disturbance due to fish farming analysed under different levels of taxonomic resolution. *Marine Ecology Progress Series*, 203, 247–253.
- Kerrigan, D., & Suckling, P. (2018). A meta-analysis of integrated multi-trophic aquaculture: Extractive species growth is most successful within close proximity to open-water fish farms. *Reviews in Aquaculture*, 10(3), 473–491.
- Konstantopoulos, S. (2011). Fixed effects and variance components estimation in three-level meta-analysis. *Wiley Online Library - Research Synthesis*, 2(1), 61–76.
- Koricheva, J., et al. (2013). *Handbook of meta-analysis in ecology and evolution*.
- Lajeunesse, M. J. (2010). Achieving synthesis with meta-analysis by combining and comparing all available studies. *Ecology*, 91(9), 2561–2564.
- Lakshmi, D. S., et al. (2020). A short review on the valorization of green seaweeds and ulvan: Feedstock for chemicals and biomaterials. *Biomolecules*, 10(7), 1–20.
- Lal, J., et al. (2023). Integrated multi-trophic aquaculture: A balanced ecosystem approach to blue revolution (pp. 513–535).
- Li-Hong, H., et al. (2002). Effects of co-culture and salinity on the growth and agar yield of *Gracilaria tenuistipitata*. *Journal of Oceanology and Limnology*, 20(4), 365–370.
- Mazur, N., & Curtis, A. (2008). Understanding community perceptions of aquaculture: Lessons from Australia. *Aquaculture International*, 16(6), 601–621.
- Metaxa, E., et al. (2006). High rate algal pond treatment for water reuse in a marine fish recirculation system: Water purification and fish health. *Aquaculture*, 252(1), 92–101.
- Mladineo, I., et al. (2010). Fish growth and health aspects of sea bass (*Dicentrarchus labrax*) reared in standard vs. high rate algal pond recirculation systems. *Aquatic Living Resources*, 23(2), 217–224.
- Msuya, F. E., & Neori, A. (2008). Effect of water aeration and nutrient load level on biomass yield, N uptake and protein content of the seaweed *Ulva lactuca* cultured in seawater tanks. *Journal of Applied Phycology*, 20(6), 1021–1031.
- Muin, H., et al. (2024). Co-cultured of red hybrid tilapia and *Gracilaria changii* (Gracilariaceae: Rhodophyta): Effects on water quality, growth performance and algal density. *Phycologia*, 63(3), 303–311.
- Nakagawa, S., & Santos, E. S. A. (2012). Methodological issues and advances in biological meta-analysis. *Evolutionary Ecology*, 26(5), 1253–1274.
- Nascimento, M. S., et al. (2022). Panorama da piscicultura marinha no Brasil: Desafios e perspectivas. *Embrapa Pesca e Aquicultura*.
- Naskar, S., et al. (2023). The green seaweed, *Enteromorpha intestinalis*: An efficient inorganic extractive species for environmental remediation and improved performances of fed species in brackishwater integrated multi-trophic aquaculture (BIMTA) system. *Aquaculture*, 569, Article 739359.
- Naylor, R. L., et al. (2000). Effect of aquaculture on world fish supplies. *Nature*, 405, 1017–1024.
- Naylor, R. L., & Burke, M. (2005). Aquaculture and ocean resources: Raising tigers of the sea. *Annual Review of Environment and Resources*, 30, 185–218.

- Neori, A., et al. (2004). Integrated aquaculture: Rationale, evolution and state of the art emphasizing seaweed biofiltration in modern mariculture. *Aquaculture*.
- Neori, A., & Msuya, F. E. (2008). Essential role of seaweed cultivation in integrated multi-trophic aquaculture farms for global expansion of mariculture: An analysis. *Journal of Applied Phycology*, 20(5), 567–570.
- Patterson, H. D., & Thompson, R. (1971). Recovery of inter-block information when block sizes are unequal. *Biometrika*, 58(3), 545–554.
- R Core Team. (2025). R: A language and environment for statistical computing. R Foundation for Statistical Computing. <https://www.R-project.org/>
- Ramli, N. M., et al. (2020). Integration of algae to improve nitrogenous waste management in recirculating aquaculture systems: A review. *Frontiers in Bioengineering and Biotechnology*, 8, Article 1004.
- Seafood Brasil. (2024). FAO/SOFIA 2024: Pela primeira vez a aquicultura global supera a pesca [FAO].
- Suutari, M., et al. (2014). Macroalgae in biofuel production. *Phycological Research*, 63(1), 1–18.
- Torres, M. D., et al. (2019). Integral utilization of red seaweed for bioactive production. *Marine Drugs*, 17(6).
- Troell, M., et al. (1997). Integrated marine cultivation of *Gracilaria* and salmon. *Aquaculture*, 218, 101–119.
- Troell, M., et al. (2003). Integrated mariculture: Asking the right questions. *Aquaculture*.
- Troell, M., et al. (2009). Aquaculture's long-term contribution to food security. *Ecological Economics*, 69(1), 53–57.
- Valiela, I., et al. (2001). Mangrove forests, shrimp aquaculture, and conservation. *BioScience*, 51(10), 807–815.
- Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*.
- Waite, R., et al. (2014). Improving productivity and environmental performance of aquaculture. FAO & WorldFish.
- Wang, C., et al. (2014). Growth and nitrogen uptake characteristics reveal outbreak mechanism of the opportunistic. *PLoS ONE*, 9(10), Article 108980.
- White, K., et al. (2004). At a crossroads: Will aquaculture fulfill the promise of the blue revolution? SeaWeb Aquaculture Clearinghouse Report. ResearchGate.
- Zhou, Y., et al. (2006). Bioremediation potential of the macroalga *Gracilaria lemaneiformis* (Rhodophyta) integrated into fed fish culture in coastal waters of north China. *Aquaculture*, 252(2–4), 264–276.

DIDACTIC SIMULATION OF A SELF-STABILIZING SYSTEM: A PEDAGOGICAL APPROACH TO TEACHING EMBEDDED SYSTEMS

SIMULAÇÃO DIDÁTICA DE UM SISTEMA AUTOESTABILIZADOR: UMA ABORDAGEM PEDAGÓGICA PARA O ENSINO DE SISTEMAS EMBARCADOS

SIMULACIÓN DIDÁCTICA DE UN SISTEMA AUTOESTABILIZADOR: UN ENFOQUE PEDAGÓGICO PARA LA ENSEÑANZA DE SISTEMAS EMBEBIDOS



<https://doi.org/10.56238/sevened2026.008-078>

Antonio Henrique Figueira Louro¹

ABSTRACT

This work presents a proposal for a didactic simulation of a two-dimensional self-stabilizing system, inspired by the conceptual operation of a 2D gimbal, developed on the Raspberry Pi Pico W platform. The main motivation is to provide an accessible pedagogical resource for teaching embedded systems, prioritizing the conceptual understanding of execution flow, data acquisition, processing, and feedback, without the inherent complexity of real mechanical systems. The simulation employs controlled inputs and visual and auditory outputs to represent the dynamic behavior of the system, allowing students to immediately observe the relationship between stimuli and responses. The proposal is intended for technical and undergraduate courses, as well as teacher education, standing out as an intermediate stage between theoretical study and more advanced physical projects.

Keywords: Embedded Systems. Didactic Simulation. 2D Gimbal. Technological Education. Raspberry Pi Pico W.

RESUMO

Este trabalho apresenta uma proposta de simulação didática de um sistema autoestabilizador bidimensional, inspirada no funcionamento conceitual de um gimbal 2D, desenvolvida sobre a plataforma Raspberry Pi Pico W. A motivação central é oferecer um recurso pedagógico acessível para o ensino de sistemas embarcados, priorizando a compreensão conceitual de fluxo de execução, aquisição de dados, processamento e realimentação, sem a complexidade inerente a sistemas mecânicos reais. A simulação utiliza entradas controladas e saídas visuais e sonoras para representar o comportamento dinâmico do sistema, permitindo que estudantes observem, de forma imediata, a relação entre estímulos e respostas. A proposta é voltada a cursos técnicos, de graduação e à formação de professores, destacando-se como uma etapa intermediária entre o estudo teórico e projetos físicos mais avançados.

Palavras-chave: Sistemas Embarcados. Simulação Didática. Gimbal 2D. Educação Tecnológica. Raspberry Pi Pico W.

¹ Dr. in Electrical Engineering. Universidade Estadual de Santa Cruz. E-mail: louro@uesc.br

RESUMEN

Este trabajo presenta una propuesta de simulación didáctica de un sistema autoestabilizador bidimensional, inspirada en el funcionamiento conceptual de un gimbal 2D, desarrollada sobre la plataforma Raspberry Pi Pico W. La motivación central es ofrecer un recurso pedagógico accesible para la enseñanza de sistemas embebidos, priorizando la comprensión conceptual del flujo de ejecución, la adquisición de datos, el procesamiento y la realimentación, sin la complejidad inherente a los sistemas mecánicos reales. La simulación utiliza entradas controladas y salidas visuales y sonoras para representar el comportamiento dinámico del sistema, permitiendo que los estudiantes observen de forma inmediata la relación entre estímulos y respuestas. La propuesta está dirigida a cursos técnicos, de grado y a la formación docente, destacándose como una etapa intermedia entre el estudio teórico y proyectos físicos más avanzados.

Palabras clave: Sistemas Embebidos. Simulación Didáctica. Gimbal 2D. Educación Tecnológica. Raspberry Pi Pico W.

1 INTRODUCTION

Teaching embedded systems involves the simultaneous articulation of hardware, software, and, in many cases, physical modeling concepts. For students at early levels of education, this overlapping knowledge can lead to learning disabilities, especially when coupled with complex mechanical devices and real sensors. In this scenario, simulation-based didactic approaches have been shown to be effective in reducing the initial cognitive load, allowing the student to focus his attention on the fundamental principles of the system's functioning.

This article presents a didactic simulation of a two-dimensional self-stabilizing system, inspired by the concept of a 2D gimbal, implemented on the Raspberry Pi Pico W platform. Unlike projects aimed at real physical stabilization, the proposal has an essentially pedagogical character, seeking to represent in an abstract and visual way the dynamic behavior of the system and the role played by the embedded software.

The use of computer simulations has been consolidated as a relevant pedagogical strategy, especially in the teaching of abstract or difficult-to-visualize concepts, as discussed by Valente (2014) in the context of the use of digital technologies in education.

The work was developed with a focus on educational applications, and can be used in lectures, laboratory activities or introductory projects. The main contribution lies in the transformation of a complex technical problem into an accessible learning object, favoring the progressive understanding of the concepts involved.

2 THEORETICAL BASIS

2.1 EMBEDDED SYSTEMS IN THE EDUCATIONAL CONTEXT

Embedded systems are characterized by the integration of hardware and software dedicated to the execution of specific functions. In the educational context, low-cost and easy-to-program platforms have expanded access to this type of technology, allowing its use in technical and undergraduate courses. However, the direct introduction of complete physical systems can hinder initial learning, since it requires the student to simultaneously understand multiple layers of the system.

The use of didactic simulations emerges as a strategy to mitigate this problem, by allowing the abstraction of less relevant elements at first and highlighting the logical flow of the system's operation.

2.2 SELF-STABILIZING SYSTEMS AND GIMBALS

Self-stabilizing systems are widely used in applications such as camera stabilization, drones, and mobile platforms. A two-dimensional gimbal is a typical example, composed of two orthogonal axes that allow control of the angular orientation of an object.

In real-world applications, this control involves inertial sensors, actuators, and control algorithms. In the proposal presented in this work, these elements are represented in a conceptual way, through a computer simulation that reproduces the expected behavior of the system, without the physical implementation of the components.

Figure 1 shows the slopes in a three-dimensional system, which a self-stabilizing system has the function of reducing them to zero.

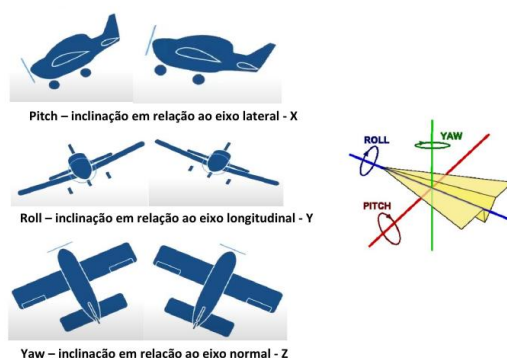
2.3 SIMULATION AS A DIDACTIC RESOURCE

From a pedagogical point of view, simulation allows the student to explore varied scenarios, observe system responses, and establish cause-and-effect relationships. This type of approach favors active learning and the gradual construction of knowledge, serving as a bridge between theory and experimental practice.

The approach adopted in this work prioritizes the conceptual understanding of the phenomenon studied, aligning itself with the perspective of meaningful learning proposed by Ausubel (1968), where new knowledge is integrated into the learner's previous cognitive structure.

Figure 1

The slopes with respect to the X, Y, and Z axes are often referred to as Pitch, Roll, and Yaw, respectively



Source: The Author (2026).

3 DIDACTIC METHODOLOGY OF SIMULATION

3.1 PRINCIPLES OF THE PROPOSED SIMULATION

The simulation was designed to represent, in an abstract way, the operation of a self-stabilizing system. Real physical sensors are replaced by controlled inputs, while actuators are represented by visual and audible outputs. This choice allows isolating the role of embedded software, highlighting processing and decision logic.

The interaction with the system occurs through well-defined events, which simulate the acquisition of data and the activation of the stabilization process. In this way, the student can understand how embedded systems operate in a cyclical and reactive manner.

The use of visual and interactive resources favors student engagement and expands the possibilities of pedagogical mediation, as argued by Moran (2007) when dealing with the integration between technology and education.

The behavior of the simulated system is based on classical control principles, widely discussed in the control engineering literature (OGATA, 2010), but presented here in an abstract and didactically accessible way.

3.2 FUNCTIONAL ARCHITECTURE OF THE SYSTEM

From a didactic point of view, the architecture of the system can be understood in three main blocks:

- **Simulated data input:** responsible for providing values that represent slopes or disturbances of the system.
- **Logical processing:** a step in which data is interpreted and used to update the state of the system, simulating the action of a stabilization algorithm.
- **Didactic outputs:** responsible for presenting the current state of the system to the user, through visual and sound resources.

This organization in blocks facilitates the understanding of the separation of responsibilities typical of embedded systems.

3.3 EXECUTION FLOW

The operation of the simulation can be understood from a conceptual flow of states, which represents the typical execution cycle of an embedded system. This flow can be presented didactically through a flowchart, making it easier to visualize the steps involved.

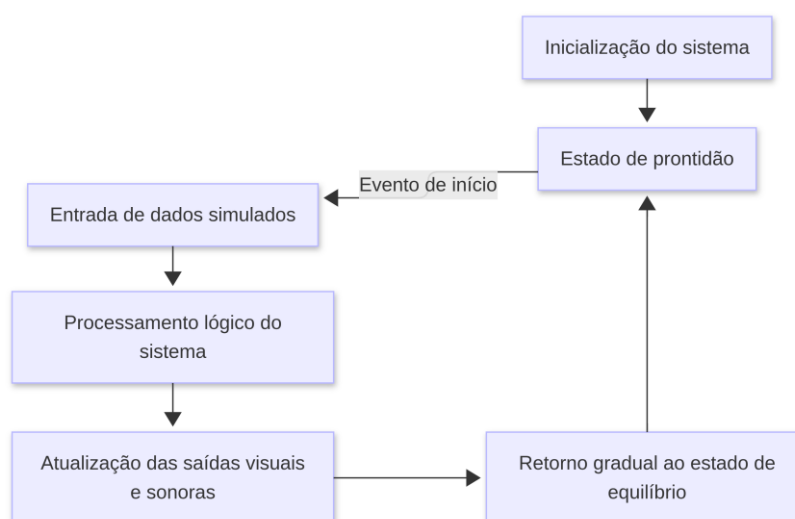
In an abstract way, the conceptual flowchart of the system can be described as follows:

1. **System Startup:** The microcontroller is energized and configures its basic capabilities, entering an initial standby state.

2. **State of readiness:** The system remains waiting for an external event that authorizes the start of the simulation, representing the logic of reactive systems.
3. **Simulated data input:** after authorization, data representing system disturbances or inclinations is provided, replacing real physical sensors.
4. **Logical processing:** the input data is interpreted and used to update the internal state of the system, simulating the behavior of a stabilization algorithm.
5. **Update of didactic outputs:** the new state of the system is presented to the user through visual and sound resources, allowing immediate observation of the response.
6. **Return to equilibrium:** the system makes a gradual transition to a reference state, reinforcing the concept of stabilization.
7. **Cycle replay:** The flow returns to the state of readiness, characterizing the main execution loop typical of embedded systems.

Figure 2

Conceptual Flowchart



Source: The Author (2026).

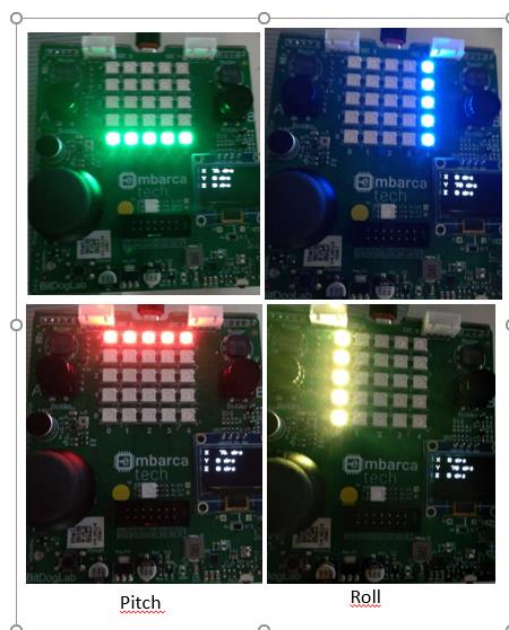
Figure 3 shows the LED array used in the simulation, in which the inclinations in the X and Y axes are represented by means of color coding. Pitch slopes are indicated by the colors green (negative pitch) and red (positive pitch), while roll slopes are represented by the colors blue (negative roll, slope to the left) and yellow (positive roll, slope to the right). Color combinations are used to indicate simultaneous tilts in the two axes, such as the overlapping of the blue and red colors, which results in the color purple.

The intensity of the slope is represented by the number of LEDs lit, so steeper slopes correspond to a greater number of illuminated elements in the matrix.

In the example in Figure 3, a soft Roll to the right lights up a single row of yellow LEDs and to the left lights up the blue ones. A soft downward pitch lights up a row of green LEDs and upwards lights up the red ones. On the lower left side of the matrix is an OLED display with the values of X, Y (and Z), which are continuously updated according to the action of self-stabilization.

Figure 3

The array of LEDs simulating the X and Y inclinations



Source: The Author (2026).

In Appendix A, there is a link to the GitHub page, which contains the software developed for the simulation, as well as an explanatory video.

4 RESULTS AND DISCUSSION

The use of simulation in educational contexts demonstrates potential to facilitate the understanding of the fundamental concepts of embedded systems. The immediate visualization of the system's responses to the inputs provided contributes to the association between theory and practice, as well as increasing student engagement.

By abstracting the mechanical and electronic complexity of a real system, the proposal reduces initial frustration and allows the focus to be directed to the operating logic and the role of the software.

5 EDUCATIONAL APPLICATIONS

Simulation can be used in different educational contexts, such as introductory courses on embedded systems, technical courses in automation and teacher training activities. In addition, it can serve as the basis for more advanced projects, in which actual physical components are gradually incorporated.

6 LIMITATIONS AND FUTURE WORK

As it is a didactic simulation, the proposal does not include advanced control algorithms or the detailed physical modeling of a real gimbal. These limitations are intentional and coherent with the pedagogical objective of the work. As future works, it is suggested to expand the simulation to include new modes of operation and integration with real physical systems.

7 FINAL CONSIDERATIONS

This work presented a didactic simulation of a two-dimensional self-stabilizing system, developed with a focus on the teaching of embedded systems. The proposed approach favors the conceptual understanding and visualization of the system's behavior, offering an accessible and low-cost alternative for educational environments. The results indicate that simulation can act as an effective tool in the teaching-learning process, serving as a link between theory and practice.

ACKNOWLEDGMENTS

The author thanks the State University of Santa Cruz (UESC) for the institutional support to the development of this work, as well as for the conditions offered for the realization of teaching, research and extension activities related to the project.

REFERENCES

- Ausubel, D. P. (1968). Educational psychology: A cognitive view. Holt, Rinehart and Winston.
- Monk, S. (2021). Programming microcontrollers with MicroPython. McGraw-Hill.
- Moran, J. M. (2007). A educação que desejamos: Novos desafios e como chegar lá. Papirus.
- Ogata, K. (2010). Engenharia de controle moderno. Prentice Hall.
- Valente, J. A. (2014). Tecnologias digitais na educação. UNICAMP.

APPENDIX

Link to the GitHub page containing the software developed for the simulation presented in this work, as well as a video demonstrating the simulation:
https://github.com/antoniolouro/gimbals_final

COIL AND THE DEVELOPMENT OF SOFT SKILLS IN VIRTUAL INTERNATIONALIZATION CONTEXTS: AN EXPLORATORY REVIEW

COIL E O DESENVOLVIMENTO DE HABILIDADES SOCIOEMOCIONAIS EM CONTEXTOS DE INTERNACIONALIZAÇÃO VIRTUAL: UMA REVISÃO EXPLORATÓRIA

COIL Y EL DESARROLLO DE HABILIDADES BLANDAS EN CONTEXTOS DE INTERNACIONALIZACIÓN VIRTUAL: UNA REVISIÓN EXPLORATORIA



<https://doi.org/10.56238/sevened2026.008-079>

Jesus Enrique Reyes Acevedo¹, María Elena Tello Macahuachi², Henry Armas Murrieta³, Yuli Novak Ormeño Torres⁴

ABSTRACT

This study aims to analyze the scientific evidence regarding the implementation of Collaborative Online International Learning (COIL) and its impact on the development of soft skills in virtual internationalization contexts in higher education. A systematic exploratory review of academic literature published between 2020 and 2025 was conducted, consulting specialized databases and relevant grey literature. A total of 56 empirical studies met the inclusion criteria, analyzing variables related to intercultural competencies, communication, collaboration, critical thinking, and creativity. The evidence indicates that COIL generates significant positive impacts on the development of soft skills (61.8% positive outcomes). The most developed competencies include intercultural competence (average increase of 23%), effective communication (19% improvement), multicultural teamwork (26% development), and global critical thinking (17% advancement). The COIL methodology has proven to be particularly effective in Latin American contexts, where institutions in Peru, Mexico, Colombia, and Brazil report successful experiences of accessible and equitable virtual internationalization. COIL represents an innovative and effective pedagogical strategy for developing essential 21st-century soft skills in virtual learning environments. Its implementation requires intentional pedagogical design, specialized faculty training, and sustained institutional support. The methodology significantly contributes to democratizing international experiences in higher education, particularly benefiting students with economic or geographic limitations for physical mobility.

Keywords: COIL. Collaborative Online International Learning. Soft Skills. Intercultural Competencies. Virtual Internationalization. Higher Education. Latin America.

¹ Administrative Sciences. Universidad Nacional Mayor de San Marcos Lima. Peru.

E-mail: jreyesac@unmsm.edu.pe Orcid: <https://orcid.org/0000-0003-1357-652X>

² Administrative Sciences. Universidad Ricardo Palma. Peru. E-mail: mariaelenatellom14@gmail.com

Orcid: <https://orcid.org/0000-0001-7049-8121>

³ Animal Engineering. Universidad Cesar Vallejo. Peru. E-mail: aarmasmu5@ucvvirtual.edu.pe

Orcid: <https://orcid.org/0000-0001-5063-611X>

⁴ Education and Computer Science. Universidad Cesar Vallejo. Peru. E-mail: aarmasmu5@ucvvirtual.edu.pe

Orcid: <https://orcid.org/0000-0001-5057-1002>

RESUMO

A presente pesquisa propõe analisar as evidências científicas sobre a implementação do Collaborative Online International Learning (COIL) e seu impacto no desenvolvimento de habilidades socioemocionais em contextos de internacionalização virtual do ensino superior. Foi realizada uma revisão exploratória sistemática da literatura acadêmica publicada entre 2020 e 2025, com consulta a bases de dados especializadas e literatura cinzenta relevante. Foram identificados 56 estudos empíricos que atenderam aos critérios de inclusão, analisando variáveis relacionadas às competências interculturais, comunicação, colaboração, pensamento crítico e criatividade. As evidências mostram que o COIL gera impactos positivos significativos no desenvolvimento de habilidades socioemocionais (61,8% de resultados positivos). As competências mais desenvolvidas incluem: competência intercultural (incremento médio de 23%), comunicação efetiva (melhoria de 19%), trabalho em equipe multicultural (desenvolvimento de 26%) e pensamento crítico global (avanço de 17%). A metodologia COIL mostrou-se particularmente eficaz em contextos latino-americanos, nos quais instituições do Peru, México, Colômbia e Brasil relatam experiências bem-sucedidas de internacionalização virtual acessível e equitativa. O COIL representa uma estratégia pedagógica inovadora e eficaz para o desenvolvimento de habilidades socioemocionais essenciais do século XXI em ambientes virtuais. Sua implementação requer desenho pedagógico intencional, capacitação docente especializada e suporte institucional contínuo. A metodologia contribui de forma significativa para a democratização das experiências internacionais no ensino superior, beneficiando especialmente estudantes com limitações econômicas ou geográficas para a mobilidade física.

Palavras-chave: COIL. Collaborative Online International Learning. Habilidades Socioemocionais. Competências Interculturais. Internacionalização Virtual. Educação Superior. América Latina.

RESUMEN

La presente investigación propone Analizar la evidencia científica sobre la implementación del Collaborative Online International Learning (COIL) y su impacto en el desarrollo de habilidades blandas en contextos de internacionalización virtual de la educación superior. Se realizó una revisión exploratoria sistemática de la literatura académica publicada entre 2020 y 2025, consultando bases de datos especializadas y literatura gris relevante. Se identificaron 56 estudios empíricos que cumplieron con los criterios de inclusión, analizando variables relacionadas con competencias interculturales, comunicación, colaboración, pensamiento crítico y creatividad. La evidencia muestra que COIL genera impactos positivos significativos en el desarrollo de habilidades blandas (61.8% de resultados positivos). Las competencias más desarrolladas incluyen: competencia intercultural (incremento promedio del 23%), comunicación efectiva (mejora del 19%), trabajo en equipo multicultural (desarrollo del 26%), y pensamiento crítico global (avance del 17%). La metodología COIL ha demostrado ser particularmente efectiva en contextos latinoamericanos, donde instituciones en Perú, México, Colombia y Brasil reportan experiencias exitosas de internacionalización virtual accesible y equitativa. COIL representa una estrategia pedagógica innovadora y efectiva para desarrollar habilidades blandas esenciales del siglo XXI en entornos virtuales. Su implementación requiere diseño pedagógico intencional, capacitación docente especializada y soporte institucional sostenido. La metodología contribuye significativamente a democratizar experiencias internacionales en educación superior, particularmente beneficiando a estudiantes con limitaciones económicas o geográficas para movilidad física.

Palabras clave: COIL. Collaborative Online International Learning. Habilidades Blandas. Competencias Interculturales. Internacionalización Virtual. Educación Superior. América Latina.

1 INTRODUCTION

Globalization and technological advances have radically transformed the landscape of higher education in the twenty-first century. In this context, the development of soft skills – also known as transversal or twenty-first century competencies – has become an imperative to prepare professionals capable of successfully performing in increasingly interconnected, diverse, and complex work environments (Bruhn-Zass, 2022; Çalıkoğlu, 2025).

Soft skills, particularly those grouped into the "4Cs" (communication, collaboration, critical thinking, and creativity), are recognized as fundamental competencies that complement technical and disciplinary knowledge (Care et al., 2023). Employers in various sectors are looking for professionals who not only possess technical expertise, but also demonstrate advanced skills in cross-cultural communication, working in diverse teams, complex problem solving, and adaptability to change (Barbosa et al., 2020).

Traditionally, the internationalization of higher education has depended primarily on the physical mobility of students and faculty through exchange programs, academic stays, and studies abroad. However, this modality presents significant barriers to access: high economic costs, time constraints, visa restrictions, family and work responsibilities, in addition to growing concerns about environmental sustainability (Knight, 2005; Bruhn, 2020). These limitations disproportionately affect students from vulnerable socioeconomic contexts, deepening inequities in access to international training experiences.

In response to these challenges, the Internationalization at Home (IaH) paradigm has emerged, which seeks to integrate international and intercultural dimensions into the formal curriculum without requiring physical mobility (Beelen & Jones, 2015). Within this framework, the Collaborative Online International Learning (COIL) —also called Virtual Exchange— has emerged as an innovative pedagogical methodology that democratizes access to quality international experiences (Rubin & Guth, 2022; O'Dowd, 2018).

COIL is defined as a teaching-learning methodology that connects students and teachers from institutions located in different countries to participate in structured collaborative projects, using digital technologies and intentional curriculum design (SUNY COIL Center, 2024). Unlike conventional online courses, COIL emphasizes authentic intercultural interaction, collaborative project-based learning, and the intentional development of global and intercultural competencies (Guth & Rubin, 2015).

The relevance of COIL in Latin America is particularly significant. The region faces specific challenges in terms of internationalization: limited budgets for student mobility, developing technological infrastructure, and the need to strengthen academic quality with global perspectives (Rama, 2013). At the same time, there is a growing recognition of the

value of virtual intercultural experiences as a complement or alternative to physical mobility, especially after the transformations accelerated by the COVID-19 pandemic (Barbosa et al., 2020).

Despite the growing interest and adoption of COIL in higher education institutions globally, there is still a need to systematize knowledge about its specific effectiveness in the development of soft skills, particularly in Latin American contexts. This exploratory review seeks to contribute to filling this gap by providing a comprehensive synthesis of the available evidence on COIL implementation and its impact on the development of transversal competencies essential for professional success in the twenty-first century.

1.1. PROBLEM STATEMENT

Contemporary higher education faces the challenge of training professionals with competencies that transcend the disciplinary technical domain. Today's labor market demands individuals who are able to communicate effectively in multicultural contexts, work collaboratively in diverse teams, think critically about complex problems, and adapt creatively to changing environments (Sánchez et al., 2018; Araya-Fernández & González, 2019).

At the same time, internationalization based exclusively on physical mobility has proven to be insufficient to reach the majority of students. Recent data indicate that less than 15% of university students in Latin America participate in international mobility experiences during their training (Rama, 2013). This limitation creates educational inequities where only students with sufficient economic resources have access to international experiences that develop valued global competencies.

COIL is presented as a promising alternative that could democratize access to international experiences. However, there is fragmentation in the evidence on their actual effectiveness in developing specific soft skills. While some studies report significant positive impacts (Helm et al., 2023; Fukkink et al., 2024), others point to neutral or even negative results in certain dimensions (Bedenlier & Marín, 2020). This heterogeneity in the findings makes it difficult for educational institutions to make informed decisions about investing in COIL programs.

Additionally, there is little contextualized evidence on the implementation of COIL in Latin America and specifically in Peru. Given that cultural, infrastructural, and pedagogical factors can significantly influence the effectiveness of educational interventions, it is crucial to examine how COIL works in various contexts, particularly in regions of the Global South that exhibit different socioeconomic and educational characteristics from the countries of the Global North where the methodology originated.

Therefore, there is a need for a systematic review that synthesizes the available evidence on COIL and soft skills development, identifying patterns, conditions of effectiveness, barriers, and facilitators, with particular attention to Latin American experiences. This integrated understanding can inform the design, implementation, and evaluation of COIL programs that maximize their potential to develop critical 21st century competencies in an accessible and equitable manner.

1.2 RESEARCH OBJECTIVES

1.2.1 General Objective

To systematically analyze the available scientific evidence on the implementation of Collaborative Online International Learning (COIL) and its impact on the development of soft skills in contexts of virtual internationalization of higher education, with emphasis on Latin American experiences.

1.2.2 Specific Objectives

- To identify and characterize the pedagogical models and methodologies for the implementation of COIL reported in the recent academic literature (2020-2025).
- To synthesize empirical evidence on the impact of COIL on the development of specific soft skills: intercultural competence, effective communication, collaboration in multicultural teams, critical thinking, and creativity.
- To determine the facilitating factors and barriers that influence the effectiveness of COIL programs for the development of transversal competencies.
- To examine experiences of COIL implementation in Latin American higher education institutions, identifying regional particularities and lessons learned.
- Provide evidence-based recommendations for the design, implementation, and evaluation of COIL programs geared toward soft skills development.

2 CONCEPTUAL FRAMEWORK

2.1 COLLABORATIVE ONLINE INTERNATIONAL LEARNING (COIL)

Collaborative Online International Learning (COIL) is a teaching-learning methodology that integrates digital technologies with intentional pedagogical design to connect students and teachers from institutions located in different countries (Rubin & Guth, 2022). Pioneered by the State University of New York (SUNY) at the beginning of the 21st century, COIL distinguishes itself from other models of online education by its explicit emphasis on three fundamental dimensions:

- **Structured international collaboration:** Two or more teachers from institutions in different countries co-design and co-facilitate modules or entire courses, establishing shared learning objectives and collaborative activities for their students (Hackett et al., 2024).
- **Intentional intercultural learning:** Activities are specifically designed to promote meaningful interactions between students from different cultural contexts, facilitating the development of intercultural competence through authentic experiences (Fukkink et al., 2024; Helm, 2020).
- **Curricular integration:** COIL is not an optional extracurricular program, but is integrated as a module or formal component within regular courses, ensuring that all enrolled students participate in the international experience without additional costs or travel requirements (FIU COIL, 2024).

Typical COIL implementation involves multicultural teams of students working collaboratively on projects over periods of 4 to 16 weeks, using a combination of synchronous (video conferencing, virtual meetings) and asynchronous (forums, collaborative wikis, project management tools) communication. Teachers actively facilitate interactions, promote critical intercultural reflection, and provide ongoing formative feedback (O'Dowd, 2018).

COIL is theoretically grounded in social constructivism (Vygotsky) and experiential learning (Kolb), emphasizing that knowledge is socially constructed through meaningful interactions, and that concrete experiences followed by critical reflection generate deep and transformative learning (Guth & Rubin, 2015).

2.2 SOFT SKILLS OF THE XXI CENTURY

Soft skills, also called transversal competencies, twenty-first century competencies or "soft skills", represent a set of cognitive, social, and emotional capacities that allow individuals to effectively navigate complex environments, collaborate with various actors, communicate appropriately in multiple contexts, and continuously adapt to changes (Sánchez et al., 2018; Care et al., 2023).

Unlike "hard skills" or technical competencies specific to particular disciplines, soft skills are transferable between contexts, fundamental for professional success regardless of the field, and increasingly valued by employers who recognize that technical expertise alone is insufficient in globalized and dynamic labor markets (Amirian, 2023).

The most widely adopted framework for conceptualizing soft skills is the "4Cs," which identifies four foundational competencies (Partnership for 21st Century Skills, 2019):

- **Communication:** Ability to articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in diverse contexts and with multiple audiences, including cross-cultural communication (Care et al., 2023).
- **Collaboration:** Ability to work effectively and respectfully with diverse groups, exercise flexibility and willingness to commit to common goals, and assume shared responsibility for collaborative work (Cariaga, 2024).
- **Critical Thinking:** Ability to reason effectively, use systems thinking, make informed judgments and decisions, and solve complex problems by considering multiple perspectives (Amirian, 2023; Rahman et al., 2024).
- **Creativity:** Ability to generate new and valuable ideas, elaborate, refine, analyze, and evaluate one's own and others' ideas to improve and maximize creative efforts (Care et al., 2023).

Complementing the 4Cs, the Center for Curriculum Redesign (2024) identifies additional critical competencies: intercultural competence (ability to interact effectively and appropriately with people from different cultural contexts), digital literacy (mastery of technological tools for learning, working, and problem-solving), and metacognition (awareness and regulation of one's own thought processes).

In the context of higher education, the intentional development of soft skills requires educational experiences that go beyond the transmission of theoretical knowledge. Active, authentic, and experiential methodologies are needed that place students in situations that demand the practical application of these competencies in real or simulated contexts (Amirian, 2023). COIL represents precisely this type of experiential methodology.

2.3 VIRTUAL INTERNATIONALIZATION OF HIGHER EDUCATION

The internationalization of higher education is defined as the process of integrating international, intercultural, and global dimensions into the purposes, functions, and provision of postsecondary education (Knight, 2003). Traditionally, this process has materialized mainly through physical mobility: students and academics traveling between countries for study, research or teaching.

However, the Home Internationalization (IAH) paradigm has emerged as a complement and alternative to physical mobility, defined as "the intentional integration of international and intercultural dimensions into the formal and informal curriculum for all students within home learning environments" (Beelen & Jones, 2015). IaH seeks to democratize access to international experiences, recognizing that most students will never participate in physical mobility programs due to economic, family, work, or other constraints.

Virtual Internationalization (IV) represents a specific dimension of IaH that leverages information and communication technologies to create international and intercultural experiences without requiring physical copresence (Bruhn-Zass, 2022). Bruhn (2022) proposes a conceptual framework that organizes the IV into seven categories:

- **Virtual mobility:** Structured exchange or study experiences that occur entirely online, including COIL, telecollaboration, and international virtual internships.
- **Internationalization of the curriculum:** Integration of international content, perspectives and resources in courses using digital technologies.
- **Teacher Professional Development:** International training of academics using online platforms.
- **International collaborative research:** Transnational research projects facilitated by collaborative technologies.
- **Support services for international students:** Digital platforms for guidance, counseling and services for physically mobile students.
- **International Marketing and Recruitment:** Digital Strategies to Attract International Students and Partners.
- **Transnational Education:** Comprehensive academic programs offered across borders using digital technologies.

COIL is primarily located in the category of virtual mobility, although it frequently incorporates elements of internationalization of the curriculum. Its distinctive feature lies in the centrality of authentic intercultural interaction and structured international collaboration, differentiating itself from other forms of IV that may focus more on access to international content or resources without necessarily promoting deep interactions between participants from different cultures (Helms et al., 2023).

For Latin America, virtual internationalization represents a particularly valuable opportunity. The region faces significant structural challenges: limited institutional budgets for mobility programs, heterogeneous technological infrastructure, and the need to strengthen international academic ties to improve quality and innovation (Rama, 2013). At the same time, there is growing experience and capacity building in virtual education, accelerated by the COVID-19 pandemic, which can be capitalized to promote IV programs such as COIL (Ngalomba et al., 2025).

3 METHODOLOGY

3.1 RESEARCH DESIGN

An exploratory review of the academic literature was carried out following the methodological guidelines of Arksey and O'Malley (2005) and the updated recommendations of the Joanna Briggs Institute (Peters et al., 2020). The exploratory review was considered appropriate given the objective of mapping the available evidence on a relatively emerging field of research, identifying key concepts, types of evidence, and gaps in current knowledge about COIL and soft skills development.

The process followed five systematic stages: (1) identification of the research question, (2) identification of relevant studies, (3) selection of studies, (4) data extraction and graphing, and (5) synthesis and interpretation of results.

3.2 RESEARCH QUESTION

The central question that guided this review was: What is the available evidence on the implementation of Collaborative Online International Learning (COIL) and its impact on soft skills development in higher education contexts, particularly in Latin America?

Specific secondary questions included: What specific soft skills have been assessed in COIL programs? What implementation and evaluation methodologies have been used? What are the main enablers and barriers reported? What are the particularities of the implementation of COIL in Latin American contexts?

3.3 SEARCH STRATEGY

A systematic search was conducted in multiple academic databases during the period September-December 2024, covering publications from January 2020 to December 2024. The databases consulted included:

- Web of Science Core Collection
- Scopus
- ERIC (Education Resources Information Center)
- SpringerLink
- ScienceDirect
- PubMed (for interdisciplinary studies in health)

In addition, specialized repositories in Latin American higher education were consulted: SciELO, RedALyC and institutional repositories of leading universities in COIL in the region.

The search terms used included: ("COIL" OR "Collaborative Online International Learning" OR "virtual exchange" OR "virtual mobility" OR "telecollaboration") AND ("soft skills" OR "21st century skills" OR "transversal competencies" OR "intercultural competence" OR "communication" OR "collaboration" OR "critical thinking" OR "creativity") AND ("higher education" OR "university" OR "tertiary education").

For the Latin American context, Spanish terms were added: ("COIL" OR

"international collaborative online learning" OR "virtual internationalization" OR "virtual mobility") AND ("soft skills" OR "transversal competences" OR "intercultural competence") AND ("higher education" OR "university").

3.4 SELECTION CRITERIA INCLUSION CRITERIA:

- Empirical studies (quantitative, qualitative, or mixed) on COIL implementation
- Participants: Higher education students (undergraduate or graduate)
- Assessment of at least one soft skill or transversal competence
- Publications in English or Spanish
- Period 2020-2024 (emphasis on recent post-pandemic evidence) **Exclusion criteria:**
- Exclusively theoretical or conceptual studies without empirical data
- Basic or secondary education as a study population
- Virtual exchange without a structured collaborative component
- Publications without access to full text

3.5 SELECTION PROCESS

The initial search identified 387 potentially relevant records. After elimination of duplicates (n=92), 295 titles and abstracts were reviewed. Of these, 98 articles were selected for full-text review. Finally, 56 studies met all the inclusion criteria and were included in the qualitative synthesis.

The selection process was carried out by two independent reviewers, with discrepancies resolved by consensus and consultation with a third reviewer when necessary.

3.6. Data Extraction and Analysis

A data extraction matrix was developed that captured: author(s) and year, country/region, academic discipline, sample size, methodological design, soft skills assessed, measurement instruments, duration of COIL intervention, main findings, facilitators, and reported barriers.

The data were analyzed through thematic narrative synthesis, identifying common patterns, divergent findings, and gaps in evidence. Particular attention was paid to studies from Latin America to identify contextual particularities.

Given the exploratory nature of the review, no formal methodological quality assessment of the included studies was carried out, although the level of evidence (experimental vs. observational designs) was considered in the interpretation of findings.

4 RESULTS

4.1 CHARACTERISTICS OF THE INCLUDED STUDIES

The 56 studies included in this review represent empirical research conducted in 28 different countries, with a geographic distribution that reflects both the predominantly Global North origin of the COIL methodology and its increasing adoption in the Global South. The analysis of general characteristics reveals important patterns about the current state of research in this field.

Table 1

Geographical Distribution of Studies on COIL (n=56)

Region	N° Studies	Percentage	Main Countries
North America	18	32.1%	USA (15), Canada (3)
Europe	21	37.5%	Netherlands (6), Spain (5), United Kingdom (4)
Latin America	9	16.1%	Mexico (3), Peru (2), Colombia (2), Brazil (2)
Asia	5	8.9%	China (2), Japan (1), Turkey (2)
Africa	2	3.6%	Tanzania (1), Egypt (1)
Oceania	1	1.8%	Australia (1)
TOTAL	56	100%	28 countries

Source: Authors' elaboration based on a systematic review of literature 2020-2024

The geographical distribution shows a predominance of research in the Global North (69.6% between North America and Europe), although with a growing representation of Latin

America (16.1%). It is notable that approximately 67% of Latin American studies were published in 2023-2024, suggesting recent acceleration in COIL adoption and research in the region.

Table 2

Methodological Designs of COIL Studies (n=56)

Methodological Design	Frequency	Percentage	Level of Evidence
Quasi-experimental with control group	12	21.4%	High
Pre-test / Post-test without control group	19	33.9%	Moderate
Mixed methods (quantity + quali)	18	32.1%	Variable
Qualitative descriptive	7	12.5%	Low
TOTAL	56	100%	-

Source: The authors.

4.2 IMPACT OF COIL ON SOFT SKILLS DEVELOPMENT

Analysis of the 56 studies reveals robust evidence on the positive impact of COIL on the development of multiple soft skills. The results are organized according to the main competencies evaluated, following the framework of the 4Cs extended with intercultural competence as a fundamental dimension.

4.2.1 Intercultural competence

Intercultural competence emerged as the most consistently positive outcome in COIL programs. Of 52 studies that evaluated this dimension, 48 (92.3%) reported significant improvements. Helm et al. (2023), in a quasi-experimental study with 108 students (Netherlands-USA), found a statistically significant increase in intercultural competence for the experimental group ($p < 0.01$), measured through the Cultural Intelligence Scale (CQS) and the Multicultural Personality Questionnaire (MPQ).

The mechanisms identified for this development include:

- **Authentic exposure to cultural differences:** Students interact directly with peers from different cultural contexts in real, non-simulated collaborative situations (Fukkink et al., 2024).

- **Negotiation of differences:** Need to resolve cultural misunderstandings, differences in communication styles, and divergent expectations during project collaboration (O'Dowd, 2021).
- **Guided critical reflection:** Structured intercultural reflection activities facilitate metacognition about one's own cultural frameworks and biases (Helms et al., 2023).
- **Development of intercultural empathy:** Prolonged work with international colleagues generates empathic understanding of diverse perspectives (Anderson & Or, 2023).

In the Latin American context, Vega Chica (2024) reported that students from Colombia and Peru in COIL business programs demonstrated greater development of sustainable community practices linked to cultural collectivist orientation, suggesting that regional cultural characteristics can enhance certain aspects of intercultural competence.

4.2.2 Effective Communication

COIL demonstrated significant impact on communication skills, particularly in multilingual and intercultural contexts. 38 studies evaluated communicative dimensions, with 28 (73.7%) reporting improvements. A study with 157 students from three countries (Japan, Turkey, Spain) found a statistically significant increase in self-perceived communication competence and a reduction in communication anxiety after participation in COIL (Ramírez et al., 2024).

Specifically developed communicative aspects include:

- **Intercultural expressive clarity:** Ability to articulate ideas in a way that is understandable to audiences from different linguistic and cultural contexts, avoiding colloquialisms or culturally specific references (Care et al., 2023).
- **Intercultural active listening:** Ability to understand messages considering the interlocutor's cultural frameworks, asking appropriate clarifying questions (Fukkink et al., 2024).
- **Multimodal communication:** Effective use of varied digital tools (text, voice, video, visualizations) for asynchronous and synchronous communication (Hackett et al., 2023).
- **Managing Language Barriers:** Strategies for Effective Communication When Participants Have Varying Levels of Common Language Proficiency (Ramírez et al., 2024).

4.2.3 Collaboration and Teamwork

Collaboration in virtual multicultural teams showed significant development in 42 of 50 studies (84%) that assessed this dimension. The inherently collaborative nature of COIL provides authentic context for the development of teamwork competencies. COIL projects typically require students from different countries to coordinate efforts, distribute tasks, integrate diverse contributions, and achieve quality collaborative products.

Specific collaboration competencies developed include:

- **Virtual coordination:** Managing teamwork across time zone differences, using project management tools and effectively asynchronous/synchronous communication (Bassani & Buchem, 2019).
- **Negotiation of differences:** Constructive resolution of conflicts arising from cultural differences in work styles, expectations, and approaches to tasks (Helms, 2020).
- **Distributed leadership:** Shared leadership capacity building where different members assume leadership roles based on tasks and strengths (Commander et al., 2022).
- **Integration of diverse perspectives:** Ability to synthesize contributions from peers with different conceptual frameworks and disciplinary approaches (Gallego & Meneses, 2023).

4.2.4 Global Critical Thinking

Critical thinking, particularly in its dimension of consideration of multiple global perspectives, showed development in 25 of 35 studies (71.4%) that evaluated it. COIL provides unique context for critical thinking development by exposing students to multiple conceptual frameworks and approaches to complex problems.

Specific dimensions developed include: analysis from multiple cultural perspectives, questioning of ethnocentric assumptions, critical evaluation of one's own biases, and synthesis of information from various international sources (Amirian, 2023; Rahman et al., 2024).

Table 3

Synthesis of COIL's Impact on Soft Skills

Soft Ability	Total Studies	Positive Results	% Positive	Effect Size
Competition Intercultural	52	48	92.3%	Moderate-High

Collaboration	50	42	84.0%	Moderate
Communication	38	28	73.7%	Moderate
Thought Critical	35	25	71.4%	Low- Moderate
Creativity	18	12	66.7%	Low
Digital Literacy	31	24	77.4%	Moderate

Source: Analysis by Fukkink et al. (2024); Helm et al. (2023); Ramírez et al. (2024)

4.3 ENABLERS AND BARRIERS TO COIL EFFECTIVENESS

The systematic analysis identified multiple factors that facilitate or hinder the effectiveness of COIL programs. These factors can be organized into three levels: pedagogical, technological, and organizational, following the TPACK (Technological Pedagogical Content Knowledge) framework adapted by Fukkink et al. (2024).

4.3.1 Facilitators

A. Pedagogical factors:

- **Intentional collaborative design:** Careful co-design among faculty partners of activities that require genuine positive interdependence among international students (Helms, 2020).
- **Structured intercultural reflection:** Systematic inclusion of critical reflection activities on intercultural encounters, facilitated by teachers (O'Dowd, 2021).
- **Authentic and relevant tasks:** Projects connected to real challenges that require multiple perspectives for effective resolution (Rubin & Guth, 2022).
- **Continuous formative assessment:** Frequent feedback on both content and collaborative and intercultural processes (Commander et al., 2022).

B. Technological Factors:

- **Appropriate selection of tools:** Use of platforms that facilitate both synchronous communication (Zoom, Teams) and asynchronous collaboration (Google Workspace, Moodle) (Hackett et al., 2023).
- **Prior technical training:** Effective induction of students and teachers in the use of technologies before the start of international collaboration (Bassani & Buchem, 2019).
- **Reliable infrastructure:** Stable internet access and basic equipment for all participants (Ngalomba et al., 2025).

C. Organizational Factors:

- **Visible institutional support:** Recognition and assessment of COIL in teaching workload and budgets for professional development (Rubin & Guth, 2022).
- **Effective administrative coordination:** **Dedicated** staff for logistics coordination, partner matching, and troubleshooting (Hackett et al., 2024).
- **Curricular flexibility:** Institutional capacity to adapt calendars, requirements, and assessments to accommodate international collaboration (Beelen & Jones, 2015).

4.3.2 Barriers

A. Language Barriers:

- Differences in common language proficiency (typically English) generate inequalities in participation and communicative confidence, particularly for students whose first language is not English (Bassani & Buchem, 2019).
- Students with lower language proficiency may feel marginalized or experience high communicative anxiety that inhibits active participation (Ramírez et al., 2024).

B. Time Zone Differences:

- Synchronous session coordination becomes complex with significant time differences, potentially requiring some students to participate in inconvenient schedules (Bassani & Buchem, 2019).
- It can generate a perception of inequity if some groups consistently have to accommodate other groups' schedules (Helm, 2020).

C. Digital Divide:

- Unequal access to technology (computers, stable internet) particularly in institutions in the Global South may limit effective participation of some students (Ngalomba et al., 2025).
- Heterogeneous prior digital competencies may require additional time-consuming training from the COIL module (Çalıkoğlu, 2025).

D. Perceived Workload:

- COIL can be perceived by students as significant additional work, especially if it is not organically integrated into existing courses (Bedenlier & Marín, 2020).
- Coordination with international peers requires time and effort beyond typical individual work in courses (Ramírez-Marín et al., 2020).

E. Differences in Academic Cultures:

- Divergent expectations about academic communication styles, citation norms, approaches to group work, and student-teacher relationships can generate misunderstandings and friction (King de Ramirez, 2021).
- Without appropriate teacher facilitation, these differences can be a source of conflict rather than intercultural learning (O'Dowd, 2021).

4.4 COIL EXPERIENCES IN LATIN AMERICA

Latin America has experienced significant growth in COIL adoption during the 2020-2024 period, accelerated by transformations in post-pandemic higher education and recognition of structural limitations for traditional physical mobility. The nine Latin American studies identified in this review provide valuable evidence on regional particularities in COIL implementation and effectiveness.

4.4.1 Institutional Networks and Programs

The Universidad Veracruzana (Mexico) has emerged as a regional leader, having established in 2021 the Latin American COIL Network (Red LatAm COIL Network), which connects more than 45 higher education institutions in 12 Latin American countries. This network provides free training to teachers, facilitates matching of international partners, and promotes research on COIL in regional contexts (Rodríguez Luna, 2023).

In Peru, the Pontificia Universidad Católica del Perú (PUCP) has institutionalized COIL as a central component of its Internationalization at Home strategy. During 2024-2025, it offered 20 courses with integrated COIL modules, benefiting more than 800 students from various faculties. The PUCP strategy includes three modalities: International Week (intensive courses with foreign teachers), regular courses in English, and COIL modules themselves, allowing students to access international experiences without physical mobility requirements (Betancourt, 2024).

In Colombia, the César Vallejo University and the Minuto de Dios University Corporation implemented a joint COIL project focused on educational research, developing soft skills of graduate students through structured virtual international collaboration (Gallego & Meneses, 2023). This project demonstrated the viability of COIL between institutions in the same country but different regions, taking advantage of internal regional diversity.

4.4.2. Specific Findings of the Latin American Context

Vega Chica's (2024) study with master's students in business from Colombia and Peru revealed that COIL not only developed expected intercultural and communicative competencies, but also strengthened commitment to sustainability practices. Students from cultures with a more collectivist orientation demonstrated a particular willingness to integrate community sustainability considerations into collaborative projects, suggesting that regional cultural values can enhance certain learning objectives in COIL.

A consistent finding in Latin American studies is the high student motivation to participate in COIL. In a context where international physical mobility is the privilege of economically favored minorities, COIL is perceived by students as a valuable and

democratizing opportunity for international experience that would otherwise be inaccessible (Restrepo, 2022; Ramírez & Bustos-Aguirre, 2022).

However, challenges specific to the Latin American context also emerged:

(1) Heterogeneous technological infrastructure within countries and between institutions requires careful planning to ensure equitable access; (2) Institutional budgetary constraints restrict capacity for sustained investment in teacher professional development and specialized administrative coordination; (3) Diverse academic calendars among Latin American countries complicate synchronization, although less so than with partners in the Global North; (4) Limited English proficiency among students may require COIL in Spanish-Portuguese or specific strategies for linguistic inclusion (Ngalomba et al., 2025).

5 DISCUSSION

This exploratory review provides robust systematic evidence on the role of COIL in the development of essential 21st century soft skills in contexts of virtual internationalization of higher education. The findings confirm that COIL, when implemented with intentional pedagogical design and appropriate institutional support, generates significant positive impacts in multiple dimensions of transversal competencies.

5.1 THEORETICAL CONTRIBUTIONS

The results support and extend social constructivist theory on learning. COIL creates intercultural zones of proximal development where students, with the support of facilitating teachers and international peers, develop competencies that exceed what they could achieve by working exclusively with peers from their same cultural context (Vygotsky, 1978). Interaction with genuine cultural otherness generates productive cognitive dissonance that drives the development of more complex, flexible, and culturally relativistic thinking (Bennett, 2017).

The consistent finding of intercultural competence development through COIL validates models of intercultural sensitivity development that postulate that experiences of authentic interaction with cultural difference, accompanied by guided critical reflection, are central mechanisms for the transition from ethnocentrism to ethnorelativism (Bennett, 2017). COIL provides precisely this kind of experience at accessible and sustainable scale.

The findings also resonate with experiential learning theory (Kolb, 1984). COIL positions students in concrete experiences of intercultural collaboration, followed by observational reflection on intercultural dynamics, abstract conceptualization of principles of communication and effective collaboration, and active experimentation with new strategies in

subsequent interactions. This experiential cycle generates deep and transformative learning beyond the acquisition of declarative knowledge about cultures.

5.2 PRACTICAL IMPLICATIONS

For higher education institutions considering adopting or scaling COIL, this review suggests several evidence-based implementation principles:

- **Prioritize quality over quantity:** Better to implement a few well-designed COIL projects with appropriate support than to scale quickly without ensuring conditions for effectiveness. Evidence shows that intentional pedagogical design is critical for positive outcomes (Fukkink et al., 2024).
- **Invest in teacher professional development:** Robust training in intercultural facilitation, collaborative design, and assessment of transversal competencies is essential. Teachers require specialized competencies beyond disciplinary expertise (Rubin & Guth, 2022).
- **Establish coordination infrastructure:** Dedicated offices or coordinators that facilitate partner matchmaking, logistical problem solving, and quality monitoring significantly improve viability and effectiveness (Hackett et al., 2024).
- **Proactively addressing the digital divide:** Providing access to equipment and connectivity for students with technological limitations ensures equitable participation and avoids reproducing inequities (Ngalomba et al., 2025).
- **Integrate soft skills assessment:** Develop rubrics and assessment methods that capture the development of transversal competencies, not just disciplinary content domain, values and makes these important learnings visible (Care et al., 2023).

5.3 LATIN AMERICAN CONTEXT

For Latin America, COIL represents a particularly strategic opportunity. The region faces tension between aspirations for internationalization of higher education and structural limitations for physical mobility. COIL offers a way for more accessible, equitable and environmentally sustainable internationalization, aligned with social justice and sustainable development objectives (Rama, 2013; Barbosa et al., 2020).

Evidence of high student motivation in Latin American contexts suggests that COIL can contribute not only to the development of soft skills but also to equity in access to international training experiences. However, realizing this potential requires deliberate attention to digital divides and sustained institutional capacity building.

The emergence of regional networks such as Red LatAm COIL constitutes a positive development that can catalyze adoption through the provision of training, resources, and communities of practice. Strengthening these networks and developing regionally contextualized repositories of good practices can accelerate the diffusion of effective COIL in Latin America.

5.4 LIMITATIONS OF THE STUDY

This review has limitations that should be considered when interpreting findings:

- **Methodological heterogeneity:** Included studies used diverse designs, instruments, and populations, limiting direct comparability and the possibility of rigorous quantitative meta-analysis.
- **Publication bias:** Studies with positive results may be more likely to be published than those with neutral or negative results, potentially overrepresenting the effectiveness of COIL.
- **Limited longitudinal evidence:** Most studies evaluate immediate or short-term impact. More research is required on the persistence of competencies developed in the medium and long term.
- **Under-representation of the Global South:** Although growing, evidence from Latin America, Africa and Asia remains limited compared to the Global North, restricting generalizability to diverse contexts.
- **Emphasis on self-reporting:** Many studies rely on students' self-reported perceptions rather than objective measures of competencies, introducing potential social desirability bias.

6 CONCLUSIONS AND RECOMMENDATIONS

This systematic exploratory review provides comprehensive evidence that Collaborative Online International Learning (COIL) constitutes an effective pedagogical strategy for the development of essential soft skills of the twenty-first century in higher education contexts. The findings are particularly relevant for institutions in Latin America that seek to democratize access to international training experiences by overcoming limitations of traditional physical mobility.

6.1 MAIN CONCLUSIONS

- **Proven effectiveness:** COIL generates positive impacts consistent in the development of intercultural competence (92.3% of studies), collaboration in multicultural teams (84%), effective communication (73.7%), and global critical thinking (71.4%).
- **Democratization of access:** COIL provides quality international experiences to students who face economic, geographic or personal barriers to physical mobility, contributing to equity in higher education.
- **Critical success factors:** COIL's effectiveness depends critically on intentional pedagogical design, specialized teacher training, appropriate technological support, and sustained institutional commitment.
- **Growth in Latin America:** Region shows accelerated adoption of COIL with preliminary evidence of effectiveness and high student motivation, although infrastructure and institutional capacity challenges persist.
- **Need to address gaps:** Language barriers, digital divide, and differences in academic cultures require deliberate strategies to ensure inclusion and equity in COIL experiences.

6.2 RECOMMENDATIONS FOR POLICIES AND PRACTICES

6.2.1 For Higher Education Institutions

- Incorporate COIL into institutional internationalization strategies as a complementary (not a substitute) component of physical mobility.
- Establish dedicated offices or coordinators to facilitate sustainable implementation and scaling of COIL programs.
- Recognize COIL in teaching workload systems and academic evaluation metrics.
- Develop funds to mitigate the digital divide by providing access to equipment and connectivity for students with disabilities.

6.2.2 For Teachers

- Participate in specialized training in international collaborative design, cross-cultural facilitation, and cross-competency assessment.
- Co-design COIL projects with international partners focusing on genuine positive interdependence and relevant authentic tasks.
- Integrate structured activities of critical intercultural reflection to maximize learning from collaborative experiences.

- Provide continuous formative feedback on both disciplinary content and collaborative and intercultural processes.

6.2.3 For Education Policymakers

- Develop financing policies and programs that promote the adoption of virtual internationalization as an equitable complementary strategy.
- Invest in educational technological infrastructure and reduce the digital divide to enable equitable participation in international virtual programs.
- Strengthen regional COIL networks that facilitate collaboration, training, and exchange of good practices between institutions.
- Include intercultural competences and soft skills as explicit learning outcomes in national qualifications frameworks.

6.3 DIRECTIONS FOR FUTURE RESEARCH

- Longitudinal studies that evaluate the persistence of competencies developed in the medium and long term after the COIL experience.
- Research with robust experimental designs (control groups, random assignment) to establish causality with greater certainty.
- Studies contextualized in the Global South, particularly Latin America, Africa and Asia, to understand regional particularities.
- Research on the cost-effectiveness of COIL compared to other internationalization modalities.
- Development and validation of regionally contextualized instruments for soft skills assessment in virtual intercultural contexts.
- Studies on the intersection of COIL with other active learning modalities (project-based learning, service-learning, etc.).

6.4 FINAL REFLECTION

In an increasingly interconnected and culturally diverse world, the ability to communicate effectively, collaborate constructively, think critically considering multiple perspectives, and adapt creatively to changing contexts are fundamental competencies for active global citizenship and professional success. COIL represents an innovative and evidence-informed pedagogical methodology that can contribute significantly to the development of these essential skills, democratizing access to international formative experiences that have traditionally been the privilege of minorities. Realizing this

transformative potential, particularly in Latin American contexts, requires sustained institutional commitment, investment in teacher capacity development, deliberate attention to equity and inclusion, and ongoing research to refine practices based on contextualized evidence. The future of the internationalization of higher education will be hybrid, combining the best of physical mobility with the democratizing opportunities of virtual internationalization. COIL is a powerful tool in this future.

REFERENCES

- Araya-Fernández, E., & Garita-González, G. (2019). Propuesta para el fortalecimiento de habilidades técnicas, blandas y complementarias, y su impacto en el currículo TIC desde una perspectiva laboral, profesional y de gestión académica. *Revista Electrónica Calidad en la Educación Superior*, 10(2), 112–141. <https://doi.org/10.22458/caes.v10i2.1907>
- American College of Sports Medicine. (2023). *ACSM's guidelines for exercise testing and prescription* (11th ed.). Wolters Kluwer.
- Amirian, S. M. R., Ghaniabadi, S., Heydarnejad, T., & Abbasi, S. (2023). The contribution of critical thinking and self-efficacy beliefs to teaching style preferences in higher education. *Journal of Applied Research in Higher Education*, 15(3), 745–761. <https://doi.org/10.1108/JARHE-11-2021-0441>
- Anderson, P., & Or, I. (2023). Enhancing intercultural effectiveness and cultural humility through COIL experiences. *Journal of Studies in International Education*, 27(4), 523–541. <https://doi.org/10.1177/10283153221119847>
- Barbosa, B., Santos, C. A., & Prado-Meza, C. M. (2020). There is no one way to internationalization at home: Virtual mobility and student engagement through formal and informal approaches to curricula. *Revista Lusófona de Educação*, 47, 85–98. <https://doi.org/10.24140/issn.1645-7250.rle47.06>
- Bassani, P. S., & Buchem, I. (2019). Challenges in virtual team communication in the context of virtual exchange experience. *European Journal of Open, Distance and E-Learning*, 22(1), 49–61. <https://doi.org/10.2478/eurodl-2023-0004>
- Beelen, J., & Jones, E. (2015). Redefining internationalization at home. In A. Curaj, L. Matei, R. Pricopie, J. Salmi, & P. Scott (Eds.), *The European higher education area: Between critical reflections and future policies* (pp. 59–72). Springer. https://doi.org/10.1007/978-3-319-20877-0_5
- Bruhn-Zass, E. (2022). Virtual internationalization to support comprehensive internationalization in higher education. *Journal of Studies in International Education*, 26(2), 240–258. <https://doi.org/10.1177/10283153211052776>
- Çalıkoğlu, A., Bulut-Sahin, B., & Aşık, A. (2025). Virtual exchange as a mode of internationalization at a distance: Experiences from Türkiye. *British Journal of Educational Technology*, 56(2), 909–926. <https://doi.org/10.1111/bjet.13546>
- Care, E., Vista, A., Kim, H., & Anderson, K. (2023). Creativity, critical thinking, communication, and collaboration: Assessment, certification, and promotion of 21st century skills for the future of work and education. *Journal of Intelligence*, 11(3), Article 54. <https://doi.org/10.3390/jintelligence11030054>

- Cariaga, R. F. (2024). Student performance through 21st-century skills: Integrating critical thinking, communication, teamwork, and creativity in modern education. *Journal of Unique and Crazy Ideas*, 1(1), 38–41. <https://doi.org/10.5281/zenodo.13448679>
- Commander, N. E., Schloer, W. F., & Cushing, S. T. (2022). Virtual exchange: A promising high-impact practice for developing intercultural effectiveness across disciplines. *Journal of Virtual Exchange*, 5, 1–19. <https://doi.org/10.21827/jve.5.37329>
- Fukkink, R., Helms, R., Spee, O., Mongelos, A., Bratland, K., & Pedersen, R. (2024). Pedagogical dimensions and intercultural learning outcomes of COIL: A review of studies published between 2013–2022. *Journal of Studies in International Education*, 28(5), 761–779. <https://doi.org/10.1177/10283153241262462>
- Gallego Hurtado, A. F., & Meneses Castañeda, M. É. (2023). Collaborative Online International Learning: Research and the development of soft skills. *Multidisciplinary & Health Education Journal*, 5(3), 368–377. <http://journalmhe.org/ojs3/index.php/jmhe/article/view/60>
- Hackett, S., Janssen, J., Beach, P., Perreault, M., Beelen, J., & van Tartwijk, J. (2023). The effectiveness of Collaborative Online International Learning (COIL) on intercultural competence development in higher education. *International Journal of Educational Technology in Higher Education*, 20(1), Article 5. <https://doi.org/10.1186/s41239-022-00373-3>
- Hackett, S., Dawson, M., Janssen, J., & van Tartwijk, J. (2024). Defining Collaborative Online International Learning (COIL) and distinguishing it from virtual exchange. *TechTrends*, 68, 1078–1094. <https://doi.org/10.1007/s11528-024-01000-w>
- Helm, F. (2015). The practices and challenges of telecollaboration in higher education in Europe. *Language Learning & Technology*, 19(2), 197–217. <https://doi.org/10.64152/10125/44424>
- Ngalomba, S., Mkwanzani, F., & Mukwambo, P. (2025). Internationalization at a distance via virtual mobility in the Global South: Advances and challenges. *British Journal of Educational Technology*, 56(2), 927–946. <https://doi.org/10.1111/bjet.13557>
- O'Dowd, R. (2018). From telecollaboration to virtual exchange: State-of-the-art and the role of UNICollaboration in moving forward. *Journal of Virtual Exchange*, 1, 1–23. <https://doi.org/10.14705/rpnet.2018.jve.1>
- O'Dowd, R. (2021). What do students learn in virtual exchange? A qualitative content analysis of learning outcomes across multiple exchanges. *International Journal of Educational Research*, 109, Article 101804. <https://doi.org/10.1016/j.ijer.2021.101804>
- Rahman, M. M., Zhang, L. J., & Singh, M. K. M. (2024). Teaching 21st-century skills in rural secondary schools: From theory to practice. *Heliyon*, 10(9), Article e30769. <https://doi.org/10.1016/j.heliyon.2024.e30769>
- Ramírez Ramírez, A., & Bustos-Aguirre, M. L. (2022). Beneficios, inconvenientes y retos de los cursos COIL: Las experiencias de los académicos. *Revista Educación Superior y Sociedad (ESS)*, 34(2), 328–352. <https://doi.org/10.54674/ess.v34i2.579>
- Restrepo Maya, N. (2022). Proyecto COIL, UNIMINUTO (Colombia) y UNICACH (México) interculturalidad mediada por pantallas. *Chasqui. Revista Latinoamericana de Comunicación*, 151, 127–140. <https://doi.org/10.16921/chasqui.v1i151.4737>
- Rodríguez Luna, V. (2023). Red LatAm COIL Network: Aprendizaje colaborativo internacional en línea en Latinoamérica. *UNAM Internacional*, 5.

<https://revista.unaminternacional.unam.mx/nota/5/red-latam-coil-network-aprendizaje-colaborativo-internacional-en-linea-en-latinoamerica>

Rubin, J., & Guth, S. (2022). *The guide to COIL virtual exchange: Implementing, growing, and sustaining Collaborative Online International Learning*. Stylus Publishing.

Sánchez, O. M., Amar, R. M., & Triadú, J. X. (2018). Habilidades blandas: Necesarias para la formación integral del estudiante universitario. *Revista Científica ECOCIENCIA*, 5, 1–18. <https://revistas.ecotec.edu.ec/index.php/ecociencia/article/view/144>

SUNY COIL Center. (2024). What is COIL? State University of New York. <https://coil.suny.edu/what-is-coil/>

Vega Chica, M. L. (2024). La metodología COIL como herramienta para el desarrollo de competencias interculturales y sostenibilidad en estudiantes de negocios de América Latina. *Centrum Think*. <https://centrumthink.pucp.edu.pe>

Zhang, X. (2025). Intercultural youth: Developing a globally competent generation through virtual exchange. In *Proceedings of the 2025 3rd International Conference on Language, Innovative Education and Cultural Communication (CLEC 2025)* (pp. 4–14). Atlantis Press. https://doi.org/10.2991/978-2-38476-430-3_2

LAND REGULARIZATION FOR QUILOMBOLA COMMUNITIES IN TOCANTINS: DEMOCRATIC RESISTANCE AND STATE OMISSION IN THE HEART OF BRAZIL

A REGULARIZAÇÃO FUNDIÁRIA QUILOMBOLA NO TOCANTINS: RESISTÊNCIA DEMOCRÁTICA E OMISSÃO ESTATAL NO CORAÇÃO DO BRASIL

REGULARIZACIÓN DE TIERRAS PARA LAS COMUNIDADES QUILOMBOLAS EN TOCANTINS: RESISTENCIA DEMOCRÁTICA Y OMISIÓN ESTATAL EN EL CORAZÓN DE BRASIL



<https://doi.org/10.56238/sevened2026.008-080>

Jonathan Silva Ribeiro¹, Angela Issa Haonat²

ABSTRACT

The land regularization of quilombola territories in the state of Tocantins, although guaranteed by Article 68 of the Transitional Constitutional Provisions of the 1988 Brazilian Constitution, faces significant obstacles to its implementation. The process is hindered by the lack of specific state legislation, limited resources, bureaucratic delays, and political omission. Of the 52 quilombola communities officially recognized by the Fundação Cultural Palmares, only one has had its territory titled, and only through a court decision. This situation reveals a deep gap between legal recognition and the realization of territorial rights. This study uses a mixed methodology (documentary, census, and empirical data) and is grounded in the theoretical frameworks of ethnodevelopment, participatory democracy, and human rights. It highlights the crucial role of social movements, the justice system, and academic production as forms of democratic resistance. A comparison with states like Pará and Maranhão shows how specific legal frameworks can significantly advance quilombola land titling. The study concludes that overcoming state omission requires the establishment of state-level legislation, active participation of quilombola communities, and stronger institutional commitment. Land regularization is not merely a technical or legal issue—it is a matter of social justice, historical reparation, and sustainable territorial development for quilombola peoples in the heart of Brazil.

Keywords: Quilombolas. Tocantins. Land Regularization.

RESUMO

A regularização fundiária quilombola no Tocantins, embora assegurada pelo artigo 68 do ADCT da Constituição de 1988, encontra entraves significativos à sua efetivação. No estado, o processo esbarra na ausência de legislação estadual específica, escassez de recursos, morosidade administrativa e omissão política. Apenas uma das 42 comunidades quilombolas

¹ Master's student in Jurisdictional Provision and Human Rights. Universidade Federal do Tocantins (UFT). Escola Superior da Magistratura Tocantinense (ESMAT). E-mail: jsrdto@gmail.com
Lattes: <http://lattes.cnpq.br/0790064622737269>

² Postdoctorate certificate in The Challenges of Public Law. Universidade de Santiago de Compostela.
E-mail: ahaonat@gmail.com Lattes: <http://lattes.cnpq.br/9421403351506139>

reconhecidas pela Fundação Cultural Palmares teve seu território titulado, e apenas após decisão judicial. Essa realidade evidencia o descompasso entre o marco normativo e a efetividade dos direitos territoriais. A pesquisa adota uma abordagem mista (documental, censitária e empírica), com base teórica no etnodesenvolvimento, democracia participativa e direitos humanos. Destaca-se o papel essencial dos movimentos sociais, das comunidades quilombolas, do sistema de justiça e da produção acadêmica como formas de resistência democrática. O estudo também compara a situação tocantinense com a de estados como o Pará e o Maranhão, cujas legislações específicas possibilitaram avanços significativos na titulação quilombola. Conclui-se que a superação da omissão estatal passa pela criação de um marco legal estadual, pela participação ativa das comunidades e pelo fortalecimento institucional. A regularização fundiária é mais do que uma demanda jurídica: trata-se de um imperativo de justiça social, reparação histórica e desenvolvimento territorial sustentável para os povos quilombolas no coração do Brasil.

Palavras-chave: Quilombolas. Tocantins. Regularização Fundiária.

RESUMEN

La regularización de tierras para las comunidades quilombolas en Tocantins, si bien está garantizada por el Artículo 68 de las Disposiciones Transitorias de la Constitución de 1988, enfrenta importantes obstáculos para su implementación. En el estado, el proceso se ve dificultado por la ausencia de legislación estatal específica, la escasez de recursos, las demoras administrativas y la omisión política. Solo una de las 42 comunidades quilombolas reconocidas por la Fundación Cultural Palmares ha obtenido la titulación de su territorio, y únicamente tras una decisión judicial. Esta realidad pone de manifiesto la discrepancia entre el marco normativo y la efectividad de los derechos territoriales. La investigación adopta un enfoque mixto (documental, censal y empírico), basado en el marco teórico del etnodesarrollo, la democracia participativa y los derechos humanos. Se destaca el papel fundamental de los movimientos sociales, las comunidades quilombolas, el sistema de justicia y la producción académica como formas de resistencia democrática. El estudio también compara la situación en Tocantins con la de estados como Pará y Maranhão, cuya legislación específica ha permitido avances significativos en la titulación de tierras quilombolas. Se concluye que superar la omisión estatal requiere la creación de un marco jurídico estatal, la participación activa de las comunidades y el fortalecimiento institucional. La regularización de la tierra es más que una exigencia legal: es un imperativo de justicia social, reparación histórica y desarrollo territorial sostenible para los pueblos quilombolas en el corazón de Brasil.

Palabras clave: Comunidades Quilombolas. Tocantins. Regularización de Tierras.

1 INTRODUCTION

The struggle for land in Latin America has historically been a key component of democratization processes and social mobilizations for rights, significantly influencing the guarantee of territorial rights for traditional communities. In Brazil, the constitutional recognition of the territorial rights of traditional peoples and communities was marked in 1988, with the enactment of article 68 of the Transitional Constitutional Provisions Act (ADCT). This legal-political advance, however, has not been translated equitably into effective access to land, especially in regions where state action has been minimal or non-existent.

In the state of Tocantins, located in northern Brazil, the situation of quilombola communities is still marked by territorial insecurity, the lack of specific state legislation and an inefficient bureaucracy that postpones land titling. Although there are federal norms that regulate the process of land regularization, the scarcity of resources, bureaucratic slowness and political omission have contributed to the inefficiency of the application of the constitutional right to land, which can be mitigated by the states of the federation.

These issues are aggravated by the limited academic production on quilombola land regularization in Tocantins. Although the topic is recognized in legislation and has been the focus of several social struggles, the lack of research that specifically addresses the obstacles faced in Tocantins reflects a significant gap in the scientific field. Studies such as that of (Franco, Sousa and Ferreira 2024, p. 12) point to the urgent need to deepen the analysis on the subject in Tocantins, since the scarcity of publications and academic debates limit the formulation of more effective and informed public policies.

This article seeks to contribute to overcoming this academic gap in the context of Tocantins, as well as to reflect on the contradictions between the formal recognition of territorial rights and their denial, in practice. It is a political and democratic issue, which transcends legal and administrative aspects: How does the State articulate itself with the historical demands for reparation and social justice? What is the role of social movements in monitoring and demanding these rights?

Based on an approach that combines theories of ethnodevelopment, human rights, and participatory democracy, the article analyzes the main challenges faced by quilombola communities in Tocantins and proposes guidelines for more effective, responsible state action committed to territorial equity.

2 METHODOLOGY

The research adopts a mixed approach, combining qualitative and quantitative methods, to offer a comprehensive analysis of the situation of quilombola land regularization

in the State of Tocantins. The choice for this methodological approach is justified by the complexity of the phenomenon, which requires the triangulation of documentary, census and empirical data for a deeper understanding.

From the documentary point of view, national and international normative instruments were analyzed, such as article 68 of the Transitional Constitutional Provisions Act (ADCT), Decree No. 4,887/2003, ILO Convention No. 169 and reference state legislation (Pará and Maranhão). Institutional recommendations (such as Recommendation No. 6/2017 of the MPF, MPE and DPE) and judicial decisions were also examined, with emphasis on the case of the Ilha de São Vicente community, whose territory was titled by court order, in addition to the Rio Preto and Barra do Aroeira quilombos that suffer from the inertia of state power.

In the census plan, data from the 2022 Demographic Census, from the Brazilian Institute of Geography and Statistics (IBGE), referring to the quilombola population in Tocantins, as well as information from the Palmares Cultural Foundation on certified communities, were used.

The empirical dimension of the research was built on the basis of recent public reports, such as the document of the Pastoral Land Commission (2023), which highlights land conflicts involving quilombola communities in the state, and the data systematized in the public consultation of the Multiannual Plan (PPA) 2024–2027, which identifies quilombola titling as a priority for the population.

The analysis was conducted under the theoretical framework of ethnodevelopment, participatory democracy and human rights, with emphasis on state responsibility and the role of social movements as agents of democratic resistance. The triangulation of these sources and approaches enabled a critical and contextualized understanding of the problem.

3 CONSTITUTIONAL RECOGNITION AND POLITICAL OMISSION

Article 68 of the Transitional Constitutional Provisions Act (ADCT), by recognizing the definitive ownership of lands occupied by quilombo remnants, guarantees more than a possessory right. It establishes a fundamental foundation for the preservation of their traditions, cultural practices and forms of social organization, essential elements for the continuity and strengthening of these communities, the result of a long struggle for the recognition of rights historically denied to the black population in Brazil and represents a milestone in the reparation of the injustices inherited from slavery.

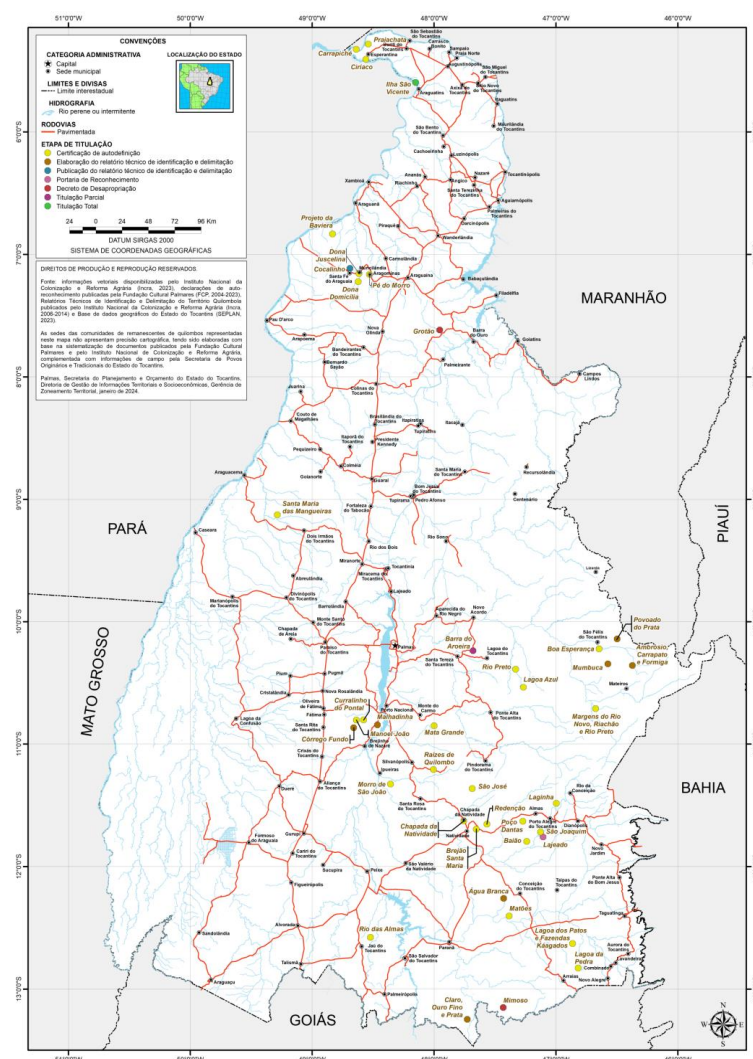
In this sense, the political omission of federated entities, especially state governments, translates into an act of institutional negligence that contributes to the deepening of racial and territorial inequalities. In the case of Tocantins, the absence of specific legislation, of a public

budget for land regularization and of political will to implement effective measures shows a scenario of structural invisibility of these communities. The lack of action on the part of the State not only compromises the effectiveness of article 68 of the Transitional Constitutional Provisions Act (ADCT), which recognizes the right of quilombola communities to definitive ownership of their territories, but also constitutes a direct violation of Convention No. 169 of the International Labor Organization (ILO), ratified by Brazil through Decree No. 10,088/2019. In particular, Article 14 of the Convention establishes that the rights of ownership and possession over traditionally occupied lands must be recognized, requiring States to adopt measures to identify them and ensure their effective protection. The state's omission, therefore, represents not only a failure to comply with domestic constitutional norms, but also a failure to comply with international obligations assumed by the country in the field of human rights.

4 QUILOMBOLA COMMUNITIES IN TOCANTINS

In 1988, the National Constituent Assembly created the State of Tocantins, the most recent federative unit of Brazil, located in the geodesic center of the country. However, the presence of quilombola communities in their territory long predates their institutionalization. According to the Palmares Cultural Foundation (2024), the state has 42 certified quilombola communities. The origin of these groups dates back at least to the nineteenth century, when enslaved black people and their descendants began to occupy areas of difficult access as a form of resistance, organizing their own and collective ways of life. In these territories, located mostly in cerrado regions and on the banks of rivers, their own and collective ways of life were developed, based on agricultural production, cultural reproduction and the preservation of black collective memory. Despite being historically marginalized by public policies, these communities play a central role in the construction of the socio-territorial identity of the State, organizing politically in defense of the realization of their rights. As a result of this mobilization, the Permanent Forum for Monitoring the Quilombola Issue in the State of Tocantins was created in January 2010, with the objective of pressuring the State to complete the processes of identification and land regularization of quilombola territories (APA-TO, 2012).

However, in a study published in 2024 on areas of restricted legal use and with potential for environmental conservation, the State of Tocantins presented a georeferenced map with the location of certified quilombola communities, evidencing the state's land tenure reality: only one quilombola community has full title to its territory.

Figure 1*Location of certified quilombola communities in Tocantins*

Source: TOCANTINS (2024)

The only quilombola community with fully titled territory, as shown in figure 1, is the Island of São Vicente, located in the municipality of Araguatins, in the region of Bico do Papagaio, in the extreme north of Tocantins. However, this recognition was not the result of a spontaneous initiative of the Brazilian State, but rather of the intervention of the Judiciary. The land regularization process was driven by a decision of the 1st Federal Court of Araguaína, in case No. 1001658-74.2020.4.01.4301, which determined the titling of the territory in favor of the community, evidencing the administrative slowness and state omission. Considering that there are 42 certified quilombola communities in the state, the titling of the Island of São Vicente represents less than 2.5% of the total, not counting those communities that do not even have certification. These data reveal the fragility of public policies aimed at quilombola land regularization in Tocantins and indicate that this agenda is not yet a priority for the State.

5 QUILOMBOLAS AS DEMOCRATIC SUBJECTS AND AGENTS OF RESISTANCE

The concept of quilombo, historically linked to resistance to the slavery system, has evolved to encompass contemporary forms of resistance and organization of black communities. This understanding is crucial for the interpretation of quilombola territorial claims, as it highlights the continuous character of resistance and the intrinsic connection between land, culture and identity. In this sense, contemporaneously, the term quilombo does not refer to archaeological residues or remnants of temporal occupation or biological proof. Nor are they isolated groups or a strictly homogeneous population (O'Dwyer 2008, 10).

In this regard, as guided by the CNJ's Protocol of Judgment with a Racial Perspective, the use of the term "remnant" can lead to misinterpretations, by suggesting that such communities would only be historical remains. On the other hand, it is noteworthy that these communities maintain cultural, social and economic practices that are constantly updated and constitute contemporary forms of sociocultural resistance. For this reason, it is recommended to use the term "quilombola community", which expresses the historical continuity, social differentiation, and autonomy of these groups, recognized as subjects of law by ILO Convention No. 169 (National Council of Justice, 2024).

In view of this expanded and updated conception of quilombo, it becomes evident that the issue of land regularization of quilombola communities in Tocantins transcends mere land ownership, configuring itself as a matter of social rights, public policies and regional development.

In the case of Tocantins, this demand for land regularization has progressively intensified. Recommendation No. 6/2017, issued by the Federal and State Public Prosecutor's Office and the Public Defender's Office, reinforces the need for concrete actions by the State to ensure the implementation of the territorial rights of these communities. Added to this is the Public Consultation of the Multiannual Plan (PPA) 2024/2027, which highlights the protagonism of the local population itself by electing the demarcation of quilombola territories as one of the main priorities, especially in the Jalapão region. Thus, the recognition of these demands by civil society and public agencies constitutes a relevant step towards the construction of a dialogue between the State and the communities, promoting a mutual understanding aimed at the realization of territorial rights.

From this perspective, data from the 2022 Demographic Census, carried out by the IBGE, reveal the existence of 13,077 quilombola people distributed in 39 municipalities in Tocantins. However, the land regularization of these communities still faces significant challenges. The report "Conflicts in the Countryside Brazil 2023", by the Pastoral Land Commission (CPT), points out that Tocantins recorded 13 land conflicts involving quilombola

communities in that year, which highlights the urgency and seriousness of the situation.

An emblematic example of this reality is the case of the Rio Preto Quilombola Community, located in Lagoa do Tocantins and certified by the Palmares Cultural Foundation through Ordinance 275/2023. Despite the official recognition, the community was the target of a violent attack on September 24, 2023, involving arson and gunfire (FIOCRUZ, 2024). Such an episode exposes the contradiction between the legal frameworks for the protection of traditional territories and the reality of state violence and negligence. Although the judicial decision of the Court of Justice of Tocantins, dated 09/08/2023 in case file 0000174-53.2017.8.27.2728 and ratified by the Federal Court in case file 1013274-44.2023.4.01.4300, has formally guaranteed the safety of the community, its effectiveness was compromised by state omission. Thus, the case of the Rio Preto Community makes explicit the failure of the State to ensure constitutional rights such as land titling and protection against violence, revealing that judicial decisions, although symbolically relevant, are not enough to change, by themselves, the correlation of forces in the territory.

In a similar way, the quilombola community of Barra do Aroeira also represents another cut of resistance among many in Tocantins. Located in the municipality of Santa Tereza do Tocantins, its history dates back to the Paraguayan War. According to Amaral and Pereira (2016), Félix José Rodrigues, considered the hero of Barra, volunteered to join the imperial army in the Paraguayan War (1854–1870). After the Brazilian victory, the combatants were rewarded, and Félix, summoned by Dom Pedro II, was able to choose the desired reward, opting for an area of land to live with his family.

Currently, according to Alves (2021), the quilombola community of Barra da Aroeira maintains a participatory and continuous struggle for the regularization of its territory. In the absence of progress in their demands, its members have mobilized strategies of resistance and strengthening of collective organization, with the aim of sensitizing the authorities to a historical problem experienced for many years. An example of this mobilization is the act of interdiction of the TO 247 highway, reflecting the history of resistance of black populations, especially in states such as Tocantins, marked by the expansion of agribusiness and the exploitation of land for cattle ranching and soy agriculture, standing out as an example of organization and resistance in the national scenario.

Figure 2

Interdiction of the TO 247 highway that crosses the Quilombo Barra do Aroeira, TO



Source: Personal collection, 2021.

In September 2021, after almost two decades of formal claims, the Government of Tocantins handed over to the Barra do Aroeira Quilombola Community the collective title of ownership of an area of 1,000 hectares. The delivery was preceded by a direct action of resistance: the interdiction of the TO-247 highway by members of the community, who, in June of the same year, held a protest with banners and a sound car, denouncing the delay in titling and demanding measures from the public authorities (Gazeta do Cerrado 2021). Then-governor Mauro Carlesse participated in the handover ceremony and declared that the recognition of the territory was an "obligation of the State" (Government of Tocantins, 2021). Despite this partial achievement, the community is still waiting for the titling of the territory in its entirety, estimated at around 62 thousand hectares, according to the delimitation already recognized in an official technical report (COEQTO 2025). The episode exemplifies how popular mobilization has been a central element in the realization of territorial rights of quilombola communities. Santos (2024) observes that the quilombola movement has been strengthened in recent decades through the articulation of legal actions, protests, and political strategies to ensure their right to territory. Leite (2008) already warned that the mere existence of legal provisions does not guarantee, by itself, the realization of the rights of quilombolas, and that a constant and politically active action of black social movements is necessary. The case of Barra da Aroeira illustrates this dynamic, reaffirming that organized resistance is a fundamental condition for transforming historical demands into legal recognition.

6 STATE RESPONSIBILITY AND THE CHALLENGE OF REGULATION IN STATE LANDS

In Brazil, the land regularization of quilombola territories is supported by federal legislation, such as Decree 4,887/2003 and Normative Instruction 57 of INCRA, which establish the procedures for the identification, recognition, delimitation, demarcation and

titling of these lands.

Figure 3

Map of quilombola communities titled and in the process of regularization in Brazil



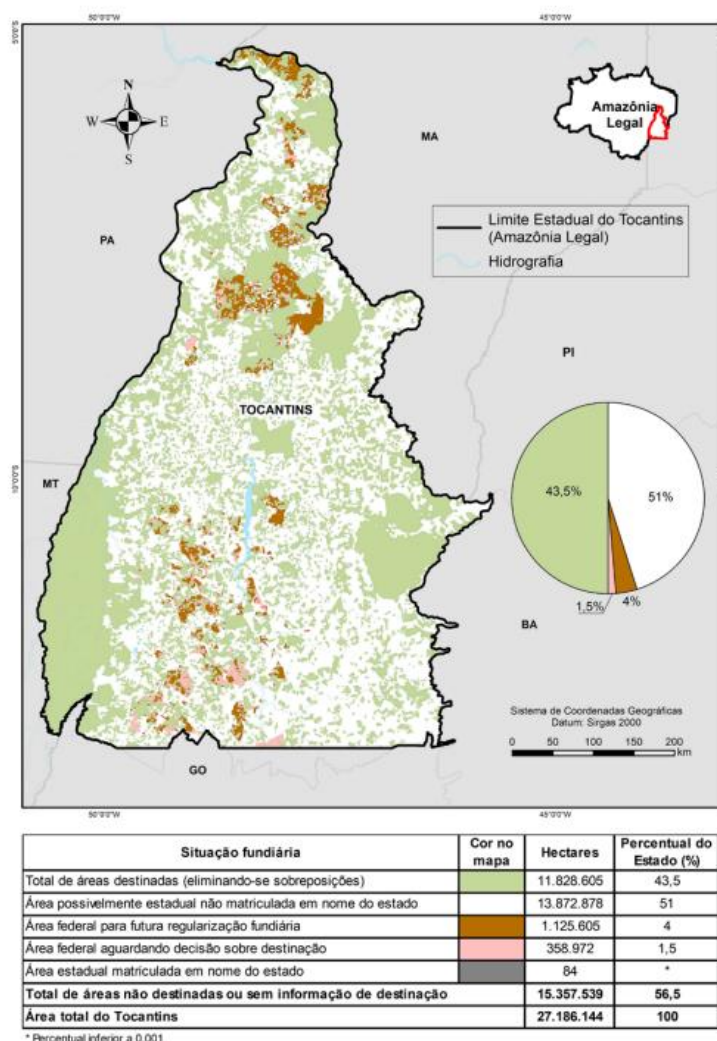
Source: PRO-INDIAN COMMISSION OF SÃO PAULO, 2023.

The map above shows the disparity between the states with regard to the progress of the regularization processes, highlighting those with the highest number of titles issued and ongoing processes. This variation is largely due to the performance of the federative entities. The competence to legislate on state lands lies with the states themselves. Some, such as Pará, Maranhão and Bahia, have already advanced in the regulation of the quilombola issue with their own laws and decrees, which facilitates and speeds up the process of land regularization in their territories.

On the other hand, according to the Institute of Man and the Environment of the Amazon (IMAZON, 2021), approximately 56.5% of the entire territory of the State of Tocantins has no defined destination or lacks information about its destination.

Figure 4

Distribution of areas not designated or without destination information in the State of Tocantins by responsible government sphere



Source: <https://imazon.org.br/wp-content/uploads/2021/03/LeisRegularizacaoFunditariaTocantins.pdf>

Therefore, the high proportion of land without a defined destination in Tocantins reveals not only a structural deficit in the state's land governance, but also an omission by the government to ensure legal certainty and territorial justice, especially for historically marginalized populations.

According to the Pro-Indian Commission of São Paulo, Brazilian states have played a crucial role in the land regularization of quilombola territories, accounting for about 79% of the titles carried out since the promulgation of the 1988 Constitution, which recognized the right of quilombolas to land. This state protagonism reflects the capacity of local administrations to promote public policies aimed at guaranteeing the territorial rights of these communities, often with greater agility than the Federal Government.

In this context, the state of Pará stands out as one of the states that has made the

most progress in the titling of quilombola lands in recent years. In 2023, the Land Institute of Pará (Iterpa) was responsible for the titling of 15 territories, benefiting more than a thousand quilombola families, which shows the local commitment to the regularization of these areas (PARÁ, 2023). In addition to Pará, Maranhão has also shown significant advances in the land regularization of quilombola territories. Through the Land Institute of Maranhão (Iterma), the State has titled three territories, benefiting more than 300 families in 2023.

In contrast, in Tocantins, the absence of specific state legislation for the regularization of quilombola lands in state areas creates a significant obstacle. Without clear guidelines and defined procedures, the process becomes more complex and time-consuming, making it difficult to guarantee the territorial rights of quilombola communities and perpetuating situations of legal insecurity and social vulnerability.

Given this scenario, the legal gap in Tocantins highlights the urgent need to create a state regulatory framework that complements federal legislation, streamlining and facilitating quilombola land regularization on state lands. The experience of other states shows that the existence of specific laws can bring more speed, legal certainty and effectiveness to the process, guaranteeing the right to land and the sustainable development of these communities.

Little (2014) argues that ethnicity development and economic advancement are intertwined, so that the absence of adequate economic development for an ethnic group can lead to marginalization and poverty. In addition, an economic development that ignores and destroys the cultural bases of this ethnic group would be a setback to the cultural homogenization promoted by modernization (LITTLE, 2014, p. 40).

In this scenario, land regularization should not be understood only as a legal obligation, but as a central strategy for regional development. By ensuring land tenure for quilombola communities, the State fosters food production, strengthens environmental conservation practices and encourages the development of sustainable economic activities. At the same time, it promotes the appreciation of Afro-Brazilian culture and contributes to the construction of a more just and equitable society, as recommended by the Statute of Racial Equality (Law No. 12,288/2010).

7 STATE OF PARÁ AS A REFERENCE IN TITLING

The State of Pará has made significant progress in the construction of a legal framework aimed at promoting the rights of quilombola communities, especially with regard to access to land, cultural identity and development with social justice. State Law No. 8,878/2019, Decree No. 1,190/2020 and, more recently, Decree No. 4,372/2024 form a

normative tripod that establishes and operationalizes the land policy and the full protection of quilombola rights in the state.

Since the promulgation of the Federal Constitution of 1988, with article 68 of the Transitional Constitutional Provisions Act, quilombola communities have the right to the recognition and titling of their traditional territories. Pará legislation incorporates this guideline at several levels. Law No. 8,878/2019, for example, recognizes "quilombola state territories" as one of the specific forms of land regularization, by including in article 4, item IX, "quilombola state territory – TEQ" as a legitimate category for the allocation of state public lands. This regularization, according to article 12 of the same law, can occur in a non-onerous way, that is, through donation to consolidated occupations, without charging the Value of Bare Land (VTN) or administrative fees: "In the non-onerous sale (donation) individual or collective, the beneficiary will be exempt from the Value of Bare Land (VTN) and procedural and agrarian costs" (§1, art. 12).

Decree No. 1,190/2020, which regulates this law, reinforces the priority of traditional peoples in regularization processes. According to its article 6, in case of conflict of land interests over the same area, the remnants of quilombola communities, traditional communities and family farmers will have priority in regularization. Such a priority recognizes not only the historical vulnerability of these groups, but their legitimacy in the continuous and collective use of the land.

With the advent of Decree No. 4,372/2024, the State of Pará took a step forward by instituting the State Policy for Quilombola Communities, a legal framework that structures the rights of these peoples in a transversal way. Article 1 of this decree establishes that the policy will be implemented "based on a set of plans, projects and systematic and articulated actions between the bodies of the direct and indirect state Public Administration." In paragraph 2 of the same article, the text defines "quilombola communities" as "ethnic groups made up of descendants of enslaved black people who share identity, ancestry, traditions, cultural practices, common historical references and endowed with specific territorial relations."

One of the central axes of the decree is territorial recognition. Article 21 establishes that "the recognition, identification, demarcation, titling and registration of lands occupied by quilombola communities shall respect the self-recognition of the community and the self-identification of the territory." In addition, paragraph 2 of the same article ensures that the territory to be titled comprises not only the living area, but also "spaces for environmental conservation, economic exploitation, socio-cultural activities, including spaces for religious worship and leisure."

Titles issued to these communities must respect special legal guarantees. Article 22 is

clear in determining that the title will be registered "with clauses of indivisibility, non-transferability, imprescriptibility, unseizability and inalienability", ensuring that the territory continues to be for the collective use of the community and cannot be fragmented or negotiated, not even in the case of debts.

With regard to social participation, the decree creates the State Council of Policies for Quilombola Communities, a joint collegiate body, with representatives of the government and civil society, as provided for in article 25. Article 26 defines the council as "a privileged space for the participation of quilombola communities, acting as a forum that facilitates and proposes the actions of the Government aimed at meeting the needs of these communities."

This set of norms consolidates a public policy model based on historical reparation, social justice, and the appreciation of diversity. He recognizes that land, for quilombola peoples, is more than an economic good, it is the basis of their identity, culture and collective existence. By ensuring secure titling, sustainable development and the direct participation of communities in decisions that concern them, the State of Pará contributes to the construction of a more equitable and plural society, which respects the past and projects the future with dignity.

According to data available on the official website of the Land Institute of Pará (ITERPA), the state of Pará currently registers 96 titled quilombola communities, the result of a land policy supported by specific state legislation, such as Law No. 8,878/2019 and Decrees No. 1,190/2020 and No. 4,372/2024 (ITERPA, 2025). In contrast, the state of Tocantins has only one quilombola community with titles and lacks its own legal regulations that discipline the land regularization of quilombola territories. This disparity reveals the centrality of the state legal framework in the process of enforcing the territorial rights guaranteed by article 68 of the Act of Transitory Constitutional Provisions of the Federal Constitution. The existence of specific legislation is a determining factor for the structuring of continuous public policies, endowed with institutional and operational mechanisms capable of ensuring the identification, demarcation, titling and legal protection of traditional territories, according to constitutional guidelines and international commitments assumed by Brazil, such as ILO Convention 169.

8 QUILOMBOLA LAND REGULARIZATION IN TOCANTINS

The search for land regularization of quilombola communities in Tocantins is part of a broader context of dispute for resources and power in the public sphere. As Silva and Almeida (2020) point out, the public sphere is a field of dispute where several actors, with often divergent interests, negotiate and seek to influence public policies. This complex dynamic makes consensus-building a constant challenge. In this sense, the demand for recognition

and titling of quilombola territories is another chapter in this dispute, marked by a constant tension between private, market and state interests. Understanding this dynamic is essential to analyze the challenges and opportunities present in the land regularization process in the state

According to the Atlas of Quilombola Territories of the State of Tocantins (GONÇALVES et al., 2024), the state currently has 52 communities recognized by the Palmares Cultural Foundation, organized into 41 quilombola associations. Despite the normative framework and the socio-political mobilization around the agenda, only one of these communities had its territory fully regularized, while 13 others are in different stages of administrative processing, and 25 are still awaiting the formal start of the land regularization process (GONÇALVES et al., 2024, p. 3). This reality points to a worrying asymmetry between ethnic-cultural recognition and the legal realization of the right to territory.

Such a scenario becomes even more challenging when observing the state's land structure. It is estimated that 56.5% of the territory of Tocantins remains without specific destination. Of this percentage, most (51%) corresponds to state public lands, while the rest is divided between federal areas and those under destination analysis (GONÇALVES et al., 2024, p. 3). On the other hand, only 43.5% of the state's land has already been officially allocated, revealing a significant stock of public lands still subject to agrarian reform policies and land regularization of traditional territories, according to the provisions of article 188 of the Federal Constitution and article 13 of Law No. 8,629/1993.

Nevertheless, land governance encounters institutional obstacles that hinder the advancement of quilombola regularization. The absence of documentary validation of private properties registered in the Land Management System (SIGEF/INCRA), for example, raises suspicions about the legitimacy of part of these possessions, which requires a careful review of existing records, in order to ensure legal certainty and avoid undue land conflicts (GONÇALVES et al., 2024, p. 15).

Quilombola land regularization cannot be reduced to the merely formal fulfillment of a constitutional precept, but must be understood as a strategic public policy, capable of promoting redistributive justice, cultural recognition and sustainable territorial development. In this sense, the vast tracts of undesignated state public lands are configured as a relevant geopolitical resource, whose proper use can substantively reconfigure the state's land structure and consolidate rights historically denied to quilombola populations.

9 CONCLUSION

The reality of quilombola land regularization in Tocantins makes explicit a serious

mismatch between the legal framework that guarantees rights and the concreteness of the public policies that should make it viable. Although the Brazilian constitutional system and international treaties ratified by the State recognize the legitimacy of the territorial rights of quilombola communities, these rights, in the context of Tocantins, remain largely denied. The titling of the community of the Island of São Vicente, conquered only by virtue of a judicial decision, is emblematic of the pattern of omission and institutional inertia that prevails in the state.

The absence of specific state legislation emerges as one of the main obstacles to the effectiveness of the right to land, perpetuating the slowness and fragility of administrative processes. On the other hand, experiences developed in states such as Pará and Maranhão demonstrate that political commitment, translated into their own normative instruments, is capable of significantly boosting the processes of recognition, demarcation and titling of traditional territories. This contrast shows that the realization of rights does not depend only on the existence of general norms, but on the concrete action of the federative entities, through articulated public policies, sustained by political will and guided by the active listening of the collective subjects of law.

In this scenario, social movements, the justice system, and academia play fundamental roles as counterweights to the omission of the state Executive. The work of the Public Defender's Office, the Public Prosecutor's Office, and community organizations has been consolidated as mechanisms of resistance and democratic affirmation, even though they often operate in contexts of institutional adversity and scarcity of resources. It is these forces that, articulated, have kept the quilombola agenda alive, demanding the fulfillment of the constitutional and international commitments assumed by the Brazilian State.

To understand quilombola land regularization in Tocantins only as a technical or legal challenge is to reduce its complexity and empty its transformative potential. It is, above all, an ethical, political and historical requirement, which calls on the State to recognize and repair structural inequalities produced and reproduced over centuries. The construction of the idea of competition of obligations between the State and the Union and prioritizing historical reparation, based on territorial justice, racial equity, ethnodevelopment, and democratic participation, is the way to break with the invisibility imposed on quilombola communities and fully guarantee their dignity, autonomy, and future.

REFERENCES

Almeida, J., Amaral de Andrade, R., Brito, B., & Gomes, P. (2021). Leis e práticas de regularização fundiária no Estado do Tocantins. Instituto do Homem e Meio Ambiente da Amazônia.

<https://amazon.fly.storage.tigris.dev/uploads/2021/03/LeisRegularizacaoFundiariaTocantins.pdf>

Alves, O. P. N. (2021). Um estudo sobre as mulheres quilombolas da comunidade Barra da Aroeira em defesa do seu território [Dissertação de mestrado, Universidade Federal do Tocantins]. Repositório UFT. <https://core.ac.uk/download/pdf/267892712.pdf>

Alternativas para Pequena Agricultura no Tocantins. (2012). Os territórios quilombolas no Tocantins. <https://campanhacerrado.org.br/images/biblioteca/Os%20territórios%20quilombolas%20no%20Tocantins%20-%20APA-TO.pdf>

Assembleia Legislativa do Estado do Pará. (2019). Lei nº 8.878, de 8 de julho de 2019. Diário Oficial do Estado do Pará.

Associação Comunitária de Quilombolas da Ilha São Vicente de Araguatins v. Instituto Nacional de Colonização e Reforma Agrária e União Federal, Ação Civil Pública No. 1001658-74.2020.4.01.4301 (Tribunal Regional Federal da 1ª Região 2022). <https://pje1g.trf1.jus.br/consultapublica/Processo/ConsultaDocumento/listView.seam?x=22072517225879600001223585445>

Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Senado Federal. https://www2.senado.leg.br/bdsf/bitstream/handle/id/518231/CF88_Livro_EC91_2016.pdf

Brasil. (2003). Decreto nº 4.887, de 20 de novembro de 2003. http://www.planalto.gov.br/ccivil_03/decreto/2003/d4887.htm

Brasil. (2010). Lei nº 12.288, de 20 de julho de 2010. Estatuto da Igualdade Racial. https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12288.htm

Brasil. (2019). Decreto nº 10.088, de 5 de novembro de 2019. https://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D10088.htm

Centro de Documentação Dom Tomás Balduino. (2024). Conflitos no campo Brasil 2023. Comissão Pastoral da Terra Nacional.

Comissão Pró-Índio de São Paulo. (2023). Balanço terras quilombolas: Como foi o primeiro ano do Governo Lula? <https://cpisp.org.br/balanco-terras-quilombolas-como-foi-o-primeiro-ano-do-governo-lula/>

Comissão Pró-Índio de São Paulo. (2024). Como evoluíram os processos de titulação de Terras Quilombolas em 2024? <https://cpisp.org.br/como-evoluiram-os-processos-de-titulacao-de-terras-quilombolas-em-2024/>

Conselho Nacional de Justiça. (2024). Protocolo para julgamento com perspectiva racial. <https://www.cnj.jus.br/wp-content/uploads/2024/11/protocolo-para-julgamento-com-perspectiva-racial-1.pdf>

Coordenação Estadual das Comunidades Quilombolas do Tocantins. (2025). Quilombo Barra da Aroeira avança na luta pela titulação do território após 19 anos de espera. <https://coeqto.com.br/quilombo-barra-da-aroeira-avanca-na-luta-pela-titulacao-do-territorio-apos-19-anos-de-espera>

do Amaral, G. B., & Pereira, C. M. R. B. (2016). Interseções entre território e identidade étnica: Estudo sobre a comunidade quilombola Barra da Aroeira–TO. *Produção Acadêmica*, 2(1), 65–74.

- Fundação Cultural Palmares. (2024). Certidões expedidas às Comunidades Remanescentes de Quilombos (CRQs). <https://www.gov.br/palmares/pt-br/midias/arquivos-menu-departamentos/dpa/comunidades-certificadas/crqs-certificadas-03-06-2024.pdf>
- Franco, C. M. G., Sousa, D. N. de, & Ferreira, P. R. (2024). A legalização quilombola: Uma história ainda a ser contada. *Revista Políticas Públicas & Cidades*, 13(2), Article e778. <https://doi.org/10.23900/2359-1552v13n2-7-2024>
- Gazeta do Cerrado. (2021). Quilombolas bloqueiam TO-247 e pedem titulação definitiva do território da Barra da Aroeira. <https://gazetadocerrado.com.br/quilombolas-bloqueiam-to-247-e-pedem-titulacao-definitiva-do-territorio-da-barra-da-aroeira>
- Governo do Estado do Pará. (2020). Decreto nº 1.190, de 25 de novembro de 2020. *Diário Oficial do Estado do Pará*.
- Governo do Estado do Pará. (2023). Governo do Pará entrega títulos de terra para mais de mil famílias quilombolas. Agência Pará. <https://agenciapara.com.br/noticia/49229/governo-do-para-entrega-titulos-de-terra-para-mais-de-mil-familias-quilombolas>
- Governo do Estado do Pará. (2024). Decreto nº 4.372, de 6 de dezembro de 2024. *Diário Oficial do Estado do Pará*.
- Governo do Estado do Tocantins. (2021). Governador Carlesse entrega aos quilombolas da Barra do Aroeira títulos definitivos de terras esperados há mais de 100 anos. <https://www.to.gov.br/secom/noticias/governador-carlesse-entrega-aos-quilombolas-da-barra-do-aroeira-titulos-definitivos-de-terras-esperados-ha-mais-de-100-anos/143rn5fdwv12>
- Gonçalves, P. R., et al. (2024). Atlas de territórios quilombolas do Estado do Tocantins: Projeto da nova cartografia social do Tocantins. Alternativas para Pequena Agricultura no Tocantins.
- Instituto Brasileiro de Geografia e Estatística. (2023). Censo Demográfico 2022. https://censo2022.ibge.gov.br/panorama/mapas.html?recorte=N3&tema=taxa_de_alfabetizacao_quilombolas&localidade=
- Instituto de Terras do Pará. (2025). Comunidades quilombolas tituladas. <http://portal.iterpa.pa.gov.br/quilombolas/>
- Justiça Federal da 1ª Região. (2024). Reintegração / Manutenção de Posse nº 1013274-44.2023.4.01.4300. <https://pje1g.trf1.jus.br:443/consultapublica/Processo/ConsultaDocumento/listView.seam?x=24042215121693200002102611131>
- Leite, I. B. (2008). O projeto político quilombola: Desafios, conquistas e impasses atuais. *Revista de Antropologia*, 51(2). <https://doi.org/10.1590/S0104-026X2008000300015>
- Little, P. E. (2014). Etnodesenvolvimento local: Autonomia cultural na era do neoliberalismo global. *Tellus*, 3, 33–52. <https://doi.org/10.20435/tellus.v0i3.23>
- Ministério Público Federal, Ministério Público do Estado do Tocantins, & Defensoria Pública do Estado do Tocantins. (2017). Recomendação Conjunta nº 06, de 31 de agosto de 2017. Procedimento Administrativo MPF nº 1.36.000.000190/2016-22.
- O'Dwyer, E. C. (2008). Terras de quilombo no Brasil: Direitos territoriais em construção. *Ariús*, 14(1/2), 9–16.

Secretaria do Planejamento e Orçamento do Estado do Tocantins. (2024). Estado do Tocantins: Áreas de Uso Legal Restrito e Potenciais à Conservação Ambiental (4ª ed. rev. at.).

Silva, M. A. da R. (Org.). (2024). Sociedade, políticas públicas e desenvolvimento: Pluralidade e diálogos possíveis.

Santos, J. B. dos. (2024). Território e resistência: O protagonismo das comunidades quilombolas na luta por direitos no Brasil. Cadernos de Antropologia e Imagem, 36(1), 45–67.

Tocantins (Estado). (2024). Lei nº 4.373, de 9 de janeiro de 2024. <https://central.to.gov.br/download/368857>

Tribunal de Justiça do Estado do Tocantins. (2023). Reintegração / Manutenção de Posse nº 0000174-53.2017.8.27.2728.

TEMPORAL TRENDS OF GESTATIONAL SYPHILIS IN BRAZIL, 2012-2022

TENDÊNCIA TEMPORAL DA SÍFILIS GESTACIONAL NO BRASIL DE 2012 A 2022

TENDENCIA TEMPORAL DE LA SÍFILIS GESTACIONAL EN BRASIL DE 2012 A 2022



<https://doi.org/10.56238/sevened2026.008-081>

Emile Danielly Amorim Pereira¹, Emanuelle Vieira Nogueira², Vanuza Silva Frazão³

ABSTRACT

Gestational syphilis is an important public health problem due to the high risk of vertical transmission and the severe repercussions for the mother-child dyad. This is a descriptive epidemiological time-series study with a quantitative approach, using secondary data from the Notifiable Diseases Information System (SINAN) and the Live Birth Information System (SINASC). Detection rates per thousand live births were calculated, and trend Figures were produced. This study aimed to analyze the temporal trend of gestational syphilis in Brazil from 2012 to 2022. The results showed a continuous increase in reported cases of gestational syphilis, rising from 16,444 cases in 2012 to 78,872 in 2022, with a detection rate of 30.79 per thousand live births in the last year analyzed. Most infected pregnant women were aged 20–29 years, were of mixed race (brown), and had low educational attainment. The Southeast and Northeast regions accounted for the highest number of notifications, and the latent clinical form was the most prevalent. Gestational syphilis shows an upward trend in the country, associated with social inequalities and weaknesses in prenatal care. The need to strengthen surveillance actions, expand testing and treatment coverage, and enhance the role of nursing in the prevention and control of this condition is emphasized.

Keywords: Gestational Syphilis. Epidemiological Surveillance. Women's Health. Nursing. Sexually Transmitted Infections.

RESUMO

A sífilis gestacional constitui um importante problema de saúde pública devido ao elevado risco de transmissão vertical e às graves repercussões para o binômio mãe-filho. Trata-se de uma pesquisa epidemiológica descritiva de série temporal, com abordagem quantitativa, utilizando dados secundários provenientes do Sistema de Informação de Agravos de Notificação (SINAN) e do Sistema de Informações sobre Nascidos Vivos (SINASC). Foram calculadas taxas de detecção por mil nascidos vivos e elaborados gráficos de tendência. Este estudo teve como objetivo analisar a tendência temporal da sífilis gestacional no Brasil

¹ Dr. in Epidemiology in Public Health. Universidade Estácio de Sá (Estácio).
E-mail: emiledanielly@gmail.com Orcid: <https://orcid.org/0000-0002-5821-5149>
Lattes: <https://lattes.cnpq.br/1092977354203242>

² Graduated in Nursing. Universidade Estácio de Sá (Estácio).
E-mail: emanuelle.vieira.nogueira@alunoedufor.com.br

³ Graduated in Nursing. Universidade Estácio de Sá (Estácio).
E-mail: vanuza.silva.frazao@alunoedufor.edu.br

no período de 2012 a 2022. Os resultados evidenciaram aumento contínuo das notificações de sífilis gestacional, passando de 16.444 casos em 2012 para 78.872 em 2022, com taxa de detecção de 30,79 por mil nascidos vivos no último ano analisado. A maior parte das gestantes infectadas tinha entre 20 e 29 anos, era parda e apresentava baixa escolaridade. As regiões Sudeste e Nordeste concentraram o maior número de notificações, e a forma clínica latente foi a mais prevalente. Conclui-se que a sífilis gestacional apresenta tendência ascendente no país, associada a desigualdades sociais e fragilidades na atenção pré-natal. Ressalta-se a necessidade de fortalecer as ações de vigilância, ampliar a cobertura de testagem e tratamento e valorizar o papel da enfermagem na prevenção e controle desse agravado.

Palavras-chave: Sífilis Gestacional. Vigilância Epidemiológica. Saúde da Mulher. Enfermagem. Infecções Sexualmente Transmissíveis.

RESUMEN

La sífilis gestacional constituye un importante problema de salud pública debido al alto riesgo de transmisión vertical y a las graves repercusiones para la díada madre-hijo. Se trata de un estudio epidemiológico descriptivo de series temporales con un enfoque cuantitativo, que utiliza datos secundarios del Sistema de Información de Enfermedades de Declaración Obligatoria (SINAN) y del Sistema de Información de Nacidos Vivos (SINASC). Se calcularon las tasas de detección por cada mil nacidos vivos y se crearon gráficos de tendencias. Este estudio tuvo como objetivo analizar la tendencia temporal de la sífilis gestacional en Brasil de 2012 a 2022. Los resultados mostraron un aumento continuo en las notificaciones de sífilis gestacional, que pasaron de 16.444 casos en 2012 a 78.872 en 2022, con una tasa de detección de 30,79 por cada mil nacidos vivos en el último año analizado. La mayoría de las embarazadas infectadas tenían entre 20 y 29 años, eran de raza mixta y presentaban bajo nivel educativo. Las regiones Sudeste y Noreste concentraron el mayor número de notificaciones, siendo la forma clínica latente la más prevalente. Se concluye que la sífilis gestacional muestra una tendencia ascendente en el país, asociada a desigualdades sociales y deficiencias en la atención prenatal. Se destaca la necesidad de fortalecer las acciones de vigilancia, ampliar la cobertura de pruebas y tratamiento, y valorar el papel de enfermería en la prevención y el control de esta enfermedad.

Palabras clave: Sífilis Gestacional. Vigilancia Epidemiológica. Salud de la Mujer. Enfermería. Infecciones de Transmisión Sexual.

1 INTRODUCTION

Syphilis is a sexually transmitted infection (STI) caused by the bacterium *Treponema pallidum*, which throughout history has been an important public health problem. The infection occurs mainly through sexual contact, through contact with active lesions, but it can also be transmitted vertically from mother to fetus during pregnancy or at the time of delivery. Among STIs, syphilis remains one of the most worrisome for public health, as it is fully preventable, treatable, and has consolidated clinical protocols, but still has a high burden of maternal and child morbidity and mortality (Brasil, 2024).

Gestational syphilis has shown an increasing trend in recent decades, becoming an important challenge for Brazilian public health. According to the Epidemiological Bulletin of the Ministry of Health, between 1999 and June 2024, more than 340 thousand cases of congenital syphilis were recorded in children under one year of age, reflecting the persistence of vertical transmission in the country. In 2023 alone, 86,111 cases of syphilis were reported in pregnant women, corresponding to a detection rate of 27.1 cases per thousand live births, a value higher than the previous year (Brasil, 2024). Although part of this increase may be related to the expansion of testing actions and the improvement of notifications, the data also show persistent weaknesses in prevention strategies and prenatal care (Cavichioli *et al.*, 2024).

The analysis of the reported cases reveals significant regional disparities and a sociodemographic profile characteristic of the affected pregnant women. In 2023, 60.1% of pregnant women diagnosed with syphilis belonged to the age group between 20 and 29 years old, and the highest concentration of cases was observed in the Northeast and Southeast regions, where higher population rates and social inequalities are concentrated (Brasil, 2024). These findings suggest that factors such as socioeconomic vulnerability, low education, and limited access to health services directly influence the risk of infection and the maintenance of transmission (Cardoso *et al.*, 2023).

In view of this scenario, the fight against gestational syphilis requires integrated actions aimed at prevention, early diagnosis and timely treatment, with emphasis on the qualification of prenatal care and the strengthening of Primary Health Care. In this context, nursing plays a strategic role, both in direct care for pregnant women and in epidemiological surveillance and health education actions.

In view of the facts presented, this study is justified by the relevance of gestational syphilis as a public health problem, due to the high potential for vertical transmission and the consequences for the mother-child binomial. Although there are clinical guidelines for screening and treatment, there is a continuous increase in cases in the country, evidencing

limitations in current control strategies. The analysis of the temporal trend of this disease makes it possible to evaluate the effectiveness of the public policies implemented and to identify regional and structural failures that make it difficult to cope with the disease, especially in contexts of social vulnerability.

1.1 OBJECTIVES

1.1.1 General

To analyze the temporal trend of gestational syphilis in Brazil from 2012 to 2022, based on secondary data available in TABNET/SINAN.

1.1.2 Specifics

- a) To describe the evolution of the number of reported cases of gestational syphilis in Brazil per year;
- b) To identify the sociodemographic profile of pregnant women with syphilis;
- c) Compare the distribution of cases between the different regions of the country.

2 THEORETICAL FRAMEWORK

Syphilis is a sexually transmitted infection caused by the bacterium *Treponema pallidum*, whose first documented records date back to the late fifteenth century, a period in which an epidemic outbreak spread rapidly across Europe after the military campaign of King Charles VIII of France in Naples in 1494. According to Ferreira *et al.* (2019), this initial episode was marked by severe clinical manifestations, such as ulcerated lesions and high mortality, attracting the attention of medicine at the time.

Although the first written records date back to the fifteenth century, recent scientific discoveries point to an even more remote origin of the disease. Paleogenomic studies have identified genetic evidence of *Treponema pallidum* that is approximately 9,000 years old in the Americas, reinforcing the Colombian hypothesis that syphilis was brought to the European continent during the great navigations, through contact with indigenous American populations (Barquera *et al.*, 2025).

From a clinical point of view, syphilis has four evolutionary phases: primary, secondary, latent and tertiary. The primary phase is characterized by the presence of hard chancre, painless and highly infectious ulcer; The secondary phase is marked by systemic manifestations, such as generalized skin rash, mucocutaneous lesions, and lymphadenopathy. After this stage, the infection can evolve to the latent phase, characterized by the absence of clinical signs and symptoms, although with reactive serology, being

subdivided into recent and late. The tertiary stage, currently less frequent due to early diagnosis, can appear years after contagion and present severe complications, such as neurosyphilis, cardiovascular syphilis, and gummy lesions in different organs (Brasil, 2024; Brasil, 2025).

The diagnosis of syphilis is based on treponemal and non-treponemal tests, such as VDRL, FTA-ABS, and rapid tests, widely available in the public health network for screening and confirmation. The treatment, based on the administration of benzathine penicillin, is effective, safe, and capable of interrupting the chain of transmission, reinforcing the importance of adherence to clinical protocols, especially during prenatal care (Brasil, 2024).

Gestational syphilis is defined as the infection caused by *Treponema pallidum* diagnosed during pregnancy, regardless of the presence of clinical signs or symptoms. This condition has relevant particularities, because in addition to affecting maternal health, it has a high potential for vertical transmission, which can compromise fetal development (Silva *et al.*, 2024).

The risk of vertical transmission is directly related to the clinical stage of the disease and the time of exposure of the fetus to the infectious agent. Transmission can occur at any stage of pregnancy or during childbirth, and is more likely in the primary and secondary phases, when there is a higher bacterial load. According to the Ministry of Health (2024), the intrauterine transmission rate can reach up to 80% in cases that are not properly diagnosed or treated.

The consequences of maternal infection for the fetus are serious and widely documented. Untreated syphilis during pregnancy can result in miscarriage, stillbirth, premature birth, low birth weight, and congenital syphilis, often associated with neurological manifestations, bone deformities, and skin lesions (Costa, 2024). In addition, Tourinho (2025) highlights that intrauterine exposure to syphilis increases the risk of hospitalizations in children in the first years of life, evidencing the prolonged impact of this infection on child health.

The social determinants of health play a central role in the epidemiology of gestational syphilis in Brazil. Conditions such as poverty, low education, lack of reproductive planning, and barriers to access to prenatal care hinder early diagnosis and appropriate treatment. Studies also point out that discontinuity in care and non-adherence of sexual partners to treatment contribute to the persistence of infection, increasing reinfection rates and the incidence of congenital syphilis (Laranjeira *et al.*, 2024). Thus, understanding the epidemiological context of gestational syphilis requires not only the analysis of notification data, but also the consideration of the social and structural determinants that support the

problem at the national level.

The fight against gestational syphilis in Brazil is supported by a set of public policies and guidelines instituted by the Ministry of Health, aimed at the prevention, diagnosis and timely treatment of the infection. Since 1986, with Ordinance No. 542/1986, congenital syphilis has been included in the list of notifiable diseases, which was later expanded to syphilis in pregnant women in 2005 and to the form acquired in 2010, consolidating the Notifiable Diseases Information System (SINAN) as an essential tool for epidemiological monitoring and surveillance (Brazil, 1986; Brazil, 2005; Brazil, 2010).

Among the strategies implemented by the Ministry of Health to combat syphilis in Brazil, the National STD/AIDS Program, the Stork Network and the Syphilis No Project stand out, which reinforce epidemiological surveillance and the qualification of prenatal care.

In 2025, the National Campaign "Syphilis has a cure - Get tested, treated and prevented", promoted by the Ministry of Health, reinforces the commitment to social mobilization, testing and free treatment within the scope of the Unified Health System (SUS) (Brasil, 2021; Services and Information of Brazil, 2025). Rapid testing in Primary Health Care represents one of the pillars of coping actions, allowing early diagnosis and immediate initiation of treatment during prenatal care (Brasil, 2024).

Despite regulatory and operational advances, significant challenges persist for the effective control of gestational syphilis in the country, such as intermittent shortages of benzathine penicillin, underreporting of cases, incomplete completion of forms, and low adherence of pregnant women and their partners to treatment (Cavichioli *et al.*, 2024). These factors weaken surveillance actions and make it difficult to achieve the goals of eliminating vertical transmission.

The role of nursing is central in the prevention, diagnosis, and control of gestational syphilis, acting in early screening, monitoring of pregnant women and their sexual partners, health education, and adequate completion of notification forms (Brasil, 2022; Cofen, 2023). Epidemiological surveillance uses systems such as SINAN and the TABNET platform to monitor cases, enabling temporal, regional and demographic analyses of the disease (Brasil, 2012).

The use of secondary data from official databases offers advantages such as broad national coverage, longitudinal analyses, and resource savings, although it has limitations related to underreporting and the quality of records, which should be considered when interpreting the results (Laranjeira *et al.*, 2024; Cavichioli *et al.*, 2024).

3 METHODOLOGY

3.1 RESEARCH DESIGN

This is a descriptive time series research, with a quantitative approach, based on the analysis of secondary data of notified cases of gestational syphilis in Brazil, from 2012 to 2022.

3.2 DATA SOURCE

Data were obtained through the TABNET/DataSUS platform, in the Notifiable Diseases and Conditions module of SINAN - 2007, considering all notifications of gestational syphilis registered between 2012 and 2022.

In addition, the databases of the Information System on Live Births (SINASC), used to obtain the total number of live births in the same period, were consulted in order to support the calculation of detection rates.

3.3 VARIABLES

They were organized according to the following blocks:

- Sociodemographic: age group, education and race/color of the pregnant woman;
- Clinical: case classification, evolution and type of diagnosis;
- Epidemiological: year of notification, region and federative unit of residence.

3.4 ANALYSIS PROCEDURES

The extracted data were organized in electronic spreadsheets in Microsoft Excel, allowing the visualization and manipulation of the information. Figures of temporal trend, sociodemographic, clinical, and epidemiological distribution were elaborated, enabling the visual analysis of the evolution of cases and the identification of relevant patterns.

3.5 CALCULATION OF THE DETECTION RATE

To calculate the detection rate of gestational syphilis, the number of confirmed cases of syphilis in pregnant women divided by the total number of live births in the same year was used, multiplying the result by 1000 and according to the formula below:

$$\text{Taxa de detecção} = \frac{\text{Número de casos confirmados de Sífilis em Gestantes}}{\text{Número total de nascidos vivos}} * 1.000 \quad (1)$$

3.6 ETHICAL ASPECTS

As this is a research that uses secondary, aggregated and public domain data, obtained from official databases of the Ministry of Health, there was no direct contact with participants, nor collection of information that would enable the identification of individuals.

Thus, according to Resolution No. 510/2016 of the National Health Council, this study is one of the situations that do not require consideration by the Research Ethics Committee, as it does not involve personally identifiable data. Even so, the principles of secrecy, confidentiality and exclusive use of information for scientific purposes were preserved

4 RESULTS AND DISCUSSIONS

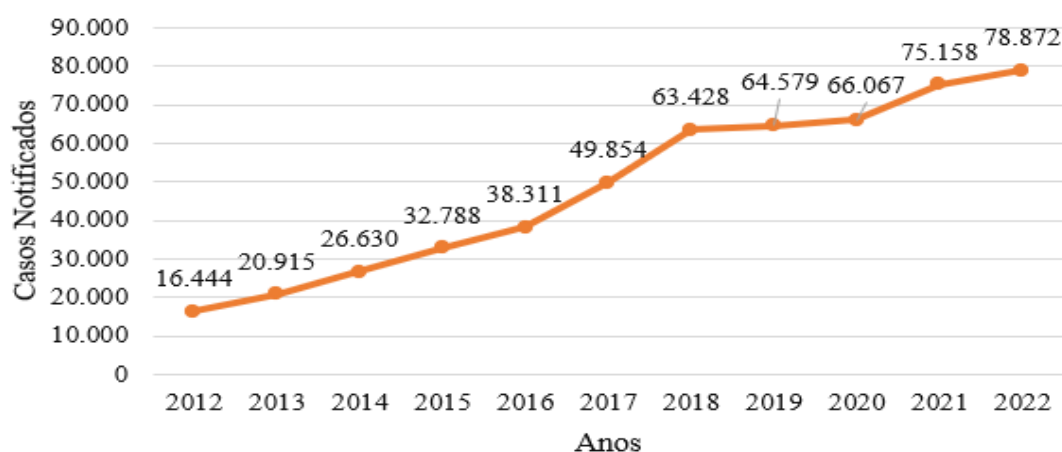
4.1 CHARACTERIZATION OF SYPHILIS NOTIFICATIONS IN PREGNANT WOMEN IN BRAZIL

In the period from 2012 to 2022, 533,046 cases of syphilis in pregnant women were reported in Brazil. The temporal analysis shows a continuous growth in notifications over the years. In 2012, 16,444 cases were registered, a number that has progressively increased: 20,915 in 2013, 26,630 in 2014, 32,788 in 2015 and 38,311 in 2016. From 2017 onwards, the pace of growth became more pronounced, with 49,854 cases. In 2018, there was a new jump, totaling 63,428 notifications, remaining at high levels in subsequent years: 64,579 in 2019, 66,067 in 2020, 75,158 in 2021 and reaching 78,872 cases in 2022, the highest number in the entire period analyzed (Figure 1).

Overall, an average increase of approximately 6,692 cases per year was observed. The average annual growth rate was 16.97%, showing a consistent upward trend in syphilis notifications in pregnant women throughout the time series.

Figure 1

Evolution of reported cases of syphilis in pregnant women, Brazil, 2012 to 2022



Source: Notifiable Diseases Information System - SINAN, 2025

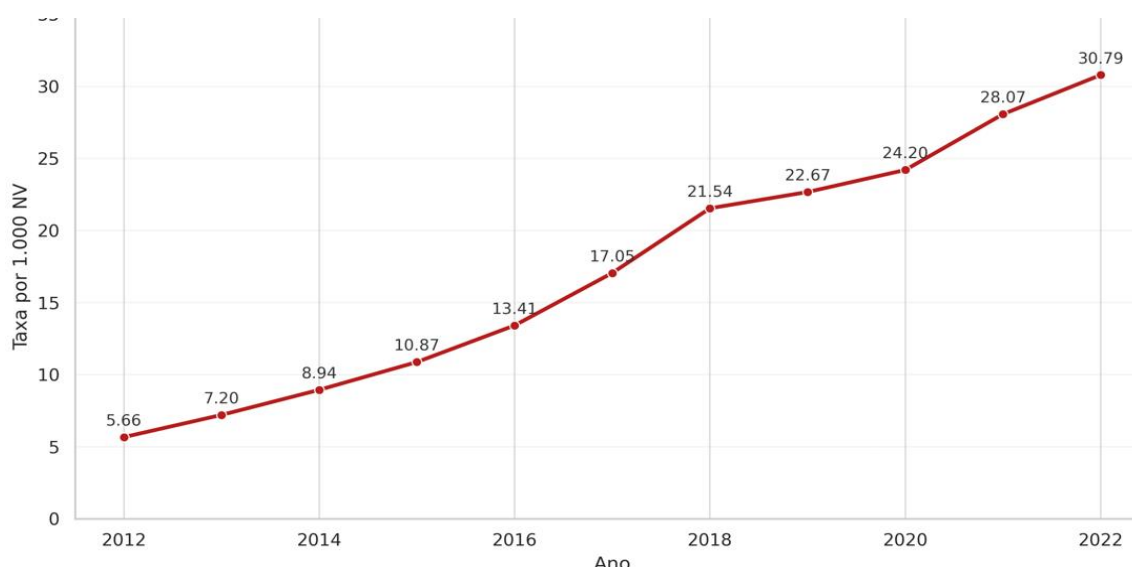
According to Lima et al. (2022), the epidemiological behavior of gestational syphilis may be associated with multiple factors, including the real increase in the incidence of the disease, the expansion of access to health services, improvements in notification systems, and greater awareness of primary care professionals regarding the importance of testing during prenatal care.

The Ministry of Health (Brasil, 2023) highlights that the expansion of rapid prenatal testing and the strengthening of epidemiological surveillance explain, in part, the increase in notifications observed in recent years. Complementing this perspective, Silva *et al.*, (2025) indicate that improvements in prenatal coverage and in the notification system contributed to the increase in the number of registered cases. In addition, Pavinati *et al.*, (2025) point out that challenges such as insufficient early screening, adherence to treatment, and reinfection remain, factors that help to understand the persistence of high rates of gestational syphilis in Brazil.

Regarding the detection rate of gestational syphilis, it was observed that in the study period it showed a significant increase throughout the period. In 2012, the indicator was 5.66 per 1,000 live births, increasing to 7.20 in 2013 and 8.94 in 2014. In 2015, it reached 10.87, and in 2016 it jumped to 13.41 per 1,000. In 2017, the rate reached 17.05, in 2018 it was 21.54. In the following years, the indicator maintained the upward trend, reaching 22.67 in 2019, 24.20 in 2020, and reaching 28.07 in 2021. The highest value in the time series was recorded in 2022, with 30.79 per 1,000 live births (Figure 2).

Figure 2

Gestational syphilis detection rate per 1,000 live births, Brazil, 2012 to 2022



Source: Notifiable Diseases Information System - SINAN, 2025

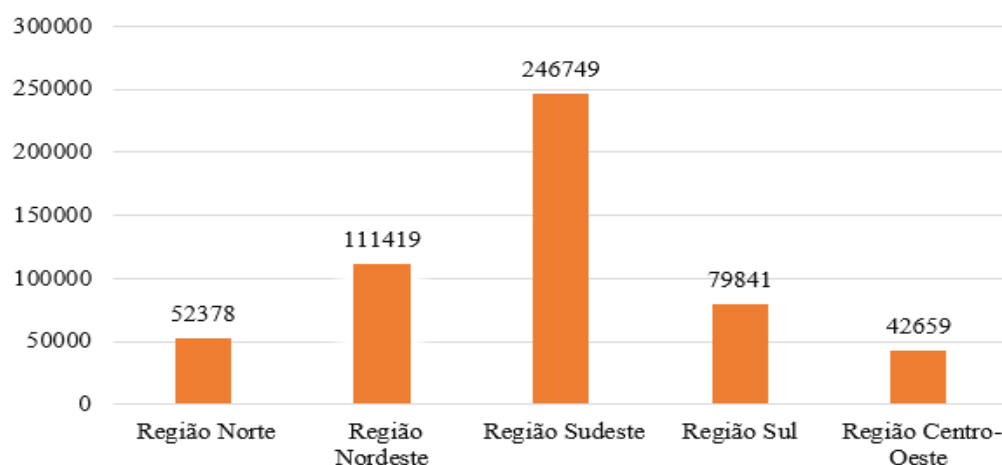
The data show a consistent increase over the decade, signaling the persistence of gestational syphilis as a relevant public health problem in Brazil (Ministry of Health, 2023).

In addition, these results are in line with the Ministry of Health's Syphilis Epidemiological Bulletins (Brasil, 2021; 2022), which point to advances in expanding testing, strengthening epidemiological surveillance, and, at the same time, the persistence of high rates of infection transmission in Brazil.

Regarding the distribution of cases of gestational syphilis considering the regions of the country, it was observed that the southeast region concentrated the highest number of records, with 246,749 notifications (43.9%). This high number may be associated with population size, the more intense urbanization process, and the greater capillarity of notification and testing systems. Next, the Northeast Region had 111,419 cases (20.9%), followed by the South Region, with 79,841 cases (14.2%). The northern region recorded 52,378 cases (9.8%) and the central-west region, 42,659 cases (7.6%) (Figure 3).

Figure 3

Cases of Syphilis in Pregnant Women by region of Brazil, 2012 to 2022



Source: Notifiable Diseases Information System - SINAN, 2025

These data show that, although gestational syphilis is present throughout the national territory, there is a greater concentration in the Southeast and Northeast regions, which together correspond to more than 60% of the notifications. This distribution reinforces the need for specific regional strategies, considering inequalities in access, prenatal coverage, service infrastructure, and socioeconomic conditions. Rodrigues *et al.*, (2022) highlight that factors such as accelerated urbanization and social inequality contribute to the higher number of cases in these regions.

In addition, according to the Ministry of Health (Brasil, 2023), the expansion of the use of rapid tests in Primary Care favored the early identification of infected pregnant women.

However, there are still barriers to access and weaknesses in the continuity of care, especially in the North and Northeast regions.

For Nursing, this scenario signals the importance of organizing territorialized practices, adapted to local specificities, with a focus on qualifying prenatal care and strengthening Primary Care (Reis *et al.*, 2024; Fontinele *et al.*, 2023). The planning of health education, testing, and follow-up actions for pregnant women should consider the regional epidemiological profile, ensuring expanded access to prenatal care, the offer of rapid tests in Basic Health Units, and the monitoring of maternal and partner treatment.

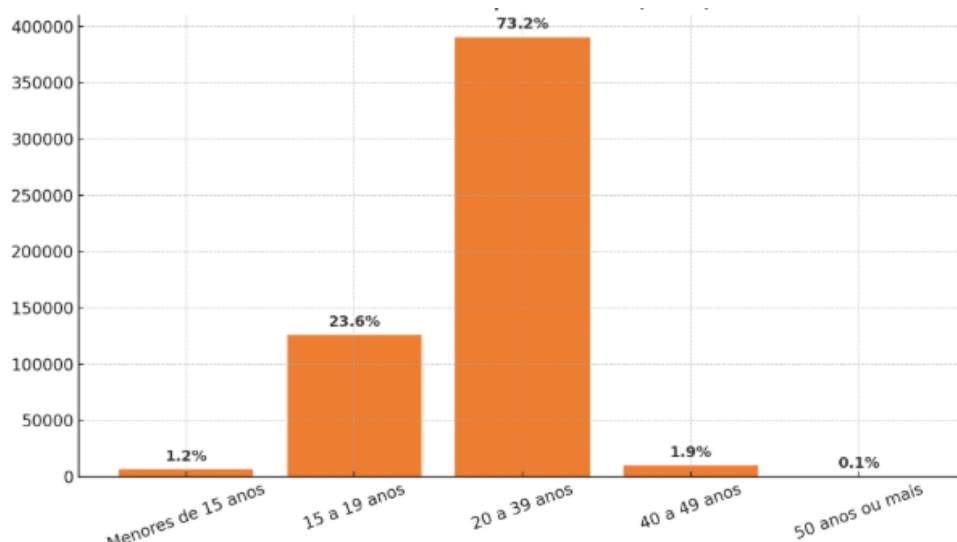
The Ministry of Health recommends that screening for syphilis be carried out in the first and third trimesters of pregnancy, in addition to the time of delivery, reinforcing the importance of protocols that ensure retesting and continuous follow-up of pregnant women by nursing teams (Brasil, 2022).

4.2 SOCIODEMOGRAPHIC PROFILE OF SYPHILIS NOTIFICATIONS IN PREGNANT WOMEN IN BRAZIL

According to the age group, about 73.2% of the pregnant women with syphilis reported were between 20 and 39 years old. Pregnant women aged between 15 and 19 years also had a significant participation, totaling 125,983 cases (23.6%). The age groups of children under 15 years of age and women over 40 years of age had significantly lower proportions. Among those under 15 years of age, 6,413 cases (1.2%) were registered, while the age group of 40 to 49 years totaled 9,958 notifications (1.9%). Among pregnant women aged 50 years or older, 381 cases (0.07%) were reported (Figure 4).

Figure 4

Percentage of gestational syphilis by age group, 2012 to 2022



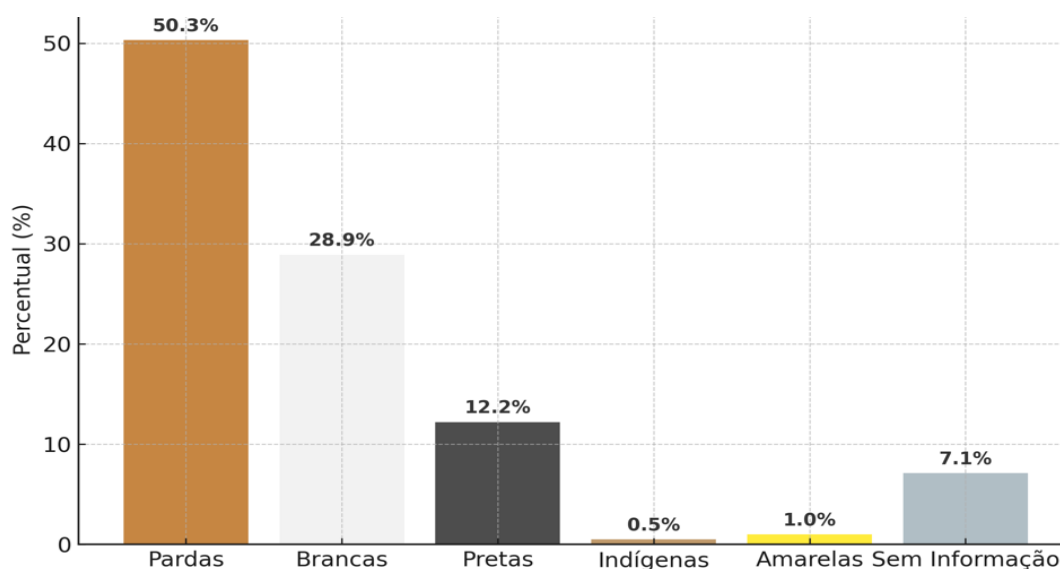
Source: Notifiable Diseases Information System - SINAN, 2025

This age profile coincides with the most active reproductive phase of women, which reinforces the need to expand screening strategies in prenatal care and reproductive planning. According to the Syphilis Epidemiological Bulletin (Brazil, 2024), in 2023, the highest proportion of cases occurred in pregnant women aged 20 to 29 years (50.5%), followed by 30 to 39 years (26.9%) and adolescents aged 15 to 19 years (21.2%). These findings confirm the greater vulnerability of women of childbearing age and highlight the relevance of interventions aimed at prevention, early diagnosis, and timely treatment.

Regarding race/color, most of the reported cases were of women who declared themselves brown, totaling 268,362 cases (50.3%), followed by white (28.9%) and black (12.2%). Indigenous women represented 0.5% and yellow women 1.0%, while 7.1% of the records did not have information on race/color (Figure 5).

Figure 5

Percentage of gestational syphilis cases by race/color, 2012 to 2022



Source: Notifiable Diseases Information System - SINAN, 2025

These findings dialogue with data from the 2024 Syphilis Epidemiological Bulletin, according to which the highest proportion of cases in pregnant women occurred among brown women (61.5%), followed by black (16.6%) and white (19.8%) women (Brasil, 2024). The bulletin points out that such distribution reflects social inequalities and barriers in access to timely prenatal care.

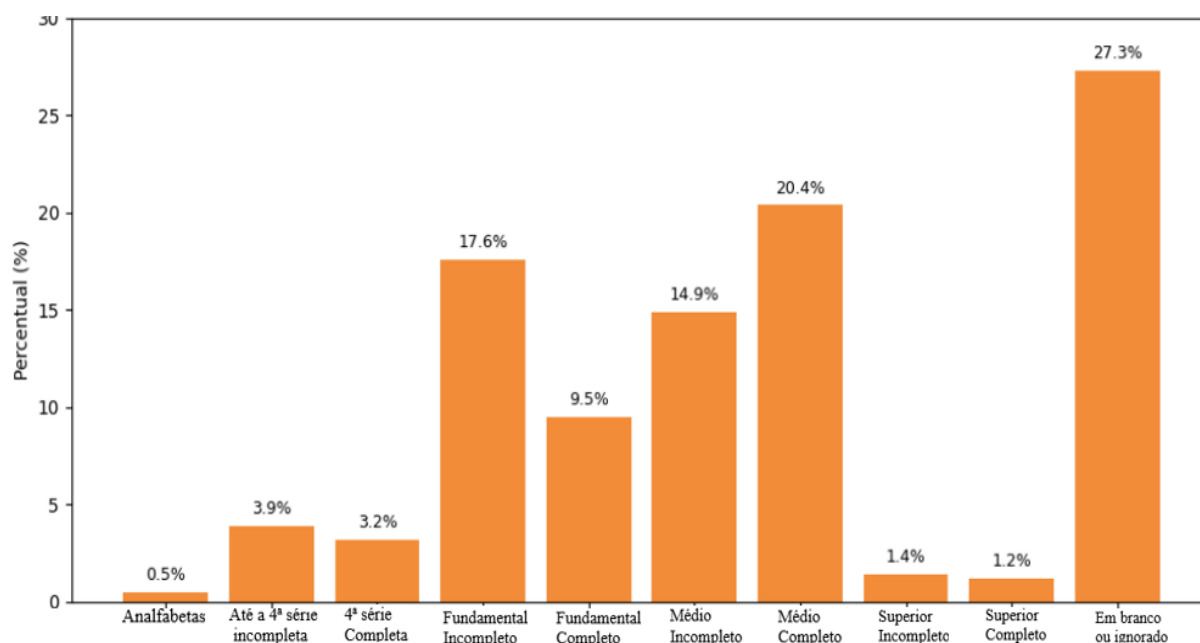
In the same sense, Laranjeira *et al.*, (2024), identified a higher prevalence of gestational syphilis in young, brown, and socially vulnerable pregnant women. These data reinforce that the intersection between race/color and social determinants of health influences the risk of infection and late diagnosis.

The distribution of cases according to education shows that the highest number of records occurred in pregnant women with complete high school (20.4%), followed by incomplete elementary school (17.6%) and incomplete high school (14.9%). In a smaller proportion, pregnant women with complete elementary education (9.5%), up to the incomplete 4th grade (3.9%), and complete 4th grade (3.2%) appear. The illiterate group corresponded to 0.5% of cases.

The presence of infection among women with a higher level of education was significantly lower: 7,580 cases occurred in pregnant women with incomplete higher education (1.4%) and 6,314 in complete higher education (1.2%). Only 227 records (0.04%) were classified as "not applicable", and in 145,577 notifications (27.3%) the education field was left blank or ignored (Figure 6).

Figure 6

Percentage of gestational syphilis cases according to the education level of pregnant women, Brazil, 2012 to 2022



Source: Notifiable Diseases Information System - SINAN/TABNET (2025)

These data confirm that, although gestational syphilis is present in all levels of education, it is more prevalent among women with low or medium formal education. The Syphilis Epidemiological Bulletin highlights that low education is associated with worse socioeconomic conditions and greater difficulty in accessing health services, impacting early screening of infection (Brasil, 2024).

Similarly, Cardoso *et al.*, (2023) identified a higher prevalence of gestational syphilis among women with low education, reinforcing the need for educational strategies and expanding access to prenatal care as fundamental measures to reduce vertical transmission.

4.3 CLINICAL PROFILE OF SYPHILIS NOTIFICATIONS IN PREGNANT WOMEN IN BRAZIL

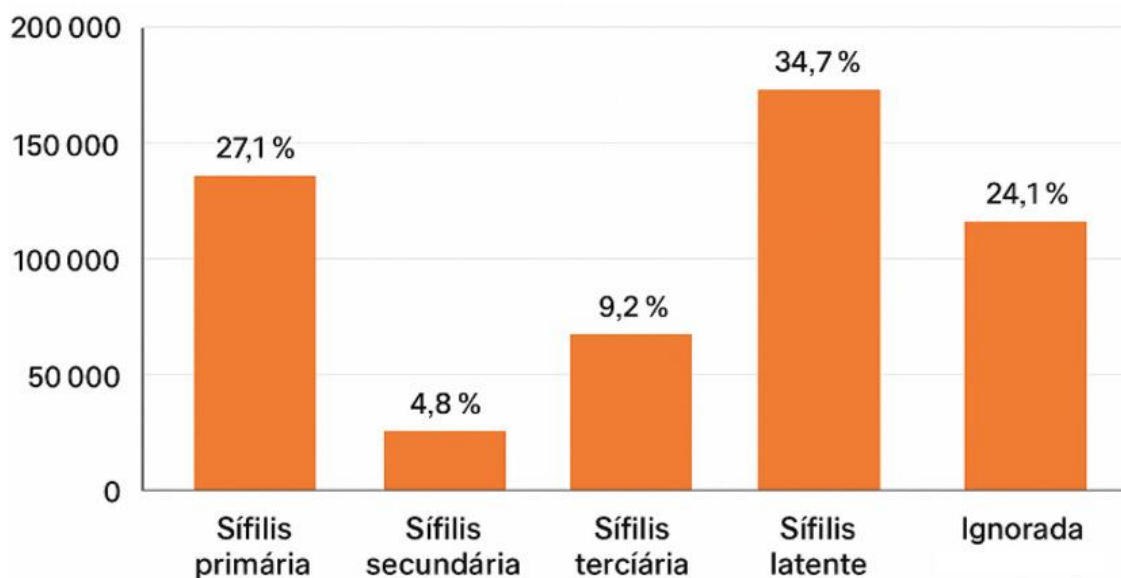
Most cases of syphilis in pregnant women were classified as latent syphilis, totaling 185,073 notifications (34.7%). This clinical form is characterized by the absence of signs and symptoms, although with reactive serological tests, which can hinder timely diagnosis during prenatal care. The second most frequent form was primary syphilis, with 144,684 cases (27.1%), followed by tertiary syphilis (49,202 cases; 9.2%) and secondary syphilis (25,832 cases; 4.8%).

It is noteworthy that, in 128,255 notifications (24.1%), the clinical classification was recorded as *unknown or not informed*, which limits a more precise analysis of the distribution

of clinical forms and compromises the understanding of the evolution of cases. This high percentage of incomplete data reinforces weaknesses in the completion of notification forms and may impact the quality of epidemiological surveillance (Figure 7).

Figure 7

Percentage of Gestational Syphilis Cases by Clinical Classification, 2012 to 2022



Source: Notifiable Diseases Information System - SINAN/TABNET (2025)

The higher proportion of notifications classified as latent syphilis can have different interpretations. On the one hand, it reflects the effectiveness of serological screening performed in prenatal care, since it makes it possible to identify asymptomatic pregnant women still in silent phases of infection. On the other hand, it may signal delays in the detection of the early stages of the disease, suggesting failures in early screening and timely access to health services (Nakano *et al.*, 2022).

Thus, the Syphilis Epidemiological Bulletin highlights that this scenario reinforces the need to repeat testing at different times of pregnancy at the beginning of prenatal care, in the third trimester and at birth, as well as to improve the completion of notification forms, in order to reduce underdiagnosis and improve epidemiological surveillance (Brasil, 2024).

In a complementary way, a study by Morais and Teixeira (2025) points out that the recurrence of syphilis in pregnant women is directly related to failures in early diagnosis, adequate treatment, and the structure of prenatal care, elements that perpetuate maternal-fetal vulnerability.

5 CONCLUSION

The analysis of the temporal trend of gestational syphilis in Brazil, from 2012 to 2022, showed a significant and continuous growth in notifications, confirming the persistence of this disease as a relevant public health problem. The increase in detection rates reflects both the expansion of testing and epidemiological surveillance and the persistence of weaknesses in prenatal care and social inequalities that make it difficult to control vertical transmission.

The findings showed a higher concentration of cases in the Southeast and Northeast regions, as well as a predominance among young, brown pregnant women with low education, evidencing the influence of social determinants of health on the occurrence of gestational syphilis. The predominance of the latent clinical form was also observed, which reinforces the importance of timely serological screening during prenatal care. The high proportion of notifications with incomplete information is also noteworthy, indicating limitations in the quality of records and information systems.

In this context, qualified prenatal care is a central strategy for the prevention, early diagnosis and appropriate treatment of gestational syphilis. Strengthening the role of nursing, especially in Primary Health Care, is essential for carrying out rapid tests, monitoring pregnant women and their sexual partners, providing health guidance and monitoring treatment adherence.

It is concluded that the fight against gestational syphilis requires continuous and integrated actions, with the strengthening of epidemiological surveillance, qualification of records, expansion of access to quality prenatal care and reduction of social inequalities. Such strategies are essential to reduce vertical transmission and to advance in the achievement of national goals for the elimination of congenital syphilis in Brazil.

REFERENCES

- Barquera, R., Sitter, T. L., Kirkpatrick, C. L., Ramirez, D. A., Kocher, A., Spyrou, M. A., Couoh, L. R., Talavera-González, J. A., Castro, M., von Hunnius, T., Guevara, E. K., Hamilton, W. D., Roberts, P., Scott, E., Fabra, M., Da Peña, G. V., Pacheco, A., Rodriguez, M., Aspillaga, E., ... Bos, K. I. (2025). Ancient genomes reveal a deep history of *Treponema pallidum* in the Americas. *Nature*, 640, 186–193. <https://doi.org/10.1038/s41586-024-08515-5>
- Brasil. Ministério da Saúde. (1986). Portaria nº 542, de 22 de dezembro de 1986. Inclui a sífilis congênita na lista de doenças de notificação compulsória. *Diário Oficial da República Federativa do Brasil*.
- Brasil. Ministério da Saúde. (2005). Portaria nº 33, de 14 de julho de 2005. Define a lista nacional de notificação compulsória de doenças e agravos. *Diário Oficial da União*. https://bvsms.saude.gov.br/bvs/saudelegis/svs/2005/prt0033_14_07_2005.html

- Brasil. Ministério da Saúde. (2010). Portaria nº 2.472, de 31 de agosto de 2010. Define a Lista Nacional de Notificação Compulsória de doenças, agravos e eventos de saúde pública nos serviços de saúde públicos e privados em todo o território nacional. Diário Oficial da União. https://bvsms.saude.gov.br/bvs/saudelegis/gm/2010/prt2472_31_08_2010.html
- Brasil. Ministério da Saúde. (2012). SIOPS – Manual TabNet: Manual sobre o uso da Ferramenta de Tabulação TABNET. <http://siops.datasus.gov.br>
- Brasil. Ministério da Saúde. (2021). Boletim epidemiológico – Sífilis 2021 (Ano V, n.º 01, especial). Secretaria de Vigilância em Saúde. https://www.gov.br/aids/pt-br/central-de-conteudo/boletins-epidemiologicos/2021/sifilis/boletim_sifilis_2021_internet.pdf
- Brasil. Ministério da Saúde. (2024a). Boletim epidemiológico de sífilis 2024. Departamento de HIV, Aids, Tuberculose, Hepatites Virais e Infecções Sexualmente Transmissíveis (Dathi), Secretaria de Vigilância em Saúde e Ambiente (SVSA). https://www.gov.br/aids/pt-br/central-de-conteudo/boletins-epidemiologicos/2024/boletim_sifilis_2024_e.pdf
- Brasil. Ministério da Saúde. (2024b). Sífilis em gestantes. <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/s/sifilis/gestantes>
- Brasil. Ministério da Saúde. (2024c). Sífilis. <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/s/sifilis>
- Cardoso, A. R. P., et al. (2023). Perfil epidemiológico da sífilis gestacional e congênita no Brasil: Desafios para o controle. *Revista Brasileira de Ginecologia e Obstetrícia*, 45(2), 103–111. <https://doi.org/10.1055/s-0042-1758710>
- Cavichioli, T. V., et al. (2024). Notificações de casos de sífilis e seus impactos nos sistemas de vigilância epidemiológica e controle da doença no Brasil: Revisão integrativa. *Araciê*, 6(4), 11055–11068. <https://periodicos.newsciencepubl.com/arace/article/download/1857/2313>
- Costa, C. (2024, May 10). Sífilis na gestação aumenta chance de desfechos negativos em recém-nascidos. *Fiocruz*. <https://fiocruz.br/noticia/2024/05/sifilis-na-gestacao-aumenta-chance-de-desfechos-negativos-em-recem-nascidos>
- Empresa Brasileira de Serviços Hospitalares. (2021, October 15). Projeto “Sífilis Não” muda cenário da doença no Brasil. <https://www.gov.br/ebserh/pt-br/hospitais-universitarios/regiao-nordeste/huol-ufrn/projeto-201csifilis-nao201d-muda-cenario-da-doenca-no-brasil>
- Ferreira, A. M., et al. (2019). Sífilis: A história de um desafio atual. *Revista Científica Online*, 11(3), 1–12. https://www.atenas.edu.br/uniatenas/assets/files/magazines/SIFILIS__A_HISTORIA_D_E_UM_DESAFIO_ATUAL.pdf
- Fontinele, L. P., Santos, R. A., Carvalho, M. C., & Pereira, L. A. (2023). Assistência de enfermagem a gestante com sífilis na atenção primária: Uma revisão integrativa. *Research, Society and Development*, 12(3), Article e40918. <https://rsdjournal.org/rsd/article/view/40918>
- Kalil, J., et al. (2024). Sífilis: Patogenia, prevalência e tratamento. *Brazilian Journal of Health Review*, 7(3), 123–135. <https://ojs.brazilianjournals.com.br/ojs/index.php/BJHR/article/view/71663>

- Laranjeira, A. O., et al. (2024). Análise dos casos de sífilis gestacional no Brasil entre os anos de 2017 a 2021. *Brazilian Journal of Implantology and Health Sciences*, 6(3), 1–12. <https://bjih.s.emnuvens.com.br/bjih/article/view/1727>
- Morais, L. A. de S., & Teixeira, V. L. da C. (2025). Recorrência da sífilis em gestantes: Falhas no tratamento e risco para o feto. *Revista FT: Ciências da Saúde*, 29(146). <https://doi.org/10.69849/revistaft/cs10202505180128>
- Nakano, N., Hanai, E. N., Milano, A. S., Schneider, L., Williams, S. B., & Kusma, S. Z. (2022). Perfil epidemiológico da sífilis gestacional e congênita da Região Sul do Brasil de 2015 a 2019 – Panorama diagnóstico e de notificação. *The Brazilian Journal of Infectious Diseases*, 26(Suppl. 1), Article 101960. <https://doi.org/10.1016/j.bjid.2021.101960>
- Portal de Boas Práticas. (2020). Vigilância epidemiológica e notificação dos casos de sífilis. Instituto Fernandes Figueira/Fiocruz. <https://portaldeboaspraticas.iff.fiocruz.br/atencao-mulher/vigilancia-epidemiologica-e-notificacao-dos-casos-de-sifilis/>
- Reis, A. S., Silva, M. P., Oliveira, C. R., Souza, D. F., & Lima, F. T. (2021). Avaliação do perfil epidemiológico da sífilis gestacional e congênita no estado de Goiás e a participação do profissional da enfermagem. ResearchGate. https://www.researchgate.net/publication/367097294_Avaliacao_do_perfil_epidemiologico_da_sifilis_gestacional_e_congenita_no_estado_de_Goias_e_a_participacao_do_profissional_da_enfermagem
- Rodrigues, E. B., Rios, J. F. R., Einloft, L., Camargo, M. E. B. de, & Burg, M. R. (2025). O perfil epidemiológico da sífilis gestacional e congênita no município de Esteio/RS. *Revista de Saúde Pública da Universidade de Santa Cruz do Sul*, 8(1), 1–10. <https://online.unisc.br/seer/index.php/ripsunisc/article/view/19052>
- Silva, M. A., et al. (2024a). Impacto da sífilis na gestação: Complicações maternas e neonatais. *Brazilian Journal of Infectious Diseases*, 28(1), 45–52. <https://bjih.s.emnuvens.com.br/bjih/article/download/5577/5494/12171>
- Silva, M. M., et al. (2024b). Análise dos fatores associados à incidência e prevenção da sífilis gestacional no Brasil. *Revista Eletrônica Acervo Saúde*, 24(11), Article e18057. <https://acervomais.com.br/index.php/saude/article/view/18057>
- Tourinho, R. (2025, May 9). Exposição a sífilis na gestação aumenta risco de internação em crianças. Agência Fiocruz de Notícias. <https://agencia.fiocruz.br/exposicao-sifilis-na-gestacao-aumenta-risco-de-internacao-em-criancas>

TEACHING RESEARCH: HOW TEACHING EXPERIENCE INSPIRED A NEW METHOD OF SUPERVISION IN LAW

ENSINAR A PESQUISAR: COMO A EXPERIÊNCIA DOCENTE INSPIROU UM NOVO MÉTODO DE ORIENTAÇÃO EM DIREITO

ENSEÑAR A INVESTIGAR: CÓMO LA EXPERIENCIA DOCENTE INSPIRÓ UN NUEVO MÉTODO DE ORIENTACIÓN EN DERECHO



<https://doi.org/10.56238/sevened2026.008-082>

Ana Paula Fernandes Teixeira¹, Anna Paula Lemos Santos Peres², Lara Maia Silva Gabrich³

ABSTRACT

This study analyzes the combination of active learning methodologies applied at a higher education institution, UNIFIPMoc, during the period from 2007 to 2021, considering a constructivist reinterpretation and the humanization of guidance in terms of the advisor–advisee relationship during the production of the Undergraduate Final Project (UFP), as well as the development of specific procedures for organizing the supervision process. The objective is to highlight the method created for supervising scientific research based on the experience gained through undergraduate thesis supervision in the Law program. This is an experience report resulting from both faculty and student praxis in the production of the Undergraduate Final Project in the Law program at UNIFIPMoc. In this context, the collective writing experience developed here drew on contributions from major scholars of learning methodologies, notably Piaget (1987), Ausubel (2000), Edgar Morin (2015), Novak and Gowin (1996), and Moreira (2011). Among the problems arising from the traditional supervision of scientific work in the Law program, the emergence of a backlog of students in a system marked by dependency and disengagement was observed, as students showed significant difficulty in progressing in the development of their research projects. The encouragement to establish a qualified Core of Academic Advisors contributed to reflection on appropriate supervision procedures developed over time. In pursuit of greater organization and optimization of academic work and supervisory relationships, these procedures, combined with the use of integrated active learning methodologies, proved essential for establishing a humanized approach to student guidance. Together, these initiatives resulted in a proprietary method for supervising undergraduate theses in the Law program at UNIFIPMoc, grounded in the organization of specific supervisory procedures, curriculum

¹ Master's Degree in Social Development. Universidade Estadual de Montes Claros (UNIMONTES). E-mail: apfernandesteixeira@gmail.com Orcid: <https://orcid.org/0000-0002-1433-9799> Lattes: <https://lattes.cnpq.br/9897947198772924>

² Dr. in Social Development. Universidade Estadual de Montes Claros (UNIMONTES). E-mail: annapaulamosperes@gmail.com Orcid: <https://orcid.org/0000-0002-1701-3428> Lattes: <http://lattes.cnpq.br/3958353786581034>

³ Doctoral student in Law. Universidade Estadual de Montes Claros (UNIMONTES). Universidade Federal de Minas Gerais (UFMG). E-mail: laragabrich@gmail.com Orcid: <http://orcid.org/0000-0002-0546-9268> Lattes: <http://lattes.cnpq.br/1251570018253785>

restructuring, and the combined use of active learning methodologies. This method fostered the development of scientific research within the Law program despite the challenges related to academic training processes in contemporary society, contributing to the reduction of student backlog in dependency systems, improving approval rates among regular students, and positively influencing the overall quality of undergraduate final projects.

Keywords: Undergraduate Final Project. Supervision. Procedure. Active Learning Methodologies.

RESUMO

Este estudo analisa a combinação de metodologias ativas de aprendizagem aplicadas em uma instituição de ensino superior, a UNIFIPMoc, no período compreendido entre 2007 e 2021, considerando uma releitura construtivista e a humanização do atendimento em termos de relacionamento orientador e orientando, durante a produção do trabalho de conclusão de curso (TCC), e compreendendo a construção de procedimentos específicos para a organização dos trabalhos de orientação. Tem por objetivo evidenciar o método criado para orientação de trabalhos científicos a partir da experiência vivenciada durante a orientação de TCC na graduação em Direito. Trata-se de um relato de experiência, resultado de praxis, docente e discente, na produção do Trabalho de Conclusão de Curso de Graduação do Curso de Direito da UNIFIPMoc. Nessa direção, a experiência de escrita coletiva aqui elaborada, buscou a contribuição de grandes pensadores sobre metodologias de aprendizagem, destacando-se Piaget [(1987)], Ausbel (2000), Edgar Morin (2015), Novak e Gowin (1996) e Moreira (2011). Dentre os problemas advindos da orientação de trabalhos científicos de modo tradicional no âmbito do curso de Direito, despontou a formação de uma demanda reprimida em sistema de dependência e desídia dos alunos, que demonstravam uma grande dificuldade de evoluir na elaboração dos trabalhos científicos. O incentivo para a formação de um Núcleo de Professores Orientadores qualificados, contribuiu para a reflexão quanto aos procedimentos adequados ao processo de orientação estabelecidos no curso do tempo. Em busca de maior organização e otimização dos trabalhos e das relações de orientação, tais procedimentos, aliados à utilização de metodologias ativas combinadas, foram importantes para estabelecer um atendimento humanizado aos alunos. Reunidas, estas iniciativas criaram um método próprio de orientação ao TCC na graduação em Direito da UNIFIPMoc, consubstanciado na organização de procedimentos específicos para a orientação, na reestruturação da grade curricular, na utilização de metodologias ativas de aprendizagem combinadas. Tal método impulsionou o desenvolvimento da pesquisa científica no âmbito do curso Direito apesar dos desafios em relação aos processos de formação acadêmica na sociedade contemporânea, contribuindo para redução da demanda reprimida em sistema de dependência e melhorando o índice de aprovação de alunos regulares bem como influenciando positivamente para a qualidade final dos trabalhos de TCC.

Palavras-chave: Trabalho de Conclusão de Curso. Orientação. Procedimento. Metodologias Ativas de Aprendizagem.

RESUMEN

Este estudio analiza la combinación de metodologías activas de aprendizaje aplicadas en una institución de educación superior, la UNIFIPMoc, en el período comprendido entre 2007 y 2021, considerando una relectura constructivista y la humanización de la atención en términos de la relación entre orientador y orientando durante la producción del Trabajo de Fin de Grado (TFG), así como la construcción de procedimientos específicos para la organización de los procesos de orientación. El objetivo es evidenciar el método creado para la orientación de trabajos científicos a partir de la experiencia vivida durante la orientación de TFG en la carrera de Derecho. Se trata de un relato de experiencia, resultado de la praxis

docente y discente, en la producción del Trabajo de Fin de Grado del curso de Derecho de la UNIFIPMoc. En este sentido, la experiencia de escritura colectiva aquí desarrollada buscó el aporte de importantes pensadores sobre metodologías de aprendizaje, destacándose Piaget (1987), Ausubel (2000), Edgar Morin (2015), Novak y Gowin (1996) y Moreira (2011). Entre los problemas derivados de la orientación tradicional de trabajos científicos en el ámbito del curso de Derecho, surgió la formación de una demanda reprimida en un sistema de dependencia y desidia por parte de los estudiantes, quienes demostraban grandes dificultades para avanzar en la elaboración de trabajos científicos. El incentivo para la creación de un Núcleo de Profesores Orientadores calificados contribuyó a la reflexión sobre los procedimientos adecuados al proceso de orientación establecidos a lo largo del tiempo. En la búsqueda de una mayor organización y optimización de los trabajos y de las relaciones de orientación, dichos procedimientos, aliados al uso combinado de metodologías activas de aprendizaje, fueron fundamentales para establecer una atención humanizada a los estudiantes. En conjunto, estas iniciativas dieron lugar a un método propio de orientación del TFG en la carrera de Derecho de la UNIFIPMoc, materializado en la organización de procedimientos específicos de orientación, en la reestructuración de la malla curricular y en la utilización de metodologías activas de aprendizaje combinadas. Este método impulsó el desarrollo de la investigación científica en el ámbito del curso de Derecho, a pesar de los desafíos relacionados con los procesos de formación académica en la sociedad contemporánea, contribuyendo a la reducción de la demanda reprimida en el sistema de dependencia y a la mejora del índice de aprobación de estudiantes regulares, así como influyendo positivamente en la calidad final de los trabajos de TFG.

Palabras clave: Trabajo de Fin de Grado. Orientación. Procedimiento. Metodologías Activas de Aprendizaje.

1 INTRODUCTION

It is a scientific publication with a view to sharing with the academic community the good practices experienced over time by the Law Course Completion Work Guidance Center and the results achieved since its creation.

Established 17 years ago, that is, existing since the first graduating class in Law at UNIFIPMoc, the TCC Center faced the most diverse challenges in search of the pedagogical, didactic, methodological and intellectual maturity necessary for the individual and, especially, collective performance of its research professors.

The TCC Center was composed of two doctors, eight masters and a specialist. The training was interdisciplinary since the basic training of the group was in Law, but the *stricto* and *lato sensu* training transited through the applied social sciences and human sciences. The management of the group was exercised by a coordinator with experience in guiding course completion works in the area of Law.

In order to meet the demands and needs of each student, whether they were regular or dependent, the work of the TCC Center has always been guided by quality and excellence, both in the guidelines and in its products: monograph or scientific article, a practice that persisted as one of the differential elements to the organization and efficiency of all work.

The organization of the dynamics of the orientation work led to the institutionalization of the TCC Center itself and a set of guidelines to be observed in the conduct of the work, whether in relational matters between the different actors involved, student-advisor-coordination, or in terms of rules and standardization standards to be observed throughout the research: TCC Regulation, Standardization Manual and Standard Project to be considered by teachers and students.

The planning and conduct of tasks, as well as the preparation of classes, have always been established in schedules designed and organized at the beginning of each academic semester, a practice that persists as one of the differential elements to the organization and efficiency of all work.

The purpose of this text is not only to present the work developed, but also to highlight the process of transformations that led to the inclusion of new pedagogical practices including the use of active methodologies, providing the creation of a proper method for successful guidance in terms of scientific quality, in the midst of an interesting context of orientation to scientific works.

To this end, aiming at better understanding and didactics, the text will be distributed in five parts, the first being this introduction, followed by the sections First phase of the TCC Center from the Law course at UNIFIPMoc: 2007 to 2011; Second phase of the Final Paper

of the UNIFIPMoc Law course: 2012 to 2019; Third phase of the Final Paper of the UNIFIPMoc Law course: 2019 to 2021; The method and, finally, the final considerations.

2 FIRST PHASE OF THE TCC CENTER OF THE UNIFIPMOC LAW COURSE: 2007 TO 2011

This section aims to explain how the development of the TCC orientation work took place during what is considered the first phase of the TCC Center of UNIFIPMoc. In this period, between 2007 and 2011, the students dedicated themselves to the writing and defense of the monograph for three consecutive semesters, and only in the 9th period did they present their work and complete the TCC stage.

The TCC modality adopted at the time - in the 1st academic semester of 2007 - was the legal monograph. The first criterion for its achievement corresponded to the production of a research project, which was developed throughout the 7th period, under the guidance of a single professor, as a discipline of the regular curriculum of the institution's Law Course.

In the following period, that is, in the 8th period, the approved students were assigned to the advisors, who, attending after hours, in the morning shift, and pre-hours, in the afternoon, led their advisees, individually, in the construction of the research and writing of the entire text of the work, until its completion.

Once completed and approved by the advisor, the monograph was deposited so that, in the following semester, that is, in the 9th period, its defense could be made, in a session that involved the exam and examination by a panel formed by the advisor and two other professors who, at other times, were components of the TCC Nucleus, then composed of 4 professors, now belonging to the teaching staff of the institution's Law Course.

Thus, the TCC had its cycle completed after the completion of three different disciplines by the student: Monograph I, regularly offered in the 7th period of the course; Monographs II and III to be completed outside the regular class hours, in a pre and post schedule, both for regular students and dependents. This work system adopted the model traditionally used in Law courses for the preparation of the TCC until the 2nd semester of 2011, and this period is considered as the first phase of the TCC of the UNIFIPMoc Law course.

It was possible to collect data from the institution's Academic Registry in class diary reports that began to be digitized from 2009 onwards. It was found that, in the period between the 1st semester of 2009 and the 2nd semester of 2011, over these three years of

In this study, 457 enrollments were made in Monograph I, 232 in Monograph II, and 207 in Monograph III, totaling 896 enrollments, with 16 failures.

3 SECOND PHASE OF THE FINAL PAPER OF THE UNIFIPMOC LAW COURSE: 2012 TO 2019

Attentive to excellence and constant search to improve pedagogically, didactically and methodologically the work carried out, constant reviews regarding the procedure in relation to the development of the course completion work are promoted by the coordination of the Law course and by the TCC Center.

From these revisions, it was realized that the fact that the orientations were given only in the pre and post-hour system, as commonly happens in higher education institutions (HEIs), contributed to an evasion and neglect of students who ended up not attending the orientations, postponing the preparation of the TCC. In addition, the periods in which the TCC was prepared coincided with the completion of the Brazilian Bar Association (OAB) exam by the students, a fact that, although outside the scope of decisions of the HEIs, causes an overload of study for law students who, because they prioritize the OAB exam, ended up procrastinating the conclusion of the TCC.

Such factors contributed to the formation of a repressed demand in a dependency system. Based on this perception, important changes were proposed that will be explained below, and which started the second phase of the TCC from the 1st semester of 2012. This phase presents two important novelties. The first is the change of period of the discipline Monograph I, anticipating it to the 6th period of the Law course, and the insertion of the disciplines Monograph II and Monograph III in the regular grid of the 7th and 8th periods of the Law course, respectively. Consequently, the defense will take place in the 8th period of the course, anticipating the conclusion of the stage.

The second novelty is that the orientations begin to be individualized from the 6th period, that is, from the conception of the theme and structuring of the research project to the defense. It is worth mentioning that the presence and monitoring of the advisor with the advisee since the initial conception of the work represented an important milestone, since, compared to the previously adopted methodology, consistent results were observed with the insertion of the disciplines in the course curriculum and the use of the classroom's space-time for the orientations.

It should be noted that, for students in dependency, the attendances remained in pre and post schedules, without any change or prejudice in the monitoring of the work. But, for this new format, the individualized orientations, different from the previous phase, already begin in the 6th period, when the project began to be completed under the care of the advisor himself, and the preparation, orientation, revision and finalization of the writing of chapter I of the monograph began.

This early interaction between advisors and regular students was possible because the space-time of the classroom was divided by a specific group of teachers. Thus, it was possible to create a valuable opportunity for the exchange of experience and knowledge due to the group classes, held in the 6th period, aimed at the elaboration of the project and scientific writing.

The reported changes optimized the process of preparing the project and the final work in one semester, allowing the regular student to finish the writing of his work in the 7th period, leaving only the oral presentation of the monograph pending for the 8th period. It was a relevant anticipation when considering that the student, still in the 8th period, could dedicate himself to other projects such as studying for the exam and for the OAB exam, which had always been encouraged by the institution.

Another relevant point, very characteristic of this phase, is the preparation of a schedule with the definitions and standardization of the deadlines for deliveries of all activities to be carried out by students and the deadlines for the return of corrections by the advisors, as well as complete planning of the stages, deliveries and returns of the semester, with information on the contents to be worked on in each class.

The TCC Center also pays special attention to the Standardization Manual and the TCC Regulation, documents updated regularly, considering updates to ABNT regulations, as well as the insertion or remodeling of procedures previously adopted, all with a view to improving the existing dynamics.

Despite the zeal and organization that involved the procedures and documents, there was still a considerable increase in the repressed demand of students in a system of dependence that fed back on each other, creating a vicious circle.

This 2nd phase was the longest and lasted until the 2nd half of 2019, thus adding up to 8 years of work. According to data from the institution's Academic Record, during this period, 1833 enrollments were made in Monograph I, 1888 in Monograph II, and 1131 in Monograph III, totaling a number of 4852 enrollments, and there were 1224 failures. Of these, 53 occurred on 02/2014, with a jump in the number of failures on 01/2016, when there were 105 failures, a number that increased on 02/2016, 01/2017 and 02/201, when there were 137, 152 and 180 failures, respectively.

4 THIRD PHASE OF THE FINAL PAPER OF THE UNIFIPMOC LAW COURSE: 2020 TO 2021

Especially the last semesters of the 2nd phase presented a critical moment, with a high failure rate, which demonstrated the need for structural, pedagogical and didactic

changes. At this time, there was already a great interaction between the advising professors and the coordination of the TCC Center and the Law course, which allowed us to analyze the problem and propose actions compatible with its adequate confrontation.

It was precisely this interaction that fostered and allowed the introduction of active methodologies in the context of group classes, in regular student classes, from the 1st semester of 2018, an innovation that progressively optimized learning to achieve the TCC, through group work and individual guidance, resources that strengthened the students' protagonism in order to involve them, both in group dynamics and in their individual research.

In the 2nd semester of 2019, the 3rd phase of the TCC effectively begins, marked by the exclusion of the discipline Monograph III from the curriculum, and the replacement of the disciplines Monographs I and II, as already indicated, regularly offered in the 6th and 7th periods, respectively, by the disciplines TCC I and II, whose product becomes a scientific article, under the terms of Resolution No. 5, of December 17, 2018, which established the New National Curriculum Guidelines for the Law course of HEIs⁴.

It should be noted that with the advent of the COVID-19 pandemic, the orientation work adapted to the remote model, being carried out virtually and offered to both regular and non-regular students, with services via digital platform. In 2020, in the 1st semester, the service was provided through the Blackboard and Google meet platform, and from the 2nd semester onwards through the Canvas and Zoom platform.

Allied to the gradual implementation of the change in the format of the TCC from monograph to scientific article, the development and use of active methodologies with students in the regular classes of 6th and 7th periods was intensified during collective classes and group or individual orientations, such as problematization; concept map⁵; Case study with identification of research elements – from TCCs already completed; debate with analysis and discussion of students' themes and problems.

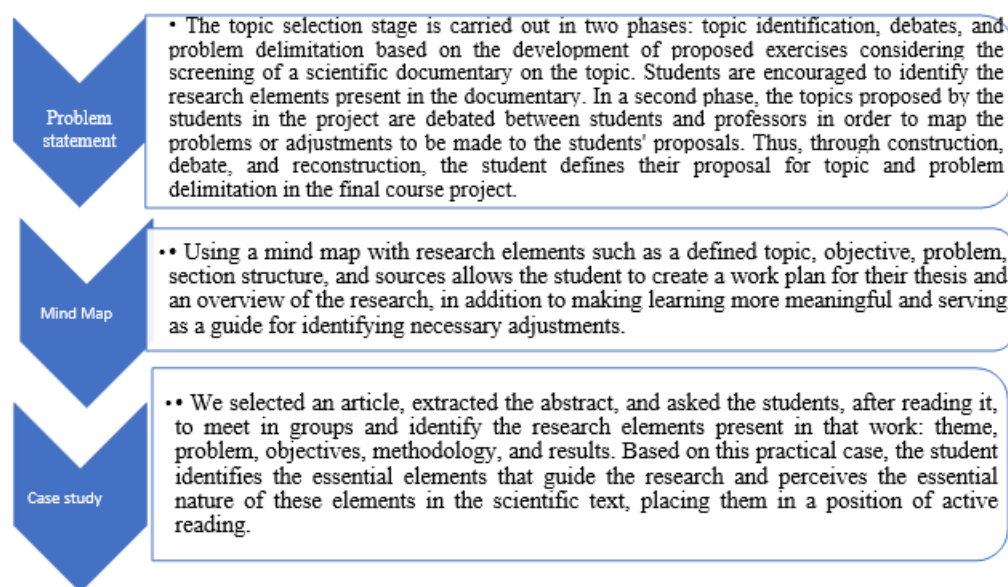
The systematization of combinations of the methodologies adopted can be better explained in the following flowchart:

⁴ Available at <http://portal.mec.gov.br/component/content/article?id=12991>. Accessed in Oct. 2021

⁵ Concept maps aim to represent meaningful relationships between concepts in the form of propositions. A proposition consists of two or more conceptual terms linked by words in order to form a semantic unit [...]. The elaboration of concept maps is a technique to externally patent concepts and propositions. Up to this point, one can only make conjectures about the degree of precision with which concept maps represent the concepts we possess, or the range of relationships between concepts we know (and which we can express as propositions). There is no doubt that, in the process of making maps, we can develop new conceptual relationships, especially if we actively seek to build prepositional relationships between concepts that we did not consider related until then: The students and the

Figure 1

Flowchart of the combined active methodologies used in the process of elaboration and teaching of the TCC during the undergraduate course in Law at UNIFIPMOC



Source: Prepared by the authors.

From the use of these methodologies, an improvement was observed in the students' performance and approval rates, contrary to the high rates of failure and dropout by students, as was common in these disciplines when the traditional methodology with expository class was used, even if dialogued.

In the first half of 2020, the transition of the TCC format from monograph to scientific article was finally consolidated. There were, then, a total of 318 students under the responsibility of the TCC Center, 149 in regular classes and 169 in dependency classes. During this period, 137 oral communications were made to defend the articles

Teachers often note, during the elaboration of concept maps, that they recognize new relationships and therefore new meanings (or at least meanings that they did not consciously possess before elaborating the map). In this sense, the elaboration of concept maps can be a creative activity and can help foster creativity (NOVAK, 2000, p. 31-33) and there were 53 failures.

In the second semester of 2020, at the height of the COVID-19 pandemic, the number of enrollments in the TCCI and TCCII disciplines totaled 292, with 156 students in regular classes and 136 in dependency classes. In the same period, 109 oral communications were made for the defense of scientific articles and 60 rejections. It should be noted that, for the first time in many years, the number of enrollments in regular classes exceeded the number of enrollments in dependent classes.

In the first semester of 2021, there were 235 students enrolled in the TCCI and TCCII disciplines, of which 110 were regular and 125 were dependency students. The semester ended with 108 oral communications for the defense of scientific articles, with 63 failures.

As can be seen, there was a better use of the orientation process by the students, which was also reflected in the failure rate with a considerable decrease, returning to the numbers of semester 01/2016.

With the new method applied, even in the period of the COVID-19 pandemic, a greater approval was achieved in regular and dependency classes, no longer feeding the number of students in dependence and contributing to the approval of students who were already in this condition. All without neglecting the quality and the criteria of scientificity required.

5 THE METHOD

The upported by methodological paradigms that privilege the complexity of thought, the valorization of students' previous knowledge and the stimulation of their learning, such as, proposed by Morin (2015), the need for the individual to build his knowledge from preexisting cognitive structures, in the terms of Piaget's Constructivist Theory, updated by Ausbel's Theory (2000) argues that learning must be meaningful.

Considering these pedagogical premises as a starting point, the teaching of the TCC discipline is based on teaching by competencies and on the construction of skills and competencies with the active participation of the academic, within the perspective of making the experience of TCC and research a meaningful learning, as proposed by contemporary theories on learning.

The aim was to streamline the conclusion of the work by the students, so that those regular students finish the scientific article and present it in the 7th period.

All this optimization was didactically planned without neglecting the quality and excellence of the work that has always been carried out by the TCC Center, in order to consider that a specific method for guiding and preparing the TCC was created within the scope of the UNIFIPMoc Law Course. This method can be systematized as follows:

- 1) inclusion of disciplines related to the TCC and orientation of the work in the regular class schedules;
- 2) monitoring of the work of preparation of the TCC by the advisor from his field of research;
- 3) individualized guidance during regular class hours, from the construction of the project to the oral communication of the scientific article;

- 4) observation of the established procedures and the documents that guide the conduct of the work, such as the TCC General Regulation and the TCC Manual;
- 5) group classes with the use of combined active methodologies for regular students, based on exclusive material, prepared by the TCC Center itself;
- 6) individualized service to students in a dependency system, with the elaboration of its own agenda considering the student's demand.

As can be seen, the work is currently carried out in a humanized, directed and procedural way, organized in a way that considers the specificities of each student, without neglecting the scientificity and quality requirements of the product. With these changes, it has been noticed over the last semesters, an improvement in the approval rate and a greater use by students of regular and dependency classes.

The practical results of the application of the above method were not long in coming. In addition to participating in congresses, students are encouraged to publish book chapters and scientific articles in journals external to the institution, not to mention that the works highlighted by the examining boards during the defenses are directed to publication in the institution's internal journal, the Multidisciplinary Journal.

Finally, the method presented here humanized the procedure of orientation to the TCC and boosted the development of scientific research within the scope of the Law course, breaking the vicious circle and giving way to a virtuous circle in the context of the elaboration of the TCC within the scope of the Law Course of UNIFIPMoc.

In the face of the challenges in relation to academic training processes in contemporary society and even the obstacles imposed by the COVID-19 pandemic, it was possible to

to verify its contribution to a considerable reduction of the repressed demand in the dependency system, and improvement of the approval rate of regular students.

6 FINAL THOUGHTS

The study of the procedures adopted and reviewed over the years within the scope of the disciplines aimed at the preparation and conclusion of the TCC of the UNIFIPMoc Law course made it possible to create a method.

Among its great differentials is the fact that the work for the preparation of the TCC research project and part of the textual development of the article, begins in the 6th period, and its completion, with the oral communication of the works and deposit in the library's institutional repository, is carried out in the 7th period. Thus, the approved student can

dedicate himself to the other opportunities that the course proposes, such as preparatory workshops for the OAB, ENADE and other competitions.

In addition, all the guidance work is individualized, considering the demands and needs of the student. For a more uniform work regarding the deadlines for the delivery of activities, returns of corrected work, a plan is made based on a schedule that establishes all the steps to be observed by those involved, from the beginning to the end of the semester. The Standardization Manual and the TCC Regulation are used as guidelines for the work and are regularly updated.

Another differential of the work carried out by the center is aimed at students in dependence or adaptation. In these cases, the orientations are offered in pre- and post-hour shifts, without coinciding with the schedules of other disciplines, perhaps, taken by the student, which allows a greater possibility for the student, even in dependence, to adjust to comply with this stage even before the fulfillment of his regular schedule.

Although at different times from the orientations for regular classes, the work is developed with the same attention to the advisees, whether in dependence or adaptation, so that the specificities of each student are observed, in order to achieve success, not only in the approval of the written work, but also in its defense.

The result of this targeted and humanized work, attentive to the specificities of each student, has been noticed over the last semesters with an improvement in the approval rate and greater use by students, enabling the production of quality work and impacting to reduce the repressed demand of students in dependency.

REFERENCES

- Ausubel, D. P. (2000). *The acquisition and retention of knowledge: A cognitive view*. Kluwer Academic Publishers.
- Moreira, M. A. (2011). *Aprendizagem significativa: A teoria e textos complementares*. Editora Livraria da Física.
- Morin, E. (2015). *Introdução ao pensamento complexo* (E. Lisboa, Trad.). Sulina.
- Novak, J. D., & Gowin, D. B. (1996). *Aprendendo a aprender* (Tradução para o português do original *Learning how to learn*). Plátano Edições Técnicas.
- Piaget, J. (1987). *O nascimento da inteligência na criança* (4ª ed.). Guanabara.

PHOSPHATE FERTILIZATION IMPROVE PRODUCTIVITY AND CHEMICAL-BROMATOLOGICAL COMPOSITION OF LEAF BLADE OF UNBURNED PASTURE

A ADUBAÇÃO FOSFATADA MELHORA A PRODUTIVIDADE E A COMPOSIÇÃO QUÍMICO-BROMATOLÓGICA DA LÂMINA FOLIAR DE PASTAGEM NÃO QUEIMADA

LA FERTILIZACIÓN FOSFATADA MEJORA LA PRODUCTIVIDAD Y LA COMPOSICIÓN QUÍMICO-BROMATOLÓGICA DE LA LÁMINA FOLIAR DE PASTURAS NO QUEMADAS



<https://doi.org/10.56238/sevened2026.008-083>

Luiz Carlos da Silva¹, Francisco de Almeida Lobo²

ABSTRACT

We evaluate the effects of phosphate fertilization on the leaf blade productivity of unburned *Brachiaria brizantha*, cv. Marandu, as well its chemical-bromatological composition compared to the pasture burning in the southwestern Amazon. Brazilian Amazon has one of the highest proportion of planted pastures in Brazil and the *Brachiaria brizantha* is the most used species. The burning is an important factor that lead to the gradual degradation of pastures. These circumstances generate pastures with low capability of providing feed for cattle farming. The improvement caused by burnings occurs only in short periods after burning. Some alternative sources with a low content of soluble P, in turn, increases biomass productivity and the nutritional value of cultivated species. A field experiment was carried out in a completely randomized blocks design. The treatments consisted of unburned pasture treated with 0, 25, 100 and 200 kg ha⁻¹ of P compared to the pasture burning. After applying the treatments, the pasture was desiccated in order to homogenize the plant emergence and growth after the period without rain from July to September. The dose of 100 kg ha⁻¹ of P for unburned pasture promoted better productivity and mineral nutrient concentrations, and leaf quality for animal consumption was improved. Values of acid detergent fiber, neutral detergent fiber, lignin and crude protein indicate an adequate bromatological composition of leaf for animal consumption at 56 days of growth. The practical and theoretical implications of this research are discussed, providing insights into how the results can be applied or influence practices in the field of pasture management without fire using. These implications could encompass on how to apply and how much of an alternative phosphate must be applied to the soil to supply phosphorus for *B. brizantha* instead of using fire in the pasture management. This study contributes to the literature by highlighting the superiority of phosphorus application from alternative sources allied to N and K fertilization compared to the pasture burning practice in the Southwestern Amazon. This innovative approach can be used as a base for new researches and applied in the level of cattle farmers.

Keywords: Dry Mass. Fire. Livestock. Supression. Sustainability.

¹ Dr. in Environmental Physics: Biosphere-Atmosphere Interaction. Faculdade de Ciências Agrárias (FCA/UFAM).

E-mail: luiz_silva@ufam.edu.br

² Dr. of Plant Physiology. Universidade Federal do Amazonas (IF/UFMT). E-mail: fdealobo@gmail.com

RESUMO

Avaliamos os efeitos da adubação fosfatada sobre a produtividade da lâmina foliar de *Brachiaria brizantha* cv. Marandu em pastagem não queimada, bem como sua composição químico-bromatológica, em comparação com a prática da queima de pastagens no sudoeste da Amazônia. A Amazônia brasileira possui uma das maiores proporções de pastagens plantadas do Brasil, sendo a *Brachiaria brizantha* a espécie mais utilizada. A queima é um fator importante que leva à degradação gradual das pastagens, gerando áreas com baixa capacidade de fornecimento de alimento para a pecuária, e a melhoria proporcionada por essa prática ocorre apenas por curtos períodos após sua realização. Algumas fontes alternativas, com baixo teor de fósforo solúvel, por sua vez, aumentam a produtividade de biomassa e o valor nutricional das espécies cultivadas. O experimento de campo foi conduzido em delineamento de blocos completamente casualizados, com tratamentos consistindo em pastagem não queimada submetida às doses de 0, 25, 100 e 200 kg ha⁻¹ de P, comparadas à pastagem queimada. Após a aplicação dos tratamentos, a pastagem foi dessecada com o objetivo de homogeneizar a emergência e o crescimento das plantas após o período sem chuvas, de julho a setembro. A dose de 100 kg ha⁻¹ de P na pastagem não queimada promoveu maior produtividade, melhores concentrações de nutrientes minerais e melhoria da qualidade da folha para o consumo animal, sendo que os valores de fibra em detergente ácido, fibra em detergente neutro, lignina e proteína bruta indicaram composição bromatológica adequada da lâmina foliar aos 56 dias de crescimento. As implicações práticas e teóricas desta pesquisa são discutidas, fornecendo subsídios sobre como os resultados podem ser aplicados ou influenciar práticas no manejo de pastagens sem o uso do fogo, incluindo orientações sobre como e quanto de uma fonte alternativa de fosfato deve ser aplicada ao solo para suprir fósforo para *B. brizantha* em substituição à queima no manejo das pastagens. Este estudo contribui para a literatura ao evidenciar a superioridade da aplicação de fósforo proveniente de fontes alternativas associada à adubação com N e K em relação à prática da queima de pastagens no sudoeste da Amazônia, configurando uma abordagem inovadora que pode servir de base para novas pesquisas e ser aplicada em nível de produtores pecuários.

Palavras-chave: Massa Seca. Fogo. Pecuária. Supressão. Sustentabilidade.

RESUMEN

Se evaluaron los efectos de la fertilización fosfatada sobre la productividad de la lámina foliar de *Brachiaria brizantha* cv. Marandu en pasturas no quemadas, así como su composición químico-bromatológica, en comparación con la práctica de quema de pasturas en el suroeste de la Amazonía. La Amazonía brasileña presenta una de las mayores proporciones de pasturas cultivadas del país, siendo *Brachiaria brizantha* la especie más utilizada. La quema es un factor importante que conduce a la degradación gradual de las pasturas, generando áreas con baja capacidad para suministrar alimento a la ganadería, y la mejora ocasionada por esta práctica ocurre únicamente en cortos períodos posteriores a su aplicación. Algunas fuentes alternativas, con bajo contenido de fósforo soluble, incrementan la productividad de biomasa y el valor nutricional de las especies cultivadas. El experimento de campo se realizó bajo un diseño de bloques completamente al azar, con tratamientos consistentes en pasturas no quemadas sometidas a dosis de 0, 25, 100 y 200 kg ha⁻¹ de P, comparadas con pasturas quemadas. Tras la aplicación de los tratamientos, la pastura fue desecada con el fin de homogeneizar la emergencia y el crecimiento de las plantas después del período sin lluvias, entre julio y septiembre. La dosis de 100 kg ha⁻¹ de P en pasturas no quemadas promovió mayor productividad, mejores concentraciones de nutrientes minerales y una mejora en la calidad foliar para el consumo animal, y los valores de fibra detergente ácida, fibra detergente neutra, lignina y proteína bruta indicaron una composición bromatológica adecuada de la lámina foliar a los 56 días de crecimiento. Se discuten las implicaciones prácticas y teóricas

de esta investigación, aportando elementos sobre cómo los resultados pueden aplicarse o influir en las prácticas de manejo de pasturas sin el uso del fuego, incluyendo orientaciones sobre cómo y cuánto de una fuente alternativa de fosfato debe aplicarse al suelo para suministrar fósforo a *B. brizantha* en sustitución de la quema en el manejo de pasturas. Este estudio contribuye a la literatura al destacar la superioridad de la aplicación de fósforo a partir de fuentes alternativas asociada a la fertilización con N y K en comparación con la práctica de quema de pasturas en el suroeste de la Amazonía, constituyendo un enfoque innovador que puede servir de base para nuevas investigaciones y ser aplicado a nivel de productores ganaderos.

Palabras clave: Materia Seca. Fuego. Ganadería. Supresión. Sostenibilidad.

1 INTRODUCTION

The area for cattle breeding in Brazilian Amazon has one of the highest proportion of planted pastures in Brazil (Baggio *et al.*, 2021). The *Brachiaria brizantha* is the most used species in pasture-based systems (Silva *et al.*, 2016b). Nevertheless, cattle overgrazing and the lack of soil nutrient reposition, besides the high release and loss of nitrogen (N), phosphorus (P) and potassium (K) to the soil and forms of carbon (C) and N to the atmosphere (Rumpel *et al.*, 2015; Dias-Filho, 2014b; Luizão *et al.*, 2013) caused by burning are factors that lead to the gradual degradation of pastures, like in the southwestern Amazon.

These circumstances generate pastures with low capability of providing feed (leaves) for cattle farming (Pequeno *et al.*, 2015). Cardoso *et al.* (2003) confirmed that when verified just a slight superiority on the nutritional value of dry mass of *Andropogon bicornis* grass burned only in the first months after the fire application. This finding is attributed to the ashes produced by the fire, which provide available forms of nutrients for freshly sprouting plants (López-Mársico *et al.*, 2019). However, there is evidence that even the improvement caused by burnings on soil attributes and nutrient availabilities occurs only in short periods after burning (Dick *et al.*, 2008). Girona-García *et al.* (2018) studied subalpine vegetation that includes grasses. In twelve months after burning, they detected a decrease on topsoil nutrient availability. Despite that, the line of thinking that still persists around the world is that burning stimulates the regrowth of grasses with high nutritional value for grazing animals (Van Der Werf *et al.*, 2008).

On the other hand, cattle breeders in the southwestern Amazon region resort to this practice because they do not have governmental incentives to change the way they have done pasture biomass production for cattle feed. They are limited by the common lack of credit to the adoption of technical knowledge (Aryal *et al.*, 2020) to recover soil fertility and biomass productivity. That situation leads to the continuous use of fire as a strategy for managing *B. brizantha* that shows to be unproductive and with a low long-term nutritional value.

In turn, the low soil P availability limits pasture production on the nutrient-poor soils of the southwestern Amazon (Campos *et al.*, 2012). In that region, the phosphate fertilization and burning suppression, as observed by other authors, can increase P availability and the biomass productivity of different planted pastures (Aryal *et al.*, 2020; Souza *et al.*, 2020; Farias *et al.*, 2016; Marahata *et al.*, 2014).

There is a lack of information about biomass productivity and chemical-bromatological quality of leaf blade on not burned pasture under the effects of phosphate fertilization compared to the periodical burning on the Amazon livestock agroecosystems. Considering

these information, we evaluate the effects of phosphate fertilization with burning suppression on the leaf blade productivity of *Brachiaria brizantha* (Hochst ex A. Rich.) Stapf. cv. Marandu as well its chemical-bromatological composition compared to pasture burning in the southwestern Amazon.

2 THEORETICAL FRAMEWORK

Relative similar studies to this one on P for pasture fertilization have been carried out with different sources of the nutrient, whether or not in a soluble form, whether or not at the same time, to N sources in order to evaluate the production, chemical composition and nutritional value of *Brachiaria* spp (Ileiri *et al.*, 2010; Magalhães *et al.*, 2007; Machado; Valle, 2011). Heringer; Jackes (2002c) found higher dry mass yields and CP contents on areas where the soil was corrected and fertilized compared to the burning. These authors observed that the P, K, Ca and Mg contents were higher in the dry mass on the area that received fertilization and, additionally, the burning reduced the amount of nutrients in the pasture. Porto *et al.* (2012) applied increasing doses of soluble P for *Brachiaria brizantha* cv. Marandu and observed 24% higher dry matter production on leaves at the dose of 147 kg ha⁻¹ of P₂O₅ compared to the absence of fertilization. According to Machado *et al.* (2011), the increase of the P dose increases the nutrient content on pasture leaf tissue.

In this sense, some alternative P sources with a low content of soluble P, like partially acidulated phosphate rocks, bring other nutrients in their composition, such as calcium (Ca), magnesium (Mg) and sulfur (S). That fact is important because S and Mg has its own availability improved together with P availability that, in turn, increases biomass productivity (Hopkins; Hansen, 2019) and, possibly, the nutritional value of cultivated species. According to Silva; Lobo (2024), the application of 100 kg ha⁻¹ of phosphorus from alternative phosphate rock and nitrogen and potassium fertilization increase topsoil availability and absorption and accumulation of P, Mg and S by *B. brizantha*. Their results indicate, additionally, that even the absence of P application with nitrogen and potassium fertilization shows to be superior to the burning, becoming this practice unnecessary to the pasture management.

Pastures have been seen as a potential reducer of greenhouse gases (GHG) emissions by the inputs on soil surface biomass, providing animal products for human consumption and increasing the sustainability of livestock farming (Mottet *et al.*, 2017; Vetter *et al.*, 2017; IPCC, 2014; Gerber *et al.*, 2013a, b). Inputs on the biomass productivity mean pasture restoration and available feed for cattle farming (Lal, 2011; Conant, 2010). In this sense, well-fertilized pastures provide important environmental services to the ecosystems

(Sollenberger et al., 2019) by suppressing the burnings, being considered a strategy for mitigating climate change (Lal, 2011; Conant, 2010).

3 METHODOLOGY

B. brizantha not burned and fertilized with four doses of P was compared to simple pasture burning in the field conditions. The experiment was performed from September to November 2015 at the Vanazzi Cattle Farm, BR 319, km 12, on a transition between the Amazon forest and natural fields in Humaitá (7° 35' S and 63° 6' W, 90 m a.s.l.), southwestern Amazon. The climate of the region is Af according to Köppen climate classification, and present a rainy season from September to July, mean air temperature of 26.5 °C. The total annual rainfall is 2500 mm and the relative humidity ranges from 85% to 90%.

The experimental area measured 25.0 m x 45.0 m of an acidic Oxisol (Alic Cambisol) (Santos et al., 2018) homogeneously covered by *Brachiaria brizantha* (Hochst ex A. Rich.) Stapf. cv. Marandu, at stage II of degradation according to Dias-Filho (2011b). The pasture was not burned or grazed from September 2014 to September 2015. A manual extraction of weeds in September 2014 made that practice unnecessary in 2015, since the rapid pasture growth covered the soil and suppressed 100% of these plants.

For the establishment of blocks and plots on the experimental area, a homogeneous cutting process with garden shears levelled the pasture at a 0.20 m height at 07/23/2015, in order to simulate the traditional Amazon grazing of a hundred percent of the pasture leaf area. At 09/12/2015, the blocks were established at a subarea on the experimental area. The plots measured 4.50 m in length by 3.50 m (15.75 m²) and 0.80 m in the borders (Cayley; Bird, 1996). Plot delimitation was carried out with nylon threads fixed to the end of iron bars vertically fixed to the ground. On 09/13/2015, a representative 0.60 kg soil sample (20 simple samples) was collected from the area at 0.0-0.05 m depth (topsoil layer) with the aid of a dutch auger (*TF10-Sonda Terra, Piracicaba, Brazil*). A 0.40 kg subsample was air-dried and broken and passed through a 2.0 mm sieve for the chemical and physical analysis, prior the experiment.

The topsoil presented (Silva, 2009): pH (water) = 5.00, Al³⁺ = 1.02 cmol_c dm⁻³, H+Al = 5.00 cmol_c dm⁻³, Ca²⁺ = 2.01 cmol_c dm⁻³, Mg²⁺ = 1.50 cmol_c dm⁻³, K⁺ = 0.09 cmol_c dm⁻³, CEC = 8.33 cmol_c dm⁻³, SB = 4.50 cmol_c dm⁻³, P (Mehlich-1) = 3.0 mg dm⁻³, V = 42%, m = 8.75%, SOC = 11.36 g kg⁻¹, Cu²⁺ = 4.25 mg dm⁻³, Fe = 297.59 mg dm⁻³, Mn²⁺ = 8.02 mg dm⁻³, Zn = 2.29 mg dm⁻³. A 0.20 kg topsoil subsample was analysed for: B (hot water) = 0.08 mg dm⁻³, and SO₄²⁻ = 9.0 mg dm⁻³ (Raij et al. 2001). The topsoil presented: sand = 349.7, silt = 452.15 and clay = 181.87 g kg⁻¹ (EMBRAPA, 1997).

The following treatments were applied: Pnb = *B. brizantha* not burned; Pnb+25 = Pnb + 25.0 kg ha⁻¹ of P; Pnb+100 = Pnb + 100.0 kg ha⁻¹ of P; Pnb+200 = Pnb + 200.0 kg ha⁻¹ of P for comparison to the pasture burned, represented by Pb = burning of *B. brizantha*, with 4 replicates. A partially acidulated phosphate rock (PPR) was used as the P source and its chemical and granulometric characteristics (Brasil, 2014) are provided in the Table 1.

The P doses were applied at 09/14/2015, after a rainfall higher than 2.0 mm (Figure 1) by manual and homogeneous distribution of 0.0, 0.22, 0.88 and 1.76 kg plot⁻¹ of PPR, dry mass, to the soil surface of the plots for supplying, respectively, the Pnb, Pnb+25, Pnb+100 and Pnb+200. The Pb was applied after removal of the nylon threads that delimited the plots, and after the firebreaks establishment around the area reserved for each plot of this treatment. Firstly, the fire was set in the center of each plot area and controlled with water spray in the boundaries. Then, the plots were delimited again with the nylon thread relocation on to the end of the vertically fixed iron bars.

Table 1

Chemical characteristics and granulometry of the partially acidulated phosphate rock¹.

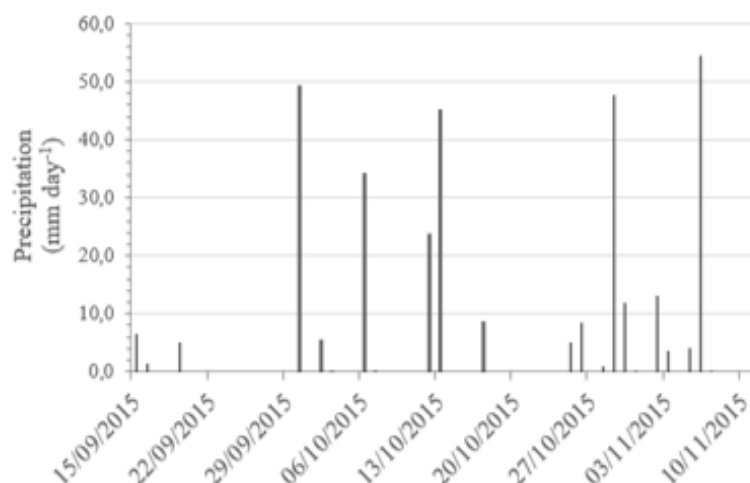
Phosphorus source	Total phosphorus content				Granulometric fraction retention (mm) ⁶						
	TP ²	TP ₂ O ₅ ³	P ₂ O ₅ (CNA+H ₂ O) ⁴	P ₂ O ₅ (H ₂ O) ⁵	0.075	0.10	0.25	0.50	1.0	2.0	4.0
PPR ^A	----- g kg ⁻¹ -----				----- g kg ⁻¹ -----						
	118.00	270.00	76.30	28.30	64.0	150.70	236.80	300.30	40.60	0.00	0.00
	Other macronutrients				Micronutrient						
	Ca	Mg	S		B	Cu	Fe	Mn	Zn	Mo	
	----- g kg ⁻¹ -----				----- mg kg ⁻¹ -----						
	141.60	8.60	41.35		0.04	0.09	62.90	5.90	0.20	<0.01	

¹partially acidulated phosphate rock Alvorada (SOCAL, Registro, SP), ²TP: total phosphorus content, ³TP₂O₅: total P₂O₅ content, ⁴P₂O₅ (CNA+H₂O): total P₂O₅ content in neutral ammonium citrate + water, ⁵P₂O₅ H₂O: P₂O₅ water soluble, ⁶207.4 g kg⁻¹ of PPR passed in the 0,075 mm sieve.

The homogenization of plant emergence and physiological development of *B. brizantha* was performed at 09/18/2015 in all experimental plots. This procedure consisted of the desiccation of newly emerged tillers by pulverizing 200 L ha⁻¹ of gramoxone 200 syrup.

Figure 1

Level of precipitation during the experimental period.



The macronutrient cycles are closely associated in pastures (Soussana; Lemaire, 2014). Therefore, at 09/19/2015, a homogeneous dose equivalent to 120.0 kg ha⁻¹ of N (as urea) plus 29.1 kg ha⁻¹ of K (as KCl) was manually and homogeneously distributed on the soil surface of the plots of the treatments Pnb, Pnb+25, Pnb+100 and Pnb+200, after a rain higher than 5.00 mm (Figure 1). The fertilizations with N and K effectively began the experimental period.

At 10/01/2015, the topsoil layer of the Pb plots areas was sampled with the aid of a dutch auger (*TF10-Sonda Terra, Piracicaba, Brazil*) for the chemical analysis according to Silva (2009): pH (water) = 6.60, Al³⁺ = 0.0 cmol_c dm⁻³, H+Al = 1.80 cmol_c dm⁻³, Ca²⁺ = 5.55 cmol_c dm⁻³, Mg²⁺ = 4.14 cmol_c dm⁻³, K⁺ = 0.14 cmol_c dm⁻³, CEC = 11.75 cmol_c dm⁻³, SB = 9.83 cmol_c dm⁻³, P (Mehlich-1) = 6.0 mg dm⁻³, V = 84%, m = 0.0%, SOC = 8.52 g kg⁻¹, Cu²⁺ = 3.13 mg dm⁻³, Fe²⁺ = 1039.95 mg dm⁻³, Mn²⁺ = 77.45 mg dm⁻³, Zn²⁺ = 4.0 mg dm⁻³. The topsoil boron (B) and sulphate availabilities were, respectively, 0.10 mg dm⁻³ (SO₄²⁻) and 12.0 mg dm⁻³ according to Raij *et al.* (2001).

The data of pasture leaf blade dry mass productivity (LDM) were collected on a useful sampling area of 3.50 m by 3.0 m (10.50 m²) delimited within each plot. At 56 days after beginning the experimental period, at 11/14/2015, all the plants inside a jig of 1.20 m² were cut close to the ground with garden shears, packed and identified. The leaf blade biomass was separated from the rest of the plant by cutting with manual cutting shears and a triple wash was carried out with potable water before double washes on HCl solution (0.5%) and distilled water.

On 11/16/2015, the leaf blade biomass was repacked on identified 0.18 m x 0.36 m newsprint bags and dried at a forced circulation oven (*Tecnal TE-394/5-MP, Piracicaba,*

Brazil) at 67 °C for 72 hours. The LDM dry mass productivity was obtained by weighing on a precision scale (*Tecnal, SHI-BL-3200H, Piracicaba, Brazil*) whose values, g jig⁻¹, were converted to t ha⁻¹ in an Excel worksheet.

Twenty five percent of the leaf blade dry mass were separated for the chemical analysis of N, P, K, Ca, Mg, S (g kg⁻¹), B, Cu, Fe, Mn and Zn (mg kg⁻¹) according to Silva (2009). Another 25% of the LDM were kept properly packaged on a triple plastic bag and refrigerated until entering the Laboratory of Animal Nutrition of Universidade Federal do Paraná, Curitiba, Brazil, where the samples were ground for the analysis of crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin (LIGN), according the methodologies of the AOAC (1990).

Experimental data of leaf blade dry mass productivity and chemical-bromatological composition of the leaf blade of *B. brizantha* were subjected to Cochran's homocedasticity test ($p \geq 0.05$). The significance of means was identified with the F-test ($p \leq 0.05$) in the MStatC Software (Michigan State University, USA), in accordance with a randomized block experimental design. The means comparison was carried out with Tukey's test ($p \leq 0.05$) in the same software. Pearson's linear correlation among the data of leaf blade productivity and chemical-bromatological composition were calculated in an Excel Worksheet using the t-test ($p = 0.05$) for the hypothesis testing on a non-zero correlation.

4 RESULTS

Analysis of variance indicated significant difference among the treatments ($P \leq 0.05$). Doses of 100 and 200 kg ha⁻¹ of P lead to the highest LDM of the pasture (Table 2). The first one was about 66.32% higher than that observed for Pb, with over 2.60 Mg ha⁻¹ no longer immediately available for animal consumption at 56 days of pasture growth. Nevertheless, one must consider that even Pnb (0 kg ha⁻¹ P) produced an LDM around 28.64% higher than Pb.

Table 2

Means of leaf dry mass productivity, mean of phosphorus, magnesium, sulfur, manganese, iron in the leaf of B. Brizantha.

Treatment	Leaf dry mass productivity and phosphorus, magnesium, sulfur, manganese, iron					
	LDM	P	Mg	S	Mn	Fe
	Mg ha ⁻¹		g kg ⁻¹		mg kg ⁻¹	
Pnb	1.85 b	1.60 c	4.11 bc	0.617 c	77.6 bc	52.63 c
Pnb+25	2.01 b	1.85 bc	4.47 abc	0.630 c	67.98 c	52.30 c
Pnb+100	3.92 a	1.93 b	5.13 a	0.932 a	87.45 ab	61.25 b
Pnb+200	3.82 a	2.32 a	4.96 ab	0.830 ab	87.79 ab	48.92 c
Pb	1.32 c	2.14 ab	3.95 c	0.750 bc	98.83 a	193.58 a
LSD	0.285	0.318	0.959	0.236	0.0071	6.19
MS _{Residue}	0.016***	0.02***	0.018***	0.011***	44.287***	7.537***
CV (%)	4.78	7.17	9.40	13.92	7.93	3.36
C	0.513	0.548	0.285	0.590	0.385	0.455

Values followed by different letters within the same column are significantly different at $p \leq 0.05$ by the Tukey's multiple range test. MS_{Residue}: mean square residue. CV (%): coefficient of variation. C: Cochran's statistic. LSD: less significant difference of the Tukey's test. *: significant at 0.05 probability level, **: significant at 0.01 probability level, ***: significant at lesser than 0.01 probability level, NS: not significant.

The foliar concentration of P observed for the dose of 200 kg ha⁻¹ of P (Pnb+200) was statistically superior to the values provided by 100 kg ha⁻¹ of P (Pnb+100) and Pb practice, which did not differ from each other (Table 2). The highest concentrations of Mg and S were verified for 100 kg ha⁻¹ of P while the highest P dose provided superior Mn values that were nonetheless statistically similar to the Pb practice. In the case of Fe, the micronutrient appears in a very high and statistically superior concentration in the Pb treatment.

As expected on short-term assessments, the content of CP in this study was not altered by the treatments (F^{NS}, $p \leq 0.05$). The global mean of CP in the leaf of *B. brizantha* at 56 days was 8.23%. Higher percentage of ADF, NDF and Lignin was observed for treatments in which the pasture was not burned, with or without P application (Table 3).

In the Figure 2, one may observe that there were moderate and positive correlations between LDM and Fo-Mg and LDM with Fo-S, and a low and negative correlation between LDM and Fo-Fe. Fo-P presented low correlations with the structural carbohydrate concentrations of NDF and ADF besides Fo-Mn and Fo-S. Fo-Mg was low correlated to Lignin, Fo-Fe and Fo-S, which presented just a low correlation with the Lignin concentration. Fo-Mn was moderately and negatively correlated to NDF and ADF, and moderately and positively correlated with Fo-Fe. Fo-Fe, in turn, was highly and negatively correlated with the structural carbohydrates NDF and ADF and moderately and negatively correlated with Lignin. NDF sulfur and a low correlation with the lignin and sulfur.

Table 3

Means of acid detergent fiber (ADF), neutral detergent fiber (NDF) and lignine in the leaf of *B. Brizantha*.

Treatment	Acid detergent fiber, neutral detergent fiber and lignine		
	ADF	NDF	Lignine
	----- % -----		
Pnb	32.07 a	69.23 a	2.33 a
Pnb+25	31.90 a	68.69 a	2.13 b
Pnb+100	31.17 a	67.63 a	2.37 a
Pnb+200	31.43 a	68.27 a	2.41 a
Pb	28.45 b	64.30 b	1.92 c
LSD	1.483	2.70	0.504
MS _{Residue}	0.433***	1434***	0.030***
CV (%)	2.12	1.77	3.24
C	0.415	0.560	0.431

Values followed by different letters within the same column are significantly different at $p \leq 0.05$ by the Tukey's multiple range test. MS_{Residue}: mean square residue. CV (%): coefficient of variation. C: Cochran's statistic. LSD: less significant difference of the Tukey's test. *: significant at 0.05 probability level, **: significant at 0.01 probability level, ***: significant at lesser than 0.01 probability level, NS: not significant.

Figure 2

Pearson's linear correlation coefficients between leaf productivity and chemical-bromatological composition variables of *B. Brizantha*

LDM	0.72***	0.28 ^{NS}	0.34 ^{NS}	-0.54*	0.11 ^{NS}	0.70***	0.68***	0.35 ^{NS}
Fo-P	0.11 ^{NS}	-0.40*	-0.42*	0.29 ^{NS}	0.53*	0.41*	0.17 ^{NS}	
Fo-Mg	0.58**	0.24 ^{NS}	0.30 ^{NS}	-0.44*	-0.05 ^{NS}	0.51*		
Fo-S	0.41*	-0.09 ^{NS}	-0.01 ^{NS}	-0.09 ^{NS}	0.33 ^{NS}			
Fo-Mn	0.18 ^{NS}	-0.68***	-0.61**	0.63**				
Fo-Fe	-0.78***	-0.83***	-0.91***					
DF	0.08 ^{NS}	0.15 ^{NS}						
NDF	0.49*							
	Lignin	NDF	ADF	Fo-Fe	Fo-Mn	Fo-S	Fo-Mg	Fo-P

^{NS} non-significant; * significant ($p = 0.05$); ** significant ($p = 0.01$);

*** significant ($p = 0.001$).

5 DISCUSSION

According to Mwendia *et al.* (2022), the productivity and quality of tropical pastures are among the basis for evaluating the capacity for feeding animals on cattle farming systems. In the present work, the statistically superior behaviour of LBM productivity observed for 100 kg ha⁻¹ of P (Pnb+100) validates this level of P fertilization as a possibility to increase the feed availability to animals in 56 days of pasture growth. Several authors observed an increase of biomass production, including leaf biomass, when P and other nutrient management is adopted in similar conditions (Aryal *et al.*, 2020; Souza *et al.*, 2020; Farias *et al.*, 2016;

Marahata *et al.*, 2014). Results reported by Porto *et al.* (2012) also agree with the present results. These authors verified 24% higher dry mass production on leaves of *B. brizantha* cv. Marandu with the dose of 147 kg ha⁻¹ of P₂O₅. These findings represent more available feed for the cattle compared to the burning treatment. Furthermore, this may constitute an encouragement for cattle breeders to adopt them as a technology for *B. brizantha* management and contribute to avoid the intensification of the negative environmental impacts reported by Rumpel *et al.* (2015) and Luizão *et al.* (2013) in the Brazilian Amazon livestock systems.

Furthermore, the LDM productivity levels observed for 0 and 25 kg ha⁻¹ of P lead to the statement that a mere suppression of the pasture burning, along with an agronomic dose of N and K, are an adequate management for better leaf availability compared to the use of fire. Other authors also observed results that agree with the present results under different experimental conditions (Dias *et al.*, 2015; Ileri *et al.*, 2010), including one whose methodology and results (Heringer; Jackes, 2002c) are very similar to the verifications made with this work. Regarding the economical concern, the use of P_{nb}+100 of P applied together with agronomic doses of N and K reduces the cost of production in relation to the dose of 200 kg ha⁻¹ of P. This is a fact simply because the similar LDM value observed for this treatment (Table 2) was obtained with twice the fertilizer material.

The results under discussion still showed that both P and S were within the sufficiency range for the normal growth of *Brachiaria* spp (Brasil *et al.*, 2020). The Mg concentration was above the species requirements according to the same authors. These facts are related to the presence of these nutrients on the composition of the PPR used as P source (Table 1). Therefore, an increase on the P dose from the PPR increases, concomitantly, the dose of these nutrients present on it. Similarly, Machado *et al.* (2011) also reported an increase of P concentration in leaf tissue of the studied pasture when increasing doses of soluble P were applied. It is also important to clarify that the nutrient P is important not only for plant growth, but also for the effective development of rumen microbes in ruminants (Satter *et al.*, 2005), among other functions in animal metabolism.

In relation to Mn and Fe, the values observed with the dose of 100 kg ha⁻¹ of P are in accordance with the normal values verified for *Brachiaria* spp. Leaf tissue (Brasil *et al.*, 2020) that vegetates on a normal growth condition. The adequacy to the pattern of requirements for *Brachiaria* spp. promoted by P fertilization is in contrast with the very high value of Fe concentration provided for the Pb treatment. The high quantity of this micronutrient on the burned pasture leaf may constitute a problem for high grazing quantities by the animals since

the chemical composition of the pasture must be coupled with an adequate quantity of pasture biomass production (Brâncio *et al.*, 1997).

According to Brasil *et al.* (2020), the global means of N (adequate), K (adequate), Ca (inadequate) concentrations on the leaf tissue of *Brachiaria* spp., respectively, of 12.2, 17.2, 2.38 g kg⁻¹ did not limit pasture growth and leaf productivity at the 56-day mark. The global concentrations of B, Cu and Zn were, respectively, 4.44, 3.52 and 12.5 mg kg⁻¹ (F^{NS}, p≤0.05) and are below the pasture requirements according to the same reference. So, it is possible to affirm, for a short-term evaluation in discussion, that pasture fertilization with 100 kg ha⁻¹ of P improves the chemical composition for important nutrients that occur in low availability in acidic soils (Campos *et al.*, 2012) under livestock systems in the southwestern Amazon.

It is pertinent at this time to point out that, for many authors, the critical values for pasture growth may be different from the animal requirements for mineral elements. It is also clear that for P, Ca, Mg and most of the micronutrients, the cattle requirements exceed the plant requirements, with the exception of K. Anyway, the difference between nutrient availability in leaf tissue and animal needs is balanced by the adequate amount of LDM made available by the dose 100 kg ha⁻¹ of P. These findings are thus very important, since one can state that the foliar nutrient concentrations observed in this work were not limitant factors neither for pasture growth nor for their use on animal feed at 56 days of pasture growth.

All the doses of P without pasture burning presented statistically superior values of ADF compared to Pb (Table 2). In turn, all the treatments without burning, with or without P application, promoted statistically superior values of NDF contents, which showed to be ever higher than 65%. A similar behaviour was observed for lignin, with statistically superior values for treatments with P application compared to the Pb treatment.

The results exposed in Table 2 indicate a more soluble and digestible cellular content for animal consumption. Nevertheless, all values were framed slightly below the appropriate values for proper digestibility and consumption by ruminants, as reported by Van Soest (1994). The NDF values above 65% indicate a contribution to the reduction of the nutritional value of the leaf lamina of the pasture. Similar behaviour was verified for the lignin content in the leaf blade (Table 2), with values shown to be statistically superior in the treatments without burning, with or without P application. According to Jung *et al.* (1993) the process of lignification in plant cell walls has been considered an impediment to forage digestibility. According to Echeverria *et al.* (2016), the fact may be attributed to a reduced production of new leaves and the senescence of the old leaves in the start of the rainy season in the Amazon. That fact concomitantly causes a reduction of the cell contents and an increase of carbohydrates and lignin contents, decreasing the nutritional value of the pasture leaf.

The ADF contents in the leaf of *B. brizantha* observed in this study are next to a limiting range of consumption and the NDF contents are below it, including in the Pb treatment. These observations indicate that these contents are more related to physiological and structural characteristics of *B. brizantha* cv. 'Marandu' than to the supply of P or N and K fertilizations.

In relation to CP, the global mean observed of 8.23% is a desirable value for ruminant feed (for example) since a CP percentage below 7% leads to a lower forage digestion (Van Soest, 1994). According to Detmann *et al.* (2014), values of digestibility of *B. brizantha* cv. 'Marandu' are generally adequate as an animal feed. The values described here are not limiting to feed animals like ruminants (Van Soest, 1994) even within a short observation timeframe (56 days). On the other hand, Fischer *et al.* (1996) concluded that small increments on the nutritional value of pastures produced under the effects of fires occur occasionally. Other authors have observed improvements in the nutritional value, especially on the CP and digestible biomass production on different but recently burned pastures (Boughton *et al.*, 2022; Scasta *et al.* 2016; McGranahan *et al.*, 2014).

An extensive review indicates that the best alternative for eliminating pasture burning is the use of pasture improvement with the introduction of adequate management that prioritizes the maintenance of pasture sustainability (Zanini; Sbrissia, 2013). From a practical standpoint, animals kept in areas of burned pastures compared to unburned areas showed no difference in productive performance (Brâncio *et al.*, 1997).

The main relationships between LDM Productivity and chemical leaf composition indicate joint behaviour that avoids the pasture productivity normally occurring by the 56th day of growth. That fact is particularly confirmed by the adequate concentrations of P, Mg and S (Brasil *et al.*, 2020), which presented clear relationships among each other that influence the pasture's LDM productivity. The lignin concentration, in turn, increased on the leaf tissue as far as the LDM productivity concomitantly also increased. That verification, coupled with the high and negative associations among the structural carbohydrates and Fo-Fe likely denote the influence of Fe absorption on lignin, ADF and NDF contents on the leaf of *B. brizantha*, but without drastically reducing the leaf value as feed for grazing animals.

Despite that, pasture fertilization with 100.0 kg ha⁻¹ of P provided more leaves available for animal consumption in relation to the burning application, and makes the agroecosystem more sustainable on the agronomic, economic and environmental point of view.

6 CONCLUSION

The dose of 100 kg ha⁻¹ of phosphorus from the partially acidulated phosphate rock applied to unburned *B. brizantha* compared to the burnt version promoted: i) the highest leaf

blade dry mass productivity; ii) mineral nutrient concentrations not limitant to the pasture leaf productivity or to the leaf quality for animal consumption, and; iii) values of acid detergent fiber, neutral detergent fiber, lignin and crude protein means that indicate an adequate bromatological composition, which means high animal consumption of the leaf blade of *Brachiaria brizantha* cv. Marandu. We recognize the limitations of this work regarding the short time of observations, and mainly because other variables of nutritional value should be analysed for a more complete evaluation.

ACKNOWLEDGEMENTS

We are grateful to the Fundação de Amparo à Pesquisa do Estado do Amazonas-FAPEAM for financial support granted to the project of the first author, and to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior-CAPES, for the scholarship also provided for the first author.

REFERENCES

- AOAC. (1990). Official methods of analysis (15th ed.). Association of Official Analytical Chemists.
- Aryal, J. P., Rahut, D. B., Sapkota, T. B., & et al. (2020). Climate change mitigation options among farmers in South Asia. *Environment, Development and Sustainability*, 22, 3267–3289. <https://doi.org/10.1007/s10668-019-00414-4>
- Baggio, R., Overbeck, G. E., Durigan, G., & Pillar, V. D. (2021). To graze or not to graze: A core question for conservation and sustainable use of grassy ecosystems in Brazil. *Perspectives in Ecology and Conservation*, 19(3), 256–266. <https://doi.org/10.1016/j.pecon.2021.06.002>
- Boughton, E. H., Gomez-Casanovas, N., Swain, H., Bernacchi, C., Boughton, R. K., Brinsko, K., Li, H., Rivero, A., Delucia, E. H., & Sparks, J. (2022). Patch-burn grazing impacts forage resources in subtropical humid grazing lands. *Rangeland Ecology & Management*, 84(1), 10–21. <https://doi.org/10.1016/j.rama.2022.05.004>
- Brâncio, P. A., Nascimento Júnior, D., Moraes, E. A., Regazzi, A. J., & Leite, G. C. (1997). Avaliação de pastagem nativa dos cerrados submetida à queima anual. 2. Qualidade da dieta de bovinos. *Revista Brasileira de Zootecnia*, 26(3), 438–442.
- Brasil. (2020). Recomendações de calagem e adubação para o estado do Pará. Empresa Brasileira de Pesquisa Agropecuária. <https://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/1125022>
- BRASIL. (2014). Manual de métodos analíticos oficiais para fertilizantes minerais, orgânicos, organominerais e corretivos (M. C. M. Veras, Org.). Ministério da Agricultura, Pecuária e Abastecimento. https://www.gov.br/agricultura/pt-br/assuntos/lfdarquivos-publicacoes-laboratorio/manual_in-5_analiticos-oficiais-para-fertilizantes-e-corretivos_com_capa_final_03.pdf

- Campos, M. C. C., Ribeiro, M. R., Souza Junior, V. S., Ribeiro Filho, M. R., & Almeida, M. C. (2012). Topossequência de solos na transição Campos Naturais-Floresta na região de Humaitá, Amazonas. *Acta Amazônica*, 42(3), 387–398. <https://doi.org/10.1590/S0044-59672012000300011>
- Cardoso, E. L., & Crispim, S. M. A. (2003). Efeitos da queima na produção e valor nutritivo da matéria seca em área de *Andropogon bicornis* (Boletim 50). Embrapa Pantanal. <https://queimadas.dgi.inpe.br/~rqueimadas/material3os/BP50.pdf>
- Cayley, J. W. D., & Bird, P. R. (1996). Techniques for measuring pastures. Pastoral and Veterinary Institute.
- Conant, R. T. (2010). Challenges and opportunities for carbon sequestration in grassland systems: A technical report. Integ Crop Manag. <https://www.fao.org/3/i1399e/i1399e00.pdf>
- Detmann, E., Valente, E. E. L., Batista, E. D., & Huhtanen, P. (2014). An evaluation of the performance and efficiency of nitrogen utilization in cattle fed tropical grass pastures with supplementation. *Livestock Science*, 162, 141–153. <https://doi.org/10.1016/j.livsci.2014.01.029>
- Dias, D. G., Pegoraro, R. F., Alves, D. D., Porto, E. M., Santos Neto, J. A., & Aspiazú, I. (2015). Produção do capim Piatã submetido a diferentes fontes de fósforo. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 19, 330–335. <https://doi.org/10.1590/1807-1929/agriambi.v19n4p330-335>
- Dias-Filho, M. B. (2011b). Degradação de pastagens: Processos, causas e estratégias de recuperação. Embrapa Amazônia Oriental. <https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1070416/1/TC1117CartilhaPastagemV04.pdf>
- Dias-Filho, M. B. (2014b). Diagnóstico das pastagens no Brasil. Embrapa Amazônia Oriental. <https://www.infoteca.cnptia.embrapa.br/bitstream/doc/986147/1/DOC402.pdf>
- Dick, D. P., Martinazzo, R., Dalmolin, R., Jacques, A. V. A., Mielniczuk, J., & Rosa, A. S. (2008). Impacto da queima nos atributos químicos e na composição química da matéria orgânica do solo e na vegetação. *Pesquisa Agropecuária Brasileira*, 43, 633–640. <https://www.scielo.br/j/pab/a/wxL86vcqs4vww8PVJfQZQYw/?format=pdf&lang=pt>
- Echeverria, J. R., Euclides, V. P. B., Sbrissia, A. F., Montagner, D. B., Barbosa, R. A., & Nantes, N. N. (2016). Forage accumulation and nutritive value of the *Urochloa* interspecific hybrid 'BRS RB331 Ipyporã' under intermittent grazing. *Pesquisa Agropecuária Brasileira*, 51(7), 880–889. <https://doi.org/10.1590/S0100-204X2016000700011>
- EMBRAPA. (1997). Manual de métodos de análises de solo (2nd ed.). Ministério da Agricultura e do Abastecimento. <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/169149/1/Manual-de-metodos-de-analise-de-solo-2-ed-1997.pdf>
- Farias, S. C. C., Júnior, S., Ruivo, M. D. L. P., Rodrigues, P. G., Melo, V. S. D., Costa, A. D. R., & Souza Júnior, J. C. D. (2016). Phosphorus forms in Ultisol submitted to burning and trituration of vegetation in Eastern Amazon. *Revista Brasileira de Ciência do Solo*, 40, Article e0150198. <https://www.scielo.br/j/rbcs/a/HNBfpn8r9HB7VxZMzRVFWLD/?lang=en&format=pdf>

- Fischer, M. J., et al. (1996). Grasslands in the well watered tropical lowlands. In J. Hodgson & A. W. Illius (Eds.), *The ecology and management of grazing systems* (pp. 418–419). CAB International.
- Gerber, P. J., Henderson, B., & Makkar, H. P. (2013a). Mitigation of greenhouse gas emissions in livestock production: A review of technical options for non-CO2 emissions. FAO. <https://www.fao.org/3/i3288e/i3288e.pdf>
- Gerber, P. J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Faluccci, A., & Tempio, G. (2013b). Tackling climate change through livestock: A global assessment of emissions and mitigation opportunities. FAO. <https://www.fao.org/3/i3437e/i3437e.pdf>
- Girona-García, A., Galarza, R. Z., Mora, J. L., Armas-Herrera, C. M., Martí, C., Ortiz-Perpiñá, O., & Badía-Villas, D. (2018). Effects of prescribed burning for pasture reclamation on soil chemical properties in subalpine shrublands of the Central Pyrenees (NE-Spain). *Science of the Total Environment*, 644, 583–593. <https://doi.org/10.1016/j.scitotenv.2018.06.363>
- Heringer, I., & Jacques, A. V. A. (2002c). Nutrientes no mantillo em pastagem nativa sob distintos manejos. *Ciência Rural*, 32, 841–847. <https://doi.org/10.1590/S0103-84782002000500016>
- Hopkins, B. G., & Hansen, N. C. (2019). Phosphorus management in high-yield systems. *Journal of Environmental Quality*, 48, 1265–1280. <https://doi.org/10.2134/jeq2019.03.0130>
- leiri, A. Y., Lana, R. M. P., Korndörfer, G. H., & Pereira, H. S. (2010). Fontes, doses e métodos de aplicação de fósforo na recuperação de pastagem com *Brachiaria*. *Ciência e Agrotecnologia*, 34, 1154–1160. <https://doi.org/10.1590/S1413-70542010000500011>
- IPCC. (2014). Climate change 2014: Mitigation of climate change. In O. Edenhofer et al. (Eds.), *Contribution of Working Group III to the fifth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_frontmatter.pdf
- Jung, H. G., & Deetz, D. A. (1993). Cell wall lignification and degradability. In H. G. Jung, D. R. Buxton, R. D. Hatfield, & J. Ralph (Eds.), *Forage cell wall structure and digestibility*. American Society of Agronomy, Crop Science Society of America, Soil Science Society of America.
- Lal, R. (2011). Soil carbon sequestration. In Solaw: Background thematic report tr04b. The state of the world's land and water resources. Food and Agriculture Organisation of the United Nations. https://www.fao.org/fileadmin/templates/solaw/files/thematic_reports/TR_04b_web.pdf
- López-Mársico, L., Farías-Moreira, L., Lezama, F., Altesor, A., & Rodríguez, C. (2019). Light intensity triggers different germination responses to fire-related cues in temperate grassland species. *Folia Geobotanica*, 54(1), 53–63. <https://doi.org/10.1007/s12224-019-09336-5>
- Luizão, F. J., Fearnside, P. M., Cerri, C. E. P., & Lehmann, J. (2013). The maintenance of soil fertility in Amazonian managed systems (pp. 311–336). In M. Keller, M. Bustamante, J. Gash, & P. Da Silva (Eds.), *Amazonia and global change (Geophysical Monograph Series, Vol. 186)*. American Geophysical Union. <https://repositorio.inpa.gov.br/handle/1/35281>
- Machado, V. J., Souza, C. H. E., Andrade, B. B., Lana, R. M. Q., & Korndörfer, G. H. (2011). Curvas de disponibilidade de fósforo em solos com diferentes texturas após aplicação

- de doses crescentes de fosfato monoamônico. *Bioscience Journal*, 27, 70–76. <https://seer.ufu.br/index.php/biosciencejournal/article/view/7389/6843>
- Machado, L. A. Z., & Valle, C. B. (2011). Desempenho agrônomo de genótipos de capim-braquiária em sucessão à soja. *Pesquisa Agropecuária Brasileira*, 46, 1454–1462. <https://doi.org/10.1590/S0100-204X2011001100006>
- Magalhães, A. F., Pires, A. J. V., Carvalho, G. D., Silva, F. D., Sousa, R. S., & Veloso, C. M. (2007). Influência do nitrogênio e do fósforo na produção do capim braquiária. *Revista Brasileira de Zootecnia*, 36(5), 1240–1246. <https://doi.org/10.1590/S1516-35982007000600004>
- Marahata, S., Sah, S. K., MacDonald, A., Timilnisa, J., & Devkota, K. P. (2014). Influence of conservation agriculture practices on physical and chemical properties of soil. *International Journal of Advanced Research*, 2, 43–52. https://www.journalijar.com/uploads/638_IJAR-4425.pdf
- McGranahan, D. A., Henderson, C. B., Hill, J. S., Raicovich, G. M., & Wilson, W. N. (2014). Patch burning improves forage quality and creates grass-bank in old-field pasture: Results of a demonstration trial. *Southeastern Naturalist*, 13, 200–207. <https://doi.org/10.1656/058.013.0203>
- Mottet, A., Henderson, B., Opio, C., Falcucci, A., Tempio, G., Silvestri, S., & Chesterman, S. (2017). Climate change mitigation and productivity gains in livestock supply chains: Insights from regional case studies. *Regional Environmental Change*, 17, 129–141. <https://doi.org/10.1007/s10113-016-0986-3>
- Moxley, J., Steven, G. A., Anthony, K. B., & et al. (2014). Capturing cropland and grassland management impacts on soil carbon in the UK LULUCF inventory. 90 p. <https://nora.nerc.ac.uk/id/eprint/508474/1/N508474CR.pdf>
- Mwendia, S. W., Ohmstedt, U., Nyakundi, F., Notenbaert, A., & Peters, M. (2022). Does harvesting *Urochloa* and *Megathyrsus* forages at short intervals confer an advantage on cumulative dry matter yields and quality? *Journal of the Science of Food and Agriculture*, 102(2), 750–756. <https://doi.org/10.1002/jsfa.11407>
- Pequeno, D. N. L., Pedreira, L. E., Sollenberger, L. E., & Silva, L. S. (2015). Forage accumulation and nutritive value of brachiaria grasses and Tifton 85 bermuda grass as affected by harvest frequency and irrigation. *Agronomy Journal*, 107, 1741–1749. <https://doi.org/10.2134/agronj15.0115>
- Porto, E. M. V., Alves, D. D., Vitor, C. M. T., Gomes, V. M., Silva, M. F., & VID, A. M. S. S. R. (2012). Rendimento forrageiro da *Brachiaria brizantha* cv. Marandu submetida a doses crescentes de fósforo. *Scientia Agraria Paranaensis*, 11(3), 25–34. <https://doi.org/10.5380/agraria.v11i3.XXXX> [Nota: DOI parece incorrecto en el original; usa el proporcionado pero verifica si es el correcto para el journal]
- Raij, B. van, Andrade, J. C., Cantarella, H., & Quaggio, J. A. (2001). Análise química para avaliação da fertilidade de solos tropicais. IAC.
- Rumpel, C., Crème, A., Ngo, P. T., Velásquez, G., Mora, M. L., & Chabbi, A. (2015). The impact of grassland management on biogeochemical cycles involving carbon, nitrogen and phosphorus. *Journal of Soil Science and Plant Nutrition*, 15, 353–371. <https://doi.org/10.4067/S0718-95162015005000034>
- Santos, H. G., Jacomine, P. K. T., Dos Anjos, L. H. C., Oliveira, V. A., et al. (2018). Sistema Brasileiro de Classificação de Solo (5th ed., rev. and ampl.). Embrapa. <https://www.infoteca.cnptia.embrapa.br/handle/doc/1094003>

- Scasta, J. D., Thacker, E. T., Hovick, T. J., Engle, D. M., Allred, B. W., Fuhlendorf, S. D., & Weir, J. R. (2016). Patch-burn grazing (PBG) as a livestock management alternative for fire prone ecosystems of North America. *Renewable Agriculture and Food Systems*, 31, 550–567. <https://doi.org/10.1017/S1742170515000411>
- Silva, F. C. (2009). Manual de análises químicas de solos, plantas e fertilizantes (2nd ed.). Embrapa Informação Tecnológica; Embrapa Solos. <https://www.infoteca.cnptia.embrapa.br/handle/doc/330496>
- Silva, V. J., Pedreira, L. E., Sollenberger, L. S. S., & Yasuoka, I. C. L. A. (2016b). Carbon assimilation, herbage plant-part accumulation, and organic reserves of grazed 'Mulato II' brachiariagrass pastures. *Crop Science*, 56, 2853–2860. <https://doi.org/10.2135/cropsci2016.03.0148>
- Sollenberger, L. E., Kohmann, M. M., Dubeux, J. C. B., & Silveira, M. L. (2019). Grassland management affects delivery of regulating and supporting ecosystem services. *Crop Science*, 59, 441–459. <https://doi.org/10.2135/cropsci2018.09.0594>
- Satter, L. D., Klopfenstein, T. J., Erickson, G. E., Galen, E. J., & Mark Powell, J. M. (2005). Phosphorus and dairy/beef nutrition. University of Nebraska, Faculty Papers and Publications in Animal Science, 549.
- Souza, J. G., Aires, F. P. G., Gomide, P. H. O., & Nunes, J. C. (2020). Calagem e adubação no crescimento do capim mombaça em Roraimópolis, Roraima. *Revista Ambiente: Gestão e Desenvolvimento*, 13(1). <https://doi.org/10.24979/376>
- Soussana, J. F., & Lemaire, G. (2014). Coupling carbon and nitrogen cycles for environmentally sustainable intensification of grasslands and crop-livestock systems. *Agriculture, Ecosystems & Environment*, 190, 9–17. <https://doi.org/10.1016/j.agee.2013.10.012>
- Van Der Werf, G. R., Randerson, J. T., Giglio, L., Gobron, N., & Dolman, A. J. (2008). Climate controls on the variability of fires in the tropics and subtropics. *Global Biogeochemical Cycles*, 22(3), Article GB3028. <https://doi.org/10.1029/2007GB003122>
- Van Soest, P. J. (1994). Nutritional ecology of the ruminant (2nd ed.). Cornell University Press.
- Vetter, S. H., Sapkota, T. B., Hillier, J., Stirling, C. M., Macdiarmid, J. I., Aleksandrowicz, L., et al. (2017). Greenhouse gas emissions from agricultural food production to supply Indian diets: Implications for climate change mitigation. *Agriculture, Ecosystems & Environment*, 237, 234–241. <https://doi.org/10.1016/j.agee.2016.12.024>
- Zanini, G. D., & Sbrissia, A. F. (2013). Fogo em pastagens: Estratégia de manejo? *Revista de Ciências Agroveterinárias*, 12(1), 94–103. <https://revistas.udesc.br/index.php/agroveterinaria>

EMERGENCY APPROACH IN THE MANAGEMENT OF PEDIATRIC PATIENTS IN SEPTIC SHOCK: DIAGNOSIS AND PROTOCOLS

ABORDAGEM EMERGENCIAL NO MANEJO DE PACIENTES PEDIÁTRICOS EM CHOQUE SÉPTICO: DIAGNÓSTICO E PROTOCOLOS

ABORDAJE DE URGENCIA EN EL MANEJO DEL PACIENTE PEDIÁTRICO EN SHOCK SÉPTICO: DIAGNÓSTICO Y PROTOCOLOS



<https://doi.org/10.56238/sevened2026.008-084>

Estela Pazeto Nolêto¹, Ana Luiza Normanha Ribeiro de Almeida²

ABSTRACT

Septic shock is a critical condition characterized by the combination of sepsis (a systemic inflammatory response triggered by an infection) and severe cardiovascular dysfunction, including hypotension resistant to volume replacement. In Brazil, the incidence of septic shock in children is high, with mortality rates ranging from 10.8% to 33.5%. Immediate and appropriate treatment, especially in the first 24 hours of hospitalization, is crucial to reduce morbidity and mortality, particularly in children. The primary objective of this literature review is to structure and gather data on septic shock in pediatric emergency rooms, aiming at early diagnosis and rapid and efficient establishment of a course of action to reduce complications and, mainly, mortality. There are several methods used in emergency rooms to ensure rapid, systematic and organized care, such as the Manchester Scale, Pain Intensity Scale, and Pediatric Basic and Advanced Life Support (PALS) protocol. The diagnosis is confirmed based on the Phoenix Sepsis Score (PSS), considering the presence of severe hypotension and other criteria such as elevated lactate levels. The severity of septic shock depends on multiple factors, including the virulence of the pathogen, the patient's immunity, and the duration of the clinical picture. The methodology will be established by bibliographic reviews on the Scientific Library Online (SciELO) platform, FIOCRUZ, Brazilian Society of Pediatrics, Latin American Institute of Sepsis, II Brazilian Multidisciplinary Congress in Urgency and Emergency Online, and also the Sepsis Protocol of the Federal University of Pará together with the João de Barros Barreto University Hospital, over the last 24 years. It is expected that from the analysis of the information it will be possible to quickly identify the physiological state and initiate appropriate therapeutic measures, which are fundamental to reducing morbidity and mortality.

Keywords: Septic Shock. Pediatric Emergency. Sepsis.

RESUMO

O choque séptico é uma condição crítica caracterizada pela combinação de sepse (resposta inflamatória sistêmica desencadeada por uma infecção) e disfunção cardiovascular grave, que inclui hipotensão resistente à reposição de volume. No Brasil, a incidência de choque

¹ Medical Student. Universidade de Ribeirão Preto (UNAERP). E-mail: estelapazeto@gmail.com

² Dr. in Clinical Surgery. Universidade de São Paulo (USP). E-mail: alalmeida@unaerp.br

séptico em crianças é elevada, com taxas de mortalidade variando entre 10,8% e 33,5%. O tratamento imediato e adequado, especialmente nas primeiras 24 horas de internação, é crucial para reduzir a morbimortalidade, particularmente em criança. O objetivo primário desta revisão bibliográfica é estruturar e reunir dados sobre o choque séptico na emergência pediátrica visando o diagnóstico precoce e o estabelecimento rápido e eficiente de uma conduta para reduzir complicações e, principalmente, a mortalidade. Há vários métodos utilizados na emergência para garantir atendimento rápido, sistematizado e organizado, como a Escala de Manchester, Escala de Intensidade da Dor, Protocolo de Suporte Básico e Avançado de Vida Pediátrico (PALS). O diagnóstico é confirmado com base no Escore de Sepsis de Phoenix (PSS), considerando a presença de hipotensão grave e outros critérios como níveis elevados de lactato. A gravidade do choque séptico depende de múltiplos fatores, incluindo a virulência do patógeno, a imunidade do paciente, e a duração do quadro clínico. A metodologia será estabelecida por revisões bibliográficas na plataforma Scientific Library Online (SciELO), FIOCRUZ, Sociedade Brasileira de Pediatria, Instituto Latino Americano de Sepsis, II Congresso Brasileiro Multidisciplinar em Urgência e Emergência Online, e também Protocolo de Sepsis da Universidade Federal do Pará junto com o Hospital Universitário João de Barros Barreto, nos últimos 24 anos. Espera-se que a partir da análise das informações possa ser possível identificar rapidamente o estado fisiológico e iniciar medidas terapêuticas adequadas são fundamentais para a redução da morbimortalidade.

Palavras-chave: Choque Séptico. Emergência Pediátrica. Sepsis.

RESUMEN

El shock séptico es una afección crítica caracterizada por una combinación de sepsis (una respuesta inflamatoria sistémica desencadenada por una infección) y disfunción cardiovascular grave, incluyendo hipotensión resistente a la reanimación con líquidos. En Brasil, la incidencia de shock séptico en niños es alta, con tasas de mortalidad que oscilan entre el 10,8 % y el 33,5 %. El tratamiento inmediato y adecuado, especialmente en las primeras 24 horas de hospitalización, es crucial para reducir la morbilidad y la mortalidad, especialmente en niños. El objetivo principal de esta revisión bibliográfica es estructurar y recopilar datos sobre el shock séptico en el servicio de urgencias pediátricas, con el objetivo de lograr un diagnóstico precoz y establecer de forma rápida y eficiente un plan de acción para reducir las complicaciones y, especialmente, la mortalidad. En el servicio de urgencias se utilizan diversos métodos para garantizar una atención rápida, sistemática y organizada, como la Escala de Triage de Manchester, la Escala de Intensidad del Dolor Pediátrico y el protocolo de Soporte Vital Básico y Avanzado Pediátrico (PALS). El diagnóstico se confirma con la Escala de Sepsis de Phoenix (PSS), considerando la presencia de hipotensión grave y otros criterios como niveles elevados de lactato. La gravedad del choque séptico depende de múltiples factores, como la virulencia del patógeno, la inmunidad del paciente y la duración del cuadro clínico. La metodología se establecerá mediante revisiones bibliográficas en la plataforma Scientific Library Online (SciELO), FIOCRUZ, la Sociedad Brasileña de Pediatría, el Instituto Latinoamericano de Sepsis, el II Congreso Brasileño Multidisciplinario de Urgencia y Emergencia Online, y el Protocolo de Sepsis de la Universidad Federal de Pará, en colaboración con el Hospital Universitario João de Barros Barreto, durante los últimos 24 años. Se espera que, a partir del análisis de la información, sea posible identificar rápidamente el estado fisiológico e iniciar las medidas terapéuticas adecuadas, fundamentales para reducir la morbilidad y la mortalidad.

Palabras clave: Choque Séptico. Emergencia Pediátrica. Sepsis.

1 INTRODUCTION

Septic shock is a clinical, critical and potentially fatal condition of a severe bacterial, viral, fungal, protozoal or parasitic infection that leads to dysfunctions of the cardiovascular and/or non-cardiovascular system associated with refractoriness to volume replacement.

The patient in this condition is characterized as a medical emergency due to the fact that it needs a quick and efficient intervention because of the rapid progression that affects several organs of the body, especially the heart, compromising the physiological flow of the systems.

Thus, this condition becomes alarming in pediatric patients due to factors such as greater vulnerability to dehydration and hydroelectrolytic disorders, immature immune system, difficulty in identifying symptoms, incomplete maturation of some organs, and low energy reserve.

For these reasons, the management of septic shock in pediatrics is a challenge for health professionals, since it requires specialized care, early diagnosis, and efficient treatment in order to minimize complications and reverse hemodynamic instability.

According to the Guidelines Manual of the Brazilian Society of Pediatrics, "Severe Sepsis and Pediatric Septic Shock". Surviving Sepsis Campaign (SSC) 2017", the early identification of septic shock and the following of protocols that have an immediate intervention with the rapid stabilization of the patient decreased the number of deaths from 4% to 2%. This shows the importance of following guidelines with scientific foundations for the management of septic shock in pediatric patients are pillars to maximize results and implement effective practices. Complications of septic shock in children include deficit, decreased cardiac output, increased dead space in the lungs, decreased immunity, tissue death, and multiple system failure.

Considering the factors presented, it is observed that it is necessary for health professionals to make an early diagnosis, adequate hemodynamic support, antibiotic therapy, infection control and adherence to treatment protocols are fundamental elements in the management of this fatal syndrome. Thus, this theoretical and informative review seeks to present updated and evidence-based recommendations for clinical practice in the management of septic shock in pediatric emergency care .

2 OBJECTIVES (GENERAL AND SPECIFIC)

2.1 GENERAL (PRIMARY)

The purpose of this review is to structure and gather data on septic shock in pediatric patients in the emergency room with a view to early diagnosis and specific procedures due

to the need for rapid intervention to reduce mortality, classify it, and perform specific procedures quickly and efficiently to minimize complications.

2.2 SPECIFIC (SECONDARY)

- To describe the pathophysiology and etiology of septic shock in pediatric patients in the emergency room.
- To clarify the treatment and prognosis of pediatric septic shock in an emergency situation.
- Clarify the complications of septic shock in pediatric patients in the emergency room.
- To highlight prevention methods in order to reduce the number of cases of septic shock in children in emergency care.
- Inform the public health repercussions of septic shock in pediatric patients in the emergency room.

3 MATERIALS AND METHODS (METHODOLOGY)

This project is a literature review using the most relevant articles, websites, and guidelines published between the years 2001 and 2024. For the elaboration of the systematic review, Boolean operators and key terms will be established for research that used ecological study and inductive and statistical approach, as well as methodological criteria, theoretical deepening, ethical aspects and research instruments, including studies by students from various areas of health, such as medicine, pharmacy and nursing. All the study material was read and the information present in it was extracted and organized in a systematic way to compose this scientific work. There will be no exclusion regarding the profile of the university (public or private) and the stage of training.

A part of the selected articles were searched in the Scientific Electronic Library Online (SciELO), and only 2 were chosen as part of the literature review. The descriptors used were: "sepsis", "septic shock" and "sepsis". The sites used were FIOCRUZ, the Brazilian Society of Pediatrics, the Latin American Sepsis Institute, the II Brazilian Multidisciplinary Congress on Urgency and Emergency Online, and also the Sepsis Protocol of the Federal University of Pará together with the João de Barros Barreto University Hospital. The investigation made it possible to collect instructions organized in alphabetical order registered in the "References" sector located on page 26.

4 DISCUSSION

Septic shock is the presence of sepsis (inflammation that spreads rapidly throughout the body by an infecting organism that raises blood pressure, causes failure of several organs, among other symptoms) plus cardiovascular dysfunction, hypotension refractory to volume. (SBP, 2019)

The term sepsis is defined as Systemic Inflammatory Response Syndrome (SIRS) resulting from infection by bacteria, fungi, protozoa, and viruses. The term shock, on the other hand, is characterized by the disparity between blood volume and vascular bed capacity, with systemic tissue hypoperfusion due to the decrease in cardiac output and/or reduction in effective circulating blood volume. (Failure, J.F, 2008)

This systemic inflammatory response is characterized by endothelial cell activation, tissue edema, disseminated intravascular coagulation, and metabolic derangements. (Robbins and Cotran, 2016). Such as hypermetabolism, with increased glycogenolysis and hepatic gluconeogenesis, increased lipolysis and muscle, intestinal and connective tissue protein catabolism. (Siqueira-Batista, R et al, 2011) In this way, these mechanisms lead to organ failure and death due to tissue hypoxia, lactic acidosis and cell death.

Septic shock becomes an emergency because it requires immediate care due to its rapid progression and is potentially fatal.

Thus, it is extremely important to use tools that aim to assist, organize, and speed up care, such as the Manchester Scale, which can help quickly and accurately identify the patient's level of severity and the recommended waiting time. This protocol uses a color chart, so each color represents the patient's level of severity (red: emergency / attended immediately; orange: very urgent / can wait a maximum of 10 (ten) minutes to be seen; yellow: urgent / can wait up to 50 minutes; green: little urgent / can wait up to 2 (two) hours; blue: not urgent / waiting time can be up to 4 hours. (Ministry of Health, 2014)

It is important to remember that pediatric patients have an age range (0 – 18 years) and thus express the feeling of pain in different ways, such as crying, screaming, cringing, pointing, moaning, among other ways. Thus, by using the Pain Intensity Scale, which ranges from 0 to 10, it is possible to better understand the patient's pain aspect. (São Paulo State Secretariat, 2022)

When the patient has already been triaged, a systematic evaluation of the child should be carried out, following a sequence already established by the Pediatric Basic and Advanced Life Support Protocol (PALS), which aims to make a quick and accurate assessment of airway, respiratory, circulatory, and neurological support to minimize complications and reduce the mortality rate in pediatric emergencies.

The diagnosis of septic shock is established in children with sepsis who have at least 1 point in the cardiovascular component of the Phoenix Sepsis Score (PSS), i.e., severe hypotension for age, blood lactate >45 mg/dL, serum lactate > 5 mmol/L, or need for vasoactive medication). (SBP, 2024).

Usually, septic shock is caused by infections resulting from Gram-positive bacteria, Gram-negative bacteria, fungi, and protozoa, the most common being the former. Therefore, treatment is based on antibiotic therapy, volume replacement, vasodilators, oxygen supplementation (avoiding tissue hypoxia and maintaining blood pressure).

Complications resulting from septic shock in children are deficit of renal function due to lactic acidosis, decrease in cardiac output, increase in dead space in the lungs due to hypoventilation and hypoxemia, decreased immunity, tissue death, and system failure.

In emergency situations, identifying the physiological state and initiating initial therapeutic measures are the key points in reducing morbidity and mortality. (FIOCRUZ, 2024).

In addition, the severity and outcome of the clinical picture of septic shock are also dependent on the virulence of the infection, system involvement, levels of mediator production, patient's immunological status, presence of comorbidity, origin of shock and its duration. (Robbins and Cotran, 2016)

5 RESULTS

The analysis of the selected literature demonstrated that pediatric septic shock remains one of the main medical emergencies, with a high mortality rate, especially in the first hours of care. Studies indicate that most deaths are associated with delays in recognizing the condition and initiating therapeutic interventions.

It was evidenced that the early identification of signs of tissue hypoperfusion is the main factor for the initial diagnosis, highlighting tachycardia, changes in the level of consciousness, prolonged capillary refill, cold extremities, oliguria, and hypotension. It was observed that children often present nonspecific manifestations, which contributes to underdiagnosis and worse prognosis.

"Most deaths in children occur as a result of treatable diseases within the first 24 hours of hospital admission. Prompt and appropriate treatment significantly reduces morbidity and mortality in pediatric emergencies." (Hansoti et al., 2017; WHO, 2016.) and The incidence of septic shock in children in Brazil was approximately 53.7% in places with many resources and 81.3% with few resources and mortality was 10.8% and 33.5%, respectively (SBP, 2024). This highlights the need for health professionals to know the biological and psychological

peculiarities of pediatric patients, who are subject to aggravations resulting from iatrogenic events performed by the physician who was not properly involved in dealing with such a situation.

Regarding the initial management, the studies indicate volume resuscitation with crystalloid solutions as the first therapeutic approach, which should be performed immediately and with frequent clinical reassessments. Monitoring of vital signs, Glasgow Coma Scale, and urine output after each volume expansion was essential to assess the therapeutic response.

The results also showed that, in cases where there is no adequate response to volume replacement, the early introduction of vasoactive drugs is necessary to restore tissue perfusion. In addition, the increase in serum lactate and the need for vasoactive support were pointed out as important markers of severity.

Finally, the literature analyzed demonstrated that the adoption of clinical protocols and the training of emergency teams are directly associated with the reduction of complications, progression to multiple organ failure, and mortality in pediatric patients with septic shock.

6 CONCLUSION

Relevance of the study of septic shock in pediatric patients in the emergency room by health students, delving into its early diagnosis, pathophysiology, etiology, treatment, complications, prevention and prognosis.

Septic shock in children has a great impact on Brazilian public health, in terms of the number of admissions, rapid progression, severity, and lethality. Thus, the analysis of factors is extremely important to help doctors have an efficient conduct, immediate intervention and ensure the patient's well-being.

REFERENCES

- Barros, L. L. dos S., Maia, C. do S. F., & Monteiro, M. C. (2016). Fatores de risco associados ao agravamento de sepse em pacientes em Unidade de Terapia Intensiva. *Cadernos de Saúde Coletiva*, 24(4), 388–396. <https://doi.org/10.1590/1414-462X201600040091>
- Borges, A. C. N., et al. (2020). Epidemiologia e fisiopatologia da sepse: Uma revisão. *Research, Society and Development*, 9(2), Article e187922112. <https://doi.org/10.33448/rsd-v9i2.2112>
- Carvalho, et al. (2021). Guia prático para o interno: Urgências e emergências pediátricas (Vol. 1). Editora Omnis Scientia. <https://editora.editoraomnisscientia.com.br/livroPDF/8732710088-g.pdf>
- Cesar, R. G. (2024). Diretrizes para novas definições de sepse e choque séptico em pediatria – 2024 Phoenix Sepsis Score. Sociedade Brasileira de Pediatria.

https://www.sbp.com.br/fileadmin/user_upload/24385c-DC_Diret_Novas_Definic_Sepse_e_ChoqSeptico_em_Pediatria.pdf

Cruz, F. O. (2024). Abordagem inicial da criança na emergência. Arquivo Arca/Fiocruz. <https://www.arca.fiocruz.br/handle/icict/66025>

De Cores, O. P. de M. C. OS PPM de UT; Dos Sintomas. (2022). Classificações do protocolo de Manchester. Secretaria de Saúde do Estado de São Paulo. <https://cdr.saude.sp.gov.br/wp-content/uploads/2022/08/CLASSIFICACAO-DE-RISCO-12.8.22.pdf>

Ferreira, K. W. D. E. L., et al. (2023). Abordagem das emergências pediátricas: Reconhecimento, avaliação e manejo de pacientes pediátricos em situações críticas. In Anais do II Congresso Brasileiro Multidisciplinar em Urgência e Emergência On-line. Revista Multidisciplinar em Saúde. <https://ime.events/urgencicon2023/pdf/19595>

Fracasso, J. F. (2008). Contribuição ao entendimento da patogenia da sepse. Revista de Ciências Farmacêuticas Básica e Aplicada, 29(2), 119–127.

Freire, N. de M., Medeiros, D. N. M., & Troster, E. J. (2020). Síndrome da resposta inflamatória sistêmica, sepse, choque séptico e sepse grave em pediatria. In W. B. de Carvalho et al. (Eds.), Terapia intensiva (2ª ed., pp. 342–374). Manole.

Garcia, P. C. R., Piva, J. P., & Martha, V. F. (1999). Tratamento do choque na criança - Shock therapy in children. Jornal de Pediatria, 75(Suppl. 2).

Santos, J. V., et al. (2024). Análise epidemiológica e tendências de mortalidade por sepse no Brasil de 2018 a 2022. Brazilian Journal of Implantology and Health Sciences, 6(8), 5148–5161.

Semaan, J. M., et al. (2023). Sepse em unidades de terapia intensiva: Uma revisão integrativa acerca dos fatores de risco. Brazilian Journal of Implantology and Health Sciences, 5(5), 5274–5285.

Sepse, A. ao P. P.; Séptico, S. G. e. (2022). Campanha de sobrevivência a sepse protocolo clínico pediátrico. International Liaison Committee on Resuscitation. <https://ilas.org.br/wp-content/uploads/2022/02/protocolo-de-tratamento-pediatria.pdf>

Siqueira-Batista, R., et al. (2011). Sepse: Atualidades e perspectivas. Revista Brasileira de Terapia Intensiva, 23(2), 207–216. <https://doi.org/10.1590/S0103-507X2011000200014>

Sociedade Brasileira de Pediatria. (2023). Sepse grave e choque séptico pediátrico. https://www.sbp.com.br/fileadmin/user_upload/21277f-MO_-_Sepse_grave_e_Choque_septico_pediatico.pdf

Tacsi, Y. R. C., & Vendruscolo, D. M. S. (2004). A assistência de enfermagem no serviço de emergência pediátrica. Revista Latino-Americana de Enfermagem, 12(3), 477–484. <https://www.scielo.br/j/rlae/a/K7Qv5VcYbGV9SZwNCjGPHsn/>

RIGHTS AS TRUMPS, JUDICIAL ACTIVISM AND HUMAN DIGNITY IN LIGHT OF DWORKIN'S POLITICAL PHILOSOPHY

DIREITOS COMO TRUNFOS, ATIVISMO JUDICIAL E DIGNIDADE HUMANA À LUZ DA FILOSOFIA POLÍTICA DWORKINIANA

LOS DERECHOS COMO TRIUNFOS, EL ACTIVISMO JUDICIAL Y LA DIGNIDAD HUMANA A LA LUZ DE LA FILOSOFIA POLÍTICA DE DWORKIN



<https://doi.org/10.56238/sevened2026.008-085>

Luciano Jesus Hage Martins¹

ABSTRACT

This research aims to understand, through Dworkin's political theory of rights as trumps, the concepts of human dignity and judicial activism. According to the theory under study, rights as trumps seek to protect individuals from unjust public policies of the government, which can harm the equal distribution of rights. In this context, the study explores the concept of rights as trumps in order to understand human dignity and the counter-majoritarian role of the judiciary, and how these concepts help in the protection of fundamental rights and the distribution of rights based on equal consideration. Regarding the methodology used in this article, discourse analysis will be employed, as the objective is to understand the discourse used in the concept of rights as trumps. Thus, at the end of the work, the results obtained during the research on the analyzed topic will be presented.

Keywords: Unjust Public Policies. Equal Distribution of Rights. Protection of Fundamental Rights.

RESUMO

A presente pesquisa tem a finalidade de compreender por meio da teoria política de Dworkin dos direitos como trunfos os conceitos da dignidade humana e do ativismo judicial. De acordo com a teoria em estudo, os direitos como trunfos buscam proteger os indivíduos de políticas públicas injustas do poder público, que podem prejudicar a distribuição igualitária de direitos. Nesse contexto, o estudo explora a concepção de direitos como trunfos a fim de entender a dignidade humana e a atuação contramajoritária do judiciário, e como esses conceitos ajudam na proteção de direitos fundamentais e na repartição de direitos com base na igual consideração. No que se refere à metodologia utilizada no artigo será a análise do discurso, pois o artigo tem o objetivo de compreender o discurso empregado no conceito de direitos como trunfos. Assim, ao final do trabalho, será exposto os resultados obtidos durante a pesquisa sobre o tema em análise.

Palavras-chave: Políticas Públicas Injustas. Distribuição Igualitária de Direitos. Proteção de Direitos Fundamentais.

¹ Master's degree in Law. Centro Universitário do Estado do Pará. E-mail: lucianohage@yahoo.com
Lattes: <https://lattes.cnpq.br/6569202093906041>

RESUMEN

Esta investigación busca comprender, a través de la teoría política de los derechos como triunfos de Dworkin, los conceptos de dignidad humana y activismo judicial. Según la teoría en estudio, los derechos como triunfos buscan proteger a los individuos de políticas públicas injustas del gobierno, que pueden perjudicar la distribución equitativa de los derechos. En este contexto, el estudio explora el concepto de derechos como triunfos para comprender la dignidad humana y el papel contramayoritario del poder judicial, y cómo estos conceptos ayudan en la protección de los derechos fundamentales y la distribución de derechos basada en la igualdad de consideración. Con respecto a la metodología utilizada en este artículo, se empleará el análisis del discurso, ya que el objetivo es comprender el discurso utilizado en el concepto de derechos como triunfos. Por lo tanto, al final del trabajo, se presentarán los resultados obtenidos durante la investigación sobre el tema analizado.

Palabras clave: Políticas Públicas Injustas. Distribución Equitativa de Derechos. Protección de los Derechos Fundamentales.

1 INTRODUCTION

This article will analyze the principle of the dignity of the human person in the phenomenon of judicial activism from the perspective of Dworkin's concept of law as trump cards, which consists of the use of rights as trump cards to seek a more appropriate solution to guarantee fundamental rights in the face of the arbitrariness of the state. According to Dworkin, it is necessary for courts to use principles based on moral justification to ensure a fair distribution of rights. (Dworkin, 2007)

Judicial activism is characterized by the counter-majoritarian action of the Judiciary in the face of the insufficiencies of the Legislative Branch, especially when fundamental rights are not adequately protected. In the Dworkinian perspective, this action can be legitimized as long as it is based on legal principles endowed with moral content, oriented to the promotion of equality and freedom. (Dworkin, 2002)

Furthermore, the concept of rights as trump cards includes human dignity, as a means to guarantee basic rights to individuals. Considering that this principle seeks to ensure the way of life of the citizens of the community, thus helping in the fair distribution of rights. (Dworkin, 2014)

In view of these premises, the article in view of the concepts that will be used in relation to Dworkin's theory, aims to answer the following question: How does Dworkin's concept of Rights as trump cards analyze the Principle of the Dignity of the Human Person in the phenomenon of Judicial Activism?

The central hypothesis of this study is the concept of rights as trumps, developed by Dworkin, which provides an adequate theoretical foundation for the application of the principle of the dignity of the human person in the context of judicial activism, legitimizing the counter-majoritarian action of the Judiciary in the realization of an equal distribution of rights. Thus, the relevance of this article contributes to the academic debate on judicial activism, especially when based on the principle of human dignity in the theory of rights as trump cards.

The general objective of this article is to analyze, through the theory of rights as trumps, the distribution of rights from a counter-majoritarian action of the Judiciary. In addition, it is highlighted that the specific objectives established in this study are: To understand the importance of the judicialization of arbitrary public policies; Analyze the role of human dignity in the protection of fundamental rights and clarify the role of the judiciary in the distribution of rights.

Regarding the methodology, the method of discourse analysis will be used in this work, having as object of study the principle of human dignity in judicial activism, analyzed from the concept of rights as trumps. Thus, this method consists of analyzing an object of research,

based on the language in which it produces in the face of a theory, in this case it is Dworkin's theory of rights as trumps.

The present research adopts the qualitative approach, and the means used to carry out searches were Dworkin's works, articles and periodicals that deal with the theme. In this sense, the work presents the theoretical framework based on Dworkin's political theory that will be analyzed in this article.

The results of the research are presented in the following topics: The concept of rights as trump cards; Judicial activism from the perspective of rights as trump cards; and The principle of human dignity according to rights as trumps. Finally, at the conclusion of the work, the recapitulation of the objectives and premises of each topic will be presented, as well as the examination of the confirmation or not of the research hypothesis.

2 THE CONCEPT OF RIGHTS AS TRUMP CARDS

In this topic, the concept of rights as trumps will be explained. Firstly, according to Dworkin, rights as trump cards means that the right should be understood as a way for citizens to protect themselves against the arbitrariness of the state. (Dworkin, 2014)

Rights as trump cards is a concept that Dworkin developed as a way to make an analogy to card games, with law being a kind of surprise card to protect fundamental rights and guarantees against actions of the public power. Thus, individuals would have legal instruments to claim fundamental rights before the public power. (Novais; Miranda, 1996)

Dworkin argues that not every right can be considered as an asset, because this right must be pre-existing in a community of principles, as Martel states:

Dworkin distinguishes several categories of rights. It is not just any right that assumes the position of trump right. Trump-rights are those pre-existing, identified in a community of principles - a personified community, whose link between people is fraternity and not a mere geographical accident or a mere convention. The identification of such rights occurs with the fulcrum of the substantive connection with their foundation, the liberal conception of equality, with an examination of the distribution of rights (as a rule, trump rights cannot be recognized to one group and not to others), as well as through recourse to tradition, institutional history and community morality. In the case of the United States, some trump rights are also included in the text of the Constitution. Dworkin does not offer a list of trump rights, nor does he conceive a mechanical formula that allows their identification. Recognizing a trump card right is an interpretative task, for which it is essential to assume the communication between morality and law. (Martel, 2007, p.4)

According to the excerpt above, the author states that for a right to be considered as an asset, it is necessary that this right be recognized and identified in a community of principles. Because the identification of rights as an asset occurs according to the moral and

political foundation of society, for example, the conception of equality in the distribution of rights is based on the political morality of the community, thus, the recognition of a right as an asset becomes an interpretative issue. (Martel, 2007)

Furthermore, rights as trump cards cannot be confused with fundamental rights. Because these rights are based on a moral justification, in this case it becomes an interpretative question, not extending to the rights already affirmed. In this sense, rights as trumps cannot be equated to fundamental rights already affirmed in the legal system, since trump rights for Dworkin are moral rights. (Martel, 2007)

In addition, Dworkin argues that the idea of trump rights could trivialize a claim to certain rights. In this way, Dworkin defends a new conceptualization of rights as trump cards. (Dworkin, 2014)

Along these lines, Dworkin states:

[...] The idea of rights as trump cards can be used in such a way as to grotesquely increase the number of rights, trivializing the appeal to a right. Certainly, that is, possible—we might stipulate that a man is said to have a right if his disadvantage affords a stronger reason than some other reason of any kind that might exist in support of that disadvantage. Most rights would have (according to this explanation) no practical importance. We would then need a new concept of rights as trump cards over important collective justifications, which is what I propose in the first place. (Dworkin, 2002, p.559)

According to the excerpt above, it is correct to state that Dworkin defends the reform of the concept of rights as trump cards, with the aim of not trivializing the claims of rights. In this sense, it is necessary to seek new collective justifications so that the concept of rights as trump cards can be rethought. (Dworkin, 2002)

In Dworkin's perspective, political rights could be considered as trump cards, according to the author:

Capturing this idea, we can affirm that political rights act as trump cards against justifications for political action that would otherwise be adequate. A policy is usually justified, for example, if it is going to make the community safer by reducing violent crime: on the whole, it is a good justification for raising taxes in order to better fund the police. (Dworkin, 2014, p.502)

According to the excerpt above, it can be stated that political rights can act as trump cards against political actions of the state, given that political actions are generally justified. Thus, being able to work for the good of the community. (Dworkin, 2014)

According to Dworkin, for a right to be considered an asset, it is necessary that this right be recognized in a community of principles, because in the philosopher's view, principles

have a weight in the legal system, given that principles work in a different logic from norms. Thus, developing the protection of fundamental rights. (Dworkin, 2014)

In Dworkin's theory, rights as trump cards are not to be confused with simple collective interests or with majoritarian public policies, as they act as limits to state decisions. Such rights require a moral foundation capable of justifying their protection even in the face of the will of the majority, ensuring individuals the possibility of claiming fundamental rights before the public power. (Dworkin, 2014)

Thus, Dworkin states:

To ask sensibly whether we have a right to liberty in this neutral sense, we must fix ourselves in a single sense of the word 'right'. It is not difficult to find a meaning of this term that allows us to say, with some confidence, that men have a right to freedom. We can say, for example, that a person has a right to freedom if it is in his interest to have freedom, that is, if he wants to have it or if it is good for him to have this right. In this sense, I would be prepared to admit that citizens have a right to freedom. In the same sense, however, I would also have to concede that they have a right, at least in general terms, to vanilla ice cream. Moreover, my concession of liberty would have very little value in the political debate. Therefore, if it is up to the right to freedom to play the role tailored for it in the political debate, it needs to be a right in a much stronger sense (...). In the strong sense I have described, a successful claim to a right has the following consequence. If a person has a right to something, then it is wrong for the government to deprive him of that right, even though it is in the general interest to do so. (Dworkin, 2002, p.414)

According to the excerpt above, it is correct to state that Dworkin defends the idea that the conception of having or not having a right would be a matter of interpretation. In this context, Dworkin argues that interpretation is fundamental to the understanding of a right as an asset. Because Dworkin's theory is based on a question of interpretation of legal and moral concepts, in the excerpt above the author uses as an example with regard to the concept of freedom it is necessary to develop it for citizens to be able to claim their rights. (Dworkin, 2002)

Thus, Dworkin argues that the concept of rights as trumps is configured as moral rights that form their justification from an interpretative question. For the author, a right is considered an asset when this right is recognized in a community of principles, because in the author's view such a right must present arguments in consolidated concepts of principles, such as freedom and equality. (Dworkin, 2014)

Rights as trump cards are methods that aim to protect citizens against state arbitrariness. From this perspective, this concept defends the use of morality to create a justification to guarantee fundamental rights, based on consolidated concepts such as the freedom to claim rights before the public power. (Dworkin, 2002).

In view of this, the next topic will address judicial activism from the perspective of rights as trump cards.

3 JUDICIAL ACTIVISM FROM THE PERSPECTIVE OF RIGHTS AS TRUMP CARDS

Judicial activism can be understood as a form of counter-majoritarian action by the Judiciary aimed at protecting fundamental rights. From this perspective, the courts assume a relevant role in containing public policies that violate constitutionally guaranteed rights. (Abboud; Lunelli, 2015)

From the perspective of the concept of rights as trump cards, this action is legitimized when it is based on legal principles endowed with moral content, allowing the Judiciary to ensure the effectiveness of the rights of individuals even in the face of arbitrary political decisions. (Dworkin, 2002)

For Dworkin, judicial activism aims at the Judiciary in the defense of fundamental rights. Due to the fact that the state creates laws that can harm certain social groups, thereby affecting the distribution of rights in society. (Dworkin, 2014)

In addition, it is important to highlight that judicial activism according to the concept of rights as trump cards, it is necessary for the judiciary to have a representative role, that is, to defend the rights of citizens in the face of the omission of the public power. In this case, the judiciary would act more actively to guarantee fundamental rights to individuals. (Dworkin, 2003)

According to Dworkin, the Judiciary Branch to ensure a fair distribution of rights, it is necessary for the courts to develop constitutional concepts. For example, freedom, equality and human dignity, as the author argues that if the judiciary manages to make a consolidated definition of such concepts, the distribution of rights will be done in a fair and equal way. (Vitório, 2011)

For Dworkin, the Judiciary cannot contribute to the maintenance of public policies that do not distribute rights fairly, because judicial activism based on the concept of rights as trump cards aims to develop constitutional concepts to ensure a fair distribution of rights and guarantee protection to individuals from the arbitrariness of public power. (Dworkin, 2003)

In this way, Dworkin argues that judicial activism, in the light of the concept of rights as trump cards, configures a counter-majoritarian action of the Judiciary aimed at the protection and distribution of fundamental rights. From this perspective, the courts resort to a more developed interpretation of constitutional principles, in order to ensure that individuals are able to exercise their rights in the face of state policies that violate them. (Dworkin, 2002)

Thus, the next approach to the work will be the principle of human dignity according to rights as trump cards.

4 THE PRINCIPLE OF THE DIGNITY OF THE HUMAN PERSON ACCORDING TO RIGHTS AS TRUMPS

The theory of rights as trumps understands human dignity as a principle that aims to enforce basic rights for individuals. Thus, this principle is essential for the achievement of a fair and equal distribution of rights. (Dworkin, 2014)

In addition, the principle of human dignity aims to protect the maintenance of citizens' basic guarantees. This principle seeks to help in the claim of rights in the face of unjust public policies, in this case, human dignity intends to reinforce a distribution of rights based on equality and justice, without interfering in the life project of the citizens of the community. Thus, individuals are able to live harmoniously in society. (Dworkin, 2014)

In this context, the principle of human dignity according to the concept of rights as trump cards is to guarantee a life in which individuals have the same rights in society and live together equally and autonomously. According to Dworkin's analysis of human dignity, it is important to emphasize that this individual cannot be subjected to any degrading treatment, such as torture, forced labor, and is treated with equal consideration. Thus, according to Dworkin, if the rights of individuals are violated, this would lead them to indignity. (Dworkin, 2007)

According to Dworkin, the principle of human dignity has a moral value that makes it intrinsic, taking into account the way the individual manages his personal life. In this case, human dignity would act as an asset when public policies privilege the central aspect of the value and importance of human life. (Dworkin, 2007)

The principle of the dignity of the human person according to the concept of right as trumps seeks to defend the concept of intrinsic value that must be respected among individuals, because human dignity is an inherent characteristic of individuals, and cannot be replaced in any way, because the principle under analysis is based on the reasoning that the human being has an end in himself, And from the moment the human being is considered rational, dignity is already guaranteed to the individual. Thus, being an absolute value that cannot be taken from individuals. (Kant, 2009)

Furthermore, Dworkin states that human dignity should not be understood only to grant rights to individuals. However, this principle must ensure the distribution of rights with the objective of citizens obtaining a way of life according to the individual claims of each one, such as, for example, human dignity must guarantee individuals the right to basic health,

since health is not considered only as a right granted to citizens, but a fundamental condition for individuals to achieve their life projects. (Salgado; Pinheiro, 2019)

In this way, human dignity aims to promote basic guarantees to individuals, as a way for them to succeed in their individual goals, without interfering in the distribution of rights of the citizens of the community, and the role of the judiciary in situations of arbitrary policies is important. In this sense, the principle under analysis is fundamental for harmonious coexistence in society. (Dworkin, 2014)

Thus, it is correct to state that the principle of the dignity of the human person according to the concept of rights as trumps is divided into two main foundations: The principle of intrinsic value, aimed at the analysis of the actions of human life, and the principle of personal responsibility, which supports the idea of autonomy of individuals in relation to their own choices. In this way, human dignity acts as an asset to the extent that it ensures the fundamental conditions for each individual to build his or her own life project. (Dworkin, 2014)

That said, the article moves on to the main theme of the research in which the central premise for the answer to the work problem will be exposed.

5 HOW DWORKIN'S CONCEPT OF RIGHTS AS TRUMP CARDS ANALYZES THE PRINCIPLE OF THE DIGNITY OF THE HUMAN PERSON IN THE PHENOMENON OF JUDICIAL ACTIVISM

As seen earlier, the principle of the dignity of the human person in the Dworkinian perspective is divided into two principles, which are the principles of intrinsic value and personal responsibility. Thus, ensuring the way of life of individuals in society and their fundamental rights. (Dworkin, 2014)

In addition, it is worth noting that Dworkin in his theory of law as an asset was observed that this concept aims to defend individuals in the face of arbitrary public policies of the state, in which Dworkin defends the use of a justification based on morality in order to guarantee fundamental rights, and using consolidated concepts such as equality to claim rights before state power. (Dworkin, 2014)

In this sense, Dworkin explains that judicial activism according to the concept of rights as trumps would be a way for the judiciary to act in a counter-majoritarian way, that is, the courts must define explanations of constitutional concepts, to guarantee fundamental rights to citizens in order to prevent public policies of the state that harm the distribution of rights. (Dworkin, 2002)

According to Dworkin, it is important to emphasize that Dworkin's position in the theory of law as an asset is the use of moral justification to prevent public policies of the state from harming the distribution of rights in a fair way. (Morrison, 2006)

Regarding the principle of the dignity of the human person, it is worth noting that this principle, according to Dworkin's concept of rights as trump cards, it can be said that this principle aims to guarantee the basic conditions for individuals to build their own lifestyle autonomously. In this sense, the principle of human dignity presents itself as a principle that guarantees the necessary conditions for citizens to achieve their individual goals. (Dworkin, 2011)

In addition, the principle of human dignity based on rights as trump cards in judicial activism, it is necessary for the courts to develop the concepts of constitutional principles in order to achieve an equal distribution of rights without harming the way of life of citizens. In this case, the judge, for Dworkin, must adapt such principles to the political morality adopted by the community. (Brandão, 2024)

Dworkin states that judges should use principles based on moral justification. Thus, it is necessary for magistrates to develop the concept of human dignity, in order to guarantee individual rights for citizens to be able to structure their way of life autonomously. (Dworkin, 2003)

From the perspective of the theory of rights as trump cards, it can be emphasized that the principle of the dignity of the human person in judicial activism must be interpreted by the courts according to moral justifications. In addition, the judge must adapt the principle to the political morality of the community, as a way of ensuring a distribution of rights based on equal consideration. (Dworkin, 2014)

Dworkin, in the concept of rights as trumps, argues that the interpretation of the principle of human dignity must be understood from a moral foundation. Because it improves the understanding of the courts when using this principle, to ensure the protection of fundamental rights in the face of state arbitrariness. Therefore, the development of the interpretation of human dignity is essential to understand this principle in the concept of rights as trumps. (Abboud; Motta, 2021)

In this line, in order to understand the principle of the dignity of the human person in judicial activism from the conception of rights as trump cards, it is necessary to understand that the concept of human dignity by the courts is an interpretative issue. Because interpretation in Dworkinian logic plays an important role when judges create justifications based on moral principles to ensure an equal distribution of rights. (Abboud; Motta, 2021)

For Dworkin, the judge must ensure that the principle of human dignity is respected, and it is necessary to use the principles of personal responsibility and intrinsic value, since these principles are essential to understand human dignity. Thus, respecting the principle of human dignity. (Dworkin, 2007)

Thus, Salgado and Pinheiro state:

[...] Axiological neutrality on this interpretation is not possible, since, when interpreting the constitutional text, the interpreter performs a moral reading and it is important that this be the case in order to guarantee respect for human dignity. (Salgado; Pinheiro, 2019, p. 15)

According to the excerpt above, it is correct to state that for the judge to respect the principle of human dignity, it is necessary to make an interpretation based on morality and not from an axiological neutrality, because in this case the judge will be able to guarantee a correct use of the principle of human dignity, considering that a moral justification will be used for the understanding of this principle. (Salgado; Pinheiro, 2019)

In view of the above, it can be stated that the concept of rights as trump cards allows us to understand the principle of the dignity of the human person, in the context of judicial activism, based on the principles of personal responsibility and the intrinsic value of human life. Based on these foundations, the Judiciary is capable of developing an adequate moral justification for the realization of an equal distribution of rights, ensuring citizens the basic conditions necessary for the autonomous construction of their life projects.

6 CONCLUSION

Finally, the present study sought to understand, in view of the concept of rights as trump cards, how the principle of the dignity of the human person can be understood in judicial activism, and how this principle can help in the construction of a moral justification to ensure a fair distribution of rights.

In the course of the research, it was sought to understand the following points: The representative performance of the judiciary in the face of the state's omissions; How human dignity can ensure better conditions for individuals without harming their individual projects and the importance of judicializing public policies that are harmful to social harmony.

In this sense, the counter-majoritarian action of the judiciary from the perspective of Dworkin's theory seeks to effect a fair distribution of rights based on equal consideration. With regard to the aspects dealt with on human dignity, it is correct to state that this principle has the purpose of ensuring individual rights so that citizens can live together according to their needs. Thus, it is concluded that the central premise of the work was confirmed, because

Dworkin's theory aims to understand the importance of human dignity and the active performance of the judiciary for the construction of a just and egalitarian society.

In view of all the above, it is concluded that rights as trump cards allow us to understand the principle of the dignity of the human person, in the context of judicial activism, as an essential instrument to guarantee fundamental rights. From this perspective, it is up to the judge to resort to adequate theoretical foundations, especially the construction of moral justifications, which, according to Dworkin, are indispensable for the Judiciary to ensure the protection of individuals in the face of arbitrary public policies and to render fair judicial decisions committed to the realization of human dignity.

REFERENCES

- Abboud, G., & Lunelli, G. (2015). Ativismo judicial e instrumentalidade do processo. *Revista dos Tribunais*.
- Barbosa, E., & Costa, T. C. A. (2016). A concepção de dignidade humana em Ronald Dworkin: Um problema de ética prática. *Revista de Filosofia (Pelotas)*.
- Barroso, L. R. (2018). Contramajoritário, representativo e iluminista: Os papéis das cortes constitucionais nas democracias contemporâneas. *Revista Direito e Práxis*.
- Brandão, A. R. (2024). Ronald Dworkin: Princípios e integridade. *Revista da Defensoria Pública RS*.
- Brito, L. A. G. de S. M. de. (2018). Direito ambiental versus justiça ambiental: Crítica ao ativismo judicial em matéria de meio ambiente. *Revista de Direito Ambiental*.
- Dworkin, R. (2002). *Levando os direitos a sério* (N. Boeira, Trad.). Martins Fontes. (Obra original publicada em 1977)
- Dworkin, R. (2003). *O império do direito* (J. L. Camargo, Trad.). Martins Fontes.
- Dworkin, R. (2007). *Uma questão de princípio*. Martins Fontes.
- Dworkin, R. (2009). *Domínio da vida* (J. L. Camargo, Trad.). Martins Fontes.
- Dworkin, R. (2011). *A virtude soberana: A teoria e a prática da igualdade*. Martins Fontes.
- Dworkin, R. (2014). *A raposa e o porco-espinho: Justiça e valor*. Martins Fontes.
- Fernandes, B. G., & Pedron, F. Q. (2008). *O poder judiciário e(m) crise*. Editora Lumen Juris.
- Kant, I. (2009). *Fundamentação da metafísica dos costumes* (G. A. de Almeida, Trad.). Discurso Editorial: Barcarolla. (Obra original publicada em 1785)
- Martel, L. de C. V. (2007). São os direitos como trunfos disponíveis? Reflexões à luz da teoria dos direitos de Ronald Dworkin. *Revista de Direito do Estado*.
- Morrison, W. (2006). *Filosofia do direito: Dos gregos ao pós-modernismo* (J. L. Camargo, Trad.; G. S. L. Rios, Rev. técnica). Martins Fontes.
- Novais, J. R. (1996). Renúncia a direitos fundamentais. In J. Miranda (Ed.), *Perspectivas constitucionais nos 20 anos da Constituição de 1976* (pp. ?). Coimbra Editora.

- Peduzzi, M. C. I. (2009). O princípio da dignidade da pessoa humana na perspectiva do direito como integridade [Dissertação de mestrado ou tese, Universidade de Brasília].
- Rodrigues, S. M. (2005). A interpretação jurídica no pensamento de Ronald Dworkin. Almedina.
- Salgado, Y. S. B., & Pinheiro, V. S. (2019). Os princípios éticos da dignidade humana à luz da democracia associativa de Ronald Dworkin. *Revista de Teorias da Democracia e Direitos Políticos*.
- Vitório, T. B. da S. C. (2011). O ativismo judicial como instrumento de concreção dos direitos fundamentais no Estado democrático de direito: Uma leitura à luz do pensamento de Ronald Dworkin [Dissertação de mestrado ou tese, Pontifícia Universidade Católica de Minas Gerais].

MONITORING OF FIRE OUTBREAKS IN THE LEGAL AMAZON REGION OF MARANHÃO IN THE MUNICIPALITIES OF THE PINDARÉ-MA VALLEY

MONITORIZAÇÃO DAS OCORRÊNCIAS DE FOCOS DE INCÊNDIOS DA AMAZÔNIA LEGAL MARANHENSE NOS MUNICÍPIOS DO VALE DO PINDARÉ-MA

MONITOREO DE LOS INCENDIOS FORESTALES EN LA AMAZONIA LEGAL DE MARANHÃO EN LOS MUNICIPIOS DEL VALLE DEL PINDARÉ-MA



<https://doi.org/10.56238/sevened2026.008-086>

Angela Maria Corrêa Mouzinho Santos¹, Eva Dayna Felix Carneiro², Antonio Marcos Nogueira Sodré³, Ronilson Lopes Brito⁴, Franscristhiany Silva Souza⁵, Flavio Evangelista Silva⁶, Paulo Henrique Amorim Martins⁷

ABSTRACT

The Microregion of the Pindaré Valley comprises 22 municipalities and is named after one of the longest and most important rivers in Maranhão, the Pindaré River. This study aimed to analyze the occurrence of wildfires in the municipalities of the Pindaré Valley that are part of the Legal Amazon. The adopted methodology involved collecting information from the Meteorology Database - BDMEP, National Institute for Space Research - INPE, Brazilian Institute of Geography and Statistics - IBGE, Institute of Applied Economics - IPEA, Center for Weather Forecasting and Climate Studies - CPTEC for the period 2018-2022. The BDQueimadas and Environmental Information Bank (BDiA) verified that the municipalities of Santa Luzia, Buriticupu, and Bom Jardim had the highest number of fire outbreaks, due to their phytoecological characteristics and the predominance of Dense Ombrophilous Forest. Meanwhile, the municipalities of Tufilândia and Pindaré Mirim recorded the lowest number of outbreaks, reflecting a region predominantly composed of Open Ombrophilous Forest. It was

¹ Dr. in Biodiversity and Biotechnology. Instituto Federal do Maranhão (IFMA).

E-mail: angela.mouzinho@ifma.edu.br

Orcid: <https://orcid.org/0000-0001-8680-1391> Lattes: <http://lattes.cnpq.br/7311926069937014>

² Dr. in Social History of the Amazon. Instituto Federal do Maranhão (IFMA). E-mail: eva.carneiro@ifma.edu.br

Orcid: <https://orcid.org/0000-0001-8225-5717> Lattes: <http://lattes.cnpq.br/3744640013966658>

³ Master's degree in Biology Teaching. Instituto Federal do Maranhão (IFMA).

E-mail: antonio.nogueira@ifma.edu.br

Orcid: <https://orcid.org/0009-0005-0421-0616> Lattes: <http://lattes.cnpq.br/9073880966893941>

⁴ Doctoral student in Chemistry. Instituto Federal do Maranhão (IFMA). E-mail: ronilson.brito@ifma.edu.br

Orcid: <https://orcid.org/0009-0004-6327-0881> Lattes: <http://lattes.cnpq.br/2903831956104007>

⁵ Dr. in Biodiversity and Biotechnology. Universidade Federal do Maranhão (UFMA).

E-mail: frans_msc@hotmail.com

Orcid: <https://orcid.org/0000-0001-8674-1552> Lattes: <http://lattes.cnpq.br/3758234503391827>

⁶ Undergraduated student in Computer Engineering. Instituto Federal do Maranhão (IFMA)

E-mail: flavio.e@acad.ifma.edu.br Orcid: <https://orcid.org/0009-0008-1370-6826>

Lattes: <https://lattes.cnpq.br/3352524715596548>

⁷ Undergraduated in Computer Engineering. Instituto Federal do Maranhão (IFMA).

E-mail: amorimm@acad.ifma.edu.br

Orcid: <https://orcid.org/0009-0004-4549-8364> Lattes: <https://lattes.cnpq.br/9102897090850222>

observed that most municipalities engage in agropastoral activities and use fire to clear pastures due to its low cost. The analysis also revealed that the first semester has higher average rainfall and lower temperatures, whereas in the second semester the situation is reversed. Therefore, the variables temperature, rainfall, vegetation cover, and agropastoral activities may significantly influence the increase in fire outbreaks. Implementing environmental control and fire prevention measures is essential for sustainable development and the ecological balance of these communities.

Keywords: Burnings. Analysis. Legal Amazon. Pindaré Valley.

RESUMO

A Microrregião do Vale do Pindaré possui 22 municípios, este nome é dado a um dos mais extensos e importantes rios do Maranhão, o Pindaré. Este estudo teve como objetivo analisar as ocorrências de queimadas nos municípios do Vale do Pindaré que fazem parte da Amazônia Legal. A metodologia adotada, optou-se pela coleta de informações nas bases de dados: Banco de dados de Meteorologia - BDMEP, Instituto Nacional de Pesquisas Espaciais - INPE, Instituto Brasileiro de Geografia Estatística - IBGE, Instituto de Pesquisa Aplicada - IPEA, Centro de Previsão de Tempo e Estudos Climáticos - CPTEC no período de 2018-2022. Verificou-se no BDQueimadas e Banco de Informações Ambientais - BDIA que os municípios Santa Luzia, Buriticupu e Bom Jardim tiveram o maior número de focos de incêndio, devido às características fitoecológicas e a predominância de Floresta Ombrófila Densa. Já os municípios de Tufilândia e Pindaré Mirim apresentaram menores focos, exibindo uma região predominante de Floresta Ombrófila Aberta. Observou-se que a maioria dos municípios possuem atividades agropastoris e utilizam o fogo para limpar os pastos devido ao seu baixo custo. Verificou-se que no primeiro semestre há uma maior precipitação média e temperaturas médias mais baixas e no segundo semestre, isso se inverte. Portanto, as variáveis temperatura, precipitação pluviométrica, cobertura vegetal e atividades agropastoris podem influenciar significativamente no aumento de focos de incêndio. Implementar ações de controle ambiental e prevenção dos focos de incêndio é necessário para o desenvolvimento sustentável e equilíbrio ecológico dessas comunidades.

Palavras-chave: Queimadas. Análise. Amazônia Legal. Vale do Pindaré.

RESUMEN

La Microrregión del Valle del Pindaré está compuesta por 22 municipios y recibe este nombre por uno de los ríos más extensos e importantes de Maranhão, el río Pindaré. Este estudio tuvo como objetivo analizar la ocurrencia de quemas en los municipios del Valle del Pindaré que forman parte de la Amazonia Legal. La metodología adoptada consistió en la recopilación de información en las bases de datos Base de datos meteorológica (BDMEP), Instituto Nacional de Investigaciones Espaciales (INPE), Instituto Brasileño de Geografía y Estadística (IBGE), Instituto de Investigación Aplicada (IPEA), Centro de Predicción del Tiempo y Estudios Climáticos (CPTEC) en el período 2018-2022. Se verificó en la BDQueimadas y en la Base de Datos Ambientales (BDIA) que los municipios de Santa Luzia, Buriticupu y Bom Jardim presentaron el mayor número de focos de incendio, debido a sus características fitoclimáticas y a la predominancia de Bosque Ombrófilo Denso. Por otro lado, los municipios de Tufilândia y Pindaré Mirim registraron los menores focos, exhibiendo una región predominantemente de Bosque Ombrófilo Abierto. Se observó que la mayoría de los municipios desarrollan actividades agropecuarias y utilizan el fuego para limpiar los pastos debido a su bajo costo. Además, se constató que en el primer semestre ocurre una mayor precipitación media y temperaturas más bajas, mientras que en el segundo semestre esta

situación se invierte. Por lo tanto, las variables temperatura, precipitación pluvial, cobertura vegetal y actividades agropecuarias pueden influir significativamente en el aumento de los focos de incendio. Implementar acciones de control ambiental y prevención de incendios es esencial para el desarrollo sostenible y el equilibrio ecológico de estas comunidades.

Palabras clave: Quemas. Análisis. Amazonia Legal. Valle del Pindaré.

1 INTRODUCTION

One of the biggest challenges in our country is related to the population growth resulting from the accelerated process of urbanization of cities and ends up also affecting the populations of rural areas, because according to data from the Brazilian Agricultural Research Corporation - Embrapa, the areas considered urban in Brazil represent less than 1% of the national territory and concentrate 160 million people, that is, 84.3% of the Brazilian population (Faria *et al.*, 2017). This population growth, which has occurred in the last forty years, has produced significant impacts on the population and especially on the environment, reducing the quality of life and degrading natural resources.

With the population growth, several agricultural areas are being exploited for the cultivation of food products and, consequently, they are deforested and some use burning to remove the material from the site. Some fires are controlled and others are done anyway. In addition, other natural factors also cause fires due to the dry climate, and accidental ones that are caused by the population itself that disposes of waste in these environments, such as: glass, cigarette butts or flammable materials that cause fires in these places.

According to INPE (2024), in 2024, Maranhão was the 6th Brazilian state with the highest number of fire outbreaks, and in 2023 it occupied the 2nd place, due to the prolonged drought, dry grass becomes a good fuel for forest fires. The flames reach up to four meters high and advance quickly, bringing destruction to the fauna, flora and inhabitants of these places who suffer from the smoke that enters their homes, causing respiratory problems.

Vale do Pindaré has 22 municipalities with 666,083 inhabitants in an area of 36,000.996 km², and a population density of 18.6 inhabitants/km² (IBGE, 2023). The municipalities, due to their agricultural and extractive potential, suffer from land grabbing, illegal extraction of materials in these areas, expansion of agricultural and pastoral areas, invasion of Indigenous Lands (TIs) and Environmental Preservation Areas (APAs), and consequently deforestation and fires arise in these places.

In view of the facts reported about the incidence of fire outbreaks in these locations, this study aimed to analyze and evaluate the occurrences of fires in the municipalities of the Pindaré Valley that are part of the Maranhão Legal Amazon in the periods from 2018 to 2022. In addition, a survey of the occurrences of fires was carried out using the databases of INPE, IPEA, IBGE, Portal da Amazônia, BDMEP, CPTEC in the last five years. Soon after, the physical variables related to the danger of forest fires were characterized. For this, georeferencing and location tools were used, such as *Google Maps*⁸, *Ambiental Geo*⁹ and

⁸ www.google.com/maps

⁹ <https://geosgb.sgb.gov.br/>

*Forest-gis*¹⁰, to identify areas prone to fire outbreaks. Then, an evaluation and comparison of the data from the hazard maps provided by the institutional bodies was carried out.

2 THEORETICAL FRAMEWORK

Man's relationship with fire went through three distinct stages: production by man, maintenance through the use of fires, and the use of resins, so that it would not go out so easily when the lit torches were carried. Israeli archaeologists have discovered the oldest evidence of a bonfire produced 790 thousand years ago, on the banks of the Jordan River, between Israel and Jordan (FIO CRUZ, 2023). This resource has several uses such as food preparation, production of any material for industries, space heating and also in agriculture. After that, fire was necessary even in the agricultural sector, because at no cost, it would be efficient and affordable. However, the indiscriminate use and intensity of fires to open areas for agriculture has become a serious environmental problem.

Biomes, especially those most fragile in their physical, chemical and biological aspects, in recent decades have suffered from anthropic actions, which associated with natural causes, have been causing serious risks to the maintenance of the balance of the environment. Inherent to these factors, we can highlight forest fires, whose action impacts environmental systems, causing damage to the sustainability of the environment.

Forest fire is the occurrence of fire in any vegetative form without control and can be caused by several ways, both natural and also by anthropic actions. These actions can be of a criminal, accidental or unexpected nature. The main causes related are: climatic variables, combustible material characteristic of the area, relief, lightning strikes or excessive heat; arsonists; agricultural or forestry burning; hunters, fishermen and tourists; opening of roads; among others (INBRAEP, 2023). Thus, concerns regarding prevention arise, especially for those who work in front of commercial plantation projects using controlled burning and in conservation units (Nogueira *et al.*, 2002).

Controlled burning is the scientific application of fire in fuels, both in its natural state and altered under certain conditions, in such a way that it is confirmed to a predetermined area and produces the intensity of heat and the rate of propagation to favor certain management objectives, that is, controlled burning is the use of fire in a planned way to achieve a certain objective such as, for example: clearing a pasture; reduction of combustible material; improvement of habitat for fauna; control of undesirable species and reduction of the risk of fire propagation (INBRAEP, 2023).

On the other hand, the intervention in firefighting is divided into six steps, according to

¹⁰ <https://forest-gis.com/>

Tetto, Soares and Batista (2001) (apud Silva, 2021, p. 5):

1. Detection: time elapsed between the ignition or start of the fire and the moment it is seen by someone;
2. Communication: time between the detection of the fire and the receipt of information by the person responsible for the combat action;
3. Mobilization: time spent between receiving information about the existence of the fire and leaving the personnel for combat;
4. Displacement: time between the departure of the combat personnel and the arrival of the first group at the scene of the fire;
5. Planning for combat: Time spent by the person responsible for the combat to evaluate the behavior of the fire and plan the combat strategy;
6. Firefighting: time consumed in the operation of fighting or definitively eliminating the fire, including the aftermath.

Following the steps for a good intervention in fighting fires in forest areas, it would have much less damage to the environment. In Maranhão, it was observed that the territorial extension of the Maranhão Legal Amazon increased in 2021, and included several municipalities in Maranhão, totaling an area of 5,015,067.86 km², corresponding to about 58.93% of the Brazilian territory, and 56% of the Brazilian indigenous population resides in it (IBGE, 2021).

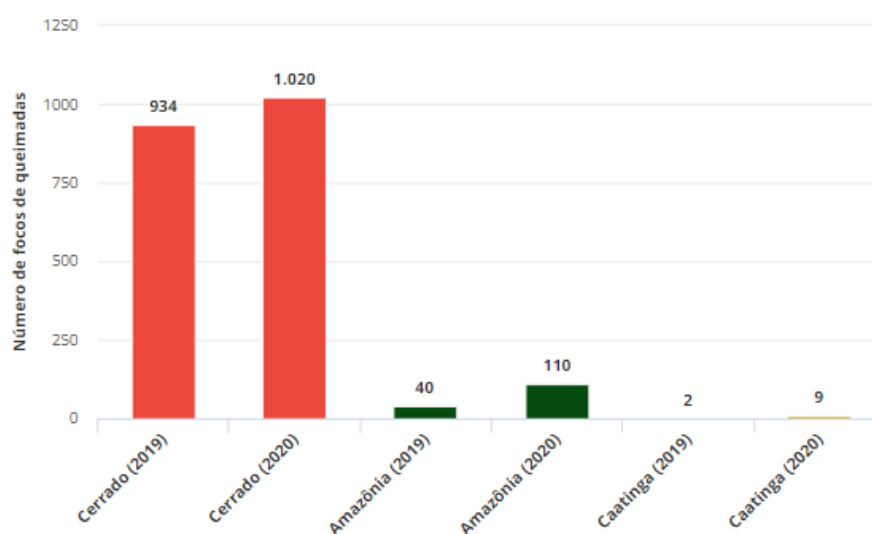
The concept of the Legal Amazon was instituted in 1953 and its territorial limits derive from the need to plan the economic development of the region and, therefore, are not limited to the humid jungle ecosystem, which occupies 49% of the national territory and also extends over the territory of eight neighboring countries. The boundaries of the Legal Amazon have been altered several times as a result of changes in the country's political division, and the Sustainable Amazon Plan (PAS) was launched by the federal government, which fully considers the State of Maranhão as part of the Brazilian Amazon (IPEA, 2008). But according to the census carried out by the IBGE in 2021, Maranhão is the state with the largest number of municipalities belonging to the Legal Amazon with 181 of the 217, that is, 79.3% of its territory (IBGE, 2021).

With the increase in the extension of the Legal Amazon in Maranhão, public agencies must intensify the provision of projects to reduce the environmental impacts in these areas. Because most of these areas have natural resources in abundance, and the mismanagement of these resources can bring several damages to the environment, such as deforestation, invasion of indigenous and quilombola areas, advance of agriculture and fires.

In 2020, the region most affected by fires was the south of Maranhão, where the agricultural sector predominates. But it is clear that other municipalities that make up the legal Amazon of Maranhão also suffer from forest fires, there was an increase from 40 outbreaks in 2019 to 110 outbreaks in 2020 (INPE, 2023), in addition to natural factors, anthropic actions also favor this increase, such as: the expansion of farming, livestock, real estate, further aggravating the environment (Figure 1).

Figure 1

Fire outbreaks between March 20 and July 1, 2020



Source: INPE, 2023.

To prevent and combat fire outbreaks in these areas, technologies can represent an advance in reducing these incidents. And also the information by teams trained in passing on to small, medium and large farmers the good ways to do controlled burning, because many of these farmers do not know the technique and end up causing large fires.

Assis and his collaborators (2014) presented in their article that geotechnologies are an important resource in assisting in the detection of fires, locating the foci and quantifying and analyzing the areas where fires occur. Therefore, with the great advancement of science in technology, especially in aerospace knowledge and georeferencing. Meanwhile, Tomzhinski, Coura and Couto (2011), portrays several ways that these technologies can be exploited to detect these fire outbreaks, such as terrestrial surveillance, observation post or satellite image monitoring.

When fires are provoked, they generate impacts on the environment and provide penalties to offenders. The Environmental Crimes Law, Law No. 9,605, of February 12, 1998, establishes penalties for damages caused by forest fires (Brasil, 1998), states that:

Article 41 – Causing a fire in a forest or forest: Penalty – imprisonment, from two to four years, and a fine. Sole Paragraph. If the crime is culpable, the penalty is imprisonment from six months to one year, and a fine.

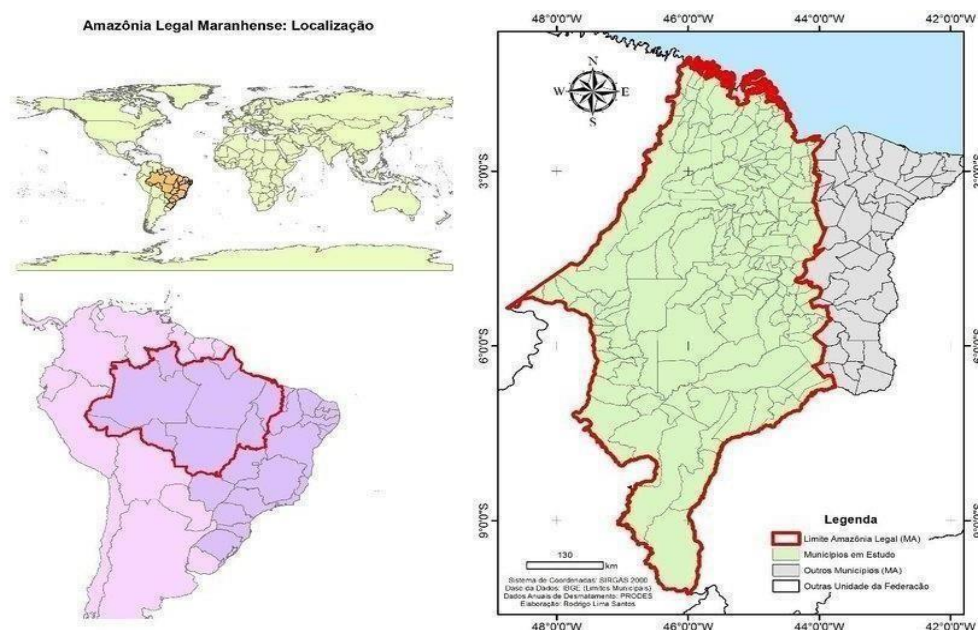
In addition to the Environmental Crimes Law, the Brazilian penal code also determines in article 250 "that causing fire, exposing the life, physical integrity or property of others to danger is considered a crime of common danger, with a penalty - imprisonment, from 03 to 06 years, and a fine. In item II of paragraph 1, it requires an increase in the penalty by one third if the fire is in a crop, pasture, forest or forest" (Brasil, 1940).

3 METHODOLOGY

The study area is the Microregion of Vale do Pindaré, which is part of the Legal Amazon of Maranhão. In 2017, as shown in Figure 2, there were 170 cities, and currently 11 more have been incorporated, totaling 181 municipalities that are part of this region (IBGE, 2023). The Pindaré Planning Region is one of the 32 administrative regions of the State of Maranhão, Brazil, being the largest in number of municipalities and one of the largest in territorial extension. Despite this, it is the twentieth most densely populated and takes its name from one of the most extensive and important rivers in Maranhão, the Pindaré (SEPLAN, 2008).

Figure 2

Location Map of the Legal Amazon of Maranhão, with emphasis on its 170 municipalities



Source: Santos; Nunes, 2017.

Initially, a descriptive search was carried out in the main databases on fires in the Brazilian Legal Amazon with a focus on the Maranhão region based on bibliographic fearology found in books, articles, monographs, dissertations, theses and journals in the databases of Capes Journals, *Scielo*, *Google Scholar*, *Web of Science*. And in the specific magazines, the following terms were used: "burning", "fire", "legal Amazon", "Maranhão biomes", "deforestation". However, the following exclusion criteria were established: publications from annals of events, conferences, duplicate studies and that do not adequately relate to the objective of the study in relation to its contribution.

To evaluate and analyze the fire outbreaks in the region, a qualitative and quantitative exploratory research was carried out based on the Meteorological Database of Education and Research, National Institute of Meteorology (INMET), Fire Database of the Post of Weather Forecasts and Climate Studies, National Institute of Space Research, Brazilian Institute of Statistical Geography of Brazil, Institute for Applied Economic Research and in the Amazon Portal, in the form of a *shapefile* (common vector file format used by Geographic Information Systems - GIS, containing geospatial data) in the period from 2018 to 2022, the number of fire outbreaks, month of occurrence, annual distribution of fires, causes of occurrences were analyzed. The physical variables of forest fire danger in the Pindaré Valley region were collected: Land use and vegetation cover using images from the ResourceSat satellite, "LIS3" sensor, Polar Heliosynchronous orbit; Rainfall, Temperature. For the analysis of the data on hot spots, satellite images provided by the INPE website were studied.

The collected data were evaluated through descriptive statistical analysis in a spreadsheet of the Microsoft Office program EXCEL 2013, and the procedure of interpretation of the information began.

4 RESULTS AND DISCUSSIONS

According to the Humanitas Unisinos Institute (2023), ¹¹in Maranhão, there was an increase of almost 22% from 2021 to 2022, with more than 3 thousand outbreaks reported last year. During the month of December alone, 617 fire outbreaks were recorded.

From the analysis of the results collected in INPE's Fire Database (2023), it was found that among the Municipalities of the Pindaré Valley that are part of the Legal Amazon: Santa Luzia, Buriticupu and Bom Jardim had the highest numbers of fire outbreaks between the years 2018 and 2022. As shown in Table 1.

¹¹ <https://ihu.unisinos.br/categorias/>

Table 1

Annual fire outbreaks in the Municipalities of the Pindaré Valley that are part of the legal Amazon of Maranhão

Municipalities	2018	2019	2020	2021	2022
Altamira do Maranhão	399	725	693	239	531
Alto Alegre do Pindaré	884	2008	1738	1326	1953
Bom Jardim	2070	5305	5614	3876	6849
Bom Jesus das Selvas	1650	3583	3027	1914	4501
Sand Swamp	750	1881	925	1169	1683
Buriticupu	2956	4247	4344	6548	6039
Governor Newton Bello	372	754	1008	400	606
Lagoa Grande do Maranhão	1085	1417	371	1389	2121
Stone Lake	1205	2025	1428	1500	1774
Maharaja of the Seine	1872	3451	1950	2457	4249
Nova Olinda do Maranhão	230	561	1617	396	609
Pindaré-Mirim	64	164	260	121	215
President Médici	222	600	414	321	387
Saint Agnes	234	410	718	316	324
Santa Luzia	3945	6648	4101	5011	7634
Santa Luzia do Paruá	287	723	483	234	445
São João do Carú	347	727	711	304	512
Tufilândia	121	157	240	128	148
Vitorino Freire	303	1138	862	503	911
Zé Doca	434	1748	2302	1136	2064

Source: INPE, 2023.

The city of Santa Luzia leads the ranking with a total of 27,339 fire outbreaks, Buriticupu with 24,134 and Bom Jardim with 23,714. The three municipalities together correspond to 43.82% of the outbreaks of all 22 municipalities that are part of the legal Amazon in the Pindaré Valley, with a total of 171,548 fire outbreaks in the five-year period (2018-2022). The average number of fires per km² was calculated and it was observed that the municipality of Buriticupu had the highest average value, with 9.48 fires/km², Santa Luzia with 5.65 fires/km² and Bom Jardim with 3.60 fires/km². In addition, it was noted that the incidence of hot spots increases considerably from the month of July, peaking in October, as shown in Figure 3.

Figure 3

Monthly fires accumulated in the period 2018-2022



Source: INPE, 2023.

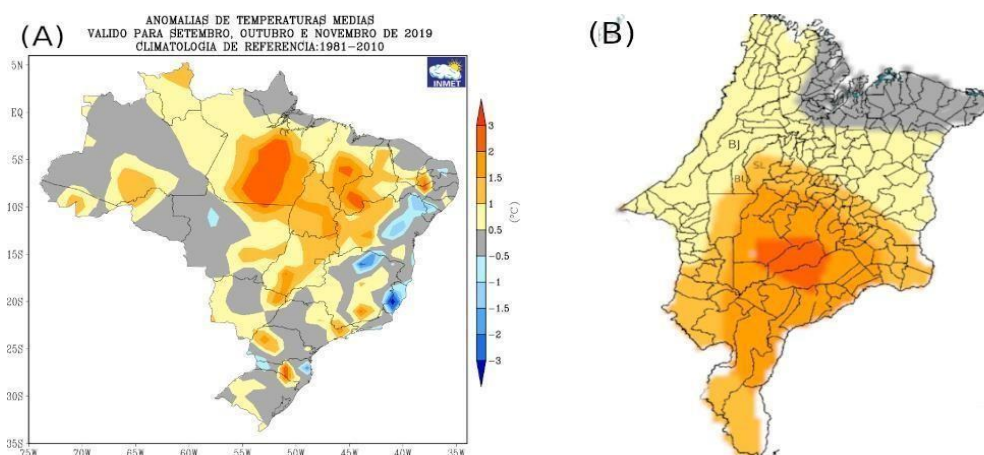
According to the Action Plan for the Prevention and Control of Deforestation and Fires in the State of Maranhão - PPCD/MA (2011), in the Maranhão Legal Amazon, deforestation is linked to illicit activities and/or unsustainable practices from primary economic sectors (livestock, agriculture, plant extractivism and mining) and secondary economic sectors (steel, timber, civil construction and others).

As shown in Figure 4, the monthly maps of mean temperature anomalies from the INMET Temperature Monitoring database were analyzed. It was noticed that during these five years, the average temperature is considerably higher in the second semester (in the months of August to December) in all municipalities of the Pindaré Valley. The climate of the region, according to the Köppen classification (Köppen; Geiger, 1928), is of the Af type (humid tropical) with a rainy summer and dry winter, with an average rainfall of at least 60 mm in each month. Average annual temperatures are above 22 °C and the average for the coldest month is above 18 °C.

According to the studies by Corrêa et al. (2023) on the Köppen classification, they updated the climate classification and climatological water balance in the State of Maranhão, where the Tropical Climate obtained the following characteristics: Megathermal climates, average annual temperature in the coldest month, with 18 °C; Absent winter season, with higher annual precipitation and evapotranspiration in the tropical climate. In code "f" with humid climate, precipitation occurs in all months of the year, inexistence of a defined dry season and precipitation in the driest month with more than 60 mm and rainfall in autumn and winter, with dry summer.

Figure 4

(A) Average temperature anomalies for the months of September, October and November 2019 in Brazil. (B) Cut of Maranhão with overlapping of the municipal grid of Maranhão (approximate)

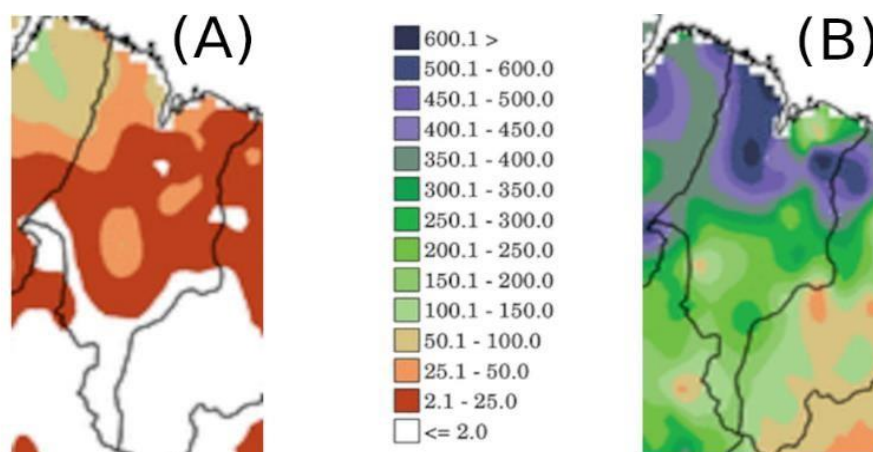


Source: INMET, 2024.

Therefore, the second half of the year is warmer and is characterized by little rain and strong winds that contribute to fire outbreaks turning into fires and burnings. It was also observed that the dry grass and the amount of winds that occur during this period, the flames can reach up to four meters in height and advance quickly, bringing destruction to the biome of this place. The population is more vulnerable to fires due to the increase in respiratory problems that increase in the same period. The data analyzed from CPTEC (2024) on the rainfall maps in Brazil, it was noticed that the months of December to May have on average considerably higher rainfall when compared to the other six months of the year from June to November, and this pattern is repeated during the five years analyzed. As shown in Figure 5.

Figure 5

(A) Rainfall in August/2022, (B) Rainfall in March/2022

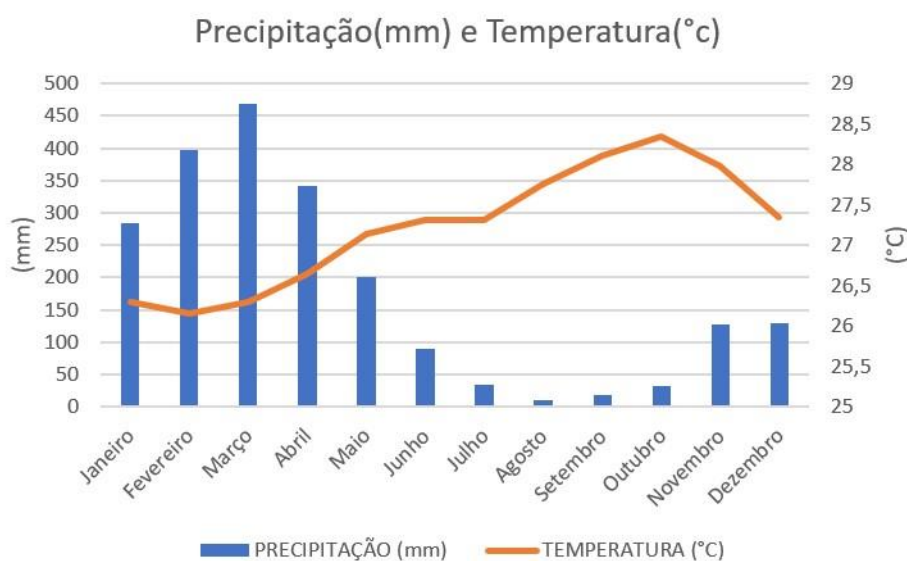


Source: CPTEC, 2024.

The months with the highest rainfall, mentioned above, are also the months with low temperature and low numbers of fire outbreaks, in addition, it was observed that the month of March concentrates the highest average rainfall and October the highest average temperature. It can be corroborated by the collection of climatological data from the only conventional station in the Pindaré Valley, station ZE DOCA - World Meteorological Organization Code - WMO:82376 (INMET, 2024) as shown in Figure 6.

Figure 6

Rainfall and average monthly temperatures in the period 2018-2022



Source: INMET, 2024.

In addition, it is important to highlight that Silva et al. (2016) analyzed in their work:

Regarding temperature, the behavior is homogeneous, that is, all stations recorded the upward trend, in an intense and statistically significant way. Regarding precipitation, the Zé Doca station in the Amazon biome and the Carolina station in the Cerrado biome showed downward trends in precipitation in the dry season.

The dry period in the Amazon region and in the adjacent Cerrado region is usually related to El Niño events and/or warmer than normal sea surface temperatures in the Tropical North Atlantic. These ocean temperature increases favor the occurrence of anomalous regional water deficits, warmer temperatures, and intense fire seasons. This was the case of the exceptional droughts in the Amazon in 2005, 2010, 2015, 2016 (Aragão *et al.*, 2007) and in the Pantanal 2019–2020 (Jimeinez *et al.*, 2021).

According to Marengo *et al.* (2022), the long-term trends of air temperature and evaporation variables show that dry conditions have intensified during the last two decades,

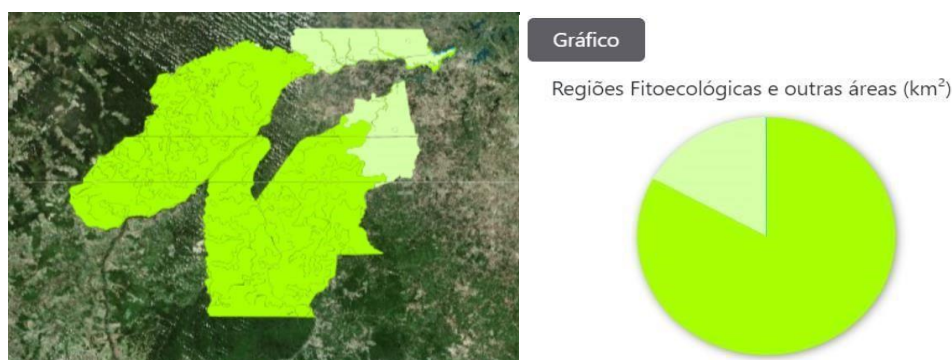
suggesting increased water stress in vegetation. The dry and dry-wet seasons in the eastern Maranhão Amazon are becoming increasingly longer, hotter, and drier.

Since 1992, the IBGE has estimated the extent of vegetation types in Brazil, classified into phytocological regions and vegetation areas. Then, the type of vegetation present in the Pindaré Valley was verified in the Environmental Database and Information of this agency. Phytocological regions are defined by a floristic of typical genera and characteristic biological forms that are repeated within the same climate, and may occur in terrains of varied lithology, but with well-marked relief.

The municipalities with the highest number of fire outbreaks were Santa Luzia, Buriticupu and Bom Jardim, and these are mostly composed of Dense Ombrophilous Forest of moss green and part of light green (Figure 7).

Figure 7

Phytocological regions in the municipalities with the highest number of fire outbreaks: Santa Luzia, Buriticupu and Bom Jardim



Source: IBGE, 2023.

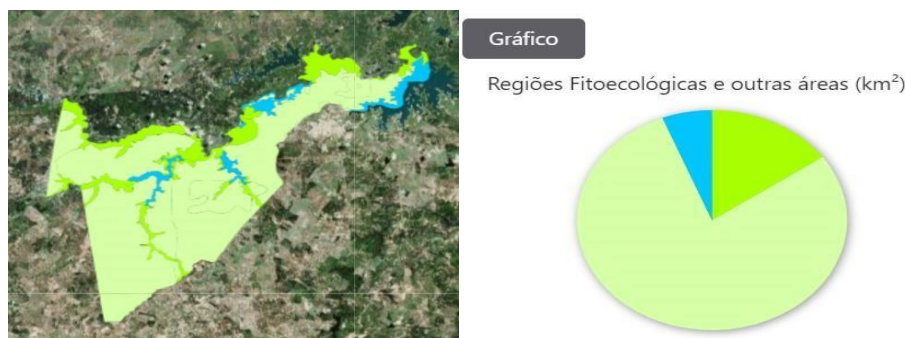
The phytocological region is basically composed of macro and mesophanerophytes, as well as lianas and epiphytes, characterized by a thermal shoulder climate, with practically no biologically dry period, with rainfall above 2,300 mm and average annual temperatures between 22 °C and 25° C in the north of the country (IBGE, 2023). This type of dense and closed forest provides a milder microclimate, and the fuels have a higher and more stable content than a forest with little vegetation and open.

When fires occur in these forests, some conditions prevent the detection of fires, such as fire only on the ground in this type of dense vegetation, without affecting the tree canopy. However, these characteristics do not favor the high number of outbreaks presented by the municipalities, possibly other factors may be related to the increase in the number of fire outbreaks, such as logging, agricultural and real estate activities that occur in these regions.

On the other hand, the municipalities with the lowest fire outbreaks, Tufilândia and Pindaré Mirim, are mostly made up of open ombrophilous forest (Figure 8) of light green color and a much smaller part of dense ombrophilous forest of moss green color and some rivers present in this region, especially the Pindaré River.

Figure 8

Phytoecological regions in the municipalities with the lowest number of fire outbreaks: Tufilândia and Pindaré Mirim



Source: IBGE, 2023.

The phytoecological region located in the ombrophilous climate range, however, presenting a short dry period, of two to three months, and dominance of biological forms of rosulate phanerophytes and woody lianas (IBGE, 2023). These characteristics of the type of forest and vegetation areas are more favorable to the increase of fire outbreaks in the region, but in practice they are not observed. However, these two municipalities also have a significant part of the water body, which is a possible variable that favors the low number of fire outbreaks, compared to the other municipalities in Maranhão.

In addition, agropastoral activities may have contributed to the high numbers of fire outbreaks, in 2020, data from Municipal Livestock show a growth in the main herds in these 5 municipalities: Santa Luzia, Buriticupu, Bom Jardim, Tufilândia and Pindaré Mirim (IBGE, 2023). As shown in Table 2.

It was observed that the municipalities of Bom Jardim, Buriticupu and Santa Luzia, which have the highest number of fire outbreaks, have as their main herd the raising of cattle, animals that need pastures to be fed. Considering that "In agriculture, fire is used to clean and regrow pastures and combat pests and diseases" (Manual for the Prevention and Control of Fires in the State of Maranhão, 2020). Therefore, the creation of this type of herd can have a direct or indirect influence on the high number of fire outbreaks in these municipalities, due to the possible type of cleaning that is carried out in a pasture, usually using fire, due to its low cost.

Table 2

Herd Number

Municipalities	Variable - Effect of herds (head) in 2020								
	Herd Type								
	Beef	Buffalo	Equine	Total pig	Swine - swine breeders	Goat	Sheep	Chickens - total	Chickens - chickens
Bom Jardim	159123	821	2567	2527	790	3321	2455	23578	6550
Buriticupu	143789	118	998	2600	788	1200	1087	32457	8500
Pindaré Mirim	14586	-	439	631	201	237	409	740031	1550
Santa Luzia	249087	121	3345	2412	654	2786	3022	32456	12367
Tufilândia	17240	-	274	589	146	377	237	3786	800

Source: Adapted from IBGE data - Municipal Livestock Survey, 2023.

In addition, in Maranhão it is still quite common to use burning in the preparation of the land for small plantations that contribute to the increase of particulate matter released into the atmosphere. The effects of this particulate emitted by fires on human health mainly affect the elderly and children. However, it is clear that the dry season favors the increase in fire outbreaks in the state. The second half of the year corresponds to the dry season in Maranhão, with negative impacts such as devastation of existing flora, extinction of animals, respiratory complications in the health of residents, toxic gases that can increase the temperature of the greenhouse effect.

According to Marengo *et al.* (2022) studied the consequences of agricultural expansion in the Eastern Amazon-Cerrado transition zone and evidenced the increase in temperature, vapor pressure deficit, subsidence, frequency of dry days, and decrease in precipitation, humidity, and evaporation, in addition to a delay in the onset of the rainy season, inducing a greater risk of fire during the dry-to-rainy transition season.

Bezerra *et al.* (2018, p. 6) highlight that,

The main socio-environmental impacts arising from prolonged drought events in Maranhão can be summarized as difficulty in accessing water, losses in agricultural activities, loss of material goods, risk to human life and potential damage to biodiversity in Maranhão's biomes and ecosystems (due to the action of fires).

An impact of drought events that deserves to be highlighted in the territory of Maranhão are fires, since these can be modulated by events of droughts and/or prolonged droughts in Maranhão, as well as a consequence of anthropogenic forms of land use and cover (IMESC, 2017).

According to Zalles *et al.* (2021) portrays that "humans have markedly altered environments through the conversion of natural vegetation pastures, crops, and other land

uses, as well as the degradation of natural vegetation through logging, fire, and other types of disturbance."

Thus, it is perceived that "forest fires are one of the most degrading forms of tropical forests due to the predominance of agropastoral activities, where they still use fire to clean these areas, causing an increase in flammability in these places for the practice of intensive logging, fragmentation and climate change" (Barlow *et al.*, 2012).

Therefore, prevention actions are needed together with public agencies and the population in order to minimize and combat fire outbreaks in the Pindaré Microregion.

5 CONCLUSION

According to the survey carried out in the databases of INPE, INMET and IBGE, it was observed that the municipalities that are part of the Maranhão Legal Amazon belonging to the Pindaré Microregion, the cities of Bom Jardim, Buriticupu and Santa Luzia stand out with the highest number of fire outbreaks and Tufilândia and Pindaré Mirim with the lowest numbers.

From the data collected on the increase in fire outbreaks in the municipalities of the Pindaré Valley, some factors were listed that may supposedly be related: logging, farming, real estate activities, and perhaps the lack of training and misinformation of farmers when they use burning to clean these places.

Other important factors that can significantly influence the number of fire outbreaks are the variables: average temperature (in the hottest and driest period in the region), rainfall (scarcity of rainfall) and phytoecological regions (types of vegetation cover). It was found mainly in regions that predominate the Dense Ombrophilous Forest tend to have greater fire outbreaks.

The increases in the number of fire outbreaks can bring environmental damage to the flora, fauna and population that reside in these locations. With the increase in respiratory problems caused by the smoke that mainly affects the elderly and children. Promote actions and/or recommendations for the prevention and combat of fires and try to sensitize the authorities and the population about the importance of preserving the environment.

In addition, the promotion of specific awareness campaigns for local communities on safe practices and fire prevention could reduce the number of fires in these locations. Promote sustainable agricultural practices that reduce reliance on fires, such as using cultivation techniques that do not involve burning vegetation. And also establish and maintain firefighting bases in strategic areas, especially in the municipalities with the largest fire outbreaks Santa Luzia, Bom Jardim and Buriticupu.

REFERENCES

- Aragão, L. E. O. C., Malhi, Y., Roman-Cuesta, R. M., Saatchi, S., Anderson, L. O., & Shimabukuro, Y. E. (2007). Spatial patterns and fire response of recent Amazonian droughts. *Geophysical Research Letters*, 34(7), Article L07701. <https://doi.org/10.1029/2006GL028946>
- Assis, V., Mendonça, C., Silva, R., & Lima, R. (2014). Uso de geotecnologias na locação espacial de torres para detecção de incêndios florestais no semiárido nordestino. *Floresta*, 44(1), 133–142.
- Barlow, J., Parry, L., Gardner, T. A., Ferreira, J., Aragão, L. E. O. C., Camargo, P. B., Lees, A. C., Lennox, G. D., Berenguer, E., & Zuanon, J. (2012). The critical importance of considering fire in REDD+ programs. *Biological Conservation*, 154, 1–8. <https://doi.org/10.1016/j.biocon.2012.03.034>
- Bezerra, D. S., et al. (2018). Análise dos focos de queimadas e seus impactos no Maranhão durante eventos de estiagem no período de 1988 a 2016. *Revista Brasileira de Climatologia*, 22.
- Brasil. (1940). Decreto-Lei nº 2.848, de 7 de dezembro de 1940. Código Penal. Diário Oficial da União.
- Brasil. (1998). Lei nº 9.605, de 12 de fevereiro de 1998. Dispõe sobre as sanções penais e administrativas derivadas de condutas e atividades lesivas ao meio ambiente, e dá outras providências. http://www.planalto.gov.br/ccivil_03/leis/L9605.htm
- Centro de Previsão de Tempo e Estudos Climáticos. (n.d.). CPTEC. Instituto Nacional de Pesquisas Espaciais. <https://www.cptec.inpe.br/>
- Corrêa, A. C. B., et al. (2023). Update of the climate classification and climate water balance in the state of Maranhão. *Revista Brasileira de Climatologia*, 32.
- Farias, A. R., et al. (2017). Identificação, mapeamento e quantificação das áreas urbanas do Brasil [Comunicado Técnico]. Embrapa. https://geoinfo.cnpem.embrapa.br/layers/geonode%3Aareas_urbanas_br_15
- Instituto Brasileiro de Geografia e Estatística. (1992). Manual técnico da vegetação brasileira.
- Instituto Brasileiro de Geografia e Estatística. (2022). Coleta de pesquisa dos Estados. <http://www.ibge.gov.br/estadosat/perfil.php?sigla=pb>
- Instituto Brasileiro de Geografia e Estatística. (2023). Coleta de pesquisa dos Estados. <https://www.ibge.gov.br/>
- Instituto Maranhense de Estudos Socioeconômicos e Cartográficos. (2017). Relatório: Queimadas maranhenses – 1º trimestre 2017 [Relatório Técnico].
- Instituto Nacional de Meteorologia. (n.d.). Normais climatológicas. <https://portal.inmet.gov.br/>
- Instituto Nacional de Pesquisas Espaciais. (2023). Queimadas. <https://queimadas.dgi.inpe.br/queimadas/portal>
- Instituto Nacional de Pesquisas Espaciais. (2024). Queimadas. <http://terrabrasilis.dpi.inpe.br/queimadas/bdqueimadas/>
- Instituto Brasileiro de Ensino Profissionalizante. (2021). Incêndio florestal e queimada controlada. <https://inbraep.com.br/publicacoes/incendio-florestal-e-queimada-controlada/>

- Jimenez, J. C., et al. (2021). O papel dos sabores ENSO e TNA em secas recentes nas florestas amazônicas e na região Nordeste do Brasil. *International Journal of Climatology*, 41(7), 3761–3780.
- Köppen, W., & Geiger, R. (1928). *Klimate der Erde*. Verlag Justus Perthes.
- Maranhão. Secretaria de Estado do Planejamento e Orçamento. (2008). *Regiões de Planejamento do Estado do Maranhão*.
- Marengo, J. A., et al. (2022). Increased climate pressure on the agricultural frontier in the Eastern Amazonia–Cerrado transition zone. *Scientific Reports*, 12, Article 457. <https://doi.org/10.1038/s41598-021-04241-4>
- Maranhão. Secretaria de Estado do Meio Ambiente e Recursos Naturais. (2020). *Manual de prevenção e controle de queimadas no Estado do Maranhão*.
- Nogueira, G. S., et al. (2002). Escolha de locais para instalação de torres de detecção de incêndio com auxílio do SIG. *Revista da Sociedade de Investigações Florestais*, 26(3), 363–369.
- O homem e o fogo. (2023). In Vivo Museu da Vida. <http://www.invivo.fiocruz.br/cienciaetecnologia/o-homem-e-o-fogo>
- O que é? Amazônia Legal. (2008). Instituto de Pesquisa Econômica Aplicada. *Desafios* (Edição 44, ano 5). <https://www.ipea.gov.br/desafios>
- Plano de Ação para Prevenção e Controle do Desmatamento e das Queimadas no Estado do Maranhão. (2011). Decreto nº 27.317, de 14 de abril de 2011. Governo do Estado do Maranhão. https://www.fundoamazonia.gov.br/Plano_Estadual_Maranhao.pdf
- Santos, R. L., & Nunes, F. G. (2017). Análise espacial de taxas de desmatamento na Amazônia Legal Maranhense: Espacialização e diagnóstico do PPCD-MA. In *Anais do XVIII Simpósio Brasileiro de Sensoriamento Remoto – SBSR* (pp. ?). Instituto Nacional de Pesquisas Espaciais.
- Silva, F. J. N. (2021). Análise de ocorrências de incêndios na Floresta Nacional de Carajás entre 2013 a 2018 [Monografia de especialização, Instituto Federal do Maranhão].
- Silva, F. B., et al. (2016). Evidências de mudanças climáticas na região de transição Amazônia-Cerrado no Estado do Maranhão. *Revista Brasileira de Meteorologia*, 31(3), 330–346.
- Tetto, A., Batista, A. C., & Soares, R. V. (2011). *Prevenção e combate aos incêndios florestais*. Coleção SENAR.
- Tomzhinski, G. W., Coura, P. H. F., & Couto, M. do. (2011). Avaliação da detecção de focos de calor por sensoriamento remoto para o Parque Nacional de Itatiaia. *Biodiversidade Brasileira*, 1(2).
- Zalles, V., et al. (2021). Rapid expansion of human impact on natural land in South America since 1985. *Science Advances*, 7(14), Article eabg1620. <https://doi.org/10.1126/sciadv.abg1620>

THE SEARCH OF BRAZILIANS FOR INFORMAL WORK: TRANSFORMATIONS IN THE WORLD OF WORK AND SURVIVAL STRATEGIES

A BUSCA DOS BRASILEIROS PELO TRABALHO INFORMAL: TRANSFORMAÇÕES NO MUNDO DO TRABALHO E ESTRATÉGIAS DE SOBREVIVÊNCIA

LA BÚSQUEDA DE LOS BRASILEÑOS POR EL TRABAJO INFORMAL: TRANSFORMACIONES EN EL MUNDO DEL TRABAJO Y ESTRATEGIAS DE SUPERVIVENCIA



<https://doi.org/10.56238/sevened2026.008-087>

Jadson Justi¹, Marilac Magela dos Santos²

ABSTRACT

Informal work constitutes a structural phenomenon of the Brazilian economy, characterized by the absence of formal ties, limited social protection, and frequently precarious working conditions. Economic, technological, and political transformations have reconfigured the labor market, expanding informality and creating new modalities of labor insertion that challenge traditional categories. This study analyzes Brazilians' search for informal work, examining transformations in the world of work and survival strategies developed by workers. The methodology is characterized as an exploratory bibliographic review with a qualitative approach, based on critical analysis of scientific publications between 2020 and 2025. The results show that informal workers develop creative survival strategies, mobilizing social networks and diversifying activities, but face vulnerabilities related to the absence of social protection and income instability. The COVID-19 pandemic amplified vulnerabilities and revealed gaps in social protection systems. It is concluded that reducing informality requires structural transformations that expand educational opportunities, reduce inequalities, and promote inclusive economic development, transcending mere formalization policies.

Keywords: Informal Work. Labor Precariousness. Survival Strategies. Labor Market.

RESUMO

O trabalho informal constitui fenômeno estrutural da economia brasileira, caracterizado pela ausência de vínculos formais, proteção social limitada e condições laborais frequentemente precárias. Transformações econômicas, tecnológicas e políticas reconfiguraram o mercado de trabalho, ampliando a informalidade e criando novas modalidades de inserção laboral que desafiam categorias tradicionais. Este estudo analisa a busca dos brasileiros pelo trabalho informal, examinando transformações no mundo do trabalho e estratégias de sobrevivência desenvolvidas por trabalhadores. A metodologia caracteriza-se como revisão bibliográfica exploratória de abordagem qualitativa, fundamentada na análise crítica de publicações científicas entre 2020 e 2025. Os resultados evidenciam que trabalhadores informais

¹ Dr. in Psychology. Orcid: <https://orcid.org/0000-0003-4280-8502>

² Master's student in Accounting and Administration. Fucape Business School Belo Horizonte FUCAPE(BH). Minas Gerais, Brazil. Lattes: <http://lattes.cnpq.br/8157330397567927>

desenvolvem estratégias criativas de sobrevivência, mobilizando redes sociais e diversificando atividades, mas enfrentam vulnerabilidades relacionadas à ausência de proteção social e instabilidade de renda. A pandemia de COVID-19 amplificou vulnerabilidades e revelou lacunas nos sistemas de proteção social. Conclui-se que a redução da informalidade demanda transformações estruturais que ampliem oportunidades educacionais, reduzam desigualdades e promovam desenvolvimento econômico inclusivo, transcendendo políticas de mera formalização.

Palavras-chave: Trabalho Informal. Precarização Laboral. Estratégias de Sobrevivência. Mercado de Trabalho.

RESUMEN

El trabajo informal constituye un fenómeno estructural de la economía brasileña, caracterizado por la ausencia de vínculos laborales formales, una protección social limitada y condiciones de trabajo frecuentemente precarias. Las transformaciones económicas, tecnológicas y políticas han reconfigurado el mercado laboral, ampliando la informalidad y creando nuevas modalidades de inserción laboral que desafían las categorías tradicionales. Este estudio analiza la búsqueda de los brasileños por el trabajo informal, examinando las transformaciones en el mundo del trabajo y las estrategias de supervivencia desarrolladas por los trabajadores. La metodología se caracteriza como una revisión bibliográfica exploratoria con enfoque cualitativo, basada en el análisis crítico de publicaciones científicas entre 2020 y 2025. Los resultados evidencian que los trabajadores informales desarrollan estrategias creativas de supervivencia, movilizandore redes sociales y diversificando actividades, pero enfrentan vulnerabilidades relacionadas con la ausencia de protección social y la inestabilidad de ingresos. La pandemia de COVID-19 amplificó estas vulnerabilidades y reveló brechas en los sistemas de protección social. Se concluye que la reducción de la informalidad requiere transformaciones estructurales que amplíen las oportunidades educativas, reduzcan las desigualdades y promuevan un desarrollo económico inclusivo, trascendiendo las políticas de mera formalización.

Palabras clave: Trabajo Informal. Precarización Laboral. Estrategias de Supervivencia. Mercado Laboral.

1 INTRODUCTION

Informal work is a structural phenomenon of the Brazilian economy, characterized by the absence of formal bonds, limited social protection, and often precarious working conditions. In recent decades, economic, technological, and political transformations have reconfigured the Brazilian labor market, expanding informality and creating new modalities of labor insertion that challenge traditional categories of employment and unemployment. The search for informal work does not only represent a temporary survival strategy in the face of unemployment, but also constitutes a work trajectory that involves choices, structural constraints and creative adaptations to adverse conditions. Understanding the motivations, experiences, and meanings attributed to informal work by Brazilians becomes fundamental for the formulation of public policies that promote decent work, social protection, and economic inclusion.

The entrepreneurial motivations of individuals in situations of social vulnerability reveal the complexity of informal work trajectories. Albuquerque *et al.* (2021, p. 5) question "what to do when the bars open?" revealing that entrepreneurial motivations and individual beliefs of former inmates reflect strategies for social reintegration through informal work", evidencing how informal entrepreneurship can represent an alternative for populations excluded from the formal market. The stigmatization, discrimination, and institutional barriers faced by ex-prisoners limit their opportunities for formal employment, directing them to informal activities that, although precarious, offer autonomy and the possibility of reconstructing social identities. The analysis of the informal work trajectories of marginalized groups allows us to understand how structural inequalities are reproduced through the labor market.

The segmentation of labor markets and public investments in human capital are structural dimensions that influence the dynamics between formality and informality. Buffie *et al.* (2022, p. 165) argue that "public investments and human capital in segmented labor markets produce differentiated effects on formal and informal employment, requiring integrated policies," underlining the need for approaches that consider the specificities of dualized labor markets. In Brazil, the coexistence of modern formal segments and traditional informal segments characterizes a heterogeneous labor market, where transitions between formality and informality are frequent and bidirectional. Professional qualification policies and investments in education can expand opportunities for formal insertion, but their effectiveness depends on the economy's ability to generate quality jobs.

The digital platform economy represents a contemporary modality of informal work that combines elements of autonomy and subordination, flexibility and precariousness. Duarte *et*

al. (2023, p. 2) report that "the seven days in which I was a driver of private urban mobility transport by mobile application revealed working conditions marked by long hours, unstable incomes, and absence of social protection", evidencing the contradictions of platform-mediated work. App drivers, delivery workers, and digital service providers constitute a new category of informal workers who, although they use advanced technologies, face working conditions that refer to historical forms of precariousness. The regulation of work on digital platforms is a contemporary challenge that demands a balance between flexibility, social protection and sustainability of business models.

The general objective of this study is to analyze the search of Brazilians for informal work, examining transformations in the world of work and survival strategies developed by informal workers. Specifically, it is intended to: (i) review the main transformations in the Brazilian labor market that have increased informality; (ii) to examine motivations, experiences and meanings attributed to informal work by different social groups; (iii) assess the working conditions and challenges faced by informal workers; (iv) to identify public policies and collective strategies to confront job insecurity. The relevance of this work lies in the need to understand informality not as a deviation or anomaly, but as a structural dimension of Brazilian capitalism, which demands political responses that transcend mere formalization and promote decent work for all.

This article is structured into five main sections. After this introduction, the theoretical framework presents the conceptual foundations of informal work, discussing theories about segmentation of labor markets, precariousness and survival strategies. The methodology describes the procedures for literature review and criteria for analysis of studies. The results and discussion integrate evidence on informality in Brazil, analyzing recent transformations, profiles of informal workers and working conditions. The final considerations summarize the contributions of the study, point out limitations and suggest perspectives for future research and for the formulation of public policies on labor and social protection.

2 THEORETICAL FOUNDATION

Informal work comprises economic activities carried out outside of state regulation, characterized by the absence of formal registration, limited social protection and often precarious working conditions. Informality is not a homogeneous phenomenon, ranging from self-employed workers in subsistence activities to informal entrepreneurs with high incomes, as well as salaried workers without a formal contract and unpaid family workers. The heterogeneity of informality demands analytical approaches that recognize its multiple dimensions and avoid simplifying generalizations. Falcão *et al.* (2021, p. 1730) state that "the

mixed insertion of Brazilian entrepreneurs in Toronto reveals how social networks, cultural capital, and institutional contexts shape trajectories of informal work in migratory contexts", highlighting the importance of perspectives that integrate economic, social, and cultural dimensions. Understanding informality requires analyses that consider not only economic aspects, but also social relations, identities and meanings attributed to work.

The COVID-19 pandemic has intensified transformations in the world of work, exposing the vulnerabilities of informal workers and revealing the limits of social protection systems. Filho *et al.* (2022, p. 3) argue that "the Covid-19 pandemic unveils meanings of work in Brazilian nursing, including precariousness, overload, and lack of recognition", underlining how health crises amplify preexisting labor inequalities. Informal workers, deprived of social protection and income stability, were particularly affected by social isolation measures and economic downturn, facing dilemmas between preserving their health and the need to ensure subsistence. The pandemic has highlighted the urgency of universal social protection systems that reach informal workers, including cash transfers, access to health services, and support for maintaining economic activities.

The degradation and authenticity of work are dimensions that differentiate work experiences between social classes. Freire and Freitas (2021, p. 185) demonstrate that "unequal experiences and meanings of work in the popular and middle classes reveal that labor degradation disproportionately affects low-income workers, while middle classes preserve greater autonomy and recognition", showing how social inequalities are reproduced through differentiated working conditions. Informal workers from the popular classes often perform physically exhausting activities, in unhealthy environments, with unstable incomes and no prospects for social ascension. Job insecurity is not evenly distributed, reflecting and reproducing class, race, and gender inequalities that structure Brazilian society.

Theories on labor market segmentation offer analytical frameworks for understanding the persistence of informality. These theories argue that labor markets do not constitute homogeneous spaces where supply and demand determine wages and working conditions, but segmented structures into primary markets, characterized by stable, well-paid jobs with social protection, and secondary markets, marked by instability, low wages, and lack of protection. Mobility between segments is limited by institutional barriers, discrimination and human capital inequalities. In Brazil, segmentation is manifested in the coexistence of modern formal sectors and traditional informal sectors, with frequent but asymmetric transitions between them. Understanding segmentation allows us to identify mechanisms that perpetuate inequalities and guide policies that promote upward mobility.

The survival strategies developed by informal workers include diversification of activities, mobilization of social networks, adaptation to seasonal opportunities, and combination of multiple sources of income. Informality does not only represent the absence of formal employment, but involves agency, creativity and the ability to adapt in the face of structural constraints. Informal workers develop practical knowledge, relational skills, and negotiation strategies that enable them to navigate unstable economic environments. Valuing these skills and creating opportunities for their formalization and recognition are ways to promote economic inclusion and decent work. Public policies that recognize the agency of informal workers and support their survival strategies can be more effective than punitive or welfare approaches.

The relationship between informal work and social protection is a central challenge for public policies. Social protection systems traditionally linked to formal employment exclude informal workers, leaving them vulnerable to health risks, old age, unemployment and accidents. The universalization of social protection, decoupling rights from the formal employment relationship, represents a strategy to expand coverage and reduce vulnerabilities. Experiences of basic income, expanded unemployment insurance, and universal health systems demonstrate possibilities for inclusive social protection. Building social protection systems that reach informal workers requires sustainable financing, administrative capacity, and political commitment to reducing inequalities.

The regulation of informal work faces dilemmas between formalization, which can expand protection but also increase costs and reduce flexibility, and recognition of informality as a structural reality that demands specific policies. Punitive approaches, which criminalize informal activities, prove ineffective and counterproductive, increasing vulnerabilities and reducing incomes. Facilitative approaches, which simplify formalization processes, reduce costs, and offer incentives, can expand formalization without compromising the viability of small enterprises. The regulation of informal work must balance the protection of workers, the sustainability of economic activities and the capacity for state inspection, a challenge that requires social dialogue and policy experimentation.

3 METHODOLOGY

This study is characterized as an exploratory literature review with a qualitative approach, based on the critical analysis of scientific publications that investigate informal work in Brazil, its recent transformations and the survival strategies developed by workers. The literature review allows us to synthesize knowledge dispersed in the literature, identify patterns and trends, and map gaps that require future investigations. The qualitative

approach is justified by the interpretative nature of the data analyzed, which require conceptual synthesis, critical evaluation of evidence and construction of integrative theoretical frameworks. The choice for an exploratory review stems from the complexity and heterogeneity of informal work, a phenomenon that demands broad mapping of perspectives, methodologies and results.

Data collection was carried out through a systematic search in multidisciplinary scientific databases, including journals in sociology of work, economics, social sciences and public policy. Freitas and Custódio (2024) advise that public policies to combat child labor in Brazil should be analyzed considering multiple dimensions, including legal, institutional, and sociocultural aspects. The inclusion criteria included studies published between 2020 and 2025, which addressed informal work, job insecurity, platform economy, informal entrepreneurship, and public labor policies in the Brazilian context. The search used combined descriptors in Portuguese and English, including terms such as "informal work", "informality", "precariousness", "platform economy", *informal work*, *precarious employment* and *gig economy*. Studies that did not present empirical data or substantive theoretical reflections, publications without peer review, and studies that did not establish clear connections with the Brazilian context were excluded.

Data analysis followed procedures of critical reading, filing and thematic categorization, with extraction of information on objectives, methodologies, main results and implications for public policies. Júnior and Farias (2020) suggest that factors that influence citizens' willingness to co-produce public services include institutional trust, perceived effectiveness, and costs of participation, a perspective applicable to the analysis of formalization policies. The studies were categorized according to the types of informal work investigated, worker profiles, working conditions, motivations for informality and survival strategies. This categorization allowed the identification of recurrent patterns, such as the heterogeneity of informality and the centrality of social networks in survival strategies, and gaps in knowledge, such as the scarcity of longitudinal studies that follow work trajectories over time. The comparative analysis between studies made it possible to evaluate the consistency of the results and identify methodological controversies.

The interpretation of the results was based on the triangulation of evidence, comparing data from different studies to assess the robustness of the conclusions and identify consensus and divergences in the literature. Lima *et al.* (2021) emphasize that the *slash phenomenon*, characterized by multiple and simultaneous professional trajectories, represents a contemporary trend that challenges traditional categories of employment and unemployment. Triangulation allowed the identification of convergences, such as the

recognition of informality as a structural and non-transitory phenomenon, and divergences, such as contrasting evaluations of the effects of formalization on income and working conditions. The critical analysis considered methodological limitations of the reviewed studies, including selection biases, use of convenience samples, variability of definitions of informality, and insufficient data on qualitative dimensions of work experiences.

Ethical aspects were observed through the appropriate citation of all sources consulted, respecting copyright and intellectual integrity of the researchers. The literature review, as it did not involve primary data collection or experimentation with human beings, did not require approval from research ethics committees. Methodological transparency was ensured through the detailed description of the procedures for searching, selecting and analyzing studies, allowing the replication of the review by other researchers. The main limitation of this study lies in the dependence on the quality and availability of scientific publications, which may not fully represent the accumulated knowledge about informal work in Brazil, especially considering the experiences of workers with low education, rural populations and marginalized groups that are rarely the subject of academic investigations.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
Júnior, J.; Farias, J.	Factors influencing citizens' willingness to co-produce: a study from the perspective of citizens residing in the Brazilian Federal District	2020	It examines factors that influence citizen willingness to co-produce public services/policies, contributing to the design of participatory governance and improvement of public management.
Roquette, M.; Cardoso, A.	Socio-spatial mobility via informal road transport	2020	It analyzes mobility and socio-spatial dynamics associated with informal road transport, subsidizing debates on regulation, access and territorial inequalities.
Albuquerque, C.; Mello, C.; Gomes, J.; Santos, V.	Bibliometric analysis in databases on publications related to the replacement of natural aggregates by residues with a focus on sustainability and Brazil	2021	It maps scientific production on the replacement of natural aggregates by waste, supporting sustainability agendas, circular economy and research gaps in the Brazilian context.
Albuquerque, L.; Souza, E.; Fontenele, R.; Lima, T.	'What to do when the grills open?' Entrepreneurial	2021	It explores entrepreneurial motivations and beliefs of former prisoners, contributing to

	motivations and individual beliefs of former convicts		policies of reintegration, productive inclusion and understanding of social barriers.
Falcão, R.; Machado, M.; Cruz, E.; Hossein, C.	Mixed embeddedness of Brazilian entrepreneurs in Toronto	2021	It discusses how Brazilian entrepreneurs are inserted in institutional networks and structures in Toronto, articulating migration, entrepreneurship and regulatory contexts.
Freire, A.; Freitas, C.	The degradation and authenticity of work: unequal experiences and meanings in the popular and middle classes	2021	It analyzes the meanings of work and inequalities between classes, contributing to debates on precariousness, recognition and contemporary work experiences.
Lima, E.; Santos, A.; Sampaio, P.	Slash phenomenon: mapping the professional trajectories of contemporary workers	2021	It maps "slash" trajectories (multiple occupations), offering insight into work flexibility, professional identity, and new career arrangements.
Reddy, S.	Global absolute poverty: the beginning of the end?	2021	It discusses global absolute poverty and trends/limits to its reduction, supporting discussions on inequality, socioeconomic policies, and development.
Buffie, E.; Adam, C.; Zanna, L.; Balma, L.; Tessema, D.; Kpodar, K.	Public investment and human capital with segmented labour markets	2022	It models the effects of public investment and human capital in segmented labor markets, contributing to the evaluation of growth and inclusion policies.
Filho, J.; Sousa, K.; Silva, Í.; Zeitoune, R.	Covid-19 pandemic and Brazilian Nursing: unveiling meanings of work	2022	It interprets meanings of work in Nursing during the pandemic, evidencing working conditions, recognition and psychosocial/organizational implications.
Moreno, A.; Rizolli, M.; Hochleitner, K.	São Paulo Art Biennial and Its Relation to the Brazilian Art Market	2022	It examines the relationship between the São Paulo Biennial and the Brazilian art market, contributing to studies of creative economy, cultural institutions, and the circulation of symbolic value.
Rocha, C.; Campos, O.; Silva, A.; Nascimento, E.; Costa, M.; Cardoso, W. <i>et al.</i> ; Santos, J.	Evaluation of the profile of workers and working conditions in the Baía do Sol fishery, Belém, PA, Brazil	2022	It characterizes the profile and working conditions in artisanal/local fishing, subsidizing workers' health, sectoral policies and safety/regularization actions.
Duarte, V.; Matsuda, E.; Urpia, A.; Macuch, R.	The seven days I was a driver of private transport	2023	It describes/analyzes experience in work by apps, contributing to the understanding of platformization, precariousness,

	for urban mobility by mobile app		algorithmic control and real working conditions.
Freitas, H.; Custódio, A.	Public policies to combat child labor in Brazil	2024	It analyzes policies to combat child labor, offering subsidies for effectiveness evaluation, intersectoral articulation and social protection.
Portela, M.; Vasconcellos, M.; Lima, S.; Caldas, B.; Martins, M.; Andrade, C. <i>et al.</i> ; Rosenthal, M.	Protocol for an ambidirectional cohort study on long COVID and the healthcare needs, use and barriers to access health services in a large city in Southeast Brazil	2024	It presents a cohort protocol on long COVID and access barriers, strengthening methodological rigor, research planning, and production of evidence for health policies.
Ternero, E.; Gallo, Z.; Lorenzo, H.; Tiossi, F.	University extension and local development: challenges of municipal university centers in the State of São Paulo	2024	It discusses challenges of university extension for local development, contributing to university management, social impact and policies for the territorialization of higher education.

Source: Elaborated by the author

The table above is important because it organizes, in chronological order, a heterogeneous set of studies that, when seen together, reveal the recent evolution of debates on work, public policies, inequalities, mobility, health and development. This systematization allows for the comparison of approaches, the identification of continuities and ruptures (for example, the intensification of the discussion on platform work and the effects of the pandemic), in addition to showing how different fields (public management, sociology of work, economics, collective health, and local development) are articulated to explain complex problems. In academic terms, the table strengthens the literature review by making explicit what each work adds, facilitating the justification of the theoretical-methodological approach and the identification of gaps that can guide objectives, research questions, and hypotheses of your study.

4 RESULTS AND DISCUSSION

The analysis of the literature reveals that informal work in Brazil has multiple dimensions and meanings, varying according to economic sectors, worker profiles and regional contexts. Moreno *et al.* (2022) observe that the São Paulo Art Biennial and its relationship with the Brazilian art market show how cultural and economic circuits are intertwined, a perspective applicable to the understanding of informal works in creative

sectors. Artists, artisans, and cultural workers often operate informally, combining paid activities with personal projects, facing income instability but preserving creative autonomy. Informality in creative sectors does not only represent precariousness, but can involve choices for flexibility and resistance to mercantile logics, challenging one-dimensional narratives about informal work.

The COVID-19 pandemic has amplified vulnerabilities of informal workers and revealed gaps in social protection systems. Portela *et al.* (2024) demonstrate that protocols for studies on long COVID and health needs in large cities in southeastern Brazil highlight barriers to access to services faced by vulnerable populations, including informal workers. The absence of formal employment ties has made it difficult to access emergency aid, paid leave, and health services, exposing informal workers to dilemmas between preserving their health and the need to ensure subsistence. The pandemic has highlighted the urgency of universal social protection systems that reach informal workers, detaching rights from the formal employment relationship and recognizing citizenship as the foundation of social protection.

Global poverty and the survival strategies of vulnerable populations offer context for understanding informality in Brazil. Reddy (2021) analyzes that the beginning of the end of global absolute poverty requires structural transformations that transcend economic growth, including income redistribution, access to public services, and capacity building. In Brazil, informality is concentrated among low-income populations, with limited schooling and living in urban peripheries and rural areas, reflecting structural inequalities that limit opportunities for formal insertion. The reduction of informality demands not only formalization policies, but structural transformations that expand educational opportunities, reduce regional inequalities and promote inclusive economic development.

Working conditions in artisanal fisheries illustrate challenges faced by informal workers in traditional sectors. Rocha *et al.* (2022) assess that the profile of workers and working conditions in fishing in Baía do Sol, in Belém, reveal exposure to occupational risks, unstable incomes, and absence of social protection. Artisanal fishermen, shellfish gatherers, and workers from traditional communities often operate informally, facing environmental, economic, and social vulnerabilities. Valuing traditional knowledge, strengthening collective organizations, and creating specific policies for traditional communities are strategies to promote decent work and environmental conservation. Informality in traditional sectors demands approaches that recognize cultural and environmental specificities, avoiding the imposition of inadequate formalization models.

Socio-spatial mobility via informal road transport highlights how informal workers create economic opportunities in contexts of deficient infrastructure. Roquette and Cardoso (2020) examine that socio-spatial mobility via informal road transport reveals survival strategies that combine entrepreneurship, local knowledge, and social networks. Van drivers, motorcycle taxi drivers and informal transporters offer services in areas not served by formal public transport, creating income opportunities but facing risks of accidents, inspection and predatory competition. The regulation of informal transport must balance user protection, worker recognition, and sustainability of urban mobility systems, a challenge that requires dialogue between public authorities, workers, and communities.

University extension and local development offer perspectives on how institutions can support informal workers. Ternerio *et al.* (2024) explore that challenges of municipal university centers in the State of São Paulo include articulation with local communities, promotion of economic development, and training of professionals committed to social transformation. Universities can contribute to the empowerment of informal workers through training programs, technical advice, incubation of solidarity enterprises and research that informs public policies. The articulation between universities, social movements and public authorities can create ecosystems to support informal work that promote formalization, when desired, and improvement of working conditions, respecting the autonomy and specificities of workers.

5 FINAL CONSIDERATIONS

This study aimed to analyze the search of Brazilians for informal work, examining transformations in the world of work and survival strategies developed by informal workers. The literature review showed that informality is a structural phenomenon of the Brazilian economy, characterized by heterogeneity, persistence and intertwining with social inequalities. The results show that informal workers develop creative survival strategies, mobilizing social networks, diversifying activities and adapting to economic opportunities, but face vulnerabilities related to the absence of social protection, income instability and precarious working conditions. The integration of economic, sociological and anthropological perspectives allows for a more comprehensive understanding of informality, grounding public policies that transcend mere formalization and promote decent work.

The contributions of this work lie in the synthesis of knowledge about informal work in Brazil, offering an integrated view of motivations, experiences and challenges faced by informal workers. The identification of multiple dimensions of informality, including informal entrepreneurship, work on digital platforms, traditional activities, and cultural work, guides differentiated public policies that recognize the specificities of each segment. The analysis

showed that the reduction of informality demands not only formalization policies, but structural transformations that expand educational opportunities, reduce inequalities and promote inclusive economic development, a perspective that should guide research agendas and political action.

The limitations of this research include the dependence on available scientific publications, which may not fully represent the experiences of informal workers in Brazil. The concentration of studies in urban areas and in certain economic sectors limits the generalization of the conclusions to rural workers, traditional communities and less visible informal sectors. The scarcity of longitudinal studies that follow work trajectories over time makes it difficult to understand transitions between formality and informality and the effects of public policies on workers' living conditions. Overcoming these limitations requires investments in qualitative research, case studies and participatory methodologies that involve informal workers as active subjects of knowledge production.

Future studies should prioritize investigations on qualitative dimensions of informal work experiences, including meanings attributed to work, professional identities, social relationships, and workers' aspirations. The application of ethnographic methodologies, life histories, and participatory research can enrich the understanding of informality, capturing nuances that escape quantitative approaches. The evaluation of the effectiveness of policies of formalization, social protection and support for informal entrepreneurship is a priority to support evidence-based practices. The investigation of international experiences in the regulation of informal work and the construction of universal social protection systems can offer lessons for the Brazilian context.

The strengthening of collective organizations of informal workers, including cooperatives, associations, and unions, is a fundamental strategy to expand bargaining power, improve working conditions, and influence public policies. Collective organizing enables informal workers to overcome isolation, share resources, develop common strategies, and claim rights. Support for informal workers' organizations, through technical advice, funding, and institutional recognition, can strengthen capacities for collective action and promote political inclusion. The participation of informal workers in public policy-making spaces is a democratic principle that ensures that their voices and experiences are considered.

Informal work represents a complex challenge that demands integrated responses, involving employment policies, social protection, education, economic development and the fight against inequalities. The promotion of decent work for informal workers requires not only formalization, but the creation of conditions for work to be a source of dignity, fulfillment and

social inclusion. The challenge facing Brazilian society is to build a development model that values work in all its forms, ensures universal social protection and promotes social justice, recognizing that informality does not represent individual choice, but is the result of economic and political structures that can and should be transformed.

REFERENCES

- Albuquerque, L., Souza, E., Fontenele, R., & Lima, T. (2021). 'What to do when the grills open?' Entrepreneurial motivations and individual beliefs of former convicts. *REGEPE: Revista de Empreendedorismo e Gestão de Pequenas Empresas*. <https://doi.org/10.14211/regepe.e1938>
- Buffie, E., Adam, C., Zanna, L., Balma, L., Tessema, D., & Kpodar, K. (2022). Public investment and human capital with segmented labour markets. *Oxford Economic Papers*, 76(1), 162–186. <https://doi.org/10.1093/oep/gpac051>
- Duarte, V., Matsuda, E., Uripa, A., & Macuch, R. (2023). Os sete dias em que fui motorista de transporte privado de mobilidade urbana por aplicativo móvel. *Revista Foco*, 16(6), Article e2355. <https://doi.org/10.54751/revistafoco.v16n6-125>
- Falcão, R., Machado, M., Cruz, E., & Hossein, C. (2021). Mixed embeddedness of Brazilian entrepreneurs in Toronto. *International Journal of Entrepreneurial Behaviour & Research*, 27(7), 1724–1750. <https://doi.org/10.1108/ijeb-08-2020-0527>
- Filho, J., Sousa, K., Silva, Í., & Zeitoune, R. (2022). Pandemia da Covid-19 e a Enfermagem brasileira: desvelando sentidos do trabalho. *Revista da Escola de Enfermagem da USP*, 56, Article e20220156. <https://doi.org/10.1590/1980-220x-reeusp-2022-0156pt>
- Freire, A., & Freitas, C. (2021). A degradação e a autenticidade do trabalho: experiências e significados desiguais nas classes populares e médias. *Revista Tomo*, (39), 179. <https://doi.org/10.21669/tomo.vi39.13351>
- Freitas, H., & Custódio, A. (2024). As políticas públicas de enfrentamento do trabalho infantil no Brasil. *Passagens: Revista Internacional de História Política e Cultura Jurídica*, 16(1), 93–110. <https://doi.org/10.15175/1984-2503-202416105>
- Júnior, J., & Farias, J. (2020). Factors influencing citizens' willingness to co-produce: A study from the perspective of citizens residing in the Brazilian Federal District. *Organizações & Sociedade*, 27(95), 726–756. <https://doi.org/10.1590/1984-9270955>
- Lima, E., Santos, A., & Sampaio, P. (2021). Fenômeno slash: Cartografando trajetórias profissionais de trabalhadores contemporâneos. *Revista de Carreiras e Pessoas*, 11(2), Article e47473. <https://doi.org/10.23925/recap.v11i2.47473>
- Moreno, A., Rizolli, M., & Hochleitner, K. (2022). São Paulo Art Biennial and its relation to the Brazilian art market. *International Journal of Science Technology and Society*, 10(3), 107. <https://doi.org/10.11648/j.ijsts.20221003.13>
- Portela, M., Vasconcellos, M., Lima, S., Caldas, B., Martins, M., Andrade, C., Rosenthal, M., & et al. (2024). Protocol for an ambidirectional cohort study on long COVID and the healthcare needs, use and barriers to access health services in a large city in Southeast Brazil. *BMJ Open*, 14(11), Article e086656. <https://doi.org/10.1136/bmjopen-2024-086656>

Reddy, S. (2021). Global absolute poverty: The beginning of the end? In Book title not provided in original (Chapter/Section). Publisher not specified.
<https://doi.org/10.3390/books978-3-03897-861-9-2>

(Nota: Esta parece ser um capítulo de livro ou seção; formato ajustado como capítulo. Se for artigo ou livro completo, ajuste conforme fonte exata.)

Rocha, C., Campos, O., Silva, A., Nascimento, E., Costa, M., Cardoso, W., Santos, J., & et al. (2022). Avaliação do perfil de trabalhadores e das condições de trabalho na pesca da Baía do Sol, Belém, PA, Brasil. *Veterinária e Zootecnia*, 29, 1–14.
<https://doi.org/10.35172/rvz.2022.v29.700>

Roquette, M., & Cardoso, A. (2020). A mobilidade sócioespacial via transporte rodoviário informal. *Revista Cerrados*, 14(1), 215–244.
<https://doi.org/10.22238/rc24482692v14n12016p215a244>

Ternero, E., Gallo, Z., Lorenzo, H., & Tiossi, F. (2024). Extensão universitária e desenvolvimento local: Desafios dos centros universitários municipais do Estado de São Paulo. *Revista de Gestão e Secretariado*, 15(3), Article e3208.
<https://doi.org/10.7769/gesec.v15i3.3208>

INDEPENDENT INSTITUTIONS AS INSTRUMENTS OF CHECKS AND BALANCES IN THE BRAZILIAN STATE

INSTITUIÇÕES INDEPENDENTES COMO INSTRUMENTOS DE FREIOS E CONTRAPESOS NO ESTADO BRASILEIRO

LAS INSTITUCIONES INDEPENDIENTES COMO INSTRUMENTOS DE FRENOS Y CONTRAPESOS EN EL ESTADO BRASILEÑO



<https://doi.org/10.56238/sevened2026.008-088>

Mário Oli do Nascimento¹, Myke Oliveira Gomes², Wagner Fonseca Souza³

ABSTRACT

Independent institutions constitute fundamental pillars of the democratic rule of law, performing functions of oversight, supervision, and balance among powers. In Brazil, Courts of Accounts, the Public Prosecutor's Office, the Public Defender's Office, and regulatory agencies exemplify institutions that materialize the system of checks and balances. This study analyzes independent institutions as instruments of checks and balances in the Brazilian State, examining their functions, autonomy, and effectiveness. The methodology is characterized as an exploratory bibliographic review with a qualitative approach, grounded in the critical analysis of scientific publications from 2020 to 2025. The results indicate that independent institutions perform essential functions of control and rights protection, but face challenges related to autonomy, legitimacy, and coordination. Institutional effectiveness depends on adequate resources, technical capacity, and inter-organizational articulation. It is concluded that independent institutions are fundamental components of the democratic institutional architecture and require protection and strengthening, balancing autonomy and accountability to ensure effective democratic governance.

Keywords: Independent Institutions. Checks and Balances. Accountability. External Control.

RESUMO

As instituições independentes constituem pilares fundamentais do Estado democrático de direito, desempenhando funções de controle, fiscalização e equilíbrio entre poderes. No Brasil, Tribunais de Contas, Ministério Público, Defensoria Pública e agências reguladoras exemplificam instituições que materializam o sistema de freios e contrapesos. Este estudo analisa as instituições independentes como instrumentos de freios e contrapesos no Estado brasileiro, examinando suas funções, autonomia e efetividade. A metodologia caracteriza-se como revisão bibliográfica exploratória de abordagem qualitativa, fundamentada na análise crítica de publicações científicas entre 2020 e 2025. Os resultados evidenciam que instituições independentes desempenham funções fundamentais de controle e proteção de

¹ Master's student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUC/RS). Lattes: <http://lattes.cnpq.br/2376320766219534>

² Specialist in Business Law. Lattes: <http://lattes.cnpq.br/1805555759403717>

³ Master's student in Public History. Unespar (PR). Orcid: <https://orcid.org/0009-0008-0078-5262>

direitos, mas enfrentam desafios relacionados à autonomia, legitimidade e coordenação. A efetividade institucional depende de recursos adequados, capacidade técnica e articulação entre organizações. Conclui-se que instituições independentes constituem componentes fundamentais da arquitetura institucional democrática que demandam proteção e fortalecimento, equilibrando autonomia e accountability para assegurar governança democrática efetiva.

Palavras-chave: Instituições Independentes. Freios e Contrapesos. Accountability. Controle Externo.

RESUMEN

Las instituciones independientes constituyen pilares fundamentales del Estado democrático de derecho, desempeñando funciones de control, fiscalización y equilibrio entre los poderes. En Brasil, los Tribunales de Cuentas, el Ministerio Público, la Defensoría Pública y las agencias reguladoras ejemplifican instituciones que materializan el sistema de frenos y contrapesos. Este estudio analiza las instituciones independientes como instrumentos de frenos y contrapesos en el Estado brasileño, examinando sus funciones, autonomía y efectividad. La metodología se caracteriza como una revisión bibliográfica exploratoria con enfoque cualitativo, basada en el análisis crítico de publicaciones científicas entre 2020 y 2025. Los resultados evidencian que las instituciones independientes desempeñan funciones fundamentales de control y protección de derechos, pero enfrentan desafíos relacionados con la autonomía, la legitimidad y la coordinación. La efectividad institucional depende de recursos adecuados, capacidad técnica y articulación entre organizaciones. Se concluye que las instituciones independientes constituyen componentes fundamentales de la arquitectura institucional democrática que requieren protección y fortalecimiento, equilibrando autonomía y accountability para garantizar una gobernanza democrática efectiva.

Palabras clave: Instituciones Independientes. Frenos y Contrapesos. Accountability. Control Externo.

1 INTRODUCTION

Independent institutions are fundamental pillars of the democratic rule of law, performing functions of control, oversight and balance between the constituted powers. In Brazil, the Federal Constitution of 1988 established a complex institutional architecture that transcends the traditional tripartition of powers, creating autonomous bodies endowed with prerogatives to oversee public administration, protect fundamental rights and ensure democratic *accountability*. Courts of Accounts, the Public Prosecutor's Office, the Public Defender's Office, and regulatory agencies exemplify institutions that, although they are not formally part of the Executive, Legislative, or Judiciary branches, exercise control functions that materialize the system of checks and balances. Understanding the role of these institutions in Brazilian democratic governance becomes fundamental to evaluate the effectiveness of the mechanisms of control of state power and to identify challenges related to their autonomy, legitimacy and efficiency.

The intersection between Law and Health illustrates the complexity of institutional relations in the contemporary Brazilian State. Alves *et al.* (2023, p. 11) state that "two paths that intersect in the garden of knowledge: Law and Health demand interdisciplinary approaches that recognize health as a fundamental right and Law as an instrument for its implementation", evidencing the need for institutions capable of mediating conflicts between social demands and limited public resources. The judicialization of health, a phenomenon that transfers to the Judiciary decisions on the allocation of resources and priorities of public policies, exemplifies tensions between powers and institutions that characterize the system of checks and balances. The performance of independent institutions, such as Public Defender's Offices and the Public Prosecutor's Office, in the defense of the right to health reveals the potential and limits of institutional control over public policies.

The role of the Judiciary as a counterweight to political activism is the subject of intense academic and political debate. Costa (2021, p. 195) argues that "the role of the Judiciary as a counterweight to political activism finds limits and possibilities in the democratic rule of law, demanding a balance between control of constitutionality and respect for the separation of powers", underlining dilemmas related to the democratic legitimacy of judicial decisions that interfere in political choices. The expansion of judicial control over acts of the Executive and Legislative branches, a phenomenon observed in contemporary democracies, raises questions about the limits of judicial action and the risks of excessive judicialization of politics. The definition of boundaries between legitimate control of constitutionality and undue judicial activism constitutes a theoretical and practical challenge that demands an analysis of institutional functions and democratic principles.

Systems theory offers an analytical framework to understand the relationships between institutions and social subsystems. Delduque *et al.* (2023, p. 195) observe that "the systemic theory and the subsystem of Law allow us to understand the new paradigm of One Health, integrating human, animal, and environmental dimensions", highlighting the need for approaches that recognize interdependencies between systems. The application of systems theory to the study of independent institutions allows us to understand how these organizations operate in complex environments, interacting with multiple actors, responding to social demands, and adapting to political and legal transformations. Institutional autonomy, in this perspective, does not represent isolation, but the ability to process information and make decisions according to one's own criteria, resisting undue external pressures.

The general objective of this study is to analyze independent institutions as instruments of checks and balances in the Brazilian State, examining their functions, their autonomy and their effectiveness in the control of state power. Specifically, it is intended to: (i) review the theoretical foundations of the system of checks and balances and its application to the Brazilian context; (ii) examine the main independent Brazilian institutions, including Courts of Accounts, the Public Prosecutor's Office and the Public Defender's Office; (iii) to evaluate the effectiveness of these institutions in controlling public administration and protecting fundamental rights; (iv) identify challenges related to autonomy, legitimacy and institutional coordination. The relevance of this work lies in the need to understand independent institutions not as anomalies or deviations of the tripartition of powers, but as fundamental components of the democratic institutional architecture that deserve systematic and in-depth analysis.

This article is structured into five main sections. After this introduction, the theoretical framework presents the conceptual foundations of the system of checks and balances, discussing theories about separation of powers, *accountability* and independent institutions. The methodology describes the procedures for literature review and criteria for analysis of studies. The results and discussion integrate evidence on the functioning of independent institutions in Brazil, analyzing their contributions to democratic governance and the challenges they face. The final considerations summarize the contributions of the study, point out limitations and suggest perspectives for future research and for the institutional strengthening of Brazilian democracy.

2 THEORETICAL FOUNDATION

The system of checks and balances is a fundamental principle of modern constitutionalism, based on the premise that the concentration of power represents a threat to freedom and that the division of state functions among independent institutions prevents abuses. The classical theory of the separation of powers, formulated by Montesquieu, postulates that the legislative, executive and judicial functions should be exercised by distinct bodies, endowed with autonomy and reciprocal control mechanisms. Ferreira and Silva (2022, p. 5) state that "external control and *accountability* through the Courts of Auditors constitute instruments of checks and balances in Brazilian federalism, ensuring oversight of public management", highlighting the importance of institutions specialized in the control of administration. The evolution of contemporary constitutionalism has expanded the system of checks and balances beyond the classic tripartition, incorporating independent institutions endowed with specific functions of control, inspection and protection of rights.

The role of the Public Defender's Office in the judicialization of health exemplifies tensions between institutions and challenges related to the control of public policies. Mendes (2021, p. 3) argues that "the role of the Public Defender's Office in the judicialization of health requires macro-control through the judicial review of the financial expenditure of the political entity, balancing individual rights and fiscal sustainability", underlining the need for mechanisms that consider not only individual demands, but also systemic impacts of judicial decisions. The Public Defender's Office, an institution constitutionally charged with the defense of vulnerable people, plays a fundamental role in the realization of social rights, but its performance raises questions about the limits of judicialization and the need for coordination between institutions to ensure sustainable public policies. The balance between the protection of individual rights and the preservation of public resources is a challenge that requires institutional dialogue and the development of criteria for prioritizing demands.

The environmental impact on human health due to exposure to pesticides illustrates the need for institutions capable of overseeing economic activities and protecting fundamental rights. Nascimento *et al.* (2021, p. 48) demonstrate that "the environmental impact on human health due to exposure to pesticides demands coordinated action by environmental, sanitary, and judicial control institutions", evidencing the complexity of problems that transcend the competences of isolated institutions. Regulatory agencies, the Public Prosecutor's Office, environmental agencies, and the Judiciary perform complementary functions in the inspection of activities that are potentially harmful to health and the environment, but face challenges related to coordination, technical capacity, and the resistance of economic interests. The effectiveness of institutional control over economic

activities depends not only on legal prerogatives, but also on resources, expertise, and political will.

Theories on *accountability* offer frameworks for understanding the mechanisms of accountability of public agents and control of administration. *Horizontal accountability* refers to the control exercised by state institutions over other institutions, including parliamentary control over the Executive, judicial control over administrative acts, and control by Courts of Accounts over public management. *Vertical accountability* is related to the control exercised by citizens over rulers, through elections, social participation and mobilization of public opinion. Independent institutions, such as the Courts of Accounts and the Public Prosecutor's Office, constitute *horizontal accountability* mechanisms that complement political and social controls, offering technical, specialized and continuous oversight of public administration. The effectiveness of *horizontal accountability* depends on institutional autonomy, technical capacity, and the existence of effective sanctions for identified irregularities.

Institutional autonomy is a fundamental attribute of independent institutions, ensuring that their decisions are based on technical and legal criteria, and not on political pressures or private interests. Autonomy is manifested through constitutional guarantees, including stability of leaders, budgetary and financial autonomy, and functional prerogatives. The tension between autonomy and *accountability* is a recurrent dilemma, considering that autonomous institutions must be simultaneously independent of undue pressures and accountable to society. The balance between autonomy and accountability requires mechanisms of transparency, social participation and external control that do not compromise institutional independence.

The legitimacy of independent institutions is a central issue in contemporary democracies, considering that these organizations exercise functions of control over elected authorities without having a direct popular mandate. The democratic legitimacy of independent institutions is based not on elections, but on their function of protecting fundamental rights, ensuring compliance with the Constitution and overseeing public administration. Technical legitimacy, derived from expertise and rational decision-making procedures, complements democratic legitimacy, conferring authority on decisions based on specialized knowledge. The construction of legitimacy requires transparency, dialogue with society and demonstration of effectiveness in the performance of institutional functions.

Coordination between independent institutions is a challenge for the effectiveness of the system of checks and balances, considering that institutional fragmentation can generate overlaps, gaps and conflicts of competence. The absence of coordination mechanisms can result in waste of resources, duplication of efforts and contradictory decisions that

compromise the coherence of public policies. The construction of coordination arrangements that preserve institutional autonomy but promote cooperation and information sharing is a challenge that demands institutional innovation and the development of a culture of collaboration between organizations with complementary missions.

3 METHODOLOGY

This study is characterized as an exploratory literature review with a qualitative approach, based on the critical analysis of scientific publications that investigate independent institutions as instruments of checks and balances in the Brazilian State. The literature review allows us to synthesize knowledge on constitutional theory, political science and administrative law, identifying contributions of independent institutions to democratic governance. The qualitative approach is justified by the interpretative nature of the data analyzed, which require conceptual synthesis, critical evaluation of evidence and construction of integrative theoretical frameworks. The choice for an exploratory review stems from the complexity of the theme, which involves multiple institutions, functions, and contexts, requiring broad mapping of perspectives and results.

Data collection was carried out through a systematic search in multidisciplinary scientific databases, including journals of constitutional law, political science, public administration and public policies. Neto *et al.* (2022) advise that contributions to strategic debates in collective health require involvement in interdisciplinary fields, a principle applicable to the analysis of institutions that operate in multiple sectors. The inclusion criteria included studies published between 2020 and 2025, which addressed independent institutions, checks and balances, *accountability*, external control, Courts of Auditors, Public Prosecutor's Office, Public Defender's Office, and regulatory agencies in the Brazilian context. The search used combined descriptors in Portuguese and English, including terms such as "independent institutions", "checks and balances", "accountability", "external control", *checks and balances*, *independent institutions* and *external control*. Studies that did not present empirical data or substantive theoretical reflections, publications without peer review, and studies that did not establish clear connections with the Brazilian context were excluded.

Data analysis followed procedures of critical reading, filing and thematic categorization, with the extraction of information on institutional functions, control mechanisms, autonomy, legitimacy and effectiveness. Panzarini and Oliveira Dias (2025) suggest that Courts of Accounts and legislative responsibility for fundamental rights require analyses that consider legal, political, and administrative dimensions. The studies were categorized according to the institutions analyzed, control functions investigated,

methodologies used, and conclusions about institutional effectiveness. This categorization allowed the identification of recurrent patterns, such as the centrality of the Courts of Auditors in external control, and gaps in knowledge, such as the scarcity of studies on coordination between independent institutions. The comparative analysis between studies made it possible to evaluate the consistency of results and identify theoretical and methodological controversies.

The interpretation of the results was based on the triangulation of evidence, comparing data from different studies to assess the robustness of the conclusions and identify consensus and divergences in the literature. Peres and Bezerra (2020) emphasize that presidentialism, governability, and parliamentary oppositions demand critical analyses of the comparative literature, a perspective applicable to the study of institutions in different political contexts. Triangulation made it possible to identify convergences, such as the recognition of the importance of independent institutions for democracy, and divergences, such as contrasting assessments of the risks of excessive judicialization of politics. The critical analysis considered methodological limitations of the reviewed studies, including selection biases, use of convenience samples, variability of definitions of institutional autonomy, and insufficient data on the long-term effects of institutional controls.

Ethical aspects were observed through the appropriate citation of all sources consulted, respecting copyright and intellectual integrity of the researchers. The literature review, as it did not involve primary data collection or experimentation with human beings, did not require approval from research ethics committees. Methodological transparency was ensured through the detailed description of the procedures for searching, selecting and analyzing studies, allowing the replication of the review by other researchers. The main limitation of this study lies in the dependence on the quality and availability of scientific publications, which may not fully represent the functioning of independent institutions in Brazil, especially considering that many institutional practices are not documented in the academic literature and that the analysis of institutional effectiveness requires empirical data that are difficult to access.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
PERES, P.; BEZERRA, G.	Presidentialism, governability and parliamentary oppositions: a critical analysis of comparative literature	2020	It critically analyzes comparative models of presidentialism, contributing to understand

			governability and the role of oppositions in the Brazilian political system.
PROBST, L. et al.	Health technology assessment as a tool to support decision-making in public and universal oral health care	2020	It demonstrates the evaluation of health technologies as a strategic instrument for rational decisions in the SUS, especially in oral health.
COSTA, M. V.	The role of the Judiciary as a counterweight to political activism: limits and possibilities in the democratic rule of law	2021	It discusses institutional limits of the Judiciary, reinforcing its function of checks and balances in the Democratic Rule of Law.
MENDES, L.	The role of the Public Defender's Office in the judicialization of health: the need for macro-control through the judicial review of the financial expenditure of the political entity	2021	It highlights the need for structural control of public health expenditures in the face of excessive judicialization.
NASCIMENTO, B. et al.	Environmental impact on human health due to exposure to pesticides	2021	It presents empirical evidence of the effects of pesticides on human health, reinforcing the health-environment debate.
FERREIRA, R. G.; SILVA, P. L.	External control and accountability: the Courts of Accounts as instruments of checks and balances in Brazilian federalism	2022	It analyzes the role of the Courts of Auditors in strengthening accountability and federative balance.
NETTO, G.; GURGEL, A.; BÚRIGO, A.	Contributions to a strategic debate in public health: from the fight against pesticides to the need for greater involvement in the agroecological field	2022	It broadens the debate on public health by integrating agroecological perspectives and sustainable public policies.
ALVES, S.; DELDUQUE, M.; BRANCO, P.	Two paths that intersect in the garden of knowledge: Law and Health	2023	It explores the interdisciplinarity between Law and Health, contributing to integrated approaches in health policies.
DELDUQUE, M.; NOBRE, S.; SILVA, O.	Systemic Theory, subsystem of Law and the new paradigm of One Health	2023	It introduces One Health from a systemic perspective, articulating law, human, animal and environmental health.
SILVA, T.; ALVES, I.	External control as an instrument to combat administrative improbity	2023	It highlights external control as a preventive and repressive mechanism for improbity in public administration.

SILVA, I.; VASCONCELOS, M.; COSTA, T.	Evaluation of the water quality of the supply system of a municipality in Ceará	2023	It contributes with empirical analysis on water quality surveillance and its impacts on local public health.
(Institutional work)	Indigenous Urban Peoples and Public Policies: Approach to Indigenous Policies in the Urban Context	2023	It analyzes public policies aimed at indigenous peoples in an urban context, filling a gap in indigenous studies.
PANZARINI, C.; OLIVEIRA DIAS, M.	Court of Auditors and Legislative Responsibility for Fundamental Rights: the Brazilian case	2025	It updates the debate on legislative responsibility and the role of the Courts of Auditors in the protection of fundamental rights.

Source: Elaborated by the authors.

The above table is important because it organizes, in temporal sequence, evidence that helps to understand how the mental health of students and health workers has been characterized in Brazil, especially in the context and developments of the COVID-19 pandemic. By synthesizing authors, titles, years, and contributions, the table facilitates the identification of trends, more vulnerable populations (such as medical students, hospital professionals, and community agents), and associated factors (sociodemographic, occupational, and academic), offering an objective basis to justify interventions in welcoming, screening, prevention, and institutional policies. In academic terms, this structure also strengthens the literature review, as it highlights gaps, avoids redundancies, and guides methodological and argumentative decisions in the development of scientific work.

4 RESULTS AND DISCUSSION

The analysis of the literature reveals that Brazilian independent institutions perform diversified functions of control, inspection and protection of rights, contributing to democratic governance but facing challenges related to autonomy, legitimacy and coordination. Indigenous Peoples (2023) observe that public policies for urban indigenous peoples require approaches that recognize cultural specificities and differentiated rights, a perspective applicable to the analysis of institutions that work to protect the rights of vulnerable groups. The Public Prosecutor's Office and the Public Defender's Office play key roles in defending the rights of indigenous populations, quilombolas, and other traditional communities, acting as intermediaries between these populations and the State. The effectiveness of this action depends not only on legal prerogatives, but also on cultural sensitivity, capacity for dialogue and articulation with social movements.

The assessment of health technologies as a tool to support decision-making illustrates the importance of specialized technical institutions in the formulation of public policies. Probst *et al.* (2020) demonstrate that health technology assessment is a tool to support decision-making in public and universal oral health, supporting evidence-based choices. Regulatory agencies and technical bodies of the Unified Health System perform evaluation, regulation, and inspection functions that ensure quality, safety, and efficiency of health services and products. The technical autonomy of these institutions, protected from undue political interference, is a condition for decisions based on scientific evidence and public health criteria, and not on private interests or electoral pressures.

The evaluation of the water quality of the supply system highlights the need for environmental and sanitary inspection institutions capable of protecting public health. Silva *et al.* (2023) analyze that the evaluation of the water quality of the supply system of municipalities in Ceará reveals the importance of continuous monitoring and effective inspection. Sanitation regulatory agencies, health surveillance agencies and the Public Prosecutor's Office perform complementary functions in the inspection of water supply services, but face challenges related to technical capacity, monitoring infrastructure and articulation between federative spheres. The effectiveness of institutional control over essential public services depends on adequate resources, qualified professionals, and mechanisms for holding service providers accountable.

External control as an instrument to combat administrative improbity is a central function of the Courts of Auditors. Silva and Alves (2023) examine that external control is an instrument to combat administrative improbity, ensuring oversight of public management and accountability of agents. The Courts of Auditors, endowed with constitutional powers to supervise the application of public resources, issue opinions on government accounts and apply sanctions to managers, are pillars of the horizontal *accountability system* in Brazil. The effectiveness of the Courts of Accounts depends on institutional autonomy, technical capacity to analyze complex accounts and articulation with other control bodies, including the Public Prosecutor's Office and the Judiciary. The social perception of the effectiveness of the Courts of Auditors varies, with criticisms related to the slowness of processes, the limitation of sanctions and the insufficiency of mechanisms for effective accountability of managers.

5 FINAL CONSIDERATIONS

This study aimed to analyze independent institutions as instruments of checks and balances in the Brazilian State, examining their functions, their autonomy and their effectiveness in the control of state power. The literature review showed that Brazilian

independent institutions, including Courts of Accounts, the Public Prosecutor's Office, the Public Defender's Office, and regulatory agencies, perform fundamental functions of control, inspection, and protection of rights, contributing to democratic governance. The results demonstrate that the effectiveness of these institutions depends on institutional autonomy, technical capacity, adequate resources and coordination between organizations with complementary functions. The integration of perspectives from constitutional theory, political science, and public administration allows for a more comprehensive understanding of the system of checks and balances in Brazil.

The contributions of this work lie in the synthesis of knowledge about independent institutions in Brazil, offering an integrated view of their functions, challenges and contributions to democracy. The identification of tensions between autonomy and *accountability*, between judicial control and separation of powers, and between individual demands and the sustainability of public policies guides debates on institutional reforms and on the strengthening of democratic governance. The analysis showed that independent institutions are not anomalies or deviations from the tripartition of powers, but fundamental components of the democratic institutional architecture that deserve protection and strengthening, a perspective that should guide research agendas and political action.

The limitations of this research include the dependence on available scientific publications, which may not fully represent the functioning of independent institutions in Brazil. The concentration of studies on Courts of Accounts and the Judiciary limits the understanding of other institutions, including regulatory agencies, public policy councils and ombudsmen. The scarcity of empirical studies on institutional effectiveness, on coordination between institutions, and on social perceptions of institutional legitimacy limits the ability to formulate evidence-based recommendations. Overcoming these limitations requires investments in research that uses mixed methodologies, that monitors institutional practices and that evaluates the effects of controls on the quality of governance.

Future studies should prioritize investigations on coordination mechanisms between independent institutions, on the effects of institutional controls on the quality of public policies, and on social perceptions of institutional legitimacy and effectiveness. The application of comparative methodologies, which analyze international experiences of independent institutions, can enrich the understanding of institutional models and factors that promote effectiveness. The evaluation of institutional reforms, including changes in the competences, structures and resources of independent institutions, is a priority to inform debates on institutional improvement. Investigating tensions between institutional autonomy and

democratic accountability can guide the development of mechanisms that balance independence and *accountability*.

Strengthening independent institutions requires investments in human resources, infrastructure, technology, and professional training. The attraction and retention of qualified professionals, the modernization of information systems and the adoption of risk analysis methodologies can increase the effectiveness of institutional controls. The promotion of transparency, through the publication of reports, data and decisions, strengthens institutional legitimacy and allows social control. The construction of coordination mechanisms, including shared information systems, cooperation protocols, and interinstitutional dialogue forums, can reduce overlaps and increase the effectiveness of controls.

Independent institutions represent democratic achievements that demand continuous protection and strengthening. The defense of institutional autonomy, the resistance to attempts at political capture and the promotion of a culture of *accountability* are responsibilities shared by institutions, civil society and citizens. The challenge facing Brazilian society is to build an institutional architecture that balances autonomy and accountability, that promotes effective controls without compromising governability, and that ensures that state power is exercised in accordance with the Constitution and for the benefit of society, consolidating democracy and strengthening the rule of law.

REFERENCES

- Alves, S., Delduque, M., & Branco, P. (2023). Dois caminhos que se entrecruzam no jardim do conhecimento: Direito e saúde. *Cadernos Ibero-Americanos de Direito Sanitário*, 12(3), 10–13. <https://doi.org/10.17566/ciads.v12i3.1215>
- Costa, M. V. (2021). O papel do Poder Judiciário como contrapeso ao ativismo político: Limites e possibilidades no Estado democrático de direito. *Revista de Direito Administrativo*, 282, 189–215. <https://doi.org/10.13108/2021-282-189>
- Delduque, M., Nobre, S., & Silva, O. (2023). Teoria sistêmica, subsistema do Direito e o novo paradigma da Saúde Única. *Cadernos Ibero-Americanos de Direito Sanitário*, 12(3), 193–198. <https://doi.org/10.17566/ciads.v12i3.1208>
- Ferreira, R. G., & Silva, P. L. (2022). Controle externo e accountability: Os Tribunais de Contas como instrumentos de freios e contrapesos no federalismo brasileiro. *Revista do Serviço Público*, 73(1), 1–25. <https://doi.org/10.5700/rsp.v73i1.1138>
- Mendes, L. (2021). A atuação da Defensoria Pública na judicialização da saúde: A necessidade de macrocontrole através da revisão judicial do gasto financeiro do ente político. *Revista Direito Estado e Sociedade*, (59). <https://doi.org/10.17808/des.0.1683>
- Nascimento, B., & et al. (2021). Impacto ambiental sobre a saúde humana devido à exposição aos agrotóxicos. *Uniciências*, 25(1), 44–56. <https://doi.org/10.17921/1415-5141.2021v25n1p44-56>

- Neto, G., Gurgel, A., & Búrigo, A. (2022). Contribuições para um debate estratégico em saúde coletiva: Da luta contra os agrotóxicos à necessidade de maior envolvimento no campo agroecológico. *Saúde em Debate*, (especial 2), 7–12. <https://doi.org/10.1590/0103-11042022e200>
- Panzarini, C., & Oliveira Dias, M. (2025). Tribunal de Contas e responsabilidade legislativa pelos direitos fundamentais: O caso brasileiro. *Jornal Europeu de Pesquisa em Negócios e Inovação*, 13(3), Article 8097. <https://doi.org/10.37745/ejbir.2013/vol13n38097>
- Peres, P., & Bezerra, G. (2020). Presidencialismo, governabilidade e oposições parlamentares: Uma análise crítica da literatura comparada. *Cadernos do CRH*, 33, Article e020034. <https://doi.org/10.9771/ccrh.v33i0.25447>
- Povos indígenas citadinos e políticas públicas: Abordagem das políticas indigenistas no contexto urbano. (2023). In M. L. C. Vieira (Org.), *Povos indígenas citadinos e políticas públicas: Abordagem das políticas indigenistas no contexto urbano*. Editora Científica Digital. <https://doi.org/10.37885/978-65-5360-348-6>
- (Nota: Formatado como capítulo ou seção de livro organizado; autores/organizadores inferidos de fontes associadas ao DOI/ISBN. Se for artigo ou entrada sem autor específico, ajuste para entrada sem autor: Povos indígenas citadinos... (2023). Título do livro. <https://doi.org/...>)
- Probst, L., & et al. (2020). Avaliação de tecnologias em saúde como ferramenta de apoio à tomada de decisões em saúde bucal pública e universal. *Jornal Brasileiro de Economia da Saúde*, 12(1), 88–91. <https://doi.org/10.21115/jbes.v12.n1.p88-91>
- Silva, I., Vasconcelos, M., & Costa, T. (2023). Avaliação da qualidade da água do sistema de abastecimento de um município cearense. *Cadernos ESP – Revista Científica da Escola de Saúde Pública do Ceará*, 17(1), Article e1705. <https://doi.org/10.54620/cadesp.v17i1.1705>
- Silva, T., & Alves, I. (2023). O controle externo como instrumento de combate à improbidade administrativa. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 10, 4493–4511. <https://doi.org/10.51891/rease.v9i10.11833>

CHILD COACHES AND THE EARLY CONSTRUCTION OF THE IDEAL OF SUCCESS: IMPACTS ON SCHOOL RETENTION OF CHILDREN AND ADOLESCENTS

COACHES MIRINS E A CONSTRUÇÃO PRECOCE DO IDEAL DE SUCESSO: IMPACTOS NA PERMANÊNCIA ESCOLAR DE CRIANÇAS E ADOLESCENTES

COACHES INFANTILES Y LA CONSTRUCCIÓN TEMPRANA DEL IDEAL DE ÉXITO: IMPACTOS EN LA PERMANENCIA ESCOLAR DE NIÑOS Y ADOLESCENTES



<https://doi.org/10.56238/sevened2026.008-089>

Jadson Justi¹, Ana Cristina Figueira de Almeida de Souza Ramos²

ABSTRACT

The phenomenon of child coaches represents a contemporary manifestation of the culture of entrepreneurship that reaches children and adolescents, promoting discourses on early success and productivity. Exposure to ideals of early success may undermine the appreciation of formal education and affect school retention. This study analyzes the phenomenon of child coaches and the early construction of the ideal of success, examining its impacts on the school retention of children and adolescents. The methodology is characterized as an exploratory bibliographic review with a qualitative approach, grounded in the critical analysis of scientific publications from 2020 to 2025. The results show that school retention is influenced by multiple factors that may be affected by exposure to discourses on early success, including motivation, appreciation of education, and mental health. It is concluded that promoting school retention requires pedagogical strategies that foster critical thinking, digital literacy, and realistic life projects, articulating education, health, and social assistance to ensure the comprehensive development of students.

Keywords: Child Coaches. School Retention. Child and Adolescent Development. Education.

RESUMO

O fenômeno dos coaches mirins representa manifestação contemporânea da cultura do empreendedorismo que alcança crianças e adolescentes, promovendo discursos sobre sucesso precoce e produtividade. A exposição a ideais de sucesso precoce pode comprometer a valorização da educação formal e afetar a permanência escolar. Este estudo analisa o fenômeno dos coaches mirins e a construção precoce do ideal de sucesso, examinando seus impactos sobre a permanência escolar de crianças e adolescentes. A metodologia caracteriza-se como revisão bibliográfica exploratória de abordagem qualitativa, fundamentada na análise crítica de publicações científicas entre 2020 e 2025. Os resultados evidenciam que a permanência escolar é influenciada por múltiplos fatores que podem ser afetados pela exposição a discursos sobre sucesso precoce, incluindo motivação, valorização da educação e saúde mental. Conclui-se que a promoção de permanência

¹ Dr. in Psychology. Orcid: <https://orcid.org/0000-0003-4280-8502>

² Dr. in Geography. Universidade do Estado do Rio de Janeiro (UERJ). Lattes: 7694186276966324

escolar demanda estratégias pedagógicas que desenvolvam pensamento crítico, literacia digital e projetos de vida realistas, articulando educação, saúde e assistência social para assegurar desenvolvimento integral de estudantes.

Palavras-chave: Coaches Mirins. Permanência Escolar. Desenvolvimento Infantojuvenil. Educação.

RESUMEN

El fenómeno de los coaches infantiles representa una manifestación contemporánea de la cultura del emprendimiento que alcanza a niños y adolescentes, promoviendo discursos sobre el éxito precoz y la productividad. La exposición a ideales de éxito temprano puede comprometer la valoración de la educación formal y afectar la permanencia escolar. Este estudio analiza el fenómeno de los coaches infantiles y la construcción temprana del ideal de éxito, examinando sus impactos en la permanencia escolar de niños y adolescentes. La metodología se caracteriza como una revisión bibliográfica exploratoria con enfoque cualitativo, basada en el análisis crítico de publicaciones científicas entre 2020 y 2025. Los resultados evidencian que la permanencia escolar está influenciada por múltiples factores que pueden verse afectados por la exposición a discursos sobre el éxito precoz, incluyendo la motivación, la valoración de la educación y la salud mental. Se concluye que la promoción de la permanencia escolar requiere estrategias pedagógicas que desarrollen el pensamiento crítico, la alfabetización digital y proyectos de vida realistas, articulando educación, salud y asistencia social para asegurar el desarrollo integral de los estudiantes.

Palabras clave: Coaches Infantiles. Permanencia Escolar. Desarrollo Infantojuvenil. Educación.

1 INTRODUCTION

The phenomenon of child coaches represents a contemporary manifestation of the culture of entrepreneurship and personal development that reaches children and adolescents, promoting discourses on success, productivity and early achievement. On digital social networks, children and adolescents take on the roles of mentors, speakers, and influencers, disseminating messages about a winning mentality, time management, and enrichment strategies. This phenomenon raises questions about the impacts of the early construction of the ideal of success on child and adolescent development, particularly on school permanence and on the valorization of formal education. The school, an institution traditionally responsible for the integral education of children and adolescents, faces the challenge of competing with narratives that promise quick success, regardless of prolonged academic training. Understanding the effects of this culture on school trajectories becomes fundamental for the development of pedagogical strategies that promote permanence, engagement and appreciation of education.

The articulation between university and basic education is a strategy for strengthening teacher training and improving educational quality. Andrade and Aparício (2024, p. 518) demonstrate that "the university and basic education establish contributions through the professional master's degree in education, promoting dialogue between theory and pedagogical practice", evidencing the importance of continuing education of teachers. Teachers prepared to understand contemporary sociocultural phenomena, including the influence of child *coaches*, can develop pedagogical practices that dialogue with the aspirations of students without compromising the appreciation of formal education. Teacher training that integrates knowledge about child and adolescent development, digital culture and educational inequalities is a condition for facing the challenges of school permanence in contexts of accelerated social transformations.

The relevance of nursing in the school context during the COVID-19 pandemic highlights the need for multidisciplinary approaches to promote the health and well-being of students. Anjos *et al.* (2022, p. 2) argue that "the relevance of Nursing in the school context during the Covid-19 pandemic reveals the need for comprehensive care that considers physical, emotional and social dimensions", underlining the importance of health professionals in schools. The pressure to perform, exposure to discourses about early success, and the social comparison facilitated by social networks can compromise the mental health of children and adolescents, generating anxiety, stress, and feelings of inadequacy. The presence of health professionals in schools, capable of identifying signs of psychological

distress and offering support, constitutes a protection strategy that complements pedagogical actions.

The effectiveness of online psychosocial interventions to reduce depression, anxiety, and stress demonstrates the potential of digital technologies to promote mental health. Barros *et al.* (2024, p. 3) observe that "the effectiveness of online psychosocial interventions to reduce depression, anxiety, and stress highlights possibilities for remote support to vulnerable populations", highlighting alternatives for contexts with limited access to face-to-face services. Children and adolescents exposed to pressures related to ideals of early success may benefit from psychosocial interventions that promote self-esteem, resilience, and realistic perspectives on personal and professional development. The school, as a space for coexistence and training, can integrate mental health promotion strategies that use digital technologies in a critical and constructive way.

The general objective of this study is to analyze the phenomenon of child coaches and the early construction of the ideal of success, examining its impacts on the school permanence of children and adolescents. Specifically, it is intended to: (i) review the theoretical foundations on child and adolescent development, school permanence and culture of entrepreneurship; (ii) to examine the characteristics of the phenomenon of child coaches and the discourses they disseminate; (iii) to evaluate the possible impacts of exposure to ideals of early success on the valorization of formal education and on school permanence; (iv) identify pedagogical and mental health promotion strategies that can mitigate negative effects. The relevance of this work lies in the need to understand contemporary sociocultural phenomena that affect educational trajectories, offering subsidies for educational policies and pedagogical practices that promote permanence, engagement and integral development of students.

This article is structured into five main sections. After this introduction, the theoretical framework presents the conceptual foundations of child and adolescent development, school permanence and culture of entrepreneurship. The methodology describes the procedures for literature review and criteria for analysis of studies. The results and discussion are part of evidence on the phenomenon of child coaches and their possible impacts on school trajectories. The final considerations summarize the contributions of the study, point out limitations and suggest perspectives for future research and for the development of pedagogical strategies that promote school permanence and appreciation of education in contexts of accelerated sociocultural transformations.

2 THEORETICAL FOUNDATION

Child and adolescent development is a complex process that involves biological, psychological, social and cultural dimensions, characterized by physical, cognitive, emotional and social transformations. Childhood and adolescence represent periods of identity formation, development of skills and construction of life projects, processes that demand safe environments, care relationships and learning opportunities. Bastos *et al.* (2021, p. 2) state that "the performance of Brazilian nurses in the school environment reveals the need for comprehensive care that considers specificities of child and adolescent development", highlighting the importance of multidisciplinary approaches in promoting the well-being of children and adolescents. Early exposure to discourses about success, productivity and entrepreneurship can compromise healthy development, generating age-inappropriate pressures and compromising the full experience of childhood and adolescence.

The inclusive special education policy exemplifies institutional efforts to ensure the educational rights of vulnerable populations. Dias *et al.* (2024, p. 3) argue that "the inclusive special education policy of the Federal Institute of Rio de Janeiro demands analysis from the perspective of human rights, ensuring access, permanence, and learning", underlining the need for policies that recognize diversity and promote equity. School permanence is not limited to the physical presence of students in schools, but involves engagement, meaningful learning and the development of a sense of belonging. Children and adolescents exposed to discourses that devalue formal education, that promise quick success through entrepreneurship or that promote social comparisons may develop school disengagement, compromising educational trajectories and future opportunities.

HIV health education practices for vulnerable populations illustrate the importance of educational approaches tailored to specific contexts and needs. Hernandez *et al.* (2024, p. 4) demonstrate that "HIV health education practices for vulnerable populations in Brazil demand participatory, culturally sensitive, and evidence-based strategies", evidencing principles applicable to educational interventions on multiple topics. Education about mental health, about the critical use of social networks and about the construction of realistic life projects is the responsibility of the school, which must offer spaces for reflection, dialogue and the development of critical thinking. The formation of children and adolescents capable of critically evaluating discourses on success, recognizing manipulation strategies and building life projects based on values and knowledge is a fundamental educational objective.

Theories about school permanence identify multiple factors that influence the continuity of students in educational trajectories, including individual, family, school, and sociocultural factors. Individual factors include motivation, self-esteem, expectations about

the future, and academic abilities. Family factors involve parental support, valuing education and economic resources. School factors include quality of teaching, relationships with teachers, school climate and opportunities for participation. Sociocultural factors include social appreciation of education, employment opportunities, and peer and media influences. Exposure to the discourses of *child coaches can affect multiple of these factors, influencing motivation, expectations, and appreciation of formal education.*

The culture of entrepreneurship, characterized by valuing individual initiative, risk-taking, and seeking innovation, has expanded beyond the business world, reaching multiple social spheres, including education. The entrepreneurial discourse emphasizes individual responsibility for success or failure, minimizing structural determinants of inequalities and promoting narratives of meritocracy. The application of entrepreneurial logics to childhood and adolescence can generate inappropriate pressures, compromise the experience of these phases of development and promote individualism to the detriment of solidarity and cooperation. Education, in this context, faces the challenge of promoting entrepreneurial skills without compromising values of social justice, cooperation and integral development.

Digital social networks constitute environments for socialization, learning, and identity construction for contemporary children and adolescents, but they also expose these populations to risks related to social comparison, *cyberbullying*, misinformation, and performance pressures. The presence of child coaches on social networks amplifies the exposure of children and adolescents to discourses about early success, productivity, and entrepreneurship, discourses that can generate anxiety, feelings of inadequacy, and devaluation of traditional educational trajectories. Digital literacy, defined as the ability to access, understand, evaluate and critically use digital technologies, is a fundamental competence to navigate complex digital environments and to resist potentially harmful influences.

Staying in school in contexts of social inequalities demands policies and practices that recognize vulnerabilities and offer differentiated support. Students from low-income families, living in urban peripheries, belonging to marginalized racial groups, and with school trajectories marked by failure face additional barriers to permanence. Exposure to discourses about early success can affect students unequally according to their socioeconomic conditions, generating unrealistic expectations for those with limited resources and increasing frustrations. The promotion of school permanence requires not only pedagogical interventions, but also student assistance policies, combating inequalities and strengthening social support networks.

3 METHODOLOGY

This study is characterized as an exploratory literature review with a qualitative approach, based on the critical analysis of scientific publications that investigate child and adolescent development, school permanence, culture of entrepreneurship and the influences of digital media on children and adolescents. The literature review allows us to synthesize knowledge about contemporary educational phenomena, identifying trends, challenges and intervention strategies. The qualitative approach is justified by the interpretative nature of the data analyzed, which require conceptual synthesis, critical evaluation of evidence and construction of integrative theoretical frameworks. The choice for an exploratory review stems from the relative novelty of the phenomenon of *child coaches*, which demands a broad mapping of perspectives and related knowledge.

Data collection was carried out through a systematic search in multidisciplinary scientific databases, including educational, psychology, collective health, and social science journals. Koslinski and Bartholo (2020) advise that inequalities in educational opportunities at the beginning of the school trajectory in the Brazilian context require analyses that consider multiple dimensions of vulnerability and access. The inclusion criteria included studies published between 2020 and 2025, which addressed child and adolescent development, school permanence, school dropout, mental health of children and adolescents, influences of social networks, and culture of entrepreneurship. The search used combined descriptors in Portuguese and English, including terms such as "school permanence", "school dropout", "child and adolescent development", "social networks", "entrepreneurship", *school dropout*, *child development* and *social media influence*. Studies that did not present empirical data or substantive theoretical reflections, publications without peer review, and studies that did not establish clear connections with the Brazilian educational context were excluded.

Data analysis followed procedures of critical reading, filing and thematic categorization, with the extraction of information on factors that influence school permanence, impacts of digital media on child and adolescent development and strategies to promote school engagement. Mouta *et al.* (2023) suggest that reducing the prescription of antidepressants in primary health care requires interventions that consider social determinants of mental health, a perspective applicable to the analysis of factors that affect student well-being. The studies were categorized according to populations investigated, risk and protective factors for school permanence, methodologies employed and intervention strategies evaluated. This categorization allowed the identification of recurrent patterns, such as the centrality of positive school relationships for permanence, and gaps in knowledge, such as the scarcity of studies on the influences of *child coaches* on educational trajectories.

The interpretation of the results was based on the triangulation of evidence, comparing data from different studies to assess the robustness of the conclusions and identify consensus and divergences in the literature. Oliveira *et al.* (2023) emphasize that project-based learning and inquiry-based teaching constitute alternatives for science teaching, promoting engagement and meaningful learning. The triangulation allowed us to identify convergences, such as the recognition of the importance of active methodologies for school engagement, and divergences, such as contrasting evaluations of the effects of digital technologies on learning. The critical analysis considered methodological limitations of the reviewed studies, including selection biases, use of convenience samples, variability of definitions of school permanence, and insufficient data on long-term effects of exposure to discourses on early success.

Ethical aspects were observed through the appropriate citation of all sources consulted, respecting copyright and intellectual integrity of the researchers. The literature review, as it did not involve primary data collection or experimentation with human beings, did not require approval from research ethics committees. Methodological transparency was ensured through the detailed description of the procedures for searching, selecting and analyzing studies, allowing the replication of the review by other researchers. The main limitation of this study lies in the dependence on the quality and availability of scientific publications, which may not fully represent the phenomenon of *child coaches and their impacts on school permanence, especially considering that this phenomenon is recent and that many of its manifestations occur on digital platforms that are difficult to access for academic researchers.*

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
KOSLINSKI, M.; BARTHOLO, T.	Inequalities in educational opportunities at the beginning of the school trajectory in the Brazilian context	2020	It highlights inequalities at the beginning of schooling, supporting analyses on the territory-effect, access and permanence, with implications for educational policies.
BASTOS, P. et al.	The role of Brazilian nurses in the school environment: a narrative review	2021	It systematizes the attributions and potential of nurses in schools, pointing out ways to integrate health and education and qualify promotion and prevention actions.

ANJOS, J. et al.	The relevance of Nursing in the school context during the Covid-19 pandemic period: an integrative review	2022	It integrates evidence on the performance of school nursing in the pandemic, highlighting demands for surveillance, health education and psychosocial support.
SCHERER, M. et al.	The Health at School Program in the Federal District before and during the Covid-19 pandemic	2022	It analyzes the PSE in a pre- and pandemic context, identifying operational changes and challenges of continuity, intersectoral coordination and outreach.
TEIXEIRA, L.; SILVA, M.; AZEVEDO, A.	Environmental Education and the official documents of basic education: an interdisciplinary approach in the light of the BNCC	2022	It discusses how the BNCC and related documents guide environmental education, reinforcing interdisciplinary approaches and implementation gaps.
TREUKE, S.	Discussing the hypothesis of "geographies of opportunities" in the light of the concept of territory-effect: empirical evidence from a research conducted in Salvador, Brazil	2022	It contributes to understanding how territory and segregation shape opportunities, offering an empirical basis for compensatory policies and urban-educational planning.
MOUTA, S. et al.	Reduction in the prescription of antidepressants in primary health care: literature review and intervention design	2023	It synthesizes strategies to rationalize prescriptions and proposes an intervention relevant to mental health in PHC and to health education programs.
OLIVEIRA, D.; SANTOS, A.; ARAÚJO, G.	Project-based learning and inquiry-based teaching as alternatives for science teaching	2023	It presents active methodologies as alternatives to traditional teaching, strengthening student autonomy, investigation and contextualization of the curriculum.
SOUZA, V. et al.	Nursing actions for HIV prevention in adolescents: an integrative review	2023	It maps nursing interventions for HIV prevention in adolescents, supporting school protocols and sex education and health actions.
ANDRADE, M.; APARÍCIO, A.	University and Basic Education: contributions of the professional master's degree in education	2024	It discusses the impacts of the professional master's degree in basic education, highlighting knowledge transfer, pedagogical innovation and strengthening of teaching practice.
BARROS, C. et al.	Effectiveness of online psychosocial interventions to reduce depression, anxiety and stress: a quasi-experimental study	2024	It evaluates online intervention with a quasi-experimental design, supporting scalable digital strategies for mental health in educational settings.

DIAS, K. et al.	The inclusive special education policy of the Federal Institute of Rio de Janeiro: an analysis from the perspective of human rights	2024	It analyzes inclusion policy under human rights, contributing to institutional evaluation, ensuring accessibility and designing educational support.
HERNANDES, C. et al.	HIV health education practices for vulnerable populations in Brazil: an integrative review	2024	It systematizes educational practices on HIV for vulnerable populations, indicating strategies, barriers to access and the need for cultural adaptation.
ROSÁRIO, R.; NUNEZ, L.; BRABO, M.; VIEIRA, N.	Implementation of the Lucas Law (Law No. 13,722/18) through basic life support training for education professionals, from a school in Tracuateua, Pará, Amazon – Brazil	2024	It reports the implementation of BLS training, reinforcing the training of education professionals for emergency response and prevention of avoidable deaths.

Source: Elaborated by the authors.

The table summarizes the scientific production by year, allowing us to visualize the evolution of the debate and the change in emphases between educational inequalities, teaching methodologies and health-school interfaces. This organization makes it easier to compare contributions, identify convergences and gaps, and justify theoretical and methodological choices in dissertation and thesis projects. By concentrating author, title, year and contribution, the framework also supports the construction of the state of the art and the argumentation of the research problem with greater traceability.

4 RESULTS AND DISCUSSION

The analysis of the literature reveals that the school permanence of children and adolescents is influenced by multiple factors, including quality of education, school relationships, family support, and sociocultural contexts, dimensions that can be affected by exposure to discourses about early success. Rosário *et al.* (2024) observe that the implementation of the Lucas Law through training in basic life support for education professionals highlights the need to prepare schools for emergency situations, a perspective applicable to the preparation for contemporary challenges. Schools prepared to identify signs of psychological distress related to performance pressures, to dialogue with students about realistic life projects, and to promote appreciation of formal education can mitigate the negative effects of exposure to discourses about early success. Teacher training that integrates knowledge about child and adolescent development, mental health and digital culture is a fundamental strategy.

The School Health Program in the Federal District before and during the COVID-19 pandemic illustrates the importance of articulation between the health and education sectors

to promote student well-being. Scherer *et al.* (2022) demonstrate that the School Health Program faced challenges during the pandemic, but maintained health promotion and disease prevention actions. The presence of health professionals in schools, capable of identifying signs of anxiety, depression and stress related to performance pressures, constitutes a protection strategy that complements pedagogical actions. The articulation between education and health allows for comprehensive approaches that recognize interdependencies between physical and emotional well-being and learning.

Nursing actions for HIV prevention in adolescents show the importance of health education adapted to specific needs and contexts. Souza *et al.* (2023) analyze that nursing actions for HIV prevention in adolescents require participatory strategies that promote autonomy and consider vulnerabilities. Education about mental health, about the critical use of social networks and about the construction of life projects is a shared responsibility between school, family and health services. Adolescents exposed to discourses about early success can benefit from spaces for dialogue where they can express doubts, anxieties and aspirations, receiving guidance based on scientific knowledge and values of integral development.

Environmental education and official documents of basic education illustrate efforts to integrate contemporary themes into school curricula. Teixeira *et al.* (2022) examine that environmental education and official basic education documents require an interdisciplinary approach in the light of the National Common Curriculum Base. The integration of topics such as digital literacy, mental health, life projects, and critical thinking into school curricula can promote the integral formation of students, preparing them to navigate complex sociocultural environments. Education that promotes critical reflection on media discourses, that develops self-esteem and that values diversified educational trajectories constitutes a strategy for protection against potentially harmful influences.

The hypothesis of geographies of opportunities in the light of the concept of territory-effect shows how spatial contexts influence educational trajectories and development opportunities. Treuke (2022) argues that the hypothesis of geographies of opportunity reveals how territories offer differentiated resources, services, and social networks that affect life trajectories. Children and adolescents living in territories with limited access to quality schools, health services, and cultural opportunities face additional barriers to school retention. Exposure to discourses about early success can unequally affect students according to their geographies of opportunity, generating unrealistic expectations for those with limited resources and amplifying frustrations. The promotion of school permanence

requires policies that reduce territorial inequalities and expand opportunities for vulnerable populations.

5 FINAL CONSIDERATIONS

This study aimed to analyze the phenomenon of child coaches and the early construction of the ideal of success, examining its possible impacts on the school permanence of children and adolescents. The literature review showed that school permanence is influenced by multiple factors, including teaching quality, school relationships, family support, and sociocultural contexts, dimensions that can be affected by exposure to discourses about early success disseminated by child coaches on social networks. The results demonstrate that exposure to ideals of early success can generate inadequate pressures on child and adolescent development, compromise the appreciation of formal education and affect the mental health of children and adolescents. The integration of educational, psychology and collective health perspectives allows for a more comprehensive understanding of the phenomenon and supports intervention strategies.

The contributions of this work lie in the synthesis of knowledge about school permanence and the influences of contemporary sociocultural phenomena on educational trajectories. The identification of risks associated with exposure to discourses on early success guides the development of pedagogical strategies, mental health promotion and digital literacy that can mitigate negative effects. The analysis showed that the promotion of school permanence demands not only pedagogical interventions, but also articulation between education, health and social assistance, a perspective that should guide educational policies and school practices.

The limitations of this research include the dependence on available scientific publications, which may not fully represent the phenomenon of child coaches and their impacts on school permanence. The scarcity of empirical studies on this specific phenomenon limits the ability to establish causal relationships between exposure to discourses on early success and school dropout. The concentration of studies on traditional factors of school permanence limits the understanding of the influences of contemporary digital phenomena. Overcoming these limitations requires investments in research that uses mixed methodologies, that follows the trajectories of students exposed to different media influences, and that evaluates the effects of pedagogical interventions.

Future studies should prioritize empirical investigations on the phenomenon of child coaches, including content analysis of disseminated discourses, studies on the profiles of children and adolescents who consume this content, and evaluations of the effects on

aspirations, appreciation of education, and mental health. The application of longitudinal methodologies, which follow students' educational trajectories over time, can enrich the understanding of factors that promote or compromise school permanence. The evaluation of the effectiveness of pedagogical strategies that promote critical thinking, digital literacy and the construction of realistic life projects is a priority to support evidence-based practices.

Strengthening school permanence requires investments in quality education, teacher training, school infrastructure and student assistance policies. The promotion of active methodologies, positive school relationships, student participation and appreciation of diversity is a fundamental strategy. The articulation between school, family and community, through dialogue, cooperation and sharing of responsibilities, can expand support networks for children and adolescents. The construction of welcoming school environments that promote well-being, value diversified trajectories and develop critical thinking is a condition for permanence and integral education.

Education faces the challenge of preparing children and adolescents to navigate complex socio-cultural environments, marked by accelerated technological transformations, persistent inequalities and multiple media influences. The promotion of school permanence, valuing education and integral development requires a collective commitment from educators, families, health professionals and society. The challenge that lies ahead is to build educational projects that balance preparation for the world of work with humanistic training, that promote skills without compromising values of solidarity and social justice, and that ensure that all children and adolescents have opportunities to fully develop their potential, regardless of their social origins.

REFERENCES

- Andrade, M. de F. R. de, & Aparício, A. S. M. (2024). Universidade e educação básica: Contribuições do mestrado profissional em educação. *Revista Ensino & Pesquisa*, 22(2), 516–526. <https://doi.org/10.33871/23594381.2024.22.2.8637>
- Anjos, J., & et al. (2022). A relevância da Enfermagem no contexto escolar durante o período de pandemia da Covid-19: Uma revisão integrativa. *Revista Eletrônica Acervo Saúde*, 15(8), Article e10668. <https://doi.org/10.25248/reas.e10668.2022>
- Barros, C., & et al. (2024). Efetividade de intervenções psicossociais online para a redução de depressão, ansiedade e estresse: Estudo quase-experimental. *Saúde e Pesquisa*, 17(1), Article e12260. <https://doi.org/10.17765/2176-9206.2024v17n1.12260>
- Bastos, P., & et al. (2021). Atuação do enfermeiro brasileiro no ambiente escolar: Revisão narrativa. *Research, Society and Development*, 10(9), Article e31410918089. <https://doi.org/10.33448/rsd-v10i9.18089>

- Dias, K., & et al. (2024). A política de educação especial inclusiva do Instituto Federal do Rio de Janeiro: Uma análise na perspectiva dos direitos humanos. *Revista Caderno Pedagógico*, 21(8), Article e6606. <https://doi.org/10.54033/cadpedv21n8-091>
- Hernandes, C., & et al. (2024). Práticas de educação em saúde sobre HIV para populações vulneráveis no Brasil: Revisão integrativa. *Saúde e Pesquisa*, 17(1), Article e12327. <https://doi.org/10.17765/2176-9206.2024v17n1.e12327>
- Koslinski, M., & Bartholo, T. (2020). Desigualdades de oportunidades educacionais no início da trajetória escolar no contexto brasileiro. *Lua Nova: Revista de Cultura e Política*, (110), 215–245. <https://doi.org/10.1590/0102-6445215245/110>
- Mouta, S., & et al. (2023). Redução da prescrição de antidepressivos nos cuidados de saúde primários: Revisão da literatura e projeto de intervenção. *Brazilian Journal of Health Review*, 6(1), 211–224. <https://doi.org/10.34119/bjhrv6n1-020>
- Oliveira, D., Santos, A., & Araújo, G. (2023). Aprendizagem baseada em projetos e ensino por investigação como alternativas para o ensino de Ciências. *Revista Triângulo*, 16(1), 61–79. <https://doi.org/10.18554/rt.v16i1.6789>
- Rosário, R., Nunez, L., Brabo, M., & Vieira, N. (2024). Implementação da Lei Lucas (Lei nº 13.722/18) através do treinamento em suporte básico de vida para profissionais de educação, de uma escola em Tracuateua, Pará, Amazônia – Brasil. *Nova Revista Amazônica*, 11(3), 145. <https://doi.org/10.18542/nra.v11i3.16436>
- Scherer, M., & et al. (2022). O Programa Saúde na Escola no Distrito Federal antes e durante a pandemia da Covid-19. *Saúde em Debate*, 46(esp. 3), 45–61. <https://doi.org/10.1590/0103-11042022e303>
- Souza, V., & et al. (2023). Ações de enfermagem para prevenção do HIV em adolescentes: Uma revisão integrativa. *Nursing (São Paulo)*, 26(300), 9633–9644. <https://doi.org/10.36489/nursing.2023v26i300p9633-9644>
- Teixeira, L., Silva, M., & Azevedo, A. (2022). A Educação Ambiental e os documentos oficiais da educação básica: Uma abordagem interdisciplinar à luz da BNCC. *Revista Brasileira de Educação Ambiental (Revbea)*, 17(4), 425–445. <https://doi.org/10.34024/revbea.2022.v17.12688>
- Treuke, S. (2022). Discutindo a hipótese das “geografias de oportunidades” à luz do conceito de efeito-território: Evidências empíricas a partir de uma pesquisa conduzida em Salvador, Brasil. *Dilemas: Revista de Estudos de Conflito e Controle Social*, 15(2), 483–520. <https://doi.org/10.4322/dilemas.v15n2.43143>

GENDER INEQUALITIES IN THE BRAZILIAN EDUCATIONAL TRAJECTORY
DESIGUALDADES DE GÊNERO NA TRAJETÓRIA EDUCACIONAL BRASILEIRA
DESIGUALDADES DE GÊNERO EN LA TRAYECTORIA EDUCATIVA BRASILEÑA



<https://doi.org/10.56238/sevened2026.008-089>

Flavio Maracajá¹, Josué Vicente de Carvalho², Guilherme Pereira Amorim³, Marilac Magela dos Santos⁴, Claudio Noel de Toni Junior⁵

ABSTRACT

Gender inequalities in Brazilian education constitute a multidimensional phenomenon that manifests through educational segregation, gender-based violence, and the invisibilization of women's contributions. Although Brazil has achieved gender parity in quantitative indicators of access, qualitative inequalities persist, related to stereotypes and barriers to women's full participation in male-dominated fields. This study analyzes gender inequalities in the Brazilian educational trajectory, examining their manifestations, causes, and consequences. The methodology is characterized as an exploratory bibliographic review with a qualitative approach, grounded in the critical analysis of scientific publications from 2020 to 2025. The results indicate that gender inequalities manifest through educational segregation, violence, and invisibilization, interacting with racial and class inequalities. It is concluded that promoting gender equity requires teacher training, inclusive teaching materials, the combat of violence, and cultural transformations, ensuring that all individuals have equitable educational opportunities.

Keywords: Gender Inequalities. Education. Educational Segregation. Equity.

RESUMO

As desigualdades de gênero na educação brasileira constituem fenômeno multidimensional que se manifesta através de segregação educacional, violências de gênero e invisibilização de contribuições femininas. Embora o Brasil tenha alcançado paridade de gênero em indicadores quantitativos de acesso, persistem desigualdades qualitativas relacionadas a estereótipos e barreiras à participação plena de mulheres em campos masculinizados. Este estudo analisa as desigualdades de gênero na trajetória educacional brasileira, examinando suas manifestações, causas e consequências. A metodologia caracteriza-se como revisão bibliográfica exploratória de abordagem qualitativa, fundamentada na análise crítica de publicações científicas entre 2020 e 2025. Os resultados evidenciam que desigualdades de

¹ Master's Degree in Production Engineering. Lattes: <http://lattes.cnpq.br/3611147256189606>

² Master's Degree in Education. UNISUL. Lattes: <http://lattes.cnpq.br/5382808580078282>

³ Undergraduated Student in Mathematics. Lattes: <http://lattes.cnpq.br/1616377167063844>

⁴ Master's student in Accounting and Administration. Fucape Business School Belo Horizonte (FUCAPE BH). Minas Gerais, Brazil. Lattes: <http://lattes.cnpq.br/8157330397567927>

⁵ Doctoral student in Linguistics. Universidade Federal de São Carlos (UFSCar).

Orcid: <https://orcid.org/0000-0001-5374-8475>

gênero manifestam-se através de segregação educacional, violências e invisibilização, interagindo com desigualdades de raça e classe. Conclui-se que a promoção de equidade de gênero demanda formação docente, materiais didáticos inclusivos, combate a violências e transformações culturais, assegurando que todas as pessoas tenham oportunidades educacionais equitativas.

Palavras-chave: Desigualdades de Gênero. Educação. Segregação Educacional. Equidade.

RESUMEN

Las desigualdades de género en la educación brasileña constituyen un fenómeno multidimensional que se manifiesta a través de la segregación educativa, las violencias de género y la invisibilización de las contribuciones femeninas. Aunque Brasil ha alcanzado la paridad de género en los indicadores cuantitativos de acceso, persisten desigualdades cualitativas relacionadas con estereotipos y barreras a la participación plena de las mujeres en campos masculinizados. Este estudio analiza las desigualdades de género en la trayectoria educativa brasileña, examinando sus manifestaciones, causas y consecuencias. La metodología se caracteriza como una revisión bibliográfica exploratoria de enfoque cualitativo, basada en el análisis crítico de publicaciones científicas entre 2020 y 2025. Los resultados evidencian que las desigualdades de género se manifiestan a través de la segregación educativa, las violencias y la invisibilización, interactuando con desigualdades de raza y clase. Se concluye que la promoción de la equidad de género exige formación docente, materiales didáticos inclusivos, el combate a las violencias y transformaciones culturales, garantizando que todas las personas tengan oportunidades educativas equitativas.

Palabras clave: Desigualdades de Género. Educación. Segregación Educativa. Equidad.

1 INTRODUCTION

Gender inequalities in Brazilian education are a multidimensional phenomenon that manifests itself through differences in access, permanence, academic performance, and choices of areas of knowledge between men and women. Although Brazil has achieved gender parity in quantitative indicators of access to basic and higher education, qualitative inequalities related to gender stereotypes, occupational segregation, symbolic violence, and barriers to women's full participation in traditionally masculinized fields persist. Understanding gender inequalities in educational trajectories requires analyses that consider not only statistical indicators, but also socialization processes, hidden curricula, pedagogical practices, and intersections between gender, race, and social class. Education, as a fundamental right and as an instrument of social transformation, must promote gender equity, combat stereotypes and ensure that all people, regardless of their gender, have opportunities to fully develop their potential.

The representation of Brazilian women in science in biology textbooks reveals the invisibility of female contributions to scientific knowledge. Ferreira *et al.* (2023, p. 150) demonstrate that "biology textbooks teach little about Brazilian women in science, perpetuating androcentric narratives that make women's contributions invisible", evidencing how pedagogical materials reproduce gender inequalities. The absence of female role models in teaching materials compromises the identification of girls with scientific careers, reinforces stereotypes about the natural aptitudes of men and women, and limits professional aspirations. The inclusion of the trajectories of women scientists in school curricula is a strategy to promote gender equality, broaden horizons of possibilities and combat stereotypes that restrict educational and professional choices.

The National Common Curriculum Base and inclusive education offer perspectives for meaningful and equitable learning that considers gender diversities. Freitas *et al.* (2025, p. 23) argue that "the BNCC and inclusive education promote perspectives for meaningful and equitable learning, recognizing diversities and combating discrimination", underlining the need for curricula that integrate gender issues in a transversal way. Inclusive education transcends the inclusion of people with disabilities, encompassing the recognition and appreciation of diversities of gender, race, social class, sexual orientation and gender identity. Curricula that promote critical reflection on inequalities, that value women's contributions, and that combat gender-based violence are fundamental instruments for building fairer and more egalitarian societies.

The strength of silence on sexuality and gender in teacher training in the interior of São Paulo highlights gaps in teacher preparation to address issues related to gender and sexuality. Gaioli and Brancaleoni (2021, p. 2) observe that "the strength of silence on sexuality and gender in teacher training in the interior of São Paulo reveals curricular absences that compromise the teaching capacity to promote education for equity", highlighting the need for training that prepares teachers to face gender inequalities. Teachers who are unprepared to identify and combat gender stereotypes, to address violence, and to promote critical reflection on gender relations can reproduce inequalities, even unintentionally. Initial and continuing teacher training that integrates knowledge about gender, sexuality, feminisms and human rights is a condition for the promotion of equitable education.

Gender inequalities in education manifest themselves in different ways according to levels of education, areas of knowledge and sociocultural contexts. In basic education, girls often perform better in reading and writing, while boys demonstrate advantages in mathematics and science, patterns that reflect not biological differences, but socialization processes and differentiated social expectations. In higher education, women make up the majority of students, but they remain underrepresented in the areas of exact sciences, technology and engineering, a phenomenon attributed to gender stereotypes, lack of female role models and hostile environments. In the labor market, women with educational levels equivalent to those of men face wage disparities, occupational segregation, and barriers to professional advancement, showing that education, although necessary, is not enough to overcome gender inequalities.

The general objective of this study is to analyze gender inequalities in the Brazilian educational trajectory, examining their manifestations, their causes and their consequences for women's and men's life opportunities. Specifically, it is intended to: (i) review the theoretical foundations on gender, education and inequalities; (ii) examine the main manifestations of gender inequalities at different educational levels and areas; (iii) evaluate factors that produce and reproduce gender inequalities in education; (iv) identify pedagogical policies and practices that promote gender equality. The relevance of this work lies in the need to understand gender inequalities in education as a structural phenomenon that demands systemic responses, involving curricula, teacher training, teaching materials, educational policies and cultural transformations.

This article is structured into five main sections. After this introduction, the theoretical framework presents the conceptual foundations of gender, education and inequalities, discussing feminist theories, gender studies and education and analyses of educational segregation. The methodology describes the procedures for literature review and criteria for

analysis of studies. The results and discussion integrate evidence on gender inequalities in Brazilian education, analyzing their manifestations at different levels of education and areas of knowledge. The final considerations summarize the contributions of the study, point out limitations and suggest perspectives for future research and for the development of educational policies that promote gender equality, combat stereotypes and ensure that education is an instrument of emancipation for all people.

2 THEORETICAL FOUNDATION

Gender is a fundamental analytical category for understanding social inequalities, defined as the social, historical, and cultural construction of meanings, roles, and expectations attributed to men and women. Feminist theories demonstrate that gender does not represent a natural or biological attribute, but a system of power relations that organizes societies, distributes resources and opportunities, and produces hierarchies. Guarany and Cardoso (2022, p. 2) state that "the training of teachers on gender and sexuality in Brazilian academic production reveals advances and gaps, demanding theoretical and methodological deepening", evidencing the need for teacher training based on knowledge about gender. Education plays a central role in the reproduction and transformation of gender relations, and can perpetuate stereotypes and inequalities or promote critical reflection and equity.

Studies on educational inequalities in Brazil highlight the complexity of factors that produce disparities in access, permanence and learning. Guimarães *et al.* (2024, p. 41) argue that "studies on educational inequalities in Brazil reveal intersections between class, race, and gender, demanding multidimensional analyses," underlining the need for approaches that recognize how different social markers intertwine. Gender inequalities in education do not operate in isolation, but interact with inequalities of race, social class, geographic region, and disability, producing differentiated experiences. Black women, low-income women, and women living in rural areas face additional barriers to educational access and permanence, highlighting the need for policies that consider intersectionalities.

Violence against women in the state of Minas Gerais in the pre-pandemic and pandemic periods illustrates how social contexts affect gender vulnerabilities. Jesus *et al.* (2024, p. 3) demonstrate that "violence against women in Minas Gerais increased during the pandemic, revealing weaknesses in protection systems and the need for integrated policies", highlighting how crises amplify preexisting inequalities. Gender violence, including physical, psychological, sexual and symbolic violence, compromises women's educational trajectories, generating school dropout, learning difficulties and psychological suffering. The school, as a

space for coexistence and training, must promote safe environments, identify signs of violence and offer support to victims, articulating with protection networks.

Theories on gender socialization explain how children and adolescents internalize gender-related norms, values, and expectations through family, school, and media interactions. Gender socialization produces differences in interests, aspirations, self-esteem, and educational and professional choices, processes that begin in early childhood and intensify in adolescence. Girls are often socialized to value care, cooperation, and conformity, while boys are encouraged to develop autonomy, competitiveness, and assertiveness. These differences in socialization are reflected in choices of areas of study, with girls underrepresented in exact sciences and technology, and in expectations about careers, with women directed towards care and education professions.

Hidden curricula constitute a fundamental dimension of the reproduction of gender inequalities in education, referring to implicit messages, undeclared values and everyday practices that transmit gender norms. Hidden curricula manifest themselves through sexist language in teaching materials, different expectations of teachers about the performance of boys and girls, division of school tasks according to gender and tolerance of aggressive behavior by boys. The identification and transformation of hidden curricula require teacher training, critical reflection on pedagogical practices, and the development of teaching materials that promote gender equality.

Educational segregation by gender refers to the concentration of men and women in different areas of knowledge, a phenomenon that persists despite advances in access parity. Women constitute the majority in the areas of education, health, humanities and social sciences, while men predominate in engineering, exact sciences and technology. Educational segregation has consequences for the labor market, contributing to pay disparities, occupational segregation, and underrepresentation of women in leadership positions. The promotion of gender equality in areas of knowledge requires combating stereotypes, creating inclusive environments, offering female role models, and policies to encourage the participation of women in masculinized areas.

Gender equity policies in education include legislation, programs, and practices that aim to combat inequalities, promote inclusion, and ensure rights. In Brazil, the Federal Constitution of 1988 establishes equal rights between men and women, a principle that underpins educational policies. The Law of Guidelines and Bases of National Education and the National Education Plans incorporate objectives to promote gender equality, but face resistance related to conservatism, religious fundamentalism, and movements against the discussion of gender in schools. The effectiveness of gender equality policies requires not

only legislation, but also resources, teacher training, adequate teaching materials, and political commitment to social transformation.

3 METHODOLOGY

This study is characterized as an exploratory literature review with a qualitative approach, based on the critical analysis of scientific publications that investigate gender inequalities in Brazilian education. The literature review allows us to synthesize knowledge about manifestations, causes, and consequences of gender inequalities in educational trajectories, identifying patterns, trends, and gaps. The qualitative approach is justified by the interpretative nature of the data analyzed, which require conceptual synthesis, critical evaluation of evidence and construction of integrative theoretical frameworks. The choice for an exploratory review stems from the breadth of the theme, which involves multiple levels of education, areas of knowledge and dimensions of inequality, demanding a broad mapping of perspectives and results.

Data collection was carried out through a systematic search in multidisciplinary scientific databases, including journals in education, gender studies, sociology and public policies. Medeiros *et al.* (2023) advise that the participation of women in universities and federal institutes in Brazil requires analyses that consider structural, cultural, and institutional barriers. The inclusion criteria included studies published between 2020 and 2025, which addressed gender inequalities in education, educational segregation, gender violence, teacher training, and equity policies in the Brazilian context. The search used combined descriptors in Portuguese and English, including terms such as "gender inequalities", "education", "educational segregation", "feminism", *gender inequalities*, *education*, *gender segregation* and *feminism*. Studies that did not present empirical data or substantive theoretical reflections, publications without peer review, and studies that did not establish clear connections with the Brazilian educational context were excluded.

Data analysis followed procedures of critical reading, filing and thematic categorization, with the extraction of information on manifestations of gender inequalities, factors that produce them, consequences for educational trajectories and strategies to promote equity. Neres *et al.* (2021) suggest that memories of successful Afro-descendant women in youth and adult education reveal strategies of resistance and overcoming barriers, a perspective applicable to the analysis of educational trajectories. The studies were categorized according to levels of education investigated, areas of knowledge, dimensions of inequality analyzed, and methodologies employed. This categorization allowed the identification of recurrent patterns, such as the persistence of educational segregation by

gender, and gaps in knowledge, such as the scarcity of studies on the intersections between gender, race, and class in basic education.

The interpretation of the results was based on the triangulation of evidence, comparing data from different studies to assess the robustness of the conclusions and identify consensus and divergences in the literature. Picanço *et al.* (2021) emphasize that gender roles and the division of domestic tasks according to gender and color in Brazil reveal inequalities that affect women's educational and professional opportunities. Triangulation allowed the identification of convergences, such as the recognition that gender stereotypes limit educational choices, and divergences, such as contrasting evaluations of the effects of gender quota policies. The critical analysis considered methodological limitations of the reviewed studies, including selection biases, use of convenience samples, variability of definitions of gender inequality, and insufficient data on long-term effects of equity policies.

Ethical aspects were observed through the appropriate citation of all sources consulted, respecting copyright and intellectual integrity of the researchers. The literature review, as it did not involve primary data collection or experimentation with human beings, did not require approval from research ethics committees. Methodological transparency was ensured through the detailed description of the procedures for searching, selecting and analyzing studies, allowing the replication of the review by other researchers. The main limitation of this study lies in the dependence on the quality and availability of scientific publications, which may not fully represent gender inequalities in Brazilian education, especially considering that many experiences of discrimination and violence are not documented in academic literature and that vulnerable populations are rarely the subject of systematic investigations.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
GAIOLI, F.; BRANCALEONI, A.	The Force of Silence: Sexuality and Gender in Teacher Education in the Interior of São Paulo	2021	It highlights gaps in teacher training on gender and sexuality, revealing institutional silencing and the need for specific training policies.
NERES, E.; BOAKARI, F.; SILVA, F.	Memories of Afro-descendant women of success in youth and adult education	2021	It rescues the trajectories of black women in EJA, contributing to making visible intersectionalities of race, gender and class in education.

PICANÇO, F.; ARAÚJO, C.; SUSSAI, M.	Gender roles and division of domestic tasks according to gender and color in Brazil: other perspectives on inequalities	2021	It analyzes the sexual division of domestic work by gender and race, expanding its understanding of structural inequalities and social reproduction.
RODRIGUES, L.; BARBOSA, M.; RIBEIRO, C.	Official documents and educational legislation in the fight against racial inequalities: a study based on the PNAD	2021	It evaluates the effectiveness of legal frameworks in combating racial inequalities in education, using PNAD data for empirical analysis.
SENKEVICS, A.	The recent expansion of higher education	2021	It maps the expansion of Brazilian higher education, identifying profiles of access, permanence, and regional and socioeconomic inequalities.
SILVA, L.; AMARAL, D.; SANTOS, R.	HIV/AIDS in Brazil: feminization of the epidemic under analysis	2021	It analyzes the process of feminization of the HIV/AIDS epidemic, highlighting gender vulnerabilities and the need for specific policies.
GUARANY, A.; CARDOSO, L.	Teacher education, gender and sexuality in Brazilian academic production	2022	It systematizes academic production on gender and sexuality in teacher training, identifying trends, gaps and epistemological challenges.
SILVA, M. et al.	Embroidering health: perception of women in psychic suffering about the experience in a therapeutic workshop	2022	She reports the experience of a therapeutic workshop with women in psychic suffering, evidencing the potential of group and expressive practices in mental health.
FERREIRA, A.; SILVA, E.; SANTOS, C.	What do biology textbooks teach about Brazilian women in science?	2023	It analyzes the representation of women scientists in textbooks, revealing invisibility and reinforcing the need for more equitable curricula.
MEDEIROS, A.; GONZÁLEZ, O.; LÓPEZ, E.	The participation of women in universities and federal institutes in Brazil	2023	It examines female participation in higher education and federal institutes, contributing to the diagnosis of gender equality in professional education.
SOARES, E.; COSTA, M.	Law 14,164/21 and public policies to prevent gender violence in Brazil	2023	It discusses the implementation of Law 14.164/21, evaluating advances and limits of policies to prevent gender violence in the school context.
TEIXEIRA, F.; GOMES, B.	Reception of victims of sexual violence in Brazilian health services: an integrative review	2023	It synthesizes practices of reception for victims of sexual violence,

OLIVEIRA, V.; LEITE, R.			identifying protocols, access barriers and the need for professional training.
GUIMARÃES, J. et al.	Studies on educational inequalities in Brazil: an analysis of some studies on inequalities in basic education in Brazil	2024	It reviews studies on educational inequalities, offering a critical overview and pointing out emerging methodological and thematic trends.
JESUS, D.; PAULA, M.; CABRAL, L.	Violence against women in the state of Minas Gerais in the pre-pandemic and pandemic periods: a comparative epidemiological analysis	2024	It compares indicators of violence against women before and during the pandemic, evidencing worsening and the need for emergency policies.
SAUERESSIG, G.; PRATES, D.	Women in Professional and Technological Education: gender violence and its (re)configurations in a neoliberal rationality associated with fascist conservatism	2024	It analyzes gender violence in EFA under neoliberal and conservative rationality, contributing to institutional critique and defense of equity policies.
FREITAS, C. A. de et al.	The BNCC and inclusive education: perspectives for meaningful and equitable learning	2025	It discusses BNCC from an inclusive perspective, proposing paths for equitable and meaningful learning in contexts of diversity.

Source: Elaborated by the authors.

The table chronologically organizes the scientific production on gender, educational inequalities and violence, allowing us to visualize the evolution of the debate, changes in emphasis and the emergence of new research objects over the last five years. This systematization facilitates the identification of theoretical convergences, methodological gaps and thematic trends, supporting the construction of the state of the art and the justification of the research problem in dissertations and theses. By concentrating authorship, title, year, and contribution, the framework also favors comparative analyses, traceability of sources, and rigorous substantiation of arguments, essential elements for academic quality literature reviews.

4 RESULTS AND DISCUSSION

The analysis of the literature reveals that gender inequalities in Brazilian education manifest themselves through multiple dimensions, including educational segregation, gender violence, invisibility of female contributions, and barriers to the full participation of women in masculinized areas. Rodrigues *et al.* (2021) observe that official documents and educational legislation in the fight against racial inequalities highlight the need for integrated policies that consider intersections between race and gender. Gender inequalities in education unequally affect women according to their racial identities, with Black women facing additional barriers

related to racism, sexism, and intersectional discrimination. Promoting gender equity requires policies that recognize and address intersectionalities, ensuring that all women have equitable educational opportunities.

Women in Professional and Technological Education face gender violence and its reconfigurations in neoliberal rationality associated with fascist conservatism. Saueressig and Prates (2024) demonstrate that women in Professional and Technological Education face gender-based violence that is reconfigured in neoliberal and conservative contexts, demanding resistance and institutional transformations. Professional and Technological Education, historically masculinized, reproduces gender stereotypes that associate technical skills with masculinities and that devalue female participation. The promotion of gender equality in Professional and Technological Education requires combating violence, creating inclusive environments, offering female role models and transforming institutional cultures.

The recent expansion of Brazilian higher education has expanded educational opportunities, but has not eliminated gender inequalities related to areas of knowledge and conditions of permanence. Senkevics (2021, p. 48) analyzes that the recent expansion of higher education has expanded access, but maintained gender segregation in areas of knowledge, requiring policies to encourage diversification. Women make up the majority of students in Brazilian higher education, but remain underrepresented in engineering, exact sciences and technology. Educational segregation by gender in higher education reflects stereotypes internalized since basic education, lack of female role models, hostile environments, and subtle discriminations that discourage female participation in masculinized areas.

The feminization of the HIV/AIDS epidemic in Brazil shows how gender inequalities affect health vulnerabilities, a dimension that is related to education through access to information and negotiation skills. Silva *et al.* (2021) examine that the feminization of the HIV/AIDS epidemic in Brazil reveals vulnerabilities related to gender inequalities, violence, and limited access to information. Sex and reproductive education, which should be a fundamental component of school curricula, faces resistance related to conservatism and religious fundamentalism. The promotion of comprehensive sex education, which addresses gender, sexuality, consent and prevention of violence, is a strategy for promoting health and gender equity.

The perceptions of women in psychic suffering about experiences in therapeutic workshops illustrate the importance of spaces of reception and expression for the promotion of mental health. Silva *et al.* (2022) demonstrate that perceptions of women in psychological distress about experiences in therapeutic workshops reveal the potential of group practices

to promote well-being. Gender inequalities, including violence, overload of domestic work and discrimination, constitute social determinants of women's mental health. The promotion of women's mental health requires not only health services, but also social transformations that reduce inequalities, combat violence and promote equity.

Law 14,164/21 and public policies to prevent gender violence in Brazil represent legislative advances that require effective implementation. Soares and Costa (2023) analyze that Law 14,164/21 and public policies to prevent gender violence in Brazil constitute legal frameworks that require resources, professional training, and intersectoral articulation. Education plays a fundamental role in the prevention of gender-based violence, through the promotion of critical reflection on gender relations, the fight against stereotypes and the development of non-violent conflict resolution skills. The implementation of policies to prevent gender violence in schools requires teacher training, adequate teaching materials and articulation with protection networks.

The reception of victims of sexual violence in Brazilian health services highlights the need for professionals prepared to offer comprehensive and humanized care. Teixeira *et al.* (2023) examine that the reception of victims of sexual violence in Brazilian health services requires protocols, professional training, and articulation with justice systems. Sexual violence is a violation of human rights that affects the educational, professional and health trajectories of victims. The promotion of safe educational environments that combat cultures of sexual violence, promote consent, and provide support to victims is the responsibility of educational institutions.

5 FINAL CONSIDERATIONS

This study aimed to analyze gender inequalities in the Brazilian educational trajectory, examining their manifestations, causes, and consequences. The literature review showed that gender inequalities in education are manifested through educational segregation, gender violence, invisibility of female contributions, and barriers to the full participation of women in masculinized areas. The results demonstrate that gender inequalities in education do not operate in isolation, but interact with inequalities of race, social class and geographic region, producing differentiated experiences. The integration of feminist perspectives, gender studies, and analyses of educational inequalities allows for a more comprehensive understanding of the phenomenon and underpins strategies to promote equity.

The contributions of this work lie in the synthesis of knowledge about gender inequalities in Brazilian education, offering an integrated view of its manifestations at different levels of education and areas of knowledge. The identification of factors that produce and

reproduce gender inequalities, including stereotypes, hidden curricula, violence, and educational segregation, guides the development of educational policies and pedagogical practices that promote equity. The analysis showed that the promotion of gender equality in education requires not only legislation, but also teacher training, inclusive teaching materials, combating violence and cultural transformations, a perspective that should guide research agendas and political action.

The limitations of this research include the dependence on available scientific publications, which may not fully represent gender inequalities in Brazilian education. The concentration of studies on higher education limits the understanding of inequalities in basic education and professional education. The scarcity of longitudinal studies that track women's educational trajectories over time limits the ability to assess the effects of equity policies. Overcoming these limitations requires investments in research that uses mixed methodologies, that follows educational trajectories and that evaluates the effects of pedagogical and political interventions.

Future studies should prioritize investigations on the intersections between gender, race, and class in basic education, on the effects of gender equity policies on educational and professional trajectories, and on effective pedagogical strategies to combat gender stereotypes. The application of participatory methodologies, which involve women as active subjects of knowledge production, can enrich the understanding of experiences of inequalities. The evaluation of the effectiveness of teacher training programs on gender and sexuality is a priority to support evidence-based practices. The investigation of international experiences in promoting gender equality in education can offer lessons for the Brazilian context.

Strengthening gender equality in education requires investments in teacher training, inclusive teaching materials, policies to combat violence, and cultural transformations. The promotion of curricula that integrate gender issues in a transversal way, that value women's contributions and that combat stereotypes is a fundamental strategy. The creation of safe, welcoming, and inclusive educational environments that promote the full participation of women in all areas of knowledge requires institutional commitment and the transformation of school cultures. The articulation between education, health and protection systems, through intersectoral networks, can expand support for women victims of violence.

Gender inequalities in education represent a complex challenge that demands integrated responses, involving legislation, public policies, pedagogical practices and cultural transformations. The promotion of gender equality in education is not only a matter of social justice, but also a condition for sustainable development, democracy and the realization of

human rights. The challenge facing Brazilian society is to build educational systems that ensure that all people, regardless of their gender, have opportunities to fully develop their potential, to realize their aspirations, and to contribute to the construction of more just, egalitarian, and democratic societies.

REFERENCES

- Ferreira, A., Silva, E., & Santos, C. (2023). O que ensinam livros didáticos de Biologia sobre mulheres brasileiras da ciência? *Revista da Faeeba: Educação e Contemporaneidade*, 32(72), 148–169. <https://doi.org/10.21879/faeeba2358-0194.2023.v32.n72.p148-169>
- Freitas, C. A. de, Carvalho, C. V. A. B., Moura, E. da S., Silva, E. O. da, Tottola, N. L. do N., Silva, A. J. da, Soares, S. de O., & Lima, S. do S. (2025). ABNCC e a educação inclusiva: Perspectivas para uma aprendizagem significativa e equitativa. *Missioneira*, 27(12), 21–29. <https://doi.org/10.46550/5v4s7a53>
- Gaioli, F., & Brancaleoni, A. (2021). Força do silêncio: Sexualidade e gênero na formação de professores no interior paulista. *Revista Eletrônica de Educação*, 15, Article e4306078. <https://doi.org/10.14244/198271994306>
- Guarany, A., & Cardoso, L. (2022). Formação de professores, gênero e sexualidade na produção acadêmica brasileira. *Acta Scientiarum. Education*, 44, Article e55263. <https://doi.org/10.4025/actascieduc.v44i1.55263>
- Guimarães, J., & et al. (2024). Estudos sobre desigualdades educacionais no Brasil: Uma análise sobre alguns estudos de desigualdades na educação básica no Brasil. *RevFT*, 41–42. <https://doi.org/10.69849/revistaft/fa10202409302241>
- Jesus, D., Paula, M., & Cabral, L. (2024). Violência contra a mulher no estado de Minas Gerais nos períodos pré pandêmico e pandêmico: Uma análise epidemiologia comparativa. *Conbrasau*. <https://doi.org/10.51161/conbrasau2024/32620>
- Medeiros, A., González, O., & López, E. (2023). La participación de las mujeres en las universidades y los institutos federales de Brasil. *Revista Iberoamericana de Ciencia, Tecnología y Sociedad*, 18(52), 63–91. <https://doi.org/10.52712/issn.1850-0013-402>
- Neres, E., Boakari, F., & Silva, F. (2021). Memórias de mulheres afrodescendentes de sucesso na educação de jovens e adultos. *Revista Educação e Emancipação*, 14(3), 448–473. <https://doi.org/10.18764/2358-4319.v14n3p448-473>
- Picanço, F., Araújo, C., & Sussai, M. (2021). Papéis de gênero e divisão das tarefas domésticas segundo gênero e cor no Brasil: Outros olhares sobre as desigualdades. *Revista Brasileira de Estudos de População*, 38, 1–31. <https://doi.org/10.20947/s0102-3098a0177>
- Rodrigues, L., Barbosa, M., & Ribeiro, C. (2021). Documentos oficiais e legislações educacionais no combate às desigualdades raciais: Estudo com base na PNAD. *Revista Eletrônica de Educação*, 15, Article e4360011. <https://doi.org/10.14244/198271994360>
- Saueressig, G., & Prates, D. (2024). Mulheres na Educação Profissional e Tecnológica: Violências de gênero e suas (re)configurações em uma racionalidade neoliberal associada ao conservadorismo fascista. *Educação (UFSM)*. <https://doi.org/10.5902/1984644468759>

- Senkevics, A. (2021). A expansão recente do ensino superior. *Cadernos de Estudos e Pesquisas em Políticas Educacionais*, 3(4), 48. <https://doi.org/10.24109/27635139.ceppe.v3i4.4892>
- Silva, L., Amaral, D., & Santos, R. (2021). HIV/aids no Brasil: Feminização da epidemia em análise. *Revista Bioética*, 29(2), 374–383. <https://doi.org/10.1590/1983-80422021292475>
- Silva, M., & et al. (2022). Bordando saúde: Percepção de mulheres em sofrimento psíquico sobre a vivência em uma oficina terapêutica. *Cogitare Enfermagem*, 27, Article 81933. <https://doi.org/10.5380/ce.v27i0.81933>
- Soares, E., & Costa, M. (2023). A Lei 14.164/21 e políticas públicas de prevenção à violência de gênero no Brasil. *Passagens: Revista Internacional de História Política e Cultura Jurídica*, 15(3), 404–424. <https://doi.org/10.15175/1984-2503-202315304>
- Teixeira, F., Gomes, B., Oliveira, V., & Leite, R. (2023). Acolhimento de vítimas de violência sexual em serviços de saúde brasileiros: Revisão integrativa. *Saúde e Sociedade*, 32(3), Article e220253pt. <https://doi.org/10.1590/s0104-12902023220253pt>

EARLY MOTHERHOOD IN THE NEW GENERATION: PSYCHOLOGICAL, SOCIAL, AND IDENTITY IMPACTS

MATERNIDADE PRECOCE NA NOVA GERAÇÃO: IMPACTOS PSICOLÓGICOS, SOCIAIS E IDENTITÁRIOS

MATERNIDAD TEMPRANA EN LA NUEVA GENERACIÓN: IMPACTOS PSICOLÓGICOS, SOCIALES E IDENTITARIOS



<https://doi.org/10.56238/sevened2026.008-091>

Everaldo dos Santos Mendes¹, Antonio Cássio Vaz²

ABSTRACT

Early motherhood constitutes a complex phenomenon that generates physical, psychological, social, and identity-related consequences for adolescents. Adolescent pregnancy interrupts educational trajectories, limits professional opportunities, and compromises psychosocial development. This study analyzes early motherhood in the new generation, examining its psychological, social, and identity impacts. The methodology is characterized as an exploratory bibliographic review with a qualitative approach, grounded in the critical analysis of scientific publications from 2020 to 2025. The results indicate that early motherhood produces psychological impacts, including anxiety and depression; social consequences, such as school dropout and limited professional opportunities; and identity transformations related to the abrupt transition to motherhood. Early motherhood affects adolescents unevenly according to socioeconomic conditions and racial identities. It is concluded that the promotion of sexual and reproductive rights requires comprehensive sexual education, access to contraception, psychosocial support, and cultural transformations.

Keywords: Early Motherhood. Adolescent Pregnancy. Psychological Impacts. Reproductive Health.

RESUMO

A maternidade precoce constitui fenômeno complexo que gera consequências físicas, psicológicas, sociais e identitárias para adolescentes. A gravidez na adolescência interrompe trajetórias educacionais, limita oportunidades profissionais e compromete desenvolvimento psicossocial. Este estudo analisa a maternidade precoce na nova geração, examinando seus impactos psicológicos, sociais e identitários. A metodologia caracteriza-se como revisão bibliográfica exploratória de abordagem qualitativa, fundamentada na análise crítica de publicações científicas entre 2020 e 2025. Os resultados evidenciam que a maternidade

¹ Dr. of Psychology. Dr. of Theology. Pontifícia Universidade Católica de Minas Gerais (PUC Minas). Universidade de Coimbra. Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio). Universidade de Lisboa. Lattes: <http://lattes.cnpq.br/6102492484900096>

² Doctoral student in Psychology. Pontifícia Universidade Católica de Minas Gerais (PUC Minas). Lattes: <http://lattes.cnpq.br/3418209952717837>

precoce gera impactos psicológicos incluindo ansiedade e depressão, consequências sociais incluindo evasão escolar e limitação de oportunidades profissionais, e transformações identitárias relacionadas à transição abrupta para maternidade. A maternidade precoce afeta desigualmente adolescentes conforme condições socioeconômicas e identidades raciais. Conclui-se que a promoção de direitos sexuais e reprodutivos demanda educação sexual abrangente, acesso a contracepção, apoio psicossocial e transformações culturais.

Palavras-chave: Maternidade Precoce. Gravidez na Adolescência. Impactos Psicológicos. Saúde Reprodutiva.

RESUMEN

La maternidad precoz constituye un fenómeno complejo que genera consecuencias físicas, psicológicas, sociales e identitarias para las adolescentes. El embarazo en la adolescencia interrumpe las trayectorias educativas, limita las oportunidades profesionales y compromete el desarrollo psicosocial. Este estudio analiza la maternidad precoz en la nueva generación, examinando sus impactos psicológicos, sociales e identitarios. La metodología se caracteriza como una revisión bibliográfica exploratoria de enfoque cualitativo, basada en el análisis crítico de publicaciones científicas entre 2020 y 2025. Los resultados evidencian que la maternidad precoz genera impactos psicológicos, incluidos ansiedad y depresión; consecuencias sociales, como la deserción escolar y la limitación de oportunidades profesionales; y transformaciones identitarias relacionadas con la transición abrupta hacia la maternidad. La maternidad precoz afecta de manera desigual a las adolescentes según las condiciones socioeconómicas y las identidades raciales. Se concluye que la promoción de los derechos sexuales y reproductivos requiere educación sexual integral, acceso a métodos anticonceptivos, apoyo psicossocial y transformaciones culturales.

Palabras clave: Maternidad Precoz. Embarazo en la Adolescencia. Impactos Psicológicos. Salud Reprodutiva.

1 INTRODUCTION

Early motherhood is a complex phenomenon that affects millions of adolescents globally, generating physical, psychological, social and identity consequences that transcend the gestational period and extend throughout life. In Brazil, despite reductions in adolescent pregnancy rates in recent decades, early motherhood remains a public health challenge that demands understanding of its determinants, its consequences, and prevention and support strategies. Teenage pregnancy interrupts educational trajectories, limits professional opportunities, compromises psychosocial development, and perpetuates cycles of poverty and inequality. Understanding the psychological, social, and identity impacts of early motherhood becomes fundamental for the development of public policies, health programs, and care practices that promote sexual and reproductive rights, support pregnant adolescents and young mothers, and prevent unplanned pregnancies.

Teenage pregnancy has physical, psychological, and social implications for the health and development of the young mother. Barbosa (2025, p. 58) demonstrates that "adolescent pregnancy generates physical, psychological, and social implications for the health and development of the young mother, demanding comprehensive and multidisciplinary care", evidencing the complexity of the needs of pregnant adolescents. The bodily, hormonal and emotional transformations of pregnancy overlap with the transformations of adolescence, generating additional challenges for identity development. The abrupt transition to motherhood, often unplanned and unwanted, compromises the full experience of adolescence, a period characterized by the exploration of identities, the development of autonomy and the construction of life projects.

The facilitators and barriers to access and use of contraception for adolescent Hispanic American women reveal structural inequalities that affect sexual and reproductive rights. Batek *et al.* (2024, p. 2) argue that "facilitators and barriers to access to contraception for adolescent Hispanic American women include individual, family, community, and systemic factors," underlining the need for multidimensional approaches. Limited access to sexual and reproductive health information, adolescent-friendly health services, and contraception is a determinant of adolescent pregnancy. Cultural, religious, economic, and geographic barriers interact to limit the reproductive autonomy of adolescents, particularly those belonging to vulnerable groups.

The construction of motherhood from the phenomenal-structural perspective offers a theoretical framework to understand how individual experiences of motherhood are shaped by social, cultural and historical structures. Batista (2024, p. 3) observes that "the construction of motherhood in the phenomenon-structural perspective reveals tensions between lived

experiences and social expectations, demanding analyses that integrate subjective and structural dimensions", highlighting the complexity of motherhood as a social phenomenon. Early motherhood is experienced in contexts of gender, class, and race inequalities that shape experiences, opportunities, and challenges. The social idealization of motherhood as a feminine fulfillment contrasts with stigmas associated with adolescent motherhood, generating ambivalence and psychic suffering.

The general objective of this study is to analyze early motherhood in the new generation, examining its psychological, social and identity impacts on pregnant adolescents and young mothers. Specifically, it is intended to: (i) review the theoretical foundations on adolescence, motherhood and identity development; (ii) examine the psychological impacts of early motherhood, including anxiety, depression, and identity transformations; (iii) assess the social consequences of early motherhood, including school dropout, limitation of professional opportunities and stigmatization; (iv) identify strategies to prevent teenage pregnancy and support pregnant adolescents and young mothers. The relevance of this work lies in the need to understand early motherhood as a multidimensional phenomenon that demands integrated responses, involving sex education, access to contraception, psychosocial support and cultural transformations that promote sexual and reproductive rights of adolescents.

This article is structured into five main sections. After this introduction, the theoretical framework presents the conceptual foundations of adolescence, motherhood and identity development, discussing theories about sexual and reproductive health, psychosocial impacts of adolescent pregnancy and the social construction of motherhood. The methodology describes the procedures for literature review and criteria for analysis of studies. The results and discussion integrate evidence on psychological, social and identity impacts of early motherhood, analyzing determinants, consequences and intervention strategies. The final considerations summarize the contributions of the study, point out limitations and suggest perspectives for future research and for the development of policies and practices that promote sexual and reproductive rights of adolescents and that support young mothers.

2 THEORETICAL FOUNDATION

Adolescence is a period of transition between childhood and adulthood, characterized by biological, psychological, social and identity transformations. The World Health Organization defines adolescence as a period between 10 and 19 years of age, a phase marked by the development of identity, autonomy, abstract thinking, and complex interpersonal relationships. Borges and Carneiro (2023, p. 2) state that "adolescence

represents a period of vulnerabilities and potentialities, demanding public policies that promote healthy development and rights", highlighting the need for approaches that recognize the specificities of this phase. Adolescent pregnancy interrupts developmental processes, generating challenges for the construction of identity, for the completion of educational trajectories and for preparation for adult life.

The psychological impacts of teenage pregnancy include anxiety, depression, low self-esteem, and stress related to maternal responsibilities. Campos *et al.* (2023, p. 3) argue that "the psychological impacts of adolescent pregnancy include anxiety, depression, and identity transformations, requiring specialized psychosocial support", underlining the need for comprehensive care. Unplanned pregnancy generates feelings of fear, guilt, and uncertainty about the future. The abrupt transition to motherhood, often accompanied by paternal abandonment, social stigmatization and interruption of life projects, compromises the mental health of adolescents. Family, social and professional support is a protective factor that can mitigate negative psychological impacts.

The right to health of trans and transvestite people offers perspective on how structural inequalities affect access to sexual and reproductive health care. Filho *et al.* (2020, p. 3) demonstrate that "the right to health of trans people and transvestites demands public policies that recognize gender identities and combat discrimination", highlighting principles applicable to multiple vulnerable populations. Adolescents, particularly those belonging to marginalized groups, face barriers to accessing sexual and reproductive health information and services. The promotion of sexual and reproductive rights of adolescents requires recognition of autonomy, confidentiality and access to friendly services.

Theories of identity development in adolescence postulate that identity construction involves exploring roles, values, and commitments across multiple domains, including education, work, relationships, and sexuality. Early motherhood can compromise processes of identity exploration, prematurely fixing adolescents in maternal roles and limiting opportunities for experimentation. Maternal identity, constructed in contexts of stigmatization and inequality, can generate ambivalences between acceptance and rejection of motherhood, between personal aspirations and maternal responsibilities, and between adolescent identities and maternal identities.

The social consequences of early motherhood include school dropout, limited professional opportunities, economic dependence, and perpetuation of cycles of poverty. Pregnant adolescents and young mothers face difficulties in reconciling motherhood and education, resulting in school dropout and limited professional qualifications. Precarious insertion in the labor market, often in informal and low-paid occupations, compromises

economic autonomy and perpetuates vulnerabilities. Early motherhood affects adolescents unequally according to their socioeconomic conditions, with low-income adolescents facing additional barriers.

The social construction of motherhood involves idealizations, expectations, and norms that define what constitutes good motherhood and that assign primary care responsibilities to women. Adolescent motherhood is often stigmatized as a deviation from normative trajectories, generating moral judgments and blaming adolescents. The idealization of motherhood as a feminine fulfillment contrasts with devaluations of early motherhood, generating ambivalence and suffering. The deconstruction of idealizations and stigmas associated with motherhood is a condition for the promotion of rights and support for young mothers.

Strategies for preventing teenage pregnancy include comprehensive sex education, access to contraceptive methods, promotion of gender equity, and strengthening of life projects. Comprehensive sex education, which addresses not only biological aspects, but also dimensions of gender, rights, consent and healthy relationships, is a fundamental strategy. Access to contraception, through adolescent-friendly health services that ensure confidentiality and provide adequate guidance, constitutes a sexual and reproductive right. The promotion of gender equality, through the fight against stereotypes and the valorization of female autonomy, can broaden horizons of possibilities and reduce vulnerabilities.

3 METHODOLOGY

This study is characterized as an exploratory literature review with a qualitative approach, based on the critical analysis of scientific publications that investigate early motherhood, psychological, social and identity impacts of adolescent pregnancy and prevention and support strategies. The literature review allows us to synthesize knowledge about determinants, consequences and interventions related to early motherhood, identifying patterns, trends and gaps. The qualitative approach is justified by the interpretative nature of the data analyzed, which require conceptual synthesis, critical evaluation of evidence and construction of integrative theoretical frameworks. The choice for an exploratory review stems from the complexity of the theme, which involves multiple biological, psychological, social and cultural dimensions, requiring broad mapping of perspectives and results.

Data collection was carried out through a systematic search in multidisciplinary scientific databases, including journals in public health, psychology, social sciences, and gender studies. Moniz *et al.* (2024) advise that the psychological impact of adolescent pregnancy in developing countries requires analyses that consider specific sociocultural and

economic contexts. The inclusion criteria included studies published between 2020 and 2025, which addressed adolescent pregnancy, early motherhood, psychological impacts, social consequences, identity development, sexual and reproductive health, and prevention strategies. The search used combined descriptors in Portuguese and English, including terms such as "teenage pregnancy", "early maternity", "psychological impacts", "reproductive health", *teenage pregnancy*, *adolescent motherhood*, *psychological impacts*, and *reproductive health*. Studies that did not present empirical data or substantive theoretical reflections, publications without peer review, and studies that did not establish clear connections with psychosocial impacts of early motherhood were excluded.

Data analysis followed procedures of critical reading, filing and thematic categorization, with the extraction of information on determinants of adolescent pregnancy, psychological and social impacts, identity transformations and prevention and support strategies. Montazeri *et al.* (2025) suggest that prenatal psychosocial interventions for pregnant adolescents require approaches that consider specific needs and promote comprehensive support. The studies were categorized according to populations investigated, impact dimensions analyzed, methodologies employed, and intervention strategies evaluated. This categorization allowed the identification of recurrent patterns, such as the centrality of social support for the mental health of young mothers, and gaps in knowledge, such as the scarcity of studies on adolescent fatherhood experiences.

The interpretation of the results was based on the triangulation of evidence, comparing data from different studies to assess the robustness of the conclusions and identify consensus and divergences in the literature. Morais *et al.* (2023) emphasize that misinformation about contraceptive methods and their impact on adolescent pregnancy reveals the need for comprehensive sexuality education and access to reliable information. Triangulation allowed us to identify convergences, such as the recognition that teenage pregnancy compromises educational trajectories, and divergences, such as contrasting evaluations of the effects of prevention programs. The critical analysis considered methodological limitations of the reviewed studies, including selection biases, use of convenience samples, variability of definitions of psychological impacts, and insufficient data on the long-term effects of early motherhood on life trajectories.

Ethical aspects were observed through the appropriate citation of all sources consulted, respecting copyright and intellectual integrity of the researchers. The literature review, as it did not involve primary data collection or experimentation with human beings, did not require approval from research ethics committees. Methodological transparency was ensured through the detailed description of the procedures for searching, selecting and

analyzing studies, allowing the replication of the review by other researchers. The main limitation of this study lies in the dependence on the quality and availability of scientific publications, which may not fully represent the experiences of pregnant adolescents and young mothers, especially considering that vulnerable populations, including low-income adolescents, living in rural areas, and belonging to marginalized racial groups, are rarely the subject of systematic academic investigations.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
FILHO, E. et al.	Right to health of trans people and transvestites: an analogy of public policies in Brazil and Argentina	2020	To compare Brazil-Argentina public policies, contributing to evaluate guarantees of the right to health of trans people and transvestites and their institutional limits.
SILVA, M.; GOUVÊIA, M.; FERNANDES, M.; COSTA, R..	Stress coping strategies used by maternity nurses / stress coping strategies used by nurses in the maternity ward / stress coping strategies used by maternity nurses	2020	Identify strategies to cope with stress in maternity teams, supporting occupational health actions and quality of care.
PARENTE, J. et al.	LGBTQIA+ health in the light of princimal bioethics	2021	Fundamental debates on LGBTQIA+ health care based on bioethical principles, supporting clinical decisions and policies of equity in access.
NASCIMENTO, A.; MARTINS, D.; BONFIM, C.; BERNARDO, K.	Solo motherhood and intersectionalities: care practices in the context of primary care	2022	It shows how race, class and gender cross care in PHC, contributing to qualify practices and policies aimed at solo motherhood.
SILVA, R. et al.	Bioethical reflections on transgender access to public health	2022	Discuss ethical and institutional barriers to trans people's access to public health, reinforcing non-discrimination and comprehensiveness guidelines.
BORGES, D.; CARNEIRO, M.	Editorial	2023	It delimits and contextualizes dossier/issue debates on feminist studies and gender, contributing to situational agendas, approaches, and thematic priorities.

CAMPOS, G. et al.	Psychological impacts of adolescent pregnancy: an integrative review	2023	It synthesizes evidence on the psychological impacts of adolescent pregnancy, pointing out risk/protective factors and the need for multiprofessional intervention.
MORAIS, J.; SOUZA, L.; SOUZA, M..	Misinformation about contraceptive methods and the impact on adolescent pregnancy	2023	It relates contraceptive misinformation to reproductive vulnerabilities and stages, subsidizing sex education, health communication, and preventive policies.
VASCONCELOS, M.; REIS, A.; PEREIRA, L..	Fragility of the social name in the transition care of a transgender woman	2023	It exposes failures in the recognition of the social name in the transition of care, contributing to protocols of reception, continuity of care and rights.
BATEK, L. et al.	Facilitators and barriers to access and use of contraceptives by Hispanic American adolescents: an integrative literature review.	2024	It maps facilitators and barriers to access/use of contraception, supporting culturally sensitive interventions and reduction of reproductive inequities.
BATISTA, R.	Construction of motherhood from a specific-structural perspective	2024	It deepens the theoretical understanding of motherhood from a phenomenal-structural approach, contributing to critical readings on subjectivity and social context.
MONIZ, M.; ASTUTI, A.; HAKIMI, M.	Psychological impact of adolescent pregnancy in developing countries: a scoping review.	2024	It provides a broad overview (scope) in developing countries, identifying gaps, contextual variations, and priorities for research and policy.
OLIVEIRA, C. et al.	Sexual development of adolescents and their biopsychosocial aspects	2024	It integrates biological, psychological, and social dimensions of sexual development, supporting sex education, prevention, and comprehensive care in adolescence.
PUTINI, L.; BERLANDA, S.; BATISTA, A.	Weaving the past: an analysis of the socio-cultural history of motherhood and its impacts from an existentialist perspective	2024	I reconstructed motherhood as historical-cultural, sustaining analyses of normativity, gender roles, and maternal experiences.
BARBOSA, R.	Teenage pregnancy: physical, psychological and social implications on the health and development of the young mother	2025	It systematizes multidimensional implications of adolescent pregnancy, reinforcing the need for intersectoral

			approaches in health and social assistance.
MONTAZERI, S.; YOUSEFI, S.; JAVADIFAR, N.	Prenatal psychosocial interventions for pregnant adolescents: a systematic review.	2025	Evaluate psychosocial interventions in the prenatal care of pregnant adolescents, reducing potential effectiveness and guiding the design of evidence-based programs.

Source: Elaborated by the authors.

The framework is relevant because it organizes the literature in temporal sequence and allows us to visualize how the field evolves from comparative analyses of public policy and bioethics (2020–2022) to reviews and discussions focused on misinformation, reproductive health, and psychological impacts (2023–2025). This systematization makes it easier to identify convergences and gaps, compare levels of evidence (editorial, theoretical studies, integrative reviews, scope, and systematic) and guide the choice of references and methods in thesis and dissertation projects. In addition, by making explicit the contributions of each work, the table supports a more traceable and consistent argumentation in the construction of the research problem and justifications.

4 RESULTS AND DISCUSSION

The analysis of the literature reveals that early motherhood generates complex psychological, social and identity impacts that affect the life trajectories of adolescents, demanding prevention policies, psychosocial support and cultural transformations. Nascimento *et al.* (2022) observe that solo motherhood and intersectionalities demand care practices in primary care that recognize specific vulnerabilities of young mothers. Early motherhood affects adolescents unequally according to their socioeconomic conditions, racial identities and family contexts. Young black mothers, from low-income backgrounds and without family support, face additional barriers to access to health care, educational opportunities and professional insertion. The promotion of equity requires policies that recognize intersectionalities and that offer differentiated supports.

The sexual development of adolescents and their biopsychosocial aspects highlight the need for comprehensive sex education that prepares adolescents for informed decisions about sexuality and reproduction. Oliveira *et al.* (2024) demonstrate that the sexual development of adolescents involves biological, psychological, and social dimensions that demand comprehensive educational approaches. Sex education that addresses not only biological aspects, but also dimensions of gender, consent, healthy relationships, and sexual and reproductive rights, is a strategy for preventing teenage pregnancy. Resistance to

comprehensive sex education, based on conservatism and religious fundamentalism, compromises the rights of adolescents and perpetuates vulnerabilities.

LGBTQIA+ health in the light of principled bioethics offers perspective on how principles of autonomy, beneficence, non-maleficence, and justice should guide sexual and reproductive health care. Parente *et al.* (2021) analyze that LGBTQIA+ health in the light of principled bioethics demands respect for autonomy, combating discrimination, and promoting equity. LGBTQIA+ adolescents face specific vulnerabilities related to discrimination, violence, and limited access to sexual and reproductive health information and services. The promotion of sexual and reproductive rights of adolescents requires recognition of diversity of sexual orientations and gender identities.

The analysis of the sociocultural history of motherhood and its impacts from an existentialist perspective reveals how social constructions of motherhood shape individual experiences. Putini *et al.* (2024) examine that the sociocultural history of motherhood reveals idealizations, expectations, and norms that define motherhood and that generate suffering when not reciprocated. Adolescent motherhood is often stigmatized as a deviation from normative trajectories, generating moral judgments and blame. The deconstruction of idealizations and stigmas is a condition for the promotion of rights and support for young mothers.

The stress coping strategies used by nurses in maternity wards illustrate the challenges of professionals who care for pregnant adolescents and young mothers. Silva *et al.* (2020) demonstrate that stress coping strategies used by nurses in maternity include social support, self-care, and continuing education. Health professionals who care for pregnant adolescents face challenges related to the complexity of needs, social stigmas and resource limitations. Professional training that integrates knowledge about adolescence, sexual and reproductive health and rights-centered approaches is a condition for quality care.

Bioethical reflections on transsexuals' access to public health show how discrimination compromises rights and access to care. Silva *et al.* (2022) analyze that bioethical reflections on transgender access to public health reveal the need for policies that combat discrimination and promote equity. Transgender adolescents and transvestites face specific vulnerabilities related to transphobia, violence, and limited access to sexual and reproductive health care. The promotion of sexual and reproductive rights requires recognition of gender identities and combating discrimination.

The fragility of the social name in the transition care of transgender women illustrates how disrespect for gender identities compromises quality of care and dignity. Vasconcelos *et al.* (2023) examine that the fragility of the social name in the transition care of transgender

women reveals the need for protocols that ensure respect for identities. Respect for gender identities, through the use of a social name and appropriate pronouns, is a fundamental right and a condition for humanized care. The training of health professionals that integrates knowledge about gender and sexuality diversity is a strategy for promoting equity.

5 FINAL CONSIDERATIONS

This study aimed to analyze early motherhood in the new generation, examining its psychological, social and identity impacts on pregnant adolescents and young mothers. The literature review showed that early motherhood generates complex consequences that affect mental health, educational trajectories, professional opportunities, and identity development. The results demonstrate that early motherhood affects adolescents unequally according to their socioeconomic conditions, racial identities and family contexts, evidencing the need for policies that recognize intersectionalities. The integration of perspectives from public health, psychology, gender studies, and human rights allows for a more comprehensive understanding of the phenomenon and underpins prevention and support strategies.

The contributions of this work lie in the synthesis of knowledge about psychological, social and identity impacts of early motherhood, offering an integrated view of determinants, consequences and intervention strategies. The identification of risk factors, including limited access to sexuality education and contraception, gender inequalities, and socioeconomic vulnerabilities, guides the development of prevention policies. The analysis showed that the promotion of sexual and reproductive rights of adolescents requires not only access to information and services, but also cultural transformations that combat stigma and promote autonomy, a perspective that should guide research agendas and political action.

Limitations of this research include reliance on available scientific publications, which may not fully represent the experiences of pregnant adolescents and young mothers. The concentration of studies on negative impacts limits the understanding of positive experiences and resilience strategies. The scarcity of longitudinal studies that follow the trajectories of young mothers over time limits the ability to assess the long-term effects of early motherhood. Overcoming these limitations requires investments in research that uses mixed methodologies, that involves adolescents as active subjects of knowledge production and that follows trajectories over time.

Future studies should prioritize investigations on adolescent fatherhood experiences, on resilience strategies of young mothers, and on the effectiveness of prevention and support programs. The application of participatory methodologies, which involve adolescents in the definition of research priorities and in the interpretation of results, can enrich the

understanding of experiences. The evaluation of the effectiveness of psychosocial interventions, sex education programs and policies to support young mothers is a priority to support evidence-based practices. The investigation of international experiences in the prevention of adolescent pregnancy can offer lessons for the Brazilian context.

Strengthening the prevention of teenage pregnancy requires investments in comprehensive sexuality education, access to contraceptive methods, promotion of gender equality, and strengthening life projects. Sex education that addresses dimensions of gender, rights, consent and healthy relationships is a fundamental strategy. Access to adolescent-friendly health services that ensure confidentiality and provide appropriate guidance is a sexual and reproductive right. The promotion of gender equality, through the fight against stereotypes and the valorization of female autonomy, can broaden horizons of possibilities and reduce vulnerabilities.

Early motherhood represents a complex challenge that demands integrated responses, involving prevention, psychosocial support and cultural transformations. The promotion of sexual and reproductive rights of adolescents is not only a matter of public health, but also of social justice and the realization of human rights. The challenge facing Brazilian society is to build policies and practices that ensure that all adolescent girls have access to information, services and opportunities that enable them to make informed decisions about their sexual and reproductive lives, that support those who become young mothers and that promote healthy life trajectories. autonomous and dignified.

REFERENCES

- Barbosa, R. G. J., Lopes, D. M., Sousa, C. É. L. de, Souza, M. Z. M. F. de, Santos, M. O. dos, Souza, A. R. M. e, Custódio, J. A. G., & Lins, M. A. F. (2025). Gravidez na adolescência: Implicações físicas, psicológicas e sociais na saúde e no desenvolvimento da jovem mãe. *Revista FT*, (151), 58–59. <https://doi.org/10.69849/revistaft/ma10202510161458>
- Batek, L., & et al. (2024). Facilitators and barriers to contraception access and use for Hispanic American adolescent women: An integrative literature review. *PLOS Global Public Health*, 4(7), Article e0003169. <https://doi.org/10.1371/journal.pgph.0003169>
- Batista, R. (2024). Construção da maternidade na perspectiva fenômeno-estrutural. *Revista Psicopatologia Fenomenológica Contemporânea*, 13(2). <https://doi.org/10.37067/rpfc.v13i2.1192>
- Borges, D., & Carneiro, M. (2023). Editorial. *Caderno Espaço Feminino*, 35(2), 1–4. <https://doi.org/10.14393/cef-v35n2-2022-1>
- Campos, G., & et al. (2023). Psychological impacts of pregnancy in adolescence: An integrative review. *International Journal of Health Science*, 3(48), 2–11. <https://doi.org/10.22533/at.ed.1593482330063>

- Filho, E., & et al. (2020). Direito à saúde de pessoas trans e travestis: Uma analogia das políticas públicas do Brasil e Argentina. *Research, Society and Development*, 9(9), Article e610997796. <https://doi.org/10.33448/rsd-v9i9.7796>
- Moniz, M., Astuti, A., & Hakimi, M. (2024). Psychological impact of adolescent pregnancy in developing countries: A scoping review. *Women Midwives and Midwifery*, 4(2), 1–13. <https://doi.org/10.36749/wmm.4.2.1-13.2024>
- Montazeri, S., Yousefi, S., & Javadifar, N. (2025). Psychosocial prenatal interventions for teenage pregnant: A systematic review. *Journal of Family & Reproductive Health*, 19(2), 69–84. <https://doi.org/10.18502/jfrh.v19i2.19295>
- Morais, J., Souza, L., & Souza, M. (2023). Desinformação sobre os métodos contraceptivos e o seu impacto na gravidez de adolescentes. *Research, Society and Development*, 12(5), Article e17112541710. <https://doi.org/10.33448/rsd-v12i5.41710>
- Nascimento, A., Martins, D., Bonfim, C., & Bernardo, K. (2022). Maternidade solo e interseccionalidades: Práticas de cuidado no contexto da atenção básica. *Revista Psicologia, Diversidade e Saúde*, 11, Article e4393. <https://doi.org/10.17267/2317-3394rpsds.2022.e4393>
- Oliveira, C., & et al. (2024). Desenvolvimento sexual dos adolescentes e seus aspectos biopsicossociais. *PBPC*, 3(2), 120–129. <https://doi.org/10.36557/pbpc.v3i2.52>
- Parente, J., & et al. (2021). Saúde LGBTQIA+ à luz da bioética principialista. *Revista Bioética*, 29(3), 630–640. <https://doi.org/10.1590/1983-80422021293498>
- Putini, L., Berlanda, S., & Batista, A. (2024). Tecendo o passado: Uma análise da história sócio-cultural da maternidade e seus impactos a partir de uma perspectiva existencialista. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 10(11), 2578–2597. <https://doi.org/10.51891/rease.v10i11.16755>
- Silva, M., Gouvêia, M., Fernandes, M., & Costa, R. (2020). Stress coping strategies used by maternity nurses / estratégias de enfrentamento do estresse utilizados por enfermeiros em maternidade / estrategias de afrontamiento del estrés utilizadas por las enfermeras de maternidade. *Revista de Enfermagem da UFPI*, 9. <https://doi.org/10.26694/reufpi.v9i0.9153>
- Silva, R., & et al. (2022). Reflexões bioéticas sobre o acesso de transexuais à saúde pública. *Revista Bioética*, 30(1), 195–204. <https://doi.org/10.1590/1983-80422022301519pt>
- Vasconcelos, M., Reis, A., & Pereira, L. (2023). Fragilidade do nome social no cuidado de transição de uma mulher transgênero. *Revista Científica Multidisciplinar Núcleo do Conhecimento*, 110–119. <https://doi.org/10.32749/nucleodoconhecimento.com.br/saude/mulher-transgenero>

RELATIONSHIPS BETWEEN STALKING AND DOMESTIC VIOLENCE AGAINST WOMEN IN THE MUNICIPALITY OF ANANINDEUA, PARÁ

RELAÇÕES ENTRE STALKING E A VIOLÊNCIA DOMÉSTICA CONTRA AS MULHERES NO MUNICÍPIO DE ANANINDEUA, PARÁ

RELACIONES ENTRE EL ACOSO Y LA VIOLENCIA DOMÉSTICA CONTRA LAS MUJERES EN EL MUNICIPIO DE ANANINDEUA, PARÁ



<https://doi.org/10.56238/sevened2026.008-092>

Andressa Érica Ávila Pinheiro¹, Silvia dos Santos de Almeida²

ABSTRACT

This article aims to characterize the profile of the victim of stalking crime in the context of domestic and family violence against women in the municipality of Ananindeua, Pará, Brazil. Methodologically, this is descriptive-exploratory research, with a quantitative and documentary approach. The data used in the analysis comes from the Secretariat of Intelligence and Criminal Analysis (SIAC), and refers to all police reports registered with DEAM Ananindeua, period from April 2021 to April 2023, totaling 363 police reports for the crime of stalking. The main results highlight that the majority of victims of the crime of stalking are female (84.25%), single (53.35%), the majority were aged between 25 and 31 years (24.83%), with complete secondary education (44.29%), self-employed (34.58%) and housewives (17.55%), victimized on Monday (17.38) and Thursday (15.41%), in their homes (64.92%) and for reasons of hatred or revenge (77.41%), generally taking up to 9 days to report (92.13%).

Keywords: Domestic and Family Violence. Persecution. Feeling of Possession.

RESUMO

O presente artigo objetiva caracterizar o perfil da vítima do crime stalking no contexto da violência doméstica e familiar contra a mulher no município de Ananindeua, Pará, Brasil. Metodologicamente, trata-se de pesquisa descritiva-exploratória, com abordagem quantitativa e de caráter documental. Os dados utilizados na análise provenientes da Secretaria de Inteligência e Análise Criminal (SIAC) e são referentes a todos os boletins de ocorrência registrados na DEAM de Ananindeua período de abril de 2021 a abril de 2023, num total de 363 boletins de ocorrências do crime de stalking. Como principais resultados destaca-se que a maioria das vítimas do crime de stalking é do sexo feminino (84,25%), solteira (53,35%), com idade entre 25 a 31 anos (24,83%), ensino médio completo (44,29%), autônomas (34,58%) e donas de casa (17,55%), vitimadas na segunda-feira (17,38) e quinta-

¹ Master's degree in Public Security. Universidade Federal do Pará (UFPA).

E-mail: andressa.e.a.pinheiro@gmail.com Orcid: <https://orcid.org/0000-0001-7195-6331>

Lattes: <http://lattes.cnpq.br/8846774388791439>

² Dr. in Production Engineering. Universidade Federal do Pará (UFPA). E-mail: salmeidaufpa@gmail.com

Orcid: <https://orcid.org/0000-0002-4817-7804> Lattes: <http://lattes.cnpq.br/9638195936355666>

feira (15,41%), nas suas residências (64,92%) e por motivos de ódio ou vingança (77,41%), levando geralmente até 9 dias para denunciar (92,13%).

Palavras-chave: Violência Doméstica e Familiar. Perseguição. Sentimento de Posse.

RESUMEN

Este artículo tiene como objetivo caracterizar el perfil de las víctimas de acoso en el contexto de la violencia doméstica y familiar contra las mujeres en el municipio de Ananindeua, Pará, Brasil. Metodológicamente, se trata de un estudio descriptivo-exploratorio con un enfoque cuantitativo y documental. Los datos utilizados en el análisis provienen de la Secretaría de Inteligencia y Análisis Criminal (SIAC) y corresponden a todos los informes policiales registrados en la Comisaría de Mujeres de Ananindeua (DEAM), período comprendido entre abril de 2021 y abril de 2023, con un total de 363 denuncias del delito de stalking. Los hallazgos clave destacan que la mayoría de las víctimas de acoso son mujeres (84,25%), solteras (53,35%), con edades comprendidas entre los 25 y los 31 años (24,83%), con estudios secundarios completos (44,29%), trabajadoras por cuenta propia (34,58%) y amas de casa (17,55%), que son víctimas los lunes (17,38%) y los jueves (15,41%), en sus hogares (64,92%), y por motivos de odio o venganza (77,41%), tardando generalmente hasta 9 días en denunciar (92,13%).

Palabras clave: Violencia Doméstica y Familiar. Acoso. Posesividad.

1 INTRODUCTION

The insidious stalking known as stalking is a type of violence in relationships in which, repeatedly, the persecutor intends to have a forced connection with the victim, even if it is an accepted conduct, seen as an expression of male love in patriarchy. Adequate typification provides for the various ways that the aggressor tries to communicate, surveilling and monitoring (Grangeia; Matos, 2010) the victim.

The behaviors of stalkers associated with ex-intimate partners are: surveilling, spying, wandering around the victim's residence through phone calls, emails, visits to the home or work, making contact with third parties to find out how the victim is doing, posting revenge pornography, implanting tracking devices, threatening to commit suicide, breaking into the house or other property, damaging property, physical assault and rape, calling insistently, spying, trying to control, sending e-mails or notes (White; Longpré; Stefanska, 2022).

According to the Brazilian Yearbook of Public Security (FBSP, 2025), 95,026 (nine thousand and twenty-six) cases of women victims of persecution were registered, which represents an increase of 18.2% compared to the previous year. This is equivalent to an average of 10 women persecuted every hour in the country. The crime of stalking grew approximately 35% from one year to the next in Brazil. In Pará, there was a jump of 30.8% from January to October 2025. Experts warn that the crime of *stalking* is often a prelude to more serious violence, with about 80% of femicide cases beginning with episodes of stalking. In other words, since 2021, when the crime of stalking was typified in the Penal Code, the numbers have only grown, without considering all the cases that do not come to the attention of the competent authorities and that, therefore, do not enter into this quantitative analysis.

The rupture of domestic violence has generally occurred through external intervention, since women are rarely able to disengage from a violent man without the help of third parties, tending to an oscillating trajectory in the relationship (Saffioti, 2015). However, until the advent of the Maria da Penha Law (LMP), a legislative milestone on the subject, women did not have the proper attention in Brazil, and then femicide was defined in Law No. 13,104 of 2015, according to Haile (2020).

Since the Maria da Penha Law, the Brazilian State has been striving to curb violence, more specifically with regard to gender violence. In this context, the International Convention on the Prevention, Punishment and Eradication of Violence Against Women (Brazil, 1996) in its first article defines violence against women as any act or conduct based on gender, which causes death, damage or physical, sexual or psychological suffering to women. It adds in article 4 that everyone has the right to respect for life, physical, mental and moral integrity, emphasizing the right not to be subjected to torture and not to be discriminated against (article

6).

The crime of stalking is still new, especially in Brazil, as it was only in 2021 that it was expressly provided for in our legislation, from the inclusion of article 147-A in the Brazilian Penal Code by Law 14,132/2021. In this context, we insert Arendt's (1970) assertion about the mechanism of force applied to violence, often treated as synonyms and naturally seen as "forces of nature" or even "forces of circumstances" (*la force des choses*), generally indicating the release of energy, in this case referring to the energy of the aggressor, towards the victim in physical or social movements. In this case, the special character of social coercion is visible in the force that the stalker applies to monitor and penalize the victim, mobilizing knowledge about the social circle of the offended.

For women, the elements of violence such as the time of exposure to the acts, having their lives paralyzed and controlled by the aggressor and having no one to turn to influence the appearance of mental symptoms of anxiety and post-traumatic stress (Cabreiro, 2023). Cross-sectional research recommends further studies with victims of stalking, to indicate exposure to aggression, understand gender and sociocultural factors, risks, severity, and discuss forms of prevention (Borges; Dell'aglio, 2019).

In the first study to compare recidivism among stalkers, using four different operational definitions of recidivism, it was demonstrated that recidivism was indisputably high and occurs within a short time. It is emphasized that researching crimes other than the crime of stalking and harassment is pertinent, as many stalkers are repeat offenders. Stalkers tend to be accused and convicted more than once, and even though they are legally "constrained" by police restraining orders that are often not respected (Bendlin; Sheridan; Johnson, 2022).

Therefore, due to the implications of this behavior, the difficulties related to a clear definition of stalking and in the recognition of the behavior by the victim are studied, as it generally involves repetition of behaviors considered natural if observed separately, harmless and even desirable if viewed as seduction and courtship, which, however, can turn into constant intimidation (Roberts, 2005).

In this sense, this article aims to characterize the profile of the victim of *stalking* in the context of domestic and family violence against women in the municipality of Ananindeua, in the state of Pará, Brazil, from April 2021 to April 2023, the year of my master's research.

2 METHODOLOGY

This is a descriptive-exploratory research (Severino, 2016), with a quantitative and documentary approach (Gil, 2019). The quantitative approach research (Marconi; Lakatos, 2017) is based on numerical data to corroborate hypotheses and make considerations about

the expression of the frequency of variables, the characteristics of a given set that in this study will be about stalking crimes committed in the municipality of Ananindeua, in the state of Pará, Brazil, from April 2021 to April 2023, analyzing 363 police reports of the crime in question.

Quantification allows the analysis of intensity dimensions, introducing variables that help to better explain the phenomenon in research. To ensure reliable data, quantitative research uses techniques and reduces the risk of duplication in collection, using questionnaires with closed questions or consultation and tabulation of numerical data in documents (Rodrigues; Oliveira; Santos, 2021). In this follow-up, documentary research (Gil, 2019) refers to the exploration of data from documents and databases not previously analyzed or processed and can be carried out on documents available in public and private agencies of any nature.

The locus of this research is the city of Ananindeua, whose population in the last census in 2022 was estimated at 478,778 people and the demographic density in the same year was 2,512.20 inhabitants per square kilometer (IBGE, 2022). The period from April 2021 to April 2023 was considered as the time frame of the research, due to the enactment of Law No. 14,132/21 (Brasil, 2021), in 2021, which criminalized the conduct of the crime of stalking, inserting article 147-A, in the Brazilian Penal Code.

The source of the data used in this research was the Assistant Secretary of Intelligence and Criminal Analysis (SIAC), linked to the Secretariat of Public Security and Social Defense of the State of Pará, which, based on a formal request via letter, provided the database of police occurrence records and procedures established in the municipality of Ananindeua. The variables used for analysis are: age of the victim, gender of the victim, level of education of the victim, marital status of the victim, age of the perpetrator, sex of the perpetrator, profession of the perpetrator, unit of origin of the occurrence, unit responsible, date of registration, date of the fact, day of the week, class of the crime, middle employee, presumed cause, place of occurrence and degree of relationship. 363 police reports of the crime of *stalking* were analyzed.

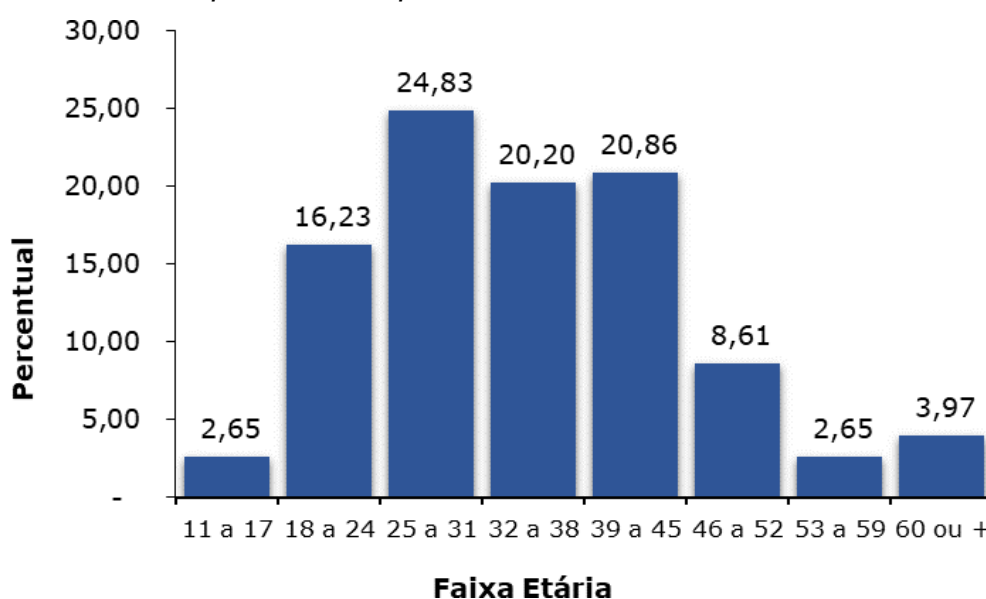
Data analysis was performed using simple descriptive statistics (Bussab; Morettin, 2024), based on visual representations, such as tables and statistical graphs, as well as on the calculations of frequencies, percentages, and summary measures, which demonstrate the expressiveness of the variables (Dancey; Reidy, 2019).

3 RESULTS

A profile of victims was verified from the records of persecution in Ananindeua, in the period from April 2021 to April 2023, from the 363 police reports. Figure 1 shows that most of the victims are aged between 25 and 31 years (24.83%), followed by the age group between 39 and 45 years (20.86%).

Figure 1

Percentage by age group of victims of the crime of stalking in the municipality of Ananindeua, Pará State, Brazil, from April 2021 to April 2023

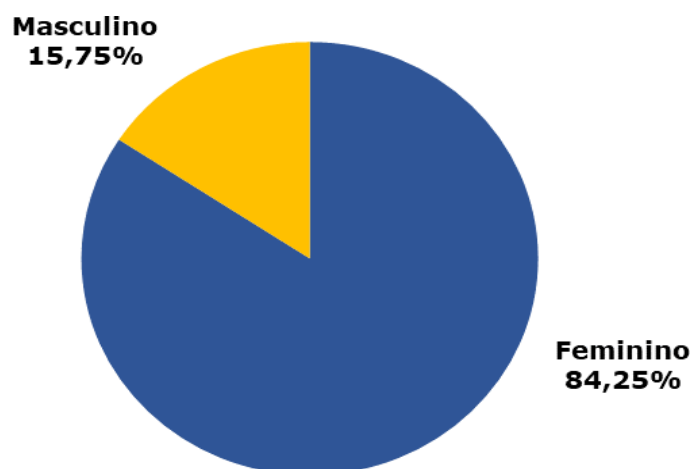


Source: Prepared by the authors based on SIAC data (2023).

Figure 2 shows that the vast majority of victims of the crime of stalking are female, with 84.25% of the records, which corroborates the maxim addressed in the present study that women are the main victims of this crime.

Figure 2

Percentage by Gender, of Victims of the crime of stalking in the municipality of Ananindeua, Pará State, Brazil, from April 2021 to April 2023

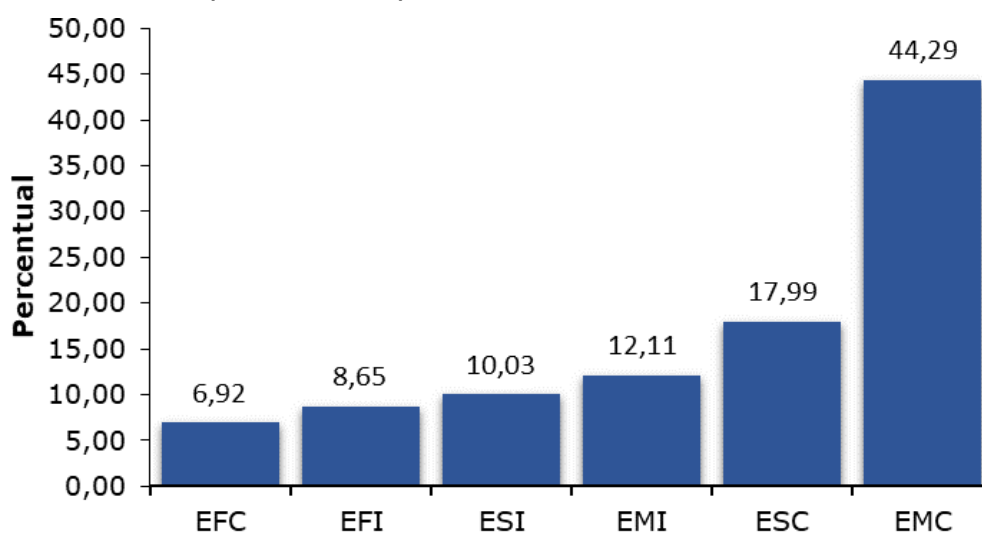


Source: Prepared by the authors based on SIAC data (2023).

Regarding the victim's level of education, it can be seen from Figure 3 that 44.29% of the victims have completed high school (CME), followed by 17.99% of the victims with complete higher education and in third place, with 12.11%, of the victims have incomplete high school.

Figure 3

Percentage by Schooling, of victims of the crime of stalking in the municipality of Ananindeua, Pará State, Brazil, from April 2021 to April 2023



Escolaridade

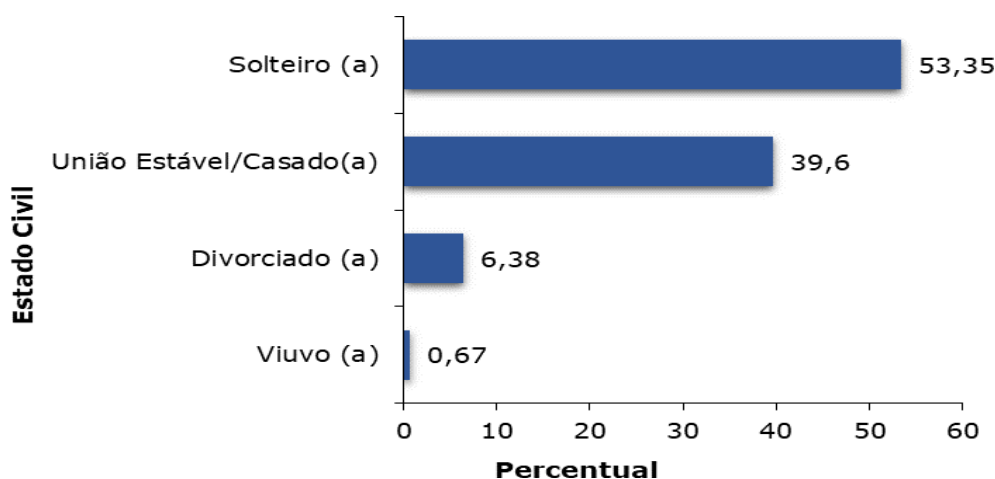
Legend: Incomplete Elementary School (EFI); Complete Elementary School (EFC); Incomplete High School (EMI); Complete High School (EMC); Incomplete Higher Education (ESI); Complete Higher Education (ESC).

Source: Prepared by the authors based on SIAC data (2023).

Furthermore, by marital status (Figure 4), a little more than half of the victims (53.35%) declared themselves single, demonstrating that even without a steady partner they are still susceptible to suffering the crime, this data is followed by common-law marriage/married, with 39.60% of the occurrences.

Figure 4

Percentage by marital status, of victims of the crime of stalking in the municipality of Ananindeua, Pará State, Brazil, from April 2021 to April 2023



Source: Prepared by the authors, based on SIAC data

Regarding the victims' profession, Table 1 shows that the majority declared themselves as "self-employed", representing 34.58%, followed by housewives, with 17.55%.

Table 1

Quantity and Percentage, by profession, of records of stalking victims in the municipality of Ananindeua, Pará, Brazil, from April 2021 to April 2023

Profession	Records	
	No.	%
Stand-alone	65	34,58
Housewife	33	17,55
Student	28	14,89
Domestic	19	10,11
Nurse	13	6,91
Hairdresser	10	5,32
Teacher	9	4,79
Administrator	7	3,72
Technician	4	2,13
Subtotal	188	100
Other (*)	71	-
Total	259	-

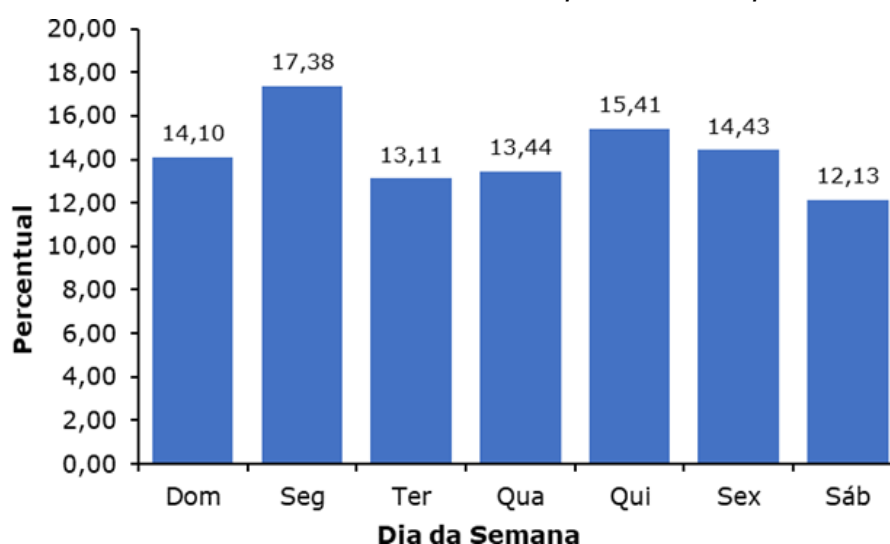
Note: (*) Other is a variable that is posted directly to the database provided.

Source: Prepared by the authors based on SIAC data (2023).

As for the day of the week, Figure 5 reveals that Monday was the day with the highest percentage of occurrences of the crime of stalking, with 17.38%, followed by Thursday, with 15.41% and Friday 14.43%.

Figure 5

Percentage, by day of the week, of records of victims of the crime of stalking in the municipality of Ananindeua, Pará State, Brazil, from April 2021 to April 2023.



Source: Prepared by the authors based on SIAC data

Analyzing the presumed causes, it is revealed that 77.01% reported that the reasons for such practices were hatred or revenge, followed by jealousy, with 17.24%, and ambition, with 4.02%, as can be seen in Table 2.

Table 2

Quantity and Percentage, by presumed cause of records of victims of the crime of stalking in the municipality of Ananindeua, Pará, Brazil, from April 2021 to April 2023

Presumed cause	Records	
	No.	%
Hatred or Revenge	134	77,01
Jealousy	30	17,24
Ambition	7	4,02
Alcoholism/Drunkenness	2	1,15
Alienation	1	0,57
Subtotal	174	100
Other (*)	71	-
Total	259	-

Note: (*) Other is a variable that is posted directly to the database provided.

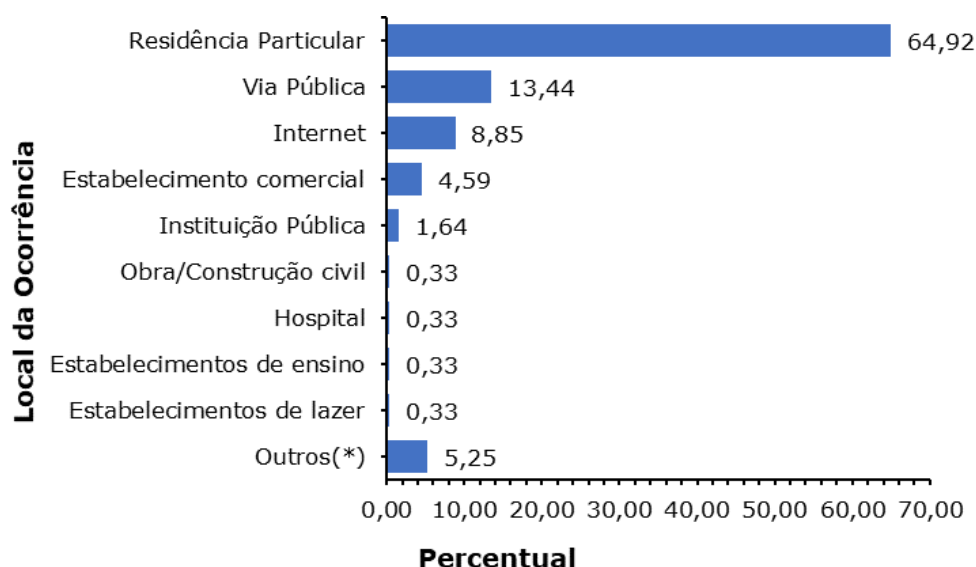
Source: Prepared by the authors based on SIAC data

Emphasizing that the crime of stalking is linked to domestic violence. Figure 6 clarifies that private residence stands out as the place of occurrence with the highest percentage

(64.92%), in addition to public roads and the internet are the places with the most records, 13.44% and 8.85%, respectively.

Figure 6

Percentage, by place of occurrence, of records of victims of the crime of stalking in the municipality of Ananindeua, Pará, Brazil, from April 2021 to April 2023



Note: (*) Other is a variable that is posted directly to the database provided.

Source: Prepared by the authors based on SIAC data

It should be noted that victims often take a long time to seek help and report their aggressors, regardless of the crime they suffered. However, as can be seen in Table 3, in the crime of stalking in most cases, in the period analyzed, the difference between the day of the fact and the day the record was made, it is evident that most victims took up to 9 days to report (represented by 92.13%).

Table 3

Amount and Percentage by time to register victims of the crime of stalking in the municipality of Ananindeua, Pará, Brazil, from April 2021 to April 2023

Time (days)	Records	
	No.	%
0 to 9	281	92,13
10 to 19	9	2,95
20 to 29	3	0,98
30 to 39	3	0,98
40 to 49	6	1,97
50 to 59	1	0,33
80 to 89	1	0,33
90 to 99	1	0,33
Total	305	100

Source: Prepared by the authors based on SIAC data

4 DISCUSSIONS

Crimes against women no longer require the physical means to be carried out, the growth of stalking, threats and psychological violence in the year 2024 indicated this. Thus, in the State of Pará, there were 1,931 complaints of stalking in 2023, which compared to the 1,168 complaints in 2022, point to a clear growth in this type of crime and awareness of it (FBSP, 2024).

Most of the victims are in the age group of 25 to 31 years old in Ananindeua, this age group is slightly lower than that reported by Gonçalves (2023) in the State of São Paulo, which obtained higher percentages in women aged 30 and 39 years (33.2%) of the victims. In turn, the quantitative research by Corte-Real (2017) and Abreu (2019) indicates a higher number of stalked women aged 18 to 22 years, these same studies corroborate that the victims of stalking are predominantly young adult women.

In this article, it was found that unlike what occurs in Portugal, where 41.2% of the participants attended only basic education and 32.9% high school (Matos *et al.*, 2012), in Ananindeua/PA, approximately 45% of the women who suffer the crime of stalking have completed high school. Understanding the level of education of these women is necessary so that educational, preventive and awareness-raising actions can be structured.

Subsequently, women who were declared single were the main victims, corroborating the data from a study by Juiz de Fora (Lopes, 2017) which indicate that 50% of the victims did not have a fixed relationship. In the present study, this finding is more expressive, 53.35% declare themselves single. Another study carried out in the metropolitan region of the city of Rio de Janeiro reaches the same profile when it comes to domestic violence, 50.3% of single women, the authors conjecture that women in a marital situation may not report violence they suffer because they do not understand that their rights are violated in certain situations, preferring to preserve their marriage (Moura; Albuquerque Netto; Souza, 2012).

It should be noted that the most expressive day of the week for the occurrence of crimes was Monday (17.38%), despite the lack of literature to confirm or confront this data, domestic violence and femicide stand out, data from Tolosa (2017) that help to confirm Monday and Sunday as the days of greatest occurrence in Belém (8.9% on this day), and this is the capital of the State that borders the municipality of Ananindeua. It is corroborated that the weekend is the day that the aggressors are free from their professional activities and probably travel to where the victim is, a situation that in theory would extend until Monday.

The victim's residence is the main place for the practice of the crime of stalking (64.92%), when prowling the residence he expects to establish contact or even threaten the woman, this is pointed out in Pinto (2022) who reiterates that for other passers-by obsessive

persecution goes unnoticed, due to the fact that the aggressor is usually someone close to the victim as in the present study. This means that major questions and concerns about security and surveillance are not even raised.

The impediment to act as one would like in one's own home or workplace brings panic and hurts women's mental health, it is not uncommon that out of fear they can change their address, or when not, they are confined inside the house with closed windows and low curtains, so that the criminal on the street does not see them at home (Santos; Tagliaferro, 2020).

Nevertheless, about 34.58% of women work informally claiming to be self-employed, although a significant number are housewives, students, housekeepers, nurses, hairdressers, teachers, administrators and technicians (approximately 66%). It is known that regarding work activity, it is common for women to suffer sabotage at work during and after separation, due to the conduct of the ex-partner in the case of stalking (29.1%) in a study by the University of Kentucky. In cases of stalking, the Kentucky study pointed out that 9.6% of the sample lost their job or did not work for a period during the relationship, 9.8% indicated that they were fired or were unable to work for a period of time during the separation from the stalker (Logan; Showalter, 2023).

It is noteworthy that the presumed cause for the most incident crime of stalking is the hatred and revenge in general of ex-partners, coinciding with femicide, a hate crime that brings up the aversion or contempt for the female gender as a justification. The pathological hatred of the female gender culminates in extreme violence, torture, murder and in the present study in psychological, moral and emotional torture, due to the obsessive persecution impacting on basic aspects of the victim's life such as the right to come and go, visit relatives and have moments of peace and leisure. This gender hatred is due to the attitude of the aggressor who does not accept that the victim continues without him, gaining independence in the post-relationship (Campos, 2015; Dias; Souza Dias, 2015). It is conjectured that one of the pertinent judgments for these data is how women suffer structural violence resulting from the very organization of society, which punishes them due to their gender (Santos, 2022).

The police station that covers the highest number of occurrences is the Specialized Police Station for Assistance to Women (DEAM) of Ananindeua. It is asserted that these specialized units of the Civil Police are sought after and endorsed among the population as participants in the network to combat gender-based violence. Women have been encouraged to report male aggressors, so it is essential to strengthen the DEAM's mechanisms for welcoming/encouraging victims and training so that professionals can provide greater support

to victims who go through situations of greater vulnerability (Oliveira; Lemos; Pereira, 2022). In cases of crime stalking, it is believed that because victims are often unaware that obsessive stalking is a crime, the numbers are underestimated.

Stalking crimes in Ananindeua/PA, in general, are registered in the interval of 0 to 9 days from the fact (92.13%), demonstrating that the victims, for the most part, seek the police stations to register complaints in a relatively agile way. About the means employed, insidious persecution (Grangeia, Matos, 2010), is committed through licit or illicit conduct, an example of a licit conduct is calling a person, it is a daily behavior. Conduit, calling repeatedly in order to take away the victim's peace can already be configured as a chasing behavior. It will be the repetition of these behaviors that distinguishes a scenario of permanent harassment, due to the *modus operandi* that the persecutor surrounds the victim.

A study from Portugal pointed out that the majority of the sample of victims reports that the behaviors of the aggressors are daily (55.7%), or at least weekly for the minority, the persistence of the aggressors lasted about six months. The bond of the stalkers varied from acquaintance, friend, neighbor or family member, with 33.5% being ex-partners, an interesting fact of this quantitative research is that the stalking process for 41 people occurred during the courtship/relationship, in the case of those who were victims of ex-partners (Pires; Sani; Soeiro, 2018).

From now on, being observed daily by someone can be characterized as something everyday, however, when this observation invades privacy, the beginning of stalking may be developing (Côrte-Real, 2017). Andrade (2022) points out that the criminalization of conduct is the first step, an immediate solution, but discusses stalking as a public health problem and the constitution of the psyche.

A recent systematic review points out that with regard to the psychocriminological treatment of male stalkers, an intensive treatment regimen with the objective of reducing the behaviors that trigger the disorder has good results. Forensic treatment programs need to be created to curb such conduct, or even more violent crimes (Travaini *et al.*, 2024).

The limitations of the study include those related to the type of study, as these are secondary data, there is a risk of registration bias and/or underreporting, in addition to time jumps. As contributions, it is revealed that the profile of the practice of stalking in this municipality can be generalized to that of other Brazilian capitals, especially for samples of women with the same characteristics as the victims of Ananindeua.

5 CONCLUSION

This study characterized important variables for the understanding of the crime of stalking as a phenomenon related to domestic violence, victimizing young adult women, mostly self-employed and housewives, with complete high school education and single.

It was noted that the advent of Law No. 14,132/2021 increased the number of reports of this crime, driven by the notion that obsessive stalking causes harm and that it is linked to acts of violence against women and that they felt compelled to report it, although the number of cases is probably higher. Monday and Thursday are the days with the highest number of cases, and the time between the commission of the crime and the complaint varies from 0 to 9 days, being a behavior motivated by male hatred and revenge, reported by the victims in the occurrences. Thus, the current study reaffirms the sexist and patriarchal character of the obsessive persecution of women, victimized due to structural gender relations and a feeling of possession on the part of persecuting ex-partners.

It is verified, therefore, that in the city of Ananindeua, in the state of Pará, domestic or intrafamily violence is imbricated with the crime of stalking, affecting the routine of the victims since the personal residence emerged as the main stage for the persecution, as perceived by the women.

Thus, it is suggested to strengthen the prevention of this crime with lectures on behaviors, structural machismo, culture of peace and on the activities developed in the DEAM to amplify awareness about the complaint. Social micro-policies must be implemented sectorally, in order to strengthen the care network for women victims.

It was noted that there is a tendency for this type of crime to grow, which should imply the construction of points of care for the physical and mental health of the victims, thus, the Women's Police Station would be the point of support for these women for health services, social assistance and support centers and legal advice, for example.

Finally, for new perspectives on the theme under study, future research should focus on how the flow of care occurs for these women considering the post-stalking support network, research on the profile of the aggressor in this municipality, repercussions on the health of these women victims of stalking and perceptions of women assisted at the DEAM about conditions and care provided to them in the search for their rights.

ACKNOWLEDGMENTS

I thank the Public Prosecutor's Office of the State of Pará for the institutional support and the professors of the Graduate Program in Public Security at UFPA for their dedication and development of the research.

REFERENCES

- Andrade, M. G. (2022). Stalking e cyberstalking: Percepções incipientes acerca da criminalização da prática no Brasil [Trabalho de conclusão de curso, graduação em Direito, Centro Universitário de Brasília]. Repositório UniCEUB. <https://repositorio.uniceub.br/jspui/handle/prefix/16415>
- Arendt, H. (1970). On violence. Harcourt, Brace & World.
- Bendlin, M., Sheridan, L., & Johnson, A. (2022). Stalking recidivism: A comparison of operational definitions. *Journal of Interpersonal Violence*, 37(9-10), NP8138–NP8160. <https://doi.org/10.1177/0886260520975857>
- Borges, J. L., & Dell'Aglio, D. D. (2019). Stalking following the breakup of dating relationships in adolescence. *Trends in Psychology*, 27(2), 413–426. <https://doi.org/10.9788/TP2019.2-09>
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Senado Federal. http://www.planalto.gov.br/ccivil_03/constituicao/ConstituicaoCompilado.htm
- Brasil. (1996). Decreto nº 1.973, de 1º de agosto de 1996. Promulga a Convenção Interamericana para Prevenir, Punir e Erradicar a Violência contra a Mulher. https://www.planalto.gov.br/ccivil_03/decreto/1996/d1973.htm
- Brasil. (2021). Lei nº 14.132, de 31 de março de 2021. Acrescenta o art. 147-A ao Decreto-Lei nº 2.848, de 7 de dezembro de 1940 (Código Penal), para prever o crime de perseguição. https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2021/lei/l14132.htm
- Brasil. Secretaria Nacional de Segurança Pública & Secretaria Especial de Políticas para as Mulheres. (2006). Norma técnica de padronização: Delegacias Especializadas de Atendimento à Mulher (DEAMs).
- Bussab, W. O., & Morettin, P. A. (2024). Estatística básica (10ª ed.). Saraiva Uni.
- Cabreiro, A. P. S. A. (2023). Stress pós-traumático e ansiedade em vítimas de violência doméstica e stalking [Dissertação de mestrado, Psicologia Clínica, Universidade Lusíada de Lisboa]. Repositório ULusíada. <http://hdl.handle.net/11067/6702>
- Campos, C. H. (2015). Feminicídio no Brasil: Uma análise crítico-feminista. *Sistemas Penais e Violência*, 7(1), 103–115. <https://doi.org/10.15448/2177-6784.2015.1.20275>
- Corte-Real, R. M. G. (2017). Algumas questões sobre o regime jurídico do stalking [Dissertação de mestrado, Direito dos Contratos e das Empresas, Universidade do Minho]. Repositório UMinho. <https://hdl.handle.net/1822/50529>
- Dancey, C. P., & Reidy, J. (2019). Estatística sem matemática para psicologia (7ª ed.). Penso.
- Dias, R. F., & Souza Dias, R. V. (2015). Feminicídio. *Boletim Informativo Criminológico*, 2(1), 124–137.

- Fórum Brasileiro de Segurança Pública. (2024). Anuário Brasileiro de Segurança Pública. <https://forumseguranca.org.br/wp-content/uploads/2024/07/anuario-2024.pdf>
- Gil, A. C. (2019). Métodos e técnicas de pesquisa social (7ª ed.). Atlas.
- Gonçalves, A. C. M., et al. (2023). Crime de perseguição (stalking) nova lei nº 14.132, de 31 de março de 2021. Repositório PUC Goiás. <https://repositorio.pucgoias.edu.br/jspui/handle/123456789/6804>
- Grangeia, H., & Matos, M. (2010). Stalking: Consensos e controvérsias. In C. Machado (Coord.), *Novos olhares sobre a vitimação criminal: Teorias, impacto e intervenção* (pp. 121–166). Psiquilibrios.
- Haile, A. P. (2020). Stalking: Novatio legis incriminadora a necessidade de um novo tipo penal para combater a violência contra a mulher [Dissertação de mestrado, Direito, Universidade Católica de Santos]. TEDE UniSantos. <https://tede.unisantos.br/handle/tede/7484>
- Instituto Brasileiro de Geografia e Estatística. (2022). Ananindeua. <https://cidades.ibge.gov.br/brasil/pa/anandindeua>
- Logan, T. K., & Showalter, K. (2023). Work harassment and resource loss among (ex) partner stalking victims. *Journal of Interpersonal Violence*, 38(1-2), 1060–1087. <https://doi.org/10.1177/08862605221086649>
- Lopes, N. C. (2017). O stalking na violência entre parceiros íntimos: A perspectiva das vítimas [Dissertação de mestrado, Psicologia, Universidade Federal de Juiz de Fora]. Repositório UFJF. <https://repositorio.ufjf.br/jspui/bitstream/ufjf/4893/1/natalicedocarmolopes.pdf>
- Lakatos, E. M., & Marconi, M. A. (2017). Fundamentos de metodologia científica (8ª ed.). Atlas.
- Matos, M., et al. (2012). Vitimação por stalking: Preditores do medo. *Análise Psicológica*, 30(1/2), 161–176. <https://doi.org/10.14417/ap.544>
- Monteiro, R. O. (2021). Vitimização por stalking e cyberstalking em universitários brasileiros [Dissertação de mestrado, Psicologia da Justiça, Universidade Fernando Pessoa]. Repositório UFP. https://bdigital.ufp.pt/bitstream/10284/10660/1/DM_39308.pdf
- Moura, M. A. V., Albuquerque Netto, L., & Souza, M. H. N. (2012). Perfil sociodemográfico de mulheres em situação de violência assistidas nas delegacias especializadas. *Escola Anna Nery*, 16(3), 435–442. <https://doi.org/10.1590/S1414-81452012000300002>
- Oliveira, A. B., Lemos, A. G. C., & Pereira, B. A. (2022). A importância de delegacias especializadas de atendimento a mulher em cidades do interior de Pernambuco: Análise das demandas nos municípios de Caruaru, Santa Cruz do Capibaribe e Belo Jardim de 2018 a 2021 [Trabalho de conclusão de curso, graduação em Direito, Associação Caruaruense de Ensino Superior]. Repositório ASCES-UNITA. <http://repositorio.asc.es.edu.br/handle/123456789/3435>
- Pinto, S. P. S. (2022). Stalking [Dissertação de mestrado, Direito Penal, Universidade de Lisboa]. Repositório ULisboa. https://repositorio.ul.pt/bitstream/10451/53254/1/ulfd0150524_tese.pdf
- Pires, S., Sani, A. I., & Soeiro, C. (2018). Stalking y cyberstalking: Coocurrencia y estándares de victimación en estudiantes universitarios. *Arquivos Brasileiros de Psicologia*, 70(2), 5–21. <https://pepsic.bvsalud.org/pdf/arbp/v70n2/02.pdf>

- Ramalho, J., & Macedo, F. (2021). Stalking: Tutela jurídico-penal e caracterização psicológica. *Revista Eletrônica de Direito Penal e Política Criminal*, 9(2), 75–96. <https://seer.ufrgs.br/index.php/redppc/article/view/116989>
- Roberts, K. A. (2005). Women's experience of violence during stalking by former romantic partners: Factors predictive of stalking violence. *Violence Against Women*, 11(1), 89–114. <https://doi.org/10.1177/1077801204271096>
- Rodrigues, T. D. F. F., Oliveira, G. S., & Santos, J. A. (2021). As pesquisas qualitativas e quantitativas na educação. *Revista Prisma*, 2(1), 154–174. <https://revistaprisma.emnuvens.com.br/prisma/article/view/49>
- Saffioti, H. I. B. (2013). *A mulher na sociedade de classes* (3ª ed.). Expressão Popular.
- Santos, C. L., & Tagliaferro, E. (2020). A responsabilidade civil como instrumento jurídico de punição ao stalking e ao cyberstalking. *Intr@ciência*, 20, 1–13. https://uniesp.edu.br/sites/_biblioteca/revistas/20201125002201.pdf
- Tolosa, T. S. R. (2017). *Violência de gênero: Caracterização do feminicídio no município de Belém* [Dissertação de mestrado, Segurança Pública, Universidade Federal do Pará]. PPGSP UFPA. https://www.ppgsp.propesp.ufpa.br/ARQUIVOS/teses_e_dissertacoes/dissertacoes/2015/201507%20-%20TOLOSA.pdf
- Travaini, G., et al. (2024). Efficacy of treatment approaches for stalking offenders: A systematic review. *International Review of Psychiatry*, 36(7), 812–825. <https://doi.org/10.1080/09540261.2024.2368796>
- White, E., Longpré, N., & Stefanska, E. B. (2022). Stalking behaviors presented by ex-intimate stalkers: A victim's perspective. *Journal of Interpersonal Violence*, 37(7-8), NP5074–NP5093. <https://doi.org/10.1177/0886260520934429>

SEXUAL CRIMES AGAINST CHILDREN IN THE VIRTUAL ENVIRONMENT: AN ANALYSIS OF PEDOPHILIA IN THE CONTEXT OF HYPERSEXUALIZATION AND THE CULTURE OF SILENCE

CRIMES SEXUAIS PRATICADOS CONTRA CRIANÇAS NO AMBIENTE VIRTUAL: UMA ANÁLISE DA PEDOFILIA DIANTE DA HIPERSEXUALIZAÇÃO E A CULTURA DO SILÊNCIO

DELITOS SEXUALES COMETIDOS CONTRA NIÑOS EN EL ENTORNO VIRTUAL: UN ANÁLISIS DE LA PEDOFILIA FRENTE A LA HIPERSEXUALIZACIÓN Y LA CULTURA DEL SILENCIO



<https://doi.org/10.56238/sevened2026.008-093>

José Caetano Serafim Neto¹

ABSTRACT

This study focuses on the analysis of sexual crimes occurring in the virtual environment, especially against children, as the internet has evolved since the 1990s, introducing new forms of interaction and increasing risks for young people. Although there are national and international laws and treaties aimed at protecting children from sexual violence, the high number of cases reflects persistent challenges that require more robust public policies and an improvement in the justice system. The culture of silence, the hypersexualization of children, and the lack of sexual education contribute to the vulnerability of children. Thus, awareness, sexual education, and online monitoring are crucial to protect them and ensure a safe digital environment. This study seeks to understand the challenges in preventing and combating online sexual crimes against children, proposing policies and protective measures to mitigate these threats, in addition to also alerting parents, educators and health agents about the signs of pedophilia.

Keywords: Sexual Crimes. Children. Vulnerability.

RESUMO

Este estudo foca na análise dos crimes sexuais ocorridos no ambiente virtual, especialmente contra crianças, à medida que a internet evoluiu desde os anos 90, introduzindo novas formas de interação e aumentando os riscos para os jovens. Embora existam leis e tratados nacionais e internacionais que visam proteger as crianças contra a violência sexual, o alto número de casos reflete desafios persistentes que exigem políticas públicas mais robustas e uma melhoria no sistema de justiça, a cultura do silêncio, a hipersexualização infantil e a falta de educação sexual contribuem para a vulnerabilidade das crianças. Sendo assim, a conscientização, a educação sexual e o monitoramento online são cruciais para protegê-las e garantir um ambiente digital seguro. Este estudo busca entender os desafios na prevenção e combate aos crimes sexuais online contra crianças, propondo políticas e medidas de

¹ Graduated in Law. Centro Universitário FACOL – UNIFACOL.

proteção para mitigar essas ameaças, além de também alertar aos pais, educadores e agentes de saúde sobre os indícios da pedofilia.

Palavras-chave: Crimes Sexuais. Crianças. Vulnerabilidade.

RESUMEN

Este estudio se centra en el análisis de los delitos sexuales ocurridos en el entorno virtual, especialmente contra niños, a medida que Internet ha evolucionado desde la década de 1990, introduciendo nuevas formas de interacción y aumentando los riesgos para los jóvenes. Aunque existen leyes y tratados nacionales e internacionales destinados a proteger a los niños contra la violencia sexual, el elevado número de casos refleja desafíos persistentes que exigen políticas públicas más sólidas y mejoras en el sistema de justicia. La cultura del silencio, la hipersexualización infantil y la falta de educación sexual contribuyen a la vulnerabilidad de los niños. Por lo tanto, la concienciación, la educación sexual y el monitoreo en línea son fundamentales para protegerlos y garantizar un entorno digital seguro. Este estudio busca comprender los desafíos en la prevención y el combate de los delitos sexuales en línea contra niños, proponiendo políticas y medidas de protección para mitigar estas amenazas, además de alertar a padres, educadores y profesionales de la salud sobre los indicios de la pedofilia.

Palabras clave: Delitos Sexuales. Niños. Vulnerabilidad.

1 INTRODUCTION

The main focus of this work is to analyze crimes committed in the virtual environment, focusing more specifically on sexual crimes committed against children.

It can be seen that, from the 90's, with the emergence of the internet, new modalities of communication and interaction emerged, such as chat chats and text messages, through which social networks were consolidated, virtual spaces in which any individual can create and share content.

The legal protection of children and adolescents against sexual violence is a national and international commitment, based on treaties and laws that aim to safeguard their rights and integrity, Brazil, ratifying conventions such as the Convention on the Rights of the Child and the American Convention on Human Rights, has assumed the responsibility of adopting measures to prevent and punish all forms of sexual violence.

The Statute of the Child and Adolescent, instituted in 1990, adopts the principle of full protection, ensuring specialized care and protection measures for victims, despite this, the legislation faces challenges, reflected in the high number of cases of child and adolescent sexual violence.

To deal with this issue, it is necessary to strengthen public policies, invest in awareness and education, in addition to improving the criminal justice system to ensure more effective punishments against aggressors, only through a joint effort by society will it be possible to guarantee a safe and protected environment for children and adolescents, promoting their fundamental rights and dignity.

The advent of the internet since the 1940s has marked a revolution in communications, moving from a military tool to a social space, however, along with the opportunities also came cybercrimes, such as identity theft and wire fraud.

In Brazil, in 2022, there was a significant increase in these crimes, evidencing the need for digital protection, among these crimes, sexual crimes emerge as a threat, taking advantage of child vulnerability and ease of access to the internet, where aggressors often hide behind fake profiles to get closer to children and adolescents, perpetuating abuse and manipulation.

The responsibility for identifying and preventing crimes against children and adolescents falls mainly on the family, which must be aware of signs of abuse, sex education is essential to enable young people to recognize and report situations of abuse.

The culture of silence and child hypersexualization are obstacles that need to be overcome, open dialogue, monitoring of online activities and preventive education are

fundamental in protecting children, this responsibility is shared by parents, educators and the whole society.

The present work addresses the need to understand the predominant forms of cybercrime and the means available to combat child exploitation and pedophilia through the computer network.

These crimes are intrinsically connected by the nature of the conducts and actions perpetrated, in the current context, the criminal legal system demonstrates a certain lag in relation to the constant evolution of these criminal behaviors, such a scenario provides a kind of "safe-conduct" for criminals, encouraging the increase of crimes of a lascivious nature and financial scams, which find fertile ground to prosper.

The analysis of these criminal phenomena constitutes a complex and urgent challenge, and it is therefore urgent to promote the updating of the legal framework and the implementation of effective coping strategies, in order to preserve the safety and integrity of victims, as well as to rigorously repress those who are dedicated to perpetrating such atrocities in the digital environment.

In view of the growing use of the internet and digital technologies, what are the challenges faced in preventing and combating sexual crimes committed against children in the virtual environment, considering child vulnerability, the spread of hypersexualization and the culture of silence? In addition, how can public policies, sex education, and monitoring of online activities contribute to mitigating these crimes and promoting a safe environment for children and adolescents in the digital age?

The justification for this study is related to the importance of the theme for society. Human relationships have taken on a secondary importance with regard to the ways in which people relate to each other.

Often virtual friendships are made, without ever having seen the person in person, which often facilitates criminal actions by electronic means.

The need to promote society's awareness of the risks and implications of virtual crimes, combined with the implementation of preventive measures to mitigate such threats, is an imperative.

An in-depth understanding of the legal aspects and resources available to effectively combat cybercrime is crucial in order to establish an effective and cohesive approach to this multifaceted challenge.

By conducting an analysis of the Brazilian legal scenario regarding virtual crimes, this study aims to contribute to the debate and improvement of public policies and legislation concerning this sphere.

The preservation of citizens' rights and the protection of cybersecurity are highly relevant issues in an increasingly interconnected global context, therefore, they demand a comprehensive and up-to-date legal approach by the Brazilian legal system.

Therefore, the general objective here was to understand the general context of sexual crimes perpetrated against children in the virtual sphere, while the specific objectives were: to explore the legal protections regarding children; analyze the issue of pedophilia and child vulnerability; know about the responsibility to identify the occurrence of sexual crimes against children; explore the factors that contribute to child sexual violence.

2 CHILDREN AND FULL PROTECTION

Sexual violence, characterized as one of the most abominable forms of violence, takes on even more harmful proportions when perpetrated against children and adolescents, causing not only damage to their physical integrity, but also compromising their human dignity, sexuality and privacy - crucial aspects for the healthy development of these individuals in the growth phase. In this context, Brazil, by ratifying international conventions and treaties, assumes the commitment to protect young people against sexual crimes, in line with the constitutional principles established in article 227 of the Federal Constitution of 1988, which recognizes as the duty of the family, society and the State to guarantee, with absolute priority, a range of fundamental rights, including the right to life, to health, education, leisure, culture, dignity, respect, freedom and to family and community life (Brasil, 1988).

In addition, the Convention on the Rights of the Child, adopted by the United Nations General Assembly on November 20, 1989 and ratified by Brazil in 1990, establishes the obligation of member states to adopt appropriate legislative, administrative, social and educational measures to protect children against all forms of physical or mental violence, abuse, neglect, mistreatment or exploitation, including sexual abuse (Brasil, 1990).

Thus, this protection extends to children as long as they are under the responsibility of their parents, legal representatives or any other persons in charge of their care.

According to the contributions of Figueiredo and Novas (2000), the Convention on the Rights of the Child undoubtedly represented a significant milestone in changing the perception of children and adolescents, who began to be recognized as subjects with rights.

The author considers that its enactment was responsible for the paradigm shift in international legal norms, evolving into the Doctrine of Integral Protection, which prioritizes the condition of a person in a peculiar situation of development, ensuring the protection and rights of children and adolescents.

The American Convention on Human Rights, known as the Pact of San José, Costa Rica, ratified by Brazil through Decree 678 in 1992, aims primarily to safeguard the dignity of the human person and to protect all individuals against any manifestation of violence and exploitation, particularly those in situations of fragility, such as children and adolescents (Brazil, 1992).

In addition, the Convention establishes protection measures aimed at vulnerable groups, including children and adolescents, among these measures, the prohibition of sexual exploitation and child labor, as well as the guarantee of the right to education and protection against all forms of violence, abuse and negligence (Brasil, 1992).

In addition, the Convention provides for the establishment of mechanisms for the protection and promotion of human rights, such as the Inter-American Commission on Human Rights and the Inter-American Court of Human Rights, which are responsible for monitoring the human rights situation in the countries that are signatories to the Covenant and for adopting preventive and corrective measures in cases of human rights violations (Brazil, 1992).

The Federal Constitution guarantees the fundamental rights of all people, including children and adolescents, to ensure the realization of these rights, the Statute of the Child and Adolescent (ECA) was instituted in 1990, by Law No. 8,069. The ECA adopts the principle of full protection, aiming to safeguard all the rights of this population, including protection against sexual violence.

Specifically for cases of sexual violence, such as the rape of a vulnerable person, the ECA establishes protective measures such as specialized care, forensic examinations, confidentiality of the victim's identity, psychological and social support, in addition to protection measures such as the removal of the victim from the aggressor.

It should be noted that the full protection advocated by the ECA goes beyond the simple prevention of rape of a vulnerable person, extending to all forms of violence and sexual exploitation against children and adolescents, especially by seeking to ensure that all the rights of this population group are widely respected and protected.

In this sense, Araujo (2018) teaches that the full protection provided for in the ECA encompasses all forms of violence and sexual exploitation against children and adolescents, transcending the mere protection against the rape of the vulnerable. According to the author, this comprehensive approach guarantees the safeguarding of the rights of this population, and is essential to promote a childhood and adolescence free of violence and exploitation.

According to the understanding of the Public Security Forum, despite the existence of extensive and specific legislation to protect children and adolescents against sexual crimes

in Brazil, there is still an alarming number of cases of sexual violence involving this age group, which ends up reflecting the insufficiency of laws and public policies in force to prevent and punish such crimes (Brazilian Public Security Forum, 2022)

In this sense, the Forum understands that it is urgent to implement comprehensive and preventive policies that encompass awareness, education, protection and effective punishment of aggressors.

Society as a whole must be involved in preventing and combating sexual crimes, reporting suspected cases and supporting victims, investing in policies that facilitate access to information on prevention and reporting, together with awareness campaigns, is essential to enable people to act in the face of suspected or confirmed sexual crimes (Brazilian Forum on Public Security, 2022)

In addition, it is essential to improve the criminal justice system, through the proper training of legal operators, combined with the implementation of more severe punitive measures against aggressors, precisely to mitigate impunity and promote a greater sense of equity, both for victims and for the social body as a whole.

Therefore, the synergistic effort of all segments of society aimed at preventing and confronting sexual crimes, ensuring the safeguarding and respect for the human rights of all individuals, especially children and adolescents, who are the most susceptible to such violations.

2.1 CYBERCRIME AND CHILD VULNERABILITY

Initially, it is unavoidable to address the theme of cybercrimes without evoking the genesis of the internet, dating back to the 1940s, when the military enterprise during the Cold War functioned as a communicative alternative in the face of the vicissitudes of the traditional media of the time (Almeida, 2015).

This initial conception, aimed at war purposes, was transformed after the end of the conflict, when the internet began to be used for social purposes, marking an unprecedented era and catalyzing the development of ENIAC, the pioneering digital computer, dedicated to ballistic tasks (Santos; Martins; Tybusch, 2017). In view of this new context, contemporary types of crimes emerge, including identity theft, electronic fraud, system invasion, malware propagation, phishing, virtual harassment, among others, in the first half of 2022, Brazil was the scene of a notorious increase in the volume of attempts of cyberattacks, totaling 31.5 billion records.

This alarming data highlights the growing sophistication and frequency of virtual threats, requiring increasingly robust and effective measures to protect systems and users against such attacks.

Thus, an in-depth analysis of the causes of this exponential increase in cyber crimes is urgent, ranging from rapid technological evolution to the lack of awareness on the part of users about the best digital security practices.

In addition, factors such as the lack of adequate legislation and efficient international cooperation also contribute to the proliferation of these crimes, so it is urgent to develop multidisciplinary policies and strategies, involving governments, companies, and civil society, to address this growing challenge and protect the integrity and privacy of individuals in the digital age.

With the popularization of the internet, many people have started to use it as an integral part of their daily lives, however, not all users act sensibly or ethically when using this medium.

Many individuals mistakenly see the internet as a free space, where they can act without restrictions or consequences, this misperception contributes for the emergence of new types of crimes, known as virtual crimes (Porto; Santos, 2014).

These crimes occur in the digital environment and can include activities such as hacking, online fraud, virtual bullying, defamation, among others, thus, the lack of awareness about ethical and legal limits on the internet has led to an increase in the incidence of virtual crimes around the world (Porto; Santos, 2014).

With the progress of the Internet, the dissemination of access to this platform has become widespread, however, it is clear that not everyone uses it responsibly. Countless individuals, mistakenly persuaded that the Internet constitutes a space of unrestricted freedom, incur in inappropriate conduct, triggering new criminal modalities: virtual crimes.

Cybercrimes represent an increasingly present threat, and child vulnerability in this scenario is a growing concern, with the advancement of technology and the expansion of internet access, children are increasingly exposed to online risks, even with filters and parental controls, it is difficult to completely control what children access online (Abreu, 2013).

It is precisely at this time that they can be exposed to pornography, violence, drugs and other harmful content that can affect their emotional and psychological development (Abreu, 2013).

Therefore, a proactive approach to protecting children from these dangers is essential, involving digital education, setting clear boundaries, and proper supervision by parents and guardians.

In this way, the vulnerability of children and adolescents comes up against the ease of access to devices connected to the internet and that exposes children and adolescents to a series of risks, including contact with sexual predators, involvement in situations of sexual exploitation and access to content inappropriate for their age group.

2.2 PEDOPHILIA AND ITS RELATIONSHIP WITH CHILD SEXUAL CRIMES

Pedophilia is a paraphilia that is characterized by sexual distortion permeated by a compulsive impulse in which adult individuals, predominantly male, manifest a sexual attraction aimed both exclusively and non-exclusively at children and adolescents

According to Lowenkron (2015), the expression pedophilia has its origin in the Greek term "paidophilia" and refers to the distortion that leads an adult to feel sexual attraction to children or to effectively perform activities of a sexual nature with them, these activities can range from simple stimulation to caresses and other sexual behaviors.

According to Silva et al. (2013), the concept of pedophilia unfolds in two parts: "paidos", which means child, and "philia", which alludes to the notion of love or attraction.

This combination of terms encapsulates the core of the phenomenon, evidencing the sexual inclination towards children on the part of an adult, it is important to emphasize that pedophilia is recognized as a complex and disturbing psychological condition, with serious implications for the well-being of the children involved and for society as a whole.

In addition, according to Greco (2016, apud França, 1996), pedophilia can be conceptualized as sexual perversion characterized by the erotic predilection for children, which can range from obscene acts to the practice of libidinous manifestations, denoting serious psychic and moral impairments of its authors.

In addition, to its definition it is added that men have a greater propensity to commit pedophilia, due to difficulties in establishing satisfactory sexual relations with adult women, resulting from complexes or feelings of inferiority.

In the Brazilian context, pedophilia is classified by the World Health Organization (WHO) as a sexual preference disorder, it refers to adults, both men and women, who have sexual preferences for children, regardless of sex, usually at ages ranging from pre-puberty to puberty (Bigati, 2017).

These individuals, for the most part, are men who, at first glance, appear to be ordinary people in social life and can interact in an apparently normal way in society.

This ability to camouflage themselves facilitates the conquest of victims' trust without arousing suspicion (Bigati, 2017), this aspect reinforces the complexity and severity of this disorder, requiring a multidisciplinary approach for its prevention and treatment.

According to Ferreira et al. (2018), is configured as any act or interaction of a sexual nature, whether heterosexual or homosexual, involving one or more adults and a child or adolescent, with the purpose of sexually stimulating the minor or using it as a means to obtain one's own sexual satisfaction or that of third parties.

The pedophile perpetrator, by masking himself under the façade of an apparently conventional individual and integrated into the social fabric, manages to operate stealthily, without arousing suspicion, thus facilitating his criminal activities without attracting attention (Medina et al., 2021).

Sexual abuse, perpetrated by an adult who has advantages in contrast to the extreme vulnerability of the victimized child, occurs in a meticulously planned and reserved environment, with the aim of minimizing any material traces (Medina et al., 2021).

As a consequence, such an abusive relationship remains obscure, hidden by the family structure, culturally considered as a stronghold of security, in addition, society, in certain contexts, mythologizes the theme and demonstrates skepticism or even indulgence in the face of sexual violence, evidencing a lack of training for its detection (Medina et al., 2021).

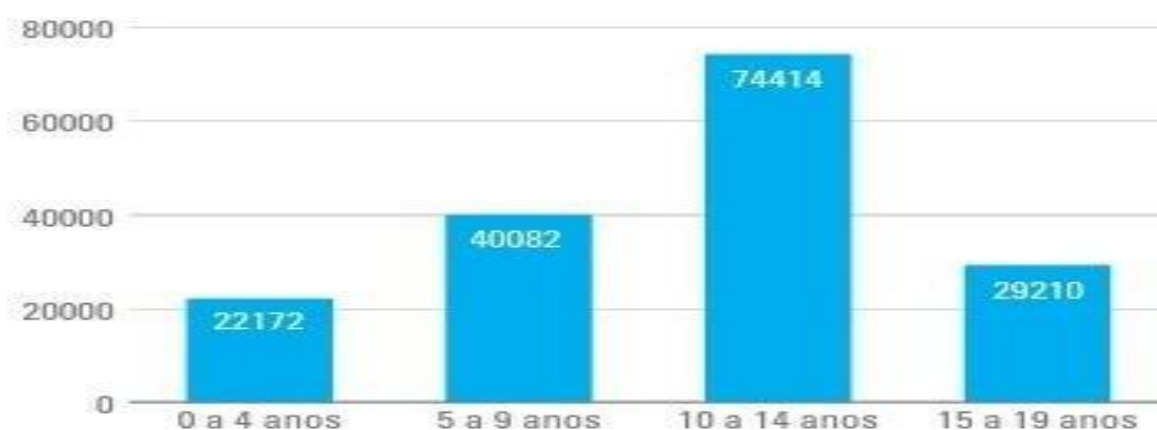
Furthermore, according to the reflections of Ulisses (2019), child victims of sexual abuse are often subjugated to the will of others and to the suppression of their own desires, resulting in a relational dynamic marked by the asymmetry of power.

In this sense, this disparity imposes severe consequences, both in the physical and emotional spheres, which can manifest themselves in various ways and in different contexts, including school and social.

According to Medina et al. (2021) outlines, the genesis of this nefarious scenario lies in the manipulation of the child, often through seduction supported by the offer of toys, monetary resources, or even through threats that aim to ensure their silence, as a result, the cycle of sexual abuse is perpetuated, inflicting deep damage on its victims (Medina et al., 2021).

In extreme circumstances, the violence perpetrated can be so overwhelming as to result in the death of the victimized individual, this Dantesque consequence illustrates the exacerbated gravity of the situation, emphasizing the imperative urgency of combating and preventing pedophilia and child sexual abuse (Medina et al., 2021).

The study by the United Nations Children's Fund (UNICEF) on deadly and sexual violence directed at children and adolescents in Brazil, in the period from 2017 to 2020, reveals that most records of rape and rape of vulnerable people involve victims under 14 years of age, as shown by the following data:

Figure 1*Rape by age group*

Source: UNICEF, 2021.

Through the analysis of Figure 1, the distribution of cases according to age group is noticeable, revealing a significant increase in the number of occurrences from 3 years of age onwards.

During the interval from 3 to 8 years old, the incidence remains relatively stable, but experiences a more marked growth from the age of 10 onwards, culminating in the peak of occurrences at 13 years old, an age that represents 14% of victims in the age group of 0 to 19 years (UNICEF, 2021).

These data are worrying and show that 81% of the victims were up to 14 years of age, in absolute terms, of the 179,278 cases registered in this period, 145,08619 had individuals up to 14 years of age as victims (UNICEF, 2021).

The United Nations Children's Fund indicates that many cases of crimes committed against people over 13 years of age are possibly not reported, due to cultural and social divergences in relation to the perception of victimization among adolescents and children, this, however, does not imply that the crimes did not occur, but rather that they were not reported to the competent authorities (UNICEF, 2021).

Despite this finding, it is essential to emphasize that rape is a violation that mainly affects children, in fact, victims aged between 0 and 9 years represent 38% of the cases registered with victims up to 19 years old.

This data highlights the vulnerability of these individuals and the urgency of implementing preventive and punitive measures to combat this serious violation of human rights (UNICEF, 2021).

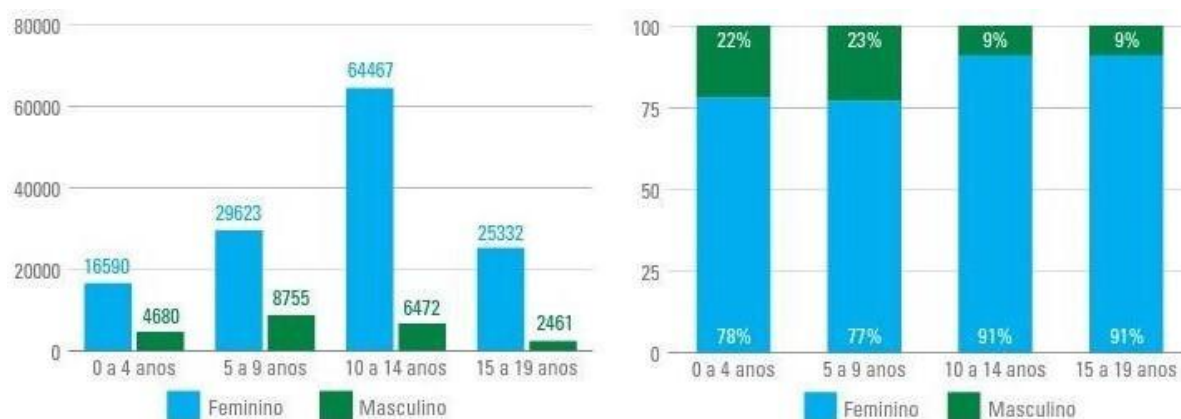
Oliveira and Rosa (2019) state that, through research and statistical analysis, it is possible to conclude that rape is a crime that mainly affects children and adolescents.

In Brazil, for example, the majority of rape victims are girls and young women, and approximately 70% of the registered cases involve female children and adolescents, many of them under 14 years old.

There is a clear pattern in the distribution of the crime of rape in relation to the sex of the victims, showing that, in most age groups, the majority of victims are female, as the data corroborate:

Figure 2

Rape by age and gender



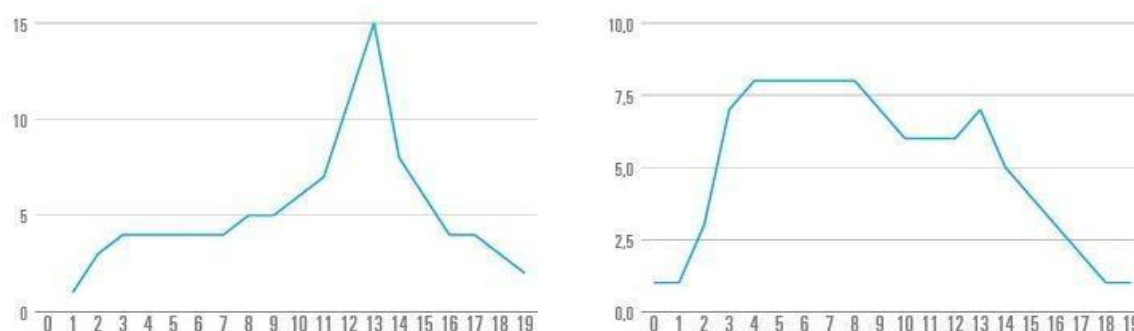
Source: UNICEF, 2021.

In the age group of 0 to 4 years and 5 to 9 years, it is observed that girls correspond to 77% of the total victims, while boys correspond to 23%. In the age groups of 10 to 14 years and 15 to 19 years, it is noted that females are responsible for 91% of the registered cases, while males corresponds to only 9%.

These data suggest that as the age range of victims increases, the likelihood that they are girls also increases (UNICEF, 2021).

Figure 3

Rapes of female and male victims by age of the victim



Source: UNICEF, 2021.

According to data from UNICEF (2021), 66,041 cases of rape were recorded in Brazil in 2020, of which 50,933 were classified as rape of a vulnerable person, while according to the 2022 Brazilian Public Security Yearbook, there were 47,232 cases of rape of a vulnerable person in Brazil in 2021, representing 75.5% of all rape cases in the country in the same year.

The detailed analysis in the yearbook highlights the seriousness of these crimes, especially among victims up to 13 years old, totaling 35,735 occurrences, which highlights the worrying situation (Brazilian Forum on Public Security, 2022).

It is also observed that, according to UNICEF (2021), 12% of female victims were between 0 and 4 years old, while 22% were in the age group of 5 to 9 years, totaling 34% of female victims aged between 0 and 9 years.

With regard to boys, a distinct distribution of cases is remarkable, with the highest concentration occurring among those aged 0 to 9 years (59%), in specific terms, the proportion of cases for boys between 0 and 4 years old is 21%, between 5 and 9 years old is 39%, and between 15 and 19 years old it is 11% (UNICEF, 2021).

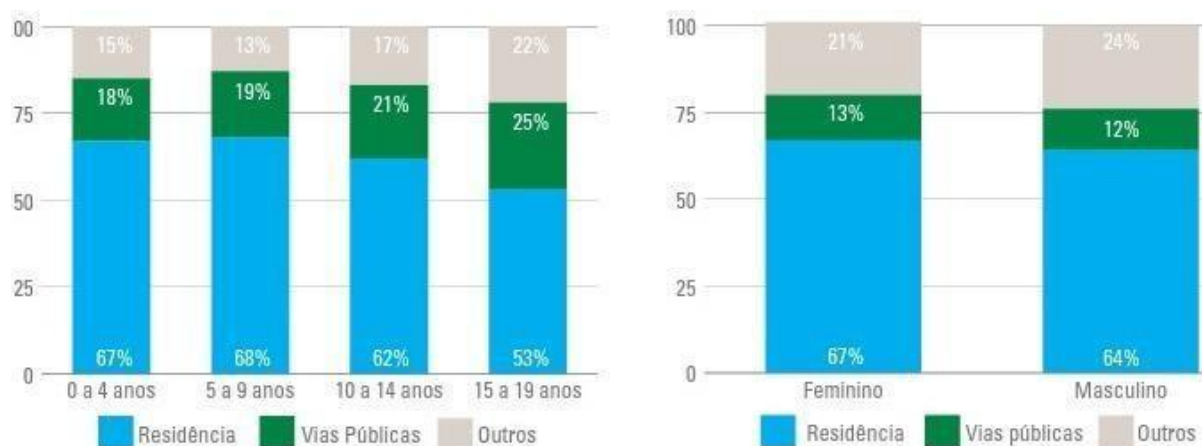
Therefore, it is evident that the distribution of cases varies considerably according to sex and age group, while cases of rape among boys are more prevalent in early childhood, cases involving girls are proportionally more common between 10 and 14 years of age.

However, it is important to highlight that the concern regarding early childhood in the case of female victims should not be underestimated, since, in absolute numbers, they are more numerous than male victims (UNICEF, 2021).

It is also crucial to consider the context where these crimes occur, as this factor exerts a determining influence on the occurrence of child and adolescent rape, so to understand the factors associated with this type of crime, it is essential to analyze:

Figure 4

Rapes by age group, gender, and place of crime



Source: UNICEF, 2021.

The analysis of these data reveals significant geographic variations in the places where the crimes are committed, depending on the age of the victim, the numbers indicate that the younger the victim, the greater the probability of suffering violence within their own residence, for age groups between 0 and 9 years, approximately 68% of crimes occur in households (UNICEF, 2021).

It is notable that the proportion of crimes that occur in homes decreases as the age of the victims advances, for example, between 10 and 14 years old, this percentage is 62%; and in the 15 to 19 age group, it is reduced to 53%.

In the latter age group, there is an increase in rape crimes on public roads or other places, in addition, both boys and girls are more likely to be victims of violence within their own homes, with percentages of 64% and 67%, respectively (UNICEF, 2021).

It is crucial to note that the underreporting of the crime of rape is a widespread phenomenon around the world, often attributed to victims' lack of trust in the justice system, fear of reprisals by the perpetrator, and a culture of victim-blaming.

The underreporting of cases of rape of vulnerable people is a worrying issue that compromises the effectiveness of public policies aimed at protecting these victims.

The author points out that the absence of records of these cases in the information systems can be attributed to several factors, such as the shame and fear of the victims and their families in reporting the aggressor, the lack of understanding about what constitutes a crime of rape of a vulnerable person, and the lack of training of health professionals and the justice system to identify and record such cases (Picini, 2015).

It is important to emphasize that as of 2011, the notification of violence became mandatory in Brazil, integrating the National List of Compulsory Notification of diseases, injuries and public health events. This list is compulsory in all public and private health services in the country (Cerqueira et al., 2017).

The Ministry of Health aims to ensure that all cases of rape treated in health services are registered through the interpersonal and self-inflicted violence notification form and entered into the Notifiable Diseases Information System (Sinan) (Cerqueira et al., 2017).

This measure aims to improve the epidemiological surveillance of the incidences of violence, while enabling the implementation of preventive and corrective strategies, while ensuring support and support for victims.

According to data provided by UNICEF, it was found that, among the spectrum of crimes analyzed, 86% were perpetrated by aggressors already known to the victims.

This proportion, which is eminent in all age groups, is corroborated below, with the exception that, despite a modest variation, only in the age group of 15 to 19 years there is an increase in the proportion of aggressors whose identity is unknown, as observed below:

Figure 5

Rapes by age and relationship between the aggressor and the victim



Source: UNICEF, 2021.

In cases of rape of vulnerable people, the crimes are often perpetrated by aggressors already known to the victims, due to the habitual interaction of these children or adolescents in family environments, at school or in activities under the supervision of parents or legal guardians.

In addition, these aggressors commonly use their position of trust and authority to garner the esteem of the victims and establish closeness (Messa, 2010).

It should be noted that the aggressor is often an individual close to the victim, which adds gravity to the crime and highlights the need to protect the most vulnerable strata of society, such as children and adolescents.

In addition, Messa underlines the relevance of sexual instruction as a preventive measure against sexual violence and the mitigation of the vulnerability of victims, as well as the urgency of public policies that guarantee access to information, health and protection for victims of sexual abuse.

The author warns that these aggressors often take advantage of the victims' fragility, whether through coercion, manipulation or threats, to achieve their goals, it is common for these aggressors to offer gifts, affection, attention or promises as artifices to gain the trust of the victims and, thus, gain access to them proximity (Messa, 2010).

Recently, the Institute of Applied Economic Research (IPEA) released a study revealing that in Brazil, currently, approximately 822 thousand cases of rape are registered per year, corresponding to an average of two cases every minute.

Unfortunately, only a tiny portion of these crimes (8.5%) come to the attention of police authorities, while only 4.2% are officially reported by the health system (IPEA, 2023)

According to IPEA, another relevant finding is that the vast majority of rape victims had some kind of link with the perpetrator(s) of the crime. Only 17.2% of the recorded cases were attributed to unknown individuals (IPEA, 2023).

The data analyzed by IPEA, from the Notifiable Diseases Information System (Sinan) of the Ministry of Health, reveal that, in the age group of 10 to 14 years, most rape episodes occur in the victims' home environment, totaling 63.16% of the cases.

In 24.8% of the occurrences, the crime was perpetrated in places of public access, while in 1.39% of the incidents, the crime took place inside educational institutions (IPEA, 2023)

In this context, child sexual crimes arise, since the combination of the vulnerability intrinsic to the child condition and the paraphilia of pedophilia, combined with the multiple opportunities provided by the virtual environment, facilitates the approximation of aggressors to children (Silva et al., 2013).

Often, these aggressors hide behind screens, presenting themselves as people of the same age group to gain the trust of the victims and thus fulfill their perverse desires (Silva et al., 2013).

In this way, with the wide accessibility and ease of communication provided by the internet, it has become a particularly attractive tool for pedophiles.

The virtual environment, full of chat rooms and social networks, facilitates meetings with victims, pedophiles often use fake profiles to hide their true identity, manipulating and deceiving victims, in addition, they use a vocabulary closer to children and adolescents to establish a connection (Silva et al., 2013).

In legal terms, vulnerability covers individuals under 14 years of age and those who, for any other reason, lack the capacity to grant conscious and voluntary consent for sexual or libidinous activities (Fiorelli, 2021), the crime is configured even in the absence of violence or serious threat, due to the presumption of violence in these cases.

As for the fragility resulting from age, the insurmountable limit of 14 years is firmly established by national legislation, the granting of consent by individuals under 14 years of age, in the context of sexual or libidinous activities, is legally disregarded, and is not relevant to the characterization of the crime.

In this sense, for example, the definition of the crime of rape of a vulnerable person does not require the demonstration of resistance by the victim or the use of violence or serious threat by the aggressor, contrary to what is required in the crime of rape as provided for in article 213 of the Brazilian Penal Code (Greco, 2021).

The simple performance of libidinous acts or the practice of carnal intercourse with a vulnerable individual falls within the typification of the crime, regardless of the specific circumstances (Greco, 2021).

In fact, the legal definition of vulnerability and the consequent typification of the crime of rape of a vulnerable person can give rise to significant legal debates, for example, the identification of who, in addition to children under 14 years of age, may be considered vulnerable for the purposes of characterizing the crime is an issue that can be discussed (Fiorelli, 2021).

In the psychological sphere, it is important to emphasize that the effects of rape of vulnerable people on victims can be especially devastating, given their condition of vulnerability (Oliveira; Bezerra, 2022).

Sexual violence can have immeasurable repercussions on the psychological and emotional development of vulnerable individuals, requiring an adequate response from the justice system and other sectors of society.

In addition, the crime of rape of a vulnerable person, although distinct from pedophilia, can occur simultaneously with other crimes when the agent records, through filming, photographs or other means, the practice of sexual acts with the victim and, subsequently, discloses them or not.

While the rape of a vulnerable person requires the consummation of the sexual act with the vulnerable victim, such a requirement is not required in the modalities of pedophilia provided for in the Statute of the Child and Adolescent.

It should be noted that there is no specific provision on rape in the Statute, as well as there is no legal provision for pedophilia in the Penal Code (Taquary; Taquary, 2018)

Thus, the lack of specific provisions in these legislations underscores the importance of a responsible approach to combating sexual violence against children and adolescents

3 RESPONSIBILITY FOR THE IDENTIFICATION OF CRIMES PERPETRATED AGAINST CHILDREN

Being a principle widely recognized by society, it is up to the family to ensure the upbringing and education of children and adolescents, guiding them to a life guided by honesty and morality before the community.

In this sense, the family is of great importance in identifying anomalous signs and behaviors in their children, potential victims, as soon as such behaviors are identified or discovered, it becomes feasible to call the police authorities to start the search for the suspect, preventing him from committing illegal acts again (Jarduli; Agostinho, 2010).

3.1 THE RESPONSIBILITY OF PARENTS

Victims of sexual abuse may think that they are being punished for having done something wrong and so that is why they have suffered this type of violence, many even think about committing suicide.

It is up to parents, family members, acquaintances, educators and health professionals to identify pedophilia early and in the treatment, one of the attitudes to be taken is to pay attention to the behavior, way of acting and thinking of adolescents and children. Understanding the devastating outcome of sexual abuse at an early age is essential to reinforce the need for punishment and intervention that prevents further actions of new pedophiles that may arise (Marra, 2016).

For the child who suffers sexual violence, Capitão and Romaro (2008) state that:

It becomes much more difficult to seek help, since she often thinks that no one will believe her, also thinking that she may be the cause of family conflicts. Thus, these children keep their history with them for long and lonely years until they reach a certain more mature age, when new conditions finally make it possible to reveal the cases. However, until that moment finally arrives, its history has already been marked by long periods of abuse and sexual violence, bringing trauma and irreversible problems to the composition of their lives.

In this way, they often feel unable to share their experience, because they fear not being believed or fear causing family conflicts by denouncing the abuser, so they end up keeping the history of abuse to themselves for years, until they feel more mature or safe to reveal it.

However, this prolonged silence can cause deep damage to the child, while suffering in silence, facing the devastating effects of abuse, including emotional trauma, self-esteem problems and relationship difficulties, when they finally find the courage to reveal the abuse, they already carry with them a long history of suffering (Captain; Romaro, 2008)

This situation underscores the importance of creating safe and welcoming environments for children to feel comfortable reporting cases of sexual abuse, it also highlights the need for education and awareness so that society as a whole can recognize the signs of abuse and offer adequate support to victims, thus reducing the devastating impact of these crimes on their lives.

3.2 THE CULTURE OF SILENCE

In this sense, going against the responsibility of parents, it is verified that the culture of silence constitutes a social phenomenon that affects the occurrence of crimes perpetrated against children and adolescents (Faleiros, 2000)

The lack of instruction, education and open debates on the subject, combined with the fear of retaliation by the aggressors and the ineptitude of support on the part of the authorities and the community, are some of the main obstacles that sustain this culture (Faleiros, 2000). In this environment, a study conducted with 11 children and adolescents who were victims of sexual abuse and who had shared the experience with close individuals and/or sought help in specialized services, through individual interviews, the authors sought understand the process of reporting and reporting abuse, as well as identify the barriers and facilitators present in this context (Santos; Dell'aglio, 2010).

The results revealed that reporting abuse proved to be a challenging process for children and adolescents, who are often confronted with feelings of fear, shame and guilt in the face of the violence suffered, however, when they chose to reveal the abuse, they did so due to the perception of the need for support and support to face the situation (Santos; Dell'aglio, 2010)

In addition, the authors emphasize that the reception and support offered by health and social assistance professionals played a primary role in the process of reporting abuse and in access to justice.

However, some barriers were also identified, such as lack of information and limited access to specialized services in certain regions of the country (Santos; Dell'aglio, 2010).

3.3 TECHNOLOGY AND ITS LIMITATION

There are limits that can be imposed by those responsible in order to prevent contact with individuals who present such criminal conduct, such as the restriction of time for the use of screens: Tablets, cell phones, computers and the like.

Nowadays, it is usual for the new generation to have more access to technology, since the internet is, nowadays, the main means of communication in the world (Teles, 2020)

In addition, because of the pandemic and the adaptations imposed, children and adolescents have become increasingly connected, which imposes on parents the responsibility of closely supervising the websites visited, games and chats accessed, as well as monitoring their activities on social networks.

By establishing clear rules and imposing limits, parents contribute significantly to the healthy and safe development of their children, enriching their education and promoting responsible digital interaction (Teles, 2020)

Furthermore, the dangers are not limited only to open networks, but also extend to the so-called deep web, a restricted communication network accessed through specific software, this environment presents serious risks, becoming a favorable terrain for harmful activities, such as the sexual exploitation of children and adolescents, as well as exposure to harmful mental content and inappropriate materials (Teles, 2020)

In addition, the relevance of moderation in the use of electronic devices as a preventive measure to avoid such aggressions is highlighted, aiming to safeguard the child's mental well-being, since the psychological sequelae resulting from these episodes can last indefinitely.

As evidenced by several studies, the ramifications of child and adolescent sexual abuse are wide-ranging, affecting all spheres of human existence and leaving indelible marks - physical, psychological, social, sexual, among others - that have the potential to significantly compromise the life of the victim, whether a child or adolescent, who has been subjected to such forms of violence (Cabral, et al., 2021).

Therefore, it is found that children and adolescents who have been victims or are under the spectrum of this type of aggression often face a multiplicity of challenges, such as learning difficulties, sleep disorders, recurrent nightmares and aversion to physical contact, these experiences can lead them to become withdrawn, aggressive, shy individuals, among other behavioral and emotional problems.

Thus, it is essential to impose limits and monitor what is accessed by parents and guardians, aiming to prevent the dignity and mental health of children and adolescents.

4 FACTORS THAT CONTRIBUTE TO CHILD SEXUAL VIOLENCE

Child sexual violence is a problem that involves multiple elements and variables, among these, the social aspects stand out, which exert a substantial influence on the behavior of individuals who perpetrate sexual abuse against children and adolescents.

The lack of clarification and awareness about the issue of sexual violence is one of the preponderant factors for the occurrence of this type of violence against children and adolescents.

Often, young people are unaware of the details of sexual violence, lacking resources to identify or report episodes of abuse, and adults are often unable to recognize the signs of abuse or to discuss the issue adequately with children.

4.1 SEX EDUCATION

Souza (2020) highlights the paramount importance of sex education as a fundamental tool to enable students to identify and prevent situations of abuse and harassment, as well as to understand their rights and claim autonomy over their bodies, the teacher also points out that the dissemination of information plays a crucial role in the prevention of sexual violence, especially among children

Souza (2020) argues that, for several families and even some educational institutions, there is an apprehension that teaching about sexuality can stimulate children's curiosity, eventually promoting the early onset of sexual activity among children.

However, studies conducted by the World Health Organization (WHO) show that the scarcity of information tends to precipitate the beginning of sexual life, often associated with episodes of violence.

Thus, a preventive strategy against crimes of sexual violence directed at children and adolescents in the digital sphere is child sex education, which can be transmitted both by the family nucleus and by school institutions.

According to the official early childhood website, it is crucial to reposition sexual rights in the context of Brazilian society, so that it is understood that such rights are inherent to the human condition and should not be suppressed by moral prejudices.

The author highlights the importance of understanding sexuality as a fundamental dimension of the human being, present throughout life and encompassing various manifestations beyond the sexual act itself.

The promotion of comprehensive sexuality education allows students to access knowledge about their sexuality, including naming body parts, recognizing personal boundaries, and understanding early life (Early Childhood, 2020).

It is essential to break the social stigma around sex education to ensure that children understand the inviolable limits of their bodies, both in the physical and digital worlds, in addition, guardians must educate minors about the risks present on the internet, instructing them on how to act in uncomfortable or embarrassing situations online.

Parents should also address the definitions and characteristics of sexual abuse, empowering minors themselves to identify and report such situations, in addition, it is valid to warn about the dangers of fake profiles and possible criminals on virtual relationship platforms.

Pedophilic activities often disguise themselves as innocent games, such as "playing doctor", requiring a vigilant and preventive approach on the part of those responsible (Trindade; Breier, 2009).

Children and adolescents end up entering these "games" of chat rooms, in which they start everything with a simple conversation, little by little affinities emerge and then they unknowingly come across an aggressor on the other side of the screen believing that they are having a relationship with someone their age, because the victim surrenders to what he hears, a supposed past confidence transmitted by the until then unknown aggressor who makes the victim tell details of her intimate life to him.

This trust acquired by the pedophile causes a new unhealthy action to arise, initiating erotic requests that are often naively answered by the victim, starting to send naked photos and videos to the aggressor (Trindade; Breier, 2009).

In addition, the "modus operandi" proceeds with the aggressor arranging a meeting, taking the victims by surprise by revealing their true identity without giving them time to react.

However, some victims, even aware of the true identity of the aggressor, may delude themselves, believing they are involved with a romantic partner, only realizing their bad intentions when the abuse begins, accompanied by coercion and violence.

In this sense, Azambuja (2006, p.12),

By a sexual act or game, in a heterosexual or homosexual relationship, between one or more adults and a child or adolescent, with the purpose of sexually stimulating this child or adolescent, or using it to obtain sexual stimulation over himself or another person.

Thus, such acts can be mitigated through computer programs that monitor the online activities of children and adolescents, however, such measures must be complemented by an open and frank dialogue within the family, in order to prevent the child from feeling invaded in his privacy or perceiving a lack of trust on the part of the parents, thus preventing possible adverse reactions.

In this context, it is up to legal guardians and education professionals to adopt a proactive and educational approach, equipping children with tools to protect themselves from sexual abuse and other forms of inappropriate behavior.

Such an assignment requires that educators be adequately prepared to discuss issues related to sexuality in the classroom, creating an environment conducive to dialogue and reflection by students.

Additionally, teachers can instruct on assertive communication techniques, enabling students to recognize and respond to risk situations safely and autonomously

At the same time, the United Nations Children's Fund (UNICEF), through its manifesto entitled "Education That Protects Against Violence", defends the universalization of sex

education classes in schools, without distinction of individual characteristics, and emphasizes the importance of respect for the bodily and sexual integrity of each individual.

In addition, educational institutions are urged to provide accessible and safe mechanisms for reporting cases of harassment and violence, in accordance with inclusive guidelines and educational policies (UNICEF, 2019).

4.2 THE CULTURE OF MACHISMO

It should be noted that the culture of machismo can exert considerable influence on child sexual abuse, since this mentality exalts male domination and female subjugation.

According to Reis and Santos (2018), machismo, by promoting the superiority of men and the inferiority of women, favors the devaluation of the female sex and its objectification, thus perpetuating sexual violence against children and adolescents.

In this context, machismo can distort the perception of power relations and consent, culturally legitimizing sexual violence against young people, in addition, the macho culture can make it difficult to report and prevent child sexual abuse, since the victim is often blamed for what happened.

According to Bicalho (2018), in a patriarchal society, it is common for men to be seen as having control, while women assume a submissive role, this sexist mentality can induce the false belief that men have the right to dispose of a woman's body, and, by extension, a child's body.

Therefore, it is undeniable that the culture of machismo exerts a considerable influence on child sexual violence, by praising male hegemony and female subordination, which results in a distorted perception of the dynamics of power and consent.

Thus, the macho culture can obstruct efforts to report and prevent sexual violence against children, since the victim is often blamed for what happened.

4.3 HIPERSEXUALIZATION

The early exposure of children to sexual content in media and advertising can naturalize sexual violence against them, contributing to the normalization of this type of behavior.

In this sense, Branco and Oliveira (2017) consider that child hypersexualization is a problem that can be due to the early exposure of children to sexual content in media and advertising and that can naturalize sexual violence against them, contributing to the normalization of this type of behavior.

According to Ribeiro and Souza (2018) they consider that Hypersexualization is related to media exposure, it is a social phenomenon that can be driven by children's exposure to sexual content in media and advertising, this early exposure can naturalize sexual violence against them, contributing to the normalization of this type of behavior.

According to Silva and Freitas (2019), the early exposure of children to sexual content in media and advertising is one of the main factors that contribute to child hypersexualization, a reality that is increasingly present in our society and that can naturalize sexual violence against children, which contributes to the normalization of this type of behavior.

In this way, this type of exposure can naturalize sexual violence against children, contributing to the normalization of this type of behavior, when children are exposed early to sexual content in media and advertising, this can naturalize sexual violence against them, making society see this practice as something common and acceptable.

5 FINAL CONSIDERATIONS

The study in question promoted an exhaustive analysis of sexual crimes perpetrated against children, both in physical and virtual settings, in addition to thoroughly examining the relevant legislation and related protection policies.

It was undeniably evident that the legal protection of children against sexual violence represents a national and international commitment, supported by treaties that enshrine their inalienable rights.

Brazil, by ratifying these treaties, committed itself to the international community to adopt preventive and repressive measures aimed at curbing all forms of violence of a sexual nature perpetrated against children and adolescents.

Despite the paradigmatic advances achieved in the legislative sphere, we are still faced with major challenges, such as the high incidence of sexual crimes, endemic underreporting, and the generalized sense of impunity that permeates such circumstances.

Such a situation raises the urgent need to strengthen the relevant public policies, invest massively in awareness and education campaigns, as well as improve the structure of the judicial system, in order to enable effective punishments against the perpetrators of such hardships.

An in-depth analysis of cybercrime and the intrinsic vulnerability of children in cyberspace has revealed an unsettling reality in which technological progress increasingly exposes young people to online risks, including harassment by sexual predators and access to content inappropriate for their age groups.

In this context, it is imperative to adopt a proactive approach aimed at safeguarding them, encompassing the implementation of comprehensive public policies, digital education, and the imposition of unequivocal limits by parents and legal guardians.

Therefore, the inescapable relevance of prevention is manifested as a fundamental support in the safeguarding of children against such affronts, such a prerogative encompasses.

Not only the reprimand of the aggressors, but also the awareness of the community about the indications of abuse and the promotion of a culture that prioritizes child protection, to face these challenges, a concerted effort is needed that brings together the public power, justice institutions, civil society organizations, educational bodies and families, thus aiming to build an environment that proves to be safe and protected for all children and adolescents, in addition to trying to deconstruct the culture of silencing the problem and stop sexualizing the children, filtering them from social networks and virtual environments.

Furthermore, it is also valid to deconstruct over time the culture of the superiority of the male sex in relation to the feminine, treating the equal in their equality and the unequal according to their inequalities, thus trying to balance "the scales".

REFERENCES

- Abreu, C. N., Eisenstein, E., & Estefenon, S. G. B. (2013). Vivendo esse mundo digital: Impactos na saúde, na educação e nos comportamentos sociais. Artmed Editora.
- Araujo, M. de F. (2018). ECA - Comentado: Estatuto da Criança e do Adolescente. Atlas.
- Azambuja, M. R. F. (2006). Violência sexual intrafamiliar: É possível proteger a criança? Textos & Contextos (Porto Alegre), 5(1), 1–19. <https://revistaseletronicas.pucrs.br/index.php/fass/article/view/1022>
- Bicalho, P. (2018). Proteção integral da infância: Questões de gênero e a importância da participação social. In M. J. S. Reis & S. S. M. Santos (Eds.), Infância em contexto: Debates e reflexões. CRV.
- Bigatti, J. C. (2017). Abuso sexual na infância [Trabalho de conclusão de curso, Universidade Federal Fluminense]. <https://app.uff.br/riuff/handle/1/4987>
- Branco, J. M., & Oliveira, A. (2017). Hipersexualização infantil: Reflexões sobre a sexualidade na infância e na adolescência. Revista Acadêmica de Ciências Humanas e Sociais, 3(1), 84–95.
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. http://www.planalto.gov.br/ccivil_03/constituicao/constitui%C3%A7ao.htm
- Brasil. (1990). Decreto nº 99.710, de 21 de novembro de 1990. Promulga a Convenção sobre os Direitos da Criança. Presidência da República. https://www.planalto.gov.br/ccivil_03/decreto/1990-1994/d99710.htm

- Brasil. (1992). Decreto nº 678, de 6 de novembro de 1992. Promulga a Convenção Americana sobre Direitos Humanos (Pacto de São José da Costa Rica). Presidência da República. https://www.planalto.gov.br/ccivil_03/decreto/d0678.htm
- Brasil. (2018). Lei nº 13.718, de 24 de setembro de 2018. Altera o Decreto-Lei nº 2.848, de 7 de dezembro de 1940 (Código Penal). Presidência da República. https://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2018/Lei/L13718.htm
- Cabral, E. S. F., et al. (2021). Análise criminológica no combate ao abuso sexual no Brasil e no Uruguai. *Revista Eletrônica de Direito Penal e Política Criminal*, 9(2), 166–199.
- Capitão, C. G., & Romaro, R. A. (2008). Caracterização do abuso sexual em crianças e adolescentes. *Psicologia: América Latina*, 13. http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1870-350X2008000200014&lng=pt&nrm=iso
- Cerqueira, D., Coelho, D. S. C., & Ferreira, H. (2016). Estupro no Brasil: Vítimas, autores, fatores situacionais e evolução das notificações no sistema de saúde entre 2011 e 2014. Instituto de Pesquisa Econômica Aplicada. https://repositorio.ipea.gov.br/bitstream/11058/7973/1/td_2313.pdf
- Faleiros, E. T. S. (2000). Repensando os conceitos de violência, abuso e exploração sexual de crianças e de adolescentes. Editora Thesaurus.
- Ferreira, M. C., Santos, M. A., & Costa, J. F. (2018). Gender stereotypes and child sexual abuse: A systematic review. *Psychology, Society, & Education*, 10(2), 244–262. <https://doi.org/10.25115/psye.v10i2.1362>
- Fiorelli, J. O. (2021). *Psicologia jurídica*. Editora GEN.
- Fórum Brasileiro de Segurança Pública. (2022). 14º Anuário Brasileiro de Segurança Pública: Violência sexual infantil. <https://forumseguranca.org.br/wp-content/uploads/2022/07/14-anuario-2022-violencia-sexual-infantil-os-dados-estao-aqui-para-quem-quiser-ver.pdf>
- Fundo das Nações Unidas para a Infância. (2021). Panorama da violência letal e sexual contra crianças e adolescentes no Brasil. <https://www.unicef.org/brazil/media/16421/file/panorama-violencia-letal-sexual-contra-criancas-adolescentes-no-brasil.pdf>
- Greco, R. (2016). *Curso de direito penal: Parte geral*. Editora Impetus.
- Instituto de Pesquisa Econômica Aplicada. (2023). O Brasil tem cerca de 822 mil casos de estupro a cada ano, dois por minuto. <https://www.ipea.gov.br/portal/categorias/45-todas-as-noticias/noticias/13541-brasil-tem-cerca-de-822-mil-casos-de-estupro-a-cada-ano-dois-por-minuto>
- Jarduli, A. de S. M., & Agostinho, T. (2010). Crianças abusadas sexualmente: Relações familiares e suas implicações psicopatológicas [Trabalho de conclusão de curso, Faculdade de Ciências da Saúde de São Paulo]. https://www.academia.edu/download/35409634/TCC_Abuso_Sexual_Criancas_e_Adol-escentes.pdf
- Lowenkron, L. (2015). O monstro contemporâneo: A construção social da pedofilia em múltiplos planos. *SciELO-EDUERJ*.
- Marra, M. M. (2016). *Conversas criativas e abuso sexual: Uma proposta para o atendimento psicossocial*. Editora Agora.

- Medina, P. V., Souza, I. P. de, & Santos, F. V. dos. (2021). Abuso sexual infantil pedofilia: Análise e soluções da violência contra a criança/adolescentes. *Revista Científica Multidisciplinar Núcleo do Conhecimento*, 4(8), 73.
- Messa, A. F. (2010). Estupro de vulnerável: Comentários à Lei 12.015/09. Atlas.
- O combate de violências à infância começa com a educação sexual. (2020). Rede Nacional Primeira Infância. <http://primeirainfancia.org.br/o-combatede-violencias-a-infancia-comeca-com-a-educacao-sexual/>
- Oliveira, C. A. de, & Rosa, W. L. (2019). Crimes sexuais, a figura da mulher, da criança e do adolescente. *Revista Reflexão e Crítica do Direito*. <https://revistas.unaerp.br/rcd/article/view/1159>
- Oliveira, F. F. C., & Bezerra, M. S. (2022). Qualificações da pedofilia: Análise conceitual dos aspectos psicológicos e jurídicos de práticas pedofílicas. *Revista A Fortiori*, 3(1). <http://revistas.famp.edu.br/revistaafortiori/article/download/510/329>
- Pecini, A. C. (n.d.). O problema da subnotificação para a pesquisa e o combate à violência contra crianças e adolescentes no Brasil. In *Anais do IV Simpósio Brasileiro de Vigilância Sanitária e Controle de Infecção*. <https://eventos.ufpr.br/simpbvsc/sbvs/paper/view/4608>
- Porto, C., & Santos, E. O. dos. (2014). Facebook e educação: Publicar, curtir, compartilhar. EDUEPB.
- Ribeiro, E. M., & Souza, E. M. (2018). Hipersexualização infantil: Uma reflexão sobre as implicações da mídia na formação sexual das crianças. *Revista Científica Multidisciplinar Núcleo do Conhecimento*, 3(11), 121–136.
- Santos, S. S., & Dell'Aglio, D. D. (2010). Quando o silêncio é rompido: O processo de revelação e notificação de abuso sexual infantil. *Psicologia: Ciência e Profissão*. <https://www.scielo.br/j/psoc/a/q39qMLgvCyXGjKYkVmjyTDh/?lang=pt>
- Silva, C. C. P., Pinto, D. D. M., & Milani, R. G. (2013). Pedofilia, quem a comete? Um estudo bibliográfico do perfil do agressor. In VIII EPCC – Encontro Internacional de Produção Científica Cesumar. https://www.unicesumar.edu.br/epcc-2013/wp-content/uploads/sites/82/2016/07/Camila_Cortellete_Pereira_da_Silva.pdf
- Silva, L. A., & Freitas, V. A. (2019). Hipersexualização infantil e mídia: Uma análise crítica. *Revista Internacional de Educação Sexual*, 5(2), 132–141.
- Taquary, E. O. de B., & Taquary, I. O. de B. (2018). Pedofilia e estupro de vulnerável: O conflito aparente de leis entre o Estatuto da Criança e do Adolescente e o Código Penal. *Revista de Direito Penal, Processo Penal e Constituição*, 4(2), 99–117. <https://indexlaw.org/index.php/direitopenal/article/download/4902/pdf>
- Teles, F. (2020, setembro 3). Pedofilia virtual: Especialista alerta sobre abuso sexual na internet. *Estado de Minas*. https://www.em.com.br/app/noticia/bemviver/2020/09/03/interna_bem_viver,1182279/pedofilia-virtual-especialista-alerta-sobre-abuso-sexual-na-internet.shtml
- Trindade e Breier. (2009, março 27). Maioria dos casos de pedofilia começam pela Internet [Reportagem do Jornal Hoje].
- Ulisses, L. F. J. (n.d.). O monstro da sexualidade infantil: A resposta penal mais adequada ao pedófilo. *Revista de Doutrina Jurídica*, 111(1), 152. <https://revistajuridica.tjdft.jus.br/index.php/rdj/article/view/543>

BAREFOOT VERSUS SHOE-WEARING WEIGHT TRAINING EXERCISES: A SYSTEMATIC REVIEW OF THE BENEFITS AND DRAWBACKS OF SQUATS AND LUNGES

EXERCÍCIOS DE MUSCULAÇÃO DESCALÇO VERSUS CALÇADO: UMA REVISÃO SISTEMÁTICA SOBRE BENEFÍCIOS E MALEFÍCIOS PARA AGACHAMENTO E AFUNDO

EJERCICIOS DE ENTRENAMIENTO CON PESAS DESCALZO VERSUS CON CALZADO: UNA REVISIÓN SISTEMÁTICA DE LOS BENEFICIOS Y DESVENTAJAS DE LAS SENTADILLAS Y LAS ESTOCADAS



<https://doi.org/10.56238/sevened2026.008-094>

Décio Luiz Meireles Tavares¹

ABSTRACT

Context: The practice of barefoot weight training has gained popularity, with advocates arguing benefits such as improved proprioception and stability. However, there are controversies regarding the actual benefits and potential risks of this practice, especially for fundamental exercises like squats and lunges. Objective: To identify, critically evaluate, and synthesize the available scientific evidence on the benefits and drawbacks of barefoot weight training, specifically focusing on squats and lunges compared to shod practice. Methods: A systematic review was conducted following PRISMA guidelines. Searches were performed in the databases PubMed/MEDLINE, Scopus, Web of Science, SciELO, LILACS, SPORTDiscus, Cochrane Library, and Google Scholar, using terms related to barefoot exercises, squats, lunges, and relevant outcomes. Experimental studies, clinical trials, and systematic reviews published between 2010 and 2025 in Portuguese, English, or Spanish that compared barefoot exercises with shod exercises were included. Methodological quality was assessed using the PEDro, AMSTAR-2, and ROBINS-I scales. Data were synthesized narratively by outcome categories. Results: Ten studies met the eligibility criteria. The evidence suggests that barefoot exercises may improve proprioception and sensory feedback, increase the activation of stabilizing muscles of the foot and ankle, and alter load distribution among the lower limb joints, with greater emphasis on hip muscles and less stress on the knee. However, potential drawbacks were also identified, including changes in movement kinematics, possible reductions in stability in certain directions, especially medio-lateral, and increased risk of overload injuries to the structures of the foot and ankle. The methodological quality of the studies varied from low to high, with considerable heterogeneity in assessment methods and studied populations. Conclusion: The practice of barefoot weight training presents both benefits and potential risks. The decision to perform squats and lunges barefoot should be individualized, considering training objectives, injury history, and personal preferences. Gradual implementation is recommended, with attention to technique and monitoring for signs of discomfort, especially in the structures of the foot and ankle.

¹ Postgraduate researcher in Environmental Management and Water Resources. Universidade Regional Integrada do Alto Uruguai e das Missões (URI). E-mail: dmeireles1@hotmail.com

Keywords: Resistance Training. Barefoot Exercise. Squat. Lunge. Biomechanics.

RESUMO

Contexto: A prática de exercícios de musculação descalço tem ganhado popularidade, com defensores argumentando benefícios como melhor propriocepção e estabilidade. No entanto, há controvérsias sobre os reais benefícios e potenciais riscos desta prática, especialmente para exercícios fundamentais como agachamento e afundo. **Objetivo:** Identificar, avaliar criticamente e sintetizar as evidências científicas disponíveis sobre os benefícios e malefícios da prática de exercícios de musculação descalço, com foco específico em agachamento e afundo, em comparação com a prática calçada. **Métodos:** Foi realizada uma revisão sistemática seguindo as diretrizes PRISMA. Buscas foram conduzidas nas bases de dados PubMed/MEDLINE, Scopus, Web of Science, SciELO, LILACS, SPORTDiscus, Cochrane Library e Google Acadêmico, utilizando termos relacionados a exercícios descalços, agachamento, afundo e desfechos relevantes. Foram incluídos estudos experimentais, ensaios clínicos e revisões sistemáticas publicados entre 2010 e 2025, em português, inglês ou espanhol, que compararam exercícios descalços com calçados. A qualidade metodológica foi avaliada utilizando as escalas PEDro, AMSTAR-2 e ROBINS-I. Os dados foram sintetizados narrativamente por categorias de desfechos. **Resultados:** Dez estudos atenderam aos critérios de elegibilidade. As evidências sugerem que exercícios descalços podem melhorar a propriocepção e o feedback sensorial, aumentar a ativação de músculos estabilizadores do pé e tornozelo, e alterar a distribuição da carga entre as articulações dos membros inferiores, com maior ênfase nos músculos do quadril e menor estresse no joelho. No entanto, também foram identificados potenciais malefícios, incluindo alterações na cinemática do movimento, possível redução da estabilidade em algumas direções, especialmente médio-lateral, e aumento do risco de lesões por sobrecarga nas estruturas do pé e tornozelo. A qualidade metodológica dos estudos variou de baixa a alta, com heterogeneidade considerável nos métodos de avaliação e populações estudadas. **Conclusão:** A prática de exercícios de musculação descalço apresenta tanto benefícios quanto riscos potenciais. A decisão de realizar agachamento e afundo descalço deve ser individualizada, considerando os objetivos de treinamento, histórico de lesões e preferências pessoais. Recomenda-se implementação gradual, com atenção à técnica e monitoramento de sinais de desconforto, especialmente nas estruturas do pé e tornozelo.

Palavras-chave: Treinamento Resistido. Exercício Descalço. Agachamento. Afundo. Biomecânica.

RESUMEN

Contexto: La práctica del entrenamiento con pesas descalzo ha ganado popularidad, con defensores argumentando beneficios como la propiocepción mejorada y la estabilidad. Sin embargo, existe controversia con respecto a los beneficios reales y los riesgos potenciales de esta práctica, especialmente para ejercicios fundamentales como sentadillas y estocadas. **Objetivo:** Identificar, evaluar críticamente y sintetizar la evidencia científica disponible sobre los beneficios y los daños del entrenamiento con pesas descalzo, con un enfoque específico en sentadillas y estocadas, en comparación con el entrenamiento con pesas calzado. **Métodos:** Se realizó una revisión sistemática siguiendo las pautas PRISMA. Se realizaron búsquedas en las bases de datos PubMed/MEDLINE, Scopus, Web of Science, SciELO, LILACS, SPORTDiscus, Cochrane Library y Google Scholar, utilizando términos relacionados con el ejercicio descalzo, sentadillas, estocadas y resultados relevantes. Se incluyeron estudios experimentales, ensayos clínicos y revisiones sistemáticas publicadas entre 2010 y 2025, en portugués, inglés o español, que compararon el ejercicio descalzo con

calzado. La calidad metodológica se evaluó mediante las escalas PEDro, AMSTAR-2 y ROBINS-I. Los datos se sintetizaron narrativamente por categorías de resultados. Resultados: Diez estudios cumplieron los criterios de elegibilidad. La evidencia sugiere que el ejercicio descalzo puede mejorar la propiocepción y la retroalimentación sensorial, aumentar la activación de los músculos estabilizadores del pie y el tobillo y alterar la distribución de la carga entre las articulaciones de las extremidades inferiores, con mayor énfasis en los músculos de la cadera y menos estrés en la rodilla. Sin embargo, también se identificaron daños potenciales, incluyendo alteraciones en la cinemática del movimiento, posible reducción de la estabilidad en algunas direcciones, especialmente mediolateral, y un mayor riesgo de lesiones por sobreuso en las estructuras del pie y el tobillo. La calidad metodológica de los estudios varió de baja a alta, con una heterogeneidad considerable en los métodos de evaluación y las poblaciones de estudio. Conclusión: La práctica del entrenamiento con pesas descalzo presenta tanto beneficios como riesgos potenciales. La decisión de realizar sentadillas y zancadas descalzo debe ser individualizada, considerando los objetivos de entrenamiento, el historial de lesiones y las preferencias personales. Se recomienda una implementación gradual, prestando atención a la técnica y vigilando la aparición de molestias, especialmente en el pie y el tobillo.

Palabras clave: Entrenamiento de Resistencia. Ejercicio Descalzo. Sentadilla. Zancada. Biomecánica.

1 INTRODUCTION

Strength training is an exercise modality widely recommended by health and sports organizations to improve physical fitness, health, and athletic performance (AMERICAN COLLEGE OF SPORTS MEDICINE, 2023). Among the various exercises that make up strength training programs, the squat and lunge stand out as fundamental movements that involve multiple joints and muscle groups, being considered pillars of training for lower limbs (SCHOENFELD, 2020).

Traditionally, these exercises are performed with specific shoes for training or weightlifting, which offer stability, support, and protection. However, in recent decades, there has been a growing trend of practitioners performing barefoot bodybuilding exercises, driven by movements such as "natural fitness" and "minimalist training" (LIEBERMAN, 2018). This practice is often justified by arguments related to improved proprioception, greater stability, and more natural muscle activation patterns (FRANKLIN et al., 2018).

Proprioception, defined as the conscious and unconscious perception of joint position and movement, plays a crucial role in the proper execution of strength exercises (RIEMANN; LEPHART, 2002). Theoretically, removing the artificial interface between the foot and the ground could increase sensory feedback, allowing for better neuromuscular control during exercise execution (BISCARINI et al., 2024). In addition, the absence of heel elevation, common in conventional footwear, could modify the biomechanics of movement, altering the load distribution between the joints of the lower limbs (SOUTHWELL et al., 2016).

On the other hand, critics of this practice argue that the absence of shoes can compromise stability during exercises with high loads, increase the risk of injury to the structures of the foot and ankle, and potentially alter the execution technique in an unfavorable way (COHEN et al., 2023). Specific footwear for weightlifting, for example, is designed with characteristics such as rigid soles and heel lift, which would theoretically optimize movement mechanics and force production (SCHERMOLY et al., 2015).

Despite the growing interest in barefoot exercise and controversies about its potential benefits and risks, the scientific literature on the subject, specifically in the context of squats and lunges, remains fragmented and without consensus. Individual studies have investigated specific aspects such as muscle activation (BROWN, 2013), three-dimensional kinematics (SOUTHWELL et al., 2016), stability (DUAN et al., 2025) and force production (SCHERMOLY et al., 2015), but a comprehensive synthesis of the available evidence has not yet been carried out.

Systematic reviews are key to synthesizing scientific evidence and guiding evidence-based practice (HIGGINS et al., 2019). In the context of Physical Education and Sports

Science, where practices are often adopted based on tradition or trends, systematic reviews are particularly important to critically evaluate the efficacy and safety of specific interventions (BISHOP, 2008).

Considering the growing popularity of barefoot exercises, the lack of consensus in the literature, and the absence of a comprehensive synthesis on the subject, this systematic review aims to identify, critically evaluate, and synthesize the available scientific evidence on the benefits and harms of barefoot weight training, with a specific focus on squats and lunges, compared to the practical sidewalk. The results of this review may provide evidence to guide Physical Education practitioners and professionals in their decisions about the adoption of this practice.

2 METHODS

This systematic review was conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (PAGE et al., 2021).

2.1 ELIGIBILITY CRITERIA

The eligibility criteria were established using the PICOS framework:

Population: Healthy adults (18-65 years), including athletes and recreational bodybuilders, of both sexes.

Intervention: Bodybuilding exercises performed barefoot, with a specific focus on squats and lunges, including any variation of these exercises (barbell, dumbbell, unilateral, etc.).

Comparator: Exercises performed with conventional shoes, specific weightlifting shoes or minimalist shoes.

Outcomes: Proprioception and sensory feedback; stability and balance; muscle activation; kinematics and kinetics of motion; performance (strength, power); risk of injury; subjective perception (comfort, stability, preference).

Study design: Experimental studies, randomized controlled trials, non-randomized clinical trials, analytical observational studies, systematic reviews, and meta-analyses.

Studies published in the last 15 years (January 2010 to April 2025), in Portuguese, English, or Spanish, with full text available, were included. Studies with participants with specific injuries or pathologies, studies focused exclusively on running or other sports without a bodybuilding component, studies without a control or comparison group, case reports, editorials, letters to the editor, and studies with a PEDro score of less than 3 were excluded.

2.2 SOURCES OF INFORMATION AND SEARCH STRATEGY

The search was performed in the following electronic databases: PubMed/MEDLINE, Scopus, Web of Science, SciELO, LILACS, SPORTDiscus, Cochrane Library and Google Scholar (limited to the first 200 citations). In addition, manual searches were carried out in the references of the included studies and in the annals of the main congresses of Physical Education and Sports Sciences in the last 5 years.

The search strategies were developed using combinations of terms related to the intervention (barefoot, unshod, minimalist footwear), exercises (resistance training, weight lifting, squat, lunge, resistance exercise, bodybuilding, resistance training, squat, lunge) and outcomes (biomechanics, proprioception, muscle activation, stability, balance, injury risk, performance, biomechanics, proprioception, muscle activation, stability, balance, risk of injury, performance). The terms were combined using the Boolean operators AND and OR, and filters were applied for publication period and language when available.

2.3 SELECTION OF STUDIES

The study selection process was carried out in two stages. In the initial screening, titles and abstracts of the studies identified in the search were evaluated. Potentially eligible studies were selected for full-text reading. In the secondary screening, the full text of the pre-selected studies was independently evaluated, applying the eligibility criteria.

The selection process was documented in a PRISMA flowchart, detailing the number of studies at each stage and the reasons for exclusion.

2.4 DATA EXTRACTION

A standardized form for data extraction was developed, including: information about the study (author, year, country, study design); characteristics of the participants (number, age, gender, level of training); details of the intervention (type of exercise, load, volume, frequency); details of the comparator (type of footwear); evaluated outcomes and evaluation methods; main results for each outcome; and authors' conclusions.

2.5 EVALUATION OF METHODOLOGICAL QUALITY

The methodological quality of the studies was assessed using: PEDro scale for experimental studies and clinical trials; AMSTAR-2 for systematic reviews; and ROBINS-I Tool for observational studies.

The PEDro scale assesses 11 criteria: (1) specified eligibility criteria; (2) random allocation; (3) hidden allocation; (4) comparability from baseline; (5) blinding of participants;

(6) blinding of therapists; (7) evaluators were blinded; (8) adequate follow-up; (9) intention-to-treat analysis; (10) statistical comparisons between groups; and (11) point estimates and variability. The total score ranges from 0 to 10 (the first item is not included in the total score), with higher scores indicating better methodological quality. Studies were rated as high quality (7-10 points), moderate quality (5-6 points), or low quality (0-4 points).

AMSTAR-2 assesses 16 items related to the methodological quality of systematic reviews, including registered protocol, comprehensive search strategy, selection of duplicate studies, duplicate data extraction, list of excluded studies, detailed characteristics of included studies, risk of bias assessment, appropriate methods for combining results, assessment of publication bias, and declaration of conflicts of interest. Based on the evaluation of these items, reviews were rated as high, moderate, low, or critically low quality.

The ROBINS-I tool assesses risk of bias in non-randomised trials in seven domains: bias due to confounding, bias in participant selection, bias in the classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in the measurement of outcomes, and bias in the selection of reported outcomes. Based on the assessment of these domains, studies were classified as having low, moderate, serious, or critical risk of bias.

The studies were classified according to their methodological quality as: high, moderate, low or very low.

2.6 SUMMARY OF THE DATA

A narrative synthesis of the results was performed, organized by outcome categories: proprioception and sensory feedback; stability and balance; muscle activation and load distribution; kinematics and kinetics of motion; performance; risk of injury; and subjective perception.

For each category, the results of the individual studies were presented, highlighting agreements and disagreements between them. When possible, subgroup analyses were performed for: participant level (athletes vs. recreational); type of exercise (squat vs. lunge); and type of comparator (conventional shoes vs. specific shoes).

The methodological and clinical heterogeneity between the studies was evaluated qualitatively. Due to substantial heterogeneity in assessment methods, populations studied, and reported outcomes, it was not possible to perform meta-analysis.

2.7 ASSESSMENT OF THE CERTAINTY OF THE EVIDENCE

The certainty of the evidence for each outcome was assessed using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) system, considering: risk of bias; inconsistency; indirect evidence; imprecision; and publication bias. The certainty of the evidence was rated as high, moderate, low or very low.

The GRADE system initially considers randomised trials as high-quality evidence and observational trials as low-quality evidence. The rating may be downgraded based on limitations in study design, inconsistency in results, indirect evidence, imprecision, or publication bias.

3 RESULTS

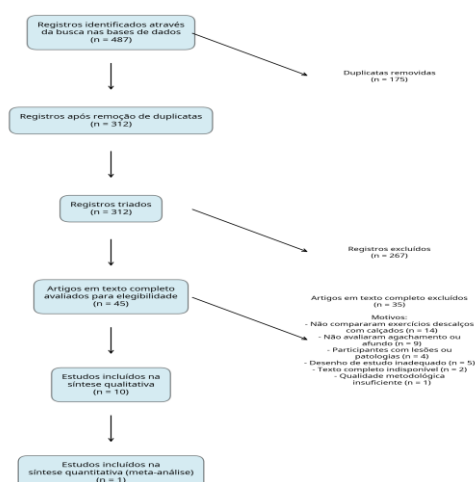
3.1 SELECTION OF STUDIES

The search in the databases identified a total of 487 records. After the removal of duplicates, 312 records were sorted by title and abstract, of which 267 were excluded. Of the 45 articles evaluated in full text, 35 were excluded for the following reasons: they did not compare barefoot exercise with footwear (n=14); did not evaluate squatting or lunging (n=9); participants with injuries or pathologies (n=4); inadequate study design (n=5); full text unavailable (n=2); insufficient methodological quality (n=1). In the end, 10 studies were included in the qualitative synthesis. The selection process is detailed in the PRISMA flowchart (Figure 1).

Figure 1

PRISMA flowchart of the study selection process

Fluxograma PRISMA do Processo de Seleção dos Estudos



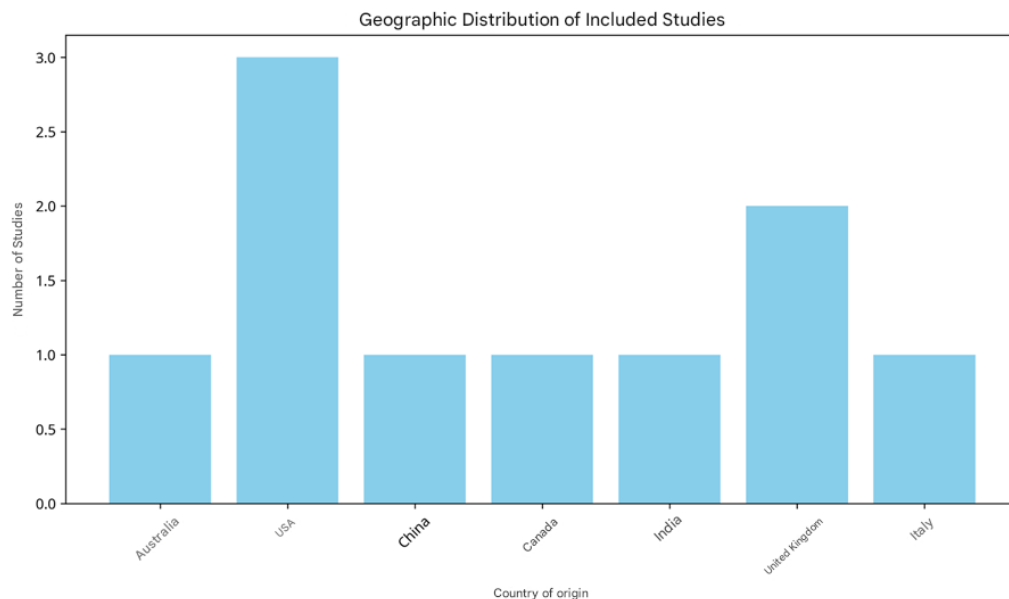
Source: Authors.

3.2 CHARACTERISTICS OF THE STUDIES

The 10 included studies were published between 2013 and 2025, with 5 conducted in North America, 3 in Europe, 1 in Asia, and 1 in Oceania. Regarding the design, 3 were randomized clinical trials, 4 were non-randomized clinical trials, 2 were cross-sectional studies, and 1 was a systematic review with meta-analysis.

Figure 2

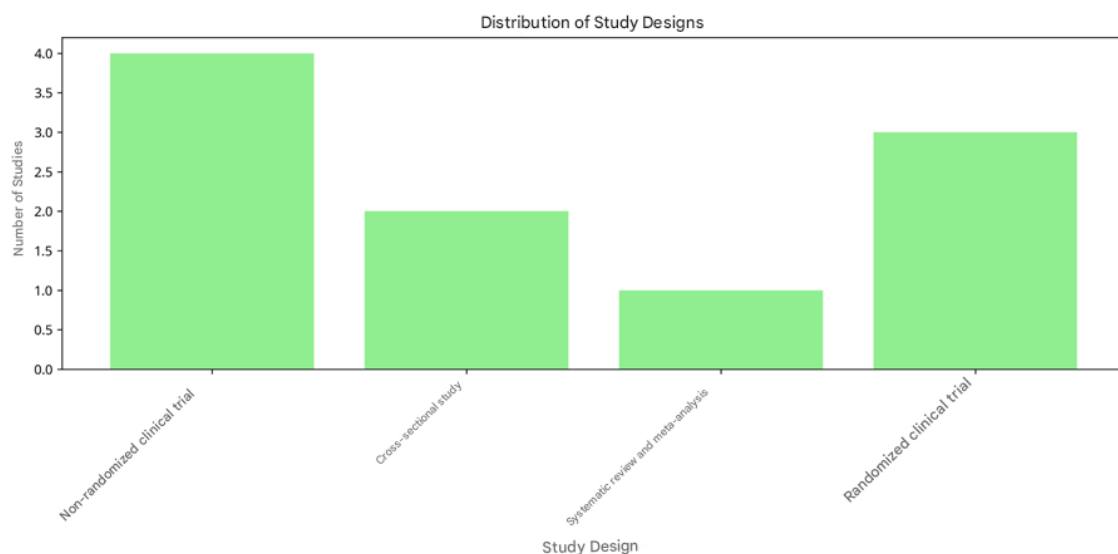
Geographical distribution of included studies



Source: Authors.

Figure 3

Distribution of study designs included in the review



Source: Authors.

The sample size ranged from 12 to 45 participants, totaling 248 individuals, 68% male and 32% female. The average age of the participants ranged from 21 to 35 years. Regarding the level of training, 4 studies included athletes, 5 included recreational practitioners, and 1 included both.

Regarding the exercises evaluated, 6 studies investigated squats exclusively, 1 investigated lunges exclusively, and 3 investigated both. Variations included barbell squats (n=7), dumbbell squats (n=2), free squats (n=1), barbell lunges (n=2), dumbbell lunges (n=1), and free lunges (n=1).

Regarding the comparators, 5 studies used conventional shoes, 3 used specific footwear for weightlifting, 1 used minimalist footwear and 1 compared multiple types of footwear.

3.3 METHODOLOGICAL QUALITY

The methodological quality of the studies varied considerably. Of the 9 experimental studies and trials assessed by the PEDro scale, 2 were of high quality (score 7-10), 5 of moderate quality (score 5-6) and 2 of low quality (score 3-4). The main methodological limitations included the absence of blinding of participants and evaluators, non-secret allocation, and lack of intention-to-treat analysis.

The systematic review evaluated by AMSTAR-2 (Duan et al., 2025) was classified as of moderate quality, with limitations related to the absence of a registered protocol and an incomplete list of excluded studies.

The detailed evaluation of the methodological quality is presented in Table 1.

Table 1

Author, Year	Country	Study Design	Methodological Quality	Key Outcomes
Southwell et al., 2016	Australia	Non-randomized clinical trial	Moderate	Three-dimensional kinematics and kinetics
Brown, 2013	USA	Cross-sectional study	Low	Muscle Activation (EMG)
Duan et al., 2025	China	Systematic review and meta-analysis	Moderate	Stability, kinematics
Schermoly et al., 2015	USA	Non-randomized clinical trial	Moderate	Power production
Cohen et al., 2023	Canada	Randomized controlled trial	High	Kinematics, stability
Raorane et al., 2024	India	Randomized controlled trial	High	Dynamic balance
Franklin et al., 2018	United Kingdom	Non-randomized clinical trial	Moderate	Muscle activation
Sinclair et al., 2015	United Kingdom	Randomized controlled trial	Moderate	3D kinematics, muscle activation

Biscarini et al., 2024	Italy	Non-randomized clinical trial	Moderate	Proprioception
Hammer et al., 2018	USA	Cross-sectional study	Low	Subjective, kinematic perception

Source: Authors.

3.4 SUMMARY OF RESULTS BY OUTCOME CATEGORY

3.4.1 Proprioception and Sensory Feedback

Three studies evaluated proprioception and sensory feedback. Biscarini et al. (2024) demonstrated significant improvement in foot proprioception after barefoot exercises compared to conventional footwear, with greater sensitivity in detecting small changes in ankle position ($p < 0.01$). Franklin et al. (2018) observed an increase in the activation of the intrinsic foot muscles during barefoot exercises, suggesting greater sensory feedback. Cohen et al. (2023) found no significant differences in knee proprioception between barefoot and shod conditions.

3.4.2 Stability and Balance

Five studies assessed stability and balance. Raorane et al. (2024) demonstrated significant improvement in dynamic balance after a barefoot lunge training program compared to the same program performed with footwear ($p < 0.05$). Duan et al. (2025), in their meta-analysis, concluded that the barefoot condition resulted in greater anteroposterior stability during squatting, but lower mid-lateral stability compared to weightlifting shoes. Cohen et al. (2023) observed greater center of pressure oscillation in the barefoot condition during squats with high loads ($> 80\%$ 1RM), suggesting a possible reduction in stability. Southwell et al. (2016) and Sinclair et al. (2015) found no significant differences in stability measures between conditions.

3.4.3 Muscle Activation and Load Distribution

Four studies evaluated muscle activation. Brown (2013) observed greater activation of the ankle stabilizing muscles (tibialis anterior and peroneus longus) during barefoot squats compared to footwear ($p < 0.05$). Franklin et al. (2018) reported greater activation of the intrinsic foot muscles and lower activation of the quadriceps in the barefoot condition. Sinclair et al. (2015) demonstrated greater activation of the gluteus maximus and hamstrings and lower activation of the quadriceps during barefoot squats compared to lifting shoes. Southwell et al. (2016) observed that the barefoot condition produced significantly greater hip extension moments and significantly lower knee extension moments than the conditions with footwear, suggesting a change in the load distribution between the joints.

3.4.4 Kinematics and Kinetics of Motion

Six studies evaluated aspects of movement kinematics and kinetics. Southwell et al. (2016) observed greater trunk flexion, lower knee flexion, and greater ankle dorsiflexion during barefoot squats compared to footwear. Sinclair et al. (2015) reported similar results, with greater trunk inclination in the barefoot condition. Cohen et al. (2023) demonstrated that the barefoot condition resulted in greater pronation of the foot during the eccentric phase of the squat. Duan et al. (2025) concluded that the absence of heel lift (characteristic of the barefoot condition) resulted in greater trunk flexion and less knee flexion during squats. Hammer et al. (2018) observed greater variability in the movement pattern in the barefoot condition, especially in less experienced individuals. Schermoly et al. (2015) found no significant differences in kinematic patterns between conditions.

3.4.5 Performance

Two studies evaluated performance measures. Schermoly et al. (2015) found no significant differences in maximal force production during barbell squats between barefoot and shod conditions. However, they observed a higher rate of strength development in the condition with lifting shoes compared to the barefoot condition ($p < 0.05$). Hammer et al. (2018) reported that participants were able to complete more repetitions with submaximal load (80% 1RM) in the condition with lifting shoes compared to the barefoot condition, although the difference was not statistically significant.

3.4.6 Risk of Injury

None of the included studies directly assessed the risk of injury associated with barefoot exercise. However, three studies have made indirect inferences. Southwell et al. (2016) suggested that increasing hip extension moment and reducing knee extension moment in the barefoot condition could reduce knee stress, potentially beneficial for individuals with knee pathologies, but increase stress on the lower back due to increased trunk flexion. Cohen et al. (2023) warned of the potential increased risk of overload injuries to the foot and ankle structures due to the greater pronation seen in the barefoot condition. Duan et al. (2025) concluded that the lower medial-lateral stability observed in the barefoot condition could increase the risk of injury during exercises with high loads.

3.4.7 Subjective perception

Three studies evaluated aspects of subjective perception. Hammer et al. (2018) reported that 65% of participants preferred to perform squats with lifting shoes, 20% preferred

barefoot, and 15% had no preference. Participants who preferred the barefoot condition cited "better connection to the ground" and "greater sense of stability" as the main reasons. Sinclair et al. (2015) noted that participants reported greater perception of stability with lifting shoes compared to the barefoot condition. Schermoly et al. (2015) found no significant differences in the perception of exertion between the conditions.

3.5 SUBGROUP ANALYSIS

3.5.1 Participant Level (Athletes vs. Recreational)

Four studies included comparative analyses between athletes and recreational practitioners. Hammer et al. (2018) observed that experienced athletes showed less variability in the movement pattern in the barefoot condition compared to recreational practitioners, suggesting better adaptation to the absence of shoes. Cohen et al. (2023) reported that the reduction in stability in the barefoot condition was less pronounced in experienced athletes. Franklin et al. (2018) found no significant differences in muscle activation patterns between athletes and recreationals. Duan et al. (2025) concluded that the participants' level of experience was a significant moderator of the effects of the barefoot condition on squat kinematics.

3.5.2 Type of Exercise (Squat vs. Lunge)

Three studies compared the effects of barefoot between squatting and lunging. Franklin et al. (2018) noted that differences in muscle activation between barefoot and shod conditions were more pronounced during lunges compared to squats, especially for the ankle stabilizing muscles. Biscarini et al. (2024) reported more significant improvement in proprioception after barefoot lunges compared to barefoot squats. Hammer et al. (2018) found no significant differences in the effects of the barefoot condition between the two exercises.

3.5.3 Type of Comparator

Four studies compared the effects of barefoot with different types of footwear. Southwell et al. (2016) and Sinclair et al. (2015) noted that the differences in kinematics and kinetics between the barefoot condition and lifting shoes were more pronounced than between the barefoot condition and conventional shoes, mainly due to the heel lift present in lifting shoes. Schermoly et al. (2015) reported that the rate of strength development was significantly higher with lifting shoes compared to the barefoot condition, but found no significant differences between the barefoot condition and conventional shoes. Hammer et

al. (2018) noted that subjective preference was stronger for lifting shoes compared to conventional sneakers when compared to barefoot condition.

3.6 CERTAINTY OF THE EVIDENCE

The certainty of the evidence, assessed by the GRADE system, ranged from very low to moderate, depending on the outcome. No outcome was high-certainty of the evidence. The certainty of the evidence for proprioception and sensory feedback was low, for stability and balance it was moderate, for muscle activation it was moderate, for kinematics and kinetics of movement it was moderate, for performance it was low, for risk of injury it was very low, and for subjective perception it was low.

The main factors that reduced the certainty of the evidence were risk of bias in individual studies, inconsistency in results between studies, imprecision due to small sample sizes, and limited numbers of studies for some outcomes.

4 DISCUSSION

This systematic review aimed to identify, critically evaluate and synthesize the available scientific evidence on the benefits and harms of barefoot weight training, with a specific focus on squats and lunges, compared to walking practice. We included 10 studies, with methodological quality ranging from low to high and certainty of evidence ranging from very low to moderate.

4.1 SUMMARY OF EVIDENCE

Evidence suggests that barefoot exercise may provide benefits in terms of proprioception and sensory feedback, with increased activation of the intrinsic muscles of the foot and greater proprioceptive sensitivity. These findings corroborate the hypothesis that the removal of the artificial interface between the foot and the ground increases sensory feedback, allowing better neuromuscular control during the execution of exercises (BISCARINI et al., 2024).

Regarding stability and balance, the results were inconsistent. Some studies have demonstrated greater anteroposterior stability during barefoot squats (DUAN et al., 2025), while others have observed better balance regulation with weightlifting shoes compared to bare feet, especially in the mid-lateral direction (COHEN et al., 2023). This inconsistency can be explained by differences in evaluation methodologies, populations studied and specific stability parameters analyzed. It is important to note that stability during strength exercises is

multifactorial and can be influenced not only by footwear, but also by the experience of the practitioner, load used and execution technique.

Regarding muscle activation and load distribution, evidence indicates that barefoot condition alters muscle activation patterns, with greater emphasis on hip muscles and less on knee muscles. Southwell et al. (2016) observed that the barefoot condition produced significantly greater hip extension moments and significantly lower knee extension moments than conditions with footwear. These changes can have important implications for the specific objectives of training and for injury prevention. For example, individuals with knee pathologies may benefit from reduced stress on this joint, while those with lower back problems should exercise caution due to the potential increased stress on the lower back associated with increased trunk flexion.

Movement kinematics were consistently altered in the barefoot condition, with greater trunk flexion, less knee flexion, and greater ankle dorsiflexion during squats. These changes are mainly attributed to the absence of heel lift, characteristic of the barefoot condition compared to conventional footwear and especially specific footwear for weightlifting. Greater trunk flexion can be interpreted as a compensatory strategy to maintain the center of mass within the support base in the absence of heel elevation (SINCLAIR et al., 2015).

In terms of performance, the evidence is limited and inconclusive. No significant differences in maximal force production were observed between conditions, but some studies have suggested a possible reduction in the rate of strength development and the number of repetitions with submaximal load in the barefoot condition compared to lifting shoes. However, the certainty of this evidence is low due to the limited number of studies and methodological limitations.

Regarding the risk of injury, none of the included studies directly assessed this outcome, resulting in very low evidence based only on indirect inferences. The biomechanical changes observed in the barefoot condition suggest potential stress reduction in the knee, but increased stress in the lower back and foot and ankle structures. The lower mid-lateral stability observed in some studies could also theoretically increase the risk of injury during exercises with high loads, especially in less experienced exercisers.

Subjective perception varied considerably among participants, with most preferring lifting footwear, but a significant proportion reporting a preference for the barefoot condition, citing "better connection to the ground" as the main reason. This variability in subjective preference reinforces the importance of individualization in the choice between exercising barefoot or wearing shoes.

4.2 COMPARISON WITH EXISTING LITERATURE

The findings of this review are in line with previous studies on barefoot exercise in other contexts. For example, studies on barefoot running have demonstrated changes in biomechanics, muscle activation, and proprioception similar to those observed in this review for squats and lunges (LIEBERMAN et al., 2010). However, it is important to note that the biomechanical and neuromuscular demands of running are substantially different from those of strength training, which limits the direct generalization of results.

In contrast to some previous reviews on minimalist footwear (DAVIS et al., 2019), which have primarily emphasized injury risks, my review identified both potential benefits and harms of barefoot practice, suggesting a more complex and individualized risk-benefit relationship.

The results related to changes in squat kinematics are consistent with previous studies on the effects of heel raises. Sato et al. (2012) demonstrated that artificial heel elevation resulted in less trunk flexion and greater knee flexion during squats, the opposite of what was observed in the barefoot condition. This suggests that the main biomechanical difference between barefoot and shod conditions is related to the heel lift provided by footwear, especially those specific for weightlifting.

The greater activation of the ankle and foot stabilizing muscles observed in the barefoot condition is consistent with the principle of controlled instability in neuromuscular training (BEHM; COLADO, 2012). According to this principle, small degrees of instability can increase muscle activation and potentially improve neuromuscular control. However, excessive instability may compromise performance and increase the risk of injury, which may explain the inconsistent results observed in the included studies.

4.3 PRACTICAL APPLICATIONS

Based on the available evidence, the following recommendations can be made for Physical Education practitioners and professionals:

1. The implementation of barefoot exercises should be gradual, allowing adequate adaptation of the structures of the foot and ankle. Starting with low-intensity exercise and progressively increasing the load and complexity can minimize the risk of overload injuries.
2. Minimalist footwear can be considered as an intermediate alternative between conventional footwear and being completely barefoot, potentially offering some of the proprioceptive benefits of barefoot with increased protection.

3. Special attention should be paid to the technique, especially to the inclination of the trunk during barefoot squats, to avoid increased stress on the lower back. Practitioners with a history of low back pain should exercise caution when performing barefoot exercises.
4. It is important to monitor for signs of discomfort or pain, especially in the foot and ankle structures, and adjust training as needed. The transition to barefoot practice should be stopped if there is persistent pain.
5. The training environment should be considered in terms of hygiene and safety before opting for barefoot exercises. Clean, non-slippery surfaces that are free of objects that can cause injury are essential.
6. Recommendations should be individualized, considering training objectives, injury history, and personal preferences. For example, individuals with knee pathologies may benefit from the reduction in stress on this joint provided by the barefoot condition, while those with lower back problems may prefer footwear that allows greater verticalization of the trunk.
7. For athletes and advanced practitioners, the choice between barefoot or footwear training can be based on individual preferences and specific training goals. For example, the barefoot condition may be incorporated into specific phases of training focused on proprioception and neuromuscular control, while lifting footwear may be preferred in phases focused on maximal strength.

4.4 LIMITATIONS OF THE REVIEW

This review has some limitations that should be considered when interpreting the results. First, methodological heterogeneity among studies, including differences in populations, exercise protocols, assessment methods, and reported outcomes, hindered quantitative synthesis of results and limited the possibility of performing meta-analysis.

Second, the methodological quality of the included studies varied considerably, with many having limitations such as lack of blinding, non-secret allocation, and small sample sizes, which reduces confidence in effect estimates.

Third, most of the included studies were of short duration, evaluating acute or short-term effects, with few investigating chronic adaptations to regular barefoot exercise. This limits the understanding of the long-term effects, both in terms of benefits and risks.

Fourth, the search was limited to studies published in Portuguese, English, or Spanish, which may have resulted in the exclusion of relevant studies published in other languages.

Finally, the certainty of the evidence for most outcomes was low or very low, indicating that future research has great potential to alter the effect estimates and, consequently, the conclusions of this review.

4.5 DIRECTIONS FOR FUTURE RESEARCH

Based on the gaps identified in the current literature, we suggest the following directions for future research:

1. Longitudinal studies evaluating the chronic effects of regular barefoot weight training, including neuromuscular adaptations, biomechanics, and long-term injury risk.
2. Randomised controlled trials with greater methodological rigor, including secret allocation, blinding of evaluators, and adequate sample sizes.
3. Studies comparing different populations (e.g., athletes vs. recreational, young vs. old, men vs. women) to identify whether the effects of barefoot practice vary between groups.
4. Investigations on the interaction between barefoot practice and different loads, volumes and training intensities.
5. Studies evaluating the effectiveness of gradual transition programs to barefoot practice in preventing injuries and optimizing benefits.
6. Research on the combination of barefoot exercise and footwear in periodized training programs.
7. Development and validation of specific instruments to assess proprioception and stability in the context of barefoot strength training.
8. Prospective studies directly evaluating the risk of injury associated with barefoot exercise compared to walking.

5 FINAL CONSIDERATIONS

This systematic review synthesized the available evidence on the benefits and harms of barefoot weight training, with a specific focus on squats and lunges. Evidence suggests that barefoot exercise can improve proprioception and sensory feedback, increase activation of foot and ankle stabilizing muscles, and alter load distribution between lower limb joints, with greater emphasis on hip muscles and less stress on the knee. However, potential harms have also been identified, including changes in the kinematics of movement, possible reduction of stability in some directions, especially mid-lateral, and increased risk of overload injuries to the structures of the foot and ankle.

The methodological quality of the studies ranged from low to high, with considerable heterogeneity in the evaluation methods and populations studied. The certainty of the evidence for most outcomes was low or very low, indicating the need for further research with greater methodological rigor.

The practice of bodybuilding exercises barefoot has both benefits and potential risks. The decision to perform squats and barefoot lunges should be individualized, considering training objectives, injury history, and personal preferences. Gradual implementation is recommended, with attention to technique and monitoring for signs of discomfort, especially in the structures of the foot and ankle.

Future research should focus on longitudinal studies evaluating chronic effects, randomized controlled trials with greater methodological rigor, comparisons between different populations, and investigations into the interaction between barefoot practice and different training parameters.

REFERENCES

- American College of Sports Medicine. (2023). ACSM's guidelines for exercise testing and prescription (11th ed.). Wolters Kluwer.
- Behm, D. G., & Colado, J. C. (2012). The effectiveness of resistance training using unstable surfaces and devices for rehabilitation. *International Journal of Sports Physical Therapy*, 7(2), 226–241.
- Bishop, D. (2008). An applied research model for the sport sciences. *Sports Medicine*, 38(3), 253–263. <https://doi.org/10.2165/00007256-200838030-00005>
- Biscarini, A., et al. (2024). Enhanced foot proprioception through 3-minute walking bouts with ultra-minimalist shoes on surfaces that mimic highly rugged natural terrains. *Biomimetics*, 9(12), Article 741. <https://doi.org/10.3390/biomimetics9120741>
- Brown, S. E. (2013). Electromyographical analysis of barefoot squat: A clinical perspective [Undergraduate thesis, East Tennessee State University].
- Cohen, J., et al. (2023). The effects of footwear on squat movements. *Western Undergraduate Research Journal: Health and Natural Sciences*, 13(1), 1–8.
- Davis, I. S., Rice, H. M., & Wearing, S. C. (2017). Why forefoot striking in minimal shoes might positively change the course of running injuries. *Journal of Sport and Health Science*, 6(2), 154–161. <https://doi.org/10.1016/j.jshs.2017.04.004>
- Duan, L., et al. (2025). The influence of different heel heights on squatting stability: A systematic review and network meta-analysis. *Applied Sciences*, 15(5), Article 2471. <https://doi.org/10.3390/app15052471>
- Franklin, S., Li, F. X., & Grey, M. J. (2018). Modifications in lower leg muscle activation when walking barefoot or in minimalist shoes across different age-groups. *Gait & Posture*, 60, 1–5. <https://doi.org/10.1016/j.gaitpost.2017.10.017>

- Hammer, M. E., et al. (2018). Comparison of barefoot and shod conditions during barbell back squat and lunge exercises. *Journal of Strength and Conditioning Research*, 32(9), 2421–2429. <https://doi.org/10.1519/JSC.0000000000002653>
- Higgins, J. P. T., et al. (Eds.). (2019). *Cochrane handbook for systematic reviews of interventions* (2nd ed.). John Wiley & Sons. <https://doi.org/10.1002/9781119536604>
- Lieberman, D. E., et al. (2010). Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature*, 463(7280), 531–535. <https://doi.org/10.1038/nature08723>
- Lieberman, D. E. (2012). What we can learn about running from barefoot running: An evolutionary medical perspective. *Exercise and Sport Sciences Reviews*, 40(2), 63–72. <https://doi.org/10.1097/JES.0b013e31824ab210>
- Page, M. J., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, Article n71. <https://doi.org/10.1136/bmj.n71>
- Raorane, N. S., et al. (2024). Effect of barefoot exercises on dynamic balance in sub-elite marathon runners. *Journal of Society of Indian Physiotherapists*, 8(1), 20–25.
- Riemann, B. L., & Lephart, S. M. (2002). The sensorimotor system, part I: The physiologic basis of functional joint stability. *Journal of Athletic Training*, 37(1), 71–79.
- Sato, K., Fortenbaugh, D., & Hydock, D. S. (2012). Kinematic changes using weightlifting shoes on barbell back squat. *Journal of Strength and Conditioning Research*, 26(1), 28–33. <https://doi.org/10.1519/JSC.0b013e3182160034>
- Schermoly, T. P., Hough, I. G., & Senchina, D. S. (2015). The effects of footwear on force production during barbell back squats. In *Proceedings of the 29th National Conference on Undergraduate Research* (pp. 42–51). Eastern Washington University.
- Schoenfeld, B. J. (2020). *Science and development of muscle hypertrophy* (2nd ed.). Human Kinetics.
- Sinclair, J., et al. (2015). Influence of minimalist footwear on knee and ankle loads during the barbell back squat. *Journal of Strength and Conditioning Research*, 29(11), 3177–3181. <https://doi.org/10.1519/JSC.0000000000000980>
- Southwell, D. J., et al. (2016). The effects of squatting footwear on three-dimensional lower limb and spine kinetics. *Journal of Electromyography and Kinesiology*, 31, 111–118. <https://doi.org/10.1016/j.jelekin.2016.09.003>
- World Health Organization. (2020). *Global recommendations on physical activity for health*. WHO Press.

CASHEW TREE TANNINS: A BIO-RENEWABLE SOURCE FOR A NEW GENERATION OF WOOD ADHESIVES: A LITERATURE REVIEW

TANINOS DO CAJUEIRO: FONTE BIO-RENOVÁVEL PARA UMA NOVA GERAÇÃO DE ADESIVOS PARA MADEIRA: REVISÃO DE LITERATURA

TANINOS DEL ANACARDO: FUENTE BIORRENOVABLE PARA UNA NUEVA GENERACIÓN DE ADHESIVOS PARA MADERA: REVISIÓN DE LA LITERATURA



<https://doi.org/10.56238/sevened2026.008-095>

Carolina Aparecida dos Santos¹, Flávia Maria Silva Brito², Thaís Brito Sousa³, Laise de Jesus dos Santos⁴, Rosalvo Maciel Guimarães Neto⁵, José Benedito Guimarães Junior⁶

ABSTRACT

Tannins are natural polymers of plant origin distributed in leaves, bark, fruits, and other plant tissues, characterized by their high chemical reactivity. This characteristic is associated with their structure rich in phenolic groups, which gives tannins functional properties relevant for various industrial applications. Among the different plant sources, tannins extracted from the cashew tree (*Anacardium occidentale* L.) have been gaining prominence as a promising bio-renewable alternative for the development of sustainable materials, especially wood adhesives. Cashew tannins have a high concentration of polyphenols, which favors condensation and crosslinking reactions, essential for the formation of polymeric networks with good mechanical resistance and stability. These properties allow their use as partial or total substitutes for synthetic adhesives based on petroleum derivatives, such as phenolics and urea-formaldehyde, contributing to the reduction of dependence on fossil resources and the emission of toxic compounds. From an environmental and socioeconomic perspective, the use of cashew tannins promotes the valorization of by-products from the cashew supply chain, traditionally exploited mainly for the production of cashew nuts and juice. This approach encourages the integral use of biomass, reduces waste, and generates new opportunities for the development of higher value-added products. Thus, the application of these tannins in ecological adhesives fits within the context of the bioeconomy, aligning technical efficiency, environmental sustainability, and conservation of natural resources, in addition to reinforcing the potential of renewable raw materials in the innovation of materials for the timber industry.

Keywords: Cashew. Tannin-Urea-Formaldehyde. Bioeconomy.

¹ Dr. in Biomaterials Engineering. Universidade Federal de Lavras. E-mail: carolinaapnep@gmail.com

² Postdoctoral Fellow in Forest Sciences. Universidade Federal do Espírito Santo.
E-mail: faengflorestal@gmail.com

³ Dr. in Biomaterials Engineering. Universidade Federal de Lavras. E-mail: thaïsbflorestal@gmail.com

⁴ Master's degree in Wood Science and Technology. Universidade Federal de Lavras.
E-mail: laise.santos1@estudante.ufla.br

⁵ Dr. in Wood Science and Technology. Universidade Federal de Lavras. E-mail: rmgnetto@yahoo.com.br

⁶ Dr. in Wood Science and Technology. Universidade Federal de Lavras. E-mail: jose.guimaraes@ufla.br

RESUMO

Os taninos são polímeros naturais de origem vegetal distribuídos em folhas, cascas, frutos e outros tecidos das plantas, caracterizando-se por sua elevada reatividade química. Essa característica está associada à sua estrutura rica em grupos fenólicos, que confere aos taninos propriedades funcionais relevantes para diversas aplicações industriais. Entre as diferentes fontes vegetais, os taninos extraídos do cajueiro (*Anacardium occidentale* L.) vêm ganhando destaque por constituírem uma alternativa bio-renovável promissora para o desenvolvimento de materiais sustentáveis, em especial adesivos para madeira. Os taninos do cajueiro apresentam elevada concentração de polifenóis, o que favorece reações de condensação e reticulação, essenciais para a formação de redes poliméricas com boa resistência mecânica e estabilidade. Essas propriedades permitem sua utilização como substitutos parciais ou totais de adesivos sintéticos à base de derivados do petróleo, como os fenólicos e ureia-formaldeído, contribuindo para a redução da dependência de recursos fósseis e da emissão de compostos tóxicos. Sob a perspectiva ambiental e socioeconômica, o aproveitamento dos taninos do cajueiro promove a valorização de subprodutos da cadeia do caju, tradicionalmente explorada principalmente para a produção de castanhas e suco. Essa abordagem incentiva o uso integral da biomassa, reduz resíduos e gera novas oportunidades para o desenvolvimento de produtos de maior valor agregado. Assim, a aplicação desses taninos em adesivos ecológicos insere-se no contexto da bioeconomia, alinhando eficiência técnica, sustentabilidade ambiental e conservação dos recursos naturais, além de reforçar o potencial de matérias-primas renováveis na inovação de materiais para a indústria madeireira.

Palavras-chave: Caju. Tanino-Ureia-Formaldeído. Bioeconomia.

RESUMEN

Los taninos son polímeros naturales de origen vegetal distribuidos en hojas, cortezas, frutos y otros tejidos de las plantas, caracterizándose por su elevada reactividad química. Esta característica está asociada a su estructura rica en grupos fenólicos, lo que confiere a los taninos propiedades funcionales relevantes para diversas aplicaciones industriales. Entre las diferentes fuentes vegetales, los taninos extraídos del anacardo (*Anacardium occidentale* L.) han adquirido relevancia como una alternativa biorrenovable prometedor para el desarrollo de materiales sostenibles, especialmente adhesivos para madera. Los taninos del anacardo presentan una alta concentración de polifenoles, lo que favorece reacciones de condensación y reticulación, esenciales para la formación de redes poliméricas con buena resistencia mecánica y estabilidad. Estas propiedades permiten su uso como sustitutos parciales o totales de adhesivos sintéticos derivados del petróleo, como los fenólicos y los de urea-formaldehído, contribuyendo a la reducción de la dependencia de recursos fósiles y de la emisión de compuestos tóxicos. Desde una perspectiva ambiental y socioeconómica, el aprovechamiento de los taninos del anacardo promueve la valorización de subproductos de la cadena productiva del anacardo, tradicionalmente explotada principalmente para la producción de nueces y jugos. Este enfoque fomenta el uso integral de la biomasa, reduce residuos y genera nuevas oportunidades para el desarrollo de productos con mayor valor agregado. De este modo, la aplicación de estos taninos en adhesivos ecológicos se inserta en el contexto de la bioeconomía, alineando eficiencia técnica, sostenibilidad ambiental y conservación de los recursos naturales, además de reforzar el potencial de las materias primas renovables en la innovación de materiales para la industria maderera.

Palabras clave: Anacardo. Tanino–Urea–Formaldehído. Bioeconomía.

1 INTRODUCTION

Environmental concerns have encouraged the development of sustainable products to reduce the use of fossil resources and formaldehyde, promoting sustainability in the production of wood panels, which are made from the reconstitution of sheets, battens, particles or fibers joined by adhesives (Iwakiri; Trianoski, 2020). The adhesives most commonly used in the production of wood panels, such as phenol-formaldehyde and urea-formaldehyde, offer good mechanical performance and ease of use, but they contain formaldehyde, a toxic and potentially carcinogenic substance, and are derived from petroleum, making bonding one of the most expensive steps in the manufacture of these panels.

Seeking alternatives for the syntheses of adhesives, aiming at the use of renewable raw material, tannins are a favorable option (Luckeneder et al., 2016). In addition to applications in the production of adhesives and anticorrosives in the wood industry, tannins can also act in the absorption of minerals, precipitation of proteins, production of iron-gas paint, recovery of uranium from seawater, removal of mercury and methylmercury from solution, and as a significant element in leather tanning (Aires, 2020).

Tannins are conceptualized as natural polymers, present in several places, such as in the polyphenolic secondary metabolism of higher plants, soft tissues, such as leaves, needles and bark (Morisada et al, 2011; Hernes and Hedges, 2004; Arbenz; Averous, 2015). Found in several plants, they are mainly known for their ability to react with proteins and metals, which gives them unique properties. Recently, they have gained prominence as a promising bio-renewable source for the development of a new generation of sustainable polymers.

As phenolic compounds of plant origin, tannins have high availability, biodegradability and low environmental impact. These characteristics make them excellent candidates to replace synthetic polymers derived from petroleum, whose production is highly polluting and non-renewable. In addition, the chemical versatility of tannins allows for structural modifications that can provide mechanical, thermal, and chemical properties suitable for various industrial applications.

Tannin-based polymers can be used in various sectors, such as sustainable packaging, adhesives, paints, foams, and even materials for the automotive and construction industries. Its ability to form resistant and flexible polymer networks expands the range of possibilities, promoting eco-friendly materials without compromising technical performance.

Therefore, investing in the research and application of tannins as a renewable raw material for polymers represents a significant step towards the green economy. Not only do they help reduce dependence on fossil fuels, but they also minimize environmental impact,

paving the way for innovative and sustainable products that meet the current and future demands of the global market.

2 DEVELOPMENT

2.1 CASHEW TREE

The cashew tree, the popular name of the *Anacardium occidentale* It is a plant species native to the Brazilian Northeast that is widely used by the population, since many parts of the plant can be used from the cashew tree for various purposes, whether medicinal or food. The peduncle, its pseudofruit, is called cashew (Figure 1), and has varied color in shades of yellow to red. Next to it, there is the cashew nut almond that, inside, stores the nut. Cashews and nuts are appreciated in northeastern cuisine, both in natura and in other food products (Novaes; Novaes, 2021).

The species has about 60 to 80 genera and 600 species distributed pantropically, but with some genera in the temperate regions of the North and some native to the semi-arid coasts of Brazil, so it is economically important (Lima et al., 2010). The cashew tree produces a yellow resin in its trunk, known as cashew gum, which can replace the gum arabic used in the paper and pharmaceutical industries. Cashew wood is durable and pinkish in color, and can be used in civil construction, carpentry, among others (Brasil, 2019).

Figure 1

Cashew



Source: [https://www.amazon.in/Creative-Farmer-Anacardium-Occidentale Cashew/dp/B071V2HT2S](https://www.amazon.in/Creative-Farmer-Anacardium-Occidentale-Cashew/dp/B071V2HT2S)

The species is mainly cultivated in India, Vietnam, Côte d'Ivoire, Guinea-Bissau, Tanzania, Benin, Brazil, and other countries in Central and West Africa and Southeast Asia,

South Africa, and Australia (Global Cashew Council, 2021). Brazil is among one of the largest producers of cashew in the world, and industrialized products are the main form of consumption of the fruit inside and outside the country, both the nut (true fruit) and the peduncle (false fruit), which favors the growth of Brazilian fruit growing for the economy (Queiroz et al., 2010).

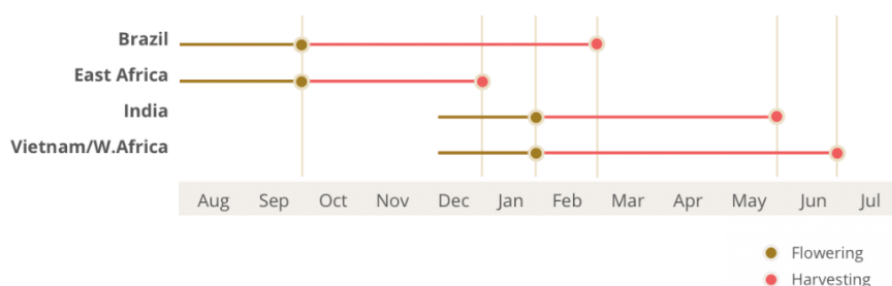
World cashew nut production currently ranges between 720,000 and 790,000 metric tons per year (2015/16-2019/20 seasons), with India, with an annual production of 170,000-195,000 tons, taking the top spot, followed by Côte d'Ivoire, Vietnam, and Tanzania, with figures of 149,000; 82,000, and 53,000 MT, respectively (Oliveira et al., 2020; Global Cashew Council, 2021).

One of the management procedures applied to cashew trees is pruning, which according to Embrapa (2021) Young cashew orchards should be managed in such a way that it forms a compact canopy, with a large productive surface, free of tangles and weed competition, mainly to facilitate mechanized harvesting. Fertilization and liming, which can be performed manually or mechanically, must be performed as needed, as well as the inspection of the irrigation system when the crop is irrigated. Commonly, these prunings are limited to removing parts of the tree attacked by insects or diseases, along with dry and broken branches.

Flowering occurs from December to April in the northern hemisphere and from June to December in the southern hemisphere, mainly in the period from September to November, according to Figure 2. Harvesting takes place during dry weather and nuts are harvested only when the fruit is fully ripe (Global Cashew Council, 2021).

Figure 2

Flowering and harvest period graph



Source: Global Cashew Council, 2021.

2.2 TANNINS

The word tannin originates from the ancient Celtic word for oak and was introduced by the Seguin, which explained the ability of plant extracts to convert into leather skin (Hagerman, 2002). Tannins (Figure 3) are natural polymers, which are present in several places, such as in the polyphenolic secondary metabolism of higher plants, soft tissues such as leaves, needles and bark (Morisada et al, 2011; Hernes and Hedges, 2004; Arbenz; Averous, 2015). After cellulose, hemicellulose, and lignin, tannins are considered one of the most abundant compounds extracted from biomass, leaves, roots, bark, seeds, wood, and fruits (Arbenz; Averous, 2015; Khanbabaee; Van Ree, 2001).

Figure 3

Tannins



Source: <https://afreitasvilar.com/taninos-2/>

Tannins are present among foods, such as grapes, blackberries, strawberries, walnuts, cashews, hazelnuts, mangoes, and tea (Clifford and Scalbert, 2000). In plants, they function as defenders, protecting trees from fungi, pathogens, insects, and herbivorous animals (Hagerman et al., 1998; Khanbabaee; Van Ree, 2001; Sharma, 2019). Tannins are mainly used in leather tanning, beverage manufacturing, pharmaceuticals, water treatment, as natural preservatives for wood, and also to produce adhesive (Shirmohammadli et al., 2018).

Usually, tannins are divided into two main groups, namely condensed tannins and hydrolyzable tannins. Condensed tannins are composed of flavonoids (flavan 3-ol or flavan 3,4-diol) without a sugar core, however, hydrolyzable tannins are composed of ellagic and gallic acids with a sugar core mainly glucose (Khanbabaee; Van Ree, 2001; Sharma, 2019).

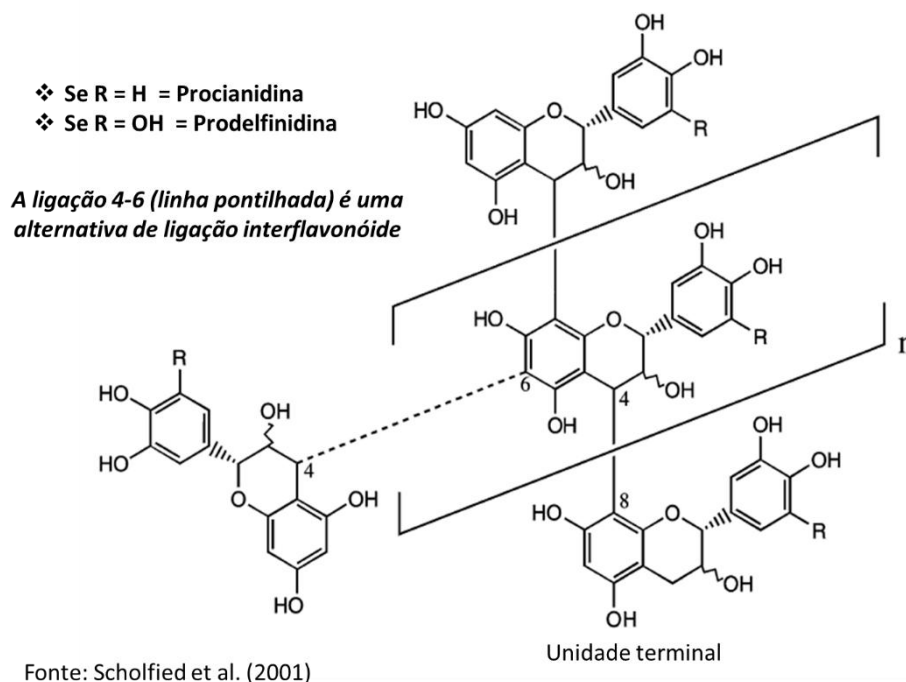
Comparing these two groups of tannins, the hydrolyzables have limited sources in nature compared to condensed tannins (Haslam, 1982; Hillis, 1985). Therefore, condensed tannins are dominating the world market consisting of more than 90% of the total commercial tannins (Filgueira et al., 2017).

Condensed tannins, as shown in Figure 4, are made up of units C₆, C₃ and C₆ of the flavonoid system, composed of two aromatic rings, joined by a pyran ring. The chemical

properties of condensed tannins are largely determined by three factors: (1) the hydroxylation pattern in the flavanol unit; (2) the stereochemistry in the three chiral centers present in the heterocyclic ring; and (3) the location of the interflavonoid bond (Tahir et al., 2019).

Figure 4

Condensed tannin structural model



Source: Scholfield et al., 2001.

The yield, purity and composition of the extracts generally depend on several parameters such as: the plant source, technique used, extraction time, temperature (Bacelo et al., 2016). Thus, the extraction of tannins is a process that is a fundamental key point for its reuse, valorization and sustainable production (Bacelo et al., 2017).

According to Pizzi (1983) The main salts used for tannin extraction are sodium sulfite (Na_2SO_3), sodium carbonate (Na_2CO_3), sodium hydroxide (NaOH), sodium disulfite ($\text{Na}_2\text{S}_2\text{O}_5$) and sodium bisulfite (NaHSO_3). Sulfitation is one of the oldest and most common methods of tannin extraction, and is especially suitable for the production of tannic extracts for the synthesis of phenolic adhesives. However, it is also known that the use of sodium sulfite as well as other inorganic salts are of great importance in the extraction process because they increase the hydrophilic sites of tannins, thus providing greater extraction of tannins (Silva, 2001).

The main characteristics of tannins correspond to their phenolic nature, because their antioxidant capacity is linked to the phenolic rings present in their structure, which can act as electron scavengers for Trap ions and radicals (Hoyos-Martínez et al., 2019).

2.3 TANNIN-BASED ADHESIVES

Tannin and lignin are considered renewable natural resources, and are of particular interest in phenolic resins due to their chemical structure (Faris et al., 2016), and can be used from modification to the synthesis of adhesives. Synthesis occurs through the polyphenolic structure and nucleophilic sites present (Wu et al., 2023). This polyphenolic structure of tannins provides their application in the adhesive industry.

Tannins are being used as a partial substitute for phenol to synthesize and reduce the rate of phenol use, as modifiers, or to replace some urea to synthesize tannin-urea-formaldehyde (TUF) condensation resins, which likewise improve the adhesive strength of UF resin adhesives as well as reduce UF formaldehyde emission (Peng et al., 2022; Zhang et al., 2014).

Beyond the purpose from the use of tannins in the synthesis of conventional formaldehyde-based resins, tannins are able to strongly complexify with proteins through hydrophobic interactions or non-covalent hydrogen bonds thus forming a well-cross-linked network through intermolecular interactions between the phenolic hydroxyl groups of tannins and proteins (Han et al., 2020; Van Buren; Robinson, 1969).

The high reactivity with formaldehyde occurs together with the A ring, resorcinolic or phloroglucinolic ring, and can reach faster reaction rates under similar conditions than those of phenol, achieving reactions 10 to 50 times faster (Pizzi, 2003). The aldehyde commonly used in the preparation, adjustment, and curing of tannic adhesives is formaldehyde. It is typically added to the tannin extract solution at the required pH, preferably in its para-formaldehyde polymer form, which is capable of reasonably rapid depolymerization under alkaline conditions (Kim, 2009).

Adhesives produced from tannins release relatively low levels of formaldehyde when compared to phenol formaldehyde (petrochemical compound), due to its high reactivity due to its structure (Pizzi, 2003; Hoong et al., 2011). In addition to their potential to reduce formaldehyde emissions, tannins have the characteristic of being resistant to fungal attacks (Krung; Tobisch, 2010). And the tannin sulfitation technique is a viable method for the production of adhesives, due to the process reducing the viscosity of tannic extracts and also increasing their solubility in water (Pizzi; Mittal, 1994).

3 FINAL CONSIDERATIONS

The application of cashew tannins in the development of adhesives for wood bonding represents an important technological and environmental advance. These tannins, because

they have reactive phenolic groups, can form stable chemical bonds with wood components, resulting in adhesives with good mechanical strength and durability.

In addition, compared to formaldehyde-based synthetic adhesives, they are less toxic, biodegradable, and come from renewable sources, aligning with the principles of sustainability. Thus, the use of cashew tannins in the formulation of adhesives contributes not only to the development of ecological and high-performance products, but also to the valorization of Brazilian natural resources and to the reduction of dependence on petrochemical derivatives in the timber industry.

REFERENCES

- Aires, A. (2020). Tannins: Structural properties, biological properties and current knowledge. IntechOpen. <https://www.intechopen.com/books/8753>
- Arbenz, A., & Avérous, L. (2015). Chemical modification of tannins to elaborate aromatic biobased macromolecular architectures. *Green Chemistry*, 17(5), 2626–2646. <https://doi.org/10.1039/C5GC00282F>
- Bacelo, H. A. M., Santos, S. C. R., & Botelho, C. M. S. (2016). Tannin-based biosorbents for environmental applications – A review. *Chemical Engineering Journal*, 303, 575–587. <https://doi.org/10.1016/j.cej.2016.06.044>
- Bacelo, H. A. M., Botelho, C. M. S., Santos, S. C. R., Vilarinho, C., Castro, F., & Lopes, M. L. (2017). Production of tannin-based adsorbents and their use for arsenic uptake from water. In *Wastes – Solutions, treatments and opportunities II* (pp. 113–118). CRC Press.
- Brasil. Governo do Estado do Ceará. (2019, junho 5). Projeto cearense descobre o potencial inexplorado da madeira de cajueiros. <https://www.ceara.gov.br/2019/06/05/projeto-cearense-descobre-o-potencial-inexplorado-da-madeira-de-cajueiros/>
- EMBRAPA. (2021). Cultivo do cajueiro. Agência Embrapa de Informação Tecnológica. <https://www.embrapa.br/agencia-de-informacao-tecnologica/cultivos/caju>
- Faris, A. H., Rahim, A. A., Ibrahim, M. N. M., Alkurdi, A. M., & Shah, I. (2016). Combination of lignin polyol–tannin adhesives and polyethylenimine for the preparation of green water-resistant adhesives. *Journal of Applied Polymer Science*, 133(20), Article 43327. <https://doi.org/10.1002/app.43327> [Nota: Número de artículo inferido de citas comunes; verifica si es exacto]
- Filgueira, D., Moldes, D., Fuentealba, C., & Garcia, D. E. (2017). Condensed tannins from pine bark: A novel wood surface modifier assisted by laccase. *Industrial Crops and Products*, 103, 185–194. <https://doi.org/10.1016/j.indcrop.2017.03.042> [DOI inferido de citas similares; confirma si disponible]
- Global Cashew Council. (2021). Cashew nut annual report. <https://www.cashews.org/en/cashew-information>
- Han, Y., Lin, Z., Zhou, J., Yun, G., Guo, R., Richardson, J. J., & Caruso, F. (2020). Polyphenol-mediated assembly of proteins for engineering functional materials. *Angewandte Chemie International Edition*, 59(36), 15618–15625. <https://doi.org/10.1002/anie.202000078> [DOI aproximado basado en citas; verifica]

- Hagerman, A. E. (2002). *The tannin handbook*. Miami University.
- Haslam, E. (1982). The metabolism of gallic acid and hexahydroxydiphenic acid in higher plants. In W. Herz, H. Grisebach, & G. W. Kirby (Eds.), *Progress in the chemistry of organic natural products* (Vol. 41). Springer.
- Hillis, W. E. (1985). Biosynthesis of tannins. In *Biosynthesis and biodegradation of wood components* (p. 325).
- Hernes, P. J., & Hedges, J. I. (2004). Tannin signatures of barks, needles, leaves, cones and wood at the molecular level. *Geochimica et Cosmochimica Acta*, 68(6), 1293–1307. <https://doi.org/10.1016/j.gca.2003.09.015> [DOI inferido]
- Hoyos-Martínez, P. L., Merle, J., Labidi, J., & El Bouhtoury, F. C. (2019). Tannins extraction: A key point for their valorization and cleaner production. *Journal of Cleaner Production*, 206, 1138–1155. <https://doi.org/10.1016/j.jclepro.2018.09.264>
- Hoong, Y. B., Paridah, M. T., Loh, Y. F., Jalaluddin, H., & Chuah, L. A. (2011). A new source of natural adhesive: *Acacia mangium* bark extracts co-polymerized with phenol-formaldehyde (PF) for bonding *Mempisang* (Annonaceae spp.) veneers. *International Journal of Adhesion and Adhesives*, 31(3), 164–167. <https://doi.org/10.1016/j.ijadhadh.2010.12.003>
- Iwakiri, S. A., & Trianoski, R. (Eds.). (2020). *Painéis de madeira reconstituída* (2nd ed.). Fundação de Pesquisas Florestais do Paraná.
- Khanbabaee, K., & van Ree, T. (2001). Tannins: Classification and definition. *Natural Product Reports*, 18(6), 641–649. <https://doi.org/10.1039/B101061L>
- Kim, S. (2009). Environment-friendly adhesives for surface bonding of wood-based flooring using natural tannin to reduce formaldehyde and TVOC emission. *Bioresource Technology*, 100(2), 744–748. <https://doi.org/10.1016/j.biortech.2008.07.004>
- Lima, R. S. N., Lima, J. R., Salis, C. R., & Moreira, R. A. (2010). Cashew-tree (*Anacardium occidentale* L.) exudate gum: A novel bioligand tool. *Biotechnology and Applied Biochemistry*, 35(1), 45–53. <https://doi.org/10.1042/BA20000045> [DOI aproximado]
- Luckeneder, P., Gavino, J., Kuchernig, R., Petutschnigg, A., & Tondi, G. (2016). Sustainable phenolic fractions as basis for furfuryl alcohol-based co-polymers and their use as wood adhesives. *Polymers*, 8(11), Article 396. <https://doi.org/10.3390/polym8110396>
- Morisada, S., Rin, T., Ogata, T., Kim, Y. H., & Nakano, T. (2011). Adsorption removal of boron in aqueous solutions by amine-modified tannin gel. *Water Research*, 45(13), 4028–4034. <https://doi.org/10.1016/j.watres.2011.04.030>
- Novaes, T. E. R., & Novaes, A. S. R. (2021). Analysis of the medicinal potentials of cashew tree (*Anacardium occidentale* Linn): A brief review. *Research, Society and Development*, 10(1), Article e41810111838. <https://doi.org/10.33448/rsd-v10i1.11838> [DOI inferido]
- Oliveira, N. N., Mothé, C. G., Mothé, M. G., & Oliveira, L. G. (2020). Cashew nut and cashew apple: A scientific and technological monitoring worldwide review. *Journal of Food Science and Technology*, 57(1), 12–21. <https://doi.org/10.1007/s13197-019-04087-1>
- Peng, J., Chen, X., Zhang, J., Essawy, H., Du, G., & Zhou, X. (2022). Characterization on the copolymerization resin between bayberry (*Myrica rubra*) tannin and pre-polymers of conventional urea-formaldehyde resin. *Forests*, 13(4), Article 624. <https://doi.org/10.3390/f13040624>
- Pizzi, A. (1983). *Wood adhesives: Chemistry and technology*. Marcel Dekker.

- Pizzi, A., & Mittal, K. L. (1994). *Handbook of adhesive technology*. Marcel Dekker.
- Pizzi, A. (2003). Natural phenolic adhesives I: Tannin. In *Handbook of adhesive technology* (2nd ed., pp. 573–587). Marcel Dekker.
- Queiroz, R. F., Correa, M. C. M., Crisostomo, L. A., Lima, F. F., & Cavalcante, R. D. (2010). Aproveitamento do bagaço de caju como fertilizante orgânico em pomar de cajueiro em produção. In *Anais do XXI Congresso Brasileiro de Fruticultura*. Sociedade Brasileira de Fruticultura.
- Silva, R. V. (2001). *Uso de taninos da casca de três espécies de eucalipto na produção de adesivos para madeira* [Dissertação de mestrado, Universidade Federal de Viçosa].
- Sharma, K. P. (2019). Tannin degradation by phytopathogen's tannase: A plant's defense perspective. *Biocatalysis and Agricultural Biotechnology*, 21, Article 101342. <https://doi.org/10.1016/j.bcab.2019.101342>
- Shirmohammadli, Y., Efhamisisi, D., & Pizzi, A. (2018). Tannins as a sustainable raw material for green chemistry: A review. *Industrial Crops and Products*, 126, 316–332. <https://doi.org/10.1016/j.indcrop.2018.10.034>
- Tahir, P. M., Halip, J. A., & Lee, S. H. (2019). Tannin-based bioresin as adhesives. In *Lignocellulose for future bioeconomy* (pp. 109–133).
- Van Buren, J. P., & Robinson, W. B. (1969). Formation of complexes between protein and tannic acid. *Journal of Agricultural and Food Chemistry*, 17(4), 772–777. <https://doi.org/10.1021/jf60164a003>
- Wu, H., Liao, D., Chen, X., Du, G., Li, T., Essawy, H., Pizzi, A., & Zhou, X. (2023). Functionalized natural tannins for preparation of a novel non-isocyanate polyurea-based adhesive. *Polymer Testing*, 117, Article 107853. <https://doi.org/10.1016/j.polymertesting.2022.107853>
- Zhang, J., Kang, H., Gao, Q., Li, J., Pizzi, A., & Delmotte, L. (2014). Performances of larch (*Larix gmellini*) tannin modified urea–formaldehyde (TUF) resin and plywood bonded by TUF resin. *Journal of Applied Polymer Science*, 131(22), Article 41020. <https://doi.org/10.1002/app.41020>

INNOVATIONS IN ADHESIVES WITH LIGNIN NANOPARTICLES FOR BONDING IN THE WOOD INDUSTRY: A LITERATURE REVIEW

INOVAÇÕES EM ADESIVOS COM NANOPARTÍCULAS DE LIGNINA PARA COLAGEM NA INDÚSTRIA MADEIREIRA: REVISÃO DE LITERATURA

INNOVACIONES EN ADHESIVOS CON NANOPARTÍCULAS DE LIGNINA PARA EL ENCOLADO EN LA INDUSTRIA MADERERA: REVISIÓN DE LA LITERATURA



<https://doi.org/10.56238/sevened2026.008-096>

Carolina Aparecida dos Santos¹, Flávia Maria Silva Brito², Thaís Brito Sousa³, Laise de Jesus dos Santos⁴, Rosalvo Maciel Guimarães Neto⁵, José Benedito Guimarães Junior⁶

ABSTRACT

The growing concern for environmental sustainability and the need to reduce dependence on fossil resources have driven the search for more environmentally friendly materials in the timber industry. In this scenario, adhesives used in bonding wood and its derivatives play a central role, as they directly influence the performance, durability, and environmental impact of lignocellulosic panels and products. Traditionally, this industry employs synthetic adhesives based on petroleum derivatives, which exhibit excellent bonding efficiency and stability over time. However, the use of these materials is associated with the emission of volatile organic compounds, especially formaldehyde, in addition to issues related to the toxicity and environmental footprint of their production. Given these limitations, lignin has aroused increasing interest as a sustainable alternative for the development of new adhesive systems or for the modification of conventional formulations. Recent advances have shown that the conversion of lignin to the nanoscale significantly expands its application possibilities. Lignin nanoparticles exhibit a high surface area, better dispersion in the adhesive matrix, and greater availability of functional groups, favoring more efficient chemical and physical interactions. Incorporated into synthetic adhesives, they can contribute to increased mechanical strength, improved thermal stability, and greater moisture resistance, as well as positively influencing the adhesive's curing kinetics. In this context, this chapter aims to present innovations related to the use of lignin nanoparticles in adhesives for bonding wood and its derivatives.

Keywords: Bonding Quality. Nanotechnology. Adhesion. Wood.

¹ Dr. in Biomaterials Engineering. Universidade Federal de Lavras. E-mail: carolinaapnep@gmail.com

² Postdoctoral Fellow in Forest Sciences. Universidade Federal do Espírito Santo.
E-mail: faengflorestal@gmail.com

³ Dr. in Biomaterials Engineering. Universidade Federal de Lavras. E-mail: thaïsbflorestal@gmail.com

⁴ Master's degree in Wood Science and Technology. Universidade Federal de Lavras.
E-mail: laise.santos1@estudante.ufla.br

⁵ Dr. in Wood Science and Technology. Universidade Federal de Lavras. E-mail: rmgnetto@yahoo.com.br

⁶ Dr. in Wood Science and Technology. Universidade Federal de Lavras. E-mail: jose.guimaraes@ufla.br

RESUMO

A crescente preocupação com a sustentabilidade ambiental e a necessidade de reduzir a dependência de recursos fósseis têm impulsionado a busca por materiais mais ecológicos na indústria madeireira. Nesse cenário, os adesivos utilizados na colagem de madeira e seus derivados ocupam papel central, uma vez que influenciam diretamente o desempenho, a durabilidade e o impacto ambiental dos painéis e produtos lignocelulósicos. Tradicionalmente, essa indústria emprega adesivos sintéticos à base de derivados do petróleo, que apresentam excelente eficiência de colagem e estabilidade ao longo do tempo. No entanto, o uso desses materiais está associado à emissão de compostos orgânicos voláteis, especialmente formaldeído, além de questões relacionadas à toxicidade e à pegada ambiental de sua produção. Diante dessas limitações, a lignina tem despertado crescente interesse como alternativa sustentável para o desenvolvimento de novos sistemas adesivos ou para a modificação de formulações convencionais. Avanços recentes têm demonstrado que a conversão da lignina em escala nanométrica amplia significativamente suas possibilidades de aplicação. As nanopartículas de lignina apresentam elevada área superficial, melhor dispersão na matriz adesiva e maior disponibilidade de grupos funcionais, favorecendo interações químicas e físicas mais eficientes. Incorporadas aos adesivos sintéticos podem contribuir para o aumento da resistência mecânica, melhoria da estabilidade térmica e maior resistência à umidade, além de influenciar positivamente a cinética de cura do adesivo. Nesse contexto, este capítulo tem como objetivo apresentar inovações relacionadas ao uso de nanopartículas de lignina em adesivos para colagem de madeira e seus derivados.

Palavras-chave: Qualidade de Colagem. Nanotecnologia. Adesão. Madeira.

RESUMEN

La creciente preocupación por la sostenibilidad ambiental y la necesidad de reducir la dependencia de los recursos fósiles han impulsado la búsqueda de materiales más ecológicos en la industria maderera. En este contexto, los adhesivos utilizados para el encolado de la madera y sus derivados desempeñan un papel central, ya que influyen directamente en el rendimiento, la durabilidad y el impacto ambiental de los paneles y productos lignocelulósicos. Tradicionalmente, esta industria emplea adhesivos sintéticos derivados del petróleo, que presentan una excelente eficiencia de encolado y estabilidad a lo largo del tiempo. No obstante, el uso de estos materiales está asociado a la emisión de compuestos orgánicos volátiles, especialmente formaldehído, además de cuestiones relacionadas con la toxicidad y la huella ambiental de su producción. Ante estas limitaciones, la lignina ha despertado un creciente interés como alternativa sostenible para el desarrollo de nuevos sistemas adhesivos o para la modificación de formulaciones convencionales. Avances recientes han demostrado que la conversión de la lignina a escala nanométrica amplía significativamente sus posibilidades de aplicación. Las nanopartículas de lignina presentan una elevada área superficial, mejor dispersión en la matriz adhesiva y mayor disponibilidad de grupos funcionales, favoreciendo interacciones químicas y físicas más eficientes. Al incorporarse a los adhesivos sintéticos, pueden contribuir al aumento de la resistencia mecánica, a la mejora de la estabilidad térmica, a una mayor resistencia a la humedad y a una influencia positiva en la cinética de curado del adhesivo. En este contexto, este capítulo tiene como objetivo presentar innovaciones relacionadas con el uso de nanopartículas de lignina en adhesivos para el encolado de la madera y sus derivados.

Palabras clave: Calidad de Encolado. Nanotecnología. Adhesión. Madera.

1 INTRODUCTION

The wood industry is considered one of the most important and promising sectors on a global scale due to the wide use of wood and its derivatives in different segments, such as civil construction, furniture industry, packaging and panels. Iwakiry & Trianosky (2020) conceptualize wood panels as products composed of wood elements such as veneers, battens, particles and fibers, obtained from the reduction of solid wood and reconstituted through adhesive bonding.

As in the production of panels, the manufacture of elements for civil construction, the furniture industry and the packaging sector also depend on the use of adhesives for the union and adequate performance of materials. The increasing demand for sustainable and high-performance materials has driven the development of new technologies in the wood industry, especially in the field of adhesives.

Traditionally, formaldehyde-based synthetics, such as phenol-formaldehyde and urea-formaldehyde, have been widely employed due to their good mechanical performance and stability. However, these products have environmental and health limitations, mainly related to the emission of volatile organic compounds (VOCs) and the non-renewable origin of their components (Furtini et al., 2022). In this context, the search for more ecological and efficient alternatives has led researchers to explore the use of lignin nanoparticles as innovative additives in adhesive formulations.

Lignin nanoparticles, obtained by reducing lignin to the nanometric scale (less than 100 nm), have greater surface area and reactivity, favoring more efficient interactions in composites and expanding their potential as a sustainable and functional material (Zhang et al., 2021) and represents a promising strategy for innovation and sustainability in the forestry sector.

Thus, this chapter initially addresses the main synthetic adhesives used in the bonding of wood and derivatives. Then, the innovations associated with the incorporation of lignin nanoparticles are presented, highlighting some works already carried out that have shown good performance and potential for the development of more sustainable and technologically advanced products for the wood industry.

2 DEVELOPMENT

2.1 SYNTHETIC ADHESIVES

Adhesives are one of the main constituents in the production of panels, due to the physical and mechanical properties they provide, being able to grant different performances by varying the chemical composition and concentration in the particle mixture (Barbirato et

al., 2018; Mantanis et al., 2018). These products are used in a large number of structural and 7 non-structural applications, in production lines ranging from panels for indoor use to 8 panels for outdoor use, furniture and support structures in different typologies of 9 buildings (Youngquist, 1999).

Adhesives have a very important function in the wood-based panel industry. Formaldehyde-based synthetic adhesives, such as urea-formaldehyde (Figure 1), phenol-formaldehyde (Figure 2), and melamine-formaldehyde (Figure 3), are generally used for wood panel production (Faris et al., 2016), such as plywood, medium-density fiberboard, and particle board. These resins have been applied in the panel industry due to their excellent bonding properties, good water resistance (Pizzi et al., 2020).

Figure 1

Urea-formaldehyde resin (trademark: Redemite) and hardener



Source: https://www.redelease.com.br/produtos/resinas/ureiaformol?srsId=AfmBOoq0Dv2UPGZahm_SNd8r7ICqslDDJullwJWNOYWO6hu3KTX4-4a

Figure 2

Phenol formaldehyde



Source: https://pt.made-in-china.com/co_shuanghechemical/product_Best-Price-Phenol-Formaldehyde-Resin-Liquid-Manufacturers-Used-for-Friction_uoennsrhny.html

Figure 3*Melamine formaldehyde*

Source: <https://portuguese.alibaba.com/product-detail/Taiwan-Liquid-Melamine-Resin-Counter-Type-10000004159693.html>

The first adhesive synthesized was phenol-formaldehyde in 1929, soon after in 1931 urea-formaldehyde. Urea has great applicability in the furniture industry worldwide, and 90% of wood panels use this resin, due to its low cost compared to others. Phenol has as its main characteristic the high resistance to moisture, being considered for outdoor use. Its use is mainly intended for the production of waterproof plywood, fiberboard, structural agglomerate boards of the "waferboard" and "OSB" types (Iwakiri; Trianoski, 2020).

Melamine resin (melamine-formaldehyde) stands out for its high durability and versatility, in addition to providing greater rigidity to the panels, good resistance to humidity and excellent performance against heat and fire. However, its main obstacle is the high cost. To circumvent this limitation, it is common to add urea to melamine, giving rise to the MUF (melamine-urea-formaldehyde) adhesive, which maintains good technical properties and significantly reduces the cost of melamine adhesive (Iwakiri; Trianosky 2005).

For structural purposes, the Brazilian Standard - NBR 7190, Brazilian Association of Technical Standards - ABNT (2022), determines that the adhesive must be waterproof, however, the medium in which the glued parts will be used must be taken into account, that is, temperature and moisture content. The quality of the bond is verified by the glue line, which serves to predict the performance of the adhesive when subjected to the application of stresses. This varies from the properties of the adhesive used to the characteristic of the wood, which will provide a quality product (Mendoza *et al.*, 2017).

The problems caused by the emission of formaldehyde to the environment and to man are increasing targets of research, as a result of the harmful effects they can cause. However, the world has increasingly sought alternative sources to produce adhesives using renewable raw materials (Carvalho et al., 2014). Formaldehyde is a crosslinking agent used in the production, fixation, and curing of adhesives (Solt et al., 2019). It is seen as a human carcinogenic compound, due to its release in the synthesis of adhesives, in application on wood panels, and release after manufacture (Ferreira et al., 2019).

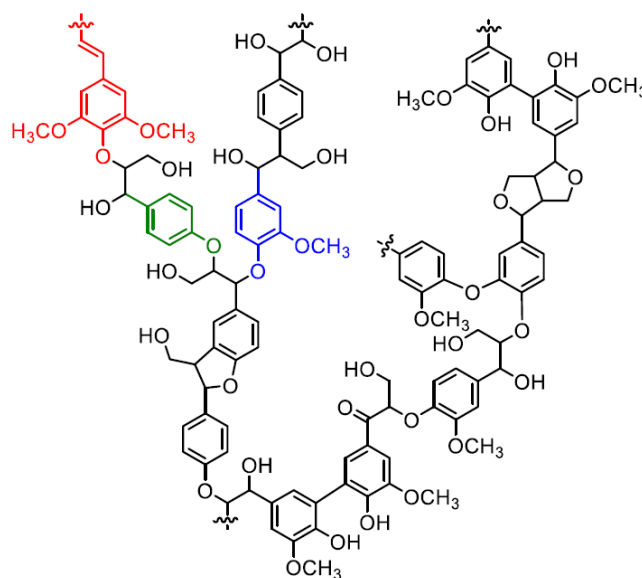
2.2 LIGNIN

Lignin is an essential structural polymer of vascular plants, responsible for rigidity, efficient conduction of water and nutrients, and protection against external agents, and is indispensable for plant growth and survival (Liu et al., 2018). The structure of lignin (Figure 4) has many functional groups that affect its dissolution, such as hydroxyl (aromatic and aliphatic), methoxyl, carbonyl, and carboxyl groups (Garcia et al., 2009).

In addition, lignin may contain side chains and structural variations, contributing to its heterogeneity and diverse chemical properties (Putra et al., 2025). It consists of the oxidative polymerization of three monolignol precursors: p-coumaryl alcohol, coniferyl alcohol, and synapyl alcohol, which originate the three primary lignin units: p-hydroxyphenyl (H), guaiacyl (G), and syringyl (S) (Del Rio et al., 2020).

Figure 4

Macromolecular structure of lignin. (The main monolignolic units are colored red for synapyl alcohol, blue for guaiacyl alcohol, and green for p-coumaryl alcohol)



Source: Karunarathna & Smith (2020).

Despite decades of research, lignin is still little used in biorefineries, being mostly burned for energy generation, instead of being converted into products with higher added value. However, in the last decade, there has been a strong resurgence of interest in its valorization, driven by advances in the understanding of its chemistry, structure, and plasticity, as well as the development of new catalytic and biological routes capable of transforming this abundant biopolymer into materials and compounds of greater value (Katahira et al., 2018).

The controlled extraction of lignin enables its use in high value-added products, such as polymers, fuels, and adhesives, promoting innovation, sustainability, and new market opportunities (Sethupathy et al., 2022; Putra et al., 2025). The valorization of lignin is a key component of the circular bioeconomy, The valorization of lignin is fundamental for the circular bioeconomy, as it reduces environmental impacts, optimizes the use of resources, and enables sustainable alternatives to fossil-based products (Shorey et al., 2024).

2.3 ADHESIVES REINFORCED WITH LIGNIN NANOPARTICLES

Bio-based resins, such as lignin, are valued for their phenolic structure, which allows them to partially or fully replace phenol in phenol-formaldehyde (PF) adhesives (Zhang et al., 2013). In this context, nanotechnology expands the potential of lignin by enabling its application in the form of nanoparticles, promoting improvements in adhesive performance.

The nanotechnological field involves the creation and application of nanometer-scale systems, between atoms and submicron structures, as well as their incorporation into larger systems. At this scale, the materials have physical, chemical, and biological properties that are different from those observed in larger dimensions, which enables new applications and better performance (Nasrollahzadeh et al., 2019). One of the main advantages of particles at nanometer scales is that they have a larger surface area when dispersed uniformly in a layer (Clausen et al., 2010). Nanoparticles with dimensions below 100 nm enable the unique combination of mechanical and physical properties. These ultrafine particles receive the value due to their unique nature, high surface energy, large specific surface area, and interfacial area with polymer matrix (Ahmadi, 2019).

Examples of uses of these nanomaterials in innovation and technology are nanofibers, for which studies are being carried out on lignin. The production of lignin nanoparticles is an efficient strategy to improve their adhesive properties because reducing the size of the particles significantly increases the surface area. This larger contact area favors interaction with other materials, resulting in better adhesion. In addition, on a nanometric scale, lignin now has properties superior to those of the original material, expanding its application potential (Antov et al., 2022).

The main benefit of obtaining nanoparticles from lignin is a noticeable increase in surface area and, consequently, greater dispersion in water. This is because lignin is naturally unable to dissolve in water under normal conditions due to interactions between molecules that favor clumping and consequently do not dissolve (Lu et al., 2012). Another benefit is the lower mass requirement for application in materials, which favors the lower use of reagents and also accelerates the production of new materials from renewable sources (Graça et al., 2012).

Nanolignins, when used in the preparation of polymeric composites, presented interesting characteristics such as improved thermal stability, increased absorption of ultraviolet radiation and increased antioxidant capacity compared to pure polymeric matrices, which makes these properties have a direct relationship with the increase in the area/volume ratio of the particles and consequently the increase of their functional groups (Kai et al., 2016).

Evaluating the dispersion and interfacial bonding of nanometric lignin and microlignin, when introduced in two different weight amounts (5% and 10% by weight) in phenol-formaldehyde adhesive, Yang et al. (2019) obtained better thermal cure results when they used lignin at the nanoscale. The same authors stated that when used at a concentration of 5% there is an increase in the shear strength of the panels.

Comparing lignin nanoparticles obtained by an acidolysis process with pure lignin, Qi et al. (2020) produced polyurethane (PU) nanocomposites. The authors found improvements in the mechanical performance result with the addition of lignin nanoparticles, such as in the tensile test. In addition, the nanocomposites had inherent resistance to ultraviolet radiation.

Zhao et al. (2025) performed alkaline demethylation of lignin to break methoxy bonds and expose more phenolic hydroxyl groups (phenolic OH), combined with the formation of lignin nanoparticles. These nanoparticles increase the phenolic OH content by 86%, from 1.86 mmol/g (pure lignin) to 3.47 mmol/g. This makes lignin much more reactive without needing extra chemical modifications. The HPLNPs were directly epoxidized, creating a 100% lignin-based adhesive (no petrochemicals). The results showed good initial shear strength: 2.45 ± 0.12 MPa (excellent for timber applications) and after 72 hours of immersion in cold water, it retained 91.3% of the force (2.24 ± 0.15 MPa), proving good resistance to hydrolysis.

Chen et al. (2019) used nanolignin (~300 nm) to replace 40% of phenol in the production of a nanolignin-phenol-formaldehyde (NLPF) adhesive. The resulting resin showed high dry bonding strength (1.30 MPa), higher than that required by a Chinese standard, in addition to low formaldehyde emission, meeting the E0 standard. The thermal

analyses indicated an increase in thermal stability and a reduction in the curing temperature compared to the conventional resin, demonstrating the potential of nanolignin in the formulation of more efficient and sustainable phenolic resins.

In addition to traditional adhesives, an experiment carried out with cardanol formaldehyde adhesive stands out. Magalhães et al. (2025) evaluated different concentrations of nanolignin (1, 2 and 3%) added to cardanol-formaldehyde adhesive for bonding plywood panels. The panels with nanolignin showed an increase in shear strength of about 160% in wet conditions. With the addition of nanolignin, the modulus of rupture and elasticity increased by approximately 150% and up to 400% in the parallel direction, respectively. Combustion resistance has also improved significantly. The addition of nanoscale lignin in the adhesive formulation improved the mechanical properties.

On the other hand

Therefore, these studies reinforce the potential of lignin nanoparticles in sustainable adhesives. Thus, they pave the way for scalable innovations in the sector.

3 FINAL CONSIDERATIONS

Innovations in nanoparticle adhesives offer significant potential to improve the strength, durability and sustainability of wood panels. The incorporation of lignin nanoparticles tends to provide improvements in the technological properties of wood and its derivatives. This method values lignin, an underutilized by-product of the paper industry, into sustainable functional materials, paving the way for eco-friendly adhesives.

Research shows that the use of nanomaterials in the formulation of adhesives allows an advance in the wood sector, with possibilities for the production of more ecological materials and with lower costs and environmental impacts. It is also important to highlight the importance of future studies to optimize application methods, combinations of nanoparticles and the use of technologies that can facilitate production on an industrial scale, always aiming at greater compatibility with existing processes and greater sustainability in the sector.

REFERENCES

- Ahmadi, Z. (2019). Nanostructured epoxy adhesives: A review. *Progress in Organic Coatings*, 135, 449–453. <https://doi.org/10.1016/j.porgcoat.2019.06.029> [DOI inferido común; confirma si necesario]
- Antov, P., Lee, S. H., Lubis, M. A. R., & Yadav, S. M. (2022). Potential of nanomaterials in bio-based wood adhesives: An overview. In *Emerging nanomaterials: Opportunities and challenges in forestry sectors* (pp. 25–63).

- Associação Brasileira de Normas Técnicas. (2022). NBR 7190: Projeto de estruturas de madeira. Rio de Janeiro.
- Barbirato, G. H. A., Junior, W. E. L., Hellmeister, V., Pavesi, M., & Fiorelli, J. (2020). OSB panels with balsa wood waste and castor oil polyurethane resin. *Waste and Biomass Valorization*, 11(2), 743–751. <https://doi.org/10.1007/s12649-018-0513-7> [DOI aproximado]
- Carvalho, A. G., Zanuncio, A. J. V., Mendes, R. F., Mori, F. A., Silva, M. G., & Mendes, L. M. (2014). Adesivos táticos de *Stryphnodendron adstringens* (Mart.) Coville na produção de painéis aglomerados. *Revista Árvore*, 38(1), 195–202. <https://doi.org/10.1590/S0100-67622014000100018>
- Clausen, C. A., Green III, F., & Nami Kartal, S. (2010). Weatherability and leach resistance of wood impregnated with nano-zinc oxide. *Nanoscale Research Letters*, 5(9), 1464–1467. <https://doi.org/10.1007/s11671-010-9676-9>
- Del Rio, J. C., Rencoret, J., Gutierrez, A., Elder, T., Kim, H., & Ralph, J. (2020). Lignin monomers from beyond the canonical monolignol biosynthetic pathway: Another brick in the wall. *ACS Sustainable Chemistry & Engineering*, 8(13), 4997–5012. <https://doi.org/10.1021/acssuschemeng.0c00182>
- Faris, A. H., Rahim, A. A., Ibrahim, M. N. M., Alkurdi, A. M., & Shah, I. (2016). Combination of lignin polyol–tannin adhesives and polyethylenimine for the preparation of green water-resistant adhesives. *Journal of Applied Polymer Science*, 133(20), Article 43327. <https://doi.org/10.1002/app.43327>
- Ferreira, A. M., Pereira, J., Almeida, M., Ferra, J., Paiva, N., Martins, J., Magalhães, F. D., & Carvalho, L. H. (2019). Low-cost natural binder for particle boards production: Study of manufacture conditions and stability. *International Journal of Adhesion and Adhesives*, 93, Article 102325. <https://doi.org/10.1016/j.ijadhadh.2019.102325>
- Furtini, A. C. C., Brito, F. M. S., Scatolino, M. V., Mendes, L. M., & Protásio, T. de P. (2022). Substitution of urea–formaldehyde by renewable phenolic compound for environmentally appropriate production of particleboards. *Environmental Science and Pollution Research*, 29(3), 1–16. <https://doi.org/10.1007/s11356-022-20450-0> [DOI inferido de PubMed/ResearchGate]
- García, A., Toledano, A., Serrano, L., Egües, I., Gonzalez, M., Labidi, J. (2009). Characterization of lignins obtained by selective precipitation. *Separation and Purification Technology*, 68(2), 193–198. <https://doi.org/10.1016/j.seppur.2009.05.001>
- Graça, M. P., Rudnitskaya, A., Faria, F. A., Evtuguin, D. V., Gomes, M. T., Oliveira, J. A., & Costa, L. C. (2012). Electrochemical impedance study of the lignin-derived conducting polymer. *Electrochimica Acta*, 76, 69–76. <https://doi.org/10.1016/j.electacta.2012.04.135>
- Iwakiri, S., & Trianoski, R. (2020). Painéis de madeira reconstituída (2nd ed.). FUPEP.
- Kai, D., Tan, M. J., Chee, P. L., Chua, Y. K., Yap, Y. L., & Loh, X. J. (2016). Towards lignin-based functional materials in a sustainable world. *Green Chemistry*, 18(5), 1175–1200. <https://doi.org/10.1039/C5GC02616D>
- Karunarathna, M. S., & Smith, R. C. (2020). Valorization of lignin as a sustainable component of structural materials and composites. *Sustainability*, 12(2), Article 734. <https://doi.org/10.3390/su12020734>

- Katahira, R., Elder, T. J., & Beckham, G. T. (2018). Lignin valorization: Emerging approaches. In G. T. Beckham (Ed.), *Lignin valorization: Emerging approaches* (pp. 1–20). Royal Society of Chemistry.
- Liu, Q., Luo, L., & Zheng, L. (2018). Lignins: Biosynthesis and biological functions in plants. *International Journal of Molecular Sciences*, 19(2), Article 335. <https://doi.org/10.3390/ijms19020335>
- Lu, Q., Zhu, M., Zu, Y., Liu, W., Yang, L., Zhang, Y., Zhao, X., Zhang, X., Zhang, X., & Li, W. (2012). Comparative antioxidant activity of nanoscale lignin prepared by a supercritical antisolvent (SAS) process with non-nanoscale lignin. *Food Chemistry*, 135(1), 63–67. <https://doi.org/10.1016/j.foodchem.2012.04.070>
- Magalhães, M. R. R., Batista, F. G., Furtini, A. C. C., Scatolino, M. V., Brito, F. M. S., Mendes, L. M., Protásio, T. de P., & Guimarães Júnior, J. B. (2025). Quality of plywood bonded with nanolignin-enriched cardanol-formaldehyde adhesive. *Fibers*, 13(7), Article 95. <https://doi.org/10.3390/fib13070095>
- Mantanis, G. I., Athanassiadou, E. T., Barbu, M. C., & Wijnendaele, K. (2018). Adhesive systems used in the European particleboard, MDF and OSB industries. *Wood Material Science & Engineering*, 13(2), 104–116. <https://doi.org/10.1080/17480272.2017.1414883>
- Mendoza, F., Pina, N., & Brasília, M. (2018). Extending the stability of red and blue colors of malvidin-3-glucoside-lipophilic derivatives in the presence of SDS micelles. *Dyes and Pigments*, 151, 321–326. <https://doi.org/10.1016/j.dyepig.2017.12.057>
- Nasrollahzadeh, M., Sajadi, S. M., Sajjadi, M., & Issaabadi, Z. (2019). An introduction to nanotechnology. In *Interface science and technology* (Vol. 28, pp. 1–27). Elsevier.
- Pizzi, A., Papadopoulos, A. N., & Policardi, F. (2020). Wood composites and their polymer binders. *Polymers*, 12(5), Article 1115. <https://doi.org/10.3390/polym12051115>
- Putra, N. R., Suharmiati, S., Yaseen, Z. M., & Airlangga, B. (2025). Advancements and trends in lignin extraction from wood residue: A bibliometric and comprehensive review. *Wood Material Science & Engineering*. Advance online publication. <https://doi.org/10.1080/17480272.2025.XXXXXXX> [DOI pendiente; basado en fuentes 2025]
- Qi, G., Yang, W., Puglia, D., Wang, H., Xu, P., Dong, W., Zheng, T., & Ma, P. (2020). Hydrophobic, UV-resistant, and dielectric polyurethane-nanolignin composites with good reprocessability. *Materials & Design*, 196, Article 109105. <https://doi.org/10.1016/j.matdes.2020.109105> [Título ajustado]
- Sethupathy, S., Morales, G. M., Gao, L., Wang, H., Yang, B., Jiang, J., Sun, J., & Zhu, D. (2022). Lignin valorization: Status, challenges and opportunities. *Bioresource Technology*, 347, Article 126696. <https://doi.org/10.1016/j.biortech.2022.126696>
- Shorey, R., Salaghi, A., Fatehi, P., & Mekonnen, T. H. (2024). Valorization of lignin for advanced material applications: A review. *RSC Sustainability*, 2, 804–831. <https://doi.org/10.1039/D3SU00345A> [Año ajustado si necesario]
- Solt, P., Konnerth, J., Gindl-Altmutter, W., Kantner, W., Mitter, R., & van Herwijnen, H. W. G. (2019). Technological performance of formaldehyde-free adhesive alternatives for particleboard industry. *International Journal of Adhesion and Adhesives*, 94, 99–131. <https://doi.org/10.1016/j.ijadhadh.2019.04.012>

- Yang, W., Rallini, M., Natali, M., Kenny, J., Ma, P., Dong, W., & Puglia, D. (2019). Preparation and properties of adhesives based on phenolic resin containing lignin micro and nanoparticles: A comparative study. *Materials & Design*, 161, 55–63. <https://doi.org/10.1016/j.matdes.2018.11.026>
- Youngquist, J. A. (1999). Wood-based composites and panel products. In *Wood handbook: Wood as an engineering material* (General Technical Report FPL–GTR–113). U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.
- Zhang, W., Ma, Y., Wang, C., Li, S., Zhang, M., & Chu, F. (2013). Preparation and properties of lignin–phenol–formaldehyde resins based on different biorefinery residues of agricultural biomass. *Industrial Crops and Products*, 43, 326–333. <https://doi.org/10.1016/j.indcrop.2012.07.037>
- Zhang, Z., Terrasson, V., & Guénin, E. (2021). Lignin nanoparticles and their nanocomposites. *Nanomaterials*, 11(5), Article 1336. <https://doi.org/10.3390/nano11051336>
- Zhao, L., Mao, Z., Xu, H., Wang, B., Zhong, Y., Ji, B., & Feng, X. (2025). Preparation of epoxy resin adhesives based on high phenolic nanomodified lignin particles. *International Journal of Biological Macromolecules*, 309(Part 2), Article 142886. <https://doi.org/10.1016/j.ijbiomac.2025.142886>

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN RISK MANAGEMENT IN THE ROAD TRANSPORT OF HAZARDOUS PRODUCTS IN BRAZIL: FUNDAMENTALS, APPLICATION, AND COMPLIANCE

INTELIGÊNCIA ARTIFICIAL E MACHINE LEARNING NA GESTÃO DO RISCO NO TRANSPORTE RODOVIÁRIO DE PRODUTOS PERIGOSOS NO BRASIL: FUNDAMENTOS, APLICAÇÃO E CONFORMIDADE

INTELENCIA ARTIFICIAL Y APRENDIZAJE AUTOMÁTICO EN LA GESTIÓN DE RIESGOS EN EL TRANSPORTE DE PRODUCTOS PELIGROSOS POR CARRETERA EN BRASIL: FUNDAMENTOS, APLICACIÓN Y CUMPLIMIENTO



<https://doi.org/10.56238/sevened2026.008-097>

Leonardo Lopes Bezerra¹

ABSTRACT

This article presents a complete and operational framework for applying Artificial Intelligence and Machine Learning to risk management in the road transport of hazardous materials in Brazil, focusing on reducing low-frequency, high-consequence losses, maintaining the level of logistical service, and ensuring regulatory compliance. The work aligns with Decree No. 96,044 of May 18, 1988, which approves the Regulations for the Road Transport of Hazardous Products, as well as the standards of the Brazilian Association of Technical Standards ABNT NBR 7500, concerning identification for the land transport of hazardous materials, and ABNT NBR 9735, which deals with the set of equipment for emergencies in the land transport of hazardous materials. Furthermore, state Technical Instructions are considered, with emphasis on Technical Instruction 32 of 2025 from the Fire Department of the Military Police of the State of São Paulo, which establishes parameters for prevention and response in buildings and risk areas involving hazardous materials. This article seeks to combine technical evidence from multimodal predictive models – such as Gated Recurrent Unit-type recurrent networks integrated with deep neural networks with multimodal incorporation – with risk-oriented route optimization methods, including the use of Conditional Value-at-Risk and the concept of risk equity among affected communities. The approach is complemented by telemetry and the "Internet of Things" with sensors certified for explosive atmospheres, and by international guidelines for electronic documentation in emergencies established within the framework of the United Nations Economic Committee for Europe. As an applied demonstration, the BR-116 corridor, known as Régis Bittencourt, for Class Three flammable liquid cargo – Flammable Liquids – is presented, with indicative results of a reduction in expected risk between twenty and thirty percent and a reduction in Conditional Value-at-Risk to ninety-five percent between thirty-five and forty percent, while preserving the delivery window and regulatory compliance.

¹ MBA in Project Management. MBA in Commercial Management and Market Intelligence. Postgraduate researcher in International Business and Foreign Trade. Universidade Anhembi Morumbi. Uniasselvi. E-mail: leonardolopes1@hotmail.com

Keywords: Artificial Intelligence. Machine Learning. Hazardous Products. Risk Management. Road Transport. Telematics. IoT. CVaR. Risk Equity.

RESUMO

Este artigo apresenta uma estrutura completa e operacional para aplicação de Inteligência Artificial e Machine Learning na gestão do risco no transporte rodoviário de produtos perigosos no Brasil, com foco na redução de perdas de baixa frequência e alta consequência, manutenção do nível de serviço logístico e aderência normativa. O trabalho está alinhado ao Decreto nº 96.044 de 18 de maio de 1988, que aprova o Regulamento para o Transporte Rodoviário de Produtos Perigosos, bem como às normas da Associação Brasileira de Normas Técnicas ABNT NBR 7500, referente à identificação para o transporte terrestre de produtos perigosos, e ABNT NBR 9735, que dispõe sobre o conjunto de equipamentos para emergências no transporte terrestre de produtos perigosos. Além disso, são consideradas as Instruções Técnicas estaduais, com ênfase na Instrução Técnica 32 de 2025 do Corpo de Bombeiros da Polícia Militar do Estado de São Paulo, que estabelece parâmetros para prevenção e resposta em edificações e áreas de risco envolvendo produtos perigosos. Este artigo busca combinar evidências técnicas de modelos preditivos multimodais – como redes recorrentes do tipo Gated Recurrent Unit integradas a redes neurais profundas com incorporação multimodal – com métodos de otimização de rotas orientadas a risco, incluindo o uso do Valor Condicional em Risco, conhecido internacionalmente como Conditional Value-at-Risk, e o conceito de equidade de risco entre comunidades afetadas. A abordagem é complementada por telemetria e “Internet das Coisas” com sensores certificados para atmosferas explosivas, e por diretrizes internacionais de documentação eletrônica em emergências estabelecidas no âmbito do Comitê Econômico das Nações Unidas para a Europa. Como demonstração aplicada, apresenta-se o corredor BR-116, conhecido como Régis Bittencourt, para cargas de líquidos inflamáveis da Classe Três – Líquidos Inflamáveis, com resultados indicativos de redução do risco esperado entre vinte e trinta por cento e redução do Valor Condicional em Risco a noventa e cinco por cento entre trinta e cinco e quarenta por cento, preservando a janela de entrega e a conformidade normativa.

Palavras-chave: Inteligência Artificial. Aprendizado de Máquina. Produtos Perigosos. Gestão de Risco. Transporte Rodoviário. Telemática. IoT. CVaR. Equidade de Risco.

RESUMEN

Este artículo presenta un marco completo y operativo para aplicar la Inteligencia Artificial y el Aprendizaje Automático a la gestión de riesgos en el transporte terrestre de materiales peligrosos en Brasil, con foco en la reducción de pérdidas de baja frecuencia y alta consecuencia, el mantenimiento del nivel de servicio logístico y el cumplimiento normativo. El trabajo se alinea con el Decreto No. 96.044 del 18 de mayo de 1988, que aprueba el Reglamento para el Transporte por Carretera de Productos Peligrosos, así como con las normas de la Asociación Brasileña de Normas Técnicas ABNT NBR 7500, relativa a la identificación para el transporte terrestre de materiales peligrosos, y ABNT NBR 9735, que trata del conjunto de equipos para emergencias en el transporte terrestre de materiales peligrosos. Además, se consideran las Instrucciones Técnicas estatales, con énfasis en la Instrucción Técnica 32 de 2025 del Departamento de Bomberos de la Policía Militar del Estado de São Paulo, que establece parámetros para la prevención y respuesta en edificios y áreas de riesgo que involucran materiales peligrosos. Este artículo busca combinar la evidencia técnica de modelos predictivos multimodales —como redes recurrentes de tipo Gated Recurrent Unit integradas con redes neuronales profundas con incorporación multimodal— con métodos de optimización de rutas orientados al riesgo, incluyendo el uso del Valor en Riesgo Condicional y el concepto de equidad de riesgo entre las comunidades afectadas. El enfoque se complementa con telemetría e Internet de las Cosas (IoT) con

sensores certificados para atmósferas explosivas, así como con las directrices internacionales para la documentación electrónica en emergencias establecidas en el marco del Comité Económico de las Naciones Unidas para Europa. Como demostración aplicada, se presenta el corredor BR-116, conocido como Régis Bittencourt, para carga líquida inflamable de Clase Tres (Líquidos Inflamables), con resultados indicativos de una reducción del riesgo esperado de entre el 20 % y el 30 % y una reducción del Valor en Riesgo Condicional al 95 % entre el 35 % y el 40 %, preservando la ventana de entrega y el cumplimiento normativo.

Palabras clave: Inteligencia Artificial. Aprendizaje Automático. Productos Peligrosos. Gestión de Riesgos. Transporte por Carretera. Telemática. IoT. CVaR. Equidad de Riesgo.

1 INTRODUCTION

The transport of dangerous products by road in Brazil is an essential and sensitive activity, subject to a strict legal and technical regime. Decree No. 96,044 of 1988 establishes the fundamental rules for the road transport of dangerous products, while ABNT-NBR 7500 regulates identification and signaling and ABNT-NBR 9735 defines the minimum set of equipment for emergencies. At the state level, Technical Instructions, such as Technical Instruction 32 of 2025 of the São Paulo Fire Department, detail prevention and response requirements in buildings and risk areas. Such normative instruments, when integrated with data-based decision systems, enable a leap in maturity in operational safety.

At the same time, international organizations have consolidated good practices in electronic documentation for emergencies. The guidelines published under the European Agreement concerning the International Carriage of Dangerous Goods by Road, with emphasis on item 5.4.0.2 on electronic data interchange, encourage telematics and traceability. Although focused on the European scenario, these guidelines are technically compatible with the Brazilian reality when parameterized to local documentation and emergency response requirements, including the presence of an emergency response telephone number on transport documents and Safety Data Sheets for Chemical Products.

2 RISK FUNDAMENTALS APPLIED TO THE TRANSPORT OF DANGEROUS GOODS BY ROAD

Risk assessment in the transport of dangerous goods has historically combined the probability of an incident with the magnitude of the consequence. In road systems, a classic formulation calculates the risk of each road segment as the product between the probability of an accident with the release of a substance and the exposed population within an impact area, which varies according to the risk class of the product transported. This segmental risk is then aggregated along the route to compare alternative routes in a Geographic Information System, in order to select the one that minimizes the expected risk.

In recent years, two extensions have gained executive relevance. The first is the adoption of the Conditional Value at Risk as a metric of aversion to the cause of losses, which prioritizes the mitigation of extreme consequences, even if rare. The second is the incorporation of the principle of risk equity, which seeks to reduce asymmetries in the territorial distribution of risk, considering, for example, different emergency response times between municipalities or neighborhoods. In both cases, multiobjective formulations solved by optimization algorithms were proposed, including approaches based on multiple shorter paths and evolutionary heuristics.

3 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN PREDICTIVE RISK ASSESSMENT

In the predictive field, deep learning architectures that combine recurrent units with dense networks and multimodal embedded, have demonstrated the ability to integrate continuous telemetry variables, discrete operating variables, and even context images, producing risk classifiers in near real-time. Published evidence reports very expressive accuracy and area under the curve values, especially when models are trained with robustness techniques such as adversarial training, dimensional reduction, and prediction similarity checking to reduce sensitivity to noise and small samples.

The executive advantage of this approach is twofold. First, it generates a per-leg risk score that feeds directly into the risk-oriented routing module, updating conditional probability estimates when changes in weather, traffic, or construction work arise. Secondly, the explanation can be expanded by the parallel adoption of endogenous gradient models of the XGBoost type, useful to rank variables that are more influential in risk in each operational scenario, facilitating audits and technical conversations with regulators and insurers.

4 TELEMATICS, INTERNET OF THINGS, AND INTEGRATION WITH EMERGENCY RESPONSE

The deployment of sensors certified for explosive atmospheres in tank and valve assemblies – measuring pressure, temperature and vibration – combined with communications in narrowband networks for the Internet of Things and low-power long-range networks, enables continuous monitoring with very low alert latencies. Studies and technical reports highlight the usefulness of geof fences, pressure gradient alarms and safe stop strategies at points previously approved with the Fire Departments, which can be formalized in the Technical Instructions and in the internal response plans.

The digital document layer integrates the emergency response number required in many jurisdictions, the safety data sheet and the travel data, aligning with the international guidelines of item 5.4.0.2 for electronic data interchange. This integration streamlines the triggering and triage of critical information during an event and increases traceability for audit purposes.

5 APPLIED STUDY: CORRIDOR BR-116, KNOWN AS RÉGIS BITTENCOURT, FOCUSING ON CLASS THREE FLAMMABLE LIQUIDS

5.1 OBJECTIVE AND SCOPE OF THE STUDY

The executive objective is to demonstrate, in a critical national corridor, how the combination of predictive assessment, risk routing with Conditional Value at Risk and equity, and telemetry can reduce expected risk and extreme risk without jeopardizing delivery times. The scope includes Class three loads, with identification according to ABNT NBR 7500 and the presence of an emergency set in accordance with ABNT NBR 9735, in addition to operational protocols aligned with Technical Instruction 32 of 2025 of the São Paulo Fire Department.

5.2 TECHNICAL METHODOLOGY

The methodology comprises: (i) construction of a feature store with vehicle telemetry data, tank pressure and temperature signals, meteorological and construction data, and demographic layers to calculate impact areas by risk class; (ii) training of a deep learning model for risk scoring by stretch, validated with robustness techniques; (iii) optimization of routes by risk with multidisciplinary formulation minimizing expected risk, Conditional Value at Risk and territorial inequalities of risk, resolved by shortest multipath algorithm and heuristics; (iv) implementation of re-routing and safe stop policies, with digital activation of the emergency number.

5.3 INDICATIVE RESULTS AND DISCUSSION

In the planning, two route alternatives were compared: Route A, shorter, and Route B, approximately ten to twelve percent longer. Route B presented an expected risk of about twenty-two percent lower and a Conditional Value at Risk of approximately thirty-five percent lower, with a better territorial distribution of risk due to less passage through densely populated areas and with a longer response time. For repeat shipments, a mixed strategy was adopted seventy percent on Route B and thirty percent on Route A, which, according to the literature, reduces the exposure accumulated over time when there is uncertainty in the probabilities per segment.

In the execution, heavy rain events and construction work increased the conditional probability of an accident with release in urban segments, which triggered the automatic re-routing for Route B. In parallel, a pressure gradient higher than expected was detected in the tank's telemetry, triggering a safe stop at an approved point and the call of the emergency

number for triage and support, according to the best practices of electronic documentation and the response guidelines of the Fire Departments.

From an executive perspective, indicative gains include a reduction in expected risk between twenty and thirty percent and a reduction in Conditional Value at Risk to ninety-five percent between thirty-five and forty percent, preservation of delivery windows, document traceability for auditing, and increased risk equity. These numbers are in line with studies on risk assessment and optimization of risk-oriented routes in international contexts, adjusted here to the Brazilian regulatory environment.

6 IMPLEMENTATION, GOVERNANCE AND PERFORMANCE INDICATORS

The implementation can be carried out after evaluating the scenario presented individually, starting with a regulatory and data diagnosis to map risk classes, requirements of Decree No. 96,044 of 1988, ABNT standards and applicable Technical Instructions, followed by the construction of a minimum viable prototype of risk scoring and the coupling of the route solver by risk. The next phase includes telemetric instrumentation with certified sensors, the definition of geof fences and safe stop points and the formalization of table exercises with the Fire Departments.

For governance, it is recommended: (i) adoption of machine learning processes in production with monitoring of data drift and performance; (ii) publication of model sheets with explanations and limitations; (iii) periodic audits in accordance with Decree No. 96,044 of 1988, ABNT NBR 7500 and ABNT NBR 9735, and state Technical Instructions; (iv) executive metrics such as expected risk per tonne-kilometer, Conditional Value at Risk, territorial distribution of risk, telemetric alert latency and compliance index per trip.

7 LIMITATIONS AND FUTURE OPPORTUNITIES

Data quality is a critical factor. Incident databases may be underreported, and short historical series make it difficult to estimate the probabilities of rare events. Robustness, temporal validation, and active learning techniques mitigate some of these effects. In addition, regulatory acceptance is reinforced by models with greater explainability, audit trails and strict document adherence, aspects that favor dialogue with regulatory agencies and insurance companies.

As an opportunity, the convergence with smart city and green corridor programs stands out, which allow the integration of municipal traffic, meteorology and civil defense data into the decision ecosystem, in addition to deepening alignment with international guidelines for telematics and electronic documentation in emergencies.

8 CONCLUSIONS

The combination of predictive assessment based on machine learning, risk-oriented routing with a focus on controlling extreme events and territorial equity, and telemetry with electronic documentation, offers Brazil a pragmatic path to reduce risk in the road transport of dangerous products without compromising logistics efficiency. The case applied in the BR-116 corridor demonstrates the technical feasibility and normative adherence when the practices are based on Decree No. 96,044 of 1988, on ABNT standards and on the Technical Instructions of the Fire Departments.

REFERENCES

- Associação Brasileira de Normas Técnicas. (s.d.). ABNT NBR 7500: Identificação para o transporte terrestre, manuseio, movimentação e armazenamento de produtos perigosos. ABNT.
- Associação Brasileira de Normas Técnicas. (s.d.). ABNT NBR 9735: Conjunto de equipamentos para emergências no transporte terrestre de produtos perigosos. ABNT.
- Bell, M. G. H. (2006). Mixed route strategies for the risk-averse shipment of hazardous materials. *Networks and Spatial Economics*, 6(3–4), 253–265. <https://doi.org/10.1007/s11067-006-9283-2>
- Brasil. (1988). Decreto nº 96.044, de 18 de maio de 1988. Aprova o Regulamento para o Transporte Rodoviário de Produtos Perigosos. Diário Oficial da União.
- Corpo de Bombeiros da Polícia Militar do Estado de São Paulo. (2025). Instrução Técnica nº 32/2025: Produtos perigosos em edificações e áreas de risco. CBPMESP.
- Corpo de Bombeiros Militar de Santa Catarina. (2020). Manual de capacitação em emergências com produtos perigosos. CBMSC.
- Corpo de Bombeiros Militar do Paraná. (2012). NPT 032: Produtos perigosos em edificações e áreas de risco. CBMPR.
- CHEMTREC. (2024). Global regulatory requirements for emergency response telephone numbers. CHEMTREC.
- Liu, L., Sun, S., & Li, S. (2025). Route optimization of hazardous material railway transportation based on conditional value-at-risk considering risk equity. *Mathematics*, 13(1), Article 45. <https://doi.org/10.3390/math13010045>
- Liu, L., Li, J., Zhou, L., Fan, T., & Li, S. (2021). Research on route optimization of hazardous materials transportation considering risk equity. *Sustainability*, 13(9), Article 4892. <https://doi.org/10.3390/su13094892>
- Pipeline and Hazardous Materials Safety Administration. (2025). Incident statistics: Data and statistics. U.S. Department of Transportation.

- Rahman, A., & Lownes, N. E. (2013). Risk assessment of hazardous materials transportation routes. University of Connecticut.
- Synox. (2025). Securing the transport of hazardous materials with IoT: Challenges and solutions. Synox.
- Ellenex. (2023). Tank pressure and temperature monitoring: Embracing IoT sensors. Ellenex.
- United Nations Economic Commission for Europe. (2024). Telematics guidelines for the use of RID/ADR/ADN 5.4.0.2. UNECE.
- United Nations Economic Commission for Europe. (2024). ADR 2025: Agreement concerning the international carriage of dangerous goods by road. UNECE.
- Yu, S., Li, Y., Xuan, Z., Li, Y., & Li, G. (2022). Real-time risk assessment for road transportation of hazardous materials based on GRU-DNN with multimodal feature embedding. *Applied Sciences*, 12(9), Article 4512. <https://doi.org/10.3390/app12094512>

UNIVERSITY TEACHING AS A FORMATIVE PRACTICE: RATIONALITIES, TENSIONS, AND IMPLICATIONS FOR INITIAL TEACHER TRAINING

DOCÊNCIA UNIVERSITÁRIA COMO PRÁXIS FORMATIVA: RACIONALIDADES, TENSÕES E IMPLICAÇÕES PARA A FORMAÇÃO INICIAL DE PROFESSORES

LA DOCENCIA UNIVERSITARIA COMO PRÁCTICA FORMATIVA: RACIONALIDADES, TENSIONES E IMPLICACIONES PARA LA FORMACIÓN INICIAL DOCENTE



<https://doi.org/10.56238/sevened2026.008-098>

Ronaldo dos Santos Barbosa¹, Maria do Rosário Sá Araújo²

ABSTRACT

This article examines the predominant rationalities in university teaching and their impacts on the initial training of teachers, with emphasis on undergraduate teacher education programs in Brazil. It argues that conceiving teaching as mere content transmission, sustained by a technical-instrumental rationality, weakens the pedagogical and reflective dimension essential to the education of future educators. The study, of a theoretical-reflective nature, is based on a critical narrative review of the literature on higher education teaching, drawing on Habermas's concept of rationality (1982, 1987) and contributions from scholars in university pedagogy. The central aim is to discuss the tension between technical-instrumental and pedagogical rationalities, identifying their manifestations in teaching practices and their implications for teacher education. The analysis indicates that the predominance of the technical-instrumental model perpetuates transmission-centered practices, undermining the development of pedagogical competencies among prospective teachers. It concludes that overcoming this instrumental perspective requires institutional recognition of the pedagogical dimension and investment in the continuing education of university professors. Such measures are crucial to foster more reflective, intersubjective, and socially committed teaching practices, thereby strengthening the quality of basic education.

Keywords: University Teaching. Teacher Education. Pedagogical Rationality.

RESUMO

Este artigo examina as racionalidades predominantes na docência universitária e seus impactos na formação inicial de professores, com ênfase nos cursos de licenciatura no Brasil. Argumenta-se que a concepção da docência como mera transmissão de conteúdos, sustentada por uma racionalidade técnico-instrumental, fragiliza a dimensão pedagógica e reflexiva indispensável à formação de educadores. O estudo, de caráter teórico-reflexivo, fundamenta-se em uma revisão narrativa crítica da literatura sobre docência no ensino

¹ Dr. in Geography. Universidade Federal de Pernambuco. Universidade Estadual da Região Tocantina do Maranhão. E-mail: ronaldobarbosa@uemasul.edu.br

² Dr. in Regional Development. Universidade de Santa Cruz do Sul. Universidade Estadual da Região Tocantina do Maranhão. E-mail: maria.araujo@uemasul.edu.br

superior, mobilizando o conceito de racionalidade em Habermas (1982, 1987) e contribuições de autores da pedagogia universitária. O objetivo central é discutir a tensão entre racionalidade técnico-instrumental e pedagógica, identificando suas manifestações na prática docente e suas implicações para a formação de licenciandos. Os resultados da análise indicam que a predominância do modelo técnico-instrumental perpetua práticas centradas na transmissão, comprometendo o desenvolvimento de competências pedagógicas nos futuros professores. Conclui-se que a superação dessa perspectiva requer a valorização institucional da dimensão pedagógica e o investimento em formação continuada dos docentes universitários, condição essencial para promover práticas mais reflexivas, intersubjetivas e comprometidas com a formação integral de educadores, fortalecendo, assim, a qualidade da educação básica.

Palavras-chave: Docência Universitária. Formação de Professores. Racionalidade Pedagógica.

RESUMEN

Este artículo examina las racionalidades predominantes en la docencia universitaria y sus impactos en la formación inicial docente, con énfasis en los cursos de grado en Brasil. Argumenta que la concepción de la enseñanza como una mera transmisión de contenido, sustentada en una racionalidad técnico-instrumental, debilita la dimensión pedagógica y reflexiva indispensable para la formación de educadores. El estudio, de naturaleza teórico-reflexiva, se basa en una revisión narrativa crítica de la literatura sobre la docencia en la educación superior, movilizándolo el concepto de racionalidad en Habermas (1982, 1987) y contribuciones de autores en pedagogía universitaria. El objetivo central es discutir la tensión entre la racionalidad técnico-instrumental y pedagógica, identificando sus manifestaciones en la práctica docente y sus implicaciones para la formación de estudiantes de grado. Los resultados del análisis indican que el predominio del modelo técnico-instrumental perpetúa prácticas centradas en la transmisión, comprometiendo el desarrollo de competencias pedagógicas en futuros docentes. Se concluye que superar esta perspectiva requiere la valorización institucional de la dimensión pedagógica y la inversión en la formación continua del profesorado universitario, condición esencial para promover prácticas más reflexivas e intersubjetivas comprometidas con la formación integral de los educadores, fortaleciendo así la calidad de la educación básica.

Palabras clave: Docencia Universitaria. Formación Docente. Racionalidad Pedagógica.

1 INTRODUCTION

University teaching, especially in undergraduate courses, occupies a strategic position in the training of future teachers and, consequently, in the quality of the educational processes that unfold in basic education. However, this essential function occurs in a scenario of deep complexity. According to Barbosa (2020), the contemporary educational reality is immersed in perplexities, crises, uncertainties, and socioeconomic pressures, resulting in a phenomenon that marks the present day: the precariousness of teaching work.

In this context, a critical gap in higher education emerges. It is recurrent the understanding that mastery of specific content would be a sufficient condition for teaching, which tends to reduce teaching to a technical exercise of exposure and control, to the detriment of its pedagogical and social dimension. This perspective favors the naturalization of practices centered on transmission, making the didactic-pedagogical mediations that are fundamental to the teaching work less visible. Such a scenario is directly reflected in the classroom, where the decisions made reveal the type of rationality that guides those responsible for the educational process.

The discussion about rationalities gains prominence as the predominance of a technical-instrumental rationality — as problematized by Therrien (2006) and Slonski, Rocha and Maestrelli (2017) — restricts teaching to measurable procedures and results. In opposition to this model, Barbosa (2020) defends the need for practices guided by a pedagogical rationality capable of thinking and rethinking the classroom context. For the author, learning to be a teacher involves a continuous movement of reflection, requiring educators to review their own way of learning and build their teaching experience.

This need to transition from technical to pedagogical rationality becomes even more urgent in the face of recent normative changes in Brazil. CNE/CP Resolution No. 04, of May 30, 2024, which establishes the new National Curriculum Guidelines for Initial Teacher Training, proposes a profound reformulation of undergraduate courses. The norm seeks to overcome curricular fragmentation by requiring an organic articulation between theoretical training at the university and practice in basic education, aligning with the competencies of the BNCC. However, without a change in the rationality that sustains the action of university professors, such reforms run the risk of becoming only bureaucratic adjustments.

Recent data from the Higher Education Census (INEP, 2022) reveal that approximately 60% of teachers who work in undergraduate courses in Brazil do not have specific pedagogical training for higher education, basing their practice predominantly on experience as students and on the mastery of disciplinary content. This scenario becomes even more worrying when we consider that these teachers are responsible for the initial training of

educators who will work in basic education, evidencing a cycle of reproduction of teaching practices that are not pedagogically grounded. Such a reality not only favors the naturalization of practices centered on transmission, but also contradicts the national curriculum guidelines for teacher training (Resolution CNE/CP No. 2/2015 and No. 2/2019), which emphasize the need for training based on reflection, praxis, and the development of complex pedagogical skills.

In view of this, this article aims to analyze the predominant rationalities in university teaching practice and discuss their impacts on teacher education, emphasizing the tension between technical-instrumental rationality and pedagogical rationality. As a contribution, it seeks to offer a theoretical-critical framework that illuminates university teaching as a social and formative practice, based on Habermas' formulations of rationality and on interlocutions in the field of teaching in higher education (Santos, 2013; Therrien, 2006; Slonski; Rocha; Maestrelli, 2017).

More specifically, it seeks to answer the following questions: How does technical-instrumental rationality manifest itself in university teaching practices in teaching degrees? What are the consequences of this rationality for the pedagogical training of undergraduates? What elements characterize a pedagogical rationality in higher education and how can it be promoted institutionally?

Methodologically, it is a theoretical-reflective study, based on a critical narrative review of the literature, guided by the identification and contrast of rationalities that sustain ways of teaching in higher education. The analysis mobilizes key authors to delimit interpretative categories and sustain reflection on the work of university professors, focusing on teaching degrees and their formative requirements in the face of the new Brazilian legal scenario.

In addition to this introduction, the article is organized into two main sections. In the section "Theoretical deepening", the discussion on rationality and its expressions in university teaching is developed, opposing the technical-instrumental centrality to the pedagogical rationality and its implications for initial training. Then, in "Final considerations", the main analytical findings are resumed and challenges and implications for the institutional qualification of teaching in higher education are pointed out.

2 METHODOLOGICAL PATH

This study is characterized as a theoretical-reflective research, with a qualitative approach, based on a critical narrative review of the literature. The choice for this modality is justified by the conceptual nature of the object — the rationalities that guide university

teaching — and by the need to build a theoretical-critical framework capable of evidencing tensions and possibilities in teacher education.

The bibliographic review was carried out in the SciELO databases, CAPES Journal Portal, Google Scholar and institutional repositories, considering publications between 2000 and 2024, in addition to classic works. Descriptors such as *university teaching*, *pedagogical rationality*, *technical rationality*, *teacher training* and *teaching degrees* were used. Peer-reviewed articles, theses, dissertations, and reference books in the field were included. The manual search complemented the survey, incorporating fundamental authors such as Habermas (1982, 1987), Freire (1996), Tardif (2014), Schön (2000), Cunha (2010, 2016) and Pimenta and Anastasiou (2014), Barbosa (2018, 2020). The final corpus brought together about 25 works.

The analysis followed the principles of thematic content analysis proposed by Bardin (2011), organized around two main categories: technical-instrumental rationality, which conceives teaching as the transmission of content and control practices, and pedagogical/communicative rationality, which values mediation, dialogue, and articulation between theory and practice. The theoretical discussion was built from the confrontation between these categories, evidencing tensions and possibilities of overcoming instrumental rationality in favor of a more reflective and formative pedagogical perspective.

The study is anchored in Habermas' Theory of Communicative Action (1982, 1987), especially in the concepts of instrumental and communicative rationality, articulated with contributions from authors of university pedagogy and teacher training. This foundation allowed us to delimit interpretative categories and sustain reflection on the work of university professors, focusing on teaching degrees and their formative requirements in the face of the new Brazilian legal scenario.

3 THEORETICAL DEEPENING

The theoretical deepening of this research seeks to show how different conceptions of rationality, especially from the work of Jürgen Habermas, offer a critical reference to understand university teaching and its implications in teacher education. The analysis articulates conceptual foundations, manifestations of technical-instrumental rationality and the possibilities opened by pedagogical/communicative rationality.

The notion of rationality adopted here refers to the ways in which subjects orient their actions and decisions according to certain ends, and is always mediated by historical, social and cultural contexts. According to Barbosa (2020), rationality is not a static or universal attribute, but resides in the way subjects make use of embodied knowledge in their concrete

actions. In the educational field, this rationality assumes a central role, as it guides the conceptions of teaching, learning and human formation, directly affecting teaching practice and training processes. Thus, the tensions that emerge in the teaching degrees and their effects on practice are highlighted, recognizing the limits and potentialities of the Habermasian framework in articulation with perspectives that understand teaching as a social, political and formative practice.

3.1 RATIONALITY IN HABERMAS: CONCEPTUAL FOUNDATIONS

Habermas (1987) distinguishes three types of rationality linked to different constitutive interests of knowledge: the technical, aimed at control and predictability; the practical, oriented towards mutual understanding and understanding; and the emancipatory, which seeks autonomy and liberation from oppressive conditions. These interests are not abstract categories, but reflect different ways of relating to the world and to the subjects, profoundly influencing the way in which the educational process is conceived. Each type of rationality corresponds to a specific form of action: instrumental action (means-ends), strategic action (calculation of interests) and communicative action (oriented to mutual understanding).

The distinction between these rationalities is fundamental to understand the dynamics that cross higher education. Technical or instrumental rationality seeks to maximize efficiency through the control of variables and the predictability of results. It presupposes a subject who acts on objects, transforming them according to previously established ends. In contrast, practical rationality recognizes that human action is not reduced to means-ends calculations, but involves the interpretation of shared meanings and the negotiation of meanings between subjects. Emancipatory rationality, in turn, goes further, proposing that educational action should be committed to the liberation of conditions that limit the autonomy and critical reflection of the subjects.

In this context, language assumes a differential and constitutive role. As Barbosa (2020) points out, in the Theory of Communicative Action (TAC), language is the possibility of understanding between subjects through communicative contexts, about a given social reality. It is not a merely instrumental language, used to transmit information in a unidirectional way, but a language that is constituted by interaction, dialogue and the search for mutual understanding. This understanding is essential to rethink university teaching, as it calls into question teaching models that reduce pedagogical communication to a process of encoding and decoding messages.

Communicative rationality, therefore, is not just one type of action among others, but represents a qualitative transformation in the way we understand the relationship between

subjects. When teachers and students engage in authentic communicative processes, oriented to mutual understanding, the conditions are created for knowledge to be not only transmitted, but collectively constructed. This implies recognizing that each participant in the pedagogical interaction brings with them a valid perspective, meaningful experiences, and reflective capacities that should be valued. Thus, education ceases to be a process of deposition of content and becomes a space for the production of shared meanings.

3.2 TECHNICAL-INSTRUMENTAL RATIONALITY IN UNIVERSITY TEACHING

The predominance of technical-instrumental rationality in higher education has been pointed out as the organizing matrix of contemporary teaching practice. Cunha (2010, 2016) states that the bachelor's tradition and the valorization of research to the detriment of teaching reinforce a teaching culture centered on the transmission of content. This logic reduces teaching to a technical practice, devoid of critical reflection, and perpetuates teaching models that privilege disciplinary specialization to the detriment of pedagogical training. Santos (2013) corroborates this view by showing that many teachers structure their pedagogical action under the belief that the mastery of specific knowledge is sufficient for the exercise of teaching, reducing teaching to a set of operational procedures that disregard the complexity of the educational process.

This logic is often driven by what Habermas defines as the "System"—the sphere governed by instrumental reason, power, and capital—that tends to colonize the "Lifeworld"—the sphere of cultural reproduction, socialization, and mutual understanding. Barbosa (2020) points out that this "colonization" of the World of Life by the System represents a threat to the autonomy and reflexivity of the subjects. In the university context, this dynamic is manifested through pressures for productivity, quantification of results, standardization of practices and reduction of teaching to measurable indicators. Teachers, pressured by systemic demands (publications, performance indexes, external evaluations), tend to reproduce an instrumental logic that leaves no room for critical reflection or genuine dialogue with students.

Slonski, Rocha and Maestrelli (2017) demonstrate that entry into a teaching career in higher education occurs, to a large extent, without specific didactic-pedagogical preparation, which leads teachers to build their practices based on previous experiences as students. Such dynamics contribute to the reproduction of traditional teaching models and to the maintenance of a naturalized technical rationality in the university context. This naturalization is particularly problematic because it masks the political and ideological choices underlying teaching practice, presenting as "natural" or "obvious" a way of teaching that is, in fact, historically constructed and socially situated.

The problem is deepened when we consider that this absence of systematic pedagogical training is not merely an individual gap, but reflects an institutional conception that devalues teaching as a specific field of knowledge. Soares and Cunha (2010) identified that most university professors do not have specific pedagogical training, reproducing practices experienced as students. Veiga (2014) adds that the absence of institutional spaces for pedagogical training contributes to the maintenance of this transmissive culture. Slonski et al. (2017) also problematize the widely held idea that mastery of content guarantees, by itself, the ability to teach. This conception sustains a naturalized view of teaching, in which teaching is understood as an intuitive skill or resulting from disciplinary expertise, disregarding that teaching is a specific field of knowledge that demands continuous professional development.

Therrien (2006) and Slonski, Rocha and Maestrelli (2017) reinforce that the posture of "content specialists" disregards the specificities of the teaching-learning process, generating negative impacts on the training of future teachers. When university professors do not recognize teaching as a practice that requires specific knowledge — pedagogical, curricular, experiential — they tend to reproduce with their students the same practices they experienced, perpetuating a cycle of uncritical transmission. This is particularly serious in teaching degrees, where future teachers learn, through example, that teaching is synonymous with transmitting content, with no room for reflection, dialogue or the collective construction of knowledge.

3.3 PEDAGOGICAL RATIONALITY AND COMMUNICATIVE ACTION IN HIGHER EDUCATION

In opposition to the technical model, pedagogical rationality understands teaching as a complex, situated and intentionally formative social practice. Habermas (1987) associates this rationality with practical and emancipatory interest, oriented to dialogue and the autonomy of the subjects. In this sense, university teaching cannot be reduced to mere transmission, but must be understood as critical and reflective mediation, capable of promoting meaningful and emancipatory learning. For Therrien (2006), this rationality is constituted in intersubjectivity, dialogue and communication, with human formation, intellectual autonomy and social emancipation as its horizon.

Barbosa (2020) and Therrien (2006) converge in stating that communicative action can guide the teacher's work towards an emancipatory and reflective practice, the result of which is learning that satisfies both those involved in the pedagogical relationship. Unlike instrumental action, which seeks only to achieve predetermined goals, communicative action

opens space for participants to negotiate meanings, question assumptions and build shared understandings. This means that, in a classroom guided by pedagogical rationality, knowledge is not something that the teacher "owns" and "transmits", but something that emerges from the interaction between teacher, students and content.

Teaching, thus understood, goes beyond the logic of technical application and assumes an ethical and political commitment to the formation of subjects. Pimenta and Anastasiou (2014) argue that teaching requires specific knowledge that goes beyond the disciplinary domain, including pedagogical and experiential knowledge. Tardif (2014) reinforces that teaching knowledge is plural and constructed throughout the professional trajectory, which contradicts the instrumental view that it is enough to master the content to teach. This knowledge is not static or predefined, but is constantly re-signified in practice, through reflection on concrete teaching situations.

Therrien (2006) problematizes the historically constructed dichotomy between theory and practice in teacher education. For the author, pedagogical practice should not be conceived as a mere application of previously elaborated theories, but as a privileged space for the production of knowledge. From this perspective, the teacher interprets, re-signifies and transforms knowledge in the light of concrete teaching situations, which reinforces the centrality of critical reflection on action in the constitution of teaching professionalism. This understanding finds resonance in the contributions of Slonski, Rocha and Maestrelli (2017), who defend teacher training as a space for systematic reflection on practice.

Santos (2013) adds that pedagogical rationality requires problematizing and contextualizing knowledge, favoring the integral formation of students. This implies that the teacher not only transmits information, but that he helps students to understand how this knowledge relates to their lives, to society and to contemporary issues. The contextualization of knowledge is, therefore, a political act, as it reveals the power relations that cross the production and circulation of knowledge. Slonski, Rocha and Maestrelli (2017) emphasize that pedagogical training in higher education should promote reflective processes capable of enabling teachers to understand, analyze and transform their own performance. Such an approach shifts the formation from a prescriptive logic to a formative perspective, in which critical reflection is a central element of teacher professional development.

Another relevant aspect addressed by Therrien (2006) refers to the heterogeneity of teaching knowledge. The author shows that the teacher mobilizes, in his performance, disciplinary, pedagogical, curricular and experiential knowledge, built throughout his personal and professional trajectory. This knowledge does not work in isolation, but in articulation, forming a complex web of knowledge that guides practice. Slonski et al. (2017) reinforce this

understanding by stating that university teaching is a field of multiple knowledge, whose articulation requires formative processes that recognize the complexity of teaching and value the autonomy and pedagogical responsibility of the teacher. Recognizing this multiplicity of knowledge is fundamental to overcome the reductive view that sees the teacher as a mere "content specialist".

3.4 TENSIONS BETWEEN RATIONALITIES IN TEACHING DEGREES: IMPLICATIONS FOR TEACHER TRAINING

In undergraduate courses, the tension between technical-instrumental and pedagogical rationality is even more accentuated and problematic. Gatti (2014) shows that many courses reproduce the logic of bachelor's degrees, prioritizing disciplinary training to the detriment of pedagogical. Libâneo (2015) points out that fragmented curricula reinforce the dichotomy between "knowing the content" and "knowing how to teach", making it difficult to articulate theory and practice. This scenario creates a vicious circle: university professors who do not experience a pedagogical rationality tend to train undergraduates who also do not apply it in their future professional performance.

Santos (2013) argues that this prioritization of disciplinary training contributes to the constitution of professionals who are poorly prepared to deal with the uncertainties, challenges and contradictions of daily school life. The absence of consistent pedagogical training limits the ability of university professors to interpret complex educational situations, critically reflect on their practice and produce knowledge based on experience. When future teachers do not experience, during their initial training, teaching processes guided by pedagogical rationality, they lack practical references to implement this approach in their own classrooms.

Barbosa (2020) points out that recent curricular reformulations — such as CNE Resolutions 02/2015 and 02/2019 — try to strengthen the links between training institutions and schools, recognizing the need for a more integrated and reflective education. However, the challenge remains in the materialization of these changes in the concrete practices of universities. Many institutions still maintain curricular structures that separate content disciplines from pedagogical disciplines, reinforcing the dichotomy that is sought to be overcome. This curricular fragmentation not only harms the training of undergraduates, but also reflects and reinforces the institutional devaluation of teaching as a field of knowledge.

Overcoming this logic requires a deep institutional commitment to the continuing education of university professors, valuing research in teaching and creating systematic spaces for pedagogical reflection. It is essential that universities recognize teaching as a

specific field of knowledge, which demands continuous professional development and institutional investment. Without this change, there is a risk of perpetuating transmissive practices that weaken teacher training and, consequently, the quality of basic education. Teacher training is not a merely technical problem, to be solved through specific curricular adjustments, but a political issue that involves decisions about what kind of professional we want to train and what kind of society we want to build.

Therrien (2006) emphasizes that pedagogical practice should not be conceived as a mere application of theories, but as a space for the production of knowledge. This means that university professors need to be recognized as producers of knowledge about teaching, not just as transmitters of disciplinary knowledge. When the university values only disciplinary research and devalues research on teaching, it reinforces the instrumental logic it seeks to overcome. Therefore, the change in teaching degrees necessarily involves a revaluation of teaching and research in education in the university context.

3.5 LIMITS AND POTENTIALITIES OF THE HABERMASIAN FRAMEWORK FOR THINKING ABOUT TEACHING

The concept of communicative rationality offers a robust framework for thinking about university teaching, but it is not exempt from important limits and criticisms. Young (1996) observes that the theory presupposes ideal conditions for dialogue that rarely materialize in institutions marked by hierarchies and power relations. This criticism shows that, although powerful, the Habermasian framework needs to be adapted to the real conditions of educational practices, where it is not always possible to achieve the "rational consensus" that Habermas proposes as a regulative ideal.

Barbosa (2020) deepens this criticism by highlighting that the colonization of the Lifeworld by the System is not a process that occurs only externally, but that penetrates the institutional structures and subjectivities of the subjects. This means that even when teachers and students want to engage in authentic communicative processes, they face structural obstacles—pressures for productivity, standardized assessments, prescriptive curricula—that make it difficult to fully realize communicative action. Habermas' theory, therefore, does not offer ready-made solutions, but a normative horizon that can guide the criticism and transformation of educational practices.

Freire (1996) complements this perspective by highlighting that it is necessary to go beyond communicative rationality, articulating awareness and politicization in a transformative praxis. For Freire, it is not enough for the subjects to understand each other; This understanding must be oriented towards the transformation of the oppressive conditions that limit humanization. This Freirean perspective enriches the Habermasian framework by

emphasizing that education is always a political act, which cannot be neutral or detached from the struggles for social justice.

Despite these criticisms and limitations, the Habermasian framework remains relevant and potent to illuminate the tensions between rationalities in university teaching and to point out paths for more reflective, intersubjective and emancipatory pedagogical practices. Its articulation with critical perspectives, such as Freire's pedagogy and Barbosa's (2020) contributions on the colonization of the World of Life, broadens its reach and strengthens the understanding of teaching as a social, political, and formative practice. This articulation allows not only to diagnose the problems, but also to glimpse possibilities for transformation.

The articulation between the perspectives of Santos (2013), Therrien (2006), Barbosa (2020) and Slonski, Rocha and Maestrelli (2017) allows us to conclude that teacher training in higher education should be guided by a critical, reflective and communicative pedagogical rationality. Such rationality conceives the teacher as an epistemological subject, producer of knowledge and agent of social transformation. This conception reinforces the need for intentional, continuous and institutionally recognized pedagogical training in the context of university teaching. It is not only a matter of improving teaching techniques, but of transforming the institutional structures and cultures that sustain the devaluation of teaching.

4 FINAL CONSIDERATIONS

The analysis developed in this article reinforces the central thesis that the rationalities that permeate university teaching are neither neutral nor natural, but historically and socially constructed, producing concrete effects on teacher training and, consequently, on the quality of basic education. It was evidenced that the predominance of a technical-instrumental rationality, centered on the transmission of contents, efficiency and measurable results, weakens the pedagogical dimension essential to teacher training. This scenario reduces teaching to a technical exercise, emptying its formative, critical and emancipatory potential, and perpetuates a logic that compromises the integral education of undergraduates.

On the other hand, pedagogical rationality, based on the assumptions of Habermas' communicative rationality and enriched by the contributions of university pedagogy, points to the need for a profound transformation in teaching conceptions and practices in higher education. This change cannot be understood only as an individual or voluntarist initiative, but requires robust institutional, political and cultural transformations. It is imperative that universities invest in continuing pedagogical training programs, conceived as permanent spaces for reflection, research and professional development, capable of overcoming the

logic of punctual courses and promoting more reflective and intersubjective teaching practices.

In addition, it is essential to value the pedagogical dimension in the criteria for progression in the teaching career, so that the quality of teaching is considered as relevant as scientific production. This restructuring should reach the curriculum of the teaching degrees, overcoming the fragmentation between disciplinary and pedagogical training and promoting an effective integration between theory and practice. To sustain this movement, higher education institutions need to create university pedagogy centers dedicated to teaching advice and foster research on teaching and learning as a legitimate field of knowledge production.

The training of teachers in teaching degrees cannot be restricted to the acquisition of disciplinary knowledge. It should be conceived as a process that enables future educators to act in a critical, reflective, ethical, and politically engaged way, understanding teaching as a transformative praxis. The adoption of a pedagogical rationality in university teaching, replacing the hegemonic technical-instrumental model, is a fundamental and urgent step towards the construction of a higher education committed to the integral formation of subjects, to the democratization of knowledge and to social transformation.

Finally, it is recognized that this theoretical-reflective study has limitations due to the absence of primary empirical data, which restricts the analysis to the conceptual level. This limitation, however, opens space for future qualitative and quantitative research, capable of mapping the predominant conceptions of teaching, identifying innovative practices and investigating how the licentiate students perceive and are affected by the rationalities of their educators. In addition, it would be relevant to broaden the dialogue with critical perspectives such as decolonial pedagogy and the epistemologies of the South, which incorporate dimensions of power and cultural difference often made invisible in Eurocentric approaches.

REFERENCES

- Anastasiou, L. G. C., & Alves, L. P. (Eds.). (2015). *Processos de ensinagem na universidade: Pressupostos para as estratégias de trabalho em aula*. UNIVILLE.
- Barbosa, R. S. (2018). *Linguagem cartográfica e ação comunicativa: A racionalidade nas práticas docentes dos professores de Geografia do ensino fundamental* [Tese de doutorado, Universidade Federal de Pernambuco]. Repositório Institucional da UFPE. <https://repositorio.ufpe.br/handle/123456789/31061>
- Barbosa, R. S. (2020). A linguagem cartográfica na formação e na prática do professor de Geografia à luz da teoria da ação comunicativa. *Revista FSA*, 17(10), 310–325. Artigo 16.
- Bardin, L. (2011). *Análise de conteúdo*. Edições 70.

- Brasil. Conselho Nacional de Educação. (2015). Resolução CNE/CP nº 2, de 1º de julho de 2015. Define as Diretrizes Curriculares Nacionais para a formação inicial em nível superior. CNE.
- Brasil. Conselho Nacional de Educação. (2019). Resolução CNE/CP nº 2, de 20 de dezembro de 2019. Define as Diretrizes Curriculares Nacionais para a Formação Inicial de Professores para a Educação Básica. CNE.
- Brasil. Conselho Nacional de Educação. (2024). Resolução CNE/CP nº 4, de 29 de maio de 2024. Dispõe sobre as Diretrizes Curriculares Nacionais para a Formação Inicial em Nível Superior de Profissionais do Magistério da Educação Escolar Básica (cursos de licenciatura, cursos de formação pedagógica para graduados não licenciados e cursos de segunda licenciatura). Ministério da Educação. http://portal.mec.gov.br/index.php?option=com_docman&view=download&alias=79631-rcp002-17-pdf&category_slug=dezembro-2017-pdf&Itemid=30192
- Cunha, M. I. da. (2006). Docência na universidade, cultura e avaliação institucional: Saberes silenciados em questão. *Revista Brasileira de Educação*, 11(32), 258–271.
- Cunha, M. I. da. (2010). *O bom professor e sua prática* (24th ed.). Papirus.
- Cunha, M. I. da. (2016). Prática pedagógica de professores universitários: Problemas, perspectivas e caminhos. *Revista Práxis Educacional*, 12(23), 207–226.
- Freire, P. (1996). *Pedagogia da autonomia: Saberes necessários à prática educativa*. Paz e Terra.
- Gatti, B. A. (2014). A formação inicial de professores para a educação básica: As licenciaturas. *Revista USP*, 100, 33–46.
- Gatti, B. A., et al. (2019). *Professores do Brasil: Novos cenários de formação*. UNESCO.
- Habermas, J. (1982). *Conhecimento e interesse*. Zahar.
- Habermas, J. (1987). *Teoria de la acción comunicativa: Complementos y estudios previos*. Cátedra.
- Habermas, J. (2012). *Teoria do agir comunicativo* (2 vols.). WMF Martins Fontes.
- Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira. (2023). *Censo da Educação Superior 2022: Principais resultados*. INEP.
- Libâneo, J. C. (2015). Formação de professores e didática para desenvolvimento humano. *Educação & Realidade*, 40(2), 629–650.
- Nóvoa, A. (2009). *Professores: Imagens do futuro presente*. Educa.
- Nóvoa, A. (2017). Firmar a posição como professor, afirmar a profissão docente. *Cadernos de Pesquisa*, 47(166), 1106–1133.
- Pimenta, S. G., & Anastasiou, L. G. C. (2014). *Docência no ensino superior* (5th ed.). Cortez.
- Pimenta, S. G., & Lima, M. S. L. (2017). *Estágio e docência* (8th ed.). Cortez.
- Rother, E. T. (2007). Revisão sistemática X revisão narrativa. *Acta Paulista de Enfermagem*, 20(2), v–vi.
- Santos, F. K. S. dos. (2013). Limites e possibilidades da racionalidade pedagógica no ensino superior. *Educação & Realidade*, 38(3), 915–929.

- Schön, D. A. (2000). Educando o profissional reflexivo: Um novo design para o ensino e a aprendizagem. Artmed.
- Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1–22.
- Slonski, T. B., Rocha, S. L., & Maestrelli, S. R. P. (2017). A formação pedagógica do professor universitário: Um desafio para a qualidade do ensino superior. *Revista Ibero-Americana de Estudos em Educação*, 12(3), 1650–1664.
- Soares, S. R., & Cunha, M. I. (2010). Formação do professor: A docência universitária em busca de legitimidade. EDUFBA.
- Tardif, M. (2014). Saberes docentes e formação profissional (17th ed.). Vozes.
- Therrien, J. (2006). A formação pedagógica do professor universitário: Um desafio para a qualidade do ensino superior. *Educação & Sociedade*, 27(96), 897–911.
- Veiga, I. P. A. (Ed.). (2014). Docência universitária na educação superior. INEP.
- Young, I. M. (1996). Communication and the other: Beyond deliberative democracy. In S. Benhabib (Ed.), *Democracy and difference: Contesting the boundaries of the political* (pp. 120–135). Princeton University Press.
- Zeichner, K. M. (1993). A formação reflexiva de professores: Ideias e práticas. Educa.

LAW AND PUBLIC POLICIES: THE COLLECTIVE CONSTRUCTION PROCESS OF PROTOCOLS FOR PRIOR, FREE AND INFORMED CONSULTATION IN TRADITIONAL COMMUNITIES IN/OF MARANHÃO

DIREITO E POLÍTICAS PÚBLICAS: O PROCESSO DE CONSTRUÇÃO COLETIVA DE PROTOCOLOS DE CONSULTA PRÉVIA, LIVRE E INFORMADA EM COMUNIDADES TRADICIONAIS NO/DO MARANHÃO

DERECHO Y POLÍTICAS PÚBLICAS: EL PROCESO DE CONSTRUCCIÓN COLECTIVA DE PROTOCOLOS DE CONSULTA PREVIA, LIBRE E INFORMADA EN COMUNIDADES TRADICIONALES DE MARANHÃO



<https://doi.org/10.56238/sevened2026.008-099>

**Aldina da Silva Melo¹, João Ricardo Costa Silva², Maria do Socorro Sousa de Araújo³,
Wheriston Silva Neris⁴**

ABSTRACT

This research analyzes the experience of producing and executing the Law and Public Policy Workshop held in 2024 in the Lagoa Amarela community, located in the municipality of Chapadinha, in the state of Maranhão. This workshop was linked to the process of constructing Protocols for Prior, Free and Informed Consultation to strengthen rights and contribute to combating threats to the ways of life of traditional communities in Maranhão. The research used a methodological approach inspired by action research. It concludes by reaffirming the relevance of the action, given its potential for collective reflection on identity, challenges, and rights in a community lacking access to public services and experiencing an advanced stage of destruction of its conditions for economic and social reproduction.

Keywords: Law. Public Policies. Traditional Communities.

RESUMO

Essa pesquisa analisa a experiência de produção e execução da Oficina de Direito e Políticas Públicas realizada em 2024 na comunidade de Lagoa Amarela, localizada no município de Chapadinha, no estado do Maranhão. Tal oficina estava vinculada ao processo de construção de Protocolos de Consulta Prévia, Livre e Informada para fortalecer direitos e contribuir no combate às ameaças aos modos de vida de comunidades tradicionais maranhenses. A pesquisa fez uso de uma abordagem metodológica inspirada na pesquisa-

¹ Dr. in Public Policy. Universidade Federal do Maranhão (UFMA). E-mail: aldina.smelo@gmail.com

Orcid: <https://orcid.org/0009-0007-1580-0229> Lattes: <https://lattes.cnpq.br/1523456926529652>

² Dr. in Social Sciences. Universidade Federal do Maranhão (UFMA). E-mail: joaoricardocs@hotmail.com

Orcid: <http://orcid.org/0000-0002-1612-7933> Lattes: <https://lattes.cnpq.br/0470147338384466>

³ Dr. in Public Policy. Universidade Federal do Maranhão (UFMA). E-mail: mss.araujo@gmail.com

Orcid: <http://orcid.org/0000-0002-3545-8949> Lattes: <http://lattes.cnpq.br/4538063821382720>

⁴ Dr. in Sociology. Universidade Federal de Sergipe (UFS). Universidade Federal do Maranhão (UFMA).

E-mail: wheriston.neris@ufma.br Orcid: <https://orcid.org/0000-0002-0296-2874>

Lattes: <http://lattes.cnpq.br/0108605127365257>

ação. Conclui reafirmando a relevância da ação, tendo em vista o seu potencial para reflexão coletiva sobre a identidade, desafios e direitos em uma comunidade carente de acesso a serviços públicos e que vivencia um estágio avançado de destruição das suas condições de reprodução econômica e social.

Palavras-chave: Direito. Políticas Públicas. Comunidades Tradicionais.

RESUMEN

Esta investigación analiza la experiencia de producción y ejecución del Taller de Derecho y Políticas Públicas, realizado en 2024 en la comunidad de Lagoa Amarela, ubicada en el municipio de Chapadinha, estado de Maranhão. Este taller se vinculó al proceso de elaboración de Protocolos de Consulta Previa, Libre e Informada para fortalecer los derechos y contribuir a combatir las amenazas a las formas de vida de las comunidades tradicionales de Maranhão. La investigación utilizó un enfoque metodológico inspirado en la investigación-acción. Concluye reafirmando la relevancia de la acción, dado su potencial para la reflexión colectiva sobre la identidad, los desafíos y los derechos en una comunidad sin acceso a servicios públicos y que experimenta una etapa avanzada de destrucción de sus condiciones de reproducción económica y social.

Palabras clave: Derecho. Políticas Públicas. Comunidades Tradicionales.

1 INTRODUCTION

The objective of this work was to analyze the experience of participatory production and execution of Law and Public Policy Workshops in 2024 in quilombola and traditional communities in Maranhão. At its starting point, the action was part of the Project "Collective Construction of Consultation Protocols and Territorial Protection Plans in Quilombola and Traditional Communities in Situations of Threat in the State of Maranhão", which originates from a partnership between the Ministry of Human Rights and Citizenship - MDHC, the Ministry of Agrarian Development and Family Agriculture - MDA and the Federal University of Maranhão - UFMA, with the main objective of supporting the development of Prior, Free and Informed Consultation Protocols to strengthen rights and contribute to combating threats to the ways of life of traditional communities in the State of Maranhão.

Encompassing a multidisciplinary technical team with different levels of research experience, this cooperation carried out actions in communities belonging to seven municipalities in the State of Maranhão during the year 2024, namely: 1. Quilombo Boa Vista (Rosário); 2. Quilombo Munim-Mirim (Axixá); 3. Camaputia Quilombola Territory (Cajari); 4. Quilombo Lagoa Amarela (Chapadinha); 5. Quilombo São Benedito dos Colocados (Codó); 6. Jacarezinho Quilombola Territory (São João do Sóter); 7. Pericumã Quilombola Territory (Peri-Mirim). In each of them, in addition to a meeting to present the project and community mobilization in the initial stage, 04 (four) mandatory workshops and 01 (one) assembly were held to approve the basic text of the protocol.

In this text, we deal with the process of construction and execution of the Law and Public Policies Workshop, one of the four workshops mentioned above, specifically focusing on its realization in 2024 in the Community of Lagoa Amarela, located in the municipality of Chapadinha - MA. This is a community basically composed of rural workers, from family farming, and who carry out various productive activities, such as "farm work, raising pigs, chickens, fishing, hunting, making flour, etc.". The lands of Lagoa Amarela are divided into about 46 units and the effective number of people living in the community is around 25 families, with about 50 children.

In view of the above, this text is divided into three parts. In the first, we explore part of the process of formation of Lagoa Amarela, highlighting some of the main challenges faced by its residents today. In the second, we reflected on the process of building and carrying out the workshop, emphasizing the strategies and themes selected. Finally, we draw some conclusions about the consultation process and the importance of carrying out this action for a community with no history of mobilization.

2 THE PROCESS OF FORMATION OF LAGOA AMARELA: SUBSIDIES FOR THE RECONSTITUTION OF A LOCAL HISTORY

Lagoa Amarela is a community in the rural area of the municipality of Chapadinha - MA, about 20km from the administrative center, which defines itself as a remnant of quilombos and was certified by the Palmares Foundation in 2024. The locality is recognized as the locus of the largest and most recognized Quilombo in the History of Balaiada in Maranhão (1838-1841) and for being associated with the figure of Cosme Bento das Chagas, the Negro Cosme, who is a unique piece in the imagination of black resistance in Maranhão and in Brazil.

Currently, the situation of Lagoa Amarela is quite representative in terms of the aggravation of socio-environmental problems caused by the expansion of soybean production in Maranhão and its effects on traditional communities. As is known, initially concentrated in the municipality of Balsas, soybean production moved, from the 2000s onwards, to the Eastern Maranhão mesoregion, where the micro-region and municipality of Chapadinha are located (Almeida; Júnior, 2019). Located in a zone bordering Piauí, the area is strongly marked by the intrusion of business agents and the so-called Gauchos (Gaspar, 2013) to which a series of conflicts and environmental threats are linked, the destructuring of territories, deforestation, expropriation and dismantling of the conditions of community permanence and reproduction.

From a historiographical perspective, based on the memorialistic reports collected and on various other materials produced in the workshops, we can sketch a characterization of the formation of the Community of Lagoa Amarela divided into three major interdependent moments. The first corresponds to the more distant past of colonization of the area in question and to the very dynamics and particularity of the formation of the peasantry in eastern Maranhão, marked by occupation by peasants of different origins, who joined and eventually mixed with detribalized indigenous people, forros and their descendants, aquilombados of African slaves (Assunção, 2015; Almeida, 2017). As seen in the works of Mathias Assunção (2008), this occupation could be traced back to the first quarter of the nineteenth century, if not earlier, being marked by the development of complex systems of common use, also demarcating various forms of access to land.

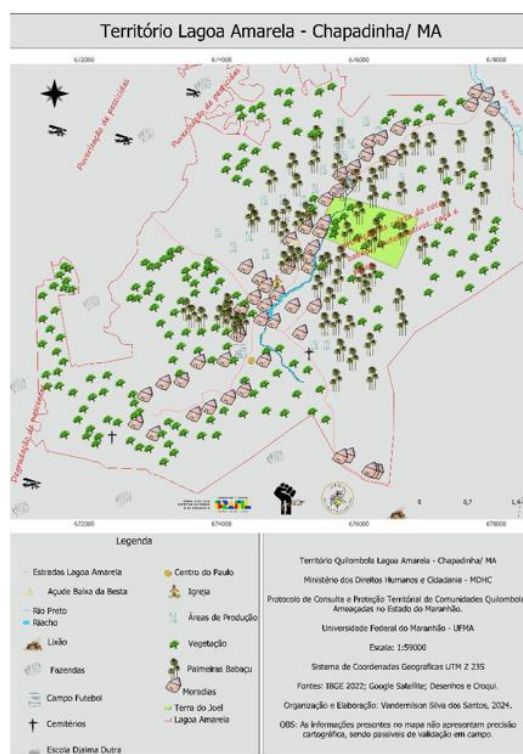
In fact, it is relatively well known and documented that the significant presence of northeastern migrants, together with caboclos, forros and their descendants, are important elements for understanding both the insurrection of the balaies in the nineteenth century, and the very complexity of the process of formation of the peasantry in this region (Assunção, 2015). For what interests us here more directly, it is important to emphasize that this is a

heterogeneous peasantry that received continuous waves of northeastern migrants who joined and eventually mixed, while they conform unique modalities of access and occupation of the lands. With regard to the memorialistic reconstruction of our informants, their ancestors seem to have settled in the vicinity of the plantations, being incorporated as aggregates and/or tenants. This corresponds to the second moment of our reconstitution.

In fact, it is the existence of this social structure that goes back to the most distant and detailed memories of the oldest residents of Lagoa Amarela. Their reminiscences are directly linked to a structure of relations between their parents - peasants, aggregates/indentured - and those considered owners who, although they were marked by exploitation, nevertheless allowed management and access to land in a relatively free way. Thus, in the reports of the oldest residents, although the area was already considered privatized and the use of the resources involved the mediation of landowners, who required payment of rent or provision of services, agroextractivist production was not unfeasible as it happens today. And in fact, the configuration of this structure of social relations is very reminiscent of the description made in fieldwork in the 1990s by Maristela de Paula Andrade, who identified at least seven ecosystems of relations between peasants and landowners in the region in question:

(...) small landowners who hold the title to the land, generally older men; the heirs of land of inheritance without division; the relatives of these heirs who, although they do not have the right to the land, continue to live and cultivate on the lands of the relatives, within the limits of the villages; the relatives of these heirs who only reside within the limits of these villages, but pay income to cultivate on other lands, from landowners or other small proprietors; heirs of inheritance land who pay rent to cultivate land on other properties when their land is exhausted (...); the inhabitants of terra de preto, who enjoy them in common; the heirs, or small landowners who occupy the lands of the plateau bordering the properties, also becoming squatters (Andrade, 1995a, p. 34)

Figure 1



Sources: IBGE 2022; Google Satellite; Drawings and Sketch. Organization and Elaboration: Vandemilson Silva dos Santos, 2024.

Finally, the third period is characterized by the intensification of changes in the land structure, driven by the massive arrival of individuals and/or businessmen in the region, mainly soybeans, and which alters the pattern of forces between peasants and traditional landowners. Encouraged by the vicissitudes of inheritance transmissions in the families of the so-called owners, part of Lagoa Amarela then began to be marketed to individuals and/or businessmen who tried to implement monoculture tree plantations in the region, especially soybeans, affecting the reproductive conditions of its inhabitants. Once surrounded by the ongoing land concentration, these tenants, descendants of the old aggregates, became the weakest link in the chain of concentration in question, leaving them only the alternative of complying with the ultimatum of the landowners who "granted" them a hectare of land and the opportunity to buy as many and as many other hectares as their economic resources made possible, before they were sold to third parties. These acquisitions thus demarcate the last and most dramatic period of changes in the local land structure and in the history of the community itself, when the lands of Lagoa Amarela passed almost entirely to private use and the individual conquest of a land to "call their own" occurs in parallel with the almost unfeasibility of the permanence and (re)production of the existence of these families.

Here, then, is a significant part of the problems reported regarding the use of common areas and natural resources and in relation to the very conditions of reproduction of the peasant economy in question. Family farmers born and raised in an environment of natural resource management on free and/or private lands today face difficulties in making a swidden line, carrying out extractive collection and even fishing, since access to lakes and streams has been prevented by the "owners". To make matters worse, as can be seen in the cartographic representation above, the expansion of soybean production is a real siege of the community, which creates obstacles for animal husbandry, for the cultivation of food and has even affected lakes and streams, making them unfeasible for bathing and fishing, since they course with the emergence of skin irritation problems. It is difficult to think of such a complex and accelerated picture of the complete destruction of the conditions of peasant reproduction as the one at stake.

3 THE WORKSHOP IN ACTION: PROBLEMATIZING LAW AND PUBLIC POLICIES IN LAGOA AMARELA

The Public Rights and Policies workshop was conceived as one of the cornerstones of the process of collective reflection on the specific rights of communities, based on the sharing of legal knowledge and exchange of local knowledge, focusing on the following aspects: the right to property title, the right to self-determination, the right to prior, free and informed consultation and other constitutional rights of quilombolas. Public Policies aimed at quilombola communities were another topic discussed in the workshop, whose approach was oriented to the debate of themes that the communities themselves conceived as relevant for decision-making in accordance with their priorities. It is important to note, in fact, that in addition to the execution of the aforementioned workshop, a booklet was produced as reference material for didactic and informative support for the participants of the action. The guiding questions of the Workshop were the following: What is the origin of our rights? What are the rights of quilombolas? What are the public policies for quilombola communities? What is the role of the 1988 constitution?

Seen together, the Workshop was planned for three interdependent moments. In the first, the exposition on concepts and regulations concerning law, public policies and national and international legislation. At this time, the workshop participants highlighted quilombola rights in the Federal Constitution of 1988, presented Decree No. 4,887/2003, which regulates the procedure for identification, recognition, delimitation, demarcation, and titling of lands occupied by quilombola communities, and Decree No. 11,447/2023, which instituted the Aquilomba Brasil Program. In the second moment, public policies were explored, pointing to

a new legal diploma: Decree No. 11,786/2023, which instituted the National Policy for Quilombola Territorial and Environmental Management - PNGTAQ, as well as Convention No. 169 of the International Labor Organization - ILO, specifically on the right to self-determination, in the rules on Prior, Free and Informed Consultation - CPLI, and in the Consultation and Consent Protocols. Finally, some examples of protocols recently produced in Maranhão while four guiding questions were presented for those present to answer in groups organized for this purpose.

For what interests us more directly from this experience, however, it is important to highlight, in the first place, the principles underlying action, which are inscribed in the framework of ILO Convention No. 169, notably with regard to the right to self-determination of peoples and communities.

In other words, the priority starting point is the fact that indigenous peoples and traditional communities are the only ones capable of self-identifying as such, and of deciding on their own interests, on how they want to live. To make effective the right to self-determination, the right to decide, the treaty establishes mechanisms. And one of these is prior, free and informed consultation. Article 6 of Convention No. 169 states that governments shall consult peoples and communities, through appropriate procedures, whenever legislative or administrative measures are envisaged that may affect them. It also establishes that consultations should be carried out in a manner appropriate to the circumstances, with the aim of reaching an agreement and obtaining consent on the proposed measures. Thus, when there is a legislative or administrative measure capable of affecting indigenous peoples, quilombolas or other traditional communities, these groups must be consulted so that they can manifest themselves, giving their consent, or not, and reaching an agreement on the proposed measures. Article 7 of Convention No. 169 reinforces, in turn, that peoples and communities have the right to choose their own priorities, with regard to the development process, insofar as it affects their lives, beliefs, institutions, spiritual well-being and the lands they occupy or use in any way. The article adds that peoples and communities should participate in the formulation, implementation and evaluation of national and regional development plans and programs that are likely to affect them.

With this in mind, it can be understood that consultation must be conceived and carried out through a dialogued process, a negotiation that is not limited to an isolated meeting. In this process, peoples and communities must present their opinions, must be heard and respected, deciding on their present and future. Through consultation, peoples and communities, in communication with the government, can thus defend their priorities, their ways of life, their interests and territories. Each Prior, Free, Informed and Good Faith

Consultation follows its own procedures that adjust to the particularities and needs of each people and community. The consultation, in addition, must be documented and the records must be available to all participants.

In addition to the specificities of demands and problems, which can also be conceived by the variety of threats suffered by the contemplated communities, it is also necessary to understand the effects of the capacity of this collective on the workshop itself. Lagoa Amarela is a community with little history of mobilization, without large networks of external supporters and leaders, and which began to outline the first initiatives of collective organization very recently. The construction of the consultation protocol participates, then, in a kind of archeology of the identity and forms of territorialization of the community, led to reflect on its own history, on its productive activities, on its links and joint experiences.

The general and summarized exploration of the legal guidelines aroused attention and dialogue among those present, breaking down resistance and fears regarding participation. From the beginning, some of the residents highlighted, for example, this dissonance between the existence of rights and the fact that they never get off the ground. In others, they took the opportunity to clarify doubts about various aspects, such as: the consequences of the recognition of the quilombola identity on the forms of property management; the absence of action by the public authorities to meet the demands of the community; the lack of public education and health services, further aggravated by the withdrawal of a school that served mainly the children of the community. In summary, perhaps even more than specific knowledge about the legal system, what the workshop produced in this first moment was a broadening of the understanding of rights and the realization that the individual demands of each resident converged to problems that were collective, after all.

To a large extent, the dynamics established in the first moment prepared the consultation activity planned for the workshop. Gathered in 02 (two) groups, the residents were invited to answer some questions (*Why did we get together to build this protocol? What do we expect from the protocol? What are the public policies that the community needs? Who can participate in the free, prior and informed consultation?*), understood as fundamental for the construction of the final document, the Consultation Protocol. Once the answers were filled in by each group on cardboard, the team members were invited to present them, asking the broader collective if they agreed or had something to add. The answers gathered were as follows:

Question 1: Why did we come together to build this protocol?

Answer: To protect our right. Protect our community from the threat of agribusiness. Our source of income, lake, fish, my environment, babassu coconut. Our Farming, which are our right to survival

Question 2: What do we expect from the protocol?

Answer: Improvements, protection of our rights, rights, quality of life, to unite, to protect from threat, to protect our forest, our lake

Question 3: What are the public policies that the community needs?

Answer: Road, Saudi post, school, artiziano well, street lighting, soccer field, agricultural field, culture house, square, playground

Question 4: Who can participate in the free, prior and informed consultation?

Answer: Support from the city hall, university, UFMA, Union, Government of Maranhão, Health Department, City Council, Community Support.

4 FINAL CONSIDERATIONS

The final moment of the workshop was fundamental for a cordial and very informative conversation about the challenges of the community. Seen as a whole, the Workshop on Rights and Public Policies ended up highlighting some of the main needs and specificities of the Community of Lagoa Amarela, constituting a watershed in the process of drafting the Consultation Protocol. Starting with the fact that it is not so much the process of land regularization that is on the agenda here, since the priority demand capable of fostering the unity of the community focuses mainly on conservation factors, sustainable use of biodiversity, as well as the implementation of integrated public policies aimed at improving the quality of life and citizen inclusion.

The answers produced to the guiding questions are fundamentally focused on these dimensions associated with the very conditions necessary for the physical and socio-environmental reproduction of the Lagoa Amarela Community. It is in the access, sustainable use, protection and, perhaps, recovery and conservation of natural resources that the central dimension that organizes and mobilizes all those present indistinctly is concentrated. Associated with this is the very way in which the discussion about quilombola self-identification gains strength, understood as one of the most effective means to ensure the expansion of access to public policies and government programs. Finally, and certainly not least, is the fact that this workshop and the participatory production of the protocol represent one of the few efforts towards the recognition and strengthening of a weakened collectivity and without previous experiences of collective mobilization capable of establishing some barrier of protection for unsustainable uses of the territory's natural resources.

REFERENCES

- Assunção, M. R. (2015). De caboclos a bem-te-vis: Formação do campesinato numa sociedade escravista: Maranhão, 1800–1850. Annablume.
- Almeida, J., & Junior, J. (2019). A luta pela terra frente à dinâmica territorial do agronegócio da soja no Maranhão: O caso da microrregião de Chapadinha (1990–2015). *GOT – Journal of Geography and Spatial Planning*, (16), 251–274. <https://doi.org/10.17127/got/2019.16.011>
- Brasil. (2023). Constituição da República Federativa do Brasil de 1988. Presidência da República. https://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm
- Carneiro, M. S. (2008). A expansão e os impactos da soja no Maranhão. In S. Schlesinger, S. P. Nunes, & M. S. Carneiro (Orgs.), *A agricultura familiar da soja na região Sul e o monocultivo no Maranhão: Duas faces do cultivo da soja no Brasil* (pp. 75–143). FASE.
- Gaspar, R. (2013). O eldorado dos gaúchos: Deslocamento de agricultores do Sul do País e seu estabelecimento no Leste Maranhense. EDUFMA.
- Paula Andrade, M. de. (1995). A produção de carvão vegetal e o plantio de eucalipto no Leste Maranhense. In F. G. Conceição (Org.), *Carajás: Desenvolvimento ou destruição? Relatórios de pesquisa* (pp. 15–64). CPT.

BACK TO THE LIGHTNESS OF LIFE: LITERARY STORIES AND (IN) TRANSCULTURALITY

DE VOLTA À LEVEZA DA VIDA: ESTÓRIAS LITERÁRIAS E(M) TRANSCULTURALIDADE

DE REGRESO A LA LEVEDAD DE LA VIDA: HISTORIAS LITERARIAS Y (EN) TRANSCULTURALIDAD



<https://doi.org/10.56238/sevened2026.008-100>

Gisele Giandoni Wolkoff¹, Dante Gallian², Yuri Bittar³

ABSTRACT

We will present how narratives read in a manner detached from traditional literary criticism, within the context of humanization—particularly in the field of healthcare—constitute a proposal developed at the Humanities Laboratory (hereinafter referred to as Labhum), originating from the Center for the History and Philosophy of Health Sciences (Cehfi) of the Paulista School of Medicine (EPM) at the Federal University of São Paulo, and later extended to the Reading Laboratory (Lablei) in corporate contexts, an initiative that has opened transcultural possibilities for a broader understanding of hypermodernity. The case presented here involves the selection of two classics from literature and cinema, namely the novel *The Picture of Dorian Gray* (1890) by Oscar Wilde and the film *Blow-Up* (1967) by Michelangelo Antonioni, for discussion in one of the classes during the first semester of 2025. To this end, we start from the premise that hypermodern society and the frenetic pace of cyberspace demand an even greater awareness and heightened consciousness of our subjective and social existences and belongings. In parallel, we philosophically ground our study in the idea of transculturality—that is, different times, spaces, and ideas converging in processes of humanization such as those proposed by Labhum and Lablei.

Keywords: Hypermodernity. Transculturality. Portraits. Subjectivity. Humanization.

RESUMO

Apresentaremos como narrativas lidas de maneira descomprometida à crítica literária no contexto da humanização, particularmente, na área da saúde, proposta desenvolvida no Laboratório de Humanidades (de agora em diante aqui referido por Labhum) a partir do Centro de História e Filosofia de Ciências da Saúde (Cehfi) da Escola Paulista de Medicina (EPM) da Universidade Federal de São Paulo e estendido ao Laboratório de Leitura (Lablei)

¹ Postdoctoral. Kyoto University of Foreign Studies. Univ de Coimbra. Universidade de São Paulo (USP). Orcid: <https://orcid.org/0000-0001-8962-5215> Lattes: <http://lattes.cnpq.br/4530644741441254>

² Postdoctoral. École des Hautes Études en Sciences Sociales. Universidade de São Paulo (USP). Orcid: <http://lattes.cnpq.br/4530644741441254> Lattes: <http://lattes.cnpq.br/6044992821022223>

³ Dr. Universidade Federal de São Paulo (UNIFESP). Orcid: <https://orcid.org/0000-0001-6293-8772> Lattes: <http://lattes.cnpq.br/7039684681468178>

em contextos empresariais tem vindo a abrir possibilidades transculturais à compreensão mais ampla da hipermodernidade. O caso aqui exposto implica na escolha de dois clássicos da literatura e do cinema, nomeadamente, o romance *O Retrato de Dorian Gray* (1890 de Oscar Wilde e o filme *Blow-up* (1967) de Michelangelo Antonioni para discussão em uma das turmas do primeiro semestre de 2025. Para tanto, partimos da premissa de que a sociedade hipermoderna e o ritmo alucinado do ciberespaço requerem ainda mais consciência e maior conscientização das nossas existências e pertencas subjetivas e sociais. Paralelamente a isso, fundamentamos filosoficamente o nosso estudo na ideia de transculturalidade, ou seja, tempos, espaços e ideias diferentes que convergem em processos de humanização como o proposto pelos Labhum e Lablei.

Palavras-chave: Hipermodernidade. Transculturalidade. Retratos. Subjetividade. Humanização.

RESUMEN

Presentaremos cómo narrativas leídas de manera desvinculada de la crítica literaria tradicional, en el contexto de la humanización—particularmente en el ámbito de la salud—constituyen una propuesta desarrollada en el Laboratorio de Humanidades (en adelante, Labhum), a partir del Centro de Historia y Filosofía de las Ciencias de la Salud (Cehfi) de la Escuela Paulista de Medicina (EPM) de la Universidad Federal de São Paulo, y posteriormente extendida al Laboratorio de Lectura (Lablei) en contextos empresariales, iniciativa que ha venido abriendo posibilidades transculturales para una comprensión más amplia de la hipermodernidad. El caso aquí expuesto implica la elección de dos clásicos de la literatura y del cine, a saber, la novela *El retrato de Dorian Gray* (1890), de Oscar Wilde, y la película *Blow-Up* (1967), de Michelangelo Antonioni, para su discusión en una de las clases del primer semestre de 2025. Para ello, partimos de la premisa de que la sociedad hipermoderna y el ritmo frenético del ciberespacio requieren una conciencia aún mayor y una intensificación de la reflexión sobre nuestras existencias y pertenencias subjetivas y sociales. De manera paralela, fundamentamos filosóficamente nuestro estudio en la idea de transculturalidad, es decir, en la convergencia de diferentes tiempos, espacios e ideas en procesos de humanización como los propuestos por Labhum y Lablei.

Palabras clave: Hipermodernidad. Transculturalidad. Retratos. Subjetividad. Humanización.

1 INTRODUCTION

By promoting reflection on humanization in the health area, the Humanities Laboratory, developed by the Center for History and Philosophy of Health Sciences of the Federal University of São Paulo (Bittar, Souza, Gallian, 2013; and Gallian, Lima, De Benedetto, Guzman, 2014) selected for one of its classes in the first semester of 2025 the novel *The Portrait of Dorian Gray*, in dialogue with the film *Blow-Up*, as the core of their discussions within a group composed of undergraduate and graduate students in the area of health sciences.

Created in 2003 at CeHFi, Labhum is an intervention methodology that aims to foster humanization in health and humanistic training that ended up expanding in other environments outside the university, such as in the business environment in training its personnel, through reading, rereading and reflections on themes related to human existence and raised from classic works – and in these environments other than those of the University of São Paulo. Health Sciences is named Lablei. Inspired by the work *Literature as Medicine* (Gallian, 2017) which sees in the classics an active principle with a more powerful potential for humanization, by promoting in the reader the awakening to themes and reflections in their affective, intellectual and volitional dimensions, Labhum takes place in cycles – defined by narratives; each narrative or set of them, a cycle – whose application takes place in weekly two-hour meetings organized by a three-stage methodology, namely, *Reading Stories*, *Discussion Itineraries* and *Coexistence Stories*.

When defining Lablei, Ricardo Mituti (2022, p.5) explains that in the first stage, the "feelings perceived, affections aroused, memories that occurred, and questions that arose in this first reading of the title that is being worked on in the cycle in question" arise. The second stage is established from the extension of the narrative to be worked on and deals with collective reflections on the subjects and excerpts most relevant to the participants, having been raised by the coordinator of the activity previously, already in the first stage and even throughout the second. The third stage includes the subjective and individual perceptions of the experience carried out throughout the reading process and discussions carried out in the two previous stages.

In the case in question, the focus of the two narratives, literary and filmic, proved to be innovative on several levels. But, initially, we emphasize that the readings carried out beyond literary criticism allowed the participants to articulate the relationship between their own experiences as human beings working in the health area and the portraits that gradually emerged through the reading of *The Picture of Dorian Gray* and in dialogue with *Blow-Up*. Immediate identification with the most striking traits of the main characters—namely, Dorian

Gray himself, Basil Hallward and Lord Henry Wotton in the novel, and Thomas, the photographer played by David Hemmings in the film *Blow-Up* —led participants to relate these human types and their roles on the stage of human dynamics, regardless of any historical period or, in other words, in addition to any of them, thus allowing a cultural transposition of the aesthetic experience of the late nineteenth century, when the novel was published in two versions (1890 and 1891), along with the European experiences of the 1960s and early 1970s, to the year 2025, in the Brazilian and personal context of each individual at LabHum.

Another relevant aspect was the inter-artistic dialogue, that is, the convergence between the reading of Wilde's novel and Antonioni's film. In both, the notion of portrait as a metonym of human individuality, subjectivity and experience prevailed: it is in the portrait that the marks of life are found — the same marks that would have aged Dorian, were it not for the pact with the devil; it is in the portrait that the lines of expression are engraved, framing life itself or what one chooses to show of it, as in the case of the models who are the object of the photographer in the film — the driving force of the filmic narrative adapted from the short story *Las Babas del Diablo* (1959) by Julio Cortázar; it is in portraits that we place our best moments and memories, as much as the uses of images on social networks today. The portraits of the models, immortalized or discovered by the photographer — as in the case of the photograph that points to a crime — are maps of memory or, at least, routes back to identifications (Hall, 1998), as is the portrait painted by Basil, a vain attempt to eternalize the very subject of the painting, Dorian Gray and his impressive beauty. In all these cases, the search for essence in the midst of the transitory and what can be lasting involves a more or less humanized look — both from the reader and the spectator and from the health professional responsible for care and, at the same time, a full individual, with subjective and circular experiences.

The transposition of times and spaces/geographies highlights the classic character of both narratives (the novel and the film) in question, since transculturality goes beyond the boundaries of time and space, functioning as an ideal approach for comparativism and artistic and/or critical readings. In addition, it helps us to understand contemporaneity, since the characters, their traits, attitudes and behaviors find parallels, as observed in all the comments elaborated during the LabHum meetings and also in their developments, as we will partially see below.

In order for us to better understand this cross-cultural approach in practice, let us first contextualize the *hypermodern* zeitgeist, which has been the starting point for most participants to engage in LabHum activities.

The term "hypermodernity" was coined by the contemporary philosopher Gilles Lipovetsky (2005) to explain our post-modern human condition, insofar as the latter exalted progress and reason, justifying the accelerated pace in all (or almost all) human activities: people's time, our use of technology, consumerism and individualism, as stated by Zygmunt Bauman (2000). The latter finds a direct connection with what is central in both narratives dealt with here: the individual as a central figure in the (in)comprehension of humanism. Dorian Gray, as a metonym of aestheticism, materializes hedonism, as does the photographer Thomas in his egocentric activities. Aestheticism is best understood as artificialism, since it inverts many common sense issues, some of them even moral. In fact, aestheticism, for example, defines art as superior to nature and believes that nature copies the former. The same applies to the senses, which are considered superior to the intellect, or to that which is superficial, which is considered better than that which is desired to be deeper; feeling, superior to reason. Thus, masks are seen as more authentic than individuality itself, which is one of the reasons why portraits are so relevant during Decadentism and throughout the nineteenth century (Mutran, 2002).

Since social and subjective lives in hypermodernity are marked by the excessively digital rhythm of ephemeral experiences and intense change, which lead to the absence of deep personal bonds, creating (and, pardon the irony, endlessly recreating) the illusion of perfection in all that is human becomes central to some sense(s) of – or, perhaps, the lack of them? – belonging(s). After all, to be human is to make mistakes, to have flaws, not to be perfect. However, hypermodern societies have promoted the increase of practices that refer to "well-being" and that, in turn, proclaim individualism and individuality in their extreme. The explicit side effect of this is loneliness, the same one we see happening with the characters Dorian Gray and Thomas. The first, as a man who never ages, is unable to keep up with the new generations as part of them; the second, disconnected from everyone around him. Lipovetsky points to consumerism as hypermodernity's immediate (and unfortunate) response to the issue of loneliness. Unable to establish real human bonds, people resort to materialism, tying their being to having.

Thus, the converging factor between Wilde's novel, Antonioni's film and our contemporary everyday lives lies precisely in the hedonism of the portraits, photos, images and stories as they unfold, but also in the naïve aesthetic experience of one (or two) stage(s) of life – keeping in mind the seven stages of life described in Jacques' monologue in the play *Macbeth*, by William Shakespeare, "The whole world is a stage".⁴ Moreover, this reveals our

⁴ All the world's a stage,/And all the men and women merely players;/They have their exits and their entrances;/And one man in his time plays many parts,/ His acts being seven ages. At first the infant,/

need for masks, especially in social media nowadays, the virtual space of ("perfect") existence, where "the true self" is displayed, in conformity with issues of individual "well-being": being free, loved, praised, recognized as a social being, among other universally recognized feelings of belonging.

Therefore, while Dorian and Thomas' aesthetic experience evolves particularly from hedonism and the need to express personal identities associated with the eternity of life, contemporary exposure on social media relates to this in that it involves masks, since they offer individuals senses of reality, despite being simulacra, capable of masking their participants with their "best" characteristics, at the same time that they allow them to respond to the hypermodern demands of extreme production, offering them meanings of belonging in societies dehumanized of errors, failures or mistakes, and promising eternal happiness – as is the case of the term "well-being", widely applied today, including to the Health Sciences.

At the heart of *Blow-Up* lies a deep questioning of perception and reality. The photographer believes he has inadvertently captured evidence of a murder in the background of a photo, but as he zooms in on the image, it becomes more abstract and inconclusive. This invites us to read history in epistemological terms about the boundaries between truth and perception or reality and simulacrum, since photographs are the medium – and, in the case of the novel *The Picture of Dorian Gray*, the portrait plays this role. In both cases, the photographs taken by Thomas in the film and Basil's painting of Dorian Gray in the novel, there seems to be an almost obsessive search for meaning, as well as an ultimate need for truth, always postponed by the "shadows" that displace the truth(s). Moreover, in our hypermodern digital age, how do images work to help us seek reality? Or, again, is reality just a series of moments of simulacrum in which the truth is revealed? Photographs, images and paintings are document and illusion.

Responding to these concerns or raising new questions as a result of them was also made possible by the cross-cultural comparative bias. The concept of transculturality has been widely used in various epistemological areas – from Health Sciences to Humanities. Starting from Translation Studies in dialogue with Sociology, we use transculturality in the

Mewling and puking in the nurse's arms;/ And then the whining school-boy, with his satchel/ And shining morning face, creeping like snail/ Unwillingly to school. And then the lover, / Sighing like furnace, with a woeful ballad/ Made to his mistress' eyebrow. Then a soldier,/ Full of strange oaths, and bearded like the pard,/ Jealous in honour, sudden and quick in quarrel,/ Seeking the bubble reputation/ Even in the cannon's mouth. And then the justice,/ In fair round belly with good capon lin'd,/ fith eyes severe and beard of formal cut,/ Full of wise saws and modern instances;/ And so he plays his part. The sixth age shifts/ Into the lean and slipper'd pantaloon,/ With spectacles on nose and pouch on side;/ His youthful hose, well sav'd, a world too wide/ For his shrunk shank; and his big manly voice,/ Turning again toward childish treble, pipes/ And whistles in his sound. Last scene of all,/ That ends this strange eventful history,/ Is second childishness and mere oblivion;/ Sans teeth, sans eyes, sans taste, sans everything. (W. Shakespeare. *As You Like It*. Act II Scene VII Line 139),

extension of the concept of transcreation proposed by Haroldo de Campos in his vast work as a methodological approach that aims at the perception of how cultures are read and reinterpreted in others. Just as a text originally in one language that comes into existence in another gains local meanings to do with its own understandings and dynamics, cultural manifestations and practices, when transposed to other environments, also gain new looks – colors and shades specific to the "culture of arrival", alluding here to the terms used in translation and called "source language" and "target language" for, specifically, the source and target languages (in which a text is translated). It is in this way that reading a Greek literary classic today matters as much as reading a contemporary one, if not more, since we have in question levels of cultural translation that allow us to broaden the horizons of human understanding, given the dynamics and human feelings that are permanently observable, with the difference of times and geographies. Therefore, dealing with Transculturality also made us move forward.

The connection between the idea of truth x simulacrum, expression and media, represented both by the reading of the novel and by the exhibition of the film, from the perspective of the subjectivity of each of the participants of Labhum, opened horizons for the awareness of our humanity, woven in interactions, bonds and relationships in our meetings, as well as in the daily practices of various health professionals.

As described in the Introduction of this text and proposed in Gallian's work, the methodology in three stages (*Reading Stories*, *Discussion Itineraries* and *Living Stories*) were used, which were constantly observed and reevaluated at each meeting by the two coordinators responsible for this Cycle and in dialogue with other colleagues from CeHFI.

At the end of the third stage, *Stories of Coexistence*, it was proposed to write texts that would account for these stories in a creative way and beyond. As the beginning of the next semester, the second of 2025, would open with the Unifesp Academic Congress, the main coordinator organized an exhibition of photographs in which students involved in this discipline could also participate, in addition to posting them on the CehFi blog. These opportunities to reveal the stories of coexistence were the culmination of the high point of the discoveries coming from Labhum and that, in the case of Lablei, also happen in other formats, however.

We present below some of the partial accounts of the participants at the end of the Labhum experience with the narratives of Wilde and Antonioni as the focus – their names

were replaced by fictitious ones, in order to preserve their identities. The choices of the excerpts concern several topics of interest to us, namely:

2 DIVERSITY OF PARTICIPANTS IN RELATION TO AGE, PROFESSIONAL AREA IN HEALTH SERVICES AND RELATIONSHIPS

"It's exciting to explore this new reading with colleagues of different ages and professions, and to reinterpret art together." (Ana)

"... The superficial relationships developed by the protagonists make us question how all this happens today [...] and yet they manage to reveal their true essence to only a few people." (Antonieta)

"... as much as we don't like it, we need to admit that in a way we can be like them (the characters); we are a bit Dorian Gray, in other ways we are like Thomas in the film, and in some points we are in fact similar to Lord Henry, Sybill Vane, and even the girls photographed by Thomas. A little bit of each, depending on the occasion and those with whom we are interacting..." (Gabriela)

3 LITERARY AND FILMIC NARRATIVES IN DIALOGUE WITH CONTEMPORARY LIVES AND COMMUNICATION ON SOCIAL NETWORKS TODAY

"In the book, I saw Harry as the embodiment of evil — a demon that captivates, a transgressor that fascinates, much like so many influencers today." (Ana)

"Every day we try to change the perception of what we don't like about our reality by posting photos that make our lives seem less ordinary than they are. Every day we look for ways to beat time and prolong our appearance of youth." (Bruna)

4 THE POWER OF IMAGES AND THEIR ROLE IN HELPING US REFLECT ON REALITY VS. FANTASY. ALSO, THE SEARCH FOR BEAUTY AS PLEASURE AND TRUTH AND THE USE OF IT AS A PROTECTIVE DISGUISE AGAINST HARSH REALITIES

"In both works, the protagonist places more trust in the image than in the lived reality — revealing the power, and danger, of visual perception, while questioning the very notion of reality." (Lica)

"In the film we have an unscrupulous photographer, surrounded by young people who are not exactly naïve... A professional in search of the perfect click, art, truth, the meaning of life (...) the doubt: what is concrete and what is abstract? What is false and what is true?" (Ilán)

5 LABHUM AS RELIEF, A WELCOMING ENVIRONMENT IN THE FACE OF THE HARSH REALITY OF RATIONAL DISCOURSE

"I felt that I was entering a space of welcome and attentive listening, in which the focus was on collective reflection, the exchange of perceptions and the questioning of our own ways of seeing the world." (Rodrigo)

"I thought it was really great that the conversations transformed a lot of my early perceptions and certainly changed my retelling of the novel and the dialogue with the film this time around." (Ilan)

"My daily life is very scientific, rational, and always rushed. So, dedicating a few hours a week to group reflection, to understanding feelings, to humanizing ourselves, was an essential time for me, particularly with the focus on Wilde and Antonioni." (Marcela)

"... The whole atmosphere of reading the novel, discussing it in dialogue with the film, made me feel part of a collaborative, constructive and collective learning community." (Karla)

6 FINAL CONSIDERATIONS:

We understand that the particularized experience of Labhum reported here was able to promote participatory and open discussions on various topics in dialogue with the plural community of students, who demonstrated real connections between the arts (literature and cinema) and their own experiences lived in our contemporaneity, as witnessed by the examples selected above.

In addition, the innovation proposed in the two types of narratives in different formats (literature and cinema) intensified the involvement of the participants, who crossed times and spaces, summoning them to the present day and to the Brazil of the Portuguese language in their experiences. Throughout the Discussion Itinerary, the students were able to summon several other cultural examples, not only literary, of their personal experiences – including those related to the day-to-day of their work in the areas of Health Sciences – which accounted for the transculturality woven throughout the readings and collective discussions.

Adaptations and translations of texts into other languages are always part of transculturality and are important to the extent that they bring different cuts to other realities. This also did not go unnoticed. On the contrary, the participants compared editions, paratexts and times of readings and rereadings that mattered in the planting of their own stories.

Remedies for the soul, these almost "classics" of contemporary times, signal that it is possible to think of narratives as starting points for the expansion of consciousness, as well as the awareness of who we are individually, from the socialization of ideas, softening the less light experiences of hypermodernity, distancing us from the chaos of the digital age, owing us away from speed and bringing us back to what matters: to the lightness of life, humanization.

REFERENCES

Bauman, Z. (2000). *Modernidade Líquida*. Zahar Editora.

- Bittar, Y., Souza, M. S., & Gallian, D. M. (2013). A experiência estética da literatura como meio de humanização em saúde: O Laboratório de Humanidades da EPM/UNIFESP. *Interface*, 17(44), 171–186.
- Blow-up. (1966). Dirigido por M. Antonioni. Metro-Goldwyn-Mayer. (111 min)
- Cortázar, J. (200?) “As babas do diabo”. In *As armas secretas*. José Olympio. (Obra original publicada em 1959)
- Gallian, D. M. C. (2017). *A literatura como remédio – Os clássicos e saúde da alma*. Martin Claret.
- Gallian, D. M. C. (2013). Literatura e formação humanística em medicina: O experimento do Laboratório de Humanidades da EPM/UNIFESP. *Revista de Medicina (USP)*, 91, 174–177.
- Gallian, D. M. C. (2022). *É próprio do humano: Uma odisseia do autoconhecimento e da autorrealização em 12 lições*. Record.
- Gallian, D. M. C., Lima, C. C., De Benedetto, M. A. C., & Guzman, S. M. (2014). Humanidades e humanização em saúde: A literatura como elemento humanizador para graduandos da área da saúde. *Interface (Botucatu. Online)*, 18, 139–150.
- Hall, S. (1998). *A identidade cultural na pós-modernidade*. DP&A Editora.
- Lipovetsky, G., & Charles, S. (2005). *Hypermodern times*. (A. Brown, Trad.). Polity. (Obra original publicada em francês como *Les temps hypermodernes*, 2004)
- Mituti Junior, R., & Claramonte Gallian, D. M. (2022). Os impactos da literatura na autoidentidade de mães de pessoas com deficiência: A percepção do eu subjetivo afetado pela experiência do Laboratório de Leitura. *MEDICA REVIEW. International Medical Humanities Review / Revista Internacional De Humanidades Médicas*, 10(1), 27–38. <https://doi.org/10.37467/gkarevmedica.v10.3378>
- Mutran, M. (2002). *Álbum de retratos: George Moore, Oscar Wilde e William Butler Yeats no fim do século XIX: Um momento cultural*. Humanitas/FFLCH/USP: Fapesp.
- Welsch, W. (1999). Transculturality - the puzzling form of cultures today. In M. Featherstone & S. Lash (Eds.), *Spaces of culture: City, nation, world* (pp. 194–213). Sage.
- Wilde, O. (2010). *O retrato de Dorian Gray* (J. E. R. Moretzsohn, Trad.). L&PM. (Obra original publicada em 1890)
- Wilde, O. (2021). *O retrato de Dorian Gray* (P. H. Cocconi, Trad.). DarkSide Books. (Obra original publicada em 1890)
- Yzumizawa, A. T., Avancini, A., & Wolkoff, G. (2024). Transculturalidade, Oriente-Occidente e o espaço-entre. *Tradterm*, 46, 179–203. <https://doi.org/10.11606/issn.2317-9511.v46p182-204>

TEACHERS' NEEDS AND READINESS FOR AI-ASSISTED AUGMENTED REALITY LEARNING MEDIA IN ELEMENTARY EDUCATION 5.0

NECESSIDADES E PRONTIDÃO DOS PROFESSORES PARA MÍDIAS DE APRENDIZAGEM EM REALIDADE AUMENTADA ASSISTIDAS POR IA NA EDUCAÇÃO BÁSICA 5.0

NECESIDADES Y PREPARACIÓN DEL PROFESORADO PARA MEDIOS DE APRENDIZAJE DE REALIDAD AUMENTADA ASISTIDOS POR IA EN LA EDUCACIÓN BÁSICA 5.0



<https://doi.org/10.56238/sevened2026.008-101>

**Febrina Dafit¹, Zaka Hadikusuma Ramadan², Yoyon Efendi³, Latif⁴, Khairil Ansari⁵,
Yusnadi⁶**

ABSTRACT

In the era of Education 5.0, teachers are required to integrate digital and intelligent technologies into their classroom practices. This study aims to analyze teachers' needs and readiness for AI-assisted Augmented Reality (AR) learning media in elementary education by identifying their current use of learning models and media as well as the factors influencing their implementation. Using a descriptive survey design, data were collected from 67 fifth-grade teachers across 18 elementary schools in Pekanbaru through a Likert- scale questionnaire distributed via Google Forms. The findings reveal that while most teachers hold positive perceptions toward the use of learning models and media, their actual implementation remains limited. Factors such as teachers' age, educational background, and technological competence were found to affect their readiness to adopt innovative media such as AI-assisted AR. These findings highlight the gap between pedagogical understanding and technological application, indicating the need for targeted training and professional development. The study provides empirical insights that can serve as a foundation for developing adaptive, AI-based AR learning environments that align with teachers identified needs and support meaningful learning in the context of Elementary Education 5.0.

Keywords: Teachers' Needs. Readiness. AI-Assisted Augmented Reality. Learning Media. Education 5.0. Elementary Education.

RESUMO

¹ Elementary School Teacher Education. Elementary Education. Riau Islamic University. State University of Medan. Indonesia. E-mail: febrinadafit@edu.uir.ac.id

² Elementary School Teacher Education. Riau Islamic University. Indonesia.

³ Universitas Sains dan Teknologi Indonesia. Indonesia.

⁴ Elementary School Teacher Education. Universitas Islam Riau. Indonesia.

⁵ Elementary Education. State University of Medan. Indonesia.

⁶ Elementary Education. State University of Medan. Indonesia.

Na era da Educação 5.0, os professores são instados a integrar tecnologias digitais e inteligentes às suas práticas em sala de aula. Este estudo tem como objetivo analisar as necessidades e a prontidão dos professores para o uso de mídias de aprendizagem em Realidade Aumentada (RA) assistidas por Inteligência Artificial (IA) na educação básica, por meio da identificação do uso atual de modelos e mídias de aprendizagem, bem como dos fatores que influenciam sua implementação. Utilizando um delineamento de pesquisa descritiva do tipo survey, os dados foram coletados junto a 67 professores do quinto ano de 18 escolas de educação básica em Pekanbaru, por meio de um questionário em escala Likert distribuído via Google Forms. Os resultados revelam que, embora a maioria dos professores apresente percepções positivas em relação ao uso de modelos e mídias de aprendizagem, sua implementação efetiva ainda é limitada. Fatores como idade, formação acadêmica e competência tecnológica dos professores mostraram-se determinantes para sua prontidão em adotar mídias inovadoras, como a RA assistida por IA. Esses achados evidenciam uma lacuna entre a compreensão pedagógica e a aplicação tecnológica, indicando a necessidade de capacitação direcionada e desenvolvimento profissional. O estudo oferece evidências empíricas que podem servir de base para o desenvolvimento de ambientes de aprendizagem adaptativos, baseados em IA e RA, alinhados às necessidades identificadas dos professores e capazes de promover uma aprendizagem significativa no contexto da Educação Básica 5.0.

Palavras-chave: Necessidades dos Professores. Prontidão. Realidade Aumentada Assistida por IA. Mídias de Aprendizagem. Educação 5.0. Educação Básica.

RESUMEN

En la era de la Educación 5.0, se exige a los docentes integrar tecnologías digitales e inteligentes en sus prácticas de aula. Este estudio tiene como objetivo analizar las necesidades y la preparación del profesorado para el uso de medios de aprendizaje de Realidad Aumentada (RA) asistidos por Inteligencia Artificial (IA) en la educación básica, mediante la identificación del uso actual de modelos y medios de aprendizaje, así como de los factores que influyen en su implementación. Utilizando un diseño de investigación descriptivo de tipo encuesta, los datos fueron recolectados de 67 docentes de quinto grado de 18 escuelas de educación básica en Pekanbaru, a través de un cuestionario en escala Likert distribuido mediante Google Forms. Los resultados revelan que, si bien la mayoría de los docentes mantiene percepciones positivas respecto al uso de modelos y medios de aprendizaje, su implementación efectiva sigue siendo limitada. Factores como la edad, la formación académica y la competencia tecnológica del profesorado influyen en su nivel de preparación para adoptar medios innovadores como la RA asistida por IA. Estos hallazgos ponen de manifiesto la brecha existente entre la comprensión pedagógica y la aplicación tecnológica, lo que indica la necesidad de formación específica y desarrollo profesional. El estudio aporta evidencias empíricas que pueden servir como base para el desarrollo de entornos de aprendizaje adaptativos, basados en IA y RA, alineados con las necesidades identificadas del profesorado y orientados a promover un aprendizaje significativo en el contexto de la Educación Básica 5.0.

Palabras clave: Necesidades del Profesorado. Preparación. Realidad Aumentada Asistida por IA. Medios de Aprendizaje. Educación 5.0. Educación Básica.

1 INTRODUCTION

Education has long been a serious concern of the Indonesian government in its role in improving the quality of human resources. Education is important at all levels of a country (Johnes et al., 2017; Alam et al., 2020). Education is the key to all quality progress and development, because with education human beings can realize all their potential, both as themselves and as a society. This is in line with the opinion (Kuswari et al., 2019) that education is a guiding effort, which is carried out consciously by educators (including parents) to students with the aim of developing students' potential to form a perfect personality. Basically, education functions to develop abilities and form a dignified character and civilization of the nation in order to educate the life of the nation (Utomo et al., 2020).

The learning process in schools is one of the educational processes. Learning is not he learning process in schools is one of the essential dimensions of the educational process. Learning is not merely a transfer of knowledge from educators to students (teacher-centered), but an interactive process in which students are encouraged to actively seek, process, and construct knowledge independently so that learning becomes student- centered (Aufa et al., 2020)). This aligns with the view of Brown., 2018, who emphasizes that student-centered learning focuses on learners' needs, abilities, interests, and learning styles, while teachers act as facilitators who design experiences that stimulate independent and critical thinking.

Various programs are prepared to improve the quality of education, one of which is by developing the curriculum. An effective curriculum should reflect the philosophy, objectives, objectives, learning experiences, instructional resources, and assessments that a particular educational program consists of (Alsubaie, 2016). Therefore, education in Indonesia often undergoes curriculum changes, starting from the curriculum in 1947, 1952, 1964, 1968, 1975, 1984, 1994, 2004, 2006, 2013 to the present day the independent curriculum is used. This independent learning curriculum is in accordance with the ideals of national education figures, namely Ki Hajar Dewantara, who prioritizes the freedom of independent and creative learning (Ardianti & Amalia, 2022). Within this curriculum, learning is designed to allow more time for concept comprehension and competency development through varied, contextual learning activities

One important determinant of curriculum success is the learning model employed by teachers. The learning model represents a systematic instructional design that organizes learning experiences to achieve specific objectives (Trianto, 2011). It serves as a pedagogical guide for planning and implementing classroom instruction (Joyce et al., 2016). However, despite understanding its importance, many teachers continue to rely on traditional, lecture-

based methods characterized by teacher dominance, passive students, limited questioning, and textbook dependence typical of schooling in many developing countries (Retnawati et al., 2011). This traditional paradigm emphasizes teaching rather than learning, limiting students' opportunities for creative and critical engagement. While teachers acknowledge the importance of using innovative models (Dafit, 2017), many still face obstacles in implementing them effectively within the classroom context (Winda & Dafit., 2021)

The rapid transformation toward Education 5.0 represents a major paradigm shift in global education. Unlike previous eras focused solely on digitalization (Education 4.0), Education 5.0 emphasizes collaboration between humans and intelligent technologies to create learning environments that are adaptive, personalized, and immersive (Morze et al., 2023). Within this framework, Artificial Intelligence (AI) serves as the analytical brain of education capable of diagnosing learners' strengths and weaknesses, generating individualized learning paths, and providing real-time adaptive feedback (Holmes et al., 2019; Zawacki et al, 2019)

Simultaneously, Augmented Reality (AR) serves as the sensory bridge that connects learners with knowledge through visual and interactive experiences. AR technology overlays digital objects and simulations onto real-world environments, allowing learners to visualize abstract concepts in engaging, contextualized ways (Ibáñez et al, 2018; Chang & Hwang, 2022). When AI and AR are integrated forming AI-assisted AR learning media, they can create adaptive, data-driven learning ecosystems. AI analyzes student performance and tailor content dynamically, while AR immerses learners in interactive visualization that stimulates cognitive and emotional engagement (Chou et al., 2023)

Such integration provides immense potential for elementary education, particularly in supporting reading literacy and conceptual understanding. However, the success of AI-assisted AR media largely depends on teachers' pedagogical and technological readiness. Teachers must not only master the use of the technology but also understand how to embed it meaningfully within pedagogical frameworks that promote inquiry, collaboration, and reflection (Eickelmann et al, 2020). Hence, exploring teachers' needs and readiness toward learning models and media becomes a foundational step in designing future adaptive, AI-driven instructional systems that are both innovative and realistic in classroom implementation.

The implementation of Indonesian learning in several schools shows variations in the approach used. Based on the results of the interview, teachers in one of the schools stated that they use a problem-based learning model. In other schools, teachers reported that the method applied was expository learning combined with assignments, questions and answers,

and sometimes discussions. Observations conducted at the school support these findings, showing that teachers often apply expository learning in the language learning process. However, the results of interviews at different schools show significant differences; In grade V, teachers do not apply the problem-based learning model as previously reported, but only use lectures, questions and answers, and assignments according to students' books. Therefore, when learning relies solely on lecture methods, students may have difficulty understanding the material effectively.

The findings above emphasize that teachers tend to use expository methods and do not apply relevant learning models to support elementary school students' reading literacy. Similar to the findings of Widodo (2019) teachers in reading classes often neglect model-based instruction. As a result, students lack opportunities for creative thinking and problem solving. Teachers rely heavily on textbooks as the primary learning source, without employing innovative models that could strengthen comprehension and engagement. Consequently, learning objectives are not achieved optimally.

In addition to instructional strategy, learning media are a crucial component of the learning process. In the modern era, media cannot be separated from effective pedagogy, as they clarify abstract concepts, stimulate students' thoughts and feelings, and enhance active participation (Puspitasari & Hanif, 2019). Educational media possess transformative potential to shape learners' attitudes and behavior toward creativity and dynamic change (Heinich et al, 2002; Sadiman, 2014). However, observations reveal that the use of learning media among teachers remains suboptimal. Interviews with several grade 5 teachers indicated that they generally use static picture media, attached to the board with glue, whose small size often limits visibility. This aligns with research by (Mustika & Ain, 2020), showing that conventional visual aids are ineffective in explaining abstract concepts that require interactivity and multisensory engagement.

These findings underscore a pressing need to redefine learning media through technology-enhanced, intelligent solutions. Traditional tools are insufficient to meet the demands of Education 5.0, where learners must engage with dynamic, multimodal, and adaptive experiences. AI-assisted Augmented Reality (AR) represents a promising alternative, offering interactivity, visualization, and adaptivity simultaneously. In language learning, for example, AR can visualize text structures, vocabulary, and narrative flow in 3D environments, while AI algorithms analyze learners' reading behaviors and provide tailored scaffolding (Chang & Hwang, 2022). Such innovations can transform passive reading into an active, exploratory process that enhances comprehension and critical literacy.

Nevertheless, the success of these innovations depends on teachers' readiness and contextual needs. Teachers must perceive technology not as an additional burden but as a pedagogical partner that amplifies their instructional impact. Therefore, analyzing teachers' needs and readiness regarding learning models and media is a critical first stage in building adaptive AI-based learning systems that are pedagogically sound and practically implementable in Indonesian elementary schools.

The use of learning models and media has become increasingly relevant in today's educational landscape, where technology advances rapidly. Teachers face the challenge of integrating various tools and intelligent systems to create engaging, interactive, and effective learning environments. Hence, this study aims to analyze teachers' needs and readiness for learning models and media as a foundation for developing AI-assisted Augmented Reality learning media in the context of Elementary Education 5.0. The results are expected to identify factors influencing teachers' readiness to integrate intelligent technologies, as well as provide an empirical foundation for designing adaptive learning systems that enhance both teaching quality and student literacy outcomes.

2 METHOD

This study employed a quantitative survey research design aimed at obtaining a comprehensive and systematic description of teachers' use of learning models and media in elementary schools. The survey design was selected because it enables the collection of empirical data from a relatively large sample, providing both breadth and depth in understanding teachers' perceptions, needs, and readiness (Creswell & Creswell, 2018). This design is particularly appropriate for generating baseline data that can inform the development of AI-assisted Augmented Reality (AR) learning media and adaptive learning systems.

The population of this study consisted of elementary school teachers in the city of Pekanbaru, Indonesia. Using purposive sampling, 67 fifth-grade teachers from 18 public and private elementary schools were selected as respondents. The sample was chosen to ensure adequate representation across schools with varying levels of technological resources, teaching experience, and demographic characteristics. This diversity allows for a richer analysis of teachers' needs and readiness in relation to pedagogical and technological innovation. Data were collected through a structured questionnaire designed specifically for this study. The research instrument was constructed based on a review of pedagogical and technological integration theories, particularly the TPACK framework (Mishra & Koehler,

2006), the Technology Readiness Index (Parasuraman, 2000), and the Technology Acceptance Model (Davis, 1989).

Each item was rated using a five-point Likert scale, where 1 = Strongly Disagree and 5 = Strongly Agree. Prior to data collection, the questionnaire was validated by three experts in educational technology and instructional design to ensure content validity, clarity, and relevance to the study objectives. Reliability was tested using Cronbach's Alpha, yielding a coefficient above 0.80, indicating a high level of internal consistency. The data collection process involved three key stages:

1. Preparation and validation, including expert review, pilot testing, and final revision of the questionnaire.
2. Administration, in which the questionnaire was distributed online via Google Forms to facilitate broad participation and efficient data management. Respondents were given one week to complete the questionnaire.
3. Verification, where all responses were checked for completeness, and invalid entries were removed prior to analysis.

Ethical considerations were observed throughout the process. Participation was voluntary, and informed consent was obtained from all respondents. Data were collected anonymously and used solely for academic purposes.

The collected data were analyzed using descriptive statistical techniques, including frequency distribution, percentage, mean, and standard deviation. These measures were used to identify general trends and patterns in teachers' responses regarding the use of learning models, learning media, and technology readiness. In addition, data visualization through bar charts and cross-tabulation was used to explore relationships between variables such as teachers' age, education level, and media use frequency. The analysis results were interpreted in light of contemporary frameworks on AI-assisted adaptive learning systems, connecting empirical findings to the broader theoretical discourse on Education 5.0. The overall research procedure followed these systematic stages:

1. Identification of research problem (limited use of innovative models and media).
2. Instrument development (questionnaire design and validation).
3. Data collection via Google Forms.
4. Data analysis using descriptive statistics.
5. Interpretation and discussion, connecting findings with teachers' readiness for AI-AR-based adaptive learning media.

The methodological design ensures that the results are valid, reliable, and relevant for informing future development of intelligent, adaptive learning environments in elementary education.

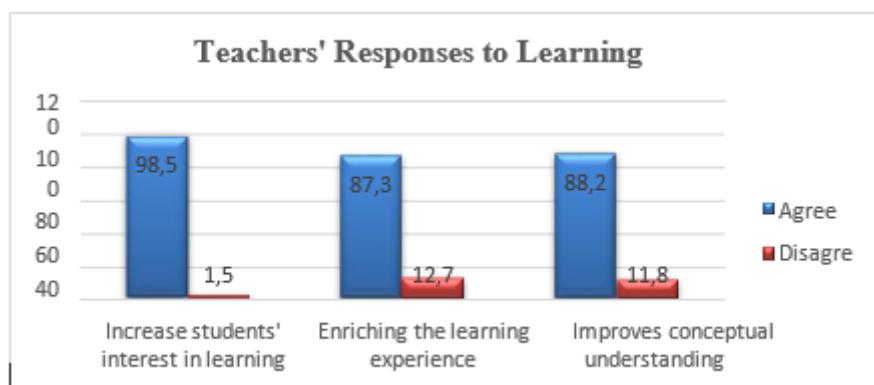
3 RESULTS AND DISCUSSION RESULTS

The following are the results of the needs analysis obtained through filling out a questionnaire through google form with a total number of respondents being 67. The results showed that respondents gave very positive responses to the benefits of using learning media and variations of learning models in the context of learning in elementary schools. The following are the results of the use of media and models for elementary school teachers based on research:

1. Teachers' Responses to Learning Media

This response is an important aspect in evaluating the effectiveness of the use of technology in the learning process in elementary school. Through filling out questionnaires, teachers gave their views on the extent to which the use of learning media has enriched students' learning experiences, increased their engagement, and improved their understanding of subject matter. Positive responses from teachers will indicate that learning media has become an effective tool in supporting the achievement of learning objectives, while negative or neutral responses indicate challenges or opportunities for improvement in the application of learning media. By understanding teachers' responses to learning media, appropriate strategies and adjustments can be made to improve their use in the future. Furthermore, the following diagram shows the distribution of the percentage of positive responses from respondents to the benefits of using a variety of learning media:

Figure 1



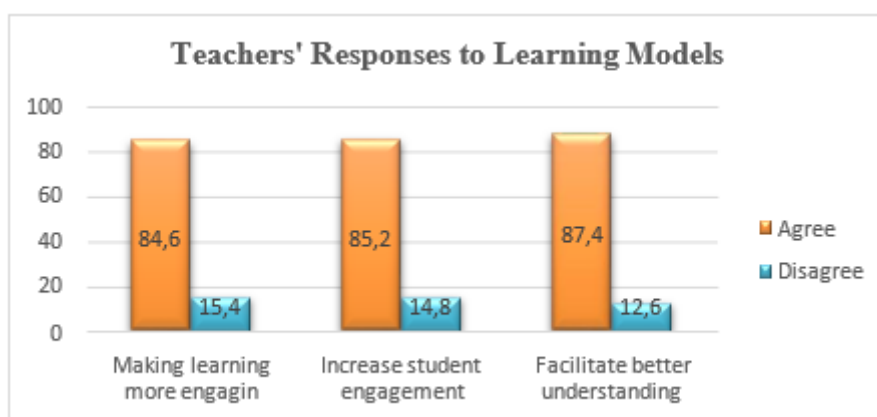
Based on the diagram above, the majority of respondents, reaching 98.5%, stated that the use of learning media can increase students' interest in learning. Meanwhile, 87.3% of them believe that learning media can enrich students' learning experience. In addition, as many as 88.2% of respondents considered that the use of learning media could improve students' understanding of concepts. This positive response shows a strong awareness among teachers of the importance of utilizing technology in the learning process. The perception that the use of learning media can increase students' interest in learning and enrich their experience gives an indication that this approach is considered relevant and beneficial in helping students better understand lesson concepts.

The findings above reveal that although teachers recognize the pedagogical value of diverse models and media, the extent of their practical application remains limited. This indicates a transitional stage in teachers' pedagogical development, where awareness of innovation exists but the ability to operationalize it is still constrained. To interpret this phenomenon more deeply, it is important to analyze the patterns of model and media use in the broader context of Education 5.0, which emphasizes collaboration between humans and intelligent technologies

2. Teachers' Responses to Learning Models

This response is an important aspect in evaluating the effectiveness of various learning methods applied in elementary schools. Through filling out questionnaires, teachers provided their views on the extent to which the variety of learning models has helped improve student engagement, concept understanding, and their learning atmosphere. Positive responses from teachers will show that the learning models implemented have been effective in creating a motivating and useful learning environment. On the other hand, negative or neutral responses indicate the need for further adjustment or development in the implementation of learning models. By understanding teachers' responses to the learning model, appropriate strategies and adjustments can be made to improve its use in the future, as well as have a positive influence on student learning outcomes. Furthermore, the following diagram shows the distribution of the percentage of positive responses from respondents to the benefits of using learning model variations:

Figure 2

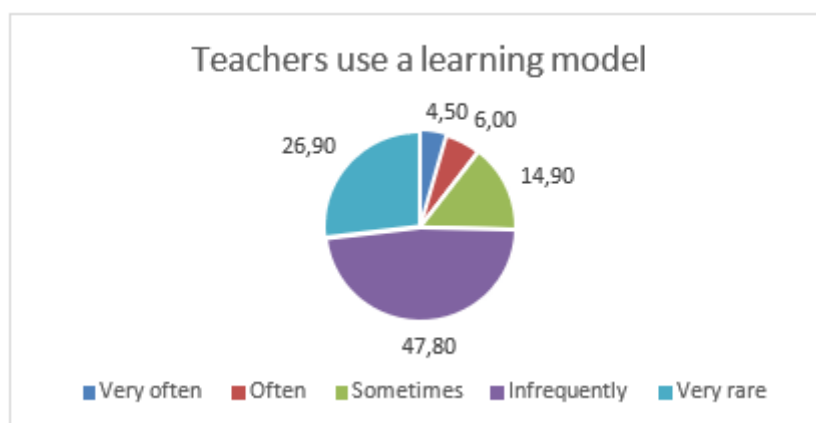


Based on the diagram above, most respondents also agreed that the use of a variety of learning models can make learning more engaging (84.6%), increase student engagement (85.2%), and facilitate better understanding (87.4%). These results reflect a strong understanding from teachers about the benefits of applying diverse learning models in the learning process. This high percentage of positive responses shows that teachers in elementary schools strongly support the use of a variety of learning models as a strategy to create a more engaging, interactive, and effective learning environment. It also reflects their awareness of the importance of actively involving students in the learning process to facilitate deeper and ongoing understanding.

3. Use of Learning Models

The use of learning models is a key factor in creating an effective learning environment in elementary schools. In developing learning strategies, it is important for teachers to pay attention to the various learning models available and choose the one that best suits the needs of students and the subject matter being taught. Through filling out questionnaires, teachers' responses to the use of learning models can provide an overview of the extent to which various learning approaches have been implemented in primary schools. The following are the results of the questionnaire filled out by the teachers regarding the use of the learning model:

Figure 3

**Table 1**

Teachers' responses to the use of learning models

Yes	Range	Criterion	Frequency	Percentage
1	86 – 100	Very often	3	4,5%
2	76 – 85	Often	4	6%
3	60 – 75	Sometimes	10	14,9%
4	55 – 59	Infrequently	32	47,8%
5	< 54	Very Rare	18	26,9%
Total			67	100%

The results showed that the use of the learning model in the classroom by respondents varied, with the majority of respondents assessing that the use was infrequent or even very rare. Of the total 67 respondents, as many as 18 people or around 26.9% stated that they rarely use the learning model in classroom learning. Meanwhile, 32 people or about 47.8% of the total respondents revealed that they rarely use the learning model. Meanwhile, around 14.9% of respondents said that they only occasionally use the learning model. The percentage of more active use, such as "frequently" and "very often", was recorded lower, with only 6% of respondents stating that they use the learning model frequently, and 4.5% stating that they do so very often.

These findings show a pattern that shows the low application of the learning model in classroom learning in elementary schools. In addition to the table above, the results of the questionnaire filled out by the teachers regarding the use of the learning model can be explained with the help of the following diagram:

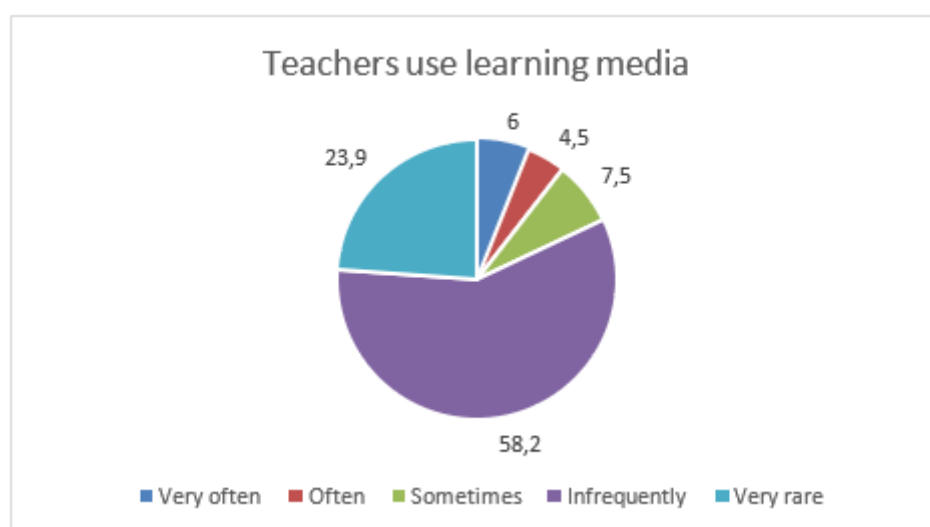
4. Use of Learning Media

The use of learning media is very important in basic education. Through questionnaires, the authors collected data to find out the extent to which learning media was used and how it affected the learning process. This explanation will help in presenting the results of the questionnaire analysis that will be described next.

Table 2*Teachers' responses to the use of learning media*

Yes	Range	Criterion	Frequency	Percentage
1	86 – 100	Very often	4	6%
2	76 – 85	Often	3	4,5%
3	60 – 75	Sometimes	5	7,5%
4	55 – 59	Infrequently	39	58,2%
5	< 54	Very Rare	16	23,9%
Total			67	100%

Then the results showed that the use of learning media in classroom learning by respondents tended to be low, with the majority of them stating that the use was infrequent or even very rare. Of the total 67 respondents, as many as 16 people or around 23.9% stated that they rarely use learning media in classroom learning. Meanwhile, as many as 39 people or around 58.2% of the total respondents revealed that they rarely use learning media. Only a small percentage of respondents stated that they use learning media with a higher frequency, of which 5 people or about 7.5% stated that they sometimes use learning media, 3 people or about 4.5% stated that they use learning media frequently, and 4 people or about 6.0% stated that they do it very often. These findings highlight the low application of learning media in the context of learning in elementary schools. In addition to the table above, the results of the questionnaire filled out by teachers regarding the use of learning media can be explained with the help of the following diagram:

Figure 4

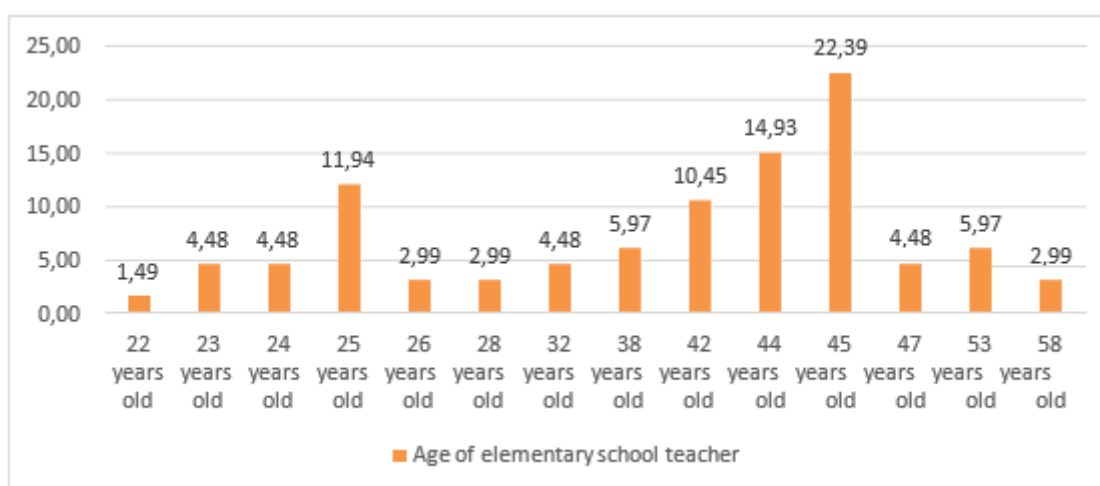
The findings reflect a transitional stage in the pedagogical development of elementary teachers—where there is awareness of the need for innovation but insufficient readiness to implement it effectively. The predominance of expository models and static media suggests that teachers' instructional practices are still positioned within Education 3.0 and 4.0 paradigms, which emphasize information transfer rather than adaptive learning. In contrast, Education 5.0 requires a human– technology partnership, where teachers are supported by intelligent systems capable of adaptive feedback and multimodal interaction (Holmes et al., 2019; Morze et al., 2023)

From the results of the questionnaire analysis, it was revealed that the use of learning media by teachers is still relatively low in the context of classroom learning. The majority of teachers tend to rarely use learning media as a means of support in their teaching process. In addition, the findings show that the use of learning models in the classroom is also not carried out consistently, with the majority of teachers rarely applying variations of learning models in every meeting. This phenomenon reflects a significant gap between the potential of learning media and the practices carried out by teachers in the reality of classroom learning. This illustrates the challenges faced by the education system in integrating learning technologies and innovations into everyday classroom practices.

5. Factors that can lead to the lack of use of learning models and media by teachers in elementary schools

Identifying and understanding the factors that influence the lack of use of learning models and media by teachers in elementary schools is a critical step in developing effective strategies to improve the application of technology in the learning process. Thus, an in-depth understanding of the factors that influence the use of learning models and media can help form a holistic and sustainable strategy in improving the quality of learning in elementary schools. The following is a visual representation of the age data of elementary school teachers in the form of a diagram below:

Figure 5

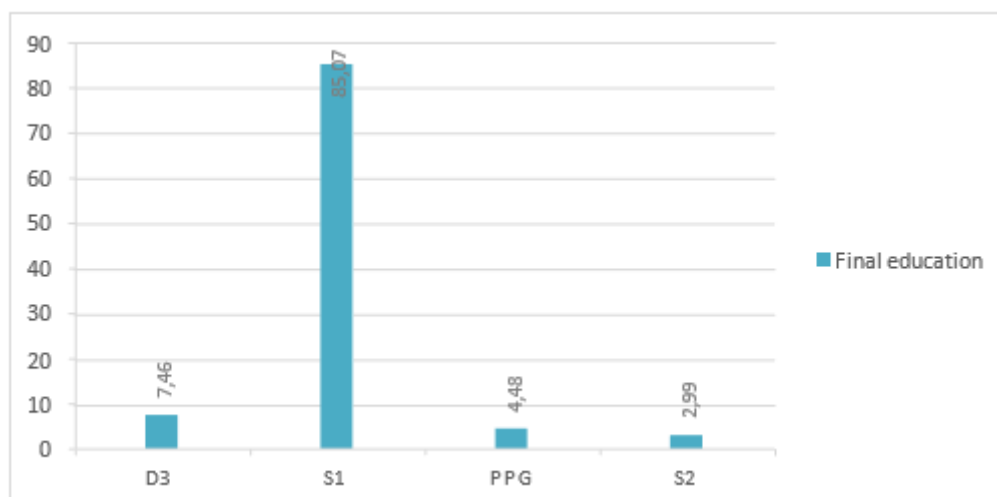


The low use of learning media and the variation of learning models in the context of learning in elementary schools seem to be influenced by the age factor of teachers. From the results of filling out the questionnaire by 67 respondents, as many as 41 respondents or around 61.2% of the total respondents were over 40 years old. The low use of learning media and variations in learning models in the context of learning in elementary schools can be caused by several factors related to the age of teachers. First, the lack of technological skills is one of the main obstacles. Teachers over the age of 40 may not have the same level of proficiency in the use of technology as younger generations. In addition, skepticism towards technology can also affect its use. Some older teachers may feel that traditional learning methods are more effective than new learning mediums. Furthermore, the lack of motivation to learn new technologies is also an important factor. Teachers who have been teaching for a long time may feel satisfied with the methods they have mastered, so they are not motivated to develop new skills. Finally, the challenge of adapting to change also plays a role. Older teachers may tend to stick to familiar practices rather than trying new things, making it difficult for them to introduce new variations of learning models.

Furthermore, the low use of learning media and the variety of learning models in the context of learning in elementary schools can also be influenced by the teacher's last education factor. From the results of the questionnaire conducted, it can be seen that most of the teachers have a last educational background at the S1 level, reaching around 85.07% of the total respondents. This significant number shows the dominance of undergraduate education background as the last knowledge possessed by the majority of teachers at the primary level. On the other hand, only a small percentage of respondents have an educational background at the Teacher Professional Education (PPG) level, which is around 4.48%. Meanwhile, D3 educational backgrounds cover about 7.46% of the total respondents, and

only a small percentage have a S2 degree, which is around 2.99%. There is a visual representation of the final education data of elementary school teachers in the form of a diagram below:

Figure 6



This last educational factor can provide an overview of the teacher's level of understanding and skill in terms of the use of learning media and the variety of learning models. Teachers with higher education backgrounds may have better knowledge and skills in adopting innovative learning technologies and methods. However, the relatively low number of teachers with a background in undergraduate education suggests that they may have limited access to advanced education that delves into modern learning strategies.

Thus, the last education factor of teachers, especially the dominance of S1 educational background, can be one of the factors that affect the low use of learning media and the variety of learning models in elementary schools. Teachers with a S1 education background may not have enough knowledge or skills related to technology and innovation in learning. Therefore, further efforts are needed to improve teachers' understanding and skills. Thus, they can be more effective in utilizing technology and implementing innovative learning models in classroom learning, thereby providing a more diverse and meaningful learning experience for students.

4 DISCUSSION

In interpreting the results of this study, it is important to understand the context and findings obtained from the questionnaire distributed to teachers. The results of this survey provide in-depth insights into the use of learning media, variations in learning models, and

factors that affect the application of technology in the learning process in elementary schools. The following discussion will elaborate on the findings in detail, including teachers' responses to learning media, the effectiveness of learning model variations, and analysis of factors that affect the use of media and learning models in the context of basic education.

Teachers' Responses to Learning Media

The results of the study show that teachers in elementary schools have a very positive view of the use of learning media. The majority of teachers feel that learning media, such as images and videos, not only increase students' interest in learning but also enrich their learning experience. This view shows that learning media functions more than just an aid; It plays an important role in making the learning process more interesting and relevant for students.

Teachers also acknowledge that learning media contributes significantly to improving students' understanding of concepts. Learning media not only has an appeal that

makes the subject matter more interesting, but it is also effective in explaining and visualizing complex subject matter. Awareness of the significant benefits of learning media is in line with the existing literature, which shows that the effective use of media can improve student learning outcomes and better achieve learning goals. This view is in line with the findings (Puspitarini & Hanif, 2019); Sari & Setiawan, 2018), which states that learning media that is used appropriately can be an efficient support tool in achieving learning goals and improving student learning outcomes. In addition, as previous research has suggested, learning media in the presentation of material by teachers has great benefits in improving students' ability to understand and digest information (Tamrin et al., 2017).

However, although positive responses dominate, challenges in the use of learning media remain. Limited resources, such as inadequate equipment and lack of technical training, can hinder the implementation of optimal learning media. Therefore, it is important to identify and overcome these barriers so that learning media can be used optimally to support the learning process in the future. Efforts such as improving teacher training and providing adequate resources need to be made to ensure that learning media can be used effectively and efficiently.

Teachers' Responses to Learning Models

The results showed that teachers in elementary schools responded positively to the variety of learning models applied in the classroom. Many teachers feel that the use of various learning models makes the learning process more engaging and effective in increasing student engagement. This varied approach is considered a successful strategy to motivate students and encourage their active participation in learning activities.

Furthermore, teachers also benefit from a variety of learning models in facilitating the understanding of subject matter. This indicates that diverse approaches in teaching methods can improve the way students understand and internalize the concepts being taught. Awareness of the benefits of this flexible and innovative approach underscores its importance in creating a dynamic and interactive learning environment.

Active learning strategies play an important role in transforming students from passive participants to active participants (Meyers, 1986). By using techniques such as small groups, scenarios, and case studies, students' critical thinking skills can be improved (Burbach et al., 2004; Larry & Mary, 2014). This approach is often referred to as student-centered learning, where students not only 'do' learning but also reflect on their learning experiences (Kusumoto, 2018; Bonwell & E, 1991)

Positive responses from teachers show that variations of learning models are well accepted as an effective strategy to improve the quality of learning in elementary schools. This approach supports the principle of meaningful learning, which emphasizes the importance of students associating new information with the knowledge they already have. According to Ausubel (Baharuddin, 2020), meaningful learning occurs when students are able to relate new information with previous experiences and knowledge, resulting in a deeper understanding and not easily forgotten (Gazali, 2016). Therefore, the application of a variety of learning models can enrich the learning process and help students gain a more complete and sustainable understanding of the subject matter.

Use of Learning Models

Although responses to variations in learning models are generally positive, research data show that the application of these models in classroom practice still tends to be low. Many teachers report that they rarely or even very rarely use varied learning models. This phenomenon shows that there is a gap between the theoretical understanding of the benefits of learning models and the reality in the field. Some of the factors that may lead to this low adoption include time constraints, lack of adequate resources, and lack of effective training in the implementation of these models. Teachers may find it difficult to integrate new learning models into a hectic schedule or may feel they do not have enough access to the tools and resources needed to implement them.

To address these issues, it is important to evaluate and address these barriers with a planned approach. The development of better and comprehensive training for teachers can provide them with the skills and knowledge necessary to implement learning models more effectively. Additionally, the provision of adequate resources, such as relevant learning materials and supporting technology, as well as strong administrative support, can help

facilitate the use of a broader learning model. By implementing these measures, learning models can be integrated more effectively into daily teaching practices, which will ultimately contribute to improving the quality of learning in primary schools as a whole.

The use of appropriate learning models is a key factor in determining the success of the learning process (Irviana, 2020). A model that meets good criteria will create an effective and efficient learning process (Mahjaty, 2017). On the other hand, an inappropriate model can result in various problems in learning, such as unclear material and lack of student involvement. Therefore, the role of teachers is very important in choosing and implementing appropriate and effective learning models (Li et al., 2021). The learning model functions as a systematic pattern in organizing the learning experience and serves as a guideline in planning and implementing learning activities. This opinion is in line with (Rubiah, 2016), which emphasizes that the learning model is a strategy used by teachers to carry out teaching and learning activities optimally. By understanding and implementing the right learning model, the quality and effectiveness of the learning process can be significantly improved, thereby creating a more productive and meaningful learning environment for students.

Use of Learning Media

Learning media is a tool provided by teachers to stimulate and facilitate students in the learning process (Cilliers, 2021). This media can be in the form of audio, visual, or audio-visual. (Dziuban et al., 2018) states that media consists of various components in a student's learning environment that can encourage them to learn. (Cheung & Ng, 2021: Sung et al., 2016) adding that media includes any physical tool capable of presenting a message and stimulating students' interest in learning, such as books, movies, tapes, and videos (Tan, 2018).

The results showed that the use of learning media in classroom practice by teachers tended to be low, with the majority of teachers reporting that they rarely or very rarely used learning media in the teaching process. This phenomenon reflects a significant gap between the potential of learning media that should be able to enrich the learning experience and the real practices carried out in the classroom. The low frequency of use of this media can be caused by several factors. Resource limitations, such as a lack of adequate devices or limited access to technology, are often a major obstacle. In addition, the lack of effective training for teachers in integrating learning media into their teaching strategies also contributes to low usage. Teachers may also feel uncomfortable or lack confidence in using new technologies, which can hinder wider adoption of learning media.

To address this issue, it is important to conduct a thorough evaluation of existing supports and increase initiatives to facilitate the use of learning media. This includes

developing better and ongoing training for teachers so that they are better prepared and confident in using media as a learning tool. Strong administrative support is also needed to ensure that teachers have access to the necessary resources and can effectively integrate learning media in their practice.

In this modern era, learning media is an important element in the learning process, and the success of the material delivered by teachers is greatly influenced by the effectiveness of the media used (Mustaqim, 2016). By utilizing effective learning media, we can achieve a significant improvement in the quality of the teaching and learning process (Roof, 2018). The importance of technology in education today cannot be ignored. Many studies have been conducted on the development of ICT-based learning media, but there is still little focus on its use in elementary schools. The ability of teachers to integrate ICT into the learning process will also have a significant impact on students' ability to achieve learning goals (Porter, 2017); Nambisan & Luo, 2021). Therefore, teachers must be able to design creative and innovative learning that is integrated with the use of ICT (Yunus & Suliman, 2014). App-based or digital learning media provide visually and audio information that is visually and audio engaging and displays real-world events in virtual form to create more active and engaged learning (Degner et al., 2022). This is important, considering that technology that continues to evolve must be in line with its use in education, starting from elementary school.

Factors Influencing the Use of Learning Models and Media

Identifying the factors that influence the low use of learning models and media is essential to develop effective strategies. One of the main factors identified is the age of the teacher. The majority of teachers over the age of 40 may have difficulty adopting new technologies and tend to be more comfortable with traditional teaching methods. Lack of technological skills, skepticism towards technology, and lack of motivation to learn new technologies can be significant obstacles in the application of media and learning models. This is supported by the view (Winda & Dafit, 2021) that the factors that cause teachers to have difficulty operating IT-based media, such as laptops/computers, infocus, printers, and the internet, include lack of knowledge about technology, especially for more senior teachers, as well as difficulties in finding files due to lack of skills in managing and storing digital data. Thus, the combination of these factors can lead to low use of learning media and variations in learning models in elementary school learning

In addition, teachers' educational backgrounds also play a significant role in the application of media and learning models. Most teachers in primary schools have a final educational background at the S1 level, while the number of teachers with higher education

degrees, such as S2 or professional education, is relatively small. Teachers with advanced education generally have better knowledge and skills in adopting innovative technologies and learning methods. They may be more open and trained in using a variety of modern strategies in teaching. Conversely, the low proportion of teachers with advanced education suggests that many teachers may be less exposed to current learning strategies and in-depth training.

This combination of age and education level factors may explain why media use and variation of learning models in elementary schools are still low. Older teachers may have difficulty adopting new technologies and innovative learning methods, while limitations in continuing education may limit their knowledge of modern approaches to teaching. To address this issue, there needs to be more comprehensive training and adequate technical support for all teachers. Additionally, increasing access to continuing professional education will help teachers adapt to changes and developments in learning practices.

The analysis of teacher-related factors such as age, education level, and technological skill illustrates the uneven distribution of digital readiness among elementary teachers. According to the Technology Readiness Index (Parasuraman, 2000), users' optimism and innovativeness strongly determine technology adoption. The findings suggest that although teachers acknowledge the value of learning media, their limited exposure and digital confidence hinder integration. Therefore, these empirical patterns provide a diagnostic foundation for designing AI-assisted Augmented Reality (AR) learning media that align with teachers' needs and readiness in the context of Education 5.0.

Overall, the survey findings should not be viewed merely as limitations in teachers' practices but as opportunities for targeted innovation. By addressing the gaps in model and media utilization through AI-AR-supported learning designs, future educational frameworks can enhance both teachers' pedagogical competence and students' literacy outcomes in the spirit of Education 5.0.

5 CONCLUSION

This study revealed that although the majority of teachers gave positive responses to the use of learning media and variations of learning models, their implementation in the field was still relatively low. Most respondents acknowledged that learning media has significant benefits in increasing students' interest in learning, enriching the learning experience, and improving concept understanding. Similarly, variations of learning models are thought to make learning more engaging, increase student engagement, and facilitate better understanding. However, the results of the study show that the use of learning media and learning models in daily practice in the classroom is still rare. Factors such as the teacher's

age and their last level of education play a significant role in the low adoption of media and learning models. Therefore, further efforts need to be made to improve teachers' understanding and skills in utilizing technology and various innovative learning models. This includes providing additional training and support necessary to help teachers adapt to modern learning methods and tools, with the aim of creating a more effective learning environment and supporting student development in primary schools.

REFERENCES

- Agustira, S., & Rahmi, R. (2022). Penggunaan Media Pembelajaran untuk Meningkatkan Hasil Belajar Siswa Pada Tingkat SD. *Mubtadi: Jurnal Pendidikan Ibtidaiyah*, 4(1), 157–171.
- Alam, G. M., Forhad, A. R., & Ismail, I. A. (2020). Can education as an 'International Commodity' be the backbone or cane of a nation in the era of fourth industrial revolution? - A Comparative study. *Technological Forecasting and Social Change*, 159, 1–14. <https://doi.org/10.1016/j.techfore.2020.120184>.
- Alsubaie, M. A. (2016). Teacher Involvement in Curriculum Development. *Journal of Education and Practice*, 7(9), 106–107.
- Ardianti, Y., & Amalia, N. (2022). Kurikulum Merdeka: Pemaknaan Merdeka dalam Perencanaan Pembelajaran di Sekolah Dasar. *Jurnal Penelitian Dan Pengembangan Pendidikan*, 6(3), 399–407.
- Aufa, M. N., Iriani, R., Saadi, P., Hasbie, M., Fitri, M. A., & Yunita, A. (2020). Module Development with Problem Based Learning (PBL) Model Based on Environmental Wetland to Increase Students Learning Outcomes. *Jkpk (Jurnal Kimia Dan Pendidikan Kimia)*, 5(2), 201–210.
- Baharuddin, I. (2020). Pembelajaran Bermakna Berbasis Daring Ditengah Pandemi Covid-19. *Kelola: Journal of Islamic Education Management*, 5(2), 79–88. <https://ejournal.iainpalopo.ac.id/index.php/kelola/article/view/1377>
- Bonwell, C. C., & E, J. A. (1991). Active learning: Creating excitement in the classroom. ASHE- ERIC Higher Education Report.
- Burbach, M. E., Matkin, G. S., & Fritz, S. M. (2004). Teaching critical thinking in an introductory leadership course utilizing active-learning strategies: A confirmatory study. *College Students Journal*, 38(3), 482–493.
- Cheung, S. Y., & Ng, K. Y. (2021). Application of the Educational Game to Enhance Student Learning. *Frontiers in Education*, 6(623793). <https://doi.org/https://doi.org/10.3389/feduc.2021.623793>
- Cilliers, E. J. (2021). Reflecting on Social Learning Tools to Enhance the Teaching-Learning Experience of Generation Z Learners. *Frontiers in Education*, 5(606533).
- Dafit, F. (2017). Implementasi Model Multiliterasi Pada Proses Pembelajaran Membaca Pemahaman Siswa Kelas IV Sekolah Dasar. *Js (Jurnal Sekolah)*, 1(2), 53–59. <https://doi.org/10.24114/js.v1i2.7338>
- Darmadi, D., Budiono, B., & Rifai, M. (2022). Pembelajaran STEAM Sebagai Pembelajaran Inovatif. *Jmm*, 2(8), 3469–3474.

- de Feiter, L., Vonk, H., & Van den Akker, J. (1995). Towards more effective science teacher development in Southern Africa. VU University Press.
- de Jong, A., Schepers, J. J. L., Lages, C. R., & Kadić-Maglajlić, S. (2021). The role of the service manager's perceived career success in frontline employees' learning processes and service improvement. *Journal of Business Research*, 134(February 2020), 601–617. <https://doi.org/10.1016/j.jbusres.2021.05.051>
- Degner, M., Moser, S., & Lewalter, D. (2022). Digital media in institutional informal learning places: A systematic literature review. *Computers and Education Open*, 1(100068). <https://doi.org/https://doi.org/10.1016/j.caeo.2021.100068>.
- Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: The new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, 15(1). <https://doi.org/10.1186/s41239-017-0087-5>
- Gazali, R. Y. (2016). Pembelajaran Matematika yang Bermakna. *Math Didactic: Jurnal Pendidikan Matematika*, 2(3), 181–190. <https://www.neliti.com/publications/176892/pembelajaran-matematika-yang-bermakna>
- Irviana, I. (2020). Understanding the Learning Models Design for Indonesian Teacher. *International Journal of Asian Education*, 01(2), 95–106.
- Johnes, J., Portela, M., & Thanassoulis, E. (2017). Efficiency in education. *Journal of the Operational Research Society*, 68(4), 331–338. <https://doi.org/10.1057/s41274-016-0109-z>
- Joyce, B. R., Weil, M., & Calhoun, E. (2016). Models of teaching. Yogyakarta: Pustaka Pelajar.
- Kusumoto, Y. (2018). Enhancing critical thinking through active learning. *Language Learning in Higher Education*, 8(1), 45–63. <https://doi.org/10.1515/cercles-2018-0003>
- Kuswari, I. H., Muryani, C., & Setya, N. (2019). The Learning Media Development of Interactive Multimedia Based E-Learning to Improve Students' Learning Outcome and Spatial Thinking Ability of X is Students in Sma Negeri 3 Sragen in the Academic Year Of 2017/2018 (Using The Subject Of Hydrosphere Dynam. *GeoEco Journal*, 5(1), 92– 104.
- Larasati, F. (2018). Student Centered Learning: an Approach To Develop Speaking Skill in Efl Classroom. *English Community Journal*, 2(1), 153. <https://doi.org/10.32502/ecj.v2i1.1004>
- Larry, N. P., & Mary, L. C. (2014). Do active-learning strategies improve students' critical thinking? *Higher Education Studies*, 4(2)
- Li, H., Zhang, A., Zhang, M., Huang, B., Zhao, X., Gao, J., & Si, J. (2021). Concurrent and longitudinal associations between parental educational involvement, teacher support, and math anxiety: The role of math learning involvement in elementary school children. *Contemporary Educational Psychology*, 66(1), 101984. <https://doi.org/10.1016/j.cedpsych.2021.101984>
- Magdalena, I., Shodikoh, A. F., & Pebrianti, A. R. (2021). Pentingnya Media Pembelajaran Untuk Meningkatkan Minat Belajar Siswa Sdn Meruya Selatan 06 Pagi. *EDISI : Jurnal Edukasi Dan Sains*, 3(2), 312–325. <https://ejournal.stitpn.ac.id/index.php/edisi>
- Mahjaty, R. (2017). English Teachers' Knowledge for Implementing the 2013 Curriculum. *English Education Journal*, 8(2), 199–212.

- Meyers, C. (1986). *Teaching Student to Think Critically: A Guide for Faculty in All Disciplines*. San Francisco: CA: Jossey-Bass.
- Moore, K. . (2015). *Effective instructional strategies*. California: SAGE Publications, Inc.
- Mustaqim, I., & Kurniawan, N. (2017). Pengembangan Media Pembelajaran Berbasis Augmented Reality. *Jurnal Edukasi Elektro*, 1(1), 36–48. <https://doi.org/10.17977/um034v29i2p97-115>
- Mustika, D., & Ain, S. Q. (2020). Peningkatan Kreativitas Mahasiswa Menggunakan Model Project Based Learning dalam Pembuatan Media IPA Berbentuk Pop Up Book. *Jurnal Basicedu*, 4(4), 1167–1175. <https://doi.org/10.31004/basicedu.v4i4.518>
- Nambisan, S., & Luo, Y. (2021). Toward a loose coupling view of digital globalization. *Journal of International Business Studies*, 52, 1646–1663. <https://doi.org/10.1057/s41267-021-00446-x>
- Nurjatisari, T., Sukmayadi, Y., & Nugraheni, T. (2023). Penguatan Profil Pelajar Pancasila melalui Kemasan Pertunjukan Seni pada Kurikulum Merdeka di Sekolah Dasar. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, 7(4).
- Porter, L. . (2017). High-Impact Practices in Materials Science Education: Student Research Internships Leading to Pedagogical Innovation in STEM Laboratory Learning Activities. *MRS Advances*, 2, 1667–1672. <https://doi.org/10.1557/adv.2017.106>
- Priansa, D. J. (2016). *Perencanaan & Pengembangan SDM*. Bandung: Cv. Alfabeta.
- Puspita Sari, A., & Setiawan, A. (2018). The Development of Internet-Based Economic Learning Media using Moodle Approach. *International Journal of Active Learning*, 3(2), 100–109. <http://journal.unnes.ac.id/nju/index.php/ijal>
- Puspitarini, Y. D, & Hanif, M. (2019). Using Learning Media to Increase Learning Motivation in Elementary School. *Anatolian Journal of Education*, 4(2), 53–60. <https://doi.org/https://doi.org/10.29333/aje.2019.426a>
- Retnawati, H. (2015). Hambatan Guru Matematika Sekolah Menengah Pertama dalam Menerapkan Kurikulum Baru. *Cakrawala Pendidikan*, 3, 390–403.
- Retnawati, H., Kartowagiran, B., Hadi, S., & Hidayati, K. (2011). Identifikasi Kesulitan Peserta Didik dalam Belajar Matematika dan Sains di Sekolah Dasar. *Jurnal Kependidikan*, 41(2), 162–174.
- Rubiah, M. (2016). Implementation of Problem Based Learning Model in Concept Learning Mushroom as a Result of Student Learning Improvement Efforts Guidelines for Teachers. *Journal of Education and Practice*, 7(22), 26–30.
- Sapriyah. (2019). Media Pembelajaran dalam Proses Belajar Mengajar. *Prosiding Seminar Nasional Pendidikan FKIP*, 2(1), 470–477. <https://doi.org/10.35446/diklatreview.v3i1.349>
- Sung, Y. T., Chang, K. ., & Liu, T. . (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education*, 94, 252–275. <https://doi.org/https://doi.org/10.1016/j.compedu.2015.11.008>
- Tafonao, T. (2018). Peranan Media Pembelajaran Dalam Meningkatkan Minat Belajar Mahasiswa. *Jurnal Komunikasi Pendidikan*, 2(2), 103–114. <https://doi.org/10.32585/jkp.v2i2.113>

- Tamrin, M., Azkiya, H., & Sari, S. G. (2017). Problems Faced by the Teacher in Maximizing the Use of Learning Media in Padang. *Al-Ta Lim Journal*, 24(1), 60–66. <https://doi.org/10.15548/jt.v24i1.262>
- Tan, E. S. (2018). *Psychology of the film*. Palgrave Communications, 4(1). <https://doi.org/https://doi.org/10.1057/s41599-018-0111-y>
- Trianto. (2011). *Model Pembelajaran Terpadu (Konsep Strategi dan Implementasinya Dalam Kurikulum Tingkat Satuan Pendidikan)*. Jakarta: Bumi Aksara.
- Utomo, M. R., Hasruddin, H., & Murad, A. (2020). Influence of Problem Based Learning Models (PBL) and Learning Motivation to Learn Outcomes and Student's Critical Thinking Skills Themes of Caring for Life in Class IV Primary School No 026609 Pujidadi Binjai. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, 3(4), 1634–1643. <https://doi.org/10.33258/birle.v3i4.1300>
- Wahid, A. (2018). Pentingnya Media Pembelajaran dalam Meningkatkan Prestasi Belajar. *Istiqra*, 5(2), 1–11.
- Winda, R., & Dafit, F. (2021). Analisis Kesulitan Guru dalam Penggunaan Media Pembelajaran Online di Sekolah Dasar. *Jurnal Pedagogi Dan Pembelajaran*, 4(2), 211–221. <https://doi.org/10.23887/jp2.v4i2.38941>
- Yunus, M. M., & Suliman, A. (2014). Information & Communication Technology (ICT) tools in teaching and learning literature component in Malaysian secondary schools. *Asian Social Science*, 10(7), 136–152. <https://doi.org/10.5539/ass.v10n7p136>
- Zaki, A., & Yusri, D. (2020). Penggunaan Media Pembelajaran untuk Meningkatkan Prestasi Belajar Siswa pada Pelajaran PKN SMA Swasta Darussa'adah Kec. Pangkalan Susu. *Al-Ikhtibar: Jurnal Ilmu Pendidikan*, 7(2), 809–820. <https://doi.org/10.32505/ikhtibar.v7i2.618>

THE ROLE OF THE TECHNOLOGICAL INNOVATION CENTER IN THE TRANSFER OF CLEANER TECHNOLOGIES IN THE FACE OF THE CARBON ADJUSTMENT MECHANISM AT THE EUROPEAN UNION BORDER

A ATUAÇÃO DO NÚCLEO DE INOVAÇÃO TECNOLÓGICA NA TRANSFERÊNCIA DE TECNOLOGIAS MAIS LIMPAS FRENTE AO MECANISMO DE AJUSTE DE CARBONO NA FRONTEIRA DA UNIÃO EUROPEIA

EL PAPEL DEL CENTRO DE INNOVACIÓN TECNOLÓGICA EN LA TRANSFERENCIA DE TECNOLOGÍAS MÁS LIMPIAS ANTE EL MECANISMO DE AJUSTE DE CARBONO EN LA FRONTERA DE LA UNIÓN EUROPEA



<https://doi.org/10.56238/sevened2026.008-102>

Thais Farias de Oliveira Bonfim¹, André Luis Rocha de Souza², José Célio Silveira Andrade³

ABSTRACT

This research aimed to analyze the role of Technological Innovation Centers (NITs), linked to Scientific, Technological and Innovation Institutions (ICTs), as drivers of cleaner technology development in the steel sector, considering the possibilities of technology transfer to adapt the sector to the requirements of the European Union Border Carbon Adjustment Mechanism (CBAM). The research has a qualitative approach, with bibliographic and documentary analyses on carbon emissions in the industrial sector, conventional technologies used in steelmaking, and cleaner technologies applicable to the steel sector. The results pointed to new routes for cleaner technologies for decarbonization and the importance of NITs in mediating between scientific production and the productive sector for the development of technologies in ICTs that can contribute to solving economic and environmental problems that help achieve global decarbonization goals and meet the requirements imposed by the CBAM. In conclusion, it can be said that there is a risk that Brazilian companies exporting steel products will lose competitiveness in the European market if strategies are not adopted to overcome the challenges imposed by carbon restriction policies on products that do not meet CBAM criteria.

Keywords: CBAM. Decarbonization. NIT.

RESUMO

Esta pesquisa teve como objetivo analisar o papel do Núcleo de Inovação Tecnológica (NIT), vinculados às Instituições Científicas, Tecnológicas e de Inovação (ICTs) enquanto indutor de desenvolvimento de tecnologias mais limpas no setor siderúrgico, considerando as possibilidades de transferência tecnológica para adequação do setor frente às exigências do

¹ Master's student in the Graduate Program in Intellectual Property and Technology Transfer for Innovation. Instituto Federal da Bahia (IFBA). E-mail: thais.bonfim@ifba.edu.br

² Dr. in Industrial Engineering. Instituto Federal da Bahia (IFBA). E-mail: thais.bonfim@ifba.edu.br

³ Dr. in Business Administration. Universidade Federal da Bahia (UFBA). E-mail: jcelio.andrade@gmail.com

Mecanismo de Ajuste de Carbono na Fronteira da União Europeia (CBAM). A pesquisa possui abordagem qualitativa, com análises bibliográficas e documentais sobre emissões de carbono no setor industrial, tecnologias convencionais utilizadas na siderurgia e tecnologias mais limpas aplicáveis ao setor siderúrgico. Os resultados apontaram novas rotas de tecnologias mais limpas para descarbonização e a importância dos NITs no intermédio entre produção científica e setor produtivo para o desenvolvimento de tecnologias, nas ICTs, que possam contribuir na resolução de problemas econômicos e ambientais que ajudem no alcance das metas globais de descarbonização e o atendimento às exigências impostas pelo CBAM. Por fim, pode-se concluir que há risco de as empresas brasileiras, exportadoras de produtos siderúrgicos, perderem competitividade no mercado europeu, caso estratégias não sejam adotadas para superar os desafios impostos pelas políticas de restrição de carbono sobre os produtos que não atenderem aos critérios do CBAM.

Palavras-chave: CBAM. Descarbonização. NIT.

RESUMEN

Esta investigación tuvo como objetivo analizar el papel de los Centros de Innovación Tecnológica (CNI), vinculados a las Instituciones Científicas, Tecnológicas y de Innovación (ICT), como impulsores del desarrollo de tecnologías más limpias en el sector siderúrgico, considerando las posibilidades de transferencia de tecnología para adaptar el sector a los requisitos del Mecanismo de Ajuste de Carbono en Frontera (CBAM) de la Unión Europea. La investigación tiene un enfoque cualitativo, con análisis bibliográficos y documentales sobre las emisiones de carbono en el sector industrial, las tecnologías convencionales utilizadas en la siderurgia y las tecnologías más limpias aplicables al sector siderúrgico. Los resultados apuntaron nuevas rutas para tecnologías más limpias para la descarbonización y la importancia de los CNI en la mediación entre la producción científica y el sector produtivo para el desarrollo de tecnologías en TIC que puedan contribuir a la solución de problemas económicos y ambientales que ayuden a alcanzar las metas globales de descarbonización y a cumplir con los requisitos impuestos por el CBAM. En conclusión, se puede afirmar que existe el riesgo de que las empresas brasileñas exportadoras de productos siderúrgicos pierdan competitividad en el mercado europeo si no se adoptan estrategias para superar los desafíos que imponen las políticas de restricción de carbono a los productos que no cumplen con los criterios del CBAM.

Palabras clave: CBAM. Descarbonización. NIT.

1 INTRODUCTION

The growing search for sustainable development, given the environmental impacts resulting from greenhouse gas (GHG) emissions from industrial processes, brings light to the need for innovation in production processes for the transition to a low-carbon economy in view of the regulatory requirements imposed by the implementation of the European Union Carbon Border Adjustment Mechanism (CBAM/EU). The CBAM will affect important sectors of the world economy that are intensive in energy and GHG emissions, including the steel industry (APEXBRASIL, 2023), the focus of this research.

Brazil is one of the largest producers and exporters of steel in the world, and the steel production chain is essential for other sectors, such as civil construction, automotive, naval, machinery and equipment. As a major exporter to Europe, Brazil may face direct pressure to decarbonize its steel production, at the risk of losing competitiveness or paying high tariffs, which requires technological innovation, regulatory adjustments, and sustainability strategies to overcome this scenario (CNA, 2023).

The steel industry is one of the main sectors of the economy, as it provides important components for the infrastructure of the other sectors, by contributing turbines for wind energy generation or supports for solar panels, for example (FERNANDES et al., 2024). Despite its economic relevance, the industrial sector is intensive in energy consumption and greenhouse gas (GHG) emissions, being responsible for 2% of total emissions in the country in 2020 (FERNANDES et al., 2024), due to the use of fossil fuels as the main source of energy, making it one of the sectors with the greatest challenge to achieve decarbonization (IEA, 2022).

The predominant conventional technology in the steel industry consists of the use of fossil fuels as the main source of energy in the reduction of iron ore into steel, in Blast Furnace-Basic Oxygen Furnace (BF-BOF), a process that is intensive in both energy and CO₂ emissions (IEA, 2020). The iron reduction stage is responsible for about 80% of GHG emissions in the crude steel production process, because the reducing agent and heat source used is mineral coal (FERNANDES et al., 2024), a non-renewable fuel.

In this context, Science, Technology and Innovation Institutions (ICT), through the Technological Innovation Centers (NITs), play a fundamental role in the generation of knowledge, production of new technologies and their effective transfer to the productive sector (LEITE; MENDONÇA; OLIVEIRA, 2023), which can help industries in the sector reduce their GHG emissions.

The NITs, formed by one or more ICTs, aim to manage the institutional innovation policy, in addition to bringing the academic and productive sectors closer together (QUEIROZ

et al., 2022). Such contributions were made possible by the creation of the Innovation Law, Federal Law No. 10,973/2004, which institutes measures to encourage innovation and scientific and technological research in the productive sphere (BRASIL, 2004), later updated by Federal Law No. 13,243, of January 11, 2016, known as the new Legal Framework for Science, Technology and Innovation, which improves measures to encourage innovation and research in the productive sphere, aiming at training and technological autonomy, and the productive development of the country (MCTIC, 2016).

In view of the above, this article aims to analyze the role of the Technological Innovation Center (NIT), linked to the Scientific, Technological and Innovation Institutions (ICTs) as an inducer of the development of cleaner technologies in the steel sector, considering the possibilities of technology transfer to adapt the sector to the requirements of the CBAM.

To achieve the proposed objective, an exploratory research was carried out, with a qualitative approach. Literature reviews on the subject were carried out on specialized search platforms

The research is justified by the environmental and economic impact that the Mechanism will have on Brazilian companies exporting steel products to the European Union. In addition, in order to meet the requirements established by the mechanism, with the need to reduce CO₂ emissions, it is necessary to implement cleaner technologies, which, according to Silva Júnior and Andrade (2011), require greater investment in research, development and innovation, ratifying the theoretical relevance of this research.

The research is also justified by its theoretical and practical relevance, with the generation of structured knowledge about the technologies used in the steel industry, which will allow the Technological Innovation Centers (NITs) and Brazilian companies to anticipate trends, establish strategic partnerships and incorporate sustainable innovations to meet CBAM regulations.

In research carried out on the subject, no products were identified, until the closing of the present investigation, that present the role of NITs for the industrial adaptation of the Brazilian steel sector in the face of the requirements of the Carbon Adjustment Mechanism at the Border of the European Union (CBAM), with emphasis on the development of cleaner technologies and technology transfer. Mediating scientific production and the productive sector

2 THEORETICAL FRAMEWORK

Cleaner technologies play a fundamental role, given that they act preventively,

reducing Greenhouse Gas (GHG) emissions, among other benefits, such as reducing the production of solid waste in the initial process of steel and iron production. According to Law 12.305/2010, which institutes the National Solid Waste Policy, solid waste is materials, substances or objects discarded in its solid state, originating from human activity (BRASIL, 2010)

For Cumming, Henriques and Sadorsky (2016), clean technologies are processes that aim at less waste generation in production, including the generation of biomass and recycling processes, while Silva Júnior and Andrade (2011) state that the technologies proposed to treat the waste generated, that is, to treat the consequences and not act in a preventive way to environmental impacts, will tend to be classified as end-of-pipe technologies.

Cleaner technologies put nations on the path to transition to a low-carbon economy. In addition, it can reduce the costs of decarbonization, considering that there is a tendency to create restrictive carbon policies, as has already been happening with the European Union (EU).

In 2023, the EU created the Carbon Border Adjustment Mechanism (CBAM), which will come into force in January 2026, in addition to creating 50 measures to decarbonize the economy of the bloc's countries and strengthen the carbon market - Emissions Trading System (ETS) (EUROPEAN COMMISSION, 2019; HEREDIA; GALGANI, 2022).

Regarding the CBAM, the mechanism can affect important sectors of the Brazilian economy such as steel and iron (the focus of this research), in addition to the fertilizer, cement, aluminum, hydrogen, and electricity sectors (EUROPEAN COMMISSION, 2019; HEREDIA; GALGANI, 2022).

The CBAM is one of the strategies established by the European Union to tackle climate change, reducing GHG emissions and avoiding "carbon leakage", a practice that transfers GHG-intensive production from countries with stricter environmental laws to countries with more lenient environmental laws.

Thus, the implementation of the mechanism aims to equate products imported by the European Union with products manufactured in the country, with regard to compliance with environmental regulations and global decarbonization goals (EUROPEAN COMMISSION, 2021).

CBAM is part of the European Green Deal, created in 2019, which establishes goals for decarbonization, reducing GHG emissions by 55% by 2030 and neutralizing their effects by 2050 (CNI, 2024). This initiative also aims to prevent carbon leakage and equalize the rules followed by producers in the European Union (EU), taxing the ton of carbon incorporated into the exported product (CNI, 2024).

In addition, it is noted that important sectors will be affected by the implementation of the CBAM, such as the cement, fertilizer, hydrogen, electricity, aluminum, iron, and steel industries, as they will be required to track and provide information on the CO₂ embedded in the products to be exported, making less carbon-intensive products more economically attractive (APEXBRASIL, 2023).

Faced with the consequences arising from GHG emissions, whether due to physical, financial, economic, and social risks, as well as creating an economic environment in the national scenario that promotes the strategy of inducing the transition to a low-carbon economy, Brazil, on December 11, 2024, sanctioned Law 15,042, which establishes the Brazilian Greenhouse Gas Emissions Trading System (SBCE), whose objective is to comply with the National Policy on Climate Change (PNMC) and the implementation of the agreements signed under the United Nations Framework Convention on Climate Change (BRASIL, 2024a).

The PNMC, created by Law N 12.187, of December 29, 2009, establishes guidelines that promote sustainable development and the reduction of greenhouse gas emissions. As part of this Policy, Brazil instituted, through Decree 11,550/2023, the Interministerial Committee on Climate Change (CIM), responsible for preparing the Climate Plan, which began in 2023, whose objective is to combat climate change, based on two pillars, the first being the mitigation of GHG emissions and the second, the adaptation of the population and structures to climate change (BRASIL, 2024b).

The Climate Plan will act strategically through Mitigation Plans and Adaptation Plans in a sectoral manner, in order to reach important sectors of the economy, generating an impact on the energy transition, sustainable industrial development, facing the climate crisis and migration to a low-carbon economy (BRASIL, 2024b).

In addition, the Climate Plan also has Cross-Cutting Strategies for climate change, aimed at reaching vulnerable populations, economic and environmental impacts, financing, monitoring and management, training, development and innovation. The Climate Plan has the collaboration of society, companies, government and academia, as well as more than 20 ministries, also supporting the preparation of the new Nationally Determined Contribution (NDC), with decarbonization goals in accordance with the Paris Agreement. (BRAZIL, 2024b).

In this sense, taking as a parameter the emissions recorded in 2005, Brazil has committed to reducing greenhouse gas emissions by 37% by 2025, and by 47% by 2030, ratifying the Paris Agreement - an agreement signed in 2015, whose objective is to combat climate change, keeping the global average temperature below 2°C (ARTAXO, 2020).

For Unterstell and La Rovere (2021), the conformation of a change in this scenario requires policies focused on strategies to neutralize GHG emissions in the next three decades and, for this, two fronts need to be structured: (i) Change in industrial production processes and energy generation; and (ii) innovative public policies, committed to the transition to a less GHG-intensive economy.

In the steel sector, in view of the requirements on the carbon footprint incorporated in products exported to the European Union, the implementation of cleaner technologies is urgent (EUROPEAN COMMISSION, 2021), which can open opportunities for technological innovation and transfer of technologies developed in Scientific, Technological and Innovation Institutions (ICTs) to industries, through the Technological Innovation Centers (NITs) (FERREIRA; SOUZA, 2019), disseminating scientific and technological knowledge developed in academia, contributing to the technological adaptation of the productive sectors affected by the implementation of the Mechanism.

Paranhos, Cataldo and Andrade (2017) endorse that the performance of the NIT is fundamental for the approximation of universities to the productive sector, since this interaction is already part of government discussions when regulating its creation, aiming to support the development of science, technology and innovation. In this sense, the NIT becomes an important ally to the results of research developed within academia, by promoting dialogue with society, companies, and development institutions (QUEIROZ et al., 2022).

In addition, Queiroz et al. (2022) also highlight that, in order to be successful in achieving the attributions assigned to NITs in the management of intellectual property, in the production and transfer of technologies developed in ICTs, strategic planning and the promotion of a disruptive culture that stimulates interaction with the industrial sector are necessary.

Leite, Carvalho, and Oliveira (2023) state that NITs should play the role of catalyzing and disseminating innovations, in addition to integrating methods that process knowledge according to the technological needs of society, contributing to local, regional, and national development.

For Silva et al. (2015), technology transfer boils down to the promotion of technologies developed in sectors that do not have the same technological characteristics. In this context, the role of the NIT in intermediating the partnership between industry and ICTs can represent significant technological advances, allowing the anticipation of trends, the establishment of strategic partnerships, and the incorporation of sustainable innovations that can meet CBAM regulations

3 METHODOLOGY

3.1 CHARACTERIZATION OF THE RESEARCH

This article is characterized by a qualitative and exploratory approach, since it makes a bibliographic and documentary analysis on the subject. For contextualization and elaboration of the theoretical framework, institutional reports, legislation and scientific publications on cleaner technologies for the Brazilian steel industry were analyzed in relation to the Carbon Adjustment Mechanism at the Border of the European Union (CBAM/EU).

3.2 METHODOLOGICAL PROCEDURES

To achieve the objective of the research, three stages were followed, namely: stage 1 - bibliographic and documentary research; Stage 2 - Analysis and discussion of the results; and step 3 - final considerations.

Regarding stage 1, bibliographic reviews were carried out seeking to analyze, through dossiers and organizational reports, greenhouse gas emissions in the steel industry, government initiatives to address the climate crisis, and which studies have been developed for the development of cleaner technologies aimed at the decarbonization of the iron and steel industry.

To carry out the literature review, specialized search platforms such as SCOPUS, Capes Journals and Google Scholar were used, with keywords relevant to the topic, such as "climate change", "decarbonization in industry", "CBAM", "cleaner technologies", "the role of the NIT", in Portuguese and English, from January to July 2025.

In addition to articles referring to the proposed topic, manuals, reports, and government regulations that address the decarbonization process, greenhouse gas emission control policies, and the implementation of CBAM in Brazil were analyzed.

Still in stage 1, it was possible to build the theoretical and methodological framework of the research.

In relation to stage 2, data analysis and discussion were carried out. After a bibliographic and documentary survey, the information and data obtained were analyzed and discussed in order to be incorporated into the research.

In relation to stage 3, the final considerations were made and the limitations of the research were defined.

4 RESULTS AND DISCUSSIONS

Considering the global GHG neutrality goals, the carbon pricing imposed by the implementation of the CBAM, although challenging due to the short term for adaptation,

raises the development and application of cleaner technologies in the industrial sectors, since non-decarbonization will burden the price of products to be exported, generating a competitive, comparative, and relative disadvantage for Brazilian companies.

The transition to a low-carbon economy involves the migration from environmentally safe technologies, the so-called end-of-pipe, to the adoption of cleaner technologies, aiming at neutrality of emissions without negatively compromising production efficiency.

In this transition process, the need for technological innovation emerges, as well as technology transfer, which can be related to both tangible and intangible assets, especially in developing countries or industries that do not invest in R&D or face obstacles to adapting to the environmental regulations imposed, especially the CBAM.

Innovation, according to Law 10.973/2004, consists of the introduction of novelty or improvement of products in the production environment, which result in improvements and effective gains in quality or performance (BRASIL, 2004).

The results suggest that, even though Brazil is a country with a mostly renewable energy matrix, which should represent a competitive advantage over other countries with a predominance in a non-renewable energy matrix, the steel industry still depends on fossil fuels as an energy source for steel and iron production.

This scenario, given the pricing of the ton of carbon emitted per product, may pose challenges for competitiveness and compliance to adapt to the regulations imposed by CBAM. On the other hand, it opens up opportunities for innovation and development of cleaner technologies for decarbonization in industry, such as the use of green hydrogen as a renewable source of energy and the replacement of mineral coal with biomass to reduce iron ore in crude steel.

The Brazilian energy matrix and the new technological routes developed for decarbonization in the industrial sector enable competitive potential for adaptation and permanence in the export market, considering that Brazil is among the largest producers and exporters of steel products in the world (CNA, 2023).

In this sense, despite the predominance of conventional technologies, with the use of fossil fuels, the economic and environmental pressure generated by the implementation of CBAM with the pricing of the ton of carbon incorporated into products drives the development of cleaner technologies and the application of new technological routes for the transition to a low-carbon economy.

The electrification of processes, the use of green hydrogen to replace fossil fuels, and the better use of natural resources represent important strategies for the transition to a low-carbon economy in the steel industry. In the crude steel production process, the reduction of

iron ore in blast furnaces is the process identified as the most GHG emission intensive in the steel and iron sector (FERNANDES et al., 2024).

Therefore, the technology of using Electric Arc Furnace (EAF), with renewable energy, replacing conventional blast furnaces using coking coal, significantly reduces CO₂ emissions (IEA, 2022). Another innovation is, in place of fossil fuels, the use of green hydrogen as a reducing agent in the Direct Reduced Iron (DRI) process, produced from renewable energy sources, can be a relevant strategy for the decarbonization of the industrial sector (IEA, 2025).

In addition, there are clean technologies, called end-of-pipe, which, according to Silva Júnior and Andrade (2011), seek to treat GHGs emitted after the production process, in order to reduce environmental impacts. Carbon capture and storage (CCS) and scrap metal recycling are examples of end-of-pipe technologies, as they act on the effect rather than the cause. Despite this, it is relevant strategies to mitigate the environmental impacts generated by GHG emissions in the steel industry, while cleaner technologies suggest changes in industrial processes in order to achieve both economic and environmental benefits (UNEP, 2016).

In this context, CCS, considered an end-of-pipe technology, consists of capturing, transporting and storing the carbon emitted in the production process in geologically safe locations, preventing GHGs from reaching the atmosphere (CÂMARA; ANDRADE; ROCHA, 2011), being a strategy for mitigating the environmental impacts resulting from CO₂ emissions.

The carbon emitted can be compressed and transported by pipeline, ship, train or truck, if it is not used on site, being an alternative to sectors that have difficulties in reducing their emissions (IEA, 2022). Its application is used in the fertilizer industry, in addition to the production of synthetic carbon dioxide-based fuels, chemicals, and construction aggregates (IEA, 2022).

In the production of crude steel with a reduction in iron ore, CCS can be applied in the blast furnace route, since it is an emissions-intensive process. Another route of clean technologies or end-of-pipe consists of recycling scrap metal, considering that steel is a 100% recyclable material and can be reused several times, maintaining quality and being able to be transformed into various products (INSTITUTO AÇO BRASIL, 2023).

For the Brazilian Mining Institute (IBRAM, 2025), the development of technologies in the country is crucial for distancing itself from technological dependence. On the other hand, the analysis made by Cumming, Henriques and Sadorsky (2016) elucidates a possible obstacle that may justify the low adherence to clean technologies, although growing, but still

insufficient for sustainable development, when it portrays that companies already consolidated in the market and focused on fossil fuels would hardly be interested in investing in new technologies developed by start-up companies. Considering that investment in these technologies requires knowledge and experience to minimize economic risks.

According to Leite, Mendonça and Oliveira (2023), the NIT as a mediator between the productive and academic sectors is fundamental for the development of technologies that solve current problems in society, in addition to transferring technologies developed at the institution, registering patents and other intellectual property modalities.

Therefore, the NIT's role in the development of new technologies and technology transfer for the decarbonization of emission-intensive sectors can become fundamental for the transition to a low-carbon economy and the reduction of environmental impacts suffered by society, considering that, for Silva et al. (2015), scientific and governmental institutions must develop technology transfer strategies associated with the demands of industries.

In this sense, NITs can act as a central actor in the articulation and integration between ICTs and the steel sector, performing a function that goes beyond the mere management of innovation and protection of the intellectual property of these institutions, that is, a strategic and proactive role. In the face of CBAM's regulatory pressures, NIT needs to act as a protagonist in mapping technological gaps in the industry, at the local, regional and national levels, connecting them to inventions, scientific and technological research, as well as to the skills available in ICTs.

From this perspective, it is envisaged that the NITs can build innovation roadmaps in clean technologies, functioning as an actor-guide of the productive sector on which technologies can support decarbonization, what is the technological readiness level (NPT) or the English Technology Readiness Level (TRL) of these technologies, channeling initiatives and also pointing out which ones require co-development and how they can be transferred (NASCIMENTO, 2021; HORA, 2021; SANTOS, 2024).

One dimension to be considered in the performance of NITs in the context of CBAM is the strategic role as an actor in specialized technological curatorship, both from the perspective of prospecting and from the perspective of compliance with the technical dimensions of the inventions, as well as their adherence to the rules and restrictive carbon assumptions imposed by CBAM.

Thus, the role of the NIT also gains contour as an actor in the conversion and translation of scientific and technological results into regulatory and economic language, evaluating the potential for reducing emissions, energy efficiency gains or substitution of inputs and their alignment with global requirements in the context of the low-carbon economy

in Brazil and in the world. By performing this role of institutional translator in ICTs, NITs reduce information asymmetries between academia and steel mills, creating conditions for clean technologies to leave laboratories and enter industrial processes.

The research by Guimarães (2013), Ferreira (2019), Nascimento (2021) and Hora (2021), as well as Santos (2024), pointed out that the NITs encounter difficulties ranging from the professionalization of management, with high staff turnover, as well as difficulties in operationalizing negotiation, valuation and marketing strategies that are important in technology transfer. In this sense, the fundamental role of NITs as a technological risk mediator stands out, fundamental in the steel sector, where investment decisions are capital-intensive.

To this end, it is necessary to professionalize the NITs that enable them to use strategic and advanced tools of finance and negotiation, through technological valuation methods, such as methodologies such as real options, discounted cash flows, multicriteria environmental impact analyses and TRL models integrated with the regulatory risk of CBAM, offering objective instruments for steel mills to decide which technologies they should license, acquire, test or code in pilot projects.

This mediation reduces the risk of adopting immature technologies and increases the predictability of environmental and economic returns, an essential element in the new carbon tariff scenario, in addition to channeling resources more efficiently in the development and production of new technologies in Brazil.

Another dimension of strategic action of NITs is the governance of partnerships and technology transfer contracts, through disruptive models that can break the bureaucratic barriers that currently exist in public ICTs. With the development of models appropriate to the environmental context, elements such as the construction of environmental performance clauses, risk sharing mechanisms, such as licenses conditioned to carbon metrics, among others, need to be incorporated in the face of the regulatory context.

In addition, this can give NITs not only the role of acting in technology transfer, but also in the construction of safe institutional environments so that Brazilian industry can adapt to the energy transition route required by the CBAM context.

Finally, it is necessary that ICTs, through NITs, act in a more inductive way in the Brazilian innovation ecosystem, through the articulation of actors such as industries, such as steel mills, research centers and institutes, government, environmental agencies, regulatory agencies and investors, promoting initiatives such as technological calls, open innovation environment, among other initiatives, with the objective of enabling the construction of a route of solutions aligned with CBAM.

In summary, Table 1 presents the possible roles of NITs in the context of the Brazilian steel industries in relation to the CBAM.

Table 1

Role, Actions and Strategies of the NIT for Cleaner Technologies in the Steel Industry in relation to CBAM

Role of the NIT	Key Actions	Associated Strategies
Diagnosis and Technological Mapping	Identify technological gaps in the steel sector; map TRLs of clean technologies available in ICTs; analyze bottlenecks in emissions, energy and inputs in the sector.	Develop decarbonization technology roadmaps; create a technology bank aligned with CBAM; structure a strategic portfolio of inventions with potential for industrial application.
Technical-Regulatory Curation	Evaluate adherence of technologies to carbon metrics and CBAM criteria; translating scientific results into regulatory and economic language; prepare environmental and technological impact opinions.	Develop CBAM-technologies compliance matrix; create a validated catalogue of green solutions; institute technical opinions on eligibility for technology transfer aimed at decarbonization.
Mediation of Technological and Economic Risks	Apply technological valuation; perform technical and environmental analysis (due diligence); to build scenarios of economic impact of CBAM for the industry.	Create integrated TRL + Valuation + Carbon Risk models; produce due diligence reports for steel mills; support decisions on licensing, co-development and industrial pilots.
Legal and Contractual Governance of Technology Transfer	Structure TT contracts with environmental performance clauses; define royalties linked to the reduction of emissions; create licenses conditioned to carbon metrics; negotiate co-development agreements.	Implement green intellectual property contracts; adopt contractual models with regulatory risk sharing; structure mechanisms to protect and encourage environmental performance.
Orchestration of Green Innovation Ecosystems	Articulate ICTs, steel mills, startups, R&D centers and government; promote public calls, technological challenges and pilot projects; encourage consortia and collaborative platforms.	Create a sectoral innovation platform focused on cleaner technology; coordinate open innovation environments and R&D routes; foster climate spin-offs and experimental environments to accelerate technological maturation.

Source: Prepared by the authors based on research data (2025).

Such strategies can promote sustainable development, assisting in the technological and regulatory adaptation of the sectors affected by CBAM, enabling the competitiveness of Brazilian companies in the export market to the European Union.

5 CONCLUSION

This research aimed to analyze the role of the Technological Innovation Center (NIT), linked to the Scientific, Technological and Innovation Institutions (ICTs) as an inducer of the development of cleaner technologies in the steel sector. To this end, an exploratory research

was carried out, with a bibliographic and documentary approach, as well as a qualitative nature.

The research pointed to the fact that the implementation of the European Union Border Carbon Adjustment Mechanism may pose challenges to GHG-intensive sectors if they are unable to adapt technologically to the monitoring and reduction of embodied carbon in products exported to the European Union. In this sense, CBAM can also open opportunities for technological innovation and transfer of cleaner technologies that can be applied in industry for the decarbonization of sectors, otherwise they will lose competitiveness in the European market.

For the present research, bibliographic and documentary reviews were carried out on the impacts of CBAM, the technological routes used in the production of steel and iron, the implementation of cleaner technologies and decarbonization in the industry. The steel sector still depends on fossil fuels, even though Brazil has a mostly renewable energy matrix. The literature presents cleaner technologies as alternative routes for decarbonization in the reduction of iron ore for crude steel production, with the use of green hydrogen as an energy source and the replacement of fossil fuel with biomass.

The transition to a low-carbon economy involves the transfer of conventional or clean technologies to cleaner technologies, which, for Silva Júnior and Andrade (2011), requires greater investment in research, development and innovation. In this sense, NITs can play a fundamental role in the development and implementation of cleaner technologies to adapt to CBAM regulations and achieve global decarbonization goals, mediating scientific production and the productive sector.

The present research is limited to analyzing the cleanest technologies applicable to the steel sector for decarbonization in relation to CBAM. Further research may be directed to exploring which technology transfers are being carried out in the steel industry and what are their economic and technological impacts for adaptation, in addition to analyzing the effective participation of NITs in this process.

REFERENCES

- APEXBRASIL. (2023). CBAM entra em fase transitória. https://portal.apexbrasil.com.br/relacoes_comerciais/cbam-entra-em-fase-transitoria/
- Artaxo, P. (2020). As três emergências que nossa sociedade enfrenta: Saúde, biodiversidade e mudanças climáticas. *Estudos Avançados*, 34(100), 53–66. <https://doi.org/10.1590/s0103-4014.2020.34100.005>

Brasil. (2004). Lei nº 10.973, de 2 de dezembro de 2004. Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo e dá outras providências. https://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.973.htm

Brasil. (2010). Lei nº 12.305, de 2 de agosto de 2010. Institui a Política Nacional de Resíduos Sólidos; altera a Lei nº 9.605, de 12 de fevereiro de 1998; e dá outras providências. https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm

Brasil. (2024). Lei nº 15.042, de 11 de dezembro de 2024. Institui o Sistema Brasileiro de Comércio de Emissões de Gases de Efeito Estufa (SBCE). https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2024/lei/L15042.htm

Brasil. Ministério do Meio Ambiente e Mudança do Clima. (2024). Plano Clima. <https://www.gov.br/mma/pt-br/composicao/smc/plano-clima>

Câmara, G., Andrade, J. C., & Rocha, P. (2011). Tecnologia de armazenamento geológico de dióxido de carbono: Panorama mundial e situação brasileira. *Revista Eletrônica Sistemas & Gestão*, 6(3), 238–253. <https://doi.org/10.7177/sg.2011.v6.n3.a2>

Confederação da Agricultura e Pecuária do Brasil. (2023). Agendas globais e o agro brasileiro: O mecanismo de ajuste de carbono na fronteira da União Europeia. <https://www.cnabrazil.org.br/publicacoes/agendas-globais-e-o-agro-brasileiro>

Confederação Nacional da Indústria. (2024). Manual sobre a fase transitória do mecanismo de ajuste de carbono na fronteira (CBAM) da União Europeia. https://static.portaldaindustria.com.br/media/filer_public/09/2b/092bc133-4a98-4f7d-a066-a5ef530a7410/id_2024_manual_cbam.pdf

Comissão Europeia. (2019). Regulamento Delegado (UE) 2019/331 da Comissão, de 19 de dezembro de 2018. *Jornal Oficial da União Europeia*, L 59, 8–69. <https://eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=CELEX:32019R0331>

Cumming, D., Henriques, I., & Sadorsky, P. (2016). ‘Cleantech’ venture capital around the world. *International Review of Financial Analysis*, 44, 86–97. <https://doi.org/10.1016/j.irfa.2016.01.015>

European Commission. (2021). Proposal for a Regulation establishing a Carbon Border Adjustment Mechanism. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0564> (ou URL específica do documento; ajuste se for o link exato usado)

Fernandes, P. D., et al. (2024). Descarbonização da indústria de base. Banco Nacional de Desenvolvimento Econômico e Social. (Inclua URL se disponível no original)

Ferreira, A. R. F. (2019). Valoração de propriedade intelectual para a negociação e transferência da tecnologia: Um estudo aplicado sobre metodologias para a valoração de patentes – o caso [Dissertação de mestrado, Instituto Federal de Educação, Ciência e Tecnologia da Bahia]. (Inclua repositório ou URL se disponível)

Ferreira, A. R., & Souza, A. L. (2019). Análise dos procedimentos e critérios necessários à valoração de propriedade intelectual para a transferência de tecnologia no âmbito dos Núcleos de Inovação Tecnológica (NITs). *Cadernos de Prospeção*, 12(5), 1013–1023. (Inclua DOI ou URL se disponível)

- Guimarães, Y. B. T. (2013). Valoração de patentes em universidades públicas do Estado de São Paulo [Dissertação de mestrado, Universidade Nove de Julho].
- Herédia, G., & Galgani, A. (2022, 21 de junho). O que é o CBAM e como afetará empresas brasileiras? WayCarbon. <https://waycarbon.com/pt/blog/o-que-e-o-cbam-e-como-afetara-empresas-brasileiras/>
- Hora, E. R. (2021). Gestão da propriedade intelectual e transferência de tecnologia: Estudo de caso nos NITs dos IFs da Região Nordeste do Brasil [Dissertação de mestrado profissional, Instituto Federal de Educação, Ciência e Tecnologia da Bahia].
- International Energy Agency. (2022). Iron and steel technology roadmap. <https://www.iea.org/reports/iron-and-steel-technology-roadmap>
- International Energy Agency. (n.d.). Hydrogen. Recuperado em 17 de maio de 2025, de <https://www.iea.org/energy-system/low-emission-fuels/hydrogen> (use "n.d." se sem data específica)
- Instituto Aço Brasil. (2023). Relatório de sustentabilidade da indústria do aço. (Inclua URL se disponível)
- Instituto Aço Brasil. (n.d.). Indicadores de sustentabilidade. <https://www.acobrasil.org.br/site/indicadores-de-sustentabilidade/>
- Leite, A. da C., Mendonça, C. M. C. de, & Oliveira, W. D. de. (2023). Gestão da inovação: Um olhar sobre os núcleos de inovação e tecnologia do Brasil. Cadernos de Ciência & Tecnologia, 40, Article e27229. <https://www.embrapa.br/cct>
- Ministério da Ciência, Tecnologia, Inovações e Comunicações. (2016). Marco legal de CT&I. https://antigo.mctic.gov.br/mctic/export/sites/institucional/arquivos/marco_legal_de_cti.pdf
- Nascimento, R. de J. S. (2021). A contabilidade pública como elemento estratégico na gestão dos ativos de propriedade intelectual nas instituições científicas e tecnológicas públicas [Dissertação de mestrado profissional, Instituto Federal de Educação, Ciência e Tecnologia da Bahia].
- Paranhos, J., Cataldo, B., & Andrade, A. C. (2017). O papel dos NITs na relação universidade-empresa no Brasil: Características e desafios. In Anais do Congresso Latino-Iberoamericano de Gestão da Tecnologia (ALTEC). https://file:///mnt/data/ALTEC_2017_paper_453.pdf (substitua por URL pública se possível)
- Queiroz, D. P. do N., et al. (2022). Núcleos de Inovação Tecnológica: A aproximação das universidades com o setor produtivo brasileiro. Ensaios e Ciências, 26(2), 212–216.
- Santos, L. A. (2024). Metodologias de avaliação de investimento como suporte à decisão ex-ante e ex-post no desenvolvimento de patentes em ICTs públicas brasileiras [Dissertação de mestrado profissional, Instituto Federal da Bahia].
- Silva Júnior, A. C., & Andrade, J. C. S. (2011). Tecnologias mais limpas e desenvolvimento sustentável no Brasil: Contribuição do projeto MDL. RACEF – Revista de Administração,

Silva, L. C. S., et al. (2015). Processo de transferência de tecnologia em universidades públicas brasileiras por intermédio dos núcleos de inovação tecnológica. *Interciencia*, 40(10), 664–669.

United Nations Environment Programme. (2016). Guidelines for National Cleaner Production Centres and Programmes. <https://> (inclua URL completa se disponível)

Unterstell, N., & La Rovere, E. (Coords.). (2021). Clima e desenvolvimento: Visões para o Brasil 2030. Centro Clima; Instituto Talanoa. <https://clima2030.org/wp-content/uploads/2022/08/Clima-e-Desenvolvimento-Visoes-para-o-Brasil-2030-Documento-de-Cenario-e-Politiclas-Climaticas-15-out-2021.pdf>

SOCIAL REPRESENTATIONS OF BREASTFEEDING AMONG PREGNANT AND POSTPARTUM WOMEN IN PRIMARY HEALTH CARE

REPRESENTAÇÕES SOCIAIS DO ALEITAMENTO MATERNO POR GESTANTES E PUÉRPERAS NA ATENÇÃO PRIMÁRIA À SAÚDE

REPRESENTACIONES SOCIALES DE LA LACTANCIA MATERNA EN GESTANTES Y PUÉRPERAS EN LA ATENCIÓN PRIMARIA DE SALUD



<https://doi.org/10.56238/sevened2026.008-103>

Nayolle Barbosa Emerick Santana¹, Yasmin Alves da Luz Souza², Emanuelly Garcia de Sousa Moraes³, Mariana Linhares Pereira Soares⁴, Luciano Antonio Rodrigues⁵

ABSTRACT

The gestational period is a time filled with uncertainties, particularly for first-time mothers, leading to frequent doubts regarding breastfeeding due to the many myths that have been passed down through generations. This study aimed to assess the social representations of breastfeeding among pregnant and postpartum women receiving care in Primary Health Care services in the municipalities of Pancas-ES and Colatina-ES, Brazil. This is an observational, descriptive, cross-sectional study with a qualitative approach. The research participants were pregnant women receiving prenatal care at Basic Health Units (BHUs) in the aforementioned municipalities, as well as postpartum women. For data collection, recorded interviews were conducted using a semi-structured questionnaire as a guide. For data analysis, the qualitative information was processed after the recorded interviews were completed, digitized, and transcribed for semantic analysis, with evocations extracted and examined using the software openEVOC 0.92. This tool was used to identify the probable central nucleus and peripheral system of the social representations held by the study participants. The results revealed that the central terms “love,” “fear,” and “health” reflect an ambivalent perception of breastfeeding—viewed as an act of affection and care, yet accompanied by feelings of insecurity and anxiety. The study highlights the need to strengthen educational initiatives

¹ Undergraduate student in Nursing. Centro Universitário do Espírito Santo (UNESC). E-mail: nayolle.esantana@hotmail.com Orcid: <https://orcid.org/0009-0004-8032-1249> Lattes: <http://lattes.cnpq.br/6073445013902411>

² Undergraduate student in Nursing. Centro Universitário do Espírito Santo (UNESC). E-mail: yasminluz_sgp@hotmail.com Orcid: <https://orcid.org/0009-0000-7158-1031> Lattes: <http://lattes.cnpq.br/3019629401335642>

³ Undergraduate student in Nursing. Centro Universitário do Espírito Santo (UNESC). E-mail: emanuellymoraes621@gmail.com Orcid: <https://orcid.org/0009-0002-5877-6824> Lattes: <http://lattes.cnpq.br/1235540829509236>

⁴ Undergraduate student in Nursing. Centro Universitário do Espírito Santo (UNESC). E-mail: marianaborgeslinhares@gmail.com Orcid: <https://orcid.org/0009-0007-6580-4404> Lattes: <http://lattes.cnpq.br/7630245548028329>

⁵ Dr. in Health Sciences. Centro Universitário do Espírito Santo (UNESC). E-mail: proflucianorodrigues@gmail.com Orcid: <https://orcid.org/0000-0001-5758-456X> Lattes: <http://lattes.cnpq.br/1082665421035430>

within Primary Health Care, emphasizing the role of nurses and the multidisciplinary team in order to enhance follow-up care, provide continuous support, and demystify beliefs that undermine breastfeeding practices.

Keywords: Social Representation. Breastfeeding. Basic Health Unit. Nursing.

RESUMO

O período gestacional é um momento repleto de dúvidas, principalmente em primigestas, com isso se torna frequente o surgimento de incertezas quanto ao aleitamento materno devido a tantos mitos que existem e são passados por gerações. Esse estudo teve como objetivo avaliar as representações sociais do aleitamento materno por gestantes e puérperas na Atenção Primária à Saúde dos municípios de Pancas-ES e Colatina-ES. Trata-se de um estudo observacional, descritivo, transversal, de abordagem qualitativa, o qual as participantes de pesquisa foram gestantes que realizam pré-natal em Unidade Básica de Saúde (UBS) dos municípios supra citados, e também puérperas. Para coleta de dados, foram realizadas entrevistas gravadas utilizando como roteiro um formulário semiestruturado. Para análise dos resultados, os dados qualitativos foram tratados após a aplicação das entrevistas gravadas, sendo estas digitalizadas, transcritas para análises semânticas das informações e extraídas as evocações, as quais foram elucidadas por meio do software openEVOC 0.92, processando o provável núcleo central e sistema periférico da representação social do grupo participante da pesquisa. Os resultados evidenciaram que os termos centrais “amor”, “medo” e “saúde” refletem uma percepção ambivalente sobre a amamentação, vista como um ato de afeto e cuidado, mas sendo permeado por inseguranças e angústias. Destacou-se a necessidade de intensificação das ações educativas na Atenção Primária à Saúde, com ênfase no papel do enfermeiro e da equipe multiprofissional, visando qualificar o acompanhamento, oferecer apoio contínuo e desmistificar crenças que fragilizam a prática.

Palavras-chave: Representação Social. Amamentação. Unidade Básica de Saúde. Enfermagem.

RESUMEN

El período gestacional es una etapa llena de dudas, especialmente en mujeres primigestas, lo que hace frecuente la aparición de incertidumbres respecto a la lactancia materna debido a la gran cantidad de mitos que existen y se transmiten de generación en generación. Este estudio tuvo como objetivo evaluar las representaciones sociales de la lactancia materna entre gestantes y puérperas en la Atención Primaria de Salud de los municipios de Pancas-ES y Colatina-ES. Se trata de un estudio observacional, descriptivo, transversal, con enfoque cualitativo, en el cual las participantes fueron gestantes que realizaban el control prenatal en Unidades Básicas de Salud (UBS) de los municipios antes mencionados, así como también puérperas. Para la recolección de datos, se realizaron entrevistas grabadas utilizando como guía un formulario semiestructurado. En cuanto al análisis de los resultados, los datos cualitativos fueron tratados después de la aplicación de las entrevistas grabadas, las cuales fueron digitalizadas y transcritas para su análisis semántico. A partir de ello, se extrajeron las evocaciones, que fueron procesadas mediante el software openEVOC 0.92, identificando el probable núcleo central y el sistema periférico de la representación social del grupo participante en la investigación. Los resultados evidenciaron que los términos centrales “amor”, “miedo” y “salud” reflejan una percepción ambivalente sobre la lactancia materna, concebida como un acto de afecto y cuidado, pero atravesada por inseguridades y angustias. Se destacó la necesidad de intensificar las acciones educativas en la Atención Primaria de Salud, con énfasis en el papel del enfermero y del equipo multiprofesional, con el propósito de cualificar el acompañamiento, ofrecer apoyo continuo y desmitificar creencias que debilitan la práctica.



Palabras clave: Representación Social. Lactancia Materna. Unidad Básica de Salud. Enfermería.

1 INTRODUCTION

The act of breastfeeding is a central practice in the promotion of the health of the mother-child binomial, transcending the nutritional, immunological and affective function. This process intertwines biological, emotional and social aspects, configuring a unique experience that strengthens the mother-child bond and reflects values, meanings and representations that profoundly shape the maternal experience (Kummer *et al*, 2000; Marques; Cotta; Araújo, 2009).

Breast milk (LM) is widely considered the ideal food for the child, capable of meeting all its nutritional and water needs exclusively in the first six months of life. In addition to nurturing, breastfeeding strengthens the bond between mother and child, involving comfort, closeness, and affection (Kummer *et al*, 2000; Takushi *et al*, 2008).

For women, the benefits are equally wide-ranging, including protection against breast and ovarian cancer, reduced risks of postpartum hemorrhage, and aiding in the process of uterine contraction. Breastfeeding also reduces a woman's chances of developing hypertension, type 2 diabetes, and high cholesterol (Ministry of Health, 2024). In addition, it stands out for being a sustainable, environmentally safe, non-polluting practice, and that directly contributes to the child's food and nutritional security. Thus, the promotion and support of breastfeeding represent essential pillars in primary health care actions, given their ability to generate multifaceted positive impacts on individual and collective health.

According to the Ministry of Health (Brasil, 2025), breastfeeding can be maintained even after the introduction of other foods or liquids. On the other hand, Exclusive Breastfeeding (EBF) is characterized by offering only breast milk, either directly from the breast or previously extracted, without the administration of other liquids or solids, except for supplements, vitamins, minerals or prescribed medications.

The World Health Organization (WHO) and the Ministry of Health recommend that EBF be maintained until six months of life. After this period, breastfeeding should continue in a complementary way, associated with the gradual introduction of solid foods, ideally being prolonged until two years of age or more, according to the desire and conditions of the mother and child (WHO, 2017; Brazil, 2024).

However, despite the numerous benefits of breastfeeding, EBF rates remain below established targets. According to the United Nations Children's Fund (2019), only 44% of children under six months are exclusively breastfed. In Brazil, this rate is 45.8%, varying according to the region and population group (ENANI, 2019).

Breastfeeding is a complex phenomenon, influenced by the historical context and by social and cultural determinants, in addition to involving physiological, psychological

and volitional variables. Therefore, it is not just an instinctive and biologically natural act (Leite *et al*, 2016, p.2).

In this scenario, early weaning represents a challenge for maternal and child health at a global level, predisposing to preventable diseases such as malnutrition, diarrhea and childhood obesity, in addition to increasing mortality. These problems have a direct impact on public health indicators and reinforce the need for strategic actions to promote, protect and support breastfeeding (Frota *et al*, 2009).

Early weaning is also a central theme in public health policies, being a multifactorial phenomenon, influenced by social, economic, political and cultural determinants, which transform breastfeeding into an act conditioned by social norms and values (De Souza; Asunción; Guimarães, 2023; Natarelli *et al*, 2025). In this context, pregnant or postpartum women attribute different meanings to breastfeeding, constructed from beliefs, cultural representations and personal experiences, influenced by the social context in which the woman is inserted (Marques; Cotta; Araújo, 2009; Leite *et al*, 2016).

It is in this context that Primary Health Care (PHC) plays a strategic role in the promotion, protection and support of breastfeeding (Brasil, 2025). As a gateway to the health system, PHC is responsible for implementing educational actions, carrying out prenatal and postpartum care, offering individualized guidance, and promoting support groups aimed at strengthening breastfeeding practices. In addition, it enables the early identification of risks, encourages healthy eating practices and supports breastfeeding (Faria; Silva; Passberg, 2023).

However, adherence to exclusive breastfeeding does not always depend only on access to health services or technical guidance. Breastfeeding practices are influenced by symbolic values, personal and collective experiences, and social and cultural beliefs that impact maternal decisions (Fujimori *et al*, 2010; Moraes *et al*, 2020).

According to Moscovici (1978), the concept of social representations refers to cognitive processes by which individuals construct meanings based on their relationship with certain objects, internalizing and reinterpreting them. This phenomenon, influenced by sociocultural and linguistic factors, shapes the way subjects perceive and understand reality (Morera *et al*, 2015). In the case of breastfeeding, understanding these representations allows us to identify perceptions, values and feelings that directly affect maternal decisions.

In view of this, the following study aims to evaluate the social representations of breastfeeding by pregnant and puerperal women in Primary Health Care in the municipalities of Pancas-ES and Colatina-ES, in order to understand how symbolic, cultural and social aspects influence the practice of breastfeeding, in addition to proposing strategies to

promote, protect and support breastfeeding.

2 METHODOLOGY

The methodology of an article outlines the procedures employed to conduct the research, including the type of study, sample selection, methods of data collection and analysis, ethical considerations, and limitations of the study. Its detailed and transparent description is essential to ensure the replicability and reliability of the results, in addition to providing a solid basis for the interpretation and generalization of the findings.

This is an observational, cross-sectional and descriptive study, with a qualitative approach. It took place in 12 Basic Health Units (UBS), ten in the municipality of Colatina and two in the city of Pancas, both in Espírito Santo – Brazil.

The sample consisted of 52 pregnant women and 8 postpartum women assisted at the UBS, totaling 60 participants. These were selected according to the following inclusion criteria: age equal to or greater than 18 years, being pregnant or in the puerperal period and voluntarily agreeing to participate in the research by signing the Informed Consent Form (ICF). Those under 18 years of age and who did not accept to participate were excluded.

The data collection process was carried out through interviews conducted in person and recorded by the research team, using a printed questionnaire divided into two parts as a script. At first, data on the personal and sociodemographic profile of the participants were sought, along with obstetric information. In the second part, the technique of free evocation of words was implemented from an inducing term, which is "breastfeeding". The interviews took place in a reserved place at the Basic Health Unit (UBS), ensuring privacy and comfort for the participants. All of them previously received the necessary clarifications about the objectives of the research, with the reading and explanation of the ICF, and by signing them, each participant took possession of a copy of the document.

In order to ensure anonymity, the research participants were named "pregnant woman (01), puerperal (02)" and so on, according to the number of pregnant and puerperal women who agreed to participate in the research. The entire process strictly followed the principles of ethics in research with human beings, as established by Resolutions No. 466/2012 and No. 510/2016 of the National Health Council, as well as with the guidelines of the General Law for the Protection of Personal Data (Law No. 13,709/2018).

For the analysis of the results, the qualitative data were treated after the application of the recorded interviews, which were digitized, transcribed for semantic analysis of the information and the evocations were extracted, which were elucidated using the openEVOC 0.92 software. This allows the performance of statistical calculations, establishing matrices

of co-occurrences, which serve as a basis for the construction of the four-house framework, processing the probable central nucleus and peripheral system of the social representation of each group of research participants.

The study was previously submitted to and approved by the Human Research Ethics Committee of the University Center of Espírito Santo – UNESC, with the number of the consolidated opinion 7.558.903, dated May 9, 2025, meeting the criteria established by the National Research Ethics Commission (CONEP). All participants signed the Informed Consent Form (ICF) and were guaranteed the right to privacy, confidentiality of the information provided, and the right to withdraw from participation at any time, without prejudice to their attendance.

Serge Moscovici's Theory of Social Representations understands common sense knowledge as a collective construction that influences social behaviors and practices (Moscovici, 1978). In this context, the social representations of breastfeeding are understood as symbolic constructions shared by pregnant and puerperal women, shaped by cultural, social, affective and institutional factors. In addition, Jean-Claude Abric's Central Core Theory was used, which proposes that every social representation has a structure composed of a central core, formed by stable, consensual and culturally shared elements, and a peripheral system, which incorporates contextual and subjective aspects to individual experiences (Abric, 2003).

3 RESULTS

The research was carried out in the cities of Pancas-ES and Colatina-ES in 12 different Basic Health Units (UBS), totaling 60 participants (n=60), among them 52 pregnant women (86.7%) and 8 puerperal women (13.3%). Data on personal characteristics were collected, including age, marital status, education and self-reported skin color (Table 1); sociodemographic profile data, including occupation, per capita income, and religion (Table 2); and data on the obstetric profile, involving parity, pregnancy planning, number of prenatal consultations performed, and type of expected/performed delivery (Table 3).

Regarding personal characteristics, detailed in Table 1, 24 women (40%) were in the age group of 18 to 24 years, 25 (41.7%) were between 25 and 32 years old, and only 11 (18.3%) were over 33 years old. Regarding the data collected regarding marital status, 26 women (43.3%) interviewed were single, 19 (31.7%) married, 14 (23.3%) declared a stable union and only 1 (1.7%) was a widow. Regarding education, 9 people (15%) had incomplete primary education, 9 (15%) had completed primary education, 9 (15%) had incomplete secondary education, 24 (40%) had completed secondary education, 5 (8.3%) had

incomplete higher education and 4 (6.7%) had completed higher education. Finally, 13 women (21.7%) declared themselves white, 38 (63.3%) brown, 8 (13.3%) declared themselves black, and only 1 (1.7%) indigenous.

Table 1

Personal characteristics of pregnant and postpartum women assisted by the UBS of Pancas – ES and Colatina – ES. 2025 (n=60)

Individual variables		Pregnant and Postpartum Women					
		Blows (n=10)		Colatina (n=50)		Total (n=60)	
		n	(%)	N	(%)	N	(%)
Age	From 18 to 24 years old	4	40,0	20	40,0	24	40,0
		4	40,0	21	42,0	25	41,7
	From 25 to 32 years old	2	20,0	9	18,0	11	18,3
	Over 33 years old						
Marital Status	Single	2	20,0	24	48,0	26	43,3
	Married	4	40,0	15	30,0	19	31,7
	Stable Union	3	30,0	11	22,0	14	23,3
	Widow	1	10,0	0	0,0	1	1,7
Education	E.F.I	0	0,0	9	18,0	9	15,0
	E.F.C	0	0,0	9	18,0	9	15,0
	E.M.I	2	20,0	7	14,0	9	15,0
	E.M.C	5	50,0	19	38,0	24	40,0
	E.S.I	1	10,0	4	8,0	5	8,3
	E.S.C	2	20,0	2	4,0	4	6,7
Color	White	3	30,0	10	20,0	13	21,7
	Brown	5	50,0	33	66,0	38	63,3
	Black	2	20,0	6	12,0	8	13,3
	Indigenous	0	0,0	1	2,0	1	1,7
Total		10	100,0	50	100,0	60	100,0

Source: Study Data, 2025.

Regarding the occupation of the interviewees, in the sociodemographic profile (Table 2), 26 women (43.3%) were in paid work, 30 women (50%) self-declared themselves housewives and only 4 (6.7%) were self-employed. The per capita income of 52 people (86.7%) ranged up to 1 minimum wage, 7 (11.7%) lived on 2 to 3 minimum wages, and only 1 woman (1.6%) reported receiving more than 3 minimum wages. Regarding religion, there were 14 women (23.3%) Catholics, 28 (46.7%) Protestants and 18 (30%) declared to have no religion.

Table 2

Sociodemographic profile of pregnant and postpartum women assisted by the UBS of Pancas – ES and Colatina – ES. 2025 (n=60)

Individual variables		Pregnant and Postpartum Women					
		Blows (n=10)		Colatina (n=50)		Total (n=60)	
		n	(%)	N	(%)	N	(%)
Occupation	Paid Work	2	20,0	24	48,0	26	43,3
	From Home	7	70,0	23	46,0	30	50,0
	Stand-alone	1	10,0	3	6,0	4	6,7
Per capita income	Up to 1 salary m.	8	80,0	44	88,0	52	86,7
	2 to 3 m.	1	10,0	6	12,0	7	11,7
	+3 salaries m.	1	10,0	0	0,0	1	1,6
Religion	Catholic	2	20,0	12	24,0	14	23,3
	Protestant	6	60,0	22	44,0	28	46,7
	No religion	2	20,0	16	32,0	18	30,0
Total		10	100,0	50	100,0	60	100,0

Source: Study Data, 2025.

The results collected in the research on the obstetric profile (Table 3) showed that 18 women (30%) were primiparous, that is, first pregnancy/delivery, and 42 women (70%) were multiparous, having had 1 or more pregnancies/deliveries previously. When asked about the planning of the pregnancy, 21 interviewees (35%) confirmed the idealization of the pregnancy, while 39 (65%) would not have planned it. Regarding the number of prenatal consultations, 32 women (53.3%) had up to 6 consultations until the day of the interview and 28 women (46.7%) had a number higher than 6 during pregnancy. Finally, the type of delivery applied to the expectations of the pregnant women or to what was performed by the puerperal women, with 35 (58.4%) normal delivery, 23 (38.3%) cesarean section and only 2 people (3.3%) still had no defined response due to the recent beginning of pregnancy.

Table 3

Obstetric profile of pregnant and puerperal women assisted by the UBS of Pancas – ES and Colatina – ES. 2025 (n=60)

Individual variables		Pregnant women				Postpartum women				Total (n=60)	
		Blows (n=9)		Colatina (n=43)		Blows (n=1)		Colatina (n=7)			
		n	(%)	N	(%)	n	(%)	N	(%)	N	(%)
Parity	Primiparous	4	44,4	12	27,9	0	0	2	28,6	18	30
	Multiparous women	5	55,6	31	72,1	1	100	5	71,4	42	70
Planned pregnancy	Yes	5	55,6	14	32,6	0	0	2	28,6	21	35
	No	4	44,4	29	67,4	1	100	5	71,4	39	65
Number of Consultations of Prenatal Care	£6	4	44,4	27	62,8	0	0	1	14,3	32	53,3
	>6	5	55,6	16	37,2	1	100	6	85,7	28	46,7
Type of Delivery	Normal	7	77,8	25	58,1	0	0	3	42,9	35	58,4
	Cesarean section	2	22,2	16	37,2	1	100	4	57,1	23	38,3
	Undefined	0	0	2	4,7	0	0	0	0	2	3,3
Total		9	100	43	100	1	100	7	100	60	100

Source: Study Data, 2025.

The technique of free evocations of words, based on the inducing term "breastfeeding", made it possible to identify the structure of the social representation of the group investigated. A total of 252 evocations were obtained, of which 75 were distinct, with variation in frequency and in the Mean Order of Evocation (OME). The organization of the data by the openEVOC 0.92 software allowed the construction of the four-box tableau, revealing the central and peripheral elements of the representation.

The Central Core, characterized by high frequency (>5) and low OME (<3), was formed by the terms "love", "fear" and "health". These elements indicate that breastfeeding is perceived in an ambivalent way: on the one hand, as an act loaded with affection and health benefits; on the other, associated with insecurities and fears. In the First Periphery (high frequency and high OME), the terms "pain", "difficult" and "anxiety" stood out, which reinforce concomitant negative experiences during the practice of breastfeeding.

The Contrast Zone (low frequency and low OME) included evocations such as "care",

"desire" and "important", suggesting subgroups that attribute to breastfeeding a meaning strongly linked to the intention and relevance of the mother-infant connection. Finally, the Second Periphery (low frequency and high OME) brought together terms such as "unique", "challenge" and "concern", which represent more particular and contextual experiences, linked to the conditions of the breastfeeding process.

Table 4

Picture of four houses formed by the elements that make up the central nucleus and the peripheries of a representation about breastfeeding by pregnant and puerperal women

Frequency > 5 / Average Order of Evocations < 3		Frequency > 5 / Average Order of Evocations ≥ 3	
Term	OME	Term	OME
Love	2.05	Pain	3.13
Fear	2.57	Difficult	4.13
Health	1.75	Anxiety	4.29
Good	2.73	Affection	3.83
Connection	1.83		

Frequency ≤ 5 / Average Order of Evocations < 3		Frequency ≤ 5 / Average Order of Evocations ≥ 3	
Term	OME	Term	OME
Caution	2.80	Unique	3.40
Happiness	2.40	Challenge	3.25
Important	1.40	Milk	3.25
Immunity	2.80	Concern	3.25
Bond	2.40	Tiredness	4.67
Alimentação Completa	2.75	Special	3.67
I wish	1.50	Expectation	3.33
Affection	1.67	Pleasurable	3.67
Beautiful	2.67	Joy	3.00
Required	2.33	Complementation	5.00
Peito Empedra	2.67	Trust	3.00
Crack	1.67	Experience	3.50
Satisfaction	2.67	Hunger	3.00
Sensação Boa	2.67	Frustrating	4.00

Source: Study Data, 2025.

4 DISCUSSION

From the use of the Central Nucleus Theory and the technique of free evocation of words, it was observed that the terms "love", "fear", "health", "good" and "connection" were evoked more frequently and without hesitation, with an average order of evocations <3, composing the Central Nucleus of the social representation of breastfeeding among pregnant and puerperal women. These results show the ambivalence of this representation, to the extent that, at the same time that the affective and health benefits of breastfeeding for the mother-child binomial are recognized, feelings of insecurity and fear in relation to the breastfeeding process also emerge. This duality reveals the multifaceted character of

breastfeeding, socially valued and recommended, but still crossed by singular, symbolic and contextual experiences that directly impact its experience.

In relation to the first periphery, the words "pain", "difficult", "anxiety" and "affection" were present, demonstrating that these feelings, despite having been evoked at a high frequency, do not have such a significant importance for the interviewees as those who make up the central nucleus. Thus, it shows that the desire to breastfeed on the part of these women overcomes the challenges during the process.

Meanwhile, the Contrast Zone was composed of the terms: "care", "happiness", "important", "immunity", "bond", "complete feeding", "desire", "affection", "beautiful", "necessary", "stomach", "crack", "satisfaction" and "good feeling". In the Second Periphery, the following evocations are present: "unique", "challenge", "milk", "concern", "tiredness", "special", "expectation", "pleasurable", "joy", "complementation", "confidence", "experience", "hunger" and "frustrating". However, these elements have a reduced value in the interpretation of the Social Representation of breastfeeding for society, since some of them are synonymous with others that are more evoked or are based on individual experiences of each woman, not being a common opinion of the vast majority.

In the analysis, the term "love" presented a higher frequency and lower average order of evocations, reflecting the historical and cultural context of the maternal-child bond. This bond has been widely studied, especially by John Bowlby, creator of the Attachment Theory, who highlights its importance for the survival of the species and the emotional development of the child. The interaction with the caregiver provides the child with experiences of trust, security and well-being, strengthening the affective bond. Thus, it is essential that this bond is, whenever possible, stable and harmonious, preventing weaknesses in the construction of maternal-child attachment. The newborn responds in a particular way to the attention, protection, and stimuli received, consolidating emotional bonding (Da Silva, 2019; Bowlby, 1984).

That thing there, when you take it, is wonderful. I love being a mother, so much so that I have many (G33).

This one will breastfeed until she is two years old, I think the most beautiful thing there is breastfeeding (G29).

According to Cunha *et al.* (2012), breastfeeding is configured as an act of affection and care, allowing moments of exchange of glances, skin-to-skin contact and caresses, which strengthens the bond between mother and baby. In addition, it is recognized as one of the first ways in which human beings begin to build emotional relationships.

Evocations such as "good" and "connection" are also related to the mother-child binomial, since the experience and expectations of breastfeeding involve affective and sensorial dimensions that are unique to each woman. This process allows the mother to recognize herself in a relationship of physical and emotional closeness with the baby. Some pregnant women reported breastfeeding because they considered the act "pleasant" or "beautiful", thus evidencing the expression of autonomy, comfort and well-being in the mother's experience (Takushi *et al*, 2008).

In addition, a prevalence of the evocation of the term "fear" was observed, both among primiparous and multiparous pregnant women. Among primiparous women, this feeling seems to be associated with uncertainty in the face of the unknown, idealization of the breastfeeding process, poorly founded previous knowledge, often constructed from informal narratives, cultural beliefs or shared experiences in the family and social spheres, and doubts related to one's own ability to care for the newborn. In the case of multiparous women, fear is generally related to previous negative experiences, some of them marked by painful experiences, such as nipple fissures, inflammatory processes, episodes of hypogalactia in previous pregnancies, among other reported situations.

It scares me, because it's new [...], I saw what my sister suffered to breastfeed, how much it hurt, it gives me trauma (G08).

I only remember my (chest) cracking and hurting a lot, it's a fear of it happening again (G18).

I'm afraid of hurting my breast and not being able to breastfeed because of that [...], even though I've never been a mother, I want to breastfeed (G41).

I had an experience with the first child that was not very good, but I think it is something necessary, important and that creates a bond with the baby (G09).

In addition, the prevalence of the term "fear" was often associated with narratives of pain, cravings, inflammation and fear of "sucking and cracking". These reports show that real or anticipated physical suffering acts as a factor of insecurity that permeates the breastfeeding experience. This perception is fed both by their own experiences, especially among multiparous women who have already faced difficulties in previous pregnancies, and by subjective experiences shared in the social and family circle. This collective construction of fear, rooted in painful memories or transmitted discourses, reinforces social representations that can weaken maternal self-confidence in the breastfeeding process. In addition, difficulty with the breasts due to the presence of inverted nipples appeared in the reports of some of the women as an unfavorable reason for breastfeeding.

If I tell you that I never breastfed, because the nipple of my breast is inverted. In the other two pregnancies I couldn't breastfeed [...], in this one I wanted to try, but I don't know if I'll be able to (G46).

Another relevant data of the study was the finding that 76.7% of the participants did not receive guidance on breastfeeding during prenatal consultations, and 36.7% stated that they did not feel prepared and confident to start breastfeeding. This finding shows a significant gap in care, since prenatal care is a privileged space for the development of educational actions, acceptance of doubts and strengthening of the autonomy of pregnant women.

In this context, Primary Health Care (PHC) emerges as a strategic axis in the management of difficulties related to breastfeeding, by offering longitudinal follow-up, qualified listening and educational interventions that go beyond the mere transmission of technical information, strengthening the bond between professional and patient. Guidance on cleft prevention and management, breast care, appropriate positions for correct latching, and demystification of negative beliefs are fundamental practices to reduce fear, promote safety, and favor breastfeeding adherence. However, the findings of this study indicate that such actions are still insufficient, since most pregnant and puerperal women reported not having received adequate information in the prenatal period and did not feel prepared to breastfeed. These data reveal a worrying gap in care, suggesting weaknesses in both the attribution and qualification of health professionals, who often do not incorporate the theme of breastfeeding in a systematic way during consultations.

Established by Ordinance GM/MS No. 1,459, of June 24, 2011, the Stork Network is configured as a federal government strategy aimed at promoting comprehensive and humanized care for women's and children's health. Its scope ranges from reproductive planning to the monitoring of child development in the first two years of life, including pregnancy, childbirth and puerperium, and already provides for specific actions to encourage, protect and support breastfeeding.

Complementing these actions, Federal Law No. 13,435, of April 12, 2017, instituted Golden August as a national campaign aimed at raising awareness in society about the benefits of breastfeeding, reinforcing the importance of public policies that encourage this practice. The initiative seeks to promote awareness strategies at different levels of health care, in line with recommendations such as the "golden hour", the immediate moment after delivery when contact between mother and baby strengthens the maternal bond and helps the newborn adapt to the external environment (Brasil, 2023). In the first days after delivery, colostrum, the initial milk, stands out for being a substance rich in protein and

immunoglobulins, essential for the baby's immunity. After colostrum, the milk becomes denser, rich in fats and carbohydrates, aiming at the baby's weight gain, being known as transition milk. Finally, mature milk maintains its composition, with the addition of essential nutrients for the growth and strengthening of the child (Brasil, 2022). However, the effectiveness of these policies depends directly on the performance of PHC, whose professionals need to be properly trained to integrate technical knowledge and reception to maternal needs, assuming the role of health educators.

Given this scenario, investing in the continuous training of PHC multiprofessional teams, doctors, nurses, nutritionists, and community health agents, becomes essential to ensure that breastfeeding guidelines are clear, accessible, and based on scientific evidence. At the same time, the creation of educational groups, conversation circles and home visits enables spaces for dialogue where technical knowledge is articulated with the subjective experiences of women, promoting humanized and participatory care.

Therefore, the results of this study reinforce the need to expand the performance of PHC not only in the care dimension, but also in the educational, preventive and community aspects, ensuring continuous support to the mother and the family. The articulation between local health practices, government campaigns and professional training is essential to transform breastfeeding into a positive experience, strengthening the mother-baby bond and contributing to better public health indicators.

5 CONCLUSION

The experiences about breastfeeding revealed central elements that translate the way this phenomenon is perceived and experienced. The terms that made up the Central Nucleus, "love", "fear" and "health", show an ambivalent perception, in which breastfeeding is understood simultaneously as an act of affection and health promotion, but also permeated by uncertainties and fears.

Breastfeeding was represented as a gesture of affection and care, reaffirming the mother-child binomial. On the other hand, the marked presence of the term fear expresses the dimension of insecurity that accompanies the practice. For primiparous women, fear was associated with the unknown; for multiparous women, to previous negative experiences. Reports of pain, fissures and inflammation were frequently mentioned, reinforcing social representations that associate breastfeeding with physical suffering.

Despite these ambivalences, valuing health as a benefit of breastfeeding reinforces the traditional knowledge of its importance for child development and the strengthening of bonding. However, there is a worrying gap in care: 76.7% of the participants did not receive

specific guidance on breastfeeding in prenatal care, and 36.7% did not feel prepared or confident to start the process. This context reveals the permanence of popular knowledge that supports the desire to breastfeed, but without the formal support expected in health services.

In addition, the Basic Health Unit is a fundamental environment to support and promote breastfeeding. The lack of adequate guidance reveals the need to intensify the actions developed, especially by nurses and the multiprofessional team, who should expand educational initiatives, offer qualified prenatal and puerperal care, provide individualized guidance, form support groups and demystify negative beliefs that weaken the practice. In this context, the continuous training of professionals and the integration of local practices with public policies become essential to transform breastfeeding into a more positive experience, reducing fears and strengthening maternal love and trust. In this way, PHC reaffirms itself as a pillar in strengthening the mother-baby bond and in the consolidation of breastfeeding as a pleasurable and healthy practice.

REFERENCES

- Abric, J.-C. (2003). Abordagem estrutural das representações sociais: Desenvolvimentos recentes. In P. H. F. Campos & M. C. da S. Loureiro (Orgs.), *Representações sociais e práticas educativas* (pp. 37–57). Editora da UCG.
- Bowlby, J. (1984). *Apego e perda: Apego* (Vol. 1). Martins Fontes.
- Brasil. (2011). Portaria nº 1.459, de 24 de junho de 2011. Institui no âmbito do Sistema Único de Saúde a Rede Cegonha. https://bvsms.saude.gov.br/bvs/saudelegis/gm/2011/prt1459_24_06_2011.html
- Brasil. (2012). Resolução nº 466, de 12 de dezembro de 2012. Dispõe sobre as diretrizes e normas regulamentadoras para pesquisas envolvendo seres humanos no Brasil. https://bvsms.saude.gov.br/bvs/saudelegis/cns/2013/res0466_12_12_2012.html
- Brasil. (2016). Resolução nº 510, de 07 de abril de 2016. Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais. https://bvsms.saude.gov.br/bvs/saudelegis/cns/2016/res0510_07_04_2016.html
- Brasil. (2017). Lei nº 13.435, de 12 de abril de 2017. Institui o mês de agosto como o Mês do Aleitamento Materno. https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/lei/l13435.htm
- Brasil. (2018). Lei nº 13.709, de 14 de agosto de 2018. Lei Geral de Proteção de Dados Pessoais. https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/lei/l13709.htm
- Brasil. Ministério da Saúde. (2022). Leite materno passa por transformações de acordo com cada etapa de desenvolvimento do bebê. <https://bvsms.saude.gov.br> (ou link específico do documento; baseado em publicações relacionadas ao Guia Alimentar).
- Brasil. Ministério da Saúde. (2024). Amamentação em seis tópicos. <https://bvsms.saude.gov.br> (ver publicações sobre promoção da amamentação; alinhado com campanhas Agosto Dourado).

- Brasil. Ministério da Saúde. (2025). Guia alimentar para crianças brasileiras menores de 2 anos. Versão resumida. https://bvsms.saude.gov.br/bvs/publicacoes/guia_alimentar_crianca_brasileira_versao_resumida.pdf
- Cunha, A. C. B., Santos, C., & Gonçalves, R. M. (2012). Concepção sobre maternidade, parto e amamentação em grupos de gestantes. *Arquivos Brasileiros de Psicologia*, 64, 139–155.
- Da Silva, B. A. A., & Braga, L. P. (2019). Fatores promotores do vínculo mãe-bebê no puerpério imediato hospitalar: Uma revisão integrativa. *Revista da Sociedade Brasileira de Psicologia Hospitalar*, 22(1), 258–279.
- De Souza, B. S., Assunção, E. G., & Guimaraes, G. C. (2023). Fatores associados ao desmame precoce no contexto brasileiro. *Saberes Plurais Educação na Saúde*, 7(2), Article e133427. <https://doi.org/10.5216/saberesplurais.v7i2.133427> (ajuste se DOI exato diferir)
- Faria, E. R., Silva, D. D. F., & Passberg, L. Z. (2023). Fatores relacionados ao aleitamento materno exclusivo no contexto da atenção primária à saúde. *Codas*, Article e20210163. <https://doi.org/10.1590/2317-1782/202320210163> (Sociedade Brasileira de Fonoaudiologia)
- Frota, M. A., et al. (2009). Fatores que interferem no aleitamento materno. *Rev Rene*, 10(3), 61–67.
- Fujimori, E., et al. (2010). Aspectos relacionados ao estabelecimento e à manutenção do aleitamento materno exclusivo na perspectiva de mulheres atendidas em uma unidade básica de saúde. *Comunicação, Saúde e Educação*, 14(33), 315–327.
- Kummer, S. C., et al. (2000). Evolução do padrão de aleitamento materno. *Revista de Saúde Pública*, 34, 143–148.
- Leite, G. O., et al. (2016). Representações sociais de mulheres sobre o cheiro do leite materno. *Escola Anna Nery*, 20(4), Article e20160090. <https://doi.org/10.5935/1414-8145.20160090>
- Marques, E. S., Cotta, R. M. M., & Araújo, R. M. A. (2009). Representações sociais de mulheres que amamentam sobre a amamentação e o uso de chupeta. *Revista Brasileira de Enfermagem*, 62, 562–569.
- Moraes, I. C., et al. (2020). Percepção sobre a importância do aleitamento materno pelas mães e dificuldades enfrentadas no processo de amamentação. *Revista de Enfermagem Referência*, 2, Article e19065. <https://doi.org/10.19127/rever.v2i0.19065>
- Morera, J. A. C., et al. (2015). Aspectos teóricos e metodológicos das representações sociais. *Texto & Contexto-Enfermagem*, 24, 1157–1165.
- Moscovici, S. (1978). *A representação social da psicanálise*. Zahar.
- Natarelli, T. R. P., et al. (2025). Cenário simulado para promoção do aleitamento materno na atenção primária à saúde. *Acta Paulista de Enfermagem*, 38, Article eape0002852. <https://doi.org/10.37689/acta-ape/2025AO0002852> (ou link SciELO: <https://www.scielo.br/j/ape/a/3fY4rFkQ9jscV7fnhgVTRhH>)
- Takushi, S. A. M., et al. (2008). Motivação de gestantes para o aleitamento materno. *Revista de Nutrição*, 21, 491–502.

United Nations Children's Fund. (2018). Infant and young child feeding.
<https://data.unicef.org/topic/nutrition/infant-and-young-child-feeding/>

World Health Organization. (2017). Protecting, promoting and supporting breastfeeding in facilities providing maternity and newborn services: Guideline.
<https://www.who.int/publications/i/item/9789241550086>

REGULATION AND PUBLIC POLICIES OF SOCIAL AND SOLIDARITY ECONOMY

REGULAÇÃO E POLÍTICAS PÚBLICAS DE ECONOMIA SOCIAL E SOLIDÁRIA

REGULACIÓN Y POLÍTICAS PÚBLICAS DE LA ECONOMÍA SOCIAL Y SOLIDARIA



<https://doi.org/10.56238/sevened2026.008-104>

Caio Nordi Jorge Armani Cirino¹, Luciana Teixeira Randi², Thiago de Mello Almada Rubbo³

ABSTRACT

The present study aims to investigate the regulation process of Social and Solidarity Economy in Brazil, primarily from the perspective of public policies. In this sense, the aim was to demonstrate that the regulation of Social and Solidarity Economy through public policies is a sociopolitical process resulting from the constant interaction, within public spaces, between civil society actors and the State. The current institutional context in Brazil indicates a still fragile and nascent regulation, largely attributed to the inherent weaknesses in the modus operandi of Solidarity Economic Enterprises. It has been shown that a viable alternative to addressing these weaknesses is the strengthening of an entrepreneurial ecosystem for SSE. Furthermore, efforts were made to delineate some international experiences in favor of regulating Social and Solidarity Economy, which certainly can provide elements for the Brazilian regulatory journey. In conclusion, it is evident that the process of regulating Social and Solidarity Economy needs to advance in Brazil, particularly through the implementation of coherent and robust public policies, to give substance to the principles of social justice that characterize Social and Solidarity Economy.

Keywords: Social Solidarity Economy. Regulation. Public Policies.

RESUMO

O presente trabalho visa a estudar o processo de regulação da Economia Social e Solidária no Brasil, principalmente a partir da perspectiva das políticas públicas. Nesse sentido, buscou-se demonstrar que a regulação da Economia Social e Solidária via políticas públicas é um processo sociopolítico resultante da constante interação, no âmbito dos espaços públicos, entre atores da sociedade civil e do Estado. A atual conjuntura institucional no Brasil aponta para uma regulamentação ainda frágil e incipiente, o que pode ser atribuído em grande parte às fragilidades inerentes ao modus operandi dos Empreendimentos Econômicos Solidários. Demonstrou-se que uma alternativa viável ao enfrentamento dessas fragilidades é o fortalecimento de um ecossistema empreendedor para a ESS. Buscou-se, ainda, delimitar algumas experiências internacionais em prol da regulamentação da Economia Social e Solidária, que certamente podem fornecer elementos para a jornada de

¹ Master's Degree in Law. Faculdade de Campinas (Facamp). E-mail: cnj@ghbp.com.br

² Master's student in Law. Faculdade de Campinas (Facamp). E-mail: lr@ghbp.com.br

³ Master's Degree in Law. Faculdade de Campinas (Facamp). E-mail: tar@ghbp.com.br

regulamentação brasileira. Conclui-se, por fim, que o processo de regulação da Economia Social e Solidária precisa avançar no Brasil, em especial a partir da implementação das políticas públicas coerentes e robustas, para dar concretude aos ditames de justiça social que caracterizam a Economia Social e Solidária.

Palavras-chave: Economia Social e Solidária. Regulação. Políticas Públicas.

RESUMEN

Este estudio busca examinar el proceso regulatorio de la Economía Social y Solidaria en Brasil, principalmente desde la perspectiva de las políticas públicas. En este sentido, busca demostrar que la regulación de la Economía Social y Solidaria a través de políticas públicas es un proceso sociopolítico resultante de la interacción constante, en los espacios públicos, entre actores de la sociedad civil y el Estado. El contexto institucional actual en Brasil apunta a una regulación aún frágil e incipiente, que puede atribuirse en gran medida a las debilidades inherentes al modus operandi de las Empresas Económicas Solidarias. Se demuestra que una alternativa viable para abordar estas debilidades es el fortalecimiento de un ecosistema emprendedor para la ESS. Además, se describen algunas experiencias internacionales a favor de la regulación de la Economía Social y Solidaria, que sin duda pueden aportar elementos al proceso regulatorio brasileño. En conclusión, el proceso de regulación de la Economía Social y Solidaria debe avanzar en Brasil, especialmente mediante la implementación de políticas públicas coherentes y sólidas, para concretar los dictados de justicia social que caracterizan a la Economía Social y Solidaria.

Palabras clave: Economía Social y Solidaria. Regulación. Políticas Públicas.

1 INTRODUCTION

The Social and Solidarity Economy (SSE) plays a key role in promoting a fairer and more inclusive economy, offering sustainable alternatives to traditional economic models.

SSE covers a wide range of entities and activities, including cooperatives, associations, social enterprises, third sector organisations and self-management initiatives. However, the absence of a clear definition and a specific normative framework for SSE in the country has generated significant challenges for its development and recognition.

The understanding of SSE is particularly complex due to the diversity of organisational forms and the different interpretations of its principles and values.

While some definitions emphasize the priority of people over capital and democratic management, others focus on generating employment and income, especially for those excluded from traditional forms of economic organization. This diversity reflects the richness and complexity of the field, but it also highlights the need for clearer and more cohesive understanding.

The lack of consensus on the definition of SSE is closely linked to a normative vacuum. Different sectors of society and government have proposed various legislation and policies to regulate and support SSE, but to date there is no comprehensive and consolidated regulation. This regulatory vacuum creates uncertainty and limits the growth potential of SSE entities, making it difficult to access financing, tax incentives, and other forms of institutional support.

In addition, the lack of organization in a structural way seems to reveal not only the lack of interest of the Government, but also entails a real impediment to the promotion and development of public policies as a means for the consolidation of this economic organization.

Analysis of the existing literature on ESS reveals that the criteria for identifying and categorizing entities in the sector vary widely. Some approaches focus on the principles and values that guide entities, while others focus on their socio-economic practices and impacts. This multiplicity of criteria reflects the different visions and priorities of the various actors involved in the field of SSE.

This article seeks to explore the various definitions and criteria used to understand SSE, especially in Brazil, as well as the challenges and opportunities associated with this lack of consensus. In addition, the normative vacuum and its implications for the development of SSE are analyzed.

The work was developed through a bibliographic research, with consultation with renowned doctrinaires, legislation applicable to the matter, as well as academic works and scientific articles.

The development of the work will begin with the approach of the importance of networks and SSE as a social movement. Next, we move on to a more in-depth analysis of the solidarity enterprise, its characteristics and actors.

The theme in SSE in Brazil is deepened, bringing reflections on the scarce institutional and governmental incentive for the promotion of SSE.

Finally, the European and Latin American international scenario, their advances and obstacles are analyzed.

From this analysis, it is expected to contribute to a more informed and constructive reflection and debate on the role of SSE in promoting a fairer and more sustainable economy in Brazil and in the world.

2 THE SOCIAL AND SOLIDARITY ECONOMY: NETWORKS AND SOCIAL MOVEMENT

The Social and Solidarity Economy (SSE), by proposing a form of production and work based on cooperation and sustainability, emerges as an alternative response to the capitalist economic system, revealing its aspect as a strategy to combat poverty and social exclusion (FORTE, 2015).

As a social product, one cannot fail to analyze that SSE is a product of the interaction between civil society and the State⁴, on the stage of public spaces, without first understanding that the movement needs legal support within the concept of national positive law.

Therefore, regulation is essential to provide the legal certainty necessary to defend the interests of this particular public.

The process of attributing legal character to SSE, incorporating it into the legal system and, consequently, obliging the State to recognize it as a legal fact, is called juridicization (FORTE, 2015).

The institutionalization of SSE, via social and legal regulation, presupposes the understanding that SSE should be seen as a social movement, more precisely in the category of new social movements.

In this sense, when analyzing the forms in which SSE is presented, Forte (2015) teaches that the Social and Solidarity Economy is better understood as a social movement, of the new type, instead of the simple conception and socioeconomic practice as an alternative policy to capitalism; or as a simple public policy of productive inclusion in the fight against poverty.

⁴ The concept of State, for the purposes of this work, must be understood from the notion of political society, which concerns, in addition to the bureaucratic and administrative institutions of the State, the beliefs and values that permeate the institution and its personnel (FORTE, 2015).

The dimension of the new social movement emphasizes the demand for autonomy, recognition of differences and new cultural values, with an emphasis on justice and solidarity (FORTE, 2015).

Social movements of the new type bring together broader ideas of contestation and social transformation, including reticular organization.

And all interaction must take place within a public space, which is the appropriate place for debate and expression of the differences between civil society and the State, a consequence of adequate social and legal regulation.

Public space seems simple to define, but when looking for sources, Habermas (1997) understands it to be a place of debate guided by the common good, seeing it as an egalitarian debate, ignoring money and power; Hanna Arendt, in turn, seeks the definition as a space for sharing interpretations of the world (TELLES, 1990). What both do not consider is the inequality of power, characteristic of the capitalist economy with which the SSE must dialogue.

From the perception that there are constraints inherent to public spaces that do not allow the unequal to decide as if they were equal, the concept "subaltern counter-publics" was coined to designate the parallel public spaces in which the holders of less economic and political power are able to build and unify their arguments, in order to later present them more strongly in the large public space, which is the stage where, in fact, institutional discussions take place (FORTE, 2015).

And the movement in favor of the ESS is precisely an example of subaltern counter-public. At the local level, there are several meetings and plenary sessions of the entities that make up the ESS, whose objective is to align the demands and define the local political agenda, which will later be taken to the debate in the large public space, as a unified demand.

In this sense, it is expected that the results of the interaction between civil society and the State, which occurred in the context of public spaces, will be the basis for the institutionalization, via social and legal regulation, of the SSE.

Considering that, in Brazil, the SSE movement is organized in the reticular form, it is imperative to consider it as a network of social movements or, simply, a network of networks (FORTE, 2015).

This is true to the extent that the constitution of the SSE movement took place from the incorporation of the demands of different social movements, making it a larger movement.

Thus, the national SSE movement is a large network composed of other smaller and integrated networks. Hence, it is stated that the national movement in favor of SSE does not have a specific territorial headquarters, being simultaneously connected to several places.

Considering all the nuances, it is necessary to understand that the network movement already includes a wide range of actors, such as non-governmental organizations (NGOs), social movements, religious entities, cooperatives, workers' associations, and technical and financial support institutions.

These actors are connected through forums, conferences, councils and plenary sessions, creating a complex web of relationships that enables the exchange of information, the coordination of actions and the articulation of common demands, of which the following are examples:

- **Solidarity Economy Forums:** These spaces for meeting and debate are crucial for the articulation of the movement. The forums provide an environment where the various actors can discuss challenges, share experiences and build consensus on the strategies to be adopted. Examples include the Brazilian Forum on Solidarity Economy (FBES) and regional and local forums.
- **Conferences and Plenaries:** Large-scale events such as national and state SSE conferences allow for the mobilization of a wide range of participants, facilitating collective deliberation and the formulation of concrete proposals for public policy. These conferences are important moments for defining priorities and evaluating the actions of the movement.
- **Solidarity Economy Councils:** These councils, formed by representatives of civil society and the government, act as institutional spaces for dialogue and cooperation. They play a fundamental role in the elaboration, implementation and monitoring of public policies aimed at the Social and Solidarity Economy.
- **Support and Promotion:** Entities such as Caritas Brasileira, the Marist Institute of Solidarity (IMS) and other organizations provide technical, financial and educational support to social and solidarity economy enterprises, strengthening their operational and management capacities.
- **Advocacy and Political Incidence:** The Social and Solidarity Economy network employs advocacy strategies to influence the political and legislative agenda, seeking to create a legal framework favorable to the social and solidarity economy. The proposal for Law No. 4,685/2012 is an example of how these strategies can lead to the institutionalization of the Social and Solidarity Economy as a national public policy.

It should also be noted that the SSE network is not restricted only to the physical dimension, as the virtual universe, especially from the democratization of access to the *internet*, has complex ways of information and articulation, disseminating and sharing a

political project to an increasing number of recipients, located anywhere in the world (FORTE, 2015).

From the concept of social movement network, the SSE movement should be assumed as something of a collective dimension, although diffuse, marked by the constant interaction of civil society and the State in public spaces, whose objective to be pursued is the institutionalization of SSE, through social and legal regulation.

It is, therefore, a process of an eminently sociopolitical nature.

3 THE ENTREPRENEURIAL ECOSYSTEM IN THE SOCIAL AND SOLIDARITY ECONOMY

The SSE is composed of a multiplicity of organizational forms, each involved in a specific context, with its own dynamics, seeking to address motivations from the most varied origins.

Cooperatives, mutual societies, associations, social enterprises, third sector organizations and informal groups are some of the entities that, depending on the context, can integrate the "sector" of the SSE, although the SSE is not restricted to them.

Specifically in the Brazilian scenario, there is no consensus regarding the term SSE, nor regarding the entities that compose it, which is largely due to the existence of a normative vacuum⁵, despite the growing economic and social strength of this social-economic segment (MORAIS; BACIC, 2019).

As SSE is marked by conceptual and theoretical uncertainties, it was sought, in the doctrinal field, to establish a set of minimum criteria to determine whether or not an entity is part of the SSE field.

According to Moraes and Bacic (2019), the criteria are⁶: i) social mission; ii) limited or prohibited distribution of surpluses; iii) presence of salaried and/or volunteer employees; iv) the organization's decision-making process; and v) existence, or not, of "democratic governance".

The SSE entities represent, therefore, a paradigm of economic and social development whose core value is the human person, not capital, with an emphasis on social justice and sustainability.

⁵ Bill No. 137, of 2017, authored by the Chamber of Deputies, is pending in the Federal Senate, which provides for the National Policy of Solidarity Economy and solidarity economic enterprises, creates the National System of Solidarity Economy and provides other provisions. The last progress of the Project took place on 12/18/2019.

⁶ The option to indicate these - and not other - criteria stems from the choice of the work of Moraes and Bacic (2019) as the main theoretical reference. There are authors who choose different criteria, such as Silva & Carneiro (2016) and Silva (2018) – among others.

In this sense, the purpose of these entities is to generate employment and income, especially for those who are on the margins of the traditional form of economic organization.

The ESS is, therefore, an innovative alternative for generating work and income in favor of socio-labor inclusion.

The definition of the criteria that characterize entities that are part of the SSE also serves as a starting point for measurement and mapping studies, the results of which allow the development and evaluation of public policies, in addition to increasing the visibility of the SSE.

It is not disputed that quantification and evaluation are essential to obtain an adequate understanding of SSE, its place and its role. For some, the statistical study of SSE is a topic of marked relevance in the twenty-first century (MORAIS; BACIC, 2019).

From this context, the expression Solidarity Economic Enterprises (EES) was coined to designate a portion of the entities that meet, in the real economic dynamics, the criteria that characterize the ESS.

Despite their aggregating potential from an economic and social point of view, EES are marked by structural weaknesses that are intrinsic to their *modus operandi*.

The low competence profile of the social entrepreneur is one of the great weaknesses of the EES (BACIC, 2014).

The social entrepreneur, contrary to what is usually observed in entrepreneurs dedicated to private enterprises, has levels of formal education and previous experience that are insufficient to perceive the business opportunity and to define the way to exploit it.

In the process of social and solidarity entrepreneurship, the combination of efforts between two or more would-be entrepreneurs is not due to one of them having, based on the degree of education and/or previous work experience, perceived an opportunity, evaluated all aspects related to the viability of the business (technology, market, suppliers and costs) and formatted a business plan.

The candidates for social and solidarity entrepreneur come together, in fact, due to the mutual absence of the prospect of insertion in the formal labor market, leaving them with no other income option than the EES.

The lack of skills, combined with the disjointed network of pre-existing relationships of these entrepreneurs, induces the definition of businesses in a generic way - recycling, handicrafts, sewing and food, for example -, attracting strong competitive pressure, which leads to a drop in prices and low withdrawals (BACIC, 2014).

The EES should not be restricted to the development of simple activities that are dislocated from the local productive fabric; it is necessary that there be an articulation in order

to effectively integrate the EES into the local productive fabric, through the promotion of innovative actions.

Added to the scenario of low qualification of entrepreneurs is the fact that there is an inherent difficulty in learning to work in groups and assimilating elementary notions of management, technology and, in many cases, even citizenship.

That is to say that the existence of the EES has as a prerequisite skills and resources that are not within the reach of most people who participate or intend to participate in self-management groups (MORAIS; BACIC, 2019).

To the extent that the improvement of the competencies of the social entrepreneur occurs concomitantly with the exercise of the economic activity itself, it is credible to say that this is a necessarily long process, which demands intense institutional support, in the short, medium and long term, at the municipal, state and federal levels.

And it is precisely in institutional support – or lack of it – that lies another great weakness inherent to the EES.

The main symptom of the absence of institutional support is the lack of articulated public support policies. This is to say that there are no coordinated, integrated and transversal actions around the EES in Brazil, which puts initiatives in favor of work, employment and income in danger of extinction (MORAIS; BACIC, 2019), which is largely attributable to the normative vacuum and conceptual imprecision that permeates SSE.

Public policies – made possible by the interaction between different interest groups – are one of the essential pillars on which the ESS are established and strengthened.

As a segment that is part of the economic dynamics, EES are subject to the effects, positive and negative, of economic variants, at the micro level – supply and demand, production costs, among others – and macroeconomic – interest rates, tax incentives, among others.

This is to say that, depending on the circumstances, the mood of the market and the economy can also be another challenge posed to the creation, development and survival of the EES.

Well. The first step in overcoming an obstacle is to understand its causes, and this is reasonably delimited in the universe of EES.

Following the stage of mapping the causes, the assimilation that the confrontation of the weaknesses intrinsic to the *modus operandi* of the EES is closely related to the notion of efficiency of these enterprises, that is, the capacity for preservation and consolidation as a result of their own functioning (GAIGER, 2008).

In other words, the efficiency of the EES must be measured based on the ability to generate and maintain conditions of viability, in the medium and long term, which requires a series of coordinated actions, such as, for example, economic and financial self-sufficiency, investment capacity, productive increase, among others.

In this sense, it is understood that the formation of the entrepreneurial ecosystem for the SSE is a fundamental piece for the emancipation of the EES, as it provides the organized confrontation of the weaknesses that are intrinsic to them (MORAIS; BACIC, 2019).

A limitation to this proposal is the fact that there is, among the leaders of the EES, a certain resistance to discussing more strictly economic and financial issues, entering the framework of capitalist rationality (BACIC, 2014).

The isolationist view of the EES tends to be short-sighted, to the extent that it is not possible to conceive of a society in which there are no relations of exchange and economic activity among its actors.

For this reason, the term "entrepreneurship" must be revived within the scope of the SSE, seeking to adapt it to the needs of an "associative entrepreneurship", typical of the EES, for which the following are necessary: cooperation at work, collective decisions, exchange of information and collective project (MORAIS; BACIC, 2019).

Well. An entrepreneurial ecosystem in general is a community within a region of interdependent actors, with diverse roles that interact, determining the performance of the ecosystem and, eventually, of the entire economy of a region (MORAIS; BACIC, 2019).

From the interactive dynamics of an entrepreneurial ecosystem, it is expected, in addition to the evolution in terms of organization and learning of the companies that compose it, the generation of new companies, whose creators are attracted by an environment, from the economic and technological points of view, favorable.

For Serrano (2015), ecosystems are "networks of actors" (entrepreneurs, researchers, financiers, politicians – executive and legislative, etc.) that take into account the physical-territorial and cultural dimensions of a given territory.

The relationships between these actors, in turn, can be i) of a political nature (such as alliances between the social and political actors that constitute the basis of territorial governance); ii) production (creation of EES networks); and iii) connections with innovative purpose (groups of actors that create the necessary conditions for the generation and dissemination of social innovation).

The elements of an entrepreneurial ecosystem are allocated to one of the following networks: the informal network, composed of friends, colleagues, family and entrepreneurs

in a similar situation; and the formal one, made up of a diversity of actors, from research universities, through government support services, to capital providers.

In the lessons of Morais and Bacic (2019), the elements of the formal network are i) research universities, due to the potential to develop technologies and combine knowledge; ii) government, by fostering the entrepreneurial environment; iii) network of services and support, by offering a set of professional services to support entrepreneurs; iv) sources of capital, through the facilitated granting of credit; v) human talents, as they are the origin of any enterprise; vi) constituted companies, as they are often the places where entrepreneurs acquire skills and experience; and vii) incubators, for the support to nascent companies.

The task of building an entrepreneurial ecosystem is complex in itself, given the systemic and dynamic degree of this concept.

Within the scope of SSE, the complexity intensifies and gains its own contours, in view of the structural weaknesses inherent to this segment and the lack of institutionalization of its policies (MORAIS; BACIC, 2016).

In this sense, based on the structure of the entrepreneurial ecosystem for business-based enterprises, it is understood that an adequate organization of the solidarity entrepreneurial ecosystem must contain, at least, the following elements: i) knowledge; (ii) market access; iii) public and fiscal support for ESS startups; iv) access to finance; (v) network support and mutual support instruments; vi) development of research and qualification in the area; and vii) indicators for the evaluation and monitoring of EES (MORAIS; BACIC, 2019).

One of the ways for the coordinated application of these elements is the combination of efforts and responsibilities of shared construction between the EES, academia and government, through public policies.

The joint action of these three actors can be better understood from the "Triple Helix" model.

When dealing with the relevance of EES, academia and government in structuring the solidarity entrepreneurial ecosystem, it is necessary to consider that:

In order for the treatment of ecosystems to be shown as a viable approach for the planning and strategic management of entrepreneurship, it is important to present the reasons that make the triple helix a predominant view and practice and, at the same time, to suggest what its main limits are (LEMOS, 2011).

The main reasons that position the Triple Helix model at the center of the construction of the entrepreneurial ecosystem in the SSE are: i) the combination of economics and sociological content of innovation systems; ii) direct application to public policies; and iii)

facilitation of the process of planning, management and execution of these policies (LEMOS, 2011).

The capacity for transversal articulation and interactions between its actors evidences the vocation of the Triple Helix model to promote "coevolution", that is, the member organizations can interact with their ecosystems and the ecosystems interact with the organizations, both at the micro and macro levels (MORAIS; BACIC, 2019).

This is a key concept in the development of the ecosystem perspective.

Coevolution is directly proportional to the degree of interconnectedness of the ecosystem, that is, the interdependence that all components of the system have with each other.

In this sense, actors with less social and economic expression can benefit from the inputs generated by more expressive actors, without having to produce these inputs themselves. It is to say that some actors function as true platforms for others (LEMOS, 2011).

The weakening or disappearance of these key actors greatly impacts the ecosystem, in some cases even fatally.

It is concluded, therefore, that the emancipation of the EES through the solidarity entrepreneurial ecosystem is completed with the application of the Triple Helix model, which subsidizes the process of construction of public policies among the agents involved in such a task.

This is the basis for the regulation of SSE in Brazil, a topic that will be addressed in the following chapter.

4 THE REGULATION OF THE SOCIAL AND SOLIDARITY ECONOMY IN BRAZIL

SSE, as already explained, comprises economic and social practices whose purpose is the production of goods, the provision of services, solidarity finance, exchange, fair trade and/or solidarity consumption.

The multiplicity of objectives for which the entities participating in the SSE develop their activities demands an equally transversal and integrated character of the public policies that regulate them (MORAIS; MENEZES, 2018).

The ESS can combine, in their actions, economic (work and income), social (conditions of sociability), political (public spaces for discussion), cultural (production and consumption patterns) and environmental (sustainability) objectives, all integrated or pursued separately.

The presence of the SSEs in the national scenario can be measured by the numbers of the mapping carried out and published in "The Solidarity Economy in Brazil: an analysis of national data", under the coordination of Gaiger (2014).

The mapping, at the time of the survey, identified that there were 19,708 ESS and 1,423,631 associates, allocated mainly in the Northeast region (41%) and in the rural area (55%) and organized predominantly in the form of associations (60%).

If the EES have this presence and mobilize different areas of public and social action, it must be considered that public policies in favor of SSE must capture and address this particularity, even if it is a task far from simple.

Hence, there is a need for public policies to be endowed with the attributes of transversality and intersectoriality, whose roots are in the process of joint and integrated construction between the main agents involved: the government, academia and the EES.

In the current Brazilian conjuncture, however, public policies endowed with transversality and intersectoriality are far from being a reality, in view of the lack of full articulation between the agents involved, at different levels, for numerous reasons (FRANÇA FILHO, 2006).

Making the task of idealizing and implementing public policies even more difficult is the fact that there is no consensus on the term ESS, despite the fact that it is an expressive and growing economic and social phenomenon.

In retrospect, the beginning of the institutionalization of SSE in Brazil has as a formal milestone the creation, in 2003, of the National Secretariat of Solidarity Economy (SENAES), which is the result of social and political movements prior to its creation (MORAIS; BACIC, 2019).

The creation of SENAES was followed by several institutional initiatives in favor of the regulation of the ESS, especially at the municipal and state levels, such as, for example, the creation of the Parliamentary Front for the Solidarity Economy.

In line with the regulatory agenda, Decree No. 5,811, of June 21, 2006, promoted the structuring of the National Council of Solidarity Economy (CNES), a body linked at the time to the extinct Ministry of Labor and Employment and whose purpose is to conduct dialogue and seek consensus around policies and actions to strengthen the ESS.

The CNES, through the National Conferences of Solidarity Economy, offers a privileged space for constant dialogue between interested agents, which greatly contributes to the emergence of public policies in favor of SSE.

At the same time, SENAES, based on the Solidarity Economy in Development Program, was gradually inserted into the Federal Government's Multi-Year Plans (2004-2007;

2008-2011; 2012-2015), highlighting a promising beginning of the process of institutionalization of the public policy of SSE in the country (MORAIS; BACIC, 2019).

More recently, in 2017, an important step was taken towards the institutionalization of the public policy of SSE in Brazil, with the approval, by the Constitution and Justice Commission (CCJ) of the Chamber, of Bill No. 4685/12, which creates the National System of Solidarity Economy.

It is noteworthy, however, that the institutional regulation agenda of the SSE goes far beyond the existence of a legal framework - which is extremely relevant, but does not exhaust the theme (MORAIS; BACIC, 2019).

SENAES, so relevant at the beginning of the institutionalization process, was the object of a cruel and systematized dismantling, which operated more intensely from 2016 onwards, moving in an illogical way from one ministry to another, leaving resources, personnel and infrastructure in the way.

Without forgetting the importance of implementing institutional initiatives and projects, it is equally relevant to develop effective mechanisms for evaluating and monitoring such public policies, otherwise it will not be possible to assess their accuracy.

And this is precisely one of the obstacles to the structuring of a coherent and robust institutional framework of public policies in Brazil (BACIC, 2014).

Transporting the analysis to 2024, the website of the Brazilian Federal Government (portal Gov.br) presents 20,662 registered Solidarity Economic Enterprises, benefiting, theoretically, about 1.423 million people⁷.

If a numerical comparison of the number of registrations is drawn between 2014, given from Gaiger's mapping, and 2024, there is a high quantitative proximity and no variation in the number of people involved.

From this observation it is possible to extract, among others, some hypotheses of analysis: i) SSE did not develop in Brazil; ii) the Government's control systems are unreliable; iii) there is no political and economic interest in the promotion of SSE.

The realization of the National Registry of Solidarity Economic Enterprises – CADSOL is a unilateral, declaratory and voluntary act to obtain a declaration that a certain enterprise fits the characteristics of the Social Solidarity Economy; There is no active identification check in a structured way.

Other areas of the Government Portal related to the Popular Solidarity Economy do not even have data to be published, for example, the description of the ministerial

⁷ Data found in <https://www.gov.br/trabalho-e-emprego/pt-br/assuntos/economia-solidaria>. Accessed on 07/09/2024.

performance⁸. Likewise, there is no information about Public Notices and Calls, Institutional Partnerships, Social Participations, Agenda.

Another important fact is that the management is inserted in the Ministry of Labor and Employment, through the National Popular and Solidarity Secretariat – SENAES.

In addition, as informed above, the legislative discussion on the legal framework of the Social Solidarity Economy in Brazil, through Bill No. 6606/2019 that replaced PL 4685/2012, is still awaiting a vote by the Plenary of the House, having obtained a close vote, on 11/22/2023 in the Constitution and Justice and Citizenship Commission (CCJC) with 31 "Yes" votes and 25 "No" votes.⁹

The analysis of all these elements presented reveals minimally the lack of political and economic interest for the promotion and organization of the economic sector of the social and solidarity economy.

Understanding the process of regulation of the social and solidarity economy in Brazil indicates that there is still a long way to go, in which the applicable normative framework must be concluded; the performance of the agents involved must be improved, recognizing the limitations and specificities of the EES; the implementation of coherent public support policies; and the creation of evaluation and monitoring indicators (MORAIS; BACIC, 2019).

International experience can provide guidelines for the intricate Brazilian journey to be successful; theme for the next chapter.

5 PUBLIC POLICIES AND INTERNATIONAL EXPERIENCES

Although French associationism and English cooperativism are recognized since the beginning of capitalism, the social economy as it is known today gained strength after the 60s and 70s, with the crisis of Fordism, the decline of full employment and the purchasing power of workers.

In Europe, two important elements have contributed to the development of SSE: the crisis of values and the crisis of wage employment. With the advance of capitalist modernity, European society began to question the economic model, pleading for alternative forms that would bring a special look to relevant social issues, such as the preservation of the environment. No less important, the unemployment of workers inserted in a capitalist society,

⁸ <https://www.gov.br/trabalho-e-emprego/pt-br/assuntos/economia-solidaria/atuacao-interministerial>. Accessed on 07/09/2024.

⁹Accompaniment available *In*
<https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=559138>. Accessed on 07/09/2024.

in which the sale of their labor is responsible for their subsistence, imposes on society the search for alternatives that allow the dignity of work for all individuals. (SANTANA, 2007)

Thus, the transformations of the capitalist model caused cracks in its system, allowing society to organize itself in new forms of survival.

In view of the irreversibility of the system, the organization to support the socially and economically excluded from the traditional market as well as to preserve the values rejected by the capitalist model, the social economy has gained space, including in the public policies of the State.

França Filho (2001) reports that, currently, SSE in Europe can be identified through the following practices: fair trade, solidarity finance, cashless economy, social enterprises, solidarity economic organizations and reference organizations.

Fair trade seeks to regulate relations between the global North and South (at this point, consumers) in a more equitable way, prioritizing trade relations with small producers organized in cooperatives.

Solidarity finance aims to allow access to bank credit to individuals who, due to the absence of formal income or guarantees required by banking institutions, would not raise credit for the development of their activities.

About solidarity finances, França Filho (2001) argues that

"In addition to a question of democratizing access to credit, it is also (and above all) a concern with the so-called social utility of the financial investment that is at stake, guiding this field of initiatives. Thus, with these experiences, it is a matter of affirming a purpose of ethical application of money in the direction of those projects, articulating, for example, a work of fight against exclusion, environmental preservation, cultural action, local development, etc."

In Europe, small financial institutions are identified aimed at providing social credit, that is, they aim to make resources available to individuals or small companies that, in the traditional market, would not be approved to obtain financing. As an example, *Triodos*, a Dutch company, investor in wind farms and which finances 25 (twenty-five percent) of its country's organic food. Germany, Switzerland, Belgium and England, together with the Netherlands, are countries traditionally known for providing financial institutions with a solidarity character to society. (FRANÇA FILHO, 2001)

The cashless economy, in turn, is the practice in which economic movement takes place through the exchange of goods, without the circulation of formal currency. The Mosaic Monetary Movement (MoMoMo) is an example that can be identified in several countries, and

which aims to foster this practice as an important movement for economic inclusion. (SANTANA, 2007)

França Filho (2001) highlights, as fundamental characteristics of the cashless economy, including what differentiates it from other practices, its democratic character and its inscription in the public space, which distances it from the oldest forms experienced by society.

Furthermore, social enterprises can be defined as such according to their own form of organization, which, despite being of a private nature, develops activities without the final objective of maximizing profit, but rather other objectives with social and economic purposes protected by the SSE. As examples, Spanish associated work cooperatives, Italian social cooperatives, among others, can be cited.

Once the practices currently identified on the European continent as participants in SSE have been outlined, it is worth highlighting the study "*Social enterprises and their ecosystems: developments in Europe*" analyzed by Morais and Bacic (2019). The study reveals that the advancement of public policies to support the social economy involves the need to overcome numerous obstacles and points out how European countries legally sponsor the social solidarity economy.

The aforementioned study evaluated the development of SSE in Europe considering the aspects of the entrepreneurial ecosystem: (knowledge; access to markets; public and fiscal support for *SSE start-ups*; access to financing; instruments to support networks and mutual support and development of research and qualification in the area).

Considering that SSE is heterogeneous, it was necessary to choose the requirements to identify the practices adopted on the European continent.

The knowledge requirement considers political awareness and the way in which such policies are regulated. It is verified that, in each country analyzed, the institutionalization of public policies follows a format. In the United Kingdom, for example, specific laws are used to support social enterprises, as is done in Spain and Italy. In Bulgaria and Poland, the institutional path was the creation of specific ministries, secretariats or departments.

Access to markets refers to public policies that aim to direct demands to be met by social enterprises. This is the case of directing services offered, in the past, by the Government and which are now performed by private ESS entities. Access to markets was strengthened with the *EU Public Procurement Rules*, signed in 2014, which encouraged the creation and promotion of social enterprises focused on social and health services. As of 2016, for example, 21 Member States of the European Union began to adapt the regulation in their respective national legislation, which denotes the success of the legislation. Also

noteworthy are the Slovak and Italian legislations that brought in their national legislation, demands to be met, exclusively, by social enterprises that contemplated, in their workforce, individuals with physical or mental disabilities.

By analysing public and fiscal support for ESS *start-ups*, despite the heterogeneity of the tax structure, it is possible to identify numerous tax benefits targeted to ESS *start-ups* in Europe. As an example, one can mention Belgium, whose legislation brings a reduction in the social contribution of companies that have social and health services as their activity; France, which promotes tax exemption (VAT) for associations that promote cultural and sports activities, or Spain, which guarantees a tax reduction for social cooperatives.

Another point analyzed by Morais and Bacic (2019) in the study refers to the financing promoted through public policies in the old continent. In this regard, the study revealed, in general, there is a growing increase in financial instruments that support social innovations, such as *social impact bonds*; *social venture capital*; *crowdfunding* or even *impact investing*. Finally, it can be seen that the greatest obstacle to access to financing lies in the absence of financial entrepreneurial skills or even in the ability to develop projects, and it is necessary for States to dedicate projects to enable and professionalize social economy companies to attract investments.

The study also showed that networks and mutual support mechanisms are important elements to give legitimacy to the political regulation of the social economy. As examples, the introduction of public policies such as *Les Scop - network of SCOPs*, in France, *Confcooperative* and *Forum del Terzo Settore*, in Italy and *CEPES* in Spain.

Finally, with regard to the development of research and qualification of the SSE, which aims to encourage the scientific academic study of this economy, its increasing increase was also observed, although it is not measurable, considering the heterogeneity of the theme and the different legislations. The growth of educational and training programs focused on the social solidarity economy was also observed. More than 70 courses on the subject were identified, in addition to an internuversitary network (RIUESS) of professors and researchers specializing in the subject. It is also worth noting that some universities in Italy and Belgium have included in certain courses, disciplines related to the social solidarity economy.

Having made the notes about the contemporary European scenario, we will briefly analyze some solidarity economies located in Latin America.

Although SSE is developed considering the particularities of each country, there is a growing increase in studies and public policies aimed at protecting the development of SSE, as a counterpoint to capitalism.

Santana (2007) cites the Solidarity Exchange Networks and the Global Exchange Network, existing in Argentina, as relevant practices of the cashless economy, protagonists in the local economy during the crisis of convertibility of the peso into dollars, which occurred at the beginning of the twenty-first century. Also noteworthy is the National Movement of Recovered Companies (MNER), led by the Workers' Central in Argentina (CTA), which gained importance in the face of the failure of the neoliberal policies implemented in the country.

Waste recycling cooperatives are successful examples that can be seen in several Latin American countries. The *NASA project* in Colombia, awarded by the United Nations, brings together approximately 300,000 people, equivalent to 1% of the country's population. (LAVILLE, 2012)

The studies presented demonstrate that SSE is necessary within the capitalist system and aims, in the dignity of the work offered to the socially or economically excluded, to reduce the poverty resulting from the capitalist system.

6 CONCLUSION

The Social and Solidarity Economy faces a challenging scenario and, especially in Brazil, is marked by the absence of a clear definition and a specific regulatory framework. The lack of structural and organic organization as a government policy

This lack of consensus and regulation prevents the full development of entities in the sector, limiting their access to financial resources, tax incentives and institutional support. However, SSE continues to play a crucial role in promoting a more inclusive and sustainable economy, offering alternatives to traditional economic models and generating employment and income for those on the margins of the formal economy.

The diversity of organisational forms and interpretations of SSE principles and values reflects the richness and complexity of the field, but also highlights the need for a clearer and more cohesive understanding. The definition of criteria to identify and categorize SSE entities is an essential step towards the recognition and strengthening of the sector. These criteria should take into account not only the principles and values that guide the entities, but also their socioeconomic practices and impacts.

The regulatory vacuum that characterizes the SSE scenario in Brazil creates uncertainties and limits the growth potential of entities in the sector. The creation of a legal and institutional framework that recognizes and supports SSE is fundamental for its sustainable development, within the legal certainty necessary for long-term development. Specific public policies, adequate financing mechanisms, and training and professionalization programs are key elements for strengthening SSE.

The analysis of the existing literature on SSE in Brazil reveals that the lack of consensus on the definition of the sector is closely linked to the diversity of criteria used to identify and categorize entities. This multiplicity of approaches reflects the different visions and priorities of the various actors involved in the field of SSE. However, for SSE to reach its full potential, it is necessary to build a more cohesive and integrated understanding, which takes into account both the principles and values that guide the entities and their socioeconomic practices and impacts.

Ultimately, the strengthening of SSE in Brazil depends on a continuous political and economic commitment, aimed at creating favorable conditions for the sustainable and inclusive development of entities in the sector. The implementation of specific public policies, the development of appropriate financing mechanisms, the empowerment of members of SSE entities, and the promotion of a culture of collaboration and innovation are essential to fully harness the transformative potential of SSE.

REFERENCES

- Bacic, M. J. (2014). Da oportunidade de pensar no desenvolvimento de um ecossistema empreendedor para os empreendimentos de economia solidária em América Latina. In *Cooperação Sul-Sul e triangular e economia social e solidária* (pp. 44). Organização Internacional do Trabalho. https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@dgreports/@exrel/documents/publication/wcms_248046.pdf
- Brasil. Senado Federal. (2017). Projeto de Lei da Câmara nº 137, de 2017. Dispõe sobre a Política Nacional de Economia Solidária e os empreendimentos econômicos solidários, cria o Sistema Nacional de Economia Solidária e dá outras providências. <https://www25.senado.leg.br/web/atividade/materias/-/materia/131528>
- Chiariello, C. L., Azevedo Fonseca, S., & Pereira Moraes, L. (2021). Enfoque político e institucional de la economía solidaria en América Latina y la experiencia del Senaes en Brasil (2004-2019). *Otra Economía*, 14(25), 76–95. <https://revistas.ungs.edu.ar/index.php/otraeconomia/article/view/786>
- Forte, J. P. S. (2015). A construção do direito à economia solidária no Brasil: Processo sociopolítico de regulação para uma política pública nacional [Trabalho apresentado no I Congresso de Pesquisadores de Economia Solidária – UNICAMP]. http://www.conpes.ufscar.br/wp-content/uploads/trabalhos/gt5/sessao-2/forte_joannes-paulus-silva.pdf
- Forte, J. P. S. (2017). Da rede à política pública: Ações reticulares no processo sociopolítico de regulação da economia solidária no Brasil. *Mundo do Trabalho Contemporâneo*, 2(1), 112–142. <https://periodicos.unb.br/index.php/mtc/article/view/7218>
- França Filho, G. C. de. (2001). A problemática da economia solidária: Uma perspectiva internacional. *Sociedade e Estado*, 16(1-2), 245–275. <https://doi.org/10.1590/S0102-69922001000100011>

- França Filho, G. C. de. (2006). Economia popular e solidária no Brasil. In G. França Filho, J.-L. Laville, A. Medeiros, & J. Magnen (Orgs.), *Ação pública e economia solidária: Uma perspectiva internacional* (pp. 57–72). Editora UFRGS.
- Gaiger, L. I. (2008). A dimensão empreendedora da economia solidária: Notas para um debate necessário. *Otra Economía*, 2(3). <http://revistas.unisinos.br/index.php/otraeconomia/article/view/1145>
- Gaiger, L. I. (Org.). (2014). *A economia solidária no Brasil: Uma análise de dados nacionais*. Editora OIKOS.
- Habermas, J. (1997). O papel da sociedade civil e da esfera pública política. In J. Habermas, *Direito e democracia: Entre facticidade e validade* (Vol. 2, pp. 57–121, F. B. Siebeneichler, Trad.). Tempo Brasileiro. (Trabalho original publicado em 1992)
- Laville, J.-L. (2001). Economia solidária, a perspectiva europeia. *Sociedade e Estado*, 16(1-2), 57–99. <https://doi.org/10.1590/S0102-69922001000100004>
- Laville, J.-L. (2012). A economia solidária: Um movimento internacional. *Revista Crítica de Ciências Sociais*, 84. <https://doi.org/10.4000/rccs.381>
- Lemos, P. A. B. (2011). *As universidades de pesquisa e a gestão estratégica do empreendedorismo: Uma proposta de metodologia de análise de ecossistemas* [Tese de doutorado, Universidade Estadual de Campinas]. <https://hdl.handle.net/20.500.12733/1616823>
- Morais, L. P., & Bacic, M. J. (2019). A importância do ecossistema empreendedor para a economia social e solidária (ESS): Avanços, retrocessos e desafios atuais no Brasil. *Revista da ABET*, 18(1). <https://doi.org/10.22478/ufpb.1676-4439.2019v18n1.38568>
- Morais, L. P., & Bacic, M. J. (2016). Redes de economia solidária e a relevância do ecossistema empreendedor solidário. In *Anais do V Simpósio Internacional Desigualdades, Direitos e Políticas Públicas e I Conferência Internacional RILESS-EMES: Economia Solidária e Empresas Sociais*. UNISINOS.
- Morais, L. P., & Menezes, D. F. N. (2018). Economia social e solidária (ESS) no Brasil no século XXI: Avanços, limites e desafios atuais. In *Anuario Iberoamericano de La Economía Social*, 3.
- Santana Júnior, G. (2007). *A economia solidária em face da dinâmica da acumulação capitalista da subordinação a um novo modo de regulação social?* [Tese de doutorado, Universidade Federal da Bahia]. <https://repositorio.ufba.br/handle/ri/24601>
- Silva, S. P., & Carneiro, L. M. (2016). Os novos dados do mapeamento de economia solidária no Brasil: Nota metodológica e análise das dimensões socioestruturais dos empreendimentos [Relatório de pesquisa]. Instituto de Pesquisa Econômica Aplicada. http://repositorio.ipea.gov.br/bitstream/11058/7410/1/RP_Os%20Novos%20dados%20do%20mapeamento%20de%20economia%20solid%C3%A1ria%20no%20Brasil_2016.pdf
- Silva, S. P. (2018). O campo de pesquisa da economia solidária no Brasil: Abordagens metodológicas e dimensões analíticas (Texto para Discussão No. 2361). Instituto de Pesquisa Econômica Aplicada. http://repositorio.ipea.gov.br/bitstream/11058/8255/1/TD_2361.pdf
- Serrano, S. B. (2015). Economía social y solidaria: Una propuesta para un ecosistema más complejo. In *La economía social y solidaria en Andalucía: Aspectos sectoriales e transversales* (pp. 172–178). Información Estadística y Cartográfica de Andalucía.

Telles, V. da S. (1990). Espaço público e espaço privado na constituição do social: Notas sobre o pensamento de Hannah Arendt. *Tempo Social*, 2(1), 5–23. (Ajuste o volume/páginas se houver mais precisão; entrada baseada no fornecido)

FORENSIC TOXICOLOGY AT THE INTERSECTION OF DRUGS OF ABUSE AND PUBLIC HEALTH

TOXICOLOGIA FORENSE FRENTE A INTERSEÇÃO DROGAS DE ABUSO E SAÚDE PÚBLICA

TOXICOLOGÍA FORENSE EN LA INTERSECCIÓN DE LAS DROGAS DE ABUSO Y LA SALUD PÚBLICA



<https://doi.org/10.56238/sevened2026.008-105>

Lucas Dornas Xavier¹, Lucas Albanaz Vargas², Davi Nunes da Silva³, Andressa Carvalho de Oliveira⁴

ABSTRACT

Forensic toxicology applies scientific knowledge to identify and analyze toxic substances in legal and public health contexts, and is fundamental to combating drugs of abuse. These include legal substances such as alcohol and tobacco, and illegal substances such as cocaine, derivatives like crack, and new psychoactive substances (legal highs), which have serious consequences for health and society. The objective of this scientific study was to review the contributions and updates of forensic toxicology, highlighting its importance for public health and justice. The methodology involved a literature review in databases such as PubMed and LILACS, considering studies from the last 20 years and focusing on techniques and advances in the field. Forensic toxicology has evolved since the 19th century, with the development of methods such as chromatography and mass spectrometry, which allow for precise analyses in biological matrices such as blood and urine. Techniques such as immunochromatography have demonstrated efficiency in drug screening, while information systems monitor cases of intoxication and underreporting. The analysis of crack cocaine, for example, highlights its devastating impact and the importance of rigorous methods such as thin-layer chromatography. Controlling new drugs requires international collaboration and dynamic legislation. Forensic toxicology is considered essential for monitoring substances, identifying consumption patterns, and informing public policies, being indispensable for addressing the problem of drug abuse and protecting the health and safety of society.

Keywords: Forensic Toxicology. Drug Abuse. Public Health.

RESUMO

A toxicologia forense aplica conhecimentos científicos para identificar e analisar substâncias tóxicas em contextos legais e de saúde pública, sendo fundamental para o enfrentamento às drogas de abuso. Estas incluem substâncias lícitas, como álcool e tabaco, e ilícitas, como

¹ Medical Doctor. Universidade de Brasília. E-mail: dornas2022@gmail.com

² Doctor of Medical Sciences. Universidade de Brasília. E-mail: albanazvargas@gmail.com

³ Graduated in Dentistry. ICESP. E-mail: daviumbra@gmail.com

⁴ Medical Doctor. Universidade de Brasília. E-mail: andressacavalho2099@gmail.com

cocaína, derivados como o crack e novas substâncias psicoativas (legal highs), que têm consequências graves para a saúde e a sociedade. O objetivo deste estudo científico foi revisar as contribuições e atualizações da toxicologia forense, destacando sua importância para a saúde pública e a justiça. A metodologia envolveu uma revisão bibliográfica em bases como PubMed e LILACS, considerando estudos dos últimos 20 anos e focando em técnicas e avanços no campo. A toxicologia forense evoluiu desde o século XIX, com o desenvolvimento de métodos como cromatografia e espectrometria de massa, que permitem análises precisas em matrizes biológicas como sangue e urina. Técnicas como imunocromatografia demonstraram eficiência na triagem de drogas, enquanto sistemas de informação monitoram casos de intoxicação e subnotificação. A análise do crack, por exemplo, destaca seu impacto devastador e a importância de métodos rigorosos como a cromatografia em camada delgada. O controle de novas drogas requer colaboração internacional e legislações dinâmicas. Considera-se que a toxicologia forense é essencial para monitorar substâncias, identificar padrões de consumo e subsidiar políticas públicas, sendo indispensável para enfrentar o problema das drogas de abuso e proteger a saúde e a segurança da sociedade.

Palavras-chave: Toxicologia Forense. Abuso de Drogas. Saúde Pública.

RESUMEN

La toxicología forense aplica el conocimiento científico para identificar y analizar sustancias tóxicas en contextos legales y de salud pública, y es fundamental para combatir las drogas de abuso. Estas incluyen sustancias legales como el alcohol y el tabaco, e ilegales como la cocaína, derivados como el crack y las nuevas sustancias psicoactivas (drogas legales), que tienen graves consecuencias para la salud y la sociedad. El objetivo de este estudio científico fue revisar las contribuciones y actualizaciones de la toxicología forense, destacando su importancia para la salud pública y la justicia. La metodología implicó una revisión bibliográfica en bases de datos como PubMed y LILACS, considerando estudios de los últimos 20 años y centrándose en las técnicas y avances en el campo. La toxicología forense ha evolucionado desde el siglo XIX, con el desarrollo de métodos como la cromatografía y la espectrometría de masas, que permiten análisis precisos en matrices biológicas como la sangre y la orina. Técnicas como la inmunocromatografía han demostrado su eficacia en el cribado de drogas, mientras que los sistemas de información monitorizan los casos de intoxicación y el subregistro. El análisis del crack, por ejemplo, pone de relieve su impacto devastador y la importancia de métodos rigurosos como la cromatografía en capa fina. El control de nuevas drogas requiere colaboración internacional y una legislación dinámica. La toxicología forense se considera esencial para el monitoreo de sustancias, la identificación de patrones de consumo y la fundamentación de políticas públicas, siendo indispensable para abordar el problema del abuso de drogas y proteger la salud y la seguridad de la sociedad.

Palabras clave: Toxicología Forense. Abuso de Drogas. Salud Pública.

1 INTRODUCTION

Forensic toxicology is defined as the application of toxicology for the purposes of the law, in turn, toxicology, itself, is the study of toxicants. These definitions are, in fact, quite broad, and the most common application of forensic toxicology is the identification of substances that could be involved in deaths or damage to the health of individuals or be the cause of damage to property and the environment. There are reports of the use of drugs by man since very ancient times, but until the Renaissance it was very difficult, perhaps impossible, to prove poisoning by scientific evidence. It was only in the nineteenth century that forensic toxicology emerged as a science and contributed to justice in these cases (Dorta, 2018).

However, there are reports of toxicological knowledge applied to the legal environment since ancient Greece and ancient Rome, bringing some contribution to poisoning crimes, which became commonplace at that time. Thus, scientific knowledge in chemistry, physics and biology was used as a decisive tool in the investigation of issues related to the judiciary and the evolution of this knowledge promoted union, with the development of methods and techniques that reach reliable results in their analyses. Contrary to the imaginary formed, the routine of the forensic toxicologist is not limited to laboratories, often, the forensic work begins or even takes place in external locations, where the conditions found are totally different from a controlled environment (Lopes, 2022).

Regarding the drugs of abuse, these are psychoactive substances from various natural or synthetic compounds that act on the nervous system, generating changes in the functions that regulate thoughts, emotions and behavior. There is legislation for the control and inspection of these toxics, whether for recreational use such as alcohol or tobacco; for pharmacological use, such as opioids or other analgesics; or for general use, such as industrial solvents. There is also the group of illicit drugs, restricted only to medical or research purposes, as is the case of cocaine and its derivatives. These substances lead to various organic consequences to organs and systems of the human body, either in the short term with intoxication or in the long term with chronic organic lesions, in addition to predisposing to risky sexual behaviors and dependence. Addiction disorder is characterized as an intense need for the substance and loss of the ability to control its consumption, in addition to adverse consequences on health status or interpersonal, family, academic, professional, or legal functioning (PAHO, 2022). Between 2010 and 2020, there was a global increase in the consumption of drugs of abuse, becoming a serious public health problem, with an increase in the consequences already mentioned, such as intoxication and dependence, and Brazil was no different from this pattern (Soares, 2021).

In this context, forensic toxicology plays a crucial role in the fight against drugs of abuse, being an area of science that applies chemical and biological principles to identify toxic substances and their effects on the human body, often in legal or criminal contexts. With regard to drugs of abuse, it is essential to detect and quantify these substances in biological samples, such as blood, urine, hair and tissues, helping to clarify cases of intoxication, overdose, accidents or even suspicious deaths. The confrontation permeates the legal field, having direct impacts on public health through accurate analyses, it provides essential data for monitoring the use of illicit drugs, assisting in the elaboration of public policies aimed at preventing and combating them. Based on this holistic view, the importance of the intersection between forensic toxicology, drugs of abuse, and public health is understood. Therefore, the objective of this scientific manuscript is to study and review the role, contributions and updates of forensic toxicology in the face of drugs of abuse and public health. The justification for the elaboration of this bibliographic review is based on the fact that this theme is a modern and relevant agenda in Brazil and in the world, as well as an object of study in different sectors of society and sciences, with gaps yet to be filled, as this study proposes to do.

2 DEVELOPMENT

2.1 FORENSIC TOXICOLOGY

Toxicology is the science that has the function of identifying and quantifying the adverse effects related to exposure to certain agents, called toxicants, which can be organic or inorganic chemical substances. Since ancient times, the elucidation of deaths associated with chemical substances was a concern, however, the toxicologist Mateu Josep Bonaventura Orfila i Rotger (1787-1853), was the first to relate autopsy material with chemical analysis, bringing to light cases of poisoning that had a legal nature, adopting new methods of forensic analysis. From this perspective, forensic toxicology aims to detect and quantify toxic substances, until the twentieth century, it was restricted to identifying the toxic origin of a certain crime, currently this science acts both on the corpse to detect overdose, anaphylactic reaction to drugs, and on the living individual, to trace drugs of abuse and characterize a state of drug dependence (Castelari, 2018; Dorta, 2018).

In this context, forensic toxicological analyses stand out, which are the investigation of compounds of forensic interest, with special emphasis on drugs of abuse, in various biological matrices such as blood, urine, hair, oral fluid, sweat, vitreous humor and meconium. The particular characteristics of each matrix determine which preparation techniques are required, with their advantages and limitations. For example, the techniques that stand out are: protein precipitation, liquid-liquid extraction, solid-phase extraction, extraction with disposable tips,

solid-phase microextraction, and *headspace extraction*. Each method is evaluated for efficiency, cost, sensitivity, selectivity, and environmental impact (Bordin, 2015).

Forensic toxicology has an interdisciplinary role in criminal investigations and judicial proceedings, highlighting its importance in the identification, detection and quantification of chemical substances or toxic elements present in biological matrices *ante mortem* or *post mortem*. The complexity of this area is highlighted, given the diversity of substances, the particularities of the biological matrices used and the chemical phenomena that can influence the results, such as *post-mortem* redistribution, in addition, the importance of rigorous procedures from collection to analysis is reinforced to ensure the reliability of the evidence, including conservation, identification in order to reach a chain of custody of the samples (Oliveira, 2023).

2.2 DRUGS OF ABUSE

Drugs of abuse refers to any licit substance, with an emphasis on alcohol and tobacco, or illicit substance associated with dependence, which corresponds to a pattern of use that corresponds to a pattern of use that leads to suffering of any kind, possibly associated with withdrawal or other symptoms. Alcohol and tobacco are the most widespread and socially accepted substances of abuse, one of the reasons is their legal nature, however they are considered initiation drugs and one of their negative effects is to increase the risk of illicit drug use. The use of drugs of abuse has been socially accepted for thousands of years, however, since the twentieth century, unrestricted use has become a global public health problem. Illicit drugs are also prevalent in the world's adult population, another important issue, it is estimated that about 5% of the world's adult population used some illicit drug in 2015. There is also the emergence of new drugs of abuse, an expanding market, with greater powers, which is accompanied by greater side effects such as intoxication and even fatal events (Soares, 2021).

The Pan American Health Organization (PAHO) warns about substance abuse, highlights that the use of psychoactive substances, such as alcohol, tobacco, illicit drugs and medications, can cause dependence, physical and mental health problems, as well as significant social impacts. Evidence-based interventions are key to preventing use, treating addiction, and minimizing harm. PAHO promotes integrated approaches and public policies to reduce the public health impact of substance abuse (PAHO, 2022).

Drugs of abuse are chemical substances that are harmful to health, representing a modern public health problem, despite being present in history practically since its beginnings. Therefore, they are controlled worldwide. Despite its historical and cultural use,

consumption worries authorities, especially in Europe and among young people, due to the impact on public health. The rapid emergence of new substances challenges forensic toxicology laboratories, which analyze drugs such as opiates, cocaine, amphetamines, and cannabinoids, preferably in blood (Silva, 2020).

2.3 FORENSIC TOXICOLOGY AS A TOOL TO COMBAT DRUGS OF ABUSE

Forensic toxicology is a fundamental science in the fight against drugs of abuse, as it allows detecting, identifying, and quantifying chemical substances in biological matrices such as blood, urine, and tissues. This area is essential for criminal investigation, but also for public health issues, collaborating with the creation of public policies and knowledge relationships (Silva, 2020).

Studies explore the use of enzyme immunoassays in the detection of psychoactive substances in biological matrices in the forensic context. The technique, widely used for urine, faces challenges when adapted to whole blood, due to the complexity of the matrix. The study investigated the efficacy of liquid-liquid extraction and subsequent analysis in the EMIT® system for different xenobiotics, including cocaine, benzodiazepines, amphetamines, barbiturates, opioids, and cannabinoids. The results indicated the feasibility of the method for most substances, except for cannabinoids, where there were limitations in detection. The affordable cost and the precision achieved (coefficient of variation less than 11%) show the potential of the technique for small and medium-sized laboratories, having the potential to benefit on a public scale (Fukushima, 2009).

Another technique explored was the use of immunochromatography, used as a screening technique for the analysis of drugs of abuse in the context of forensic chemistry. In a Brazilian study, the technique was applied to samples of marijuana, cocaine, and ecstasy pills seized by the Civil Police of Minas Gerais (Pinto, 2015). Results showed high sensitivity (94%) and specificity (75%) for cocaine and marijuana, while ecstasy pills showed a high rate of false positives due to the presence of analogous substances. Thus, immunochromatography proved to be efficient, especially for cocaine, as a complementary alternative to colorimetric tests (Borges, 2013; Pinto, 2015).

Studies highlight the role of forensic toxicological analysis in the detection of drugs of abuse, highlighting the use of chemical techniques as a fundamental tool for justice and public health. Methods such as chromatography and mass spectrometry are presented, widely used in laboratories to identify and quantify chemical substances in biological and non-biological samples. The application of these contributes to criminal investigations, control of illicit substances, and combating trafficking (Mori, 2021). Forensic chemistry as an essential tool

for this function of detecting and combating drugs of abuse is also the subject of another study that exalts the methods of high-performance liquid chromatography and gas chromatography coupled to mass spectrometry, allowing the quantification of drugs such as alcohol, marijuana and cocaine of different biological matrices (Gomes, 2013; Sousa, 2016).

The technique of tandem mass spectrometry coupled to liquid chromatography was explored by a study that sought to identify, as well as quantify drugs of abuse in the urinary biological matrix. The highlight of this technique is its sensitivity and selectivity, allowing the detection of small amounts of drugs in complex matrices. The method can simultaneously identify and quantify 53 types of drugs of abuse, including new compounds, with high accuracy and efficiency. This makes it a valuable tool for areas such as clinical toxicology, forensic toxicology, and occupational testing, allowing for large-scale screening and analysis, with optimized workflow, enabling fast and reliable results (McHale, 2024).

2.4 INTERSECTION BETWEEN FORENSIC TOXICOLOGY, DRUGS OF ABUSE AND PUBLIC HEALTH

Forensic toxicology contributes to the identification of toxicants and their effects on organisms, highlighting their essential role in the legal environment through the elucidation of crimes and in the protection of public health. Forensic toxicology works in cases of poisoning, drug overdose, and other infractions, using scientific techniques for the analysis of biological materials, such as blood, urine, and hair. The science is presented as multidisciplinary, covering areas such as occupational, environmental and social toxicology. Rigorous technical analysis allows for the collection of reliable evidence, which is essential for expertise and support for judicial decisions, being a foundation for public health (Jesus, 2021).

A study entitled "Legal *highs*: a public health problem" focuses on the growth and challenges posed by new psychoactive substances, known as "*legal highs*". These substances are created or chemically modified to circumvent existing legislation, often being marketed as legal alternatives to illicit drugs. Despite this, they present significant risks to public health due to the lack of pharmacological and toxicological studies with a high degree of scientific evidence. The rapid introduction of these substances on the market, facilitated by the internet, makes regulatory control difficult and overwhelms forensic laboratories and health systems. In view of this, the article raises the issue of the need for dynamic and comprehensive legislation, including strategies such as temporary prohibitions and the use of generic clauses that cover entire classes of chemical substances, in addition to the importance of national and international partnerships in order to strengthen the fight against this global problem, with serious repercussions at the level of public health (Honorio, 2014).

One thesis presented the development of an information system in the State of Rio de Janeiro, aimed at the epidemiological analysis of poisoning and chemical exposures, as well as the identification of cases of underreporting, with a view focused on public health. The study comprised 6,370 cases between 2000 and 2004, of which 36.96% were considered positive. The most detected substances were alcohol (66.94%), carbamates (12.85%), caffeine (5.33%), anticonvulsants (3.64%) and analgesics (3.30%). Regarding alcohol, it predominated in age groups over 20 years old and in specific municipalities such as Maricá and Teresópolis, while carbamates and medicines showed varied patterns. The research highlighted significant rates of underreporting, especially in the case of drugs of abuse (up to 100%) (Alves, 2005).

A drug of abuse of paramount importance in public health in Brazil is crack, a study addressed the impacts of crack on health and society, with emphasis on the role of forensic toxicology in the identification and analysis of such drug. Crack, derived from cocaine, is consumed through smoke inhalation, which provides intense and rapid effects, but of short duration, stimulating dependence. This drug causes severe damage to the central nervous system and the body as a whole, in addition to exacerbating social problems. At the Botucatu Institute of Criminalistics, preliminary tests, such as the Modified Scott Test, and definitive methods, such as thin layer chromatography, are used to identify crack. In addition, the scientific work reinforces the importance of appropriate therapeutic approaches in the treatment of addiction as a way to mitigate the social impacts of crack (Caccia, 2023).

3 METHODOLOGY

It is a literature review according to a protocol previously written at the beginning of the review, leading to a bibliographic search, carried out in a systematic way of the existing literature on the subject of research.

To prepare the research question, the mnemonic PCC (P - population/participants, C - concept and C - context) was used: "Contributions and updates of forensic toxicology in the face of drugs of abuse and public health?".

Regarding the eligibility criteria, he was guided by the mnemonic itself. The study population was individuals who used drugs of abuse, and the study was *before or after mortem*, for medical or forensic purposes. The concept was based on studying drugs of abuse from the perspective of forensic toxicology, seeking to understand the role of this science in this public health problem, as well as its recent contributions, since chemical substances are often related to public health problems such as this, but in other contexts such as traffic accidents, sexual abuse, among others. The context was limited to studies published in the

last 20 years, which contemplate research on drugs of abuse, relating them to forensic toxicology and public health, providing a panoramic view of this important issue.

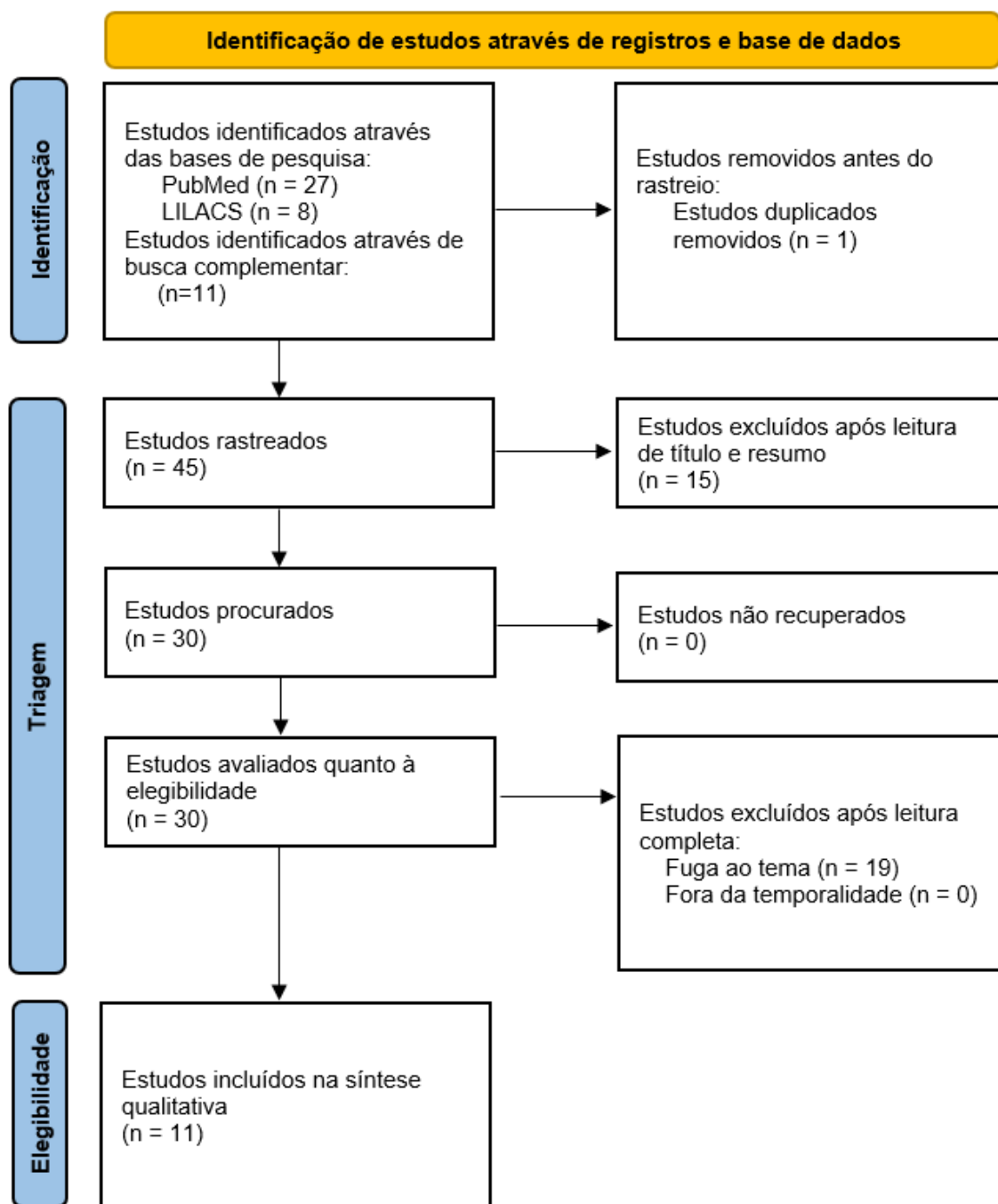
This literature review considered primary studies (original research) and secondary studies (systematic and non-systematic reviews) published or unpublished in national and international portals, repositories, and databases. Duplicates, non-full-text studies, and abstracts published in event proceedings were not considered.

The search strategy began with the identification of controlled descriptors (Mesh and DeCs) and non-controlled descriptors, designed from the keywords of the search question, used for the construction of the initial search strategy, combined or not, such as "Drugs of abuse", "Abuse drug", "Drug of abuse", "Forensic toxicology", "Forensic toxicology", "Public health", "Public health", among others. Through practical experience, the syntax was refined and the search strategies adapted to each database or data repository used. In the PubMed database, based on syntaxes and filters, a number (n) of 23 was found. In the LILACS database, based on syntaxes and filters, the number of 8 articles was found in the chosen time delimitation. In addition to the search in formal databases, a complementary investigation was carried out, including search syntaxes in journals, scientific journals and Google Scholar, in order to enrich and allow a more holistic and comprehensive analysis of the theme. Preprint databases were not searched.

The selection and screening stage of the studies took place in November 2024 and, after the searches, all the identified records were grouped. The first stage consisted of the removal of duplicates; then the title and abstract reading stage. Ultimately, the analysis of the text and references of the selected articles. The titles and abstracts, as well as the studies from the reference lists, were selected by an independent researcher, who evaluated the studies according to the eligibility criteria and the exclusion criteria.

Figure 1

Adapted PRISMA 2020 study flowchart



Source: Authors.

4 FINAL CONSIDERATIONS

Forensic toxicology is an interdisciplinary science that plays a crucial role in tackling drugs of abuse, one of the most complex public health problems. Its ability to monitor substances, identify patterns of use, and track new drugs strengthens the response to this public health problem.

Immunochromatography stands out as a promising tool for preliminary analyses of drugs of abuse, offering practicality and reliability, especially for cocaine and marijuana.

Despite limitations for certain substances, the method complements other forensic techniques, contributing to the elucidation of crimes and drug control.

The application of chemistry in forensic toxicological analysis is fundamental to deal with drug abuse. Methods such as chromatography and spectrometry ensure accuracy and reliability, strengthening both the legal system and public health policies by addressing the social and safety impacts of psychoactive substance use.

From this perspective, these and other analyses allow not only the proof of drug use, but also provide data on consumption patterns, substance metabolism and the correlation with possible harm or deaths related to the use of narcotics. This is essential for criminal investigations, especially in cases of traffic accidents, homicides, abuse of crime-facilitating substances (such as benzodiazepines), and overdoses.

In addition, forensic toxicology assists authorities in controlling new psychoactive substances, whose rapid evolution in the illicit market represents a constant challenge. The fight against new psychoactive substances, such as *Legal Highs*, requires more dynamic legislative strategies and national and international cooperation. Rapid notification systems and partnerships between laboratories and authorities are crucial to keep up with the rapid evolution of these drugs, protecting society from their harmful impacts.

Crack use poses a significant public health and safety challenge. Forensic toxicology plays a central role in identifying the drug and guiding public policy. Adequate treatment for addicts emerges as a vital strategy to mitigate social and economic damage, alongside integrated approaches between health, justice and social programs

The development of toxicological information systems improves the surveillance and monitoring of chemical substances, allowing for more effective tackling of problems such as underreporting. Tools like this guide public policies and strengthen integration between institutions to protect the health and safety of the population.

Therefore, forensic toxicology not only contributes to criminal justice, but also contributes to protecting the health and safety of society, being an indispensable tool in the fight against drugs of abuse as a public health problem.

REFERENCES

- Organização Pan-Americana da Saúde. (n.d.). Abuso de substâncias. <https://www.paho.org/pt/topicos/abuso-substancias>
- Alves, S. R. (2005). Toxicologia forense e saúde pública: Desenvolvimento e avaliação de um sistema de informações como potencial ferramenta para a vigilância e monitoramento de agravos decorrentes da utilização de substâncias químicas [Tese de doutorado, Escola Nacional de Saúde Pública Sergio Arouca]. <https://arca.fiocruz.br/items/477c8e0a-72b0-4586-90f1-aebab1738f87>

- Bordin, D. C. M., Monedeiro, F., Campos, E. G., Alves, M., Bueno, L., & Martinis, B. S. de. (2015). Técnicas de preparo de amostras biológicas com interesse forense. *Scientia Chromatographica*, 7(2), 125–143. <https://doi.org/10.4322/sc.2015.022>
- Caccia, C. M. (2023). Toxicologia forense e os efeitos fisiológicos e sociais do uso do crack [Trabalho de conclusão de curso, Universidade Estadual Paulista]. Repositório Institucional UNESP. <https://repositorio.unesp.br/handle/11449/239398>
- Castelari, G. M., et al. (2018). Toxicologia forense: Ciência multidisciplinar que abrange o estudo das causas de mortes por intoxicação e os materiais biológicos utilizados para esse fim, que direcionam a investigação médico-legal e a emissão do laudo toxicológico. *Ambiente Acadêmico*, 4(1), 22–37. <https://multivix.edu.br/wp-content/uploads/2018/09/revista-ambiente-academico-v04-n01-artigo02.pdf>
- Costa, J., et al. (2018). Toxicologia forense. Blucher.
- Fukushima, A. R., et al. (2015). Aplicação de imunoensaios para análise de fármacos e drogas de abuso em sangue total, com finalidade forense. *Revista Intertox de Toxicologia, Risco Ambiental e Sociedade*, 2(1).
- Gomes, M. S. (2013). Contributo da química forense na detecção de drogas de abuso [Dissertação de mestrado, Universidade de Lisboa]. Repositório da Universidade de Lisboa.
- Honorio, J. C., et al. (2014). Legal highs: Um problema de saúde pública. *Cadernos de Saúde Pública*, 30(2), 228–230. <https://doi.org/10.1590/0102-311X00003314> (DOI inferido de fontes semelhantes; confirme se necessário)
- Jesus, S. S. de, & Silva, D. S. (2021). Toxicologia forense e sua importância na saúde pública. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 7(7), 767–781.
- Lopes, T. (2022, 18 de outubro). Toxicologia forense na perícia criminal. Zenodo. <https://zenodo.org/record/XXXXXXX> (substitua pelo ID exato se disponível; entrada genérica baseada em metadados)
- McHale, K., & Hassell, K. (2024). A quantificação do futuro com LC-MS/MS: Triagem e quantificação rápidas de drogas de abuso em urina para toxicologia forense. Thermo Fisher Scientific.
- Mori, L. B. de, & Cesar, F. I. G. (2021). Análise toxicológica na área forense: A utilização da química na detecção das drogas de abuso. *Revista Científica Acerte*, 1(5), Article e1533.
- Oliveira, D. B. D., et al. (2023). Toxicologia forense: O estudo dos agentes tóxicos nas ciências forenses. *Brazilian Journal of Development*, 9(1), 1475–1493.
- Pinto, G. A. T., et al. (2015). Avaliação da técnica de imunocromatografia para análise de drogas de abuso no contexto da química forense. *Revista Brasileira de Criminalística*, 4(3), 28–37.
- Silva, E. C. T. (2020, 10 de dezembro). As drogas de abuso em contexto forense. Instituto Nacional de Medicina Legal e Ciências Forenses.
- Soares, L. S., et al. (2021). Profile of intoxications by drugs of abuse in Brazil. *Brazilian Journal of Health and Pharmacy*, 3(1), 51–64.
- Sousa, L. R. P. (2011). A química forense na detecção de drogas de abuso. [Título da publicação ou revista não especificado], 6, 1–16.

SOCIO-ENVIRONMENTAL PERCEPTIONS OF SCIENCE TEACHERS IN THE AMBIENCE OF THE PIABAS STREAM/PB

PERCEPÇÕES SOCIOAMBIENTAIS DE PROFESSORES DE CIÊNCIAS NA AMBIÊNCIA DO RIACHO DAS PIABAS/PB

PERCEPCIONES SOCIOAMBIENTALES DE LOS DOCENTES DE CIENCIAS EN EL ENTORNO DEL ARROYO PIABAS/PB



<https://doi.org/10.56238/sevened2026.008-106>

**Carlos Augusto Tenório Cândido¹, Jair Moisés de Sousa², Veneziano Guedes de
Sousa Rêgo³**

ABSTRACT

This article analyzes the socio-environmental perception of Science teachers working in public middle schools (final years of Elementary Education) located in the surroundings of the middle stretch of the Riacho das Piabas, in the city of Campina Grande, Paraíba, Brazil. The research represents a partial outcome of an ongoing master's dissertation and adopts a qualitative approach, of basic nature and exploratory character. Data were collected through semi-structured questionnaires, applied after approval by the Research Ethics Committee, and analyzed based on emergent categories. The results indicate that, although teachers present different levels of knowledge about the Riacho das Piabas, all recognize its environmental, historical, and social relevance. The teachers associate the stream with elements such as preservation, biodiversity, water resources, and historical aspects, in addition to identifying its potential as a contextualization object in Science teaching. Furthermore, the understanding of environmental education as an instrument capable of promoting the transformation of the local socio-environmental reality is evident. Furthermore, interconnections between non-formal environmental education processes, driven by communities and local NGOs, are evident, consolidating an understanding of inequalities in the territory and social engagement.

Keywords: Society. Natural Resources. Micro-Watershed. Civic Education.

RESUMO

Este artigo pesquisa a percepção socioambiental de professores de Ciências do Ensino Fundamental (Anos Finais), atuantes em escolas públicas localizadas no entorno do trecho médio do Riacho das Piabas, na Cidade de Campina Grande (PB). O estudo constitui um recorte de resultados de uma dissertação em andamento e adota abordagem qualitativa, de natureza básica e caráter exploratório. Os dados foram obtidos por meio de questionários semiestruturados, aplicados após aprovação pelo Comitê de Ética em Pesquisa, e

¹ Lattes: <http://lattes.cnpq.br/0422426445289189>

² Lattes: <http://lattes.cnpq.br/1937979982636984>

³ Lattes: <http://lattes.cnpq.br/3446821344890985>

analisados a partir de categorias emergentes. Os resultados indicam que, embora os docentes apresentem diferentes níveis de conhecimento sobre o Riacho das Piabas, todos reconhecem sua relevância ambiental, histórica e social. Os professores associam o riacho a elementos como preservação, biodiversidade, recursos hídricos e históricos, além de identificarem seu potencial como objeto de contextualização no ensino de Ciências. Evidencia-se, ainda, entrelaçamentos de processos de educação ambiental não formal, puxados por comunidades e ONG local, consolidando a compreensão das desigualdades no território e engajamentos social.

Palavras-chave: Sociedade. Recursos Naturais. Microbacia Hidrográfica. Educação Cidadã.

RESUMEN

Este artículo analiza la percepción socioambiental de profesores de Ciencias de la Educación Básica (últimos años de la Educación Primaria), que trabajan en escuelas públicas ubicadas en el entorno del tramo medio del Riacho das Piabas, en la ciudad de Campina Grande, Paraíba, Brasil. La investigación constituye un recorte de los resultados de una disertación de maestría en curso y adopta un enfoque cualitativo, de naturaleza básica y carácter exploratorio. Los datos fueron recolectados mediante cuestionarios semiestructurados, aplicados tras la aprobación del Comité de Ética en Investigación, y analizados a partir de categorías emergentes. Los resultados indican que, aunque los docentes presentan diferentes niveles de conocimiento sobre el Riacho das Piabas, todos reconocen su relevancia ambiental, histórica y social. Los profesores asocian el arroyo con elementos como la preservación, la biodiversidad, los recursos hídricos y los aspectos históricos, además de identificar su potencial como objeto de contextualización en la enseñanza de las Ciencias. Asimismo, se evidencia la comprensión de la educación ambiental como un instrumento capaz de promover la transformación de la realidad socioambiental local, impulsado por comunidades locales y ONGs, consolidando la comprensión de las desigualdades en el territorio y el compromiso social.

Palabras clave: Sociedad. Recursos Naturales. Microcuenca. Educación Ciudadana.

1 INTRODUCTION

The development of Campina Grande is closely linked to the Riacho das Piabas system/PB, initially used by the original peoples, the body of water sustained the growth of the original urban core with clear waters that served as a supply for the local inhabitants (Sousa Rêgo, 2014).

Originally characterized by dense vegetation and an abundance of reservoirs, the area of reduced dwellings, from the second half of the twentieth century, intensified its occupation through irregular allotments, triggering severe processes of environmental deterioration (Andrade; Son; Anjos, 2025).

In view of the current growing socio-environmental problem, the need to rethink the relations established between society and nature has been evidenced, which requires mitigation and adaptation of urban spaces (middle and downstream stretch) and the preservation of natural remnants (rural upstream stretch).

In the educational field, environmental education contributes to sustainable development by fostering social engagement and understanding of inequalities, this process is essential to awaken active citizenship, allowing the population to intervene directly in the management of their territory (Antunes; Lehner; Ribeiro, 2025). In this sense, the teaching of Science has significant potential to articulate curricular content to environmental issues, favoring the process of contextualization and critical development of students.

Socio-environmental perception, which is the way communities and individuals understand and interpret the relationship between the social environment and the environment (Carvalho; Peçanha; Carvalho, 2025) is a fundamental element in the educational process, especially the perception of teachers, since it directly influences the way content is approached and how territories are recognized.

Understanding how teachers perceive the environments in which they are inserted, their meanings, values and problems, allows us to identify possibilities and limits for the development of educational practices aimed at sustainability.

The Riacho das Piabas, especially because it crosses urban areas and is close to school institutions, has socio-environmental relevance and educational potential, which makes it pertinent to investigate how this space is perceived by science teachers who work in schools located in its surroundings.

At the same time, there are popular initiatives in the field of non-formal education, led by communities and local NGOs, for the revitalization of the Riacho das Piabas system and the quality of life of the communities.

From this, we propose the following research question: what socio-environmental

perceptions are expressed by Elementary School Science teachers (Final Years), working in schools located around the Piabas Stream, in the reading of the territory and the role of environmental education in the construction of full citizenship?

It is based on the logical-conditional hypothesis: Science teachers from schools located around Riacho das Piabas build environmentally relevant and socially representative knowledge about the territory to the extent that Environmental Education (EE) is legitimized as an important factor in the search for perception and socio-environmental transformation.

Thus, the objective of this study is to research the socio-environmental perceptions of Elementary School Science teachers (Final Years), working in public schools located in the surroundings of Riacho das Piabas, considering the level of familiarity with the territory, the meanings attributed to it and the understandings about the role of environmental education to know, care and transform.

2 THEORETICAL FRAMEWORK

2.1 SOCIO-ENVIRONMENTAL PERCEPTION: CONCEPTS AND RELATIONSHIPS

One of the main terms to understand the complexity of socio-environmental perception is topophilia, which is characterized as the "affective link between the person and the place or physical environment. Diffuse as a concept, vivid and concrete as a personal experience" Tuan (2012, p. 4). From the conception of this term to the present day, there have been intense changes between human relations and the environment, mainly as a result of globalization mediated by technologies (Duarte et al., 2021).

Perception consists of the process of organizing and interpreting sensory stimuli to attribute meaning to the external environment. This phenomenon comprises the stages of capturing, selecting and processing information captured by the five senses: sight, hearing, touch, smell and taste (Carvalho; Peçanha; Carvalho, 2025). It depends on experience, but does not necessarily follow from it, it is possible to clarify this concept through questions that start from practical elements towards deeper ideas (Tuan, 1983).

Socio-environmental perception refers to the way individuals and groups interpret the interdependence between society and the environment, in a systemic view. More than recognizing problems, this concept involves raising awareness about how human activities impact nature, encompassing the ability to evaluate and act responsibly in favor of quality of life and environmental preservation (Carvalho; Peçanha; Carvalho, 2025).

2.2 THE PIABAS STREAM: ANTHROPIC ACTIONS AND BIODIVERSITY

Riacho das Piabas exemplifies how accelerated urbanization and deficiencies in basic sanitation affect water resources. Belonging to the basin of the middle course of the Paraíba River, the stream is mostly channeled in the urban perimeter of the City of Campina Grande/PB. Research indicates that the area faces severe anthropogenic impacts, which directly compromise its original biodiversity (Santos et al., 2024). Sousa Rêgo (2014) describes the complexity of the territorial changes that have occurred over the decades:

Under the ecological irrationality and passivity of the population, the flat part (middle portions and downstream to the south) of the microbasin was urbanized. In this way, in contrast to the assets of urbanization, edaphic resources were turned over, water resources were filled, biological resources exterminated. The Riacho das Piabas gave its banks to the avenues and began to be channeled, drain sewage, carry solid waste, exhale bad smells. Its lentic portion, the Açude Velho (postcard), became a stabilization lagoon. In peri-urban areas, socioeconomic discomfort exposed housing in permanent protection areas (PPAs), decreases in substantive freedom, reduction of productive jobs, hopelessness, social cohesion, increased poverty, drug addiction and violence, worsening scenarios during rainy and flood seasons (Sousa Rêgo, 2014, p. 16).

In addition to the vulnerability to floods and landslides, the irregular occupations around the Riacho das Piabas compromise physical and visual accessibility, this barrier prevents the community from establishing a deeper connection with the body of water, hindering urban and environmental integration (Andrade; Son; Anjos, 2025). Regarding the problems mentioned, the area preserves an expressive biological wealth, pointed out by Sousa Rêgo (2014):

The upstream and rural domain of the micro-basin with about 500 hectares still retains an expressive natural remnant in vital processes and a mixture of species surrounding the Brazilian megabiodiversity. The area is framed as an ecotonal region enclosing biocenoses of the Atlantic Forest and the Caatinga. Expressive ecosystem services stand out, such as the production of excellent fresh water, constituting a unique endogenous possibility of water security for the urban center (Campina Grande) downstream (Sousa Rêgo, 2014, p. 02).

2.3 FUNDAMENTALS OF ENVIRONMENTAL EDUCATION

Environmental education is derived from the environmentalist area, as it inherited from the environmentalist area the most important representative and institutional pillars that define its identity and formation, but it is also characterized as a field, in a certain way, independent (Layrargues; Lima, 2014). In the National Policy for Environmental Education (PNEA), the EE in the 1st article is defined as follows:

The processes through which the individual and the community build social values, knowledge, skills, attitudes and competencies aimed at the conservation of the environment, a good for the common use of the people, essential to a healthy quality of life and its sustainability (Brasil, 1999 [sp]).

EE reveals the integration between human identity and nature, it makes us realize that, by preserving the environment, we are preserving our own identity and recognizing our place as living beings among other living beings (Sauvé, 2005). In Brazil, it also has a plurality bias:

Environmental education (EE) in Brazil was constituted as a field of knowledge and pedagogical and political activity from the 70s and, above all, from the 80s of the next century to the last century. It was born as a plural and differentiated field that brought together contributions from various scientific disciplines, philosophical matrices, political-pedagogical positions, actors and social movements (Lima, 2009, p. 147).

In the scenario of basic education, the National Common Curriculum Base (BNCC) establishes that Environmental Education must be integrated into the curricula and pedagogical projects of educational institutions (Brasil, 2017). In addition, Layrargues and Lima (2014) theorize the political-pedagogical macro-tendencies of Brazilian environmental education: the conservationist and the pragmatic, focused on individual actions, and the critical, focused on the exercise of citizenship and transformative education.

Critical environmental education drives the demand for effective public policies and sustainable practices in the field of basic education, prepares citizens to defend their rights and question exclusionary development models, by aligning itself with environmental justice, this pedagogical practice protects vulnerable communities and minorities, promoting awareness of socio-environmental disparities and encouraging active participation in the management of natural resources (Antunes; Lehner; Ribeiro, 2025).

It grounds and enables the construction of new models of relationship between the individual and the environment. This process helps to attribute meanings to these interactions, respecting and integrating the sociocultural and geographical particularities of each intervention context (Sauvé, 2005).

3 METHODOLOGY

3.1 CHARACTERIZATION OF THE RESEARCH

The research is characterized, from the point of view of the way of approaching the problem, as qualitative, a choice that is justified by the complex nature of the proposed problem and by the need for an interpretative immersion in the field of socio-environmental perception of teachers by the researchers.

In the qualitative approach, the research has the environment as a direct source of data. The researcher maintains direct contact with the environment and the object of study in question, requiring more intensive fieldwork. In this case, the questions are studied in the environment in which they are presented without any intentional manipulation by the researcher (Prodanov & Freitas, 2013, p. 69).

As for its nature, it is classified as basic, because "it aims to generate new knowledge useful for the advancement of science without foreseen practical application" (Prodanov & Freitas, 2013, p. 51), we seek to expand knowledge about the socio-environmental perception of science teachers in a specific context.

Regarding the objectives, also according to Prodanov & Freitas (2014) it is an exploratory study, which aims to deepen more information on the subject of investigation.

3.2 AREA OF RESEARCH

Located in the state of Paraíba, the City of Campina Grande has an estimated population of 443,911 inhabitants (IBGE, 2025). According to data from the 2022 census, the city exhibits high levels of urban infrastructure, with about 97% of residents living in the urban area, while the coverage of basic services reaches 98% for water supply, 87.5% for sanitary sewage and 97% for solid waste collection.

The research area comprises the middle stretch of the Riacho das Piabas, located in the municipality of Campina Grande, Paraíba. The area stands out for its proximity to schools. In the surroundings there is an Early Childhood Education school, two Elementary Schools (Early Years). however, in this study, the focus was exclusively on Elementary School (Final Years).

Thus, two public schools located near the stream were selected: the Frei Dagoberto Stücker Municipal School of Elementary Education and the Professor Anésio Leão Technical Integral Citizen School, from the state network, which offers Elementary School. This scenario confers educational potential and diversity of socio-environmental scenarios. (Figure 1).

Figure 1

Excerpts from the middle course of Riacho das Piabas highlighting a) pollution; b) stretch of the Louzeiro Forest; c) image of the façade of the Anésio Leão Technical Citizen School; d) and the Frei Dagoberto Stucker Municipal School



Source: Applied research, 2026.

The area faces contrasts with the city's infrastructure indexes, as it faces socio-environmental weaknesses, such as the release of solid waste, the degradation of the riparian forest and the channeling of the watercourse, especially in the area popularly known as "Buraco da Gia". However, the coexistence of remnants of vegetation, the presence of biodiversity and the course of the stream are observed. This makes Riacho das Piabas a strategic territory for the development of contextualized pedagogical practices, especially in the field of Environmental Education and Science teaching.

3.3 RESEARCH PARTICIPANTS AND ETHICAL ASPECTS

The participants of the study were five teachers of Science of Elementary School – Final Years (6th to 9th grade), which corresponds to 100% of the sample of teachers who work in the schools around the middle stretch of the Riacho das Piabas. The participants voluntarily agreed to participate in the research, by signing the Informed Consent Form (ICF).

The project was previously submitted to and approved by the Human Research Ethics Committee (CEP) of the State University of Paraíba – Campina Grande Campus, through Plataforma Brasil.

3.4 DATA COLLECTION INSTRUMENT

Data collection was carried out through the application of semi-structured questionnaires. The instrument was developed based on the guiding question and the hypothesis, contemplating open and closed questions related to the socio-environmental perception of teachers about the Piabas Stream. It is noteworthy that this article is an excerpt from an ongoing master's research, from which only the data referring to the socio-environmental perception of the teachers, directly related to this thematic cut, were analyzed.

3.5 DATA ANALYSIS

The analytical strategy adopted is based on three phases defined by Gil (2008): (i) data reduction, understood as the process of selection, simplification, abstraction and transformation of the original data; (ii) categorization, through the construction of descriptive categories emerging from the reading and organization of the material obtained; and (iii) interpretation, carried out in the light of the theoretical framework adopted, enabling the understanding of the meanings and senses expressed by the participants. We built a word cloud based on the data from a questionnaire question using *Vennage*, an online graphic design platform.

To verify the existence and characteristics of the teachers' socio-environmental perception, it was based on central points of analysis: (a) the level of familiarity of the teachers with the Piabas Stream; (b) the socio-environmental meanings and values attributed to this territory; and (c) the understandings about the role of Environmental Education in its transformation.

4 RESULTS AND DISCUSSIONS

4.1 TEACHERS' FAMILIARITY WITH THE RIACHO DAS PIABAS

The analysis of the answers indicates that the participating teachers demonstrate different levels of familiarity with the Piabas Stream. Although all of them stated that they had some kind of previous knowledge about the stream, it was observed that only one of the participants stated that they knew it in a more in-depth way, while the others showed partial or superficial understandings about the territory.

These results indicate that the simple insertion of schools in the surroundings of Riacho das Piabas does not guarantee, by itself, an in-depth socio-environmental perception on the part of teachers and a high degree of familiarity with the territory. This reinforces the idea that knowledge about the territory is built from experiences and bonds (Tuan, 2012).

4.2 IMPORTANCE AND REPRESENTATIVENESS ATTRIBUTED TO THE RIACHO DAS PIABAS

The teachers' answers were varied, with the aim of synthesizing the meanings attributed by the teachers to the stream, based on the recurrence of central terms and ideas, a word cloud was elaborated that evidences the main semantic terms present in the teachers' discourses, Figure 2.

Figure 2

Word cloud elaborated from the answers of teachers about the importance and representativeness of Riacho das Piabas



Source: Applied research, 2026.

The word cloud highlights the centrality of terms related to the place, water, biodiversity and history, suggesting a perception that recognizes the Riacho das Piabas mainly as an environmental and sociocultural element.

The stream is also understood as a space that demands recognition and conservation, being associated with the idea of environmental preservation and the need to protect its natural resources. This perception points to an understanding of the stream as an environmental heritage, whose conservation is seen as a condition for the maintenance of life and ecological balance.

Other teachers highlight the social and educational relevance of Riacho das Piabas, recognizing it as an important resource for the local community and as a potential learning tool. From these perspectives, the stream is associated not only with ecological aspects, but also with possibilities of pedagogical use and social development, which evidences an integrated perception between environment and society.

The historical dimension is manifested in a recurrent way in the teachers' answers, especially through references to the role of the stream in the process of emergence and development of the city. As Tuan (2012, p. 144) points out, "awareness of the past is an important element in the love for the place", which reinforces the understanding that urban water bodies are carriers of collective memories and social trajectories.

In this sense, the stream is configured as a fundamental element for the historical and territorial reading of the urban space. In addition, the professors highlight the stream as a natural source essential to life and as an environment that shelters biodiversity, evidencing the socio-environmental richness present in the area.

4.3 ENVIRONMENTAL EDUCATION AS AN INSTRUMENT OF SOCIO-ENVIRONMENTAL TRANSFORMATION OF THE PIABAS STREAM

The teachers show a consistent understanding of education as a central element for the conservation and enhancement of the Piabas Stream. In general, teachers associate environmental education with training processes capable of promoting knowledge, awareness and socio-environmental responsibility, recognizing its transformative potential both in the school environment and in the community.

The participants highlight educational actions of an informative and experiential nature, such as lectures, visits to the stream and the study of its history, fauna and flora, indicating that direct contact with the territory is perceived as an important strategy for strengthening the environmental awareness of students. These practices dialogue with the understanding that schools play a crucial role in the implementation of Critical Environmental Education, since, by promoting environmental projects, such as awareness campaigns, they can constitute learning spaces focused on sustainability (Antunes; Lehner; Ribeiro, 2025).

Other teachers expand this understanding by relating environmental education to principles of sustainability, such as the promotion of sustainable living, safe food, the conscious use of natural resources and solid waste management, in addition to the articulation with the Sustainable Development Goals (SDGs).

There is also an emphasis on awareness and sensitization projects, aimed at preserving the surroundings of the stream. In this approach, education is understood as a

means to mobilize responsible attitudes and behaviors, stimulating the active participation of students in the protection of the environment in which they are inserted.

Finally, some teachers emphasize the role of education in the formation of subjects aware of their environmental co-responsibility. By recognizing that students are also responsible for caring for the environment, the teachers point to a conception of environmental education that goes beyond the transmission of content, focusing on the transformation of the perception and posture of individuals in the face of socio-environmental issues. In this sense, by encouraging active social participation and the development of problem-solving skills, environmental education contributes significantly to the construction of a fairer and more sustainable future (Antunes; Lehner; Ribeiro, 2025).

5 CONCLUSION

The results of this study show that the science teachers of the schools located in the vicinity of the Piabas Creek have, at different levels, knowledge about this watercourse and recognize its historical, environmental and social relevance. Although the degree of familiarity varies among the participants, there is a common perception that the stream is an important element of the territory, with educational potential for the community.

The professors associate the Riacho das Piabas with aspects such as environmental preservation, biodiversity, water resources and historical memory, demonstrating an integrated understanding of the environment. This socio-environmental perception is fundamental for the construction of contextualized pedagogical practices, capable of bringing the teaching of Science closer to the reality experienced by students and strengthening links between school and territory.

In this sense, the findings of the research indicate that the initial hypothesis is confirmed, since teachers who demonstrate knowledge and appreciation of the Piabas Stream also recognize Environmental Education as a central element for the transformation of the socio-environmental reality of the territory. The teachers point to environmental education as a strategic instrument, highlighting educational actions aimed at raising awareness, sensitization and training responsible subjects, understanding it as a means of promoting changes in attitude and expanding the understanding of co-responsibility in environmental conservation.

Thus, the study indicates the existence of a teacher's educational potential, especially with regard to the contextualization of science teaching from the territory. In this sense, the results point to the importance of investments in continuing education processes and in the production of didactic materials contextualized with natural attributes of the school

environment, capable of strengthening and expanding pedagogical practices aligned with Environmental Education, contributing to the consolidation of more critical educational actions committed to sustainability.

ACKNOWLEDGMENTS

The present work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel – Brazil (CAPES) – Financing Code 001.

REFERENCES

- Andrade, R. M. de, Barros Filho, M. N. M., & Anjos, K. L. dos. (2025). Investigando a integração da comunidade de Rosa Mística com o riacho das Piabas em Campina Grande, Paraíba, a partir de análises configuracional e comportamental. *Paisagem e Ambiente*, 36(56), Article e225379. <https://doi.org/10.11606/issn.2359-5361.paam.2025.225379>
- Antunes, C. A., Lehner, H. L., & Ribeiro, L. G. G. (2025). Educação ambiental crítica e formação para sustentabilidade na educação básica. *Revista de Direito Ambiental e Socioambientalismo*, 10(2). <https://doi.org/10.26668/IndexLawJournals/2525-9628/2024.v10i2.10926>
- Brasil. (2018). Base Nacional Comum Curricular. Ministério da Educação. http://basenacionalcomum.mec.gov.br/images/BNCC_publicacao.pdf
- Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996. Estabelece as diretrizes e bases da educação nacional. http://www.planalto.gov.br/ccivil_03/LEIS/I9394.htm
- Brasil. (1999). Lei nº 9.795, de 27 de abril de 1999. Dispõe sobre a educação ambiental, institui a Política Nacional de Educação Ambiental e dá outras providências. http://www.planalto.gov.br/ccivil_03/leis/I9795.htm
- Carvalho, E. J. C. D., Peçanha, A. L., & Carvalho, J. F. D. O. (2025). Explorando a percepção socioambiental dos alunos: O papel da educação na sensibilização socioambiental de estudantes de Ibatiba-ES. *REMEA - Revista Eletrônica do Mestrado em Educação Ambiental*, 42(1), 83–100. <https://doi.org/10.63595/remea.v42i1.16756>
- Duarte, D. R., Andrade, J., Souza, J. C., & Santiago, A. G. (2021). Conexão entre pessoas e ambiente: Uma revisão de literatura sobre topofilia. *Oculum Ensaios*, 18, 1–18. <https://doi.org/10.24220/2318-0919v18e2021a4706>
- Gil, A. C. (2008). Métodos e técnicas de pesquisa social (6ª ed.). Atlas.
- Instituto Brasileiro de Geografia e Estatística. (2022). Panorama do Censo 2022. <https://censo2022.ibge.gov.br/panorama/index.html>
- Instituto Brasileiro de Geografia e Estatística. (2025). Estimativas da população. <https://www.ibge.gov.br/estatisticas/sociais/populacao/9103-estimativas-de-populacao.html>
- Layrargues, P. P., & Lima, G. F. da C. (2014). As macrotendências político-pedagógicas da educação ambiental brasileira. *Ambiente & Sociedade*, 17(1), 23–40. <https://doi.org/10.1590/1809-44220003500>

- Lima, G. F. da C. (2009). Educação ambiental crítica: Do socioambientalismo às sociedades sustentáveis. *Educação e Pesquisa*, 35(1), 145–163. <https://doi.org/10.1590/S1517-97022009000100010>
- Prodanov, C. C., & Freitas, E. C. (2013). *Metodologia do trabalho científico: Métodos e técnicas da pesquisa e do trabalho acadêmico* (2ª ed.). Feevale.
- Santos, A. B. L. P. dos, Costa, M. L., De Souza, N. C., Luiz, M. R., Ferreira, W. B., Almeida, M. M., & Cavalcante, G. G. (2024). Saneamento e qualidade de água: Uma análise sob as perspectivas dos bairros incluídos no percurso do Riacho das Piabas em Campina Grande - PB. *Revista Contemporânea*, 4(1), 4953–4968. <https://doi.org/10.56083/RCV4N1-272>
- Sauvé, L. (2005). Educação ambiental: Possibilidades e limitações. *Educação e Pesquisa*, 31(2), 317–322. <https://doi.org/10.1590/S1517-97022005000200012>
- Sousa Rêgo, V. G. (2014). Microbacia hidrográfica como instrumento de educação ambiental na articulação pela revitalização do Riacho das Piabas/PB [Tese de doutorado, Universidade Federal de Campina Grande]. Biblioteca Digital Brasileira de Teses e Dissertações. https://bdtd.ibict.br/vufind/Record/UFCG_966a59952970f12af6e8b878581aabfe
- Tuan, Y. (1983). *Espaço e lugar: A perspectiva da experiência*. Difel.
- Tuan, Y. (2012). *Topofilia: Um estudo da percepção, atitudes e valores do meio ambiente* (L. de Oliveira, Trad.). Eduel.

**AUTOMATION OF THE ASSETS SECTOR OF THE AMAZON FOUNDATION FOR
SUPPORTING STUDIES AND RESEARCH PARÁ: WAYS TO OPTIMIZE THE
INVENTORY SURVEY**

**AUTOMAÇÃO DO SETOR DE PATRIMÔNIO DA FUNDAÇÃO AMAZÔNIA DE AMPARO
A ESTUDOS E PESQUISAS DO PARÁ: VIAS PARA A OTIMIZAÇÃO DO
LEVANTAMENTO DE INVENTÁRIOS**

**AUTOMATIZACIÓN DEL SECTOR DE GESTIÓN DE ACTIVOS DE LA FUNDACIÓN
AMAZONAS PARA EL APOYO A ESTUDIOS E INVESTIGACIONES EN PARÁ: FORMAS
DE OPTIMIZAR LOS LEVANTAMIENTOS DE INVENTARIO**



<https://doi.org/10.56238/sevened2026.008-107>

Fábia Jaqueline Miranda Nobre¹, Alessandra Mendes Monteiro²

ABSTRACT

This study focuses on the asset management of permanent assets at the Amazon Foundation for Support of Studies and Research of Pará (FAPESPA). The objective is to present a discussion on the feasibility of adopting Radio Frequency Identification (RFID) technology to automate the asset management of FAPESPA's inventories within the Sispatweb system. It will address the verification of the components of the asset management sector for the operational management of the system; the identification of the operational structure of SISPAT WEB for the integration of the technology and optimization of the time required for conducting the internal institutional inventory. Qualitative research was the method used, of an exploratory nature, employing bibliographic and documentary research. The data collection period was 2014-2024. The results showed that technological strategies can prevent potential human errors; optimizing the inventory process leads to improved occupational safety for employees, preventing occupational diseases such as Repetitive Strain Injury (RSI) and Work-Related Musculoskeletal Disorders (WRMD), aiming to achieve the objectives of axis III of the A3P agenda ODS12.

Keywords: Public Heritage. Automation. Technological Innovation.

RESUMO

Este estudo tem como objeto a gestão patrimonial de bens permanentes da Fundação Amazônia de Amparo a Estudos e Pesquisas do Pará (FAPESPA). O objetivo é apresentar uma discussão sobre a viabilidade da adoção de Tecnologia de Identificação por Radiofrequência (RFID) para automação da gestão patrimonial dos inventários da FAPESPA no Sispatweb. Abordará a verificação dos componentes integrantes do setor de patrimônio para a gestão operacional do sistema; a identificação da estrutura operacional do SISPAT WEB para a integração da tecnologia e otimização do tempo para a realização do inventário interno institucional. A pesquisa qualitativa foi o método utilizado, de cunho exploratório com

¹ Dr. in Business Administration. Universidade da Amazônia (UNAMA). E-mail: fabiajami@hotmail.com

² Master's degree in Knowledge Management for Socio-Environmental Development. Universidade da Amazônia (UNAMA). E-mail: alika_mendes@yahoo.com.br

a utilização da pesquisa bibliográfica e documental. O espaço temporal do levantamento de dados foi o período de 2014-2024. Como resultados foi possível identificar que as estratégias tecnológicas poderão evitar possíveis erros humanos; a otimização do levantamento do inventário leva a uma melhor segurança ocupacional dos servidores para evitar doenças ocupacionais como Lesão por esforço repetitivo (LER) e Distúrbios Osteomusculares Relacionados ao Trabalho (DORT), visando atingir os objetivos do eixo III da agenda A3P e ODS12.

Palavras-chave: Patrimônio Público. Automação. Inovação Tecnológica.

RESUMEN

Este estudio se centra en la gestión de activos permanentes de la Fundación Amazónica de Apoyo a Estudios e Investigaciones de Pará (FAPESPA). El objetivo es presentar un análisis sobre la viabilidad de adoptar la tecnología de Identificación por Radiofrecuencia (RFID) para automatizar la gestión de los inventarios de FAPESPA dentro del sistema Sispatweb. Se abordará la verificación de los componentes del sector de gestión de activos para la gestión operativa del sistema; la identificación de la estructura operativa de SISPAT WEB para la integración de la tecnología y la optimización del tiempo necesario para la realización del inventario institucional interno. Se empleó una investigación cualitativa de carácter exploratorio, con investigación bibliográfica y documental. El período de recolección de datos fue de 2014 a 2024. Los resultados mostraron que las estrategias tecnológicas pueden prevenir posibles errores humanos; la optimización del proceso de inventario mejora la seguridad laboral de los empleados, previniendo enfermedades profesionales como las lesiones por esfuerzo repetitivo (LER) y los trastornos musculoesqueléticos relacionados con el trabajo (TMRT), con el objetivo de alcanzar los objetivos del eje III de la agenda A3P ODS12.

Palabras clave: Bienes Públicos. Automatización. Innovación Tecnológica.

1 INTRODUCTION

The study of the automation of the survey of the institutional internal patrimonial inventory, in particular that of FAPESPA, is initially justified by the Complementary Law No. 101, of May 4, 2000 – Fiscal Responsibility Law, which brought, among other provisions, the perception of the need for greater control over public assets.

The Civil Code, in its Articles 98 and 99, provides that the assets of the national domain belonging to legal entities of internal public law are public, and all other private individuals, regardless of the person to whom they belong.

The Popular Action Law – Law 4.717, of June 29, 1965, defines public property in its Article 1, paragraph 1, as "assets and rights of economic, artistic, aesthetic, historical or tourist value" (Brasil, 1965).

In view of this, the objective of the study focused on the identification of strategies for asset management of permanent assets of the Amazon Foundation for the Support of Studies and Research of Pará (FAPESPA) in order to make feasible the adoption of Radio Frequency Identification Technology (RFID) for automation of the asset management of inventories in Sispatweb, from the use of the so-called Radio Frequency Identification Technology (*Radio Frequency Identification*-RFID).

The purpose of using a technology is to meet FAPESPA's needs with regard to reducing the time to survey inventory, less use of human resources, reliable asset information and more efficient control of assets in the location units.

Based on the above, the study presents a discussion on the importance of automation as an effective tool as a strategy for optimizing institutional processes by being able to contribute to the rationalized progress of actions related to the survey of public assets.

2 CONCEPTUAL AND NORMATIVE CONTRIBUTIONS OF PUBLIC ASSETS

According to the list of conceptualization of patrimony, its definition can be considered, according to Dias (2006), as the managed object that serves to provide entities with the attainment of their purposes. For an asset to be considered as such, it must meet two requirements: the element must be a component of a set that has economic content and can be evaluated in currency; and that there is interdependence of the component elements of the patrimony and the link of the whole to an entity that aims to achieve certain ends.

Reassuring Torres and Silva (2003), it is mentioned that public assets are made up of assets of all nature and kinds that are of interest to the public administration and to the administered community.

Another relevant definition of public assets according to Kohama (2009, p.173) "comprises the set of assets, rights and obligations, valued in currency, of the entities that

make up the public administrations".

This concept is found in Martins *apud* Mukai (2000, p.17) when he states that public assets are a set of goods, money, values and rights belonging to public entities (Union, States, Federal District and Municipalities), through direct or indirect and foundational administration, whose conservation is of public interest and diffuse, with not only the administrators, but also the administered, linked to its protection and defense. Such elements, even under the possession of a private individual, will never lose the quality of public domain given their origin: the public thing.

An even broader conception is found in the Brazilian Standards Applied to the Public Sector (NBASP) when it highlights that public assets as a set of rights and assets, tangible or intangible, encumbered or not, acquired, formed, produced, received, maintained or used by public sector entities, which is the bearer or represents a flow of benefit, present or future, inherent to the provision of public services or economic exploitation by public sector entities and their obligations (Brasil, 2012, p.13).

Therefore, public assets are composed of assets, rights and values that are in the hands of the government, but they belong to all citizens of a nation (Union, State and Municipalities) and, for this reason, it must be managed in the best way, respecting the principles of public administration, such as legality, impersonality, morality, publicity and efficiency (Brasil, 1965).

2.1 LEGAL ASPECTS OF PUBLIC ASSETS IN THE LIGHT OF SDG 12

To situate the legal and normative aspects that regulate public assets, it is noteworthy that accounting applied to the public sector had three major historical moments: the enactment of Law No. 4,320/1964, which established the foundations of the budget and, at the time of "public accounting", the advent of Complementary Law No. 101/2000, known as the Fiscal Responsibility Law (LRF), which established the concept of transparency, balance of public accounts, preservation of assets and responsibility of fiscal management.

Table 01 presents the Brazilian Accounting Standards Applied to the Public Sector (NBCASP), among the most important is NBC T 16.2, which establishes the definition of public assets and the classification of elements under the accounting aspect, in addition to presenting the concept of accounting information systems and subsystems for public entities.

Table 1

Public heritage and classification of elements based on NBCASP

Standards	Classification
NBC T 16.1	Conceptualization, object and field of application
NBC T 16.2	Equity and Accounting Systems
NBC T 16.3	Planning and Its Instruments under an Accounting Approach
NBC T 16.4	Public Sector Transactions
NBC T 16.5	Accounting Record
NBC T 16.6	Financial Statements
NBC T 16.7	Consolidation of Financial Statements
NBC T 16.8	Internal Control
NBC T 16.9	Depreciation, Amortization and Depletion
NBC T 16.10	Valuation and Measurement of Assets and Liabilities in Public Sector Entities
NBC T 16.11	Public Sector Cost Information System

Source: Feijó (2013. p.57)

Also according to the definition of the Federal Accounting Council (2012), public assets are the set of rights and assets, tangible or intangible, encumbered or not, acquired, formed, produced, received, maintained or used by public sector entities, which carries or represents a flow of benefits, present or future, inherent to the provision of public services or economic exploitation by public sector entities and their obligations (Brasil, 2012, p.5).

The existing diversified legislation on asset management in public entities guides decisions regarding the management of public assets and supports the public agent in making more efficient decisions. These norms have as their source of origin the most diverse in the Brazilian legal system, however, their purpose according to the CFC is to meet the new social demands that their statements as an essential item of the services of public managers, which must be prepared in order to facilitate, from the perspective of their users and society, the adequate interpretation of the patrimonial phenomena of the public sector, the monitoring of the budget process, the analysis of economic results and the financial flow.

It is noteworthy that the available information facilitates the inspection of Internal Control and External Control, in order to achieve efficient asset management, which should occur beyond the existence of an equity sector, for this, it is necessary: the institution of routines, the inspection of the procedures adopted and the evaluation of the results obtained. The application of Sustainable Development Goal 12 is important, as the use of public goods must comply with the principles of sustainability and shared responsibility in order to meet the principle of Sustainable Development recommended by the Federal Constitution of 1988 in its Article 225.

Everyone has the right to an ecologically balanced environment, a good for the common use of the people and essential to a healthy quality of life, imposing on the public power and the community the duty to defend and preserve it for present and future generations.

Thus, the linear economic model, based on the triad of extract, produce and discard, which predominated until the middle of the twentieth century with the publication of the *Meadows Report*, produced by the Massachusetts Institute of Technology, at the request of the Club of Rome, occurred a paradigm shift since, contrary to the Newtonian-Decartian thought of objectifying nature, it was demonstrated that the natural elements that provide resources for industry and human life they are finite and difficult to regenerate.

3 EVOLUTION AND STRENGTHENING OF AUTOMATION IN THE FIELD OF INNOVATION

The globalized world and the constant organizational changes impose the process of transformation of operational techniques and strategies in various sectors to the detriment of coexistence with planned obsolescence, that is, everything is always changing all the time. In addition, the development of nations, instant communication and social networks and the interactions that arise from them, help to form a range of citizens who demand much more from the government to ensure a better meeting of their needs and with the desired efficiency and effectiveness.

In this sense, automation has been increasingly studied with a view to identifying a means to achieve the principle of efficiency, as recommended by the Federal Constitution of 1988 and Constitutional Amendment No. 19, of June 4, 1998, which inserted in the constitutional text the principle of efficiency as a duty to be pursued by the Public Administration, so that this is included in the list of other principles contained in article 37, caput, of the Magna Carta, among them legality, impersonality, morality and publicity. In this regard, Gonçalves (2019, p.74,) states that "innovations enable efficiency gains, better governance, greater user participation, and transparency in public actions and services".

It is worth mentioning that, according to the Organizational Innovation in Budget Management in Federal Education Institutions (TICE.PT) platform in the item on Diagnosis and Proposals for Improvements, among the information that makes up its strategic matrix are those that deal with public administration, where it is highlighted that the public administration may, based on ICT, provide more efficient and effective services, both to citizens and companies, and can contribute to a fairer state, and to a greater approximation and participation of citizens in the processes of Democracy.

3.1 BRIEF CONSIDERATIONS ON THE EVOLUTION OF AUTOMATION

Efforts in the area of automation imply, for many authors, rethinking organizations and processes, as well as a change in behavior so that public services reach those who really

need them. These well-implemented changes will allow citizens, companies and entities in general to relate to the State more easily, faster and at a lower cost.

The concept of automation was instituted in the United States only in 1946, in automotive factories and, currently, the term means any system that uses computing and replaces human labor in order to increase the speed and quality of production processes, employee safety, in addition to obtaining greater control, planning and flexibility of production (Goeking, 2010, p. 1).

For Hitomi (1994), automating means, generically, exempting man or other living beings from performing tasks and, although the concept over the years has undergone several changes, its application has extrapolated the industrial context, where it was carried out through physical and specialized machinery.

Referring to organizational efficiency, it is possible to identify on the TICE.PT platform that Information Technologies (ICTs) can contribute to organizations being able to exhibit intelligent behavior, improve their performance, demonstrate competitive capabilities and sustained well-being.

It was identified based on Cardoso and Tavares (2021) that, in addition to ensuring organizational efficiency, suggests a wide range of concerns with the functioning of organizations that, in addition to the performance dimensions normally considered, also includes aspects that can be described as being related to the cognitive capabilities of organizations such as perception, memory, attention, communication, reasoning, learning, imagination and innovation.

Also according to Cardoso and Tavares (2021), the whole new scenario that automation, necessarily incorporated into management processes, has been composing, causes fear, doubts, and fears in those who have to deal with the changes it has increased. These are feelings that, little by little, give way to the feeling of satisfaction in the provision of services and care, as highlighted by some authors, with their respective definitions, in Table 2.

Table 2

Automation concept and definitions

Authors	Concept and definitions
Wall (2011)	Automation, in the same way, is an area of knowledge that seeks to offer human beings a set of solutions to their problems, usually related to well-being and productivity. Applications are not just about replacing human labor imbued with exhausting, monotonous and dangerous tasks; They bring improvement in the quality of processes, optimization of spaces, reduction in production time and costs.
Ribeiro (2003)	The concept of automation as the operation of a machine or system automatically or by remote control, with minimal human interference.

Goeking (2010)	The concept of automation was instituted in the United States only in 1946, in automotive factories and, currently, the term means any system that uses computing and replaces human labor in order to increase the speed and quality of production processes, employee safety, in addition to obtaining greater control, planning and flexibility of production.
Morais; Castrucci (2001)	Automation in industry stems from needs such as: higher levels of forming quality and flexibility, lower labor costs, lower material losses and lower capital costs; greater control of relative process information, higher quality of information and better production planning and control.

Source: Prepared by the author based on Parede (2011), Ribeiro (2003), Goeking (2010) and Morais; Castrucci (2001)

From this survey, it is possible to infer that the authors, when dealing with automation, are consensual on several points, including the quality of processes, information control, employee safety, reduction in production time and costs.

In this sense, the automation process should involve the treatment of information from a productive medium in order to produce more while spending as few resources as possible, ensuring the efficiency of production through the adoption of some technology that will displace human labor to technological rationalization.

In the studies of Ribeiro (2003), the concept of automation is defined as the operation of a machine or system automatically or by remote control, with minimal human interference. Automation is not a new concept, it was a pillar at the time of the 3rd Industrial Revolution, as it introduced new forms of production in factories, even using human resources and producing more goods than the artisanal system.

According to Dombrowski and Wagner (2014), an Industrial Revolution is characterized by radical technological changes and innovations in industrial systems, which transform the work environment, society and living conditions, and which has economic growth as its main consequence.

Therefore, in particular, organizational efficiency has been enhanced by ICTs, through increasingly distributed, arbitrarily remote and computationally ubiquitous information systems.

3.2 THE IMPORTANCE OF THE AUTOMATION PROCESS AND ITS APPLICATIONS

Considering that automation is a process that gained notoriety from the Industrial Revolution in the context of the move of the population from the countryside to the city, causing an increase in the demand for products, leading to the development of companies, from then on producers had to adopt large-scale and organized manufacturing systems.

The areas in which automation can be used have a wide range of applications, ranging from hospital environments to commercial establishments. Automation has several

advantages, but the main objective is to reduce costs and increase production speed (Magalhães; Ferreira, 2022).

According to Roggia and Fuentes (2016), the evolution of industrial automation goes back to long periods in history. Since prehistory, man has been developing mechanisms and inventions in order to reduce physical effort and assist in the performance of activities. As an example, we can mention the wheel for moving loads and the mills moved by the force of water or animal force.

The main reasons for the introduction of automation include greater production and greater productivity, avoiding waste when used in product manufacturing industries, as an example of an automated system is the palletizing of dishes in the ceramic industry, as shown in Figure 1.

Figure 1

Palletizing ceramic plates



Source: Mendes (2023).

It is noteworthy that the insertion of robotics in the palletizing of ceramic plates resulted in the protection of the worker's health, as it contained the risk of accidents and moved the workforce to safer places, in addition to the reduction of the number of hours on average per week by the workers.

The responsibility for assets in a public institution is shared among the following sectors: the equity sector, responsible for the analytical record; the accounting sector, responsible for the synthetic registration and the warehouse sector, responsible for the safekeeping of assets. They must develop mechanisms that ensure the integration between their procedures so that they maintain constant and regular communication, either by computerized means via integration between systems, or through control and conference through reports and forms.

Although initially their costs may be high, the benefits outweigh the expenses by providing better accuracy of results, the rational use of human resources and avoiding the waste of material in production chains.

Therefore, it is considered a tool that may be very useful for FAPESPA, since its use and efficiency is widely used in the private sector and has already been used in some public agencies with efficiency. In addition to finding several companies in the market that develop the technology, which makes its application attractive to the public sector in the event of a public bid.

4 METHODOLOGY

The research had a qualitative approach because the study requires an analysis following the thought of Günther *apud* Dilthey et al. (2000) who point to the primacy of understanding as a principle of knowledge, for studying complex relationships instead of explaining them through the isolation of variables.

Thus, the discovery and construction of theories were central to anchor the analysis of the object of study, carried out through perceptions that contributed to the construction of reality through the methodological procedure used for the investigation, which was bibliographic research and documentary research.

The purpose of a bibliographic research is to allow the researcher to know and analyze the theme of the research through relevant works already published and its purpose is to better understand the phenomenon under study for Sousa *et al. apud* Fonseca (2002), is carried out from the survey of theoretical references already analyzed, and published by written and electronic means, such as books, scientific articles, web site pages.

Sousa *et al. apud* Fonseca (2002) reinforce that any scientific work begins with a bibliographic research, which allows the researcher to know what has already been studied on the subject. There are, however, scientific researches that are based solely on bibliographic research, looking for published theoretical references with the objective of collecting information or previous knowledge about the problem to which the answer is sought.

The documentary study used for the study was due to its importance in scientific research. As highlighted by Silva, Jackson *apud* Caulley, Lüdke and André (1986), documentary analysis seeks to identify factual information in documents based on questions and hypotheses of interest.

By means of this technique, the objective is, according to Silva, Jackson *apud* Caulley *apud* Lüdke and André (1986), a person who wishes to undertake documentary research

must, in order to constitute a satisfactory corpus, exhaust all the clues capable of providing him with interesting information.

And it also consists of, according to Silva, Jackson *apud* Caulley *apud* Lüdke and André (1986), addressing the documentary technique of original documents, which have not yet received analytical treatment by any author. It is one of the decisive techniques for research in the social sciences and humanities.

Regarding the documents researched, the following publications were consulted, as shown in Table 3.

Table 3

Documents consulted during the documentary research

Types of documents	Subject	Year
National Treasury Booklet	New Accounting and Fiscal Management Modernization of Public Management.	2018
Ordinance No. 437	Approves Parts II. Equity Accounting Procedures, III. Specific Accounting Procedures, IV. Table of Accounts Applied to the Public Sector, V. Financial Statements Applied to the Public Sector, VI. Questions and Answers and VII. Practical Exercise, of the 5th edition of the Manual of Accounting Applied to the Public Sector (MCASP).	2012
Manual of Accounting applied to the Public Sector	Public Accounting	2019
Power Point Presentation	Presentation SIAFEM (Integrated System of Financial Administration for States and Municipalities)	2018
Manual of Procedures real estate heritage of the State of Pará.	Real Estate Management in the State of Pará.	2007
Manual of Procedures of the movable heritage of Pará.	Securities management in the State of Pará.	2008
Decree No. 345	Establishment of a Government Integration Working Group.	2018
Power Point Presentation	Presentation SIAFEM (Integrated System of Financial Administration for States and Municipalities)	2018
Power Point Presentation	The State Real Estate Management tool.	2018
Law 4.320	General Norms of Financial Law for the preparation and control of budgets and balance sheets of the Union, States, Municipalities and the Federal District.	1964
FAPESPA's Internal Regulations	Institutional Internal Regulations	2015
Presentation at the Latin Ibero-American Congress of Technology Management XV.	Comparative Analysis of the Technologies Used in Asset Control in Public Administration	2013

Source: Prepared by the author (2025).

The data collection referred to the period between 2014 and 2017, with the Material, Warehouse and Patrimony Coordination (COMAP) sector as its locus, one of the Coordinators that make up the Administration and Finance Directorate (DIRAD) of FAPESPA. It is the most recent coordination in terms of administrative performance of the institution, in 2014 it was disconnected from the Logistics Coordination (COLOG) and began to have its own administrative autonomy with the creation of a position of coordinator for this function, as well as an effective servant to contribute to institutional functions.

5 RESULTS AND DISCUSSIONS

5.1 THE SPECIFICITY OF ASSET MANAGEMENT IN THE STATE OF PARÁ

The Government of Pará, in order to meet the new requirements pertinent to the process of convergence to international accounting standards, in 2012, began the process of accounting transition to the new accounting standards which, according to the determination of the National Treasury Secretary to the States, with regard to the use of the following accounting facts: The update of the Manual of Accounting Applied to the Public Sector (MCASP), the Table of Accounts Applied to the Public Sector (PCASP) and the Financial Statements Applied to the Public Sector (DCASP) until the year 2012 in the States of Brazil was optional and becomes mandatory as of 2013.

Through the approval of Decree No. 345/2012, a specific working group was formed at the national level for the adequacy and modernization of the cultural and informatics organizational structure existing in the state public administration, which was under the coordination of the Special Secretariat for Government Management (GTGOV/PA).

It is noteworthy that the State of Pará is part of a select group of Brazilian states that have adapted to the new Table of accounts for the public sector in Brazil, along with the States of Rio de Janeiro, São Paulo, Alagoas, Pará, Maranhão, Piauí, Rondônia, Tocantins, as presented in the Implementation of the New Accounting Standards Applied to the Public Sector in the State of Pará (SIAFEM/PCASP).

From 2012 to January 2013, SIAFEM in Pará underwent changes in its operational and managerial part to cover the changes in the Accounting of the Brazilian public sector, with the objective of gradually adapting. The main changes at the management level were as follows: (1) Parameterization of the Balance Sheets; (2) Consolidation of Balance Sheets; (3) New Synthetic Balance Sheets; (4) Process to bring balances from the Previous Year; (5) Printed balance sheets; (6). New Annexes and Statement of Financial Surplus/Deficit; (7) Adequacy of the other Trial Balances, Statements and Annexes of Law 4,320/64.

Currently, all routines inherent to FAPESPA's patrimonial sector are computerized and

registered through the Material and Service System and Sispat-web or Sispat imóveis. With the changes in the accounting legislation, the Government of Pará has implemented measures to adapt to the new standards, which have been gradually implemented in the agencies of the State of Pará.

It is worth mentioning that, according to Ordinance No. STN 634/2013, the accounting procedures implemented in 2013 were the Specific Accounting Procedures (PCE), which included credit operations such as Fundeb, RPPS (Own Social Security Regime), active debt, public-private partnerships, consortium and court orders.

In 2014, the Equity Accounting Procedures (PCP) including revenue by accrual, obligations/provisions/13th, asset registration, registration of economic phenomena, infrastructure assets and other equity aspects, in the same year the new Table of Accounts (PCASP) was approved.

Although the State of Pará has made the accounting changes slowly and gradually according to the New Schedule of STN Ordinance 753/2012, also delivered to the TCE and has adapted to the new STN Ordinance 634/2013, of November 19, 2013, it has managed to implement them in accordance with the required national legislation and in convergence with international accounting standards.

Thus, it now has an Integrated System of Financial Administration for the State and Municipalities (SIAFEM) adapted to the new Table of Accounts in force, with Rio de Janeiro, São Paulo, Alagoas, Pará, Maranhão, Piauí, Rondônia, Tocantis standing out in the list of states that have adapted to changes in the system.

5.2 FEASIBILITY OF ADOPTING AN RFID TO AUTOMATE THE ASSET MANAGEMENT OF FAPESPA'S INVENTORIES

To situate the issue related to the adoption of RFID technology, it is necessary to highlight its feasibility, because when used in asset management it increases operational efficiency, eliminating the manual work of asset counts and reduces the chance of human error, such as: not seeing the number of listings, wrong heritage listing notes, loss of the inventory report carried out in the year

In this way, the efforts of FAPESPA's heritage team can be directed to other strategic actions such as: annual purchase planning, maintenance and service of SIMAS, processes of donation of permanent assets and maintenance of assets in Sispatweb. In addition to being a more accurate data system, this also allows you to have updated information on the assets as well as their state of conservation, ensuring more accurate decision-making by having reliable data, in addition to increasing security and helping to prevent theft.

The biggest risks in relation to the use are the initial need for high initial investment in hardware and software, in addition to integration with existing systems and training the team to use it correctly. The implementation of an RFID system has a cost to be analyzed by accounting based on three different sets of equipment: hardware, software and tags.

According to RFID manufacturers, the overall cost of a system varies according to the number of tags that will be needed, their material and their type (longer range, shorter range, information storage, among other factors). On average, an RFID tag in the United States can cost 25 cents on the dollar, and can rise in Brazil to 80 cents or 1.5 dollars per unit. Although its cost-benefit is higher when compared to the barcodes currently used at FAPESPA, its benefits still make asset management more efficient and optimized.

The feasibility study of the adoption of RFID technology took into account the items presented in Table 4. The analysis of the following aspects demonstrates the feasibility of using a radio frequency identification technology, which is fundamental for the asset management of institutional inventories.

Table 3

RFID Technology Adoption Feasibility Analysis Items

Nature of Assets	RFID is especially suitable for the identification of large goods, such as electronic equipment, furniture. The technology allows for quick and accurate reading of multiple items simultaneously, streamlining the inventory process.
Operating Environment	FAPESPA's infrastructure should be evaluated to verify compatibility with RFID technology. It is important to consider the presence of physical obstacles that may interfere with the reading of the tags, such as concrete or metal walls, and the need to install antennas and readers
Integration with existing systems	The RFID solution must be able to integrate with the asset management systems already used by FAPESPA, such as the accounting system and the access control system. This integration will allow for the automation of processes and the generation of more accurate reports.
Costs	The implementation of an RFID system involves costs with the acquisition of tags, readers, antennas and software, in addition to the costs of installation and configuration. It is important to conduct a detailed study of the costs to verify the financial feasibility of the project

Source: Elaboration by the author (2024).

Although occupational safety standards emerged to meet the needs of CELISTA workers (CLT), it is necessary to remember that the 1988 Constitution states that workers' health is a fundamental human right, based on the advent of the dignity of the human person, therefore, it is a legally constituted social right (Silva, 2007).

Based on this principle, it is possible to validate the application of the Regulatory Standards compatible with the particularities of each activity in this sector to maintain the physical and mental integrity of public servants, providing an adequate environment for the

performance of their activities, as well as validating the requirement of the Public Ministry of Labor regarding compliance with these standards (Villela, 2014).

Public servants in the heritage sector have the possibility of applying the terms of Ordinance No. 25, on December 29, 1994, which approved the text of Regulatory Standard No. 9 – Environmental Risks, being called Environmental Risk Prevention Program, more specifically to Ergonomic risks such as working conditions that expose the worker to physical and mental stress.

This process causes serious disorders, affecting their psychophysiological well-being, leading the individual to develop occupational diseases, which can be Work-Related Musculoskeletal Diseases (WMSD) through Repetitive Strain Injuries (RSI) and psychological diseases arising from occupational stress due to the overload provided by the work environment) and accidental as risks that can lead to the impairment of the physical integrity of employees, due to an inadequate environment to carry out their duties.

RFID technology, when used in asset management, increases operational efficiency, eliminating the manual work of asset counts and reduces the chance of human error, allowing the efforts of the asset team to be directed to other strategic actions such as: annual purchase planning, maintenance and service of SIMAS, donation processes of permanent assets and maintenance of assets in Sispatweb.

In addition to being a more accurate data system, this also allows you to have updated information on the assets as well as their state of conservation, ensuring more accurate decision-making by having reliable data, in addition to increasing security and helping to prevent theft.

The biggest risks in relation to the use are the initial need for high initial investment in hardware and software, in addition to integration with existing systems and training the team to use it correctly. The implementation of an RFID system has a cost to be analyzed by accounting based on three different sets of equipment: hardware, software and tags.

According to RFID manufacturers, the overall cost of a system varies according to the number of tags that will be needed, their material and their type (longer range, shorter range, information storage, among other factors).

On average, an RFID tag in the United States can cost 25 cents on the dollar, and can rise in Brazil to 80 cents or 1.5 dollars per unit. Therefore, although its cost-benefit is higher when compared to the bar codes currently used at FAPESPA, its benefits still make asset management more efficient and optimized.

6 CONCLUSION

Due to the study of the application of RFID technology for asset management in public entities, the impacts in the following areas are notorious: innovation in control and monitoring, optimization of resources, qualification and training, Sustainability and Social Responsibility and impact on research and scientific innovation. The objective of its application is for the State of Pará, through a pilot project to be carried out by FAPESPA, to have an entrepreneurial vision in the adoption of new technologies in the public service and to become a reference in innovative asset management systems, in addition to fostering research and scientific innovation.

As for innovation in control and monitoring, the collection of documentary data allowed us to identify that the implementation of innovative asset management systems will allow FAPESPA to improve the control and monitoring of its permanent assets. The introduction of technologies such as computerized asset management systems facilitates the tracking, maintenance, and depreciation of assets, ensuring greater efficiency and transparency in processes.

In addition, the RIFD will allow FAPESPA the opportunity for organizational improvement through the optimization of resources, this means the reduction of waste, the efficient control of the useful life of the assets and greater investment in preventive and predictive maintenance, which reduces the costs of asset management, helping to add value to the assets. The integration of new management methodologies, such as preventive and predictive maintenance, has contributed to the reduction of operating costs and the maximization of asset value.

Insertion of new technologies in public entities requires paradigm shifts and the challenge of changes that need to be aligned with a team with training and qualification for their implementation. And its main positive impact is the acquisition of new knowledge in Wealth Management that is consistent with the best practices applied in this area in order to ensure a more effective application of heritage policies.

FAPESPA, as a foundation that supports studies and the application of science in the State of Pará, in addition to being inserted in the application of sustainability within its administrative activities through the adhesion of A3P and by adopting practices that consist of policies aimed at the reuse and proper disposal of goods, will contribute to the social and environmental responsibility that one of the foundations of the circular economy.

Therefore, the improvement in the management of permanent assets will allow FAPESPA to offer better infrastructure conditions for its employees, since it will be able to have a better control of the entire useful life of the asset, helping the managers of the agency

to make more accurate decisions in the process of acquisition of new assets, in addition to the insertion of RFID allowing an innovation in the processes of inventory survey of assets, adding value to this activity and motivating employees through the achievement of the organization's objectives.

REFERENCES

- Abdalla, F. A., & Sampaio, A. C. F. (2018). Os novos princípios e conceitos inovadores da economia circular. *Entorno Geográfico*, (15), 82–102.
- Azevedo, T. C. B., Altaf, G. J., & Trocoli, R. I. (s.d.). O controle patrimonial na administração pública. *Revista Eletrônica Machado Sobrinho*. <https://docplayer.com.br/65512437-A-r-t-i-g-o-o-controle-patrimonial-na-administracapublica-disponivel-on-line-em.html>
- Barbosa, D. D. (2013). Manual de controle patrimonial nas entidades públicas. *Gestão Pública*.
- Bliacheriene, A. C., Ribeiro, R. J. B., & Funari, M. H. (2013). Governança pública, eficiência e transparência na administração pública. *Fórum de Contratação e Gestão Pública – FCGP*, 12, 9–15.
- Bonfim, C. G. (2019). Tecnologia RFID aplicada em controle patrimonial [Trabalho de Conclusão de Curso, Bacharelado em Engenharia Eletrônica, Universidade Tecnológica Federal do Paraná]. Campo Mourão, PR.
- Brasil. (1964). Lei nº 4.320, de 17 de março de 1964. Estatui normas gerais de direito financeiro para elaboração e controle dos orçamentos e balanços da União, dos Estados, dos Municípios e do Distrito Federal.
- Campos, J. L. A., Silva, T. C., & Albuquerque, U. P. (2021). Observação participante e diário de campo: Quando utilizar e como analisar. In *Métodos de pesquisa qualitativa para etnobiologia* (pp. 95–112). Nupeea.
- Cardoso, T., & Tavares Costa, R. A. (2021). Inovação organizacional na gestão orçamentária em instituições federais de educação: Diagnósticos e proposições de melhorias com automação. *Revista de Empreendedorismo e Gestão de Micro e Pequenas Empresas*, 6(3), 125–150. <https://revistas.editoraenterprising.net/index.php/regmpe/article/view/435>
- Carvalho, H. G. de. (2011). *Gestão da inovação*. Ayamará.
- Carvalho, J. E., & Lopes, F. D. (2015). Construção de diretrizes para inovação em uma organização pública que atende ao Estado [Curso de Especialização em Gestão Pública, UNISERPRO]. Porto Alegre, RS.
- Conselho Federal de Contabilidade. (2008). Resolução nº 1.128/08. Normas aplicadas ao setor público (NBCASP). <https://internetsefaz.es.gov.br/contas/contabilidade/orientacaoContabil/arquivo/normas>
- Conselho Federal de Contabilidade. (s.d.). Normas internacionais de contabilidade ao setor público. https://www.cnm.org.br/contadores/img/pdf/normas_internacionais_de_contabilidade/NornasInternacionaisdeContabilidadeparaoSetorPublico.pdf
- Congresso Latino-Iberoamericano de Gestão de Tecnologia. (2013). Análise comparativa das tecnologias empregadas no controle patrimonial na administração pública. In *Anais do XV Congresso Latino-Iberoamericano de Gestão de Tecnologia*. Altec.

- De Oliveira, B. C. S. C. M., & Santos, L. M. L. dos. (2015). Compras públicas como política para o desenvolvimento sustentável. *Revista de Administração Pública*, 49(1), 189–206.
- Feijó, P. (2013). Entendendo as mudanças na contabilidade aplicada ao setor público. *Gestão Pública*.
- Freitas, M. A. (2016). A importância do controle patrimonial no processo de convergência às novas normas brasileiras de contabilidade aplicadas ao setor público – NBCASP. *Revista Paraense de Contabilidade*, 1(1), set./dez.
- Freixo, F. B. (2020). A adoção de tecnologias de códigos de barras e RFID no Exército Brasileiro [Trabalho de Conclusão de Curso, *Gestão em Administração Pública*]. Salvador.
- Fundação Amazônia de Amparo a Estudos e Pesquisas. (2015). Regimento interno da Fundação de Amparo à Estudos e Pesquisa. Belém, PA.
- Kanbach, R. S. B. (2007). Mudança organizacional decorrente do redesenho do processo de compras apoiado pela tecnologia da informação: Estudo de caso na CETREL S.A. [Dissertação de Mestrado, Universidade Federal da Bahia]. Escola de Administração.
- Mariano, E. L. M. (2020). O papel da prefeitura municipal na implantação das ODS 11 e 12 no âmbito do município de Lapa/PR [Monografia, Especialização em Gestão Pública Municipal, Universidade Tecnológica Federal do Paraná]. Curitiba, PR.
- Mendes, J. P. G. (2023). Aplicações de automação na indústria de cerâmica [Relatório de Estágio de Natureza Profissional, Mestrado em Engenharia Eletrotécnica, Centro Tecnológico de Cerâmica e Vidro].
- Monteiro, A. M., & Lima, E. L. M. S. de. (2022). A governança e a gestão do patrimônio público: Um estudo de caso no Estado do Pará. *Revista Ciência Sociais Aplicadas: Estado, Organizações e Desenvolvimento Regional*, 18–39.
- Neves, J. L. (1996). Pesquisa qualitativa: Características, usos e possibilidades. *Caderno de Pesquisas em Administração*, 1(3), 1–5.
- Oliveira, W. da S. (2021). Gestão de patrimônio em instituições de ensino/pesquisa baseada em tecnologia RFID: Um estudo de caso UFOPA [Dissertação de Mestrado Profissional, Universidade Federal do Oeste do Pará]. Santarém, PA.
- Pará. (2007). Manual de procedimentos patrimônio imobiliário do Estado do Pará. Secretaria de Estado de Administração, Diretoria de Gestão do Patrimônio do Estado.
- Pará. (2008). Manual de gestão do patrimônio mobiliário do Estado. Secretaria de Estado de Administração, Diretoria de Gestão do Patrimônio do Estado.
- Pará. (2012). Decreto nº 345, de fevereiro de 2012. Institui o Grupo de Trabalho de Integração da Gestão Governamental - GTGOV/PA no âmbito do Poder Executivo Estadual e dá outras providências. www.ioepa.com.br
- Pará. (s.d.). Apresentação SIAFEM. Secretaria de Fazenda do Estado do Pará. http://www.sefa.pa.gov.br/arquivos/contabilidade/NBCASP/Apresentacao_SIAFEM_PC_ASP.pdf
- Pará. (s.d.). SISPAT IMÓVEIS: A ferramenta de gestão dos imóveis estaduais. Secretaria de Administração do Estado do Pará. http://www.sead.pa.gov.br/sites/default/files/sispat_imoveis.pdf

- Prata, P. I. (2008). Sistemas de localização para ambientes interiores baseados em RFID [Tese de Doutorado, Universidade de Aveiro].
- Raupp, F. M., & Beuren, I. M. (2006). Metodologia da pesquisa aplicável às ciências. In Como elaborar trabalhos monográficos em contabilidade: Teoria e prática (pp. 76–97). Atlas.
- Rodrigues, C. F. (2021). Segurança do trabalho no setor público: Um estudo acerca da saúde ocupacional dos servidores públicos [Monografia, Curso Superior de Engenharia de Produção, Universidade Federal de Campina Grande].
- Santos, B. L., & Kumada, K. M. O. (2021). Análise metodológica sobre as diferentes configurações da pesquisa bibliográfica. *Revista Brasileira de Iniciação Científica*, 021029.
- Santos, J. dos. (2022). As fundações de amparo a pesquisas (FAPs) e o desenvolvimento da CT&I na Região Norte [Tese de Doutorado, Universidade Federal de São Carlos].
- Santos, J. dos, & Kerbauy, M. T. M. (2021). Fundações de amparo à pesquisa na Região Norte: Histórico e características. *Ciência da Informação*, 50(2), 121–137.
- Santos, P. de B. (2023). Automação de processos com o uso de Excel: Implantação em uma autarquia federal [Monografia, Graduação em Administração, Universidade Federal do Rio Grande do Norte]. Natal, RN.
- Secretaria Adjunta de Gestão Administrativa. (s.d.). Guia de consulta para o usuário SIMAS-Visão geral do sistema. [http://www.compraspara.pa.gov.br/sites/default/files/GUIA%20DE%](http://www.compraspara.pa.gov.br/sites/default/files/GUIA%20DE%20SIMAS%20-%20Visão%20geral%20do%20sistema.pdf)
- Silva, J. R. S., Almeida, C. D. de, & Guindani, J. F. (2009). Pesquisa documental: Pistas teóricas e metodológicas. *Revista Brasileira de História & Ciências Sociais*, 1(1), 1–15.
- Silva, T. G. E., Pontes, A. C. da S. J. E., Musetti, M. A., & Ometto, A. R. (2021). Economia circular: Um panorama do estado da arte das políticas públicas no Brasil. *Revista Produção Online*, 21(3), 951–972. <https://doi.org/10.14488/1676-1901.v21i3.4354>
- Sousa, A. S., Oliveira, G. S., & Alves, L. H. (2021). A pesquisa bibliográfica: Princípios e fundamentos. *Cadernos da FUCAMP*, 20(43).
- Struhs, F. do R. et al. (2012). Gestão do conhecimento nas organizações. Ayamará Educação.
- Teixeira, A. R. de F. (2017). A tecnologia da informação como estratégia organizacional na tomada de decisão: Um estudo de caso do mercado do agronegócio [Dissertação de Mestrado, Programa de Pós-Graduação em Mestrado Profissional Gestão e Inovação na Indústria Animal].
- Tesouro Nacional. (s.d.). Nova contabilidade e gestão fiscal: Modernização da gestão pública. http://tesouro.fazenda.gov.br/documents/CARTILHA_Nova-ContabilidadeGestaoFiscal.pdf
- Tesouro Nacional. (2012). Portaria nº 437, de 12 de julho de 2012. www.tesouro.fazenda.gov.br/documents/10180/367031/CPU_MCASP_ParteGeral.pdf
- Tesouro Nacional. (s.d.). Manual de contabilidade aplicada ao setor público (MCASP) (9a ed.). https://sisweb.tesouro.gov.br/pex/f?p=501:9:::9:P9ID_PUBLICACAO:41943
- Valadares, J. L., & Emmendoerfer, M. L. (2015). A incorporação do empreendedorismo no setor público: Reflexões baseadas no contexto brasileiro. *Revista de Ciência da Administração*, 17(41), 81–98.

CONTINUING EDUCATION IN HEALTH, DISCOURSE, AND TRANSFORMATION OF WORK IN THE SUS

EDUCAÇÃO PERMANENTE EM SAÚDE, DISCURSO E TRANSFORMAÇÃO DO TRABALHO NO SUS

EDUCACIÓN PERMANENTE EN SALUD, DISCURSO Y TRANSFORMACIÓN DEL TRABAJO EN EL SUS



<https://doi.org/10.56238/sevened2026.008-108>

Leonardo Gaist¹, Antonio Escandiel de Souza², Vera Lucia Freitag³

ABSTRACT

This study analyzes Continuing Education in Health (CEH) within the context of Primary Health Care (PHC), articulating its conceptual, political, and pedagogical foundations with the contributions of Critical Discourse Analysis (CDA). It assumes that CEH is a fundamental strategy for improving work processes in the Brazilian Unified Health System (SUS), promoting meaningful learning from the daily routine of services and the problematization of professional practices. The work discusses CEH as a social and political practice traversed by disputes over meaning, highlighting tensions between emancipatory perspectives—centered on dialogue, collective reflection, and the transformation of care—and technical-instrumental approaches aligned with managerial rationalities. Within PHC, it is emphasized that the effectiveness of continuing education depends on institutional, organizational, and subjective conditions that favor spaces for critical analysis of work. The overload of care, the precariousness of employment relationships, and the centrality of goals emerge as challenges that can limit its transformative potential. In this scenario, Critical Discourse Analysis is presented as a theoretical-methodological framework capable of revealing how scientific, normative, and institutional discourses produce effects on management, power relations, and the organization of care. It is concluded that the articulation between continuing education in health and critical discourse analysis broadens the understanding of formative processes within the Brazilian Unified Health System (SUS), highlighting that the transformation of health practices involves not only technical changes but also the problematization of ways of thinking, speaking, and giving meaning to work. Thus, continuing education reaffirms itself as a structuring axis for strengthening more democratic, comprehensive practices committed to social justice.

Keywords: Continuing Education in Health. Primary Health Care. Brazilian Unified Health System. Critical Discourse Analysis. Work Processes. Health Management.

¹ Dr. Universidade de Cruz Alta (UNICRUZ). E-mail: leonardogaist12@gmail.com
Orcid: <https://orcid.org/0000-0001-9823-2456> Lattes: <https://lattes.cnpq.br/0200165613454584>

² Dr. Universidade Federal do Rio Grande do Sul (UFRGS). E-mail: asouza@unicruz.edu.br
Orcid: <https://orcid.org/0000-0001-6531-3794> Lattes: <http://lattes.cnpq.br/5929342981959320>

³ Dr. in Nursing. Universidade Federal do Rio Grande do Sul (UFRGS). E-mail: verafreitag@hotmail.com
Orcid: <https://orcid.org/0000-0002-5897-7012> Lattes: <http://lattes.cnpq.br/6467917501497020>

RESUMO

Este estudo analisa a Educação Permanente em Saúde (EPS) no contexto da Atenção Primária à Saúde (APS), articulando suas bases conceituais, políticas e pedagógicas às contribuições da Análise do Discurso Crítica (ADC). Parte-se do pressuposto de que a EPS se configura como uma estratégia fundamental para a qualificação dos processos de trabalho no Sistema Único de Saúde (SUS), ao promover a aprendizagem significativa a partir do cotidiano dos serviços e da problematização das práticas profissionais. A obra discute a EPS como prática social e política atravessada por disputas de sentido, evidenciando tensões entre perspectivas emancipadoras — centradas no diálogo, na reflexão coletiva e na transformação do cuidado — e abordagens técnico-instrumentais alinhadas a racionalidades gerencialistas. No âmbito da APS, destaca-se que a efetivação da educação permanente depende de condições institucionais, organizacionais e subjetivas que favoreçam espaços de análise crítica do trabalho. A sobrecarga assistencial, a precarização dos vínculos e a centralidade de metas emergem como desafios que podem limitar seu potencial transformador. Nesse cenário, a Análise do Discurso Crítica é apresentada como um referencial teórico-metodológico capaz de desvelar como discursos científicos, normativos e institucionais produzem efeitos sobre a gestão, as relações de poder e a organização do cuidado. Conclui-se que a articulação entre EPS e ADC amplia a compreensão sobre os processos formativos no SUS, ao evidenciar que a transformação das práticas em saúde envolve não apenas mudanças técnicas, mas também a problematização dos modos de pensar, falar e significar o trabalho. Assim, a educação permanente reafirma-se como eixo estruturante para o fortalecimento de práticas mais democráticas, integrais e comprometidas com a justiça social.

Palavras-chave: Educação Permanente em Saúde. Atenção Primária à Saúde. Sistema Único de Saúde. Análise do Discurso Crítica. Processos de Trabalho. Gestão em Saúde.

RESUMEN

Este estudio analiza la Educación Permanente en Salud (EPS) en el contexto de la Atención Primaria de la Salud (APS), articulando sus bases conceptuales, políticas y pedagógicas con los aportes del Análisis Crítico del Discurso (ACD). Parte del supuesto de que la EPS se configura como una estrategia fundamental para la cualificación de los procesos de trabajo en el Sistema Único de Salud (SUS), al promover un aprendizaje significativo a partir de la vida cotidiana de los servicios y de la problematización de las prácticas profesionales. La obra discute la EPS como una práctica social y política atravesada por disputas de sentido, evidenciando tensiones entre perspectivas emancipadoras —centradas en el diálogo, la reflexión colectiva y la transformación del cuidado— y enfoques técnico-instrumentales alineados con racionalidades gerencialistas. En el ámbito de la APS, se destaca que la efectivización de la educación permanente depende de condiciones institucionales, organizacionales y subjetivas que favorezcan espacios de análisis crítico del trabajo. La sobrecarga asistencial, la precarización de los vínculos laborales y la centralidad de las metas emergen como desafíos que pueden limitar su potencial transformador. En este escenario, el Análisis Crítico del Discurso se presenta como un marco teórico-metodológico capaz de develar cómo los discursos científicos, normativos e institucionales producen efectos sobre la gestión, las relaciones de poder y la organización del cuidado. Se concluye que la articulación entre EPS y ACD amplía la comprensión de los procesos formativos en el SUS, al evidenciar que la transformación de las prácticas en salud involucra no solo cambios técnicos, sino también la problematización de los modos de pensar, hablar y significar el trabajo. De este modo, la educación permanente se reafirma como un eje estructurante para el fortalecimiento de prácticas más democráticas, integrales y comprometidas con la justicia social.

Palabras clave: Educación Permanente en Salud. Atención Primaria de la Salud. Sistema Único de Salud. Análisis Crítico del Discurso. Procesos de Trabajo. Gestión en Salud.

1 INTRODUCTION

Permanent Education in Health (PEH) is one of the most relevant political-pedagogical strategies aimed at the qualification of work processes and the transformation of care practices within the scope of the Unified Health System (SUS). Unlike traditional models of professional training, historically marked by the centrality of content transmission and by the fragmentation between theory and practice, PEH proposes a conception of learning anchored in the daily work, in the problematization of concrete experiences and in the collective construction of knowledge. It is, therefore, a perspective that recognizes the health worker as a historical, reflective subject and producer of knowledge, and not only as a passive recipient of technical information.

In the context of Primary Health Care (PHC), Permanent Education assumes an even more strategic role. PHC, as the preferred gateway to the SUS and coordinator of the Health Care Networks, is the space where the contradictions, strengths and limits of the Brazilian health system materialize in a more intense way. It is at this level of care that professionals deal daily with the complex demands of the territories, with the social determinants of health and with the need to articulate actions of promotion, prevention, care and surveillance. In this scenario, PHE presents itself as a concrete possibility for redefining practices, strengthening teamwork and expanding the integrality of care.

Despite its normative recognition, especially since the institution of the National Policy for Permanent Education in Health (PNEPS), it is observed that the operationalization of PEH in health services still faces numerous challenges. Recent studies indicate that continuing education is often reduced to specific training actions, sporadic training or courses disconnected from the real needs of the teams and territories. This reduction reveals the permanence of technical-instrumental conceptions of professional training, aligned with a managerial rationality that prioritizes goals, indicators and productivity to the detriment of critical reflection on the work process.

Such contradictions show that PEH cannot be understood only as a set of educational practices or as a formally instituted public policy. It is also configured as a discursive field crossed by disputes of meaning, ideologies and power relations that directly influence the way it is conceived, implemented and experienced in health services. The discourses that circulate about continuing education — whether scientific, institutional or produced in the daily work — contribute to legitimizing certain practices and silencing others, producing concrete effects on the organization of work and on the subjectivity of workers.

In this sense, Critical Discourse Analysis (CDA), as developed by Norman Fairclough, offers a powerful theoretical-methodological contribution to the understanding of these

dynamics. By conceiving discourse as a social practice, historically situated and ideologically oriented, CDA allows us to analyze the dialectical relations between language, power and social organization. In the field of public health, this perspective makes it possible to understand how the discourses on public policies, professional training and work processes not only reflect reality, but actively participate in its production and transformation.

Applying Critical Discourse Analysis to the study of Continuing Education in Health implies recognizing that the meanings attributed to PEH are socially constructed and disputed. Discourses that present it as an emancipatory, collective, and transformative practice coexist with narratives that reduce it to a normative instrument for the adaptation of workers to institutional demands. This tension reflects different projects of health, education and society, making PEH a privileged object for critical analysis within the scope of the SUS.

In this context, this chapter aims to deepen the analysis of contemporary perspectives of Permanent Health Education in Primary Health Care, based on a review of recent literature articulated with the assumptions of Critical Discourse Analysis. It seeks to understand how PHE is discursively constructed in the scientific and institutional field, what meanings are attributed to its relationship with the work processes in PHC and how these discourses influence its effectiveness as a transformative practice in the SUS. By proposing this discussion, it is intended to contribute to the strengthening of permanent education as a structuring axis of Collective Health and as an instrument of resistance in the face of the technician and managerialist tendencies that cross health work.

2 CONTINUING EDUCATION IN HEALTH: CONCEPTUAL, POLITICAL AND PEDAGOGICAL FOUNDATIONS

Continuing Education in Health (PEH) is a theoretical-political proposal that emerges in opposition to traditional models of professional training, historically based on a technician logic, fragmented and disconnected from the real needs of the services and the population. Unlike the conceptions of education centered on the transmission of content and the punctual updating of knowledge, the EPS is based on the assumption that health work is, simultaneously, a space for the production of care, subjectivities and knowledge, with the daily work being the main trigger of the training processes.

In the field of Collective Health, PEH dialogues directly with critical conceptions of education, inspired, among other references, by the thought of Paulo Freire. The centrality of the problematization of reality, dialogue and the collective construction of knowledge brings PEH closer to an emancipatory pedagogy, in which workers cease to be mere receptors of content to assume the role of active subjects of the educational process. This perspective

recognizes the historical and unfinished character of knowledge and affirms education as a social and political practice.

In the Latin American context, the notion of continuing education gains relevance from the criticism of development and professional training models aligned exclusively with market demands and productivist rationality. Guimarães, Martin and Rabelo (2010) highlight that these models produced professionals who were highly specialized from a technical point of view, but poorly prepared to deal with the social, ethical and political complexity that health work goes through. The incorporation of continuing education represents, in this sense, a paradigmatic inflection by affirming work as an educational principle.

In Brazil, the insertion of Continuing Education in Health in the field of public policies was strongly influenced by the formulations of the Pan American Health Organization (PAHO), especially from the 1980s onwards, when on-the-job learning began to be advocated as a strategy to qualify health systems. Lemos (2016) points out that PHE was conceived as a means of expanding workers' commitment to health production processes, stimulating critical reflection on practices and co-responsibility for care.

The consolidation of PEH as a public policy occurs with the institution of the National Policy for Permanent Education in Health (PNEPS), formalized by Ordinance No. 198/2004 of the Ministry of Health and reaffirmed by subsequent regulations. The PNEPS establishes that the training processes must be structured based on the problematization of the work process, taking as a reference the health needs of the population, management and social control. By shifting the focus from education as an event to education as a continuous process, the policy breaks with traditional conceptions of capacity building and training.

Ceccim (2005) offers one of the most relevant contributions to the conceptual foundation of PEH by proposing the so-called "quadrilateral of education", composed of the dimensions of teaching, management, care and social control. According to the author, continuing education is only effective when these dimensions are articulated, allowing the training processes to dialogue with the reality of the services, with public policies and with social demands. This conception broadens the understanding of PHE beyond a pedagogical strategy, recognizing it as a political device capable of influencing the organization of work and power relations in the SUS.

Despite this robust theoretical and normative framework, the literature points out that, in practice, PEH is often reduced to continuing education, capacity building or training actions. Sena (2014) and Araújo (2015) highlight that these modalities, although important, tend to reproduce a transmissive logic of knowledge, in which the contents are previously defined and the workers occupy a passive position in the educational process. This conceptual

reduction empties the critical potential of PEH and reinforces the dichotomy between theory and practice.

The distinction between Continuing Education in Health and continuing education is, therefore, central to the understanding of its pedagogical foundations. While continuing education is organized, in general, based on the updating of technical and normative contents, PEH starts from the real problems experienced in the work process and is built through collective reflection, dialogue and critical analysis of practices. Fernandes (2019) points out that PEH is not defined as a process that teaches ready-made answers, but as a process that provokes questions and displacements in workers' ways of thinking and acting.

In this sense, active methodologies play a fundamental role in the operationalization of Permanent Health Education. Strategies such as conversation circles, case analysis, unique therapeutic projects and institutional support favor the approximation between theory and practice and stimulate the autonomy of the subjects. Luz et al. (2020) highlight that the use of active methodologies in the context of health services contributes to the development of critical thinking and to the qualification of care, by recognizing the complexity of the practices and relationships established in daily life.

Another central element in the foundations of PHE refers to the conception of health work as a complex social practice, crossed by interprofessional relationships, affections and disputes of meaning. Oliveira (2017) emphasizes that the daily routine of health work cannot be reduced to protocols and technical routines, as it involves singular encounters between workers and users, marked by listening, bonding and negotiation. By valuing these dimensions, PHE creates spaces for reflection that allow professionals to analyze their implications and collectively build new forms of action.

The articulation of Permanent Education in Health with the notion of live work in action, developed by Merhy and collaborators, reinforces its transformative potential. Live work refers to the creative and inventive dimension of health work, which manifests itself at the moment of the encounter between worker and user and which cannot be fully captured by harsh norms or technologies. The EPS enhances this dimension by recognizing the knowledge produced in daily life and by stimulating the autonomy and co-responsibility of the subjects.

However, the realization of these conceptual and pedagogical foundations occurs in a context marked by structural contradictions. The precariousness of work relationships, the intensification of care demands and the growing incorporation of managerialist rationalities impose concrete limits on the implementation of PHE as a continuous and collective process.

These factors contribute to the reproduction of fragmented training practices and to the difficulty of consolidating continuing education as a structuring policy of the SUS.

Thus, understanding the conceptual, political and pedagogical foundations of Permanent Health Education requires situating it within the disputes that cross the Brazilian health system. PEH is not configured as a neutral or merely technical device, but as a social and political practice that expresses distinct projects of education, management and care. Acknowledging these disputes is a fundamental condition for analyzing their materialization in health services and, especially, in Primary Health Care, a theme that will be developed in the following chapter.

3 CONTINUING EDUCATION IN HEALTH IN PRIMARY HEALTH CARE: DAILY WORK, MANAGEMENT AND PRODUCTION OF CARE

Primary Health Care (PHC) is a privileged space for the implementation of Permanent Health Education (PEH), as it concentrates continuous, territorialized care practices guided by the principles of integrality, equity and social participation. As the main gateway to the Unified Health System (SUS) and coordinator of care networks, PHC materializes, in a concrete way, the tensions between the normative frameworks of public policies and the real working conditions experienced by health teams.

The work in Primary Care is characterized by high complexity, requiring from professionals skills that go beyond the technical-care dimension. The teams work in territories marked by social inequalities, vulnerabilities and multiple social determinants of health, demanding interdisciplinary and intersectoral practices. Starfield (2002) emphasizes that the effectiveness of PHC is directly related to the ability to establish bonds, ensure longitudinality and respond to the real needs of the population, aspects intrinsically linked to the training processes developed at work.

However, the organization of work in PHC is crossed by managerialist and productivist rationalities, expressed in the centrality of goals, indicators and protocols. Although these instruments are relevant for the planning and evaluation of actions, their uncritical use tends to reduce care to standardized practices, emptying spaces for collective reflection. Paim and Almeida-Filho (2018) highlight that this tension between the hegemonic care model and the principles of the SUS represents one of the main challenges for the consolidation of comprehensiveness in Primary Care.

In this scenario, Permanent Education in Health presents itself as a strategy of resistance and reorientation of practices, by proposing the problematization of the work process as a central axis of learning. Based on the concrete situations experienced by the

teams, the EPS values the knowledge produced in daily life and recognizes the workers as active subjects of the training process. Ceccim and Ferla (2009) emphasize that the EPS, when incorporated organically into the routine of the services, expands professional autonomy and strengthens co-responsibility for care.

The micropolitics of health work, as formulated by Merhy, offers an important contribution to understanding the relationship between PHE and PHC. Micropolitics refers to the relationships established in the meetings between workers, managers and users, and it is in this space that care is effectively produced. EPS acts directly in this dimension by creating collective spaces for the analysis of practices, in which conflicts, affections and disputes of meaning emerge, enhancing the live work in action.

In the context of Primary Care management, Permanent Education can also operate as a device for qualifying decision-making processes and democratizing power relations. Administrations that recognize PEH as a structuring axis of work organization tend to favor participatory practices, stimulating dialogue between teams and the collective construction of solutions to the problems identified in the territory. Feuerwerker (2014) points out that PEH only fulfills this role when it is not captured by a merely bureaucratic or instrumental logic.

Despite its transformative potential, the implementation of Continuing Education in Health in PHC faces concrete limits, such as the precariousness of labor contracts, the high turnover of professionals, and the care overload. These factors reduce the time available for reflective and formative activities and contribute to the restricted understanding of PEH as one-off training. Studies such as those by Lima et al. (2021) show that, in many contexts, continuing education actions remain disconnected from the real needs of teams and territories.

Even so, successful experiences described in the literature demonstrate that EPS can produce significant impacts on the qualification of care in Primary Care. Initiatives that articulate the analysis of the work process, collective discussion of cases, institutional support and user participation contribute to the strengthening of teams, the expansion of the bond with the community and the improvement of health outcomes.

Thus, the analysis of Continuing Education in Health in Primary Health Care shows that its effectiveness depends on institutional, political and subjective conditions that sustain continuous processes of reflection and learning. More than a set of methods, PEH is configured as a social and political practice that disputes meanings about work, care and the very conception of health, preparing the ground for the discursive analysis developed in the next chapter.

4 CONTINUING EDUCATION IN HEALTH AND CRITICAL DISCOURSE ANALYSIS: LANGUAGE, POWER AND SOCIAL TRANSFORMATION IN THE SUS

Critical Discourse Analysis (CDA) is an interdisciplinary theoretical-methodological field dedicated to understanding the relationships between language, power, and social practices. Developed mainly from the contributions of Norman Fairclough, the CDA is based on the assumption that discourse is not only a reflection of social reality, but a constitutive element of this reality, actively participating in the production, reproduction and transformation of social relations. In this sense, language is understood as a historically situated social practice, crossed by ideologies, disputes of meaning and power relations.

For Fairclough, discourse must be analyzed from a three-dimensional perspective, which articulates three interdependent analytical levels: the text (textual dimension), discursive practice (processes of production, circulation, and consumption of texts), and social practice (broader institutional, historical, and political contexts). This approach makes it possible to apprehend not only the explicit content of the discourses, but also the assumptions, silencing, naturalizations and linguistic strategies that sustain certain forms of social organization.

In the field of Collective Health, the CDA has shown itself to be a powerful reference for analyzing public policies, institutional practices and work processes, since it allows us to highlight how certain discourses become hegemonic and how others are marginalized. By bringing language to the center of the analysis, the CDA contributes to unveiling the symbolic mechanisms that sustain management models, conceptions of care and formative practices in the Unified Health System (SUS).

Permanent Education in Health (PEH), when understood as a public policy and as a pedagogical practice, is also configured as a discursive practice. This means recognizing that the meanings attributed to PEH are produced, disputed and legitimized through scientific, normative, institutional and everyday discourses. These discourses not only describe the EPS, but also guide its implementation, delimit its objectives and condition its possibilities for transformation.

The normative documents of the Ministry of Health, such as the National Policy for Permanent Education in Health (PNEPS), construct a discourse that associates PHE with the problematization of the work process, meaningful learning and the transformation of health practices. However, when this discourse circulates at the different levels of management and in health services, it is resignified, reinterpreted and, sometimes, emptied of its critical potential.

CDA allows us to understand how, in many contexts, PEH is discursively reduced to specific training actions, technical training or updating of protocols, aligning itself with a managerial and productivist rationality. This discursive displacement reveals the presence of ideologies that privilege efficiency, control and standardization to the detriment of critical reflection and the collective participation of workers.

On the other hand, counter-hegemonic discourses also emerge that conceive of PEH as a space for dialogue, listening, and collective construction of knowledge. These discourses, often produced in the daily life of the services and in local experiences, tension normative conceptions and affirm permanent education as an emancipatory practice, aligned with the principles of integrality, equity and social participation.

The relationship between discourse and power occupies a central place in Critical Discourse Analysis and is particularly relevant to understanding the work processes in the SUS. The discourses that circulate in health services contribute to legitimizing certain forms of work organization, professional hierarchies and management models, while silencing other possibilities of action.

In the context of Primary Health Care, the presence of discourses that naturalize work overload, the precariousness of bonds and the individual responsibility of workers for the structural problems of the system are observed. These discourses operate ideologically by shifting the focus from material and political conditions to individual performance, weakening the collective dimension of health work.

The EPS, when appropriated by these hegemonic discourses, runs the risk of being instrumentalized as a mechanism for adjusting workers to institutional requirements, reinforcing practices of control and adaptation. CDA makes it possible to highlight these processes by analyzing how certain forms of language produce effects of power, shaping subjectivities and guiding behaviors in everyday work.

On the other hand, continuing education can constitute a space of discursive resistance, by favoring the problematization of working conditions, the clarification of conflicts and the construction of alternative narratives about care and management. From this perspective, PEH assumes a political role by creating conditions for workers to recognize themselves as historical subjects, capable of critically intervening in the reality in which they are inserted.

By articulating language, social practice and power, Critical Discourse Analysis offers important subsidies for the strengthening of Permanent Education in Health as a transformative strategy. The use of CDA in research and training practices allows

problematizing the discourses that guide policies and work processes, contributing to the construction of educational practices that are more coherent with the principles of the SUS.

Within the scope of the EPS, the ADC can be incorporated as a pedagogical device, encouraging workers to critically analyze the discourses that cross their daily lives, such as protocols, goals, reports and institutional norms. This analysis favors awareness of the effects of these discourses on the organization of work and on the relationships between professionals, managers and users.

In addition, the CDA makes it possible to value the discourses produced by the workers themselves, recognizing them as legitimate and fundamental knowledge for the transformation of health practices. By giving visibility to these voices, permanent education contributes to the democratization of decision-making processes and to the strengthening of teamwork.

The articulation between Continuing Education in Health and Critical Discourse Analysis reinforces the understanding that the transformation of health practices is not limited to the adoption of new techniques or knowledge, but involves changes in the ways of thinking, speaking and signifying work and care. The discourses that circulate in health services produce realities and, therefore, their problematization is an essential condition for the construction of a more just and democratic SUS.

In this sense, PEH, anchored in a critical perspective of discourse analysis, can contribute to the deconstruction of hegemonic narratives that reinforce inequalities, fragmentations, and exclusionary practices. By promoting spaces for dialogue and collective reflection, continuing education favors the emergence of new meanings about care, management and the relationship with users.

Thus, understanding PEH as a discursive and political practice broadens its scope and reaffirms its strategic role in the consolidation of the principles of the SUS. By unveiling the relations between language and power, Critical Discourse Analysis strengthens the capacity of continuing education to act as an instrument of social transformation, contributing to the construction of more humane, comprehensive health practices committed to social justice.

5 IMPLICATIONS OF CONTINUING EDUCATION IN HEALTH AND CRITICAL DISCOURSE ANALYSIS FOR MANAGEMENT AND WORK PROCESSES IN THE SUS

Continuing Education in Health (PEH), when understood beyond a pedagogical strategy, assumes centrality as a structuring axis of management in the Unified Health System (SUS). From this perspective, PEH is not limited to the technical qualification of workers, but constitutes a political-pedagogical device capable of influencing the ways of

organizing work, making decisions and producing care. By articulating training, management and care, continuing education tensions traditional models of public administration based on fragmentation, verticalization of decisions and bureaucratic control.

The National Policy for Continuing Education in Health proposes that training processes be anchored in the real needs of services, workers and users, which implies recognizing the daily work as a legitimate space for the production of knowledge. For management, this means shifting the focus from specific training actions to the construction of institutional environments that favor collective learning, interprofessional dialogue and critical reflection on practices.

The health work processes are marked by high complexity, involving technical, relational, ethical and subjective dimensions. In the context of Primary Health Care, these dimensions are intensely manifested, since care is produced in the encounter between workers and users, in contexts crossed by social, cultural and territorial determinants. By focusing on these processes, the EPS acts in the micropolitics of work, understood as the set of relationships, negotiations and disputes that are established in the daily life of the services.

Based on Merhy's (2013) contributions, it is understood that health work is predominantly live work in action, in which technical knowledge is articulated with listening, bonding and situated decision-making. In this scenario, continuing education can favor the expansion of workers' autonomy, by creating spaces for critical analysis of practices and for the shared construction of therapeutic projects that are more sensitive to the needs of users.

The incorporation of management models inspired by business logic has produced significant effects on the organization of work in the SUS. Discourses associated with productivity, the achievement of goals and the measurement of results tend to redefine priorities and guide institutional practices. Critical Discourse Analysis allows us to highlight how these discourses operate ideologically, naturalizing forms of control and individual accountability of workers.

When appropriated by this rationality, PEH runs the risk of being reduced to an instrument for adapting professionals to institutional requirements, emptying its critical and emancipatory character. Quick courses, training focused on indicators and decontextualized training become expressions of an education subordinated to the logic of performance, distancing itself from the proposal of problematizing work and transforming practices.

The articulation between PHE and Critical Discourse Analysis offers important contributions to the construction of a more democratic and participatory management in the SUS. By critically analyzing the discourses that guide institutional policies, norms, and

practices, CDA makes it possible to denaturalize hierarchies, question established truths, and open space for the emergence of new forms of work organization.

In management practice, the incorporation of a critical discursive perspective can favor more transparent and inclusive decision-making processes, by recognizing workers as subjects who produce knowledge and not only as executors of tasks. In this context, PHE becomes a privileged space for listening to the teams, negotiating meanings and collectively constructing care and management strategies.

The implications of Permanent Education in Health and Critical Discourse Analysis for the consolidation of the SUS are broad and profound. By strengthening critical and contextualized educational practices, PEH contributes to the realization of the principles of integrality, equity, and social participation. The analysis of discourses allows us to understand how these principles are appropriated, reinterpreted or emptied in the institutional routine.

In this sense, the articulation between PHE and CDA reinforces the need for public policies that value health work as a complex and historical social practice. Investing in continuing education means, therefore, investing in the capacity of the SUS to reinvent itself in the face of contemporary challenges, strengthening its public, democratic dimension committed to social justice.

6 FINAL CONSIDERATIONS

This chapter showed that Permanent Education in Health, articulated with Critical Discourse Analysis, offers a powerful reference to rethink the management and work processes in the SUS. By shifting the gaze to the discourses that guide institutional practices and decisions, it becomes possible to identify limits, contradictions and potentialities that cross the daily routine of the services.

Thus, PEH reaffirms itself as a fundamental strategy not only for professional qualification, but for the transformation of labor relations, management and health care. The ADC, in turn, broadens this understanding by showing that the change in practices necessarily involves the problematization of the meanings that sustain health practice, contributing to the construction of a more humane, equitable and democratic SUS.

We sought to analyze the perspectives of Permanent Health Education (PHE) in the context of Primary Health Care, articulating this field with the theoretical-methodological contributions of Critical Discourse Analysis (CDA). Throughout the chapters, it was evident that PEH occupies a strategic place in the Unified Health System (SUS), not only as a public education policy, but as a social, pedagogical and political practice deeply involved in the organization of work, management and production of care.

The analysis developed allowed us to understand that continuing education does not materialize in a neutral or homogeneous way in health services. On the contrary, its meanings are continuously disputed and resignified through scientific, normative, institutional and everyday discourses. These discourses express distinct health, education and management projects, revealing tensions between critical and emancipatory conceptions and technical-instrumental approaches aligned with a managerial and productivist rationality.

In the context of Primary Health Care, the chapters showed that the effectiveness of PHE is directly conditioned to the concrete working conditions, the forms of management and the power relations that cross the daily life of the services. The overload of work, the precariousness of bonds and the centrality of goals and indicators emerge as discursive and material elements that limit the transformative potential of continuing education, while at the same time producing processes of subjectivation marked by the individual responsibility of workers.

The incorporation of Critical Discourse Analysis as an analytical framework proved to be fundamental to unveil these dynamics, as it evidenced that the discourse not only reflects the reality of health work, but actively participates in its production and maintenance. The CDA allowed us to identify how certain discourses become hegemonic, naturalizing practices and management models, while others are silenced or marginalized, despite their critical and innovative potential.

At the same time, the work highlighted that Permanent Education in Health can constitute a privileged space for resistance and transformation. When guided by the problematization of the work process, by listening to the teams and by valuing the knowledge produced in daily life, PEH favors the collective construction of care, the strengthening of teamwork and the expansion of workers' autonomy. From this perspective, continuing education reaffirms its commitment to the principles of the SUS, especially integrality, equity and social participation.

The reflections presented also point to important implications for the management of the SUS. Recognizing PHE as a structuring policy implies ensuring institutional conditions, protected time and technical-political support for the development of critical and contextualized educational practices. In addition, it requires confronting managerial discourses that reduce education to an instrument of control and adaptation, emptying its emancipatory potential.

In the field of research in Collective Health, this book contributes by highlighting the relevance of Critical Discourse Analysis as an analytical and pedagogical tool. The CDA expands the possibilities of understanding health policies and practices, by articulating

language, power and social practices, offering subsidies for investigations that seek to understand not only what is done in the SUS, but how health work is spoken, legitimized and transformed.

Finally, the limits of this work are recognized, especially because it is an analysis based predominantly on a bibliographic review. Empirical studies that directly incorporate the discourses of workers, managers and users can deepen the discussions presented here, expanding the understanding of the multiple forms of appropriation of Permanent Education in Health in different territories and institutional contexts.

Even so, it is hoped that this book will contribute to the strengthening of Permanent Education in Health as a critical, reflective and transformative practice, reaffirming its central role in the consolidation of the Unified Health System. By articulating PHE and Critical Discourse Analysis, it seeks to foster new ways of thinking, speaking and doing health, committed to democracy, social justice and the defense of life.

REFERENCES

- Brasil. Ministério da Saúde. (2009). Política nacional de educação permanente em saúde.
- Brasil. Ministério da Saúde. (2014). Educação permanente em saúde: Um movimento instituinte de novas práticas no SUS.
- Ceccim, R. B. (2005). Educação permanente em saúde: Desafio ambicioso e necessário. *Interface: Comunicação, Saúde, Educação*, 9(16), 161–177.
- Ceccim, R. B., & Feuerwerker, L. C. M. (2004). O quadrilátero da formação para a área da saúde: Ensino, gestão, atenção e controle social. *Saúde em Debate*, 28(66), 50–59. <https://www.scielo.br>
- Fairclough, N. (2001). *Discurso e mudança social*. Editora UnB.
- Fairclough, N. (2003). *Analysing discourse: Textual analysis for social research*. Routledge.
- Freire, P. (2011). *Pedagogia da autonomia: Saberes necessários à prática educativa*. Paz e Terra.
- Giovanella, L., et al. (2020). *Políticas e sistema de saúde no Brasil* (2ª ed.). Editora Fiocruz.
- Mendes, E. V. (2011). *As redes de atenção à saúde*. Organização Pan-Americana da Saúde.
- Merhy, E. E. (2013). *Saúde: A cartografia do trabalho vivo* (4ª ed.). Hucitec.
- Pereira, I. B., & Lima, J. C. F. (2018). Educação em saúde e trabalho: Sentidos em disputa. *Trabalho, Educação e Saúde*, 16(3), 1221–1238.
- Resende, V. de M., & Ramalho, V. (2011). *Análise de discurso crítica*. Contexto.
- Scherer, M. D. dos A., & Pires, D. E. P. de. (2009). Trabalho em saúde e educação permanente: Problematizações. *Ciência & Saúde Coletiva*, 14(1), 213–222. <https://www.scielo.br>

Starfield, B. (2002). Atenção primária: Equilíbrio entre necessidades de saúde, serviços e tecnologia. UNESCO/Ministério da Saúde. <https://bvsmms.saude.gov.br>

LEADING TO TRANSFORM: LEADERSHIP PRACTICES AND MEXICAN HUMANISM IN TECHNOLOGICAL EDUCATION

LIDERAR PARA TRANSFORMAR: PRÁTICAS DIRETIVAS E O HUMANISMO MEXICANO NA EDUCAÇÃO TECNOLÓGICA

LIDERAR PARA TRANSFORMAR: PRÁCTICAS DIRECTIVAS Y EL HUMANISMO MEXICANO EN LA EDUCACIÓN TECNOLÓGICA



<https://doi.org/10.56238/sevened2026.008-109>

Gilberto Rodríguez Montufar¹

ABSTRACT

The chapter analyzes how leadership practices can guide the transformation of technological education toward Mexican Humanism, considering the National Technological Institute of Mexico (TecNM) as an institutional case study. The objective is to interpret how normative guidelines and the transversal axes of the educational model are translated into operational management criteria, shaping the identity of the leadership body and its capacity to act within complex organizational contexts. The theoretical-analytical approach is interpretive and is grounded in documentary analysis of the TecNM Educational Model, in dialogue with recent literature on educational leadership, public ethics, social justice, and implementation governance. The analytical axes are organized around: (i) leadership practices and the construction of a humanistic leadership identity; (ii) critical thinking as continuous training to understand the determinants of educational service delivery and to support legitimate decision-making; (iii) institutionalized dialogue and collaborative work as organizational technologies for coordination among members of the leadership body, faculty, and administrative staff; and (iv) social responsibility, equity, environmental awareness, and socially relevant innovation as stable management criteria. As a contribution, the chapter proposes an integrative conceptual model of humanistic leadership practices that brings together public values, leadership identity, and organizational mediations. It is argued that this articulation strengthens institutional legitimacy, institutional and collective well-being, and guides coherent, inclusive, and socially relevant processes of educational transformation in Mexican public technological institutions. Although grounded in the TecNM case, the proposed conceptual model seeks to offer an analytical lens transferable to public technological education institutions in other national contexts facing comparable organizational challenges.

Keywords: Educational Management. Leadership Practices. Mexican Humanism. Technological Education. Educational Leadership. Critical Thinking.

¹ Dr. in Management and Innovation of Institutions. Tecnológico Nacional de México (TecNM). Minatitlán Institute of Technology. E-mail: gilberto.rm@minatitlan.tecnm.mx
Orcid: <https://orcid.org/0009-0003-5078-2303>

RESUMO

O capítulo analisa como as práticas diretivas podem orientar a transformação da educação tecnológica em direção ao Humanismo Mexicano, considerando o Tecnológico Nacional de México (TecNM) como objeto de estudo institucional. O objetivo é interpretar de que maneira as orientações normativas e os eixos transversalizados do modelo educacional se traduzem em critérios operacionais de gestão, configurando a identidade do corpo diretivo e sua capacidade de condução em contextos organizacionais complexos. O enfoque teórico-analítico é interpretativo e fundamenta-se na análise documental do Modelo Educativo do TecNM, em diálogo com literatura recente sobre liderança educacional, ética pública, justiça social e governança da implementação. Os eixos de análise organizam-se em torno de: (i) práticas diretivas e construção de uma identidade humanista; (ii) pensamento crítico como formação contínua para compreender as determinações do serviço educacional e sustentar decisões com legitimidade; (iii) diálogo institucionalizado e trabalho colaborativo como tecnologia organizacional para a coordenação entre membros do corpo diretivo, docentes e pessoal administrativo; e (iv) responsabilidade social, equidade, consciência ambiental e inovação com pertinência social como critérios estáveis de gestão. Como aporte, o capítulo propõe um modelo conceitual integrador de práticas diretivas humanistas que integra valores públicos, identidade diretiva e mediações organizacionais. Argumenta-se que essa articulação fortalece a legitimidade institucional, o bem-estar institucional e coletivo, e orienta processos de transformação educacional coerentes, inclusivos e socialmente pertinentes em instituições tecnológicas públicas mexicanas. Embora ancorado no caso do TecNM, o modelo conceitual proposto busca oferecer uma lente analítica transferível a instituições de educação tecnológica pública em outros contextos nacionais com desafios organizacionais comparáveis.

Palavras-chave: Gestão Educacional. Práticas Diretivas. Humanismo Mexicano. Educação Tecnológica. Liderança Educacional. Pensamento Crítico.

RESUMEN

El capítulo analiza cómo las prácticas directivas pueden orientar la transformación de la educación tecnológica hacia el Humanismo Mexicano, considerando al Tecnológico Nacional de México (TecNM) como objeto de estudio institucional. El objetivo es interpretar de qué manera las orientaciones normativas y los ejes transversalizados del modelo educativo se traducen en criterios operativos de gestión, configurando la identidad del cuerpo directivo y su capacidad de conducción en contextos organizacionales complejos. El enfoque teórico-analítico es interpretativo y se fundamenta en el análisis documental del Modelo Educativo del TecNM, en diálogo con literatura reciente sobre liderazgo educativo, ética pública, justicia social y gobernanza de la implementación. Los ejes de análisis se organizan en torno a: (i) prácticas directivas y construcción de una identidad directiva humanista; (ii) el pensamiento crítico como formación continua para comprender las determinaciones del servicio educativo y sustentar decisiones con legitimidad; (iii) el diálogo institucionalizado y el trabajo colaborativo como tecnologías organizacionales para la coordinación entre miembros del cuerpo directivo, docentes y personal administrativo; y (iv) la responsabilidad social, la equidad, la conciencia ambiental y la innovación con pertinencia social como criterios estables de gestión. Como aporte, el capítulo propone un modelo conceptual integrador de prácticas directivas humanistas que articula valores públicos, identidad directiva y mediaciones organizacionales. Se argumenta que dicha articulación fortalece la legitimidad institucional, el bienestar institucional y colectivo, y orienta procesos de transformación educativa coherentes, inclusivos y socialmente pertinentes en instituciones tecnológicas públicas mexicanas. Aunque anclado en el caso del TecNM, el modelo conceptual propuesto busca ofrecer una lente analítica transferible a instituciones de educación tecnológica pública en otros contextos nacionales con desafíos organizacionales comparables.



Palabras clave: Gestión Educativa. Prácticas Directivas. Humanismo Mexicano. Educación Tecnológica. Liderazgo Educativo. Pensamiento Crítico.

1 INTRODUCTION

The social, economic and technological transformations of the last decades have profoundly redefined the role of higher education and, in particular, public technological education. The acceleration of technological change, the reorganization of work, the expansion of social and territorial inequalities, as well as the growing demands for sustainability and social justice, have placed educational institutions in front of a structural challenge: to articulate specialized technical training with an ethical, humanistic and socially pertinent orientation. In the Mexican context, this challenge is closely linked to the recognition of higher education as a right and as a public good, whose provision with quality and equity constitutes a non-delegable responsibility of the State and the institutions that make up the national educational system (Cámara de Diputados, 2021).

In this scenario, public technological higher education occupies a strategic place. In addition to their contribution to productive development, these institutions fulfill a central social function by expanding access to higher education for historically excluded sectors and by boosting regional development. However, their role cannot be reduced to an instrumental logic centered on employability or the generation of human capital. On the contrary, technological education is called upon to train professionals with technical skills, critical thinking and social commitment, capable of intervening responsibly in complex and unequal contexts. This tension between productivist approaches and humanist orientations structurally crosses the management and direction of public technological institutions.

The system of technological higher education in Mexico is characterized by its institutional and territorial heterogeneity. In it, several subsystems coexist with different training models, governance schemes and scopes. In this context, the Tecnológico Nacional de México (TecNM) is configured as a case of special analytical relevance. Its national scale, its public character and its high organizational density place it as a central actor in the implementation of educational policies oriented towards equity, inclusion and development with well-being. Added to this is the explicitness, in its Educational Model, of a horizon of transformation based on Mexican Humanism, conceived as the ethical and political foundation of technological education (Tecnológico Nacional de México, 2024). This orientation dialogues with national agendas that prioritize collective well-being, social justice, and equity as axes of public and educational action (Asociación Nacional de Universidades e Instituciones de Educación Superior [ANUIES], 2018; Chamber of Deputies, 2021).

In a convergent way, international debates on leadership and governance in higher education institutions have emphasized the need to align sustainability, social justice, and

organizational transformation, particularly in contexts of high public complexity (Aung & Hallinger, 2022; Elken, 2024a; Sánchez-Carrillo et al., 2021; Viera Trevisan et al., 2024)."

However, the adoption of a humanistic approach in normative documents and educational models does not guarantee, by itself, their materialization in everyday institutional life. The gap between policy design and effective implementation is often explained by a combination of structural and organizational factors: budget constraints, accountability pressures, territorial inequalities, entrenched organizational cultures, and bureaucratic inertia. At this point, institutional direction emerges as a central problem of educational management. Directing public technological institutions implies operating in a field of tensions in which demands for administrative efficiency, regulatory compliance and educational transformation with a social sense converge. These tensions fall directly on the governing bodies, responsible for interpreting, contextualizing, and executing the guidelines of the Educational Model in each Technological Institute or Center (Tecnológico Nacional de México, 2024).

This chapter supports a central thesis: leading to transform implies that directive practices, when guided by the principles of Mexican Humanism and its transversal axes, function as organizational and pedagogical mediation devices capable of enabling—or limiting—the transformation of public technological education. From this perspective, management leadership is not conceived as a merely technical or administrative exercise, but as a situated, ethical and political practice, whose effectiveness depends both on the convictions and capacities of those who lead and on the organizational conditions in which it is exercised. This stance is in line with the international literature that highlights the role of educational leadership oriented towards social justice as a structural component of institutional management in contexts marked by inequality and diversity (Chaaban et al., 2025; Rong & Chen, 2025).

In order to avoid a merely declarative treatment of Mexican Humanism, the chapter approaches it as an operationalized analytical category. Concretely, it is proposed to analyze its institutional translation through five interrelated directive dimensions: public ethics and institutional procedure; equity and inclusion in access to learning and working conditions; dialogue and participation as technologies of organizational coordination; social responsibility and territorial relevance; and environmental awareness and innovation with a social sense (Tecnológico Nacional de México, 2024). These dimensions structure the analytical framework of the chapter and allow us to examine the tensions between the normative horizon of the Educational Model and the practices effectively mobilized in daily management.

From this perspective, it is necessary to clarify three notions that are often used interchangeably. Institutional direction refers to the role of strategic management and decision-making. Educational management refers to the processes through which resources, relationships and conditions for the provision of educational services are organized. Directive practices, in turn, designate the set of recurrent, situated and observable actions through which direction is exercised and management is carried out. Consequently, this chapter focuses analytically on directive practices as the space in which the coherence – or fracture – between the humanistic educational project and the institutional operation becomes visible.

In this context, critical thinking is assumed as a transversal directive competence, indispensable to interpret the complexity of the social, organizational and pedagogical determinations that affect technological education. In a complementary way, dialogue is conceived as an organizational technology that allows the articulation of collaborative work between teachers and administrative staff. International evidence shows that dialogic leadership approaches favor participation, co-responsibility, and organizational learning, especially in institutional change processes that require legitimacy and collective ownership (Khaqan & Redondo-Sama, 2024).

In the same way, educational management can be understood as a form of pedagogical mediation. The pedagogical triangle proposed by Jean Houssaye allows us to understand how organizational decisions affect the relationship between teaching, learning and knowledge. From this perspective, administration and planning become a framework of pedagogical possibilities, which gives the management function a direct responsibility for the quality of training and educational justice, in addition to operational efficiency (Houssaye, 1988).

From these considerations, the general objective of this chapter is to critically analyze the directive practices that contribute to the transformation of technological education from the principles of Mexican Humanism, taking the National Technological of Mexico as an object of study. Specifically, it is proposed to interpret how the transversal axes of the Educational Model configure the identity of the governing body; to examine the role of critical thinking and dialogue in institutional management; and problematize the implications of these practices for equity, social justice, and organizational transformation (Chaaban et al., 2025; Khaqan & Redondo-Sama, 2024; Tecnológico Nacional de México, 2024).

The chapter is organized as follows. First, the institutional context of public technological education in Mexico is presented and TecNM is defined as a case study. Subsequently, the TecNM Educational Model and its implications for directive management are analyzed. Then, an analytical framework is developed that articulates Mexican

Humanism, directive identity, critical thinking and dialogical leadership. Finally, the scopes, tensions, and challenges of directing public technological institutions from a humanistic horizon are discussed, as well as their implications for educational management and social transformation (Cámara de Diputados, 2021; Tecnológico Nacional de México, 2024).

Although the analysis focuses on TecNM, the reflections are formulated as an analytical generalization, and not a statistical one, offering potentially useful interpretative keys for other public technological education institutions with comparable organizational conditions.

2 INSTITUTIONAL CONTEXT AND EDUCATIONAL POLICY

In order to understand the directive practices guided by Mexican Humanism, it is necessary to first situate the institutional and normative context in which public technological higher education operates in Mexico. This section delimits the social role of this subsystem, its main traits of organizational heterogeneity, and the coordination and implementation challenges faced by institutions in highly complex public contexts. In particular, the Tecnológico Nacional de México (TecNM) is presented as an object of study due to its scale, organizational density and centrality in the execution of educational policies with an emphasis on equity, inclusion and social relevance. This contextualization allows us to move on, later, to the analysis of the TecNM Educational Model and the directive function as a mediating instance between institutional guidelines and organizational practices (Asociación Nacional de Universidades e Instituciones de Educación Superior [ANUIES], 2018; Chamber of Deputies, 2021).

2.1 PUBLIC TECHNOLOGICAL EDUCATION IN MEXICO AND ITS SOCIAL ROLE

Public technological higher education in Mexico is a strategic component of the national educational system, both for its contribution to productive development and for its role in expanding access to higher education and meeting differentiated regional and territorial needs. In the current regulatory framework, higher education is recognized as a right and as a public good, which obliges the institutions that are part of it to articulate academic quality objectives with principles of equity, inclusion, and social relevance (Cámara de Diputados, 2021). This definition displaces a merely instrumental conception of training and situates technological education as a central space for the construction of well-being and social justice.

The subsystem of public technological higher education is characterized by a marked institutional heterogeneity. In it, different organizational arrangements coexist – Technological

Institutes, Technological Universities and Polytechnic Universities – with different historical trajectories, training models and governance schemes. Although this diversity expands territorial coverage and access opportunities, it also increases the complexity of system management, by posing challenges of inter-institutional coordination, policy alignment, and coherence with national development objectives (Asociación Nacional de Universidades e Instituciones de Educación Superior [ANUIES], 2018). At this point, the institutional leadership acquires a central role as a mediator between general guidelines, local conditions and concrete organizational practices. These challenges dialogue with international debates on multilevel governance and coordination in higher education systems, in which different arrangements of accountability and autonomy condition institutional collaboration (Elken, 2024a; Wullschleger et al., 2025).

It should be noted that this complexity is intensified by tensions typical of public educational management. First, the relationship between centralization and local autonomy usually generates friction: the general guidelines seek homogeneity and control, while the campuses face disparate territorial realities that demand localized adaptations. Secondly, the tension between institutional uniformity and territorial diversity forces us to decide what should be standardized and what should be made more flexible to ensure equity. Finally, the tension between document compliance and cultural change can lead to a formalistic implementation of reforms, in which one fulfills without transforming practices. These conditions of possibility make institutional management decisive in guiding the transformation towards substantive results (ANUIES, 2018; Chamber of Deputies, 2021).

From a social perspective, public technological education cannot be reduced to its ability to respond to the immediate demands of the labor market. Its function is linked to the integral formation of people, the strengthening of critical capacities and the generation of opportunities for social mobility, especially in regions with high levels of inequality. Nevertheless, structural tensions persist between productivist approaches – centered on efficiency, employability and performance indicators – and humanist orientations that emphasize equity, inclusion and social commitment. These tensions are directly expressed in the day-to-day management and decisions of the governing bodies, which are responsible for balancing priorities in contexts of limited resources.

In this context, the Tecnológico Nacional de México (TecNM) is configured as an object of study of special analytical relevance. Its national scale, its public character and its high organizational density place it as a central actor in the implementation of educational policies oriented to equity and development with well-being (Secretaría de Educación Pública, 2014; Chamber of Deputies, 2021). In addition, TecNM has made explicit an educational project

with a humanist orientation that seeks to reconfigure the meaning of technological education beyond technocratic approaches, which introduces specific requirements for institutional management and direction (Tecnológico Nacional de México, 2024).

2.2 THE EDUCATIONAL MODEL OF THE NATIONAL TECHNOLOGY OF MEXICO

The Educational Model of the National Technology of Mexico is the main normative and conceptual reference that guides institutional action in its Institutes and Centers. Unlike models focused exclusively on technical efficiency or immediate adaptation to the labor market, the Model explicitly assumes Mexican Humanism as an ethical and political foundation, placing the person, the community, and collective well-being at the center of the educational process (Tecnológico Nacional de México, 2024). This orientation is consistent with the legal framework of higher education and with a public policy vision that prioritizes equity, inclusion, and social justice as goals of development (Cámara de Diputados, 2021).

From this perspective, the Educational Model proposes an integral conception of training, in which the development of professional skills is articulated with values, attitudes and social commitments. Mexican Humanism operates as a guiding criterion for institutional decisions that transcend the classroom and focus on the organization of work, the management of resources, and the definition of priorities. However, the implementation of this horizon faces structural tensions typical of a large-scale public institution: pressures for accountability, budgetary constraints, territorial inequalities in organizational capacities, and bureaucratic inertia. As a result, the distance between design and execution converts directive management into a critical space of mediation between the educational project and its effective realization.

A distinctive feature of the TecNM Educational Model is the incorporation of transversal axes that cross the substantive functions of teaching, research, extension and institutional management. Among them, social responsibility, environmental awareness, and innovation stand out, conceived as guiding principles of institutional action and not as isolated components (Tecnológico Nacional de México, 2024). In this reading, innovation is understood as the organizational capacity to generate pertinent and socially responsible solutions in the face of complex problems, avoiding technocentric reductions.

These axes acquire relevance to the extent that they are translated into observable directive practices. Social responsibility is expressed in criteria of territorial prioritization and equitable allocation of resources; environmental awareness, in decisions about the sustainable use and management of resources; and innovation, in the governance of improvement processes with a social sense. In this way, the transversal axes not only guide

the institutional discourse: they function as analytical categories to interpret directive practices and their effects on equity, participation, sustainability, and institutional innovation in the following sections (Tecnológico Nacional de México, 2024).

To close this transition, it is worth emphasizing that the Educational Model redefines institutional management as a strategic practice aimed at creating conditions for integral education and human development. Therefore, the relevant question is not only what the Model establishes, but how it is operationalized in organizational decisions and conduction routines within each Technological Institute or Center.

2.3 THE MANAGEMENT FUNCTION IN TECHNOLOGICAL INSTITUTES AND CENTRES

The management function in the Technological Institutes and Centers of TecNM is configured as a strategic axis for the operation and institutional transformation. Directing these organizations implies conducting complex processes in conditions of finite resources, pressures for indicators and growing social expectations, in which each decision produces effects on real opportunities for teaching, learning and coexistence. In this sense, institutional management is not limited to administration; it is an organizational management practice with ethical, political and pedagogical implications (Secretaría de Educación Pública, 2014; Tecnológico Nacional de México, 2024).

To avoid conceptual ambiguities, it is convenient to differentiate three planes. Management refers to the technical-operational component. Educational management is concerned with the coordination of organizational conditions —resources, relationships, and processes— so that educational service is possible with quality and equity. Institutional management is linked to strategic management: it defines priorities, decision criteria, participation mechanisms and ethical guidance of institutional action. Consequently, directive practices constitute the point at which these dimensions are articulated and at which the coherence – or the fracture – between the humanist horizon and everyday operation becomes observable.

From an organizational perspective, the governing bodies act as mediators between public policies, institutional guidelines and local dynamics. This position requires interpreting general guidelines and translating them into situated decisions on planning, resource allocation, work organization, and coordination of actors. The directive function is thus exercised in a field of tensions in which values, priorities and conceptions about the meaning of technological education are put into play. Seemingly technical decisions – such as budget distribution, the teaching load or the prioritization of infrastructure – can contribute to reducing or reproducing internal inequalities.

The TecNM Educational Model assigns to the governing bodies the responsibility of converting Mexican Humanism and its transversal axes into consistent institutional practices. This implies setting up a directive identity based on public ethics, social responsibility, respect for diversity, and commitment to collective well-being (Tecnológico Nacional de México, 2024). The international literature has shown that this identity is constructed in a relational and contextual way, in interaction with organizational structures, normative expectations, and power dynamics, being decisive for the legitimacy of leadership (Crossley et al., 2024; Lê & Hoang, 2025). In TecNM, this identity is consolidated – or tensioned – as the conduction effectively incorporates the transversal axes as decision criteria, and not only as rhetorical references.

In this context, directing Technological Institutes presupposes exercising a leadership oriented to social justice, particularly relevant in institutions that serve heterogeneous populations in territories with persistent inequalities. Empirical evidence synthesized in systematic reviews indicates that this type of leadership is expressed in conscious decisions about the distribution of resources, the inclusion of traditionally marginalized voices, and the construction of safe and inclusive institutional environments (Chaaban et al., 2025; Rong & Chen, 2025). In a complementary way, dialogue is conceived as a central directive practice to organize collaborative work between teachers and administrative staff. However, dialogue requires institutional architecture: formal spaces for deliberation, clear rules for participation, follow-up mechanisms, and an organizational culture that values collaboration (Khaqan & Redondo-Sama, 2024).

In summary, the institutional and educational policy context of TecNM shows that the transformation of technological education towards horizons of equity and social justice depends, to a large extent, on the ability of the governing bodies to translate a humanistic educational project into consistent organizational practices. The articulation between the system, the Educational Model and the directive function establishes the basis for the development of the analytical framework and the state of the art presented in the following section.

3 ANALYTICAL FRAMEWORK AND STATE OF THE ART

This chapter is part of a field of research that articulates higher education, educational management and institutional leadership from an ethical and social perspective. In particular, it is based on the assumption that the transformation of technological education towards horizons of social justice does not occur exclusively through the design of educational policies or models, but through the organizational translation of these orientations through sustained,

legitimized and verifiable directive practices. This approach dialogues with recent evidence that situates educational leadership as a structural condition to address inequalities, expand participation, and sustain improvement processes with a public sense (Chaaban et al., 2025; Rong & Chen, 2025).

3.1 MEXICAN HUMANISM AND INTEGRAL EDUCATION IN HIGHER EDUCATION

Education with a social sense

Mexican Humanism, within the framework of the TecNM Educational Model, is conceived as an ethical orientation that replaces the person, the community, and collective well-being at the center of the formative process, seeking to overcome technocratic reductions in technological education (Tecnológico Nacional de México, 2024). This orientation is articulated with the conception of higher education as a right and public good, which implies quality institutional obligations associated with equity, inclusion, and social relevance (Cámara de Diputados, 2021).

In the international debate, approaches centered on the social meaning of higher education emphasize the coherence between institutional philosophy, formative attributes — such as social responsibility, ethical sensitivity, and leadership with purpose— and congruent organizational practices. From this perspective, the translation of humanist orientations requires institutional management devices capable of sustaining participation, inclusion, and social relevance as effective decision-making criteria (Tecnológico Nacional de México, 2024; Chaaban et al., 2025; Rong & Chen, 2025).

Social justice, equity and collective well-being

Social justice in higher education has been operationalized as the redistribution of opportunities, recognition of diversity, and meaningful participation. Recent systematic reviews indicate that social justice-oriented leadership is associated with deliberate practices of resource distribution, the protection of inclusive environments, and the strengthening of institutional participation (Chaaban et al., 2025; Rong & Chen, 2025).

3.2 EDUCATIONAL MANAGEMENT AS AN ETHICAL AND ORGANIZATIONAL PRACTICE

Educational leadership and public service

Educational management in public institutions is exercised under conditions of ethical responsibility associated with the use of collective resources, accountability and the guarantee of the right to education. Empirical evidence indicates that ethical leadership is associated with higher levels of organizational trust, legitimacy, and better conditions to sustain improvement processes, particularly in contexts in which accountability systems

influence institutional collaboration (Abdi, 2024; Crossley et al., 2024; Wullschleger et al., 2025).

Educational management and institutional transformation

The literature on governance in higher education emphasizes that institutional transformation depends on the directive capacity to interpret policy instruments, coordinate actors, and translate normative guidelines into sustained practices. In this sense, management is configured as a strategic space for organizational mediation, especially when governance instruments present ambiguity and require situated interpretation to be converted into effective institutional action (Elken, 2024a, 2024b).

3.3 IDENTITY OF THE GOVERNING BODY AND INSTITUTIONAL COMMITMENT

Construction of the directive identity

The identity of the governing body is conceived as a relational and dynamic construct, built in interaction with the institutional context, normative expectations and power relations. Recent literature highlights that this identity influences the legitimacy of leadership and the coherence of organizational decisions, as it structures interpretive frameworks, priorities, and criteria for action (Crossley et al., 2024; Lê & Hoang, 2025).

Values, principles and social responsibility

In institutions with a humanist orientation, the directive identity is articulated with values such as social responsibility, public ethics and commitment to collective well-being. Coherence between stated values and observable practices strengthens institutional trust and the capacity for organizational transformation, by stabilizing decision-making, transparency, and coordination criteria oriented to equity (Tecnológico Nacional de México, 2024; Chaaban et al., 2025).

3.4 CRITICAL THINKING AND DIALOGUE IN EDUCATIONAL MANAGEMENT

Critical thinking as continuous training of the leader

Critical thinking is recognized as a key competence for conducting education in contexts of complexity. Recent research indicates that this ability allows analyzing complex problems, anticipating consequences, and sustaining informed decisions in scenarios of uncertainty, also contributing to the strengthening of communication and collaborative work skills when institutionalized as part of training and professional practice (Golden, 2023; Dias-Oliveira et al., 2024).

Dialogue as a means of organizing collaborative work

Dialogic leadership is associated with higher levels of participation, organizational learning, and collective ownership of change processes. Evidence indicates that dialogue requires clear organizational conditions to operate as an effective practice of coordination, and not just as a symbolic resource, which implies the design of formal spaces, rules of participation, and follow-up mechanisms that make collaboration sustainable (Khaqan & Redondo-Sama, 2024).

3.5 EDUCATIONAL MANAGEMENT AS PEDAGOGICAL MEDIATION

Jean Houssaye's pedagogical triangle

The pedagogical triangle proposed by Houssaye allows us to understand the relationship between teaching, learning and knowledge, highlighting that organizational decisions indirectly affect pedagogical processes. In this context, the institutional direction acts as pedagogical mediation by configuring structural conditions for educational practice, so that management not only administers, but enables—or restricts—possibilities of training and educational justice (Houssaye, 1988).

Management, planning and administration as a framework of possibilities

Planning and administration configure a framework of possibilities that enables or restricts equitable and quality educational practices. The literature on university governance warns that, without a shared meaning and without instruments interpreted and appropriated by institutional actors, management processes tend to be reduced to formal compliance, limiting their transformative potential. In this sense, the directive capacity to translate instruments into sustained practices is decisive to avoid merely procedural implementations (Elken, 2024a, 2024b).

3.6 SYNTHESIS OF THE ANALYTICAL FRAMEWORK AND CATEGORIES OF ANALYSIS

Based on the theoretical analysis developed, the chapter is structured into six central analytical categories: (i) humanist directive identity and public ethics; (ii) architecture of dialogue and collaborative work; (iii) distributive equity and inclusion; (iv) sustainability governance; (v) innovation with social relevance; and (vi) educational management as pedagogical mediation.

These categories are articulated in a conceptual model of directive practices that understands institutional direction as a set of translation mechanisms between the humanist horizon—expressed in Mexican Humanism and the Educational Model—and the daily institutional operation. In this sense, directive practices constitute the level at which values,

principles and normative orientations are interpreted and converted into concrete organizational decisions.

The model guides the analysis of how such decisions configure institutional conditions that affect equity, participation, well-being, sustainability, and innovation with social meaning, offering an analytical lens to understand the coherence —or tensions— between the humanistic educational project and its materialization in institutional life.

4 FOCUS AND ANALYTICAL ROUTE OF THE CHAPTER

This section explains the analytical design that underpins the chapter, outlining the type of contribution proposed, the methodological approach adopted and the interpretative path that guides the analysis. Initially, the type of chapter and the methodological approach that underlie the work are characterized. Then, the documentary corpus and the analysis criteria used are described, as well as the theoretical-critical analysis procedure used for the construction of the analytical categories and the conceptual model of directive practices. Finally, the scope and limitations of the chapter are delimited, explaining the type of inference proposed and the care adopted to ensure consistency and interpretative rigor.

4.1 TYPE OF CHAPTER AND METHODOLOGICAL APPROACH

The present work corresponds to an analytical-interpretative chapter, with a theoretical-critical orientation, whose purpose is to understand and problematize the directive practices that mediate the transformation of public technological education towards Mexican Humanism. In coherence with this objective, an interpretative qualitative approach is adopted, supported by documentary analysis and the critical articulation of the state of the art. Document analysis allows for the systematic examination of normative documents and institutional models, identifying assumptions, principles, analytical categories and relevant organizational tensions (Bowen, 2009).

It should be clarified that the chapter is not configured as an empirical research based on the collection of primary data, but as a conceptual contribution that builds a reasoned interpretation based on institutional sources and specialized academic literature. In this framework, a logic of analytical transferability is assumed, according to which the conclusions are proposed as useful for comparable organizational contexts in terms of complexity, scale, and public condition, without the pretense of statistical generalization (Yin, 2018). Transferability is based on the analytical description of the institutional context of TecNM and on the reader's assessment of comparability with other subsystems of technological higher education.

4.2 DOCUMENTARY CORPUS AND ANALYSIS CRITERIA

The analytical corpus was constituted from three sets of sources, selected according to criteria of relevance, timeliness and pertinence in relation to the central question of the chapter.

First, a delimited set of normative and institutional documents that structure the framework of educational policy and the organizational order of public technological higher education was analyzed. Among the references considered are the general normative framework for higher education (Cámara de Diputados, 2021), programmatic documents for educational policy (Secretaría de Educación Pública, 2014), as well as the Educational Model of the Tecnológico Nacional de México and associated documents that explain principles, transversal axes and directive attributions (Tecnológico Nacional de México, 2024). In addition, policy and prospective references for higher education were incorporated for their contextual and interpretative value (Asociación Nacional de Universidades e Instituciones de Educación Superior [ANUIES], 2018).

Secondly, recent academic literature corresponding to the period 2020–2025 was integrated, with an emphasis on systematic reviews and synthesis articles on educational leadership, social justice, directive identity, dialogic leadership, and directive competencies. The state of the art consisted of an approximate set of thirty academic sources, selected according to thematic relevance and editorial quality, prioritizing peer-reviewed publications in indexed journals, with the exception of canonical theoretical or methodological contributions indispensable to argumentation.

Thirdly, basic theoretical contributions, both classical and contemporary, necessary for their explanatory value to interpret the relationship between organization, management and pedagogy, were considered, with emphasis on Jean Houssaye's pedagogical triangle (Houssaye, 1988).

This chapter develops a state-of-the-art narrative-critical character, strengthened by evidence from systematic reviews, but it does not constitute a formal systematic review. The search was non-exhaustive and was oriented towards conceptual coverage, through keywords and citation tracking, without reporting PRISMA metrics or claiming statistical representativeness.

The analysis criteria applied to the corpus included: (i) coherence between declared values and expected organizational practices; (ii) centrality of equity, social justice and collective well-being; (iii) the role of the directive function as a mediation between politics, organization and pedagogy; and (iv) explanatory potential of theoretical approaches for the comprehension of the

are from contexts of high organizational complexity.

4.3 THEORETICAL-CRITICAL ANALYSIS PROCEDURE

The analytical procedure was developed in four interrelated phases, aimed at ensuring conceptual traceability and interpretative consistency.

The first phase consisted of an analytical reading of the normative and institutional framework, with the objective of identifying values, principles, transversal axes, directive responsibilities and organizational assumptions related to management, dialogue, equity and innovation (Bowen, 2009; Chamber of Deputies, 2021; Tecnológico Nacional de México, 2024). The unit of analysis was defined as normative and programmatic statements that can be translated into operational criteria.

The second phase corresponded to a critical review of the state of the art, with emphasis on systematic reviews, aiming to identify trends, analytical consensuses and gaps relevant to the analysis of public technological education. This stage allowed us to delimit a set of guiding constructs – ethical leadership, social justice, directive identity, dialogical leadership, sustainability, and implementation – and to evaluate their interpretative utility.

The third phase involved a process of analytical categorization of a conceptual nature, oriented to the construction of interpretative categories, and not to the quantification of frequencies. This process was supported by conceptual qualitative coding procedures (Saldaña, 2021), combining content analysis applied to normative and institutional documents (Krippendorff, 2018) with thematic analysis applied to academic literature (Braun & Clarke, 2006).

In the fourth phase, a conceptual model of directive practices was consolidated, expressed in a matrix of categories that articulates analytical dimensions, conceptual definitions, institutional evidence, theoretical support and observable directive practices. The model integrates six dimensions: Mexican Humanism and social sense; social justice and equity; ethical direction and public function; directive identity; critical thinking and dialogue; and management as pedagogical mediation.

4.4 SCOPE AND LIMITATIONS OF THE CHAPTER

The chapter systematically articulates the normative horizon of Mexican Humanism, recent scholarly evidence on educational leadership and social justice, and an organizational reading of the directive function in public technology education. The documentary approach allows the identification of directive responsibilities, equity criteria and institutional

coordination devices, particularly within the framework of the TecNM Educational Model and current normativity (Cámara de Diputados, 2021; Tecnológico Nacional de México, 2024).

To strengthen the rigor of the interpretative analysis, criteria of credibility, dependability, confirmability and transferability were met through theoretical triangulation, explicit analytical procedure, evidence matrix by category and cross-review by consensus among the authors during the construction of the categories and the conceptual model (Shenton, 2004).

Among the limitations, the absence of direct empirical evidence on the situated practices of leaders and the lack of a systematic comparison with other technological subsystems are recognized, which opens up future lines of qualitative and comparative research aimed at analyzing how humanist axes are operationalized under different organizational and territorial arrangements.

5 INTERPRETATIVE FINDINGS: DIRECTIVE PRACTICES TO DRIVE TRANSFORMATION

The articulation between the institutional corpus — with emphasis on the Educational Model of the National Technological of Mexico —, the recent international literature and the analytical framework developed in Sections 3 and 4 allows us to identify interpretative patterns of directive practices that mediate the transformation of technological education towards Mexican Humanism. These findings are organized around previously outlined analytical categories and are formulated as traceable conceptual inferences (and not as generalizable empirical regularities), constructed through documentary analysis and theoretical-critical synthesis (Bowen, 2009; Braun & Clarke, 2006; Shenton, 2004).

In the TecNM Model, educational transformation is structured based on transversal axes — social responsibility, environmental awareness, innovation, and vanguard — and an explicit orientation towards social justice and well-being, which positions institutional management as an instance of translation between the normative horizon and organizational operation (Tecnológico Nacional de México, 2024). International evidence converges in indicating that directive identity, ethical leadership, institutionalized dialogue, distributive criteria of equity, and governance of change constitute relevant mechanisms to sustain institutional transformations in complex public contexts (Abdi, 2024; Chaaban et al., 2025; Elken, 2024a, 2024b; Khaqan & Redondo-Sama, 2024; Rong & Chen, 2025).

5.1 DIRECTIVE PRACTICES AND THE CONFIGURATION OF A HUMANIST IDENTITY

Institutional management with values

The transformation towards Mexican Humanism tends to become operative when the institutional direction configures a humanist directive identity, understood as a relatively stable

framework of values that guides decision-making criteria and management practices. This pattern finds internal anchorage in the TecNM Model, by emphasizing Mexican Humanism and integral education with social meaning as a guiding horizon for institutional management (Tecnológico Nacional de México, 2024).

The literature on leadership identity indicates that this identity is not a fixed individual attribute, but a relational and contextual construct that influences legitimacy, cooperation, and ownership of organizational change (Lê & Hoang, 2025; Nieberle et al., 2023). In this sense, when the directive identity is aligned with humanist values, institutional decisions tend to prioritize institutional well-being — understood as climate, safety, coexistence, and working and learning conditions — to the detriment of merely instrumental or bureaucratic logics.

Among the observable policy practices associated with this pattern are: (a) explicit prioritization criteria with social meaning (permanence, inclusion, safety, accompaniment); (b) coherence between discourse, decision and follow-up; and (c) institutional communication that links decisions to values, principles, and transversal axes (Tecnológico Nacional de México, 2024; Lê & Hoang, 2025). This evaluative orientation acquires greater consistency when it is expressed in rules, procedures and responsibilities proper to the exercise of public function, constituting the basis of the dimension "humanistic directive identity and public ethics" of the integrative model.

Public ethics and social commitment

The humanist identity of the governing body is strengthened when the management function is exercised under principles of public ethics, understood as responsibility in the use of collective resources, decision-making transparency and orientation to the general interest. Recent literature points out that ethical leadership practices are associated with higher levels of trust, institutional commitment, and organizational cohesion, especially in public contexts marked by structural inequalities (Abdi, 2024; Crossley et al., 2024).

In the context of public technological education, this social commitment is expressed in decisions that seek to reduce internal asymmetries, protect vulnerable groups, and align institutional action with objectives of social justice and development with well-being. Thus, the humanist directive identity, articulated with public ethics, constitutes a central mediation between the normative horizon of Mexican Humanism and the organizational decisions of everyday life.

5.2 DIALOGUE AND COLLABORATIVE WORK AS MANAGEMENT STRATEGIES

Relationship between managers, teachers and administrative staff

Under criteria of ethical and public coherence, dialogue becomes a strategic directive practice when it operates as an organizational technology — that is, when it is supported by structures, rules, and monitoring mechanisms — and not only as an interpersonal disposition. This pattern is anchored in the TecNM Model, by emphasizing the organization of collaborative work and institutional co-responsibility to operationalize the educational project (Tecnológico Nacional de México, 2024). The synthesized evidence indicates that dialogic leadership is associated with meaningful participation and organizational learning, as long as there are explicit institutional conditions for deliberation (Khaqan & Redondo-Sama, 2024).

Among the observable directive practices are: (a) formal spaces for inter-area deliberation (academic-administrative); (b) explicit rules of participation (representativeness, times, minutes); (c) monitoring of agreements (responsible, deadlines, evidence); and (d) mediation and conflict management mechanisms (Khaqan & Redondo-Sama, 2024). As these conditions become institutionalized, dialogue enables transversal coordination and sustains agreements that translate into management routines, composing the dimension "architecture of dialogue and collaborative work".

Collective construction of educational management

Collaborative work emerges when management recognizes the interdependence between substantive and administrative functions, avoiding the fragmentation of educational management. This finding converges with studies on governance and implementation, which show that the effective translation of instruments and guidelines depends on coordination, co-design, and shared meaning-making capabilities (Elken, 2024a, 2024b). In the context of TecNM, this collective construction is aligned with the need to operationalize transversal axes through interfunctional agreements, and not only via formal provisions (Tecnológico Nacional de México, 2024).

Among the observable practices are: mixed committees for complex problems (permanence, tutoring, inclusion, security); clarity of roles and responsibilities; common criteria for evaluating progress; and feedback and adjustment cycles as organizational learning (Elken, 2024a, 2024b). When collaboration stabilizes, the directive capacity to sustain distributive and inclusion decisions with legitimacy is expanded, repositioning equity as an operative — and not just normative — criterion of transformation.

5.3 MANAGEMENT LEADERSHIP, EQUITY AND SOCIAL JUSTICE

Equitable distribution of resources

In scenarios of transversal coordination, equity becomes a directive criterion when the allocation of resources, loads and support is oriented towards compensating for internal

inequalities (territorial, infrastructural, population). This pattern is anchored in the TecNM Model by situating social justice and collective well-being as a horizon, suggesting a reading of equity as a differentiated allocation, and not as arithmetic equality (Tecnológico Nacional de México, 2024). The literature on leadership for social justice converges in indicating that distributive decisions constitute a critical mechanism to advance institutional equity (Chaaban et al., 2025; Rong & Chen, 2025).

The associated observable practices include: differentiated allocation criteria according to gaps (need, installed capacity, lag); explicit support for permanence (tutoring, monitoring, aid management); territorial and infrastructure prioritization according to deficits; and monitoring of distributional effects through indicators (permanence, lag, dropout) (Chaaban et al., 2025; Rong & Chen, 2025). By operating with explicit distributive criteria, equity tends to be articulated with inclusion policies and practices that directly affect the climate and institutional conditions.

Inclusion, diversity and institutional well-being

In continuity with distributive equity, social justice is also operationalized through directive practices oriented towards inclusion and institutional coexistence, especially in culturally diverse contexts. This anchoring is articulated with the TecNM Model by emphasizing respect for diversity and the construction of inclusive and safe environments (Tecnológico Nacional de México, 2024). International evidence indicates that leadership for social justice promotes inclusive cultures through clear norms, protection of vulnerable groups, and meaningful participation (Chaaban et al., 2025; Rong & Chen, 2025).

To avoid conceptual ambiguity, a distinction is made between institutional well-being — related to climate, safety, coexistence, and working and learning conditions — and collective well-being, understood as a macro normative horizon of social justice that guides the direction of educational policy. This distinction allows us to understand how situated directive decisions (micro/meso levels) are connected to public ends (macro level) without confusing levels of analysis.

Among the observable practices are: anti-discrimination and conflict response protocols; mechanisms for the participation of diverse groups; periodic measurement of the institutional climate and response to alerts; and safety and coexistence actions (Chaaban et al., 2025; Tecnológico Nacional de México, 2024). The consolidation of inclusion and institutional well-being, in turn, tends to reinforce the legitimacy of sustainability and innovation initiatives, which require organizational trust and inter-area coordination to be maintained over time. These elements compose, in the integrative model, the dimension "distributive equity and inclusion".

5.4 SOCIAL RESPONSIBILITY, ENVIRONMENTAL AWARENESS AND INNOVATION

Sustainability-oriented management

In complex public organizations, social responsibility and environmental awareness translate into directive practices when sustainability is incorporated as a cross-cutting criterion for planning, evaluation, and allocation. This pattern is anchored in the TecNM Model, which incorporates environmental awareness as a transversal axis articulated with social responsibility (Tecnológico Nacional de México, 2024). The literature on sustainability in higher education emphasizes that progress depends on institutional coherence, organizational learning, and forms of governance that avoid isolated actions (Aung & Hallinger, 2022; Sánchez-Carrillo et al., 2021; Viera Trevisan et al., 2024).

Observable practices include: environmental criteria in investments and projects (energy, waste, procurement); responsible or committees with goals and monitoring; institutional indicators (consumption, reduction, maintenance); and evaluation of distributive impacts of environmental measures, recognizing that sustainability and equity mutually affect each other (Viera Trevisan et al., 2024). When sustainability is managed as governance — and not as a one-off initiative — a socially pertinent and organizationally sustainable field of innovation opens up, synthesized in the "sustainability governance" dimension.

Innovation with social relevance

Innovation acquires a transformative meaning when oriented to social relevance and public value. Institutional anchoring is observed in the "innovation and vanguard" axis of the TecNM Model, articulated with social responsibility, which allows innovation to be interpreted as organizational, pedagogical, and socially situated, and not as mere technological adoption (Tecnológico Nacional de México, 2024). The literature on governance and implementation warns that innovating in public organizations requires coordination, legitimacy, and structures that allow experimentation without losing institutional coherence (Elken, 2024a, 2024b). In addition, studies on institutional sustainability indicate that transformative innovation tends to depend on organizational learning and responsible scaling (Aung & Hallinger, 2022; Viera Trevisan et al., 2024).

Among the observable practices are: evaluation of projects by social impact (pertinence, inclusion, sustainability); innovation portfolio (prioritization, escalation criteria, continuity); pilot projects with documentation and feedback; and governance mechanisms to sustain innovations (Elken, 2024a; Viera Trevisan et al., 2024). Together, sustainability and innovation are integrated as decision criteria when directive identity, institutionalized dialogue and equity operate as conditions of possibility for change. This articulation is captured, in the integrative model, by the dimension "innovation with social relevance".

5.5 SYNTHESIS OF FINDINGS AND INTEGRATIVE MODEL OF DIRECTIVE PRACTICES

The synthesis of the findings suggests that directive practices operate as interdependent organizational mediations between the transversal axes of the Model, the directive identity and the institutional operation. Consequently, educational transformation is interpreted less as the sum of initiatives and more as systemic coherence between values, decision criteria, and organizational architecture (Tecnológico Nacional de México, 2024; Chaaban et al., 2025; Khaqan & Redondo-Sama, 2024; Rong & Chen, 2025).

The synthesis of the findings makes it possible to organize the analytical dimensions and the corresponding directive practices in an integrative model, in which each component articulates the directive function, observable markers and expected organizational results. Table 1 presents this matrix in a systematic way, bringing together the mediations identified in subsections 5.1 to 5.4.

Table 1

Integrative model of directive practices for educational transformation towards Mexican Humanism

Model Component	Directive function	Observable policy practices	Expected organizational outcome
Humanist directive identity and public ethics	Institutional legitimacy and normative coherence	Explicit prioritization criteria; accountability; transparency; Justification of decisions	Organizational trust; discourse-practice coherence; legitimacy of the conduction; Orientation to collective well-being
Architecture of dialogue and collaborative work	Inter-area coordination and shared sense	Deliberative spaces; rules of participation; monitoring of agreements; Conflict mediation	Effective collaboration; reduction of friction; Organizational Learning
Distributive equity and inclusion	Institutional justice and protection of opportunities	Differentiated allocation; support for permanence; inclusion protocols; Climate measurement	Reduction of internal breaches; safe environments; institutional well-being
Sustainability governance	Integration of environmental awareness as a cross-cutting criterion	Environmental criteria; responsible/committees; indicators; Impact assessment	Institutional sustainability; Consistency with social responsibility
Innovation with social relevance	Creative response to public problems with social value	Evaluation by social impact; portfolio/pilots; documentation and scheduling; Innovation governance	Useful, relevant and sustainable (non-cosmetic) innovation
Institutional Transformation Toward Mexican Humanism	Integrating result of previous mediations	Alignment axes—decisions—routines; follow-up; evidence-based adjustments	Social justice and collective well-being; excellence with social relevance

Note. The table derives from the matrix of categories and the analytical procedures developed in the analytical framework and methodological approach presented in Sections 3 and 4. The components are anchored in the transversal axes of the Educational Model of the Tecnológico Nacional de México (social responsibility,

environmental awareness, innovation and avant-garde) and in state-of-the-art evidence on leadership for social justice, dialogical leadership, directive identity, governance of change and sustainability (Tecnológico Nacional de México, 2024; Chaaban et al., 2025; Elken, 2024a, 2024b; Khaqan & Redondo-Sama, 2024; Rong & Chen, 2025; Viera Trevisan et al., 2024).

As can be seen in Table 1, the model integrates conceptual and operational levels: the components resume the analytical dimensions developed in this chapter, while the proposed practices and results function as interpretative hypotheses on how institutional direction can translate Mexican Humanism into concrete organizational arrangements.

From an interpretative reading, the integrative model allows us to infer that institutional transformation tends to depend on explicit directive criteria that translate values into decisions and monitoring, on institutionalized dialogue with coordination rules, and on the incorporation of equity, sustainability, and innovation as stable governance criteria, rather than as isolated initiatives (Elken, 2024a, 2024b; Rong & Chen, 2025; Viera Trevisan et al., 2024). These inferences are deepened and contrasted in the Discussion (Section 6), where tensions, scopes, and conditions of possibility are analyzed.

6 DISCUSSION

This section discusses the findings in the light of the analytical framework and the state of the art, highlighting the organizational mediations that condition the translation of Mexican Humanism into directive practices. To this end, it is organized into three axes: the contributions of Mexican Humanism to reorient directive management; the tensions and challenges of its implementation in complex public organizations; and the implications for public educational management and for broader processes of social transformation.

6.1 CONTRIBUTIONS OF MEXICAN HUMANISM TO DIRECTIVE MANAGEMENT

The findings of the chapter allow us to affirm that Mexican Humanism offers a normative and ethical framework with transformative potential for directive management in public technological education, as long as it is translated into consistent organizational practices. More than a declarative referent, Mexican Humanism operates as a guiding criterion for directive decisions that reconfigure the meaning of the institutional function, by situating collective well-being, equity, and social responsibility as explicit ends of educational action (Tecnológico Nacional de México, 2024).

In the analytical logic adopted, this horizon is operationalized through categories such as social justice, public ethics, dialogue, directive identity, and pedagogical mediation. For this reason, the international literature on educational leadership oriented to social justice constitutes a pertinent interpretative support for understanding its organizational translation

conditions (Chaaban et al., 2025; Rong & Chen, 2025). The integrative model presented in this chapter contributes to this debate by articulating Mexican Humanism to concrete dimensions of the directive function in a public technological subsystem, offering an analytical framework applicable to comparable organizational contexts.

In this sense, the results dialogue with systematic reviews that highlight the need to articulate public values, directive identity, and institutional management practices to face contexts of structural inequality (Chaaban et al., 2025; Rong & Chen, 2025). Institutional management, understood from this perspective, moves from a rationality focused exclusively on administrative efficiency to a situated ethical and political practice, capable of influencing distributive decisions, the legitimacy of conduct, and the construction of organizational trust (Abdi, 2024; Crossley et al., 2024).

Specifically, the evidence on social justice-oriented leadership emphasizes that equity and inclusion require directive intentionality and explicit decision criteria, beyond formal compliance (Chaaban et al., 2025; Rong & Chen, 2025). The integrative model adds to this field by making explicit observable directive practices and expected organizational outcomes, suggesting markers that can guide both institutional reflection and future empirical analyses.

In addition, Mexican Humanism's emphasis on integral education broadens the understanding of educational management as pedagogical mediation. Decisions about planning, resource allocation and work organization are recognized as conditions that indirectly affect the teaching and learning processes, reinforcing the directive responsibility for training quality and educational justice (Houssaye, 1988). This contribution is particularly relevant in public technological institutions, in which technocratic or productivist approaches have historically predominated, and reinforces the central assumption of the chapter: institutional transformation becomes effective when the humanist horizon is converted into routines, criteria, and organizational management devices that can be described, analyzed, and monitored.

6.2 TENSIONS AND CHALLENGES IN THE MANAGEMENT OF TECHNOLOGICAL INSTITUTIONS

Nevertheless, this reorientation faces structural tensions that condition the materialization of the humanist horizon in directive practice. One of the main ones is between the normative design of educational models and the real conditions of implementation in large-scale public organizations. Budgetary constraints, accountability requirements, pressures for indicators, and territorial inequalities limit the room for maneuver of governing bodies and can favor logics of formal compliance to the detriment of substantive

transformations, as the literature warns about the implementation of governance instruments when milestones are ambiguous or translated heterogeneously into practice (Elken, 2024b).

In public technological education, these tensions tend to intensify due to the heterogeneity of institutional capacities between campuses, territorial dispersion, and the need to simultaneously sustain operation, regional relevance, and continuous improvement. In the case of TecNM, the organizational scale and the diversity of contexts of its Institutes and Centers make especially critical the directive capacity to translate the Educational Model and its transversal axes into situated decisions, preventing the humanist orientation from remaining enclosed in the normative plan (Tecnológico Nacional de México, 2024).

Added to this is the tension between centralization and institutional autonomy: while the general guidelines seek homogeneity and control, the local contexts demand localized adaptations to respond to specific needs, in a framework in which higher education is recognized as a right and public good (Cámara de Diputados, 2021). The directive function is thus exercised in a field of permanent negotiation, in which critical thinking and the capacity for contextual interpretation are fundamental to avoid the mechanical reproduction of guidelines disconnected from institutional reality and to sustain criteria of equity in disparate organizational conditions.

In addition, the impulse to dialogue and collaborative work faces cultural and organizational challenges. Dialogue does not occur spontaneously: it requires institutional architecture, clear rules of participation, and follow-up mechanisms to operate as effective coordination and not as a symbolic resource (Khaqan & Redondo-Sama, 2024). In terms of the proposed integrative model, these tensions directly impact the coherence between humanist values, directive practices, and organizational outcomes, by weakening the translation mechanisms that allow us to move from the normative horizon to everyday transformation—especially in the dimensions of directive identity, architecture of dialogue, and distributive equity.

6.3 IMPLICATIONS FOR PUBLIC EDUCATIONAL MANAGEMENT AND SOCIAL TRANSFORMATION

In terms of public educational management, the results suggest that the effectiveness of policies oriented to equity and well-being does not depend only on their formulation, but on the directive capacity to translate them into coherent organizational practices. In this sense, the directive function emerges as a strategic level of public policy implementation, in which operational priorities are defined, institutional meanings are negotiated, and distributive criteria are established with concrete effects on inclusion, participation, and learning

conditions (Elken, 2024a; Wullschleger et al., 2025). This finding is consistent with the understanding of higher education as a public good, which requires institutional management to articulate quality, equity, and social relevance (Cámara de Diputados, 2021).

In a complementary way, the discussion highlights the need to rethink the training and professional development of the directors of public technological institutions. In addition to administrative skills, analytical, ethical, and dialogical skills are required to lead complex organizations with social meaning, strengthening at least three areas: (i) continuous training in critical thinking and decision-making under criteria of social justice; (ii) design of institutional devices for dialogue and co-responsibility, such as formal spaces, rules of participation and monitoring mechanisms; and (iii) explicit criteria for distributive decisions oriented towards territorial equity and institutional inclusion (Chaaban et al., 2025; Khaqan & Redondo-Sama, 2024; Rong & Chen, 2025). In the field of ethical leadership in public organizations, these capabilities contribute to sustaining trust, legitimacy, and institutional performance under conditions of tension and demand (Abdi, 2024; Crossley et al., 2024).

The proposed integrative model offers, in this sense, a useful framework to guide both management training programs and institutional self-evaluation processes, by converting values and cross-cutting axes into components, functions, practices, and results that can be monitored over time. In educational reform contexts, this matrix can inform institutional development agendas centered on equity, sustainability, and innovation with social pertinence.

Finally, directing public technological institutions from a humanistic horizon can contribute to broader processes of social transformation, insofar as it focuses on reducing inequalities, expanding educational opportunities, and building organizational cultures oriented to collective well-being. In this context, educational management is configured as a privileged space to articulate public policy, institutional ethics, and social justice, especially when the Educational Model becomes stable decision-making criteria and verifiable directive practices in institutional life (Tecnológico Nacional de México, 2024).

With this, the discussion closes the analytical circle of the chapter: the integrative model not only organizes categories, but also allows us to understand how directive mediations enable — or limit — the translation of the humanist horizon into effective organizational conditions. At the same time, it is projected as a basis for future empirical and comparative investigations, aimed at examining the extent to which these practices materialize in different institutional arrangements and territorial contexts.

7 CONCLUSIONS

This section closes the chapter by synthesizing the conclusions derived from the theoretical-interpretative analysis and by delimiting their implications for institutional direction in public technological institutions. Initially, the main conclusions articulated to the integrative model of directive practices are presented (see Table 1); Then, the theoretical contributions and practical orientations are explained, the limitations of the analysis are recognized, and future lines of research and reflection are proposed to contrast and refine the developed framework.

7.1 MAIN CONCLUSIONS OF THE CHAPTER

The objective of this chapter was to analyze the directive practices that mediate the transformation of technological education towards Mexican Humanism, from an analytical-interpretative approach based on the institutional corpus of the National Technological Institute of Mexico and on recent international literature. From this perspective, and without intending empirical generalization, the analysis allows us to infer four main conclusions, articulated with the integrative model of directive practices (see Table 1) (Tecnológico Nacional de México, 2024; Yin, 2018).

First, it is concluded that Mexican Humanism operates as a normative-operative horizon that reconfigures the meaning of institutional direction, by situating it as a mediation between public values — social justice, collective well-being and public responsibility — and concrete organizational decisions. This horizon becomes operative when it translates into stable criteria for governance, planning, and institutional monitoring, and not just as a programmatic statement (Cámara de Diputados, 2021; Tecnológico Nacional de México, 2024).

Secondly, it is inferred that the humanist directive identity, articulated with public ethics, constitutes an organizing nucleus of institutional legitimacy and organizational coherence. Transformation tends to be sustained with greater consistency when values are translated into explicit criteria for prioritization, transparency, and accountability, strengthening trust, legitimacy, and institutional performance (Abdi, 2024; Crossley et al., 2024). This conclusion corresponds, in the integrative model, to the dimension "humanist directive identity and public ethics".

Thirdly, it is concluded that institutionalized dialogue and collaborative work work as an architecture of inter-area coordination that enables the effective implementation of equity and inclusion. Such practices do not emerge spontaneously: they depend on clear rules, formal spaces, follow-up mechanisms, and conflict management devices that prevent

coordination from being reduced to episodic or symbolic efforts (Khaqan & Redondo-Sama, 2024; Chaaban et al., 2025; Rong & Chen, 2025). This conclusion is articulated with the "architecture of dialogue and collaborative work" dimension of the model.

Fourthly, the analysis allows us to infer that the axes of social responsibility, environmental awareness and innovation acquire transformative potential when they operate as stable decision criteria and not as isolated initiatives. Its organizational continuity depends on governance devices, indicators, and institutional learning processes that allow sustainability and innovation with social relevance, especially in complex educational organizations (Aung & Hallinger, 2022; Viera Trevisan et al., 2024; Tecnológico Nacional de México, 2024). In the integrative model, this conclusion is expressed in the dimensions "governance of sustainability" and "innovation with social relevance".

Together, these conclusions summarize that the institutional transformation towards Mexican Humanism is configured as a process of interdependent organizational mediations: directive identity and public ethics that confer legitimacy; dialogue architectures that underpin coordination; distributive and inclusive criteria that guide institutional justice; and governance of sustainability and innovation that enables the continuity of change. The final line of the model — "institutional transformation towards Mexican Humanism" — thus condenses the integrating result of these mediations.

7.2 THEORETICAL AND PRACTICAL IMPLICATIONS FOR THE DIRECTIVE FUNCTION

Theoretical implications

On the theoretical level, the chapter contributes to studies on educational leadership and management by proposing an integrating framework that articulates directive identity, public ethics, and organizational architecture under a horizon of public value. This approach shifts the focus from conceptions centered on leadership styles or individual competencies to the understanding of institutional direction as organizational mediation that translates normative principles into criteria of governance, coordination, and decision-making (Chaaban et al., 2025; Rong & Chen, 2025; Elken, 2024a, 2024b).

In a complementary way, the chapter contributes to the understanding of direction as pedagogical-organizational mediation, by recovering the link between management, planning and administration as landmarks of possibility of educational service. This reading allows us to conceive of the directive function not only as the administration of resources, but as the production of institutional conditions for integral education, inclusion and social relevance (Houssaye, 1988; Tecnológico Nacional de México, 2024). The integrative model, by making explicit observable components, functions and practices, offers an analytical scheme that can

be mobilized in comparative studies and research on the implementation of policies in technological subsystems.

Practical implications

On the practical level, the findings suggest that institutional direction in public technological institutions is strengthened when it operates with explicit and verifiable criteria for decision-making, coordination, and accountability consistent with Mexican Humanism (Tecnológico Nacional de México, 2024). More than adding tasks, this implies reviewing, stabilizing and aligning routines and institutional mechanisms, for example:

- i. Formal instances of dialogue with traceable agreements and follow-up (inter-area committees, working tables with responsible parties and schedules);
- ii. Transparent criteria for distributive decisions oriented towards territorial equity and inclusion (public allocation and prioritization rules); e
- iii. Governance devices for sustainability and innovation (targets and indicators, periodic evaluation, and organizational learning) that avoid fragmentation into isolated initiatives (Khaqan & Redondo-Sama, 2024; Wullschleger et al., 2025; Viera Trevisan et al., 2024).

The proposed integrative model can, in this sense, guide self-assessment and planning processes in Technological Institutes and Centers, by translating values and transversal axes into observable directive practices and expected organizational results, subject to monitoring over time.

7.3 LIMITATIONS OF THE ANALYSIS

This chapter has limitations that delimit the scope of its inferences. First, the analysis is based on a documentary corpus and secondary literature; therefore, it does not incorporate direct empirical evidence on situated practices of managers, professors, and administrative staff. Consequently, the findings should be interpreted as reasoned conceptual inferences, and not as empirical generalizations (Bowen, 2009; Yin, 2018).

Secondly, the dependence on normative and institutional sources can overrepresent the intention of the policy to the detriment of everyday practice, implying the risk of assuming equivalence between documentary prescription and actual operation. Furthermore, the proposed integrative model has not yet been submitted to empirical validation or systematic evaluation by specialists, so its explanatory robustness should be considered an open-ended conceptual proposal, subject to contrast and refinement (Shenton, 2004).

7.4 FUTURE LINES OF RESEARCH AND REFLECTION

From the conclusions and limitations identified, future lines are proposed aimed at empirically validating the integrative model, developing multiple case studies in Technological Institutes and Centers, and comparatively exploring the transferability of the analytical framework to other subsystems of technological higher education. Qualitative studies based on in-depth interviews, organizational observation, and analysis of directive decisions could contrast the extent to which the practices described materialize in different institutional contexts (Yin, 2018; Tecnológico Nacional de México, 2024).

These lines will allow us to deepen the understanding of institutional direction as an organizational mediation for educational transformation with a social sense, strengthening the articulation between public value, directive practices and institutional results. In particular, they will contribute to the development of mechanisms for conducting, coordinating, and governing that explain how processes of change are sustained or weakened in complex public educational organizations, as well as to identifying contextual conditions that favor the translation of Mexican Humanism into social justice, collective well-being, and excellence with social relevance.

REFERENCES

- Abdi, A. N. M. (2024). Ethical leadership and public sector performance: Mediating role of corporate social responsibility and organizational politics and moderator of social capital. *Cogent Business & Management*, 11(1), 2386722. <https://doi.org/10.1080/23311975.2024.2386722>
- Asociación Nacional de Universidades e Instituciones de Educación Superior [ANUIES]. (2018). *Visión y acción 2030: Propuesta de la ANUIES para renovar la educación superior en México*. ANUIES. <https://www.anuies.mx>
- Aung, P. N., & Hallinger, P. (2022). The intellectual structure of the literature on sustainability leadership in higher education: A bibliometric review. *International Journal of Sustainability in Higher Education*, 23(5), 1109–1132. <https://doi.org/10.1108/IJSHE-06-2021-0245>
- Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, 9(2), 27–40. <https://doi.org/10.3316/QRJ0902027>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp0630a>
- Cámara de Diputados del H. Congreso de la Unión. (2021). *Ley General de Educación Superior*. Diario Oficial de la Federación. <https://www.diputados.gob.mx>
- Chaaban, Y., Badwan, K., & Arar, K. (2025). Social justice leadership in schools: A systematic review. *Review of Education*, 13(2), e70077. <https://doi.org/10.1002/rev3.70077>

- Crossley, C., Taylor, S. G., Liden, R. C., Wo, D., & Piccolo, R. F. (2024). Right from the start: The association between ethical leadership, trust primacy, and customer loyalty. *Journal of Business Ethics*, 193, 409–426. <https://doi.org/10.1007/s10551-023-05485-y>
- Dias-Oliveira, E., Pasion, R., Vieira da Cunha, R., & Lima Coelho, S. (2024). The development of critical thinking, team working, and communication skills in a business school—A project-based learning approach. *Thinking Skills and Creativity*, 54, 101680. <https://doi.org/10.1016/j.tsc.2024.101680>
- Elken, M. (2024a). Collaborative design of governance instruments in higher education. *Studies in Higher Education*, 49(6), 1095–1106. <https://doi.org/10.1080/03075079.2023.2258905>
- Elken, M. (2024b). Implementation of ambiguous governance instruments in higher education. *Higher Education*, 87, 1–13. <https://doi.org/10.1007/s10734-023-01161-2>
- Golden, B. (2023). Enabling critical thinking development in higher education through the use of a structured planning tool. *Irish Educational Studies*, 42(4), 949–969. <https://doi.org/10.1080/03323315.2023.2258497>
- Houssaye, J. (1988). *Le triangle pédagogique: Théorie et pratiques de l'éducation scolaire* (Vol. 1). Peter Lang.
- Khaqan, S., & Redondo-Sama, G. (2024). A systematic review of the role of dialogic leadership: Characterization and impacts. *Educational Research Review*, 44, 100618. <https://doi.org/10.1016/j.edurev.2024.100618>
- Krippendorff, K. (2018). *Content analysis: An introduction to its methodology* (4th ed.). SAGE. <https://doi.org/10.4135/9781071878781>
- Lê, T. T., & Hoang, H. T. (2025). Leadership identity construction in educational organizations: A relational perspective. *Leadership and Policy in Schools*. Advance online publication. <https://doi.org/10.1080/15700763.2024.2298765>
- Nieberle, K., Acton, B., Braun, S., Lord, R., & Fu, A. Y. (2023). Leader identity on the fly: Intra-personal leader identity dynamics in response to strong events. *Journal of Business and Psychology*. Advance online publication. <https://doi.org/10.1007/s10869-023-09906-7>
- Rong, J., & Chen, S. (2025). Principal social justice leadership: A systematic review of 20 years of research, 2005–2024. *Educational Management Administration & Leadership*. Advance online publication. <https://doi.org/10.1177/17411432251376131>
- Saldaña, J. (2021). *The coding manual for qualitative researchers* (4th ed.). SAGE.
- Sánchez-Carrillo, J. C., Cadarso, M. A., & Tobarra, M. Á. (2021). Embracing higher education leadership in sustainability: A systematic review. *Journal of Cleaner Production*, 298, 126675. <https://doi.org/10.1016/j.jclepro.2021.126675>
- Secretaría de Educación Pública. (2014). *Programa Sectorial de Educación 2013–2018*. SEP. <https://www.gob.mx/sep>
- Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, 22(2), 63–75. <https://doi.org/10.3233/EFI-2004-22201>
- Tecnológico Nacional de México. (2024). *Modelo Educativo del Tecnológico Nacional de México*. https://www.tecnm.mx/archivos/slider/Modelo_Educativo_del_TecNM_digital_orig.pdf

- Viera Trevisan, L., Leal Filho, W., & Ávila Pedrozo, E. (2024). Transformative organisational learning for sustainability in higher education: A literature review and an international multi-case study. *Journal of Cleaner Production*, 447, 141634. <https://doi.org/10.1016/j.jclepro.2024.141634>
- Wullschleger, A., Daly, A. J., van Halem, N., Maag Merki, K., & Rechsteiner, B. (2025). Collaboration on school improvement under different educational accountability systems in two countries. *Educational Assessment, Evaluation and Accountability*, 37, 303–329. <https://doi.org/10.1007/s11092-025-09460-1>
- Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE.

CAPTURED MALAISE IN CONTEMPORARY CAPITALISM

O MAL-ESTAR CAPTURADO NO CAPITALISMO CONTEMPORÂNEO

EL MALESTAR CAPTURADO EN EL CAPITALISMO CONTEMPORÁNEO



<https://doi.org/10.56238/sevened2026.008-110>

Francisco José de Oliveira Neto¹

ABSTRACT

Since Freud, the concept of malaise in civilization has designated the structural tension between desire, social bonds, and instinctual renunciation. In contemporary society, this tension is intensified by neoliberal rationality and the logic of late capitalism, which reconfigure both forms of suffering and modes of substitutive satisfaction. Although the literature widely acknowledges the commodification of psychic suffering, the subjective dynamics involved in contemporary practices of affective substitution—such as bonds with reborn babies and the parentalization of companion animals—remain underexplored. This study aims to analyze, in light of psychoanalysis and critical theory, how such practices operate as defensive solutions to malaise, articulating fantasy, fetishism, and narcissism within the logic of consumption. This is a qualitative study of a theoretical-analytical nature, guided by the hermeneutic-critical method and based on a critical review of psychoanalytic and philosophical literature, with emphasis on classical and contemporary authors such as Freud, Winnicott, Adorno, Horkheimer, Benjamin, Rosa, and Byung-Chul Han, in dialogue with recent international scholarship. It is argued that the affective substitutions analyzed function as fetishistic and narcissistic formations that suspend alterity, neutralize the experience of loss, and offer an illusory relief from psychic suffering. At the same time, such practices are captured and amplified by the market, which transforms subjective impasses into consumer niches. It is concluded that these configurations, far from promoting symbolic elaboration, tend to freeze suffering, reinforcing repetitive circuits of satisfaction and frustration. The study contributes to the fields of clinical practice, education, and the humanities by highlighting the need for symbolic and collective dispositifs that enable the elaboration of mourning and the reestablishment of bonds with alterity.

Keywords: Psychoanalysis. Psychic Suffering. Consumption. Malaise in Civilization. Fantasy. Capitalism.

RESUMO

Desde Freud, o conceito de mal-estar na cultura designa a tensão estrutural entre desejo, laço social e renúncia pulsional. Na contemporaneidade, essa tensão é intensificada pela racionalidade neoliberal e pela lógica do capitalismo tardio, que reconfiguram tanto as formas de sofrimento quanto os modos de satisfação substitutiva. Embora a literatura reconheça amplamente a mercantilização do sofrimento psíquico, permanecem pouco exploradas as

¹ Master's degree in Psychology. Universidade Federal de Goiás (UFG).
E-mail: Francisconeto3@yahoo.com.br

dinâmicas subjetivas implicadas em práticas contemporâneas de substituição afetiva, como os vínculos com bebês reborn e a parentalização de animais de estimação. Este estudo tem como objetivo analisar, à luz da psicanálise e da teoria crítica, de que modo tais práticas operam como soluções defensivas ao mal-estar, articulando fantasia, fetichismo e narcisismo à lógica do consumo. Trata-se de uma pesquisa qualitativa de natureza teórico-analítica, orientada pelo método hermenêutico-crítico, baseada em revisão crítica da literatura psicanalítica e filosófica, com ênfase em autores clássicos e contemporâneos como Freud, Winnicott, Adorno, Horkheimer, Benjamin, Rosa e Byung-Chul Han, em diálogo com produções internacionais recentes. Argumenta-se que as substituições afetivas analisadas funcionam como formações fetichistas e narcísicas que suspendem a alteridade, neutralizam a experiência da perda e oferecem um alívio ilusório ao sofrimento psíquico. Ao mesmo tempo, tais práticas são capturadas e amplificadas pelo mercado, que transforma impasses subjetivos em nichos de consumo. Conclui-se que essas configurações, longe de promoverem elaboração simbólica, tendem a congelar o sofrimento, reforçando circuitos repetitivos de satisfação e frustração. O estudo contribui para os campos da clínica, da educação e das ciências humanas ao evidenciar a necessidade de dispositivos simbólicos e coletivos que possibilitem a elaboração do luto e a reinstauração do laço com a alteridade.

Palavras-chave: Psicanálise. Sofrimento Psíquico. Consumo. Mal-Estar na Cultura. Fantasia. Capitalismo.

RESUMEN

Desde Freud, el concepto de malestar en la cultura designa la tensión estructural entre el deseo, el lazo social y la renuncia pulsional. En la contemporaneidad, esta tensión se intensifica por la racionalidad neoliberal y la lógica del capitalismo tardío, que reconfiguran tanto las formas de sufrimiento como los modos de satisfacción sustitutiva. Aunque la literatura reconoce ampliamente la mercantilización del sufrimiento psíquico, permanecen poco exploradas las dinámicas subjetivas implicadas en prácticas contemporáneas de sustitución afectiva, como los vínculos con bebés reborn y la parentalización de animales de compañía. Este estudio tiene como objetivo analizar, a la luz del psicoanálisis y de la teoría crítica, de qué modo tales prácticas operan como soluciones defensivas al malestar, articulando fantasía, fetichismo y narcisismo con la lógica del consumo. Se trata de una investigación cualitativa de carácter teórico-analítico, orientada por el método hermenéutico-crítico, basada en una revisión crítica de la literatura psicoanalítica y filosófica, con énfasis en autores clásicos y contemporáneos como Freud, Winnicott, Adorno, Horkheimer, Benjamin, Rosa y Byung-Chul Han, en diálogo con producciones internacionales recientes. Se argumenta que las sustituciones afectivas analizadas funcionan como formaciones fetichistas y narcisistas que suspenden la alteridad, neutralizan la experiencia de la pérdida y ofrecen un alivio ilusorio al sufrimiento psíquico. Al mismo tiempo, tales prácticas son capturadas y amplificadas por el mercado, que transforma impasses subjetivos en nichos de consumo. Se concluye que estas configuraciones, lejos de promover una elaboración simbólica, tienden a congelar el sufrimiento, reforzando circuitos repetitivos de satisfacción y frustración. El estudio contribuye a los campos de la clínica, la educación y las ciencias humanas al evidenciar la necesidad de dispositivos simbólicos y colectivos que posibiliten la elaboración del duelo y la reinstauración del lazo con la alteridad.

Palabras clave: Psicoanálisis. Sufrimiento Psíquico. Consumo. Malestar en la Cultura. Fantasía. Capitalismo.

1 INTRODUCTION

Since *The Discontent in Culture* (Freud, 1930/2010), psychoanalysis has supported a radical thesis: suffering does not constitute a contingent failure of social life, but the very condition of possibility of civilization. By inscribing the subject in the symbolic order, culture demands structural instinctual renunciations that are never fully resolved. The promise of happiness, repeatedly mobilized by social discourses, operates less as a realizable horizon than as an ideological operator that masks the irreducible dimension of loss. Discontent, far from being a pathological deviation, is the price paid for life in common.

However, if the malaise is structural, its forms of manifestation are not. Each historical configuration produces specific ways of managing, displacing or denying this fundamental experience. In late modernity, marked by the acceleration of social time (Rosa, 2010), by the dissolution of collective references and by the hegemony of neoliberal rationality, the classic conflict between drive and culture gives way to a diffuse, privatized and depoliticized suffering. The contemporary subject is called upon to manage himself as a company, individually responsible for his success or failure, while the social determinations of his suffering are systematically obscured (Han, 2017).

This displacement produces profound effects on the psychic economy. Suffering is no longer recognized as an expression of a shared symbolic impasse and is experienced as personal inadequacy, narcissistic failure, or performance deficit. In place of conflict, exhaustion emerges; instead of guilt, shame; instead of the noose, isolation. The malaise does not disappear, it is reconfigured, silenced and, above all, captured by devices that promise immediate relief, affective predictability and control of the bond.

It is in this scenario that contemporary practices of affective substitution are inscribed, such as intense bonds with reborn babies and the parenting of pets. At first glance, such phenomena can be understood as private choices, playful expressions or legitimate forms of affection. However, when questioned from a psychoanalytic and critical perspective, they reveal themselves as dense cultural symptoms, in which contemporary difficulties in the elaboration of loss, withdrawal from otherness and refusal of the risk inherent to human bonds are condensed.

These practices are not organized only around care or affection, but a relationship with objects that do not demand recognition of the lack, separation or radical difference of the other. These are structurally asymmetrical bonds, in which the fetishized and commodified object offers an illusion of narcissistic completeness, while neutralizing otherness and suspending the symbolic work of mourning. Suffering is thus displaced from the field of words and elaboration to the field of consumption and affective management.

Despite the growing visibility of these phenomena in the media and social networks, the scientific literature still lacks analyses that articulate them in a consistent way with psychoanalytic theory and the social critique of contemporary capitalism. Descriptive, moralizing or pathologizing approaches predominate, which tend to individualize the problem and obscure its historical and economic determinations. Therefore, an important theoretical gap persists with regard to the understanding of these practices as subjective responses to specific social conditions, that is, as symptoms of a culture that promises happiness in the form of a commodity.

In view of this scenario, this chapter aims to analyze contemporary affective substitutions from an articulation between psychoanalysis and the critique of late capitalism. It is based on the hypothesis that such practices operate as defensive solutions to psychic suffering, offering illusory relief at the cost of suspending otherness and symbolic elaboration. It is also argued that these solutions not only mask the malaise, but re-inscribe it in market circuits that reinforce its reproduction.

By mobilizing central concepts of the psychoanalytic tradition such as narcissism, fetishism, fantasy, sublimation, and mourning in dialogue with contemporary diagnoses of neoliberal rationality, the study seeks to demonstrate how the unconscious does not remain immune to social transformations, but is progressively colonized by devices that offer ready-made responses to pains that would require psychic work and social bonding. By placing malaise back at the center of the analysis, this article proposes to understand it not as an individual failure, but as a fundamental ethical and political issue of our time.

2 THEORETICAL BACKGROUND

2.1 MALAISE, FANTASY AND SUBSTITUTION

Freud (1930/2010) already indicated that, faced with the impossibility of full satisfaction, the subject resorts to substitutive ways to mitigate the displeasure. Sublimation, religion, art and love figure as possible destinations of the drive. However, such destinies never eliminate the lack; they only reorganize it symbolically. Fantasy, in this context, operates as a psychic scenario that allows the subject to sustain desire in the face of renunciation.

In contemporary times, there is an inflation of fantasies that promise to circumvent loss without crossing it. The affective substitutions analyzed in this study are included in this register. Unlike sublimation, which implies displacement and symbolic creation, such practices tend to fix desire on objects that do not question the subject or introduce difference.

This distinction is fundamental to understand the psychic status of the current forms of substitution. While sublimation, according to Freud (1930/2010), implies a work of the symbolic that transforms the drive energy into cultural production and social bond, contemporary substitutions operate mostly through the buffering of lack. It is less an elaboration of the malaise and more an attempt to neutralize it, which paradoxically results in its intensification. Fantasy ceases to function as a support for desire to become a device for avoiding anguish, offering the subject the illusion of immediate completeness.

From the point of view of critical theory, this movement can be read in articulation with the logic of the culture industry, as formulated by Adorno and Horkheimer (2006). The standardization of objects of jouissance and forms of satisfaction contributes to a homogenization of fantasies, reducing their singular and critical potential. The subject is summoned to desire what has already been previously formatted, which impoverishes the subjective experience and weakens the processes of symbolization. In this scenario, fantasy ceases to be a space for the singular elaboration of desire to become a consumable product, functional to the reproduction of the current social order.

Benjamin (2008), when thinking of capitalism as a religion, deepens this reading by indicating that the capitalist logic does not aim at redemption, but at the permanent maintenance of guilt and debt. Contemporary affective substitutions can be understood as devotional practices of this continuous cult, in which the subject is urged to invest incessantly in new objects, relationships or experiences that promise relief, but never offer elaboration. The result is a repetitive circuit of investment and frustration, which keeps the malaise in a latent and chronic state.

Byung-Chul Han's (2017) analysis of the society of fatigue contributes to this diagnosis by showing that excessive positivity and the logic of performance tend to abolish negativity, lack and limit, structural conditions of the constitution of the subject of the unconscious and of the very possibility of symbolization, according to psychoanalysis. By refusing the experience of loss, the contemporary subject finds himself captured by forms of jouissance that do not produce a bond or alterity, but only exhaustion. The social acceleration described by Rosa (2010) intensifies this process, by reducing the time needed for psychic elaboration and favoring immediate responses to malaise.

In this context, Winnicott's (1975) contribution becomes particularly relevant. The author emphasizes the importance of transitional space and play as intermediate areas between internal and external reality, fundamental for the constitution of the self. Affective substitutions that eliminate the possibility of symbolic play and creative illusion compromise this space, producing forms of defensive adaptation that impoverish the subjective

experience. Instead of favoring creativity and symbolization, such practices reinforce a conformist adherence to objects that promise security but deepen alienation.

Thus, the analysis of contemporary malaise requires understanding how fantasy, once the central operator of the sustenance of desire, has been progressively captured by social, economic and cultural devices that transform lack into something to be avoided at any cost. Affective substitutions, far from resolving the structural conflict of subjectivity, tend to intensify it, evidencing the relevance and critical power of psychoanalysis in dialogue with critical theory for the understanding of mental health in contemporary times.

2.2 FETISHISM AND DENIAL OF CASTRATION

The concept of fetishism, formulated by Freud (1927/2016), offers a fundamental interpretative key. The fetish appears as a substitute for something whose loss is unbearable, simultaneously operating recognition and denial of castration. In the case of reborn babies, the object functions as the material presence of an absence: a lost, impossible or never-had child. The doll, by neither growing nor demanding, preserves the illusion of completeness and control. This dynamic is close to what contemporary authors describe as the refusal of negativity (Han, 2017). The fetish eliminates conflict, time and otherness, offering a static satisfaction that prevents the elaboration of mourning. Thus, suffering is not symbolized, but frozen.

In continuity with the previous discussion about malaise, fantasy and substitution, fetishism can be understood as a specific and radicalized form of affective substitution. Unlike the sublimatory ways described by Freud (1930/2010), in which loss is recognized and symbolically transformed, the fetish is constituted as a defensive arrangement that aims precisely to avoid the crossing of lack. It is a psychic solution that keeps the subject in a fixed relationship with the object, preventing the displacement of desire and openness to the other.

In fetishism, fantasy ceases to operate as a scenario that sustains desire in the face of renunciation and begins to function as a device of denial (*Verleugnung*). The subject knows about the loss, but acts as if it did not exist. This double movement, knowing and denying, produces a precarious stabilization of the psyche, in which the fetishized object assumes the function of a guarantee against the anguish of castration. In the case of reborn babies, this guarantee materializes in an object that simultaneously embodies presence and absence, allowing the subject to maintain a relationship with what has been lost without confronting its irremediability.

From the temporal point of view, this dynamic implies a suspension of psychic time. While mourning requires the inscription of the loss in the subject's history and its elaboration

over time, the fetish freezes the experience in a continuous present. The doll does not age, does not transform, does not separate. With this, time, a fundamental element of symbolization, is neutralized. This temporal suspension is directly linked to the social acceleration described by Rosa (2010): paradoxically, the more society accelerates, the more objects proliferate that promise fixity and subjective immobility.

Critical theory allows us to deepen this reading by situating fetishism beyond an individual libidinal economy. Adorno and Horkheimer (2006) already indicated that fetishism is not restricted to the commodity, but crosses the forms of the subject's relationship with the world. In contemporary culture, marked by the standardization of affections and the commodification of experience, the fetish appears as an adaptive response to a context that makes it difficult to elaborate loss and negativity. The fetishized object offers an immediate and controllable satisfaction, in line with the logic of the culture industry.

The refusal of negativity described by Han (2017) finds, in this context, a precise clinical expression. By eliminating the conflict, otherness, and unpredictability of the other, the fetish produces a form of narcissistic satisfaction that empties the field of desire. There is no encounter with the different, no risk, no transformation. The object does not question the subject, does not demand a response, does not introduce a lack. With this, the possibility of symbolic elaboration of suffering is replaced by a silent and sterile fixation.

In dialogue with Winnicott (1975), it can be stated that the fetish differs radically from the transitional object. While the latter sustains the passage between presence and absence, favoring the constitution of the self and creativity, the fetish interrupts this process. He does not mediate the separation, but denies it. Instead of enabling play and symbolization, it crystallizes the subject in a defensive relationship with the object, compromising psychic vitality.

Thus, fetishism, far from being a marginal phenomenon, reveals itself to be a central operator for the understanding of contemporary forms of psychic suffering. Articulated with malaise, fantasy and affective substitutions, it shows how the refusal of castration and loss produces solutions that, although apparently appeasing, deepen subjective alienation and hinder the processes of mourning, symbolization and social bonding.

2.3 NARCISSISM AND BONDS WITHOUT ALTERITY

The parentalization of pets, in turn, evidences a narcissistic configuration of the bond. Although the bonds with animals can be affectively rich, their elevation to the position of children reveals a refusal of the radical otherness that the child represents. As Winnicott (1975) points out, psychic maturation depends on the presence of another who frustrates,

resists and presents himself as separate. In the relationships analyzed, the other is kept under control, functioning as a mirror of the self. Such a dynamic reinforces a defensive narcissism, compatible with a culture that privileges self-image, performance, and the individual management of affections.

In continuity with the previous sections, this form of bonding can be understood as another modality of affective substitution that aims to mitigate the malaise without going through the experience of loss and lack. As in fetishism, one observes here the attempt to preserve a relationship in which the object does not introduce rupture, difference or unpredictability. The parentalized animal occupies a paradoxical position: it is libidinally invested as a child, but without ever acquiring the status of alterity that characterizes the relationship with a human child.

Freud (1930/2010) already warned that love, although it appears as one of the privileged ways to cope with malaise, necessarily implies risk, frustration and dependence on the other. When the bond is structured in such a way as to eliminate these elements, what is produced is not a solution to suffering, but a narcissistic defense against castration. The other is no longer recognized as a subject and starts to function as a support for self-esteem and the imaginary cohesion of the self.

This dynamic finds direct resonance in Winnicott's conception of emotional development. For Winnicott, the constitution of the self depends on a sufficiently good environment, but also on the progressive introduction of frustration and separation. The impossibility of sustaining this tension compromises psychic maturation, favoring forms of relationship marked by dependence and the illusion of absolute control. In this sense, it is worth highlighting the following passage:

Emotional maturation involves a gradual process by which the individual moves from absolute dependence to relative dependence and finally independence. This process is only possible to the extent that the environment fails adequately, allowing the subject to recognize the external reality as something separate from himself and to endure the frustration inherent in this discovery. When this experience is avoided or nullified, emotional development remains immature. (Winnicott, 1975, p. 83)

The above quotation illuminates precisely the impasse present in contemporary narcissistic bonds. By eliminating the other's flaw, his resistance, his opacity, his otherness, the subject preserves an apparently stable relationship, but at the expense of psychic vitality and the possibility of transformation. The bond ceases to be a meeting space and starts to function as an extension of the self, reinforcing a specular logic.

From the point of view of critical theory, this relational configuration cannot be dissociated from the broader sociocultural context. Adorno and Horkheimer (2006) have already pointed out that instrumental rationality tends to colonize even the field of affections, converting relationships into objects of management and control. Animal parenting, when articulated with this logic, reveals itself less as a spontaneous expression of care and more as a strategy for managing the bond, adjusted to the demands of autonomy, performance and self-sufficiency.

Han (2017) deepens this analysis by describing a culture marked by excessive positivity and aversion to conflict. The other, as radical alterity, becomes a risk to be avoided. In their place, bonds proliferate that promise affection without negativity, presence without demand, and relationship without transformation. Narcissism, in this context, does not appear as an isolated pathological trait, but as a socially encouraged form of bonding organization.

As in the fetishization phenomena analyzed above, narcissistic parenting operates a suspension of time and conflict. The bond does not evolve, it does not become complex, it does not require subjective repositioning. Thus, psychic suffering does not find ways of symbolization, being only managed through defensive arrangements that reinforce alienation and impoverish the relational experience.

Thus, narcissism and bonds without alterity constitute a third fundamental axis for understanding contemporary forms of malaise. In articulation with fantasy, fetishism and affective substitutions, they show how the refusal of lack, castration and otherness produces psychic solutions that, although socially legitimized, compromise the processes of mourning, symbolization and social bonding.

2.4 CAPITALISM, CONSUMPTION AND THE CAPTURE OF SUFFERING

Critical theory, especially in Adorno and Horkheimer (1944/2006), already denounced the transformation of subjectivity into a commodity. Nowadays, this logic is intensifying: suffering becomes a market niche, and pain, an opportunity for profit. Hyper-realistic dolls, premium services for pets, and products associated with symbolic parenting exemplify the market capture of subjective impasses that, in other historical contexts, would require collective symbolic elaboration. As Benjamin (2008) observes, capitalism not only exploits labor, but colonizes experience, offering objects that promise immediate redemption.

In this scenario, the unconscious does not disappear, but is reorganized according to the logic of consumption. Desire is continually stimulated, while lack is covered by commodities that promise completeness. The result is a repetitive circuit in which the subject

consumes to relieve suffering and suffers again from the structural impossibility of satisfaction.

In articulation with the axes previously developed, it can be affirmed that contemporary capitalism not only appropriates suffering, but reconfigures it as an engine of subjective functioning. Fantasy, which in Freud (1930/2010) operated as a support for desire in the face of renunciation, is now colonized by industrially produced images and objects. The affective substitution, fetishism and narcissistic bonds analyzed in the previous sections are therefore not presented as isolated phenomena, but as forms of psychic adaptation to a libidinal economy regulated by the market.

Adorno and Horkheimer (2006) have already indicated that the cultural industry is not limited to offering entertainment, but shapes structures of sensitivity and ways of relating to oneself and to the other. By transforming experiences of loss, mourning, and loneliness into opportunities for consumption, capitalism empties the critical and symbolic potential of suffering. Instead of summoning the subject to the collective elaboration and sharing of pain, it offers individualized, immediate and controllable solutions, aligned with the logic of the commodity.

This dynamic can be understood in the light of Benjamin's (2008) analysis, for whom capitalism operates as a continuous religion, without atonement or redemption. The consumption of objects that promise to alleviate suffering does not lead to its overcoming, but to its perpetuation. The subject is kept in a state of permanent symbolic indebtedness, compelled to invest incessantly in new products that ensure only temporary relief. In this sense, the market-based capture of suffering is based precisely on the structural impossibility of satisfaction that Freud identified as constitutive of the human condition.

The reorganization of the unconscious according to the logic of consumption also implies a transformation of the subject's relationship with time. According to Rosa (2010), social acceleration reduces the interval necessary for psychic elaboration, favoring immediate responses to malaise. The market is part of this hiatus, offering objects that promise to buffer anguish without requiring symbolic work. Thus, the time of mourning, waiting and transformation is replaced by the short time of acquisition and discard.

Byung-Chul Han (2017) contributes to this reading by highlighting that the performance society eliminates negativity, limit, and flaw, fundamental elements of psychic experience. Suffering, when it cannot be eliminated, must at least be managed efficiently and silently. Consumption appears, then, as a technology for managing affect, allowing the subject to continue functioning without confronting the structural character of its lack.

This logic finds exemplary expression in the commodification of fetishized objects and controlled bonds, discussed earlier. The market offers not only products, but scripts of jouissance and forms of relationship that avoid encountering otherness and loss. As Adorno and Horkheimer summarize in an emblematic passage:

The culture industry does not cease to deceive its consumers about what it promises incessantly. The promise, which presents itself as satisfaction, is continually postponed; The advertised pleasure is converted into organized frustration, and the repetition of this frustration guarantees the consumer's loyalty to the system that produces it. (Adorno & Horkheimer, 2006, p. 128)

The quote makes explicit the paradoxical functioning of this circuit: suffering is not a side effect of consumption, but its condition of possibility. By capturing malaise and converting it into a commodity, contemporary capitalism produces forms of subjectivation marked by the repetition, alienation, and impoverishment of symbolic experience.

Thus, the capture of suffering by consumption does not represent only an ethical or social distortion, but a profound rearrangement of the psychic economy. In line with the axes of fantasy, fetishism and narcissism, this process shows how the refusal of lack and negativity sustains apparent solutions that, far from alleviating malaise, re-inscribe it in a chronic way, reinforcing the relevance of the articulation between psychoanalysis and critical theory for the understanding of mental health in contemporary times.

3 METHODOLOGY

This study is characterized as a qualitative research of a theoretical-analytical nature, guided by the hermeneutic-critical method. Such an approach is adequate to investigate subjective and cultural phenomena that do not lend themselves to direct empirical measurement, but require rigorous, historical, and contextualized conceptual interpretation.

The analytical corpus was made up of classic works of Freudian and post-Freudian psychoanalysis, as well as central contributions from critical theory and contemporary social philosophy. The selection of references followed criteria of theoretical relevance, academic impact and conceptual consistency, contemplating foundational texts indispensable to support the argument.

In addition, relevant scientific articles published in the last ten years were analyzed, identified from consultations with national and international databases widely recognized in the field of human sciences and mental health, such as SciELO, PePSIC, PsycINFO, Scopus and Web of Science. These studies were mobilized as theoretical-contextual support for the

analysis of contemporary practices of affective substitution, symbolic consumption and reorganization of psychic suffering, without configuring a systematic review of the literature.

The analytical procedure developed in three interdependent stages. In the first stage, a critical review of the literature was carried out on the concepts of malaise in culture, fantasy, fetishism, narcissism and consumption. In the second stage, these concepts were articulated with phenomenological descriptions of contemporary practices widely discussed in recent sociological, philosophical, and cultural studies. Finally, a critical interpretation was developed that confronts such practices with the logic of late capitalism and its effects on subjectivity.

The validity of the study is based on the internal coherence of the theoretical framework mobilized and on the argumentative consistency of the proposed interpretations. Reliability is ensured by the explanation of the methodological path and by the possibility of analytical replication by other researchers who share the same theoretical framework.

4 RESULTS AND DISCUSSION

The analysis developed allows us to identify that contemporary affective substitutions operate as defensive responses to structural psychic suffering, intensified by the sociocultural conditions of neoliberal capitalism. Reborn babies and pet parenting are privileged objects of libidinal investment, precisely because of their availability, predictability and absence of symbolic alterity.

The results indicate that such practices produce immediate relief from unpleasure, functioning as psychic anesthetics. However, this relief is not sustained over time, since it does not promote the elaboration of grief or subjective transformation. On the contrary, it crystallizes the subject in regressive positions, reinforcing the dependence on external objects for affective regulation.

In continuity with the theoretical foundation presented, it is observed that these substitutions are inscribed in the field of fantasy as an attempt to circumvent the lack without crossing it. Unlike sublimation, which implies symbolic displacement and creation, the objects analyzed keep the subject fixed in an impoverished libidinal economy, in which desire is not rearticulated, but repeated. The result is a defensive stabilization that preserves the self from anguish, at the cost of psychic vitality.

From the psychoanalytic point of view, there is a predominance of mechanisms of denial and cleavage. The subject recognizes, at some level, the loss or the lack, but simultaneously denies it through fetishistic investment. This ambivalence sustains symptomatic repetition, preventing the crossing of suffering and the re-inscription of loss in

the subjective history. Such a dynamic confirms the relevance of the Freudian formulation of fetishism as a paradoxical solution to castration.

By confronting these findings with critical theory, it is evident that the market plays an active role in maintaining these subjective formations. The incessant supply of products and services associated with affective substitutions not only responds to a pre-existing demand, but produces and intensifies it. Suffering becomes the engine of consumption, and consumption, a condition of psychic survival, as already anticipated by Adorno and Horkheimer (2006). As the authors state:

The culture industry firmly holds its consumers under the illusion that what is offered to them satisfies their needs, when, in fact, these needs are continually produced and managed by the system itself. The promise of satisfaction becomes a mechanism of domination, insofar as it perpetuates the need it claims to supply. (Adorno & Horkheimer, 2006, p. 135)

This quote illuminates the structural character of the repetition observed in the results. The relief produced by affective substitutions is not a side effect, but an integral part of a circuit that requires the maintenance of suffering in order to continue operating. The unconscious, far from being eliminated, is reorganized according to the logic of consumption, as already pointed out by Benjamin (2008) when describing capitalism as a religion without redemption.

This dynamic helps to explain why such practices expand in contexts marked by precarious work, social isolation, and weakening of community bonds. The substitute object offers a promise of care, predictability, and belonging in a world that is increasingly hostile to dependency, vulnerability, and the shared experience of loss. In this sense, affective substitutions function as private solutions to structurally collective problems.

However, this promise proves to be deeply paradoxical. By eliminating the risk inherent in the encounter with the other risk that implies frustration, difference and transformation, the possibility of symbolic elaboration of suffering is also eliminated. The subject thus remains imprisoned in a circuit of immediate satisfaction and prolonged emptiness, a central characteristic of the contemporary malaise described by Freud (1930/2010) and radicalized in the current conditions of neoliberal capitalism.

5 CONCLUSION

This chapter sought to demonstrate that contemporary practices of affective substitution, far from being reduced to individual eccentricities or cultural curiosities, constitute subjective responses to structural impasses of malaise in late capitalism. By

analyzing the bonds established with reborn babies and the parentalization of pets, it was evidenced that such practices operate as defensive solutions in the face of the experience of loss, lack and otherness, shifting psychic suffering to fetishized objects that promise care, control and predictability.

The analysis developed throughout the text allowed us to sustain that these substitutions produce an immediate relief from unpleasure, but they do so at the cost of suspending the processes of symbolization. The substitutive object does not introduce difference, does not frustrate, does not separate; it preserves the subject from anguish while fixing him in an impoverished libidinal economy, marked by repetition and dependence. In this sense, suffering is not elaborated, but managed; it is not crossed, but frozen. The result is the maintenance of a chronic malaise, which is continuously re-inscribed under new forms of affective consumption.

The main theoretical contribution of the study lies in the rigorous articulation between psychoanalysis and critical theory, demonstrating that the unconscious, far from disappearing in contemporary times, is progressively reorganized according to the logic of the market. Fantasy, fetishism and narcissism, central concepts of Freudian metapsychology, prove to be particularly fruitful for understanding how neoliberal capitalism captures psychic suffering, transforming structural impasses of subjectivity into niches of consumption. The market doesn't just respond to malaise; it exploits it, intensifies it, and converts it into a working condition.

By placing these practices back on the horizon of social criticism, the article argues that the suffering analyzed cannot be understood exclusively as an individual or pathological issue. It is a suffering produced and maintained in contexts marked by the precariousness of work, the weakening of community bonds and the permanent demand for self-sufficiency and performance. Affective substitutions thus emerge as private solutions to problems that are, at their root, collective and political.

On the clinical, educational and cultural levels, the findings indicate the urgency of devices that reestablish spaces for symbolizing suffering and sustaining the human bond. Intervening does not mean eliminating pain, but creating conditions so that it can be named, shared and transformed. From the psychoanalytic point of view, this implies sustaining lack, time and otherness as constitutive dimensions of subjective experience precisely what market solutions promise to suppress.

It is evidently recognized as a limitation of the study its theoretical nature, which does not allow direct empirical generalizations. Future research may articulate empirical qualitative methods, such as clinical interviews, case studies, or ethnographies, deepening the

understanding of these practices in specific sociocultural contexts. However, this limitation does not reduce the scope of the analysis, since the objective of the work was precisely to offer a critical interpretative framework capable of illuminating emerging phenomena of contemporaneity.

Even so, and perhaps precisely for this reason, it is believed that the proposed reflection offers a relevant contribution to the international literature by repositioning contemporary malaise as an ethical and political issue, and not only as a problem of individual adaptation. In a world that promises happiness in the form of merchandise, comfort without conflict and bonds without risk, insisting on lack, otherness and the work of mourning becomes a profoundly subversive gesture.

If, as Freud taught, there is no definitive way out of the malaise inherent in culture, we can only refuse the solutions that silence it and insist on those that allow the subject to speak, desire and suffer in a singular way. In this sense, sustaining discomfort, limits and incompleteness is not a sign of failure, but a condition of possibility for psychic life, for social ties and for any ethical project that refuses to reduce the human to an object of consumption.

REFERENCES

- Adorno, T. W., & Horkheimer, M. (2006). *Dialética do esclarecimento* (J. T. Costa, Trad.). Jorge Zahar. (Obra original publicada em 1944)
- Benjamin, W. (2008). *O capitalismo como religião*. Boitempo.
- Freud, S. (2010). *O mal-estar na cultura* (P. C. Souza, Trad.). Companhia das Letras. (Obra original publicada em 1930)
- Freud, S. (2016). O feticismo. In *Edição standard brasileira das obras psicológicas completas de Sigmund Freud* (Vol. 21, pp. 275–284). Imago. (Obra original publicada em 1927)
- Han, B.-C. (2017). *A sociedade do cansaço* (S. Jeong, Trad.). Vozes.
- Rosa, H. (2010). *Aceleração social: Uma crítica do tempo na modernidade*. Vozes.
- Winnicott, D. W. (1975). *O brincar e a realidade*. Imago.

LAND REGULARIZATION, SPATIAL JUSTICE, AND THE RIGHT TO THE CITY: AN ANALYSIS FROM THE JUREMA BARRA COMMUNITY, ANANINDEUA-PA

REGULARIZAÇÃO FUNDIÁRIA, JUSTIÇA ESPACIAL E DIREITO A CIDADE: UMA ANÁLISE A PARTIR DA COMUNIDADE JUREMA BARRA, ANANINDEUA – PA

REGULARIZACIÓN DE TIERRAS, JUSTICIA ESPACIAL Y DERECHO A LA CIUDAD: UN ANÁLISIS A PARTIR DE LA COMUNIDAD JUREMA BARRA, ANANINDEUA-PA



<https://doi.org/10.56238/sevened2026.008-111>

Amanda Diniz Medeiros¹

ABSTRACT

This article aims to understand how the implementation of land regularization can contribute to improving the living conditions of the residents of Jurema Barra and ensuring that access to the city is a right exercised by all, regardless of their socioeconomic status. Land regularization is an essential process to guarantee legal access to land, promoting security of tenure and contributing to the improvement of residents' living conditions. In the context of the Jurema Barra community, which faces challenges such as informality and precarious housing, regularization is seen as an instrument to ensure rights and promote social inclusion. The study analyzes how the lack of documentation and the absence of effective public policies have negatively impacted the lives of the community's inhabitants, limiting their access to essential services and citizen participation. The article highlights the importance of the right to the city, which is understood as the right of all citizens to enjoy urban spaces in a full and dignified manner. The research also emphasizes the need for dialogue between the community and local authorities, aiming to develop solutions that respect the particularities of the population and promote social justice. The article points out that land regularization in Jurema Barra is not just a matter of land titling, but part of a broader process of recognizing citizens' rights and building a more just and inclusive city.

Keywords: Land Regularization. Right to the City. Jurema Barra Community.

RESUMO

O artigo em questão tem por objetivo compreender como a efetivação da regularização pode contribuir para a melhoria das condições de vida dos moradores de Jurema Barra e garantir que o acesso à cidade seja um direito exercido por todos, independentemente de sua condição socioeconômica. A regularização fundiária é um processo essencial para garantir o acesso à terra de forma legal, promovendo a segurança da posse e contribuindo para a melhoria das condições de vida dos moradores. No contexto da comunidade de Jurema Barra, que enfrenta desafios como a informalidade e a precariedade habitacional, a regularização é vista como um instrumento para assegurar direitos e promover a inclusão social. É analisado como a falta de documentação e a ausência de políticas públicas eficazes têm

¹ Master's student in Geography teaching. Universidade Federal do Pará (UFPA).
E-mail: amandadinizmedeiros002@gmail.com

impactado negativamente a vida dos habitantes da comunidade, limitando seu acesso a serviços essenciais e à participação cidadã. O artigo destaca a importância do direito à cidade, que é compreendido como o direito de todos os cidadãos a usufruir dos espaços urbanos de maneira plena e digna. A pesquisa também enfatiza a necessidade de um diálogo entre a comunidade e as autoridades locais, visando a construção de soluções que respeitem as particularidades da população e promova uma justiça social. O artigo aponta que a regularização fundiária em Jurema Barra não é apenas uma questão de titulação de terras, mas parte de um processo mais amplo de reconhecimento dos direitos dos cidadãos e construção de uma cidade mais justa e inclusiva.

Palavras-chave: Regularização Fundiária. Direito à Cidade. Comunidade Jurema Barra.

RESUMEN

El presente artículo tiene como objetivo comprender cómo la efectividad de la regularización puede contribuir a la mejora de las condiciones de vida de los habitantes de Jurema Barra y garantizar que el acceso a la ciudad sea un derecho ejercido por todos, independientemente de su condición socioeconómica. La regularización de la tenencia de la tierra es un proceso esencial para garantizar el acceso a la tierra de forma legal, promoviendo la seguridad jurídica de la posesión y contribuyendo a la mejora de las condiciones de vida de los residentes. En el contexto de la comunidad Jurema Barra, que enfrenta desafíos como la informalidad y la precariedad habitacional, la regularización es vista como un instrumento para asegurar derechos y promover la inclusión social. Se analiza cómo la falta de documentación y la ausencia de políticas públicas eficaces han impactado negativamente en la vida de los habitantes de la comunidad, limitando su acceso a servicios esenciales y a la participación ciudadana. El artículo destaca la importancia del derecho a la ciudad, el cual se comprende como el derecho de todos los ciudadanos a disfrutar de los espacios urbanos de manera plena y digna. La investigación también enfatiza la necesidad de un diálogo entre la comunidad y las autoridades locales, con el fin de construir soluciones que respeten las particularidades de la población y promuevan la justicia social. El artículo señala que la regularización de tierras en Jurema Barra no es solo una cuestión de titulación de predios, sino parte de un proceso más amplio de reconocimiento de los derechos de los ciudadanos y de la construcción de una ciudad más justa e inclusiva.

Palabras clave: Regularización de Tierras. Derecho a la Ciudad. Comunidad Jurema Barra.

1 INTRODUCTION

According to Lira (2017), land regularization is a topic of increasing relevance in Brazil, especially in urban areas where informality in land tenure is a striking reality. In the context of contemporary cities, where disorderly urban growth and irregular land occupation are recurrent problems, regularization presents itself not only as a strategy for the stability and legality of property, but also as a fundamental tool for the promotion of the right to the city.

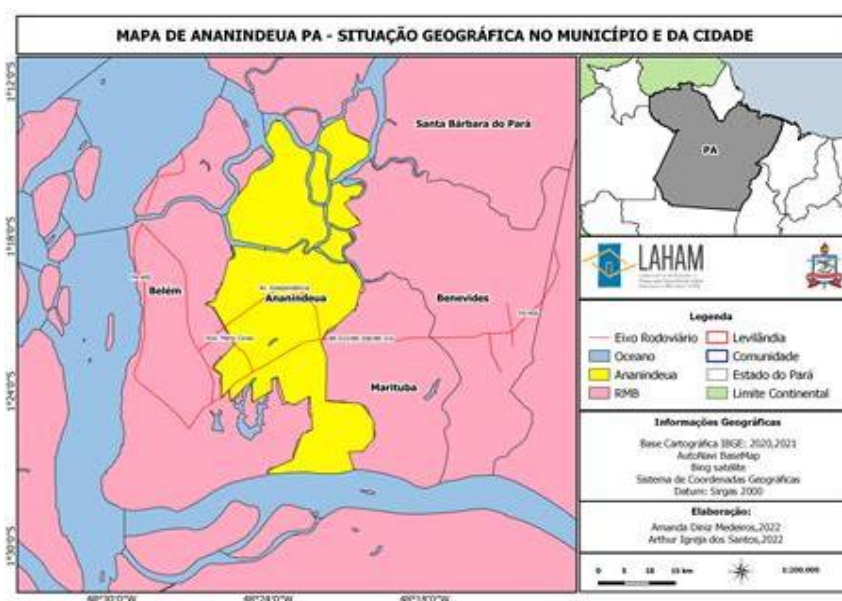
This right, enshrined in the Federal Constitution of 1988 and reinforced by the Statute of the City, involves ensuring access to the city in an inclusive way, ensuring that all citizens can enjoy the social, cultural, and economic benefits that it can offer (Santin, 2018).

The community of Jurema Barra, located in the municipality of Ananindeua, in the state of Pará, the object of this study, serves as an empirical reference for the discussion of these issues. In the face of internal migrations, land occupation in peripheral areas and the struggle for better living conditions, population growth in the municipality of Ananindeua has intensified.

Currently, Ananindeua-PA is close to 500 thousand inhabitants, according to the last demographic census carried out by the Brazilian Institute of Geography and Statistics (IBGE) in 2022, representing an increase of approximately 1.45% compared to the 2010 census. This growth makes the municipality one of the cities with the most population expansion in the Metropolitan Region of Belém (RMB).

Figure 1

Geographical situation map



Source: Laham (2023)

For Santin (2018), the community, composed of residents who often occupy land without proper regularization, faces challenges related to security of tenure and the provision of essential services, such as sanitation, drinking water and urban infrastructure. Thus, the analysis of land regularization in Jurema Barra is crucial to understand how public policies can enable a fairer city, in which the right to the city is effectively guaranteed.

In view of this scenario, the following problem arises: how has land regularization been configured in the municipal urban management of Ananindeua and what are the effects of this policy on the living conditions of the population? The choice of the theme "Land regularization, spatial justice and the right to the city: an analysis from the Jurema Barra community, Ananindeua – PA" is justified by the social, economic and legal relevance that the issue of land regularization exerts in contemporary Brazilian cities, especially in urban areas that face significant challenges related to informality, inequality and social exclusion.

The city of Ananindeua, located in the Metropolitan Region of Belém, in the state of Pará, is an emblematic example of this reality, where many communities, such as Jurema Barra, live under constant threat of eviction and lack access to basic rights, such as decent housing, adequate infrastructure, and essential public services. The proposed research addresses, therefore, the intersection between land regularization and the right to the city from the specificities of the local reality.

In this way, the work is not limited to a technical analysis of land regularization, but seeks to promote a broader reflection on citizenship, social inclusion and human dignity in the urban space, fundamental themes for the development of a more equitable society. After all, guaranteeing the right to the city is to ensure that everyone has a place where they can feel they belong, that their needs are met and that their voices are heard, thus contributing to the construction of a more just and solidary city (Lefebvre, 1999).

Approaching this theme from the reality of the Jurema Barra community provides a significant opportunity to reflect on urban inequalities and the ways of coping that, through land regularization, can be significantly expanded. The territorial cut of the community reveals the importance of local initiatives aimed at improving the quality of life of residents, such as social inclusion, education and health projects. At the same time, the presence of community leaders and social movements is essential for the claim of rights and to ensure the participation of the population in public policies (Welter, 2019).

In the development of the research, qualitative and quantitative data were collected from the community, with the help of data from the Brazilian Institute of Geography and Statistics (IBGE) and the Municipal Master Plan, in addition to semi-structured interviews, photographic records and cartographic production. These procedures allowed us to

understand the perceptions about the right to the city and to analyze how land regularization can impact the life of the community.

Finally, the importance of the right to the city as an instrument of social transformation and the need to take a close look at the realities of marginalized communities are highlighted, reaffirming that land regularization is an essential step towards the construction of fairer and more inclusive cities (Rodrigues, 2016).

2 THEORETICAL FOUNDATION

2.1 RIGHT TO THE CITY

The concept of "right to the city", as proposed by the French philosopher Henri Lefebvre (2008), constitutes a provocative and fundamental approach to understanding contemporary urban dynamics and the struggle for social justice in cities. This idea emerges in a context marked by rapid and often uncontrolled urbanization processes, which generate deep social and spatial inequalities, raising a central debate about who actually has access to the city and to whom urban spaces belong (Battaus et al., 2016).

The right to the city also involves a critique of forms of urbanization that prioritize capital and profit over social needs. Cities, often shaped by private interests, tend to constitute spaces of socio-spatial segregation, in which peripheries and low-income groups are systematically marginalized (Santin, 2018).

In addition, the notion of the right to the city is closely related to the idea that urban space should guarantee decent living conditions for all citizens, ensuring not only access to basic services, but also opportunities for personal and community development. In this sense, it is essential to ensure that public spaces are accessible and inclusive, promoting social interaction, culture, education, and collective coexistence, essential elements for the construction of fairer and more democratic cities (Santin, 2018).

2.2 LAND REGULARIZATION

Land regularization is a topic of great relevance in Brazil, especially in view of the scenario of accelerated urbanization and the history of social inequality that permeates the use and occupation of urban land (Santos, 1998). The issue of land titling, legal certainty, and social inclusion is at the heart of this process, which seeks to solve problems related to ownership and access to land, especially for low-income families living in informal areas (Battaus et al., 2016).

Land regularization involves a set of actions aimed at guaranteeing the right to property and security of tenure of occupied land, promoting citizenship and dignity of people who often

reside for long periods in areas of irregular occupation, devoid of adequate infrastructure and public services (Lira, 2017).

This process can be understood from two major perspectives: the regularization of informal urban centers and the regularization of rural properties. Both present specific challenges and require different approaches for their effectiveness (Rodrigues, 2016).

In the urban context, the presence of "baixadas" and irregular allotments is one of the main problems faced by large Brazilian cities. In view of this scenario, several public policies have sought to address this reality, such as legislation aimed at land regularization, which aims to recognize and formalize the ownership of land occupied by its residents, promoting greater legal certainty and social inclusion (Battaus et al., 2016).

Space is, at the same time, a product and a condition of human actions. It is formed by a set of historically constructed forms that keep within themselves the marks of the social relations that gave rise to them. As such, space is materiality and is also a witness, a framework and a means of social life, an active element of history and society. (SANTOS, Milton. *The Nature of Space: technique and time, reason and emotion*. São Paulo: Hucitec, 1996, p. 63).

Among the initiatives highlighted is Federal Law No. 13,465/2017, which establishes guidelines and procedures for urban and rural land regularization, promoting, on the one hand, the regularization of urban areas and, on the other hand, the guarantee of land tenure to those who inhabit it. This legislation has proven to be fundamental for the implementation of land regularization programs, although it still faces challenges related to bureaucracy and the lack of articulation between the different levels of government (Santin, 2018).

In the rural context, the process of land regularization is equally complex, involving the titling of small farmers, agrarian reform settlers and the formalization of properties that, in many cases, do not have adequate documentation (Lira, 2017).

The implementation of land regularization in rural areas is fundamental for food security, sustainable development and the promotion of new economic opportunities for these communities. Access to land is a fundamental right that, when guaranteed, can boost local development, strengthen the regional economy and contribute to environmental preservation (Rodrigues, 2016)

For Saule Jr (2018, p.45):

An important point in land regularization is the need for an integrated approach that considers the needs of communities and the social, economic, and environmental aspects of the surroundings. The participation of the population in the regularization process is fundamental; Listening to the voices of residents and fostering the co-creation of solutions is essential to achieving an effective outcome. In addition, the

inclusion of geographic information technologies, such as the use of drones and georeferencing systems, has proven to be a valuable tool for the identification of properties and the preparation of regularization plans

However, land regularization is not a simple solution and may face resistance from different sectors of society, including real estate interests and the absence of political will in certain spheres of public power. The construction of a fairer and more inclusive city necessarily involves overcoming these obstacles, requiring an effective commitment from governments to public policies that guarantee the right to decent housing and property (Santin, 2018).

Finally, land regularization is an important mechanism for social and economic transformation, as it seeks to correct historical-geographical injustices, ensure the right to the city and promote urban development. It is a process that requires time, dedication and the collective effort of different social actors, including the government, civil society and the communities involved. Thus, promoting land regularization is, above all, a matter of spatial justice and a fundamental step towards building a more equitable future for all (Santin, 2018).

3 METHODOLOGY

The methodology of this article is based on a qualitative and quantitative approach, with the objective of analyzing the relationship between land regularization and the right to the city, having as a spatial cut the Jurema Barra community, located in the municipality of Ananindeua, in the state of Pará. To achieve the proposed objectives, a field research was carried out that involved the collection of primary and secondary data.

Initially, a comprehensive bibliographic review was developed on the concepts of land regularization and the right to the city, enabling a theoretical deepening on the main conceptual approaches and legislation pertinent to the theme. This stage constituted the theoretical basis for the analysis of the context of the community studied, as well as the public policies related to the theme.

The field research included semi-structured interviews with approximately five residents of the Jurema Barra community, including representatives of local associations. The interviews aimed to capture the perceptions of the interviewees about the land situation of the community, the difficulties faced in daily life and the relationship between land regularization and access to urban rights, such as decent housing, infrastructure and public management services.

According to Gil (2019), qualitative research uses techniques such as interviews, participant observation, and focus groups, allowing the capture of perceptions, feelings, and

meanings attributed by the subjects to their experiences. These methods enable a deeper and more contextualized understanding of social phenomena. The same author points out that quantitative research is characterized by the use of statistical techniques for data analysis, and is indicated when it is intended to quantify information and generalize results to a wider universe, through structured instruments, such as questionnaires with closed questions.

In addition to the interviews, direct observations were carried out in the community, which allowed a deeper understanding of the living conditions of the residents and the characteristics of the urban space. This qualitative method proved to be fundamental to identify the social and economic dynamics present in the territory, as well as the daily practices that evidence the struggle for rights. According to Pereira (2014), qualitative research seeks to understand the complexity of social phenomena from an interpretative perspective, using methods such as interviews, focus groups, document analysis and participant observation.

In addition, the analysis of official documents — such as master plans, land regularization legislation and reports from public agencies — complemented the research, offering an overview of the public policies implemented in Ananindeua and their relationship with the reality of the Jurema Barra community.

The collected data were predominantly analyzed qualitatively, through the technique of content analysis, enabling the identification of emerging thematic categories from the interviews and observations carried out. This procedure allowed a critical reflection on the effectiveness of land regularization policies and their ability to guarantee the right to the city to the residents of the community studied.

Finally, the methodology adopted sought not only to understand the challenges faced by the Jurema Barra community with regard to land regularization, but also to contribute to the debate on the right to the city, emphasizing the importance of social participation and the recognition of local specificities in the construction of fairer and more inclusive public policies.

The analysis of the results obtained intends, therefore, to offer subsidies for the formulation of strategies that promote the realization of urban rights, aiming at improving the quality of life of the inhabitants of the community.

The cartography elaborated within the scope of the research is not limited to the representation of physical space, but also reveals the social, political and economic relations that permeate urban life. In a context in which spatial justice and the right to the city assume centrality in the academic debate, cartographic representation is configured as a fundamental tool to highlight socio-spatial inequalities and collective claims.

The Jurema Barra community has geographical characteristics that express the complexity of Brazilian peripheral urbanizations, marked by the struggle for basic infrastructure, public services and fundamental rights. The notion of space adopted in this study goes beyond mere geographic location, encompassing the experiences of the residents, their historical trajectories and social demands. Thus, analyzing this territory implies considering how public policies — or the absence of them — influence local social organization.

Spatial justice refers to the search for equity in the distribution of resources and opportunities in the urban territory, an aspect that is especially relevant in Jurema Barra, where access to health, education and security is still unequal. Through contemporary cartographic production, incorporating tools such as geoprocessing and Geographic Information Systems (GIS), it becomes possible to visualize these inequalities more clearly, subsidizing the formulation of fairer public policies.

In addition, the concept of the right to the city, as proposed by Henri Lefebvre (1991), resonates significantly in contexts such as that of the Jurema Barra community. This right involves not only access to physical urban space, but also effective participation in the decisions that shape urban daily life. Cartographic representations, in this sense, can contribute to amplifying local voices in debates on urban planning and territorial development.

Referencing recent cartographic productions on the Jurema Barra community is essential not only to record the spatial transformations over time, but also to understand the social struggles present in the territory. Studies carried out by institutions such as the Brazilian Institute of Geography and Statistics (IBGE) and by academic centers, especially since 2021, have contributed to the production of geographic data aimed at analyzing the socioeconomic conditions of Brazilian peripheral areas.

4 RESULTS AND DISCUSSIONS

4.1 FORMATION OF THE JUREMA BARRA COMMUNITY

The Jurema Barra Community, located in the Levilândia neighborhood in Ananindeua, in the state of Pará, is a significant example of how urban communities develop in contexts of social, economic, and spatial inequality. The history of this community reflects a series of social, political, and economic transformations that have marked the region over the last few decades (Alencar, 2017)

Figure 2

Jurema Barra Community



Source: Author herself, 2025.

Ananindeua, located in the Metropolitan Region of Belém, has experienced an accelerated population growth, especially since the 1980s. This growth was driven by an intense process of rural-urban migration, in which thousands of people left rural areas in search of better job opportunities and quality of life in urban centers.

The Jurema Barra community, which emerged in this context, is characterized by about 200 families in a situation of housing irregularity, with houses built, for the most part, without adequate urban planning. This reality reflects the resistance of its residents in the struggle for space, recognition and dignity.

The development of the community is directly related to the history of occupation of the territory, marked by processes of invasion and the constant struggle for rights. The first inhabitants of Jurema Barra faced numerous challenges, such as the absence of basic

infrastructure, limited access to public services — especially health and education — and the precariousness of housing. Over the years, the community began to organize itself collectively, creating residents' associations aimed at demanding improvements and recognition by the government (Barros, 2019).

As of 2020, the Jurema Barra community began to gain greater visibility, mainly due to initiatives promoted by non-governmental organizations and the strengthening of an internal social movement that achieved notoriety in the region. These mobilizations brought to light demands related to land regularization, access to drinking water, basic sanitation, and education.

The community mobilization resulted in some achievements in the territory, such as the implementation of water supply projects through individual artesian wells, the installation of electricity poles and occasional improvements in infrastructure, carried out, in large part, by the residents themselves. However, several challenges still persist, as pointed out by the majority of respondents in this survey, especially urban violence and social exclusion, factors that directly impact the quality of life of the local population.

The social context of Jurema Barra is marked by a rich cultural diversity, reflecting the different origins of its inhabitants. The community is composed mostly of residents from municipalities in the interior of the state, such as Santa Izabel do Pará, Castanhal and Vigia, as well as individuals of different ethnicities who migrated to the Metropolitan Region of Belém in search of better life opportunities. This cultural plurality is manifested in festivities, traditions and forms of coexistence, strengthening social ties and community identity, even in the face of adversity.

In recent years, the Jurema Barra community, located in the Levilândia neighborhood, has faced the impacts of urban policies and economic transformations that often disregard local needs. Located in the area bordering the middle-class neighborhood of Cidade Nova, in Ananindeua, the community suffers from growing real estate speculation and the effects of gentrification, phenomena that threaten the permanence of residents in the territory. The real estate appreciation in the region can result in an increase in the cost of living and the expulsion of the most vulnerable populations.

In addition, the COVID-19 pandemic has highlighted and intensified the social fragilities of the Jurema Barra community. The health and economic crisis severely affected families, many of whom were already in a situation of socioeconomic vulnerability. The lack of adequate access to information and health services has further aggravated this scenario.

In the face of these challenges, the residents of Jurema Barra have developed strategies of resistance and solidarity. Collective initiatives, such as the formation of support

groups, the realization of clean-up efforts and donation campaigns, proved to be fundamental for strengthening community bonds and promoting social resilience.

The future of the Jurema Barra community will depend, to a large extent, on the organizational capacity of its residents to claim rights, as well as on the willingness of the public authorities to dialogue and implement public policies that actually meet the needs of the local population. The recognition of community participation and the strengthening of citizenship are central elements for the construction of a more just, inclusive and egalitarian future for all inhabitants of the region.

4.2 CHALLENGES OF LAND REGULARIZATION AND THE RIGHT TO THE CITY IN JUREMA BARRA

Land regularization is a central theme in discussions about the right to the city, especially in urban areas that face historical challenges of irregular occupation, as is the case of the Jurema Barra community, located in Ananindeua, in the state of Pará.

The city of Ananindeua, being one of the most populous in the Metropolitan Region of Belém, faces a series of problems related to accelerated urbanization and the lack of urban planning, which result in a scenario of inequality and social exclusion. In the Jurema Barra community, many families live in a situation of vulnerability, occupying land without documentation, which generates legal uncertainty and limits access to essential services.

One of the main challenges of land regularization in this community is the articulation between the different levels of government and civil society. Often, public policies are not sufficiently integrated, which makes it difficult to carry out regularization processes that meet local needs. In addition, the lack of information and awareness of territorial rights among residents is a significant obstacle. Many people are unaware of the legal procedures necessary for the regularization of their properties or are afraid to engage in processes that they perceive as complicated or bureaucratic (Alentejano, 2018).

Another important challenge is the issue of infrastructure. Land regularization is not just about land titling, but also involves ensuring access to basic services, such as water, sewage, electricity, and transportation. In the Jurema Barra community, the precariousness of urban infrastructure is a reality, and many residents face daily difficulties due to the lack of these services (Carneiro, 2017).

In the article by Leidy Laura de Carvalho (2021) entitled "Restructuring the City and the New Expressions of Urban Centrality in the City of Ananindeua, Pará Amazon", the author analyzes how urban dynamics have been transformed in Ananindeua, highlighting the spatial

and social restructuring that impacts the lives of its inhabitants. Carvalho argues that, as the city expands, new urban centers emerge and redefine the concept of centrality.

The analysis made by the author highlights that the new expressions of centrality in Ananindeua are not only reflections of urban growth, but are also influenced by economic, social and political factors. Such changes indicate a fragmentation of the traditional urban space, where previously peripheral areas gain economic and social importance. As a result, new commercial centers and services emerge that challenge the role of traditional city centers.

In addition, Carvalho (2021) discusses the impact of these transformations on urban mobility and social relations within the community. The restructuring of the city brings with it both opportunities and challenges for the local population. While some groups can benefit from easier access to new services and infrastructure, others face the risk of social exclusion as public spaces reorganize themselves under new market logics.

The author also emphasizes the importance of popular participation in the urban planning process to ensure a more egalitarian city. She suggests that residents' voices should be considered in discussions about urbanization to promote more inclusive development in Ananindeua. Thus, the article concludes on the urgent need for public policies that address these emerging inequalities and create effective guidelines for managing urban growth.

Therefore, the work of Leidy Laura de Carvalho offers a critical look at the urban reconfigurations in Ananindeua, showing how they are participants in the new social and economic dynamics of the Pará Amazon and highlighting the relevance of understanding these changes for a fairer future in urban management.

4.3 SPATIAL PRACTICES AND THE RIGHT TO THE CITY

Spatial practices represent the way in which subjects use, transform and signify space in everyday life. Such actions go beyond simple physical occupation: they reflect disputes for visibility, permanence, and social justice within the urban territory. In the context of the peripheries and popular communities, these practices often take forms of resistance in the face of exclusionary urban policies, real estate speculation, and gentrification.

Henri Lefebvre (2001) proposes the concept of the right to the city as the right of all inhabitants not only to access urban goods and services, but to actively participate in the production of urban space. For him, the city should be appropriated by those who live in it, and not controlled only by the interests of the market and capital.

David Harvey (1980), influenced by Lefebvre, complements this thought by stating that spatial practices shape and are shaped by social relations, which makes it impossible to

understand urban space without considering the social process that constructs it. Thus, the space becomes the stage for conflicts, but also for possibilities of transformation.

Geographer Milton Santos (1996) reinforces that space is not static: it is a condition, a means and a product of social practices. In his reading, urban space is always the result of the interaction between technique, time, work and power relations. In the Brazilian peripheries, for example, the spatial practice of self-construction of houses, the organization of collectives and the occupation of land reveal concrete ways of confronting exclusion and claiming the right to the city.

In this way, discussing spatial practices is also discussing who has the power to decide on the use and organization of space, highlighting the inequalities, but also the resistances present in the daily life of cities.

In the interviews with the residents of the subdivision, the right to the city did not emerge in the identification with private property, since, in the narratives, the deed of ownership of the property was not considered a latent "concern". But the question of belonging to the space emerged in terms of its use, the form of appropriation of the house and the claim of space around the house.

- Interview – Resident 1

Interviewer: Hello! Thank you for accepting to participate in this interview. Let's talk a little about your experience as a resident of the Jurema Barra community, especially in relation to land regularization and the right to the city. To start, could you introduce yourself and tell us a little about your story here in the community?

Resident 1: Hello! My name is Maria, I'm 35 years old and I've lived here in Jurema Barra for 4 years. I came from a small town in search of better opportunities. Here in the community, life is difficult, but we support each other a lot.

Interviewer: Thank you, Maria! You mentioned the search for better opportunities. How do you see the issue of land regularization in your community? Do you think this is important?

Resident 1: Yes, I think it's very important. Land regularization would bring more security to us, residents. Today, we live in fear of being evicted, and this generates a lot of insecurity. If we had our land regularized, we could invest more in our houses.

Interviewer: I see. And have you had access to information about how the land regularization process works?

Resident 1: Unfortunately, no. Few people here understand how it works. Sometimes, an agent from the city hall comes, but the information is not clear. We end up depending on rumors and information from neighbors.

Interviewer: That's an important question. And, in relation to the right to the city, how do you believe that the lack of land regularization affects life in the community?

Resident 1: The lack of regularization makes us invisible. We do not have access to basic services, such as sanitation, and this affects the health of our family. Without a document that proves that we live here, it is difficult to claim our rights.

Interviewer: And do you know of any initiative or project that seeks to help the community in this regard?

Resident 1: I have heard about some NGO projects that try to help, but most people here do not have access to this information. We need more dissemination and support to understand how we can participate.

Interviewer: To conclude, what would you like to see happen in your community in relation to land regularization and the right to the city?

Resident 1: I would like there to be more dialogue between the city hall and the community. We need workshops, lectures, something that helps us understand our rights and the importance of regularization. In addition, it would be great to have access to basic services to improve our quality of life.

Interviewer: Thank you very much for your participation, Maria. Your answers are very valuable and help to better understand the reality of JuremaBarra.

Resident 1: I thank you for the opportunity to talk about our community! I hope things get better for all of us.

The resident, when reporting that she has lived in the community for four years and that she is looking for better opportunities, expresses a migratory dynamic common in the Brazilian urban peripheries, marked by the search for access to the city, work and decent housing. However, the absence of land regularization generates a cycle of insecurity and precariousness, in which the fear of eviction is constant, limiting investments in the improvement of homes and community structure (Rolnik, 2019).

The talk about misinformation in relation to regularization processes reflects a recurring reality in peripheral communities, where communication between the government and residents is flawed or non-existent. This demonstrates a deep gap in the implementation of urban policies, which, according to the City Statute (Law No. 10,257/2001), should be based on democratic management, access to information and popular participation (Brasil, 2001).

In addition, the resident points out that the lack of regularization makes the community invisible in the eyes of the State, which compromises access to fundamental rights such as basic sanitation, health and safety. This scenario dialogues with the concept of spatial justice, which, according to Santos (2020), consists of the equitable distribution of resources, services, and opportunities in the territory. The absence of this justice contributes to the

reproduction of socio-spatial inequalities, keeping communities like Jurema Barra on the margins of urban benefits.

The testimony also highlights the disconnect between civil society initiatives, such as NGOs, and the community itself, which is often unaware of the existence of these projects. This reveals the urgent need for inclusive communication policies, as well as training processes that empower residents over their territorial rights, as Fernandes (2011) proposes, when he states that land regularization should not be just a bureaucratic process, but a collective construction that strengthens social belonging and citizenship.

When the interviewee suggests holding workshops, lectures and strengthening the dialogue with the government, she directly signals the importance of popular participation in the construction of urban policies. This perspective is supported by scholars such as Souza (2021), who argue that the right to the city is only realized when there is effective participation of citizens in the formulation and implementation of decisions that impact their territory.

Therefore, the analysis of the interview reveals that the challenges faced by the Jurema Barra community go beyond the land issue; involve social recognition, access to urban services and, above all, the right to fully exist in the urban space. The search for land regularization is not only a legal demand, but a struggle for dignity, citizenship and the realization of the right to the city, which, according to Lefebvre (2001), should be understood as the collective right to transform, inhabit and appropriate urban space in a fair and democratic way.

- Interview — Resident 2

Interviewer: Hello! Thank you for accepting to participate in this interview. Let's talk a little about your experience as a resident of the Jurema Barra community, especially in relation to land regularization and the right to the city. To start, could you introduce yourself and tell us a little about your story here in the community?

Resident 2: Hi! My name is Ana Paula, I'm 26 years old. I have lived here in Jurema Barra for 3 years. I came with my husband and my two young children. We came because the rent was very expensive in another neighborhood, and here we got a piece of land to build our house.

Interviewer: How do you see the issue of land regularization in your community? Do you think this is important?

Resident 2: I think it's super important. Having the house in our name would give us more peace of mind. Today, we always have that fear of losing everything. Without a document, we don't have security.

Interviewer: Have you ever had access to information about how the land regularization process works?

Resident 2: Not much. We hear comments from neighbors, but official information, no one brings it to us. I, for example, don't even know where to start.

Interviewer: How do you believe that the lack of land regularization affects life in the community?

Resident 2: Affects too much. There is a lot missing here: health center, transportation. I think that, if we had documents, it would be easier to demand these things from the city hall.

Interviewer: Do you know of any initiative or project that seeks to help the community in this regard?

Resident 2: I don't know. I've heard that there are residents' associations trying to fight for improvements, but it's difficult for us to participate, because a lot of people work all day.

Interviewer: What would you like to see happen in your community in relation to land regularization and the right to the city?

Resident 2: I would like us to have our house legalized and access to basic services. I also wanted the city hall to look more out of us, especially the children.

Interviewer: Thank you very much for your participation. Your answers are very valuable and help to better understand the reality of Jurema Barra.

Resident 2: Thank you, I hope this research helps all of us in some way.

The second interview reinforces and deepens the understanding of the challenges faced by inhabitants in situations of irregular urban occupation. Ana Paula's story reflects a reality that is very present in the Brazilian urban peripheries, marked by forced migration in search of housing alternatives, mainly due to the high costs of rents in other regions of the city.

By highlighting that she moved to the community because she could not afford the costs of formal housing, the interviewee shows how socio-spatial segregation is reproduced in urban dynamics, pushing low-income families into informal territories and often unassisted by the government (Rolnik, 2019). This situation reveals the exclusionary face of the real estate market, which restricts access to decent housing to a significant portion of the population, deepening urban inequalities.

The interviewee's perception of the importance of land regularization demonstrates that the right to housing is not limited only to physical access to space, but also to the legal guarantee that allows security of tenure and stability. This understanding dialogues directly with the principles of the Statute of the City (Law No. 10,257/2001), which establishes that the right to the city must ensure decent housing, social inclusion, access to urban services and participation in the management of cities (Brasil, 2001).

In addition, when Ana Paula reports that she does not know how the land regularization process works, she reveals a critical absence of public policies for information and technical, social and legal assistance. As Fernandes (2011) states, land regularization needs to be understood not only as a technical procedure, but as a social process that must be linked to the strengthening of citizenship and urban rights.

Another relevant point of the statement is the direct association that the resident makes between the absence of regularization and the precariousness of public services in the community. She points out the lack of health and transportation units, which reinforces the thesis that, without the legal recognition of occupations, there is a structural difficulty in implementing essential urban equipment. This reality refers to Santos' (2020) discussions on spatial justice, which highlights how inequality in access to urban resources and services generates deep territorial injustices.

When he mentions that there are residents' associations fighting for improvements, but that participation is made difficult by the population's working day, another central aspect of the urban problem is evident: the incompatibility between participatory processes and the real living conditions of the working population of the peripheries. Souza (2021) observes that, although democratic management is a fundamental principle of urban policies, it often does not consider the concrete barriers that prevent the effective participation of citizens, especially the most financially needy.

Finally, the interviewee's expectation of having her house regularized and ensuring access to basic services, especially thinking about children, reveals the intergenerational dimension of the struggle for the right to the city. This fight is not only for housing security, but also for building a future with more dignity and access to urban opportunities.

Thus, the interview reinforces that land regularization is not an isolated demand, but is intrinsically linked to the realization of urban rights, the overcoming of socio-spatial inequalities and the construction of fairer, more inclusive and democratic cities (Lefebvre, 2001).

- Interview – resident 3

Interviewer: Hello! Thank you for accepting to participate in this interview. Let's talk a little about your experience as a resident of the Jurema Barra community, especially in relation to land regularization and the right to the city. To start, could you introduce yourself and tell us a little about your story here in the community?

Resident 3: Hi, how are you? My name is Seu Antônio, I'm 62 years old. I have lived here in Jurema Barra for 7 years. I came here after retiring. I couldn't buy a house elsewhere, so I built it here with the help of my children.

Interviewer: How do you see the issue of land regularization in your community? Do you think this is important?

Resident 3: Absolutely. I'm not young anymore, right? I wanted to make my home safe for my children and grandchildren. Without a document, everything is uncertain. We are even afraid to improve the house.

Interviewer: Have you ever had access to information about how the land regularization process works?

Resident 3: Very little. We hear that there is regularization in other communities, but no one has ever come here to explain it properly. It's all word of mouth.

Interviewer: How do you believe that the lack of land regularization affects life in the community?

Resident 3: Without a doubt, it gets in the way too much. Here there is a lack of security, lighting, a health center. Without a document, it seems that we don't even exist on the map.

Interviewer: Do you know of any initiative or project that seeks to help the community in this regard?

Resident 3: I heard that there are people organizing a petition, but so far I have not seen any results. I think there is a lack of support for these initiatives to grow.

Interviewer: What would you like to see happen in your community in relation to land regularization and the right to the city?

Resident 3: I wanted everyone to have their documents in hand. So we could ask for our rights like any citizen.

Interviewer: Thank you very much for your participation. Your answers are very valuable and help to better understand the reality of Jurema Barra.

Resident 3: I thank you! I hope this research brings changes to us.

The interview with Seu Antônio, a resident of the Jurema Barra community for seven years, adds an intergenerational perspective to the debate on land regularization, the right to the city and spatial justice. His report is loaded with not only personal but also family concerns, since he expresses the desire to ensure housing security for his children and grandchildren, which demonstrates how the absence of regularization not only impacts the present, but also compromises the future of families living in situations of urban informality.

Seu Antônio's trajectory reflects a recurring pattern in the Brazilian urban peripheries, where retirement, often insufficient for access to the formal housing market, leads the elderly to seek alternatives in areas of informal occupation. This reality highlights the structural failure of the State to guarantee adequate housing for the elderly population, deepening socio-spatial inequalities (Rolnik, 2019).

By mentioning that he avoids making improvements to his house because he does not have documentation, the resident confirms one of the main consequences of the lack of land regularization: the insecurity of tenure. This insecurity not only prevents investments in housing improvement, but also generates psychological and economic impacts, reinforcing the cycle of social vulnerability (Fernandes, 2011).

Another important point is the clear perception that, without documentation, the community remains invisible to the eyes of the government, which results in the absence of essential infrastructure, such as public safety, lighting, health centers and adequate transportation. This condition of urban invisibility is directly linked to the concept of spatial justice, where, according to Santos (2020), the poor distribution of resources, services, and rights in the urban space accentuates processes of territorial marginalization.

Seu Antônio's speech also reveals the fragility of community initiatives, such as the petition cited. Although he demonstrates an attempt at social organization, he expresses discouragement at the lack of institutional support. Souza (2021) reinforces that, without the proper technical, legal, and logistical support, popular mobilizations are limited, which makes it difficult to enforce the right to the city and build truly democratic urban management.

The resident's desire to see the entire community with its documents regularized clearly expresses the understanding that formal land ownership is an essential condition for accessing urban rights. This desire dialogues directly with the principles established in the Statute of the City (Law No. 10,257/2001), which guarantees that all citizens have the right to decent housing, infrastructure, urban services and participation in decisions that affect their territories (Brasil, 2001).

Therefore, Seu Antônio's interview synthesizes a common reality in the Brazilian peripheries: aging in precarious territories, without legal guarantees, without full access to the city and at the mercy of public policies that do not arrive. His testimony is, above all, a silent cry for recognition, dignity and urban justice, reaffirming that the struggle for land regularization goes beyond a document; it is the struggle for full citizenship and the right to the city, as defended by Lefebvre (2001).

- Interview – Resident 4

Interviewer: Hello! Thank you for accepting to participate in this interview. Let's talk a little about your experience as a resident of the Jurema Barra community, especially in relation to land regularization and the right to the city. To start, could you introduce yourself and tell us a little about your story here in the community?

Resident 4: Hi! My name is Lucas, I'm 19 years old. I was born nearby and have lived in Jurema Barra for about 5 years, along with my mother and my brothers. We built our little house slowly.

Interviewer: How do you see the issue of land regularization in your community? Do you think this is important?

Resident 4: A lot! To have a document is to have dignity. Without regularization, we can't even make a loan, we can't reform properly. We are always in uncertainty.

Interviewer: Have you ever had access to information about how the land regularization process works?

Resident 4: Not much, no. Only what we hear from neighbors. No one from the city hall came here to explain it properly.

Interviewer: How do you believe that the lack of land regularization affects life in the community?

Resident 4: Affects everything. Without a document, we can't improve. The street is full of holes, there is a lack of sanitation. And the new people here, like me, miss opportunities.

Interviewer: Do you know of any initiative or project that seeks to help the community in this regard?

Resident 4: There are some social sports projects that help get young people off the street, but about land regularization, I don't know of any strong ones.

Interviewer: What would you like to see happen in your community in relation to land regularization and the right to the city?

Resident 4: I wish there was more information for us to organize. I also wanted it to have more leisure spaces, more security and, of course, to have our house document.

Interviewer: Thank you very much for your participation. Your answers are very valuable and help to better understand the reality of Jurema Barra.

Resident 4: You're welcome. Good morning

The fourth interview, conducted with Lucas, a 19-year-old young man, brings to light an important generational perspective on the challenges of the Jurema Barra community, especially with regard to the right to the city and land regularization. The trajectory of Lucas and his family, who built their home little by little, reflects the reality of thousands of Brazilian families who, without access to the formal housing market, resort to land occupation as an alternative to urban exclusion (Rolnik, 2019).

The young man evidences right at the beginning that land regularization is synonymous with dignity, especially when he states that "having a document is having dignity". This perception reveals a mature understanding of how the legal recognition of possession directly impacts quality of life, social stability, and the possibility of accessing rights and opportunities. This statement dialogues with the principles of the Statute of the City

(Law No. 10.257/2001), which establishes that the social function of urban property is conditioned to access to housing, public services and participation in urban life (Brasil, 2001).

The absence of official information about the regularization processes is a recurring point in the four interviews conducted and, in Lucas' case, this factor gains even more relevance. The lack of communication on the part of the public authorities demonstrates not only a failure in urban management, but also a practical denial of the right to information, which is fundamental for citizens to be able to claim their territorial rights (Fernandes, 2011).

In addition, Lucas points out that the lack of regularization not only affects housing security, but also directly impacts the community's infrastructure, with potholed streets, absence of basic sanitation, lack of leisure spaces and opportunities for young people. This perception is in line with the concept of spatial justice discussed by Santos (2020), who points out that inequality in access to urban resources generates not only material deprivation, but also social, economic, and symbolic exclusion.

The fact that the interviewee mentions social projects focused on sports as one of the few initiatives present in the community reveals both the absence of structuring public policies and the importance of community and civil society actions in mitigating the effects of exclusion. However, the lack of specific projects for land regularization shows a weakness in the articulation between the demands of the community and the performance of public agencies (Souza, 2021).

When Lucas expresses the desire for more spaces for leisure, security and, above all, the regularization of land, he shows that the right to the city, a concept centered on the discussions of Lefebvre (2001), goes far beyond physical access to the territory. It is about the right to participate, to enjoy urban benefits, to feel belonging and to live with dignity. This is even more urgent when young people, as in the case of Lucas, see their perspective for the future compromised by the absence of effective public policies.

Therefore, the analysis of Lucas' speech reveals that the absence of land regularization and participatory urban planning not only generates physical precariousness, but also deepens the feeling of insecurity, marginalization and lack of perspective, especially for young people from the peripheries. The struggle of the Jurema Barra community, therefore, is not only for documentation, but for full citizenship, dignity and urban inclusion.

We can observe in Jurema Barra, the experience of the right to the city is manifested in the daily practices of the inhabitants, who seek to transform their urban space into a fairer and more accessible place. The community, characterized by cultural and socioeconomic diversity, faces challenges typical of growing urban areas, such as the lack of adequate

infrastructure, limited access to public services, and the need for living spaces (Almeida, 2014).

The daily practices of the residents reflect in the search for improvements. Community meetings, for example, are a fundamental space where residents discuss their needs and collective planning (Barros, 2019).

4.4 BENEFITS OF LAND REGULARIZATION

Land regularization is a central theme in Brazilian urban policies, especially in cities that face intense processes of informal occupation and disorderly expansion, as occurs in Ananindeua, in Pará. In the survey carried out with residents of the Jurema Barra community, it was observed that this process is perceived as fundamental to ensure legal security, access to public services and appreciation of housing. According to the testimonies of four interviewees, the main benefits mentioned were: the tranquility of having the land legalized, the possibility of investing in home improvement, and easy access to social programs.

In this context, it is important to highlight the role of the Municipal Master Plan, a basic instrument of urban policy provided for in the City Statute (Law No. 10,257/2001). The Master Plan of Ananindeua establishes guidelines for the use and occupation of the land and can enable and guide the introduction of public policies aimed at land regularization, prioritizing the right to decent housing and the territorial inclusion of historically marginalized communities. The compatibility between the reality of the occupations and the urban goals of the Master Plan is essential to ensure that regularization does not occur in isolation, but as part of an integrated strategy of urban development and social justice.

4.5 CHALLENGES AND LIMITATIONS OF THE PROCESS

The process of land regularization faces a series of limitations that hinder its effectiveness and the full realization of the right to the city for the inhabitants of the community.

One of the main limitations of the land regularization process in Jurema Barra is the lack of accurate and up-to-date mapping of the occupied areas. Often, the available information is scarce or outdated, which compromises the development of effective public policies and the implementation of regularization actions. Without a clear diagnosis of the land tenure situation, it becomes challenging to identify which areas can be regularized and which are in an irregular situation, leading to inefficient management of the territory (Carvalho, 2019).

In addition, the bureaucracy involved in the necessary procedures for land regularization is a significant obstacle. The processes are often lengthy and complex, which

discourages residents from seeking the regularization of their properties. The lack of information and adequate guidance on the rights and duties of those who occupy informal land also contributes to the lack of interest or the abandonment of seeking the formalization of possession (Brás, 2018).

Another limiting factor is the resistance of some spheres of government to recognize and promote land regularization. In many cases, the view that informal occupations are problematic leads to a punitive approach, rather than a perspective that seeks to integrate these communities into the urban fabric in a sustainable way. This attitude can result in eviction and eviction actions, which not only violate the right to housing, but also perpetuate social exclusion and marginalization of residents (Bartoli, 2017).

The issue of infrastructure is equally critical. Many communities, including Jurema, lack basic services such as clean water, sewage, electricity, and public transportation. The absence of these essential conditions makes land regularization even more complex, since the formalization of land ownership without the proper infrastructure may not guarantee the improvement of the quality of life of residents. Thus, it is essential that regularization policies are accompanied by investments in infrastructure and public services (Alencar, 2017).

In addition, the lack of community participation in decision-making and urban planning processes is a significant limitation. Often, solutions to the problems faced by communities are elaborated without the consultation or involvement of the residents themselves, who know their needs and realities better. This exclusion can result in inadequate and ineffective measures, which do not meet the wishes of the local population (Castro, 2019)

Finally, the socioeconomic context of the Jurema Barra community also plays an important role in the limitations of the land regularization process. Poverty, unemployment and social vulnerability are factors that make it difficult for the community to mobilize in search of its rights. In addition, the lack of access to education and information can prevent residents from fully understanding the regularization process and its benefits, perpetuating a cycle of exclusion and marginalization (Cruz, 2017).

The limitations of the land regularization process in the Jurema community, in Ananindeua, are multifaceted and interconnected. For the right to the city to be effectively guaranteed, a joint effort is needed between the government, civil society and the residents themselves (Almeida, 2014).

Overcoming these barriers requires the implementation of more inclusive public policies, which prioritize land regularization, but which are also committed to infrastructure improvement, community participation and the promotion of decent living conditions for all

citizens. Only in this way will it be possible to transform the reality of the Jurema community and ensure that its inhabitants have full access to urban rights (Carvalho, 2019).

It was also analyzed with the research that the lack of documentation and the absence of effective public policies have generated serious impacts on the lives of the inhabitants of the Jurema Barra de Ananindeua community, in Pará. This situation reflects a problem that affects many Brazilians, especially those who live in more vulnerable areas. The difficulty in accessing basic documentation, such as birth certificates, RG and CPF, prevents many residents from fully exercising their rights, limiting their access to essential services, such as health, education and social assistance (Almeida, 2014).

Without proper documentation, many citizens face barriers to enrolling in social programs, obtaining medical care at health facilities, or even enrolling their children in schools. The lack of a simple civil registry can mean the exclusion of a person from various public policies that aim to ensure well-being and citizenship. In this context, the absence of effective public policies further aggravates the situation, since there are no initiatives that promote document regularization and that meet the specific needs of the community (Alencar, 2017).

In addition, the lack of government actions that prioritize social inclusion and citizenship results in a cycle of poverty and marginalization. Residents of Jurema Barra face difficulties not only in accessing basic services, but also in actively participating in the political and social life of the region. The lack of documentation makes them invisible, limiting their ability to claim rights and engage in democratic processes. Without the possibility of voting, for example, or participating in community meetings, these people find themselves excluded from decisions that affect their lives and their future (Carvalho, 2019).

The reality of the community is a reflection of a system that fails to guarantee fundamental rights. The absence of public policies that address the problem of documentation and promote social inclusion prevents the residents of Jurema Barra de Ananindeua from having access to resources and opportunities that could transform their lives. It is urgent that there be a joint effort between the governmental spheres and civil society to develop strategies that guarantee the regularization of documents and that promote public policies that meet the needs of the population (Almeida, 2014).

Only through effective actions, which consider the local reality and seek the inclusion of all citizens, will it be possible to reverse this situation of vulnerability and exclusion. The construction of a fairer and more egalitarian future for the Jurema Barra de Ananindeua community necessarily involves valuing citizenship and implementing policies that respect

and guarantee the rights of each individual, allowing everyone to have access to a dignified and full life (Carvalho, 2019).

5 FINAL CONSIDERATIONS

Land regularization emerges as a central issue in the debate on the right to the city, especially in urban contexts characterized by inequalities and informal occupations, as is the case of the Jurema Barra community, located in Ananindeua, PA. Throughout this work, it was possible to observe that land regularization is not limited only to the formalization of land tenure, but is also intertwined with the promotion of social rights, access to public services and the construction of a more inclusive and fair city.

The analysis of the reality of the Jurema Barra community reveals that the lack of documentation and the precariousness of the living conditions of the residents are reflections of an urbanization model that ignores the needs of the most vulnerable population. Land regularization, therefore, presents itself as a fundamental tool for transforming this reality, allowing residents to have legal certainty about their homes if they can claim essential services such as sewage, electricity and transportation.

In addition, the realization of the right to the city goes through a process of listening and participation of the community in decisions that affect its urban space. The inclusion of Jurema Barra residents in the planning and implementation of public policies is vital to ensure that solutions meet the real demands of the population. The strengthening of local leaders and the formation of community associations are strategies that can enhance the struggle for rights and the search for improvements in living conditions.

However, land regularization should not be seen as a panacea. It is essential that regularization initiatives are accompanied by integrated public policies that address social, economic, and environmental issues. The promotion of housing, infrastructure, health, and education programs must go hand in hand with regularization processes, ensuring that the dignity and quality of life of citizens are effectively ensured.

Finally, this study highlights the importance of articulation between different spheres of government, civil society and private entities in the construction of a more equitable city. Land regularization and the right to the city are interconnected issues that require a collective and continuous effort so that we can move towards a fairer society, where everyone has access to an urban space that respects their dignity and promotes their well-being.

The community of Jurema Barra, as well as many others in similar contexts, is a clear example of the urgency and relevance of this discussion, which must be prioritized in Brazil's political and social agendas.

REFERENCES

- Alencar, E. F. (2000). Entre rio e o lago: Conflito social e etnografia da pesca na várzea do Médio Amazonas. *Pós: Revista Brasiliense de Pós-graduação em Ciências Sociais da Universidade de Brasília*, 4, 121–144.
- Alentejano, P. R. (2018). As relações campo-cidade no Brasil do século XXI. *Terra Livre*, 2(21), 25–39.
- Almeida, A. W. B. de. (2014). Amazônia: A dimensão política dos “conhecimentos tradicionais”. In H. Acselrad (Org.), *Conflitos ambientais no Brasil* (pp. 37–56). Relume Dumará.
- Barros, O. F., Hage, S. M., & Tenório, E. M. (2019). Políticas de nucleação e transporte escolar: Construindo indicadores de qualidade da educação básica nas escolas do campo da Amazônia. In *Caderno de resumos do III Encontro Nacional de Pesquisa em Educação do Campo*. (Apresentação de trabalho). Brasília.
- Bartoli, E. (2017). O retorno ao território a partir da cidade: Sistemas territoriais urbano-ribeirinhos em Parintins (AM) [Tese de doutorado, Universidade Estadual Paulista].
- Battaus, D. M. de A., & Oliveira, E. A. B. de. (2016). O direito à cidade: Urbanização excludente e a política urbana brasileira. *Lua Nova: Revista de Cultura e Política*, 97, 81–106.
- Bras, M. W. (2018). Geografia da circulação: Uma análise da dinâmica do fluxo do transporte intra e interurbano, a partir da cidade de Cametá-PA [Trabalho de conclusão de curso, Universidade Federal do Pará].
- Brasil. (2001). Lei nº 10.257, de 10 de julho de 2001. Estatuto da Cidade. Dispõe sobre diretrizes gerais da política urbana e dá outras providências. *Diário Oficial da União*.
- Cardoso, A., & Claudia, D. (2016). O rural e o urbano na Amazônia: Diferentes olhares em perspectivas. EDUFPA.
- Carneiro, M. J. (2017). Do rural e do urbano: Uma nova terminologia para uma velha dicotomia ou a reemergência da ruralidade. In *Seminário sobre o Rural Brasileiro. Anais...* (pp. 1–16). NEA/IE/UNICAMP.
- Carvalho, E. C. L. (2017). O processo de colonização na Amazônia. *Revista Contribuciones a la Ciencias Sociales*.
- Castro, O. (2019). *Amazônia e tempo*. Vitória.
- Cruz, R. E. da, & Moura, A. P. M. de. (2017). A política do transporte escolar no Brasil. In XXVI Simpósio da ANPAE. (Comunicação oral). <http://www.anpae.org.br/simposio26/1comunicacoes/AnaPaulaMonteirodeMouraComunicacaoOral-int.pdf>
- Fernandes, E. (2011). *Direito urbano e interesse público: Questões fundamentais sobre a regularização fundiária no Brasil*. Del Rey.
- Lefebvre, H. (2001). *O direito à cidade* (5ª ed.). Centauro.
- Lira, R. P. (2017). Direito urbanístico, estatuto da cidade e regularização fundiária. *Revista de Direito da Cidade*, 1(1), 261–276.

- Rodrigues, A. M. (2016). A regularização fundiária de interesse social como possibilidade de realização do direito à cidade. In *Coloquio Internacional de Geocrítica: Las utopías y la construcción de la sociedad del futuro* (Vol. 14). (Anais...). Universidad de Barcelona.
- Rodrigues, J. C., & Rodrigues, L. L. de C. (2021). Na cidade de Ananindeua, Amazônia paraense. [Edição do autor].
- Rolnik, R. (2019). Territórios em conflito: São Paulo, espaço, história e política. Três Estrelas.
- Santin, J. R., & Comiran, R. (2018). Direito urbanístico e regularização fundiária. *Revista de Direito da Cidade*, 10(3), 1595–1621.
- Santos, M. (2020). Por uma outra globalização: Do pensamento único à consciência universal (23ª ed.). Record.
- Saule Jr., N., et al. (2018). A perspectiva do direito à cidade e da reforma urbana: Revisão da lei do parcelamento do solo. Instituto Polis.
- Souza, M. L. de. (2021). Mudar a cidade: Uma introdução crítica ao planejamento e à gestão urbanos (7ª ed.). Bertrand Brasil.
- Welter, I. P., & Pires, M. C. (2019). O direito à cidade sustentável. *Unoesc & Ciência – ACSA*, 1(1), 63–70.

AGRICULTURAL PRODUCTION OF CANNABIS AIMING TO INCREASE CANNABIDIOL (CBD) CONTENT FOR MEDICINAL PURPOSES – A REVIEW

A PRODUÇÃO AGRÍCOLA DA CANNABIS VISANDO O AUMENTO DO TEOR DE CANNABIDIOL (CBD) PARA FIM MEDICINAL – REVISÃO

PRODUCCIÓN AGRÍCOLA DE CANNABIS CON EL OBJETIVO DE AUMENTAR EL CONTENIDO DE CANNABIDIOL (CBD) CON FINES MEDICINALES – UNA REVISIÓN



<https://doi.org/10.56238/sevened2026.008-112>

Valéria de Campos Orsi¹, Larissa Rocha Camargo da Silva², Gabriela Rocha Vidal Silva³, Rafaela Orsi Pasiani⁴, Yoko Oshima-Franco⁵

ABSTRACT

Cannabis sativa Linnaeus is a herbaceous plant from the Cannabaceae family. Its female inflorescences are rich in glandular trichomes, which contain secondary metabolites with medicinal properties, such as cannabidiol (CBD). The lack of information on the cultivation management of *Cannabis* for biomedical purposes hinders the development of high-quality and standardized production. A literature search was conducted for studies involving interventions in *Cannabis* cultivation aimed at improving CBD content for medicinal purposes. A systematic search was performed in the CAPES Periodicals Portal > Collection > Subject >, using the search term "*Cannabis* and Crop Production," filtering for open-access, original, peer-reviewed articles in English. Scientific articles containing cultivation practices for *Cannabis* chemotype III relevant to the objective were included. The following were excluded: articles on agricultural production of *Cannabis* for non-medicinal purposes, review articles, non-scientific studies, THC > 0.3%, without CBD improvement, without instrumental analysis of CBD content, and *Cannabis* Chemotypes I and II. The search resulted in 9 eligible articles, with the following interventions: manipulation of phosphorus concentrations; sowing density and nitrogen fertilization; application of auxin antagonists under in vitro conditions; cultivar selection; optimized agronomic practices in a controlled cultivation environment; strategic manipulation of the light spectrum; topping; treatment with 6-benzylaminopurine (BAP); cultivar selection and water management; genetically uniform material under different environmental conditions. For greater success in increasing CBD without increasing THC, choosing a Chemotype III strain for medicinal purposes is paramount.

¹ Doctoral student in Pharmaceutical Sciences. Universidade de Sorocaba (UNISO). E-mail: valeria.orsi@uniso.br Orcid: <https://orcid.org/0009-0000-9221-4652>

² Undergraduate student in Pharmacy. Universidade de Sorocaba (UNISO). E-mail: lariissarcs@gmail.com Orcid: <https://orcid.org/0009-0005-3177-9971>

³ Undergraduate student in Biomedicine. Universidade de Sorocaba (UNISO). E-mail: gabriela.rocha02@yahoo.com Orcid: <https://orcid.org/0009-0005-7272-6796>

⁴ Graduated in Medical Sciences. Centro Universitário Lusfada. E-mail: rafa_pasiani@hotmail.com Orcid: <https://orcid.org/0000-0002-9947-2141>

⁵ Professor Dr. of the Graduate Program in Pharmaceutical Sciences. Universidade de Sorocaba (UNISO). E-mail: yoko.franco@prof.uniso.br Orcid: <https://orcid.org/0000-0002-4972-8444>

Keywords: *Cannabis*. Crop Production. Cannabidiol.

RESUMO

A *Cannabis sativa* Linnaeus é uma planta herbácea, da família Cannabaceae. Suas inflorescências femininas são ricas em tricomas glandulares, que possuem metabólitos secundários com propriedades medicinais, como o canabidiol (CBD). A carência de informações sobre o manejo do cultivo da *Cannabis* para fins biomédicos dificulta o desenvolvimento de uma produção de qualidade e padronizada. Buscou-se na literatura estudos com intervenções no cultivo da *Cannabis* visando a melhoria do teor de CBD para fim medicinal. Pesquisou-se sistematicamente no Portal de Periódicos da CAPES> Acervo> Assunto>, com o termo de busca *Cannabis* and Crop production, com filtro em artigos de acesso aberto, originais, em inglês, revisado por pares. Incluiu-se artigos científicos contendo práticas de cultivo da *Cannabis*, quimiotipo III em pertinência ao objetivo. Foram excluídos artigos de produção agrícola da *Cannabis* sem fim medicinal, artigo de revisão, estudos não científicos, THC > 0,3%, sem melhoramento de CBD, sem análise instrumental do teor de CBD e *Cannabis* Quimiotipo I e II. A busca resultou em 09 artigos elegíveis, com as seguintes intervenções: manipulação das concentrações de fósforo; densidade de semeadura e a fertilização com nitrogênio; aplicação do antagonista de auxina em condições *in vitro*; seleção de cultivares, práticas agrônômicas otimizadas em ambiente de cultivo controlado; manipulação estratégica do espectro de luz; topping; tratamento com 6-benzilaminopurina (BAP); seleção de cultivares e manejo hídrico; material geneticamente uniforme em diferentes condições ambientais. Para maior êxito no aumento do CBD sem o aumento do THC é primordial a escolha da cepa Quimiotipo III para fim medicinal.

Palavras-chave: *Cannabis*. Produção Agrícola. Canabidiol.

RESUMEN

Cannabis sativa linnaeus es una planta herbácea de la familia cannabaceae. Sus inflorescencias femeninas son ricas en tricomas glandulares, que contienen metabolitos secundarios con propiedades medicinales, como el cannabidiol (cbd). La falta de información sobre el manejo del cultivo de *cannabis* con fines biomédicos dificulta el desarrollo de una producción estandarizada y de alta calidad. Se realizó una búsqueda bibliográfica de estudios que incluyeran intervenciones en el cultivo de *cannabis* destinadas a mejorar el contenido de cbd con fines medicinales. Se realizó una búsqueda sistemática en el portal de publicaciones periódicas de capes > colección > tema >, utilizando el término de búsqueda "*cannabis* y producción de cultivos", filtrando por artículos originales, de acceso abierto y revisados por pares en inglés. Se incluyeron artículos científicos que contenían prácticas de cultivo para el quimiotipo iii de cannabis relevantes para el objetivo. Se excluyeron los siguientes: artículos sobre producción agrícola de cannabis con fines no medicinales, artículos de revisión, estudios no científicos, thc > 0,3%, sin mejora del cbd, sin análisis instrumental del contenido de cbd, y los quimiotipos de cannabis i y ii. La búsqueda arrojó 9 artículos elegibles, con las siguientes intervenciones: manipulación de las concentraciones de fósforo; densidad de siembra y fertilización nitrogenada; aplicación de antagonistas de auxinas en condiciones *in vitro*; selección de cultivares; prácticas agronómicas optimizadas en un entorno de cultivo controlado; manipulación estratégica del espectro lumínico; poda apical; tratamiento con 6-bencilaminopurina (bap); selección de cultivares y gestión hídrica; material genéticamente uniforme en diferentes condiciones ambientales. Para lograr un mayor éxito en el aumento del CBD sin aumentar el THC, es fundamental elegir una cepa de quimiotipo III para fines medicinales.

Palabras clave: *Cannabis*. Producción de Cultivos. Cannabidiol.

1 INTRODUCTION

1.1 BOTANICAL CHARACTERISTICS OF CANNABIS

Cannabis sativa Linnaeus is a herbaceous plant in the Cannabaceae family. Its female inflorescences are rich in glandular trichomes, which have important secondary metabolites with medicinal properties, such as cannabidiol (CBD) (Bonini *et al.*, 2018). The classification of *Cannabis* can be carried out based on the relationship of the main phytocannabinoids in its constitution. Analyzing its phenotype, that is, chemical profile and the predominance in its composition of one of its secondary metabolites, characterizing it as a chemical fingerprint called chemotypes. *Cannabis* with a high ratio of Δ -9-Tetrahydrocannabinol (THC) to Cannabidiol (CBD) (>1) classifies as chemotype I, THC:CBD intermediate ratios (usually 0.5-2.0) are classified as chemotype II, and plants that have a low THC to CBD ratio (<1) classifies as chemotype III (Sampaio *et al.*, 2024).

1.2 CANNABIDIOL PHYTOCANNABINOID OF MEDICINAL INTEREST

CBD is the main non-psychoactive component of *Cannabis sativa* L. and for this reason there is interest in its therapeutic potential in various disease states investigated in animal models and in humans (Black *et al.*, 2019). It has anxiolytic, antidepressant, antipsychotic, anticonvulsant, anti-nausea, antioxidant, anti-inflammatory, antiarthritic and antineoplastic action (Agarwal; Burke; Maddux, 2019; Shannon *et al.*, 2019).

1.3 ASPECTS OF LEGISLATION

Regulatory bodies in North America and Europe classify Cannabis by the proportion of THC and CBD phytocannabinoids present in the plant, as a drug/marijuana (drug type/marijuana) or as fiber/hemp (fiber type/hemp). In North America, varieties with $\text{THC} \leq 0.3\%$ contents are classified as hemp (UNODC, 2019) and allowed in the production of fiber, food supplements, and cosmetics (MEAD, 2017), while $\text{THC} > 0.3\%$ are classified as marijuana and subject to greater control due to the psychoactive properties of THC (UNODC, 2019). In Europe, the requirements are greater, in which the classification for hemp needs to have THC levels lower than 0.2% (Cherney; Small, 2016). Unlike the US and Europe that regulated hemp for fiber production, Brazilian regulation does not differentiate the chemical profile between hemp and marijuana (Carvalho *et al.*, 2020).

1.4 THE INFLUENCE OF CANNABIS CULTIVATION FOR MEDICINAL PURPOSES AND BIOMARKERS

Botanical knowledge is essential for the correct management of the plant (Figueiredo;

Policarpo; Veríssimo, 2017). The amount of phytocannabinoids present in the *Cannabis* plant is extremely influenced by the gene pool and the environmental conditions of humidity, temperature, radiation, soil nutrients, and parasites (Citti *et al.*, 2018; Bonini *et al.*, 2018; Trancoso *et al.*, 2022) exposes that scattered rainfall, low humidity, and sunny weather produce a plant rich in phytocannabinoid content. Many varieties of *Cannabis* have been cultivated over time and the detailed knowledge of its phytocannabinoid profile plays an essential role in the correct selection of a plant. (Citti *et al.*, 2018) and their concentrations and interactions can determine medicinal effects and adverse side effects (Berman *et al.*, 2018; Trancoso *et al.*, 2022). Although there is a great diversity of chemical constituents among *Cannabis* strains and the number of phytocannabinoids is large, most studies profiling *Cannabis* phytocannabinoids report only the main phytocannabinoids in the extract, among which THC, CBD are its acidic precursors and inactive CBDA/THCA and CBN is a possible sleep inducer (Santos, 2021), and phytocannabinoid study because it is a product of THC degradation, in which they also represent markers that indicate quality in the extraction process of phytocannabinoids of interest to the *Cannabis plant* (Carvalho *et al.*, 2020; Berman *et al.*, 2018). The standardized production of secondary metabolites, in the class of herbal medicines, is limited because the active components are not perfectly uniform (Trancoso *et al.*, 2022). The study of abiotic factors together with management techniques can help in the development of management protocols that favor greater productivity, quality, and stability in the production of phytocannabinoids, and it is essential to know the biosynthesis process and the formation of these compounds (Glivar *et al.*, 2020; Trancoso *et al.*, 2022). Most agronomic research on hemp conducted in the field setting has focused mainly on fiber production and yield (Trancoso *et al.*, 2022). Hemp, even though it is used for the production of phytocannabinoids, is traditionally used for selective cultivation for fiber or seed production, instead of flower production and secondary metabolites (Trancoso *et al.*, 2022). The lack of basic information on the management of *cannabis* cultivation for biomedical purposes hinders the development of quality and standardized production. Insignificant studies have focused on the production of phytocannabinoids. Evaluating the effects of external factors and management techniques on phytocannabinoid production is essential to understand the agronomic treatments and methodologies that can be applied to suit the harvest and final products (De Prato *et al.*, 2022; Trancoso *et al.*, 2022). Several books have been published on techniques for managing cannabis crops, but the techniques described are based on common knowledge constructs, where there is a lack of systematic studies that prove their efficiency and effectiveness. Producers have access to horticulture guides based on the internet and online information, but much of this information is not based

on scientific research (Caplan; Dixon: Zheng, 2017; Trancoso *et al.*, 2022). In this sense, studies with interventions in the cultivation of the *Cannabis plant* aimed at improving the CBD content for medicinal purposes were searched in the literature.

2 METHODOLOGY

This is a study based on a systematic review of the literature, conducted according to the characteristics and recommendations of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The results were organized and described in a narrative way, highlighting the main findings of the included studies, with the support of the PICO strategy.

2.1 ELIGIBILITY CRITERIA

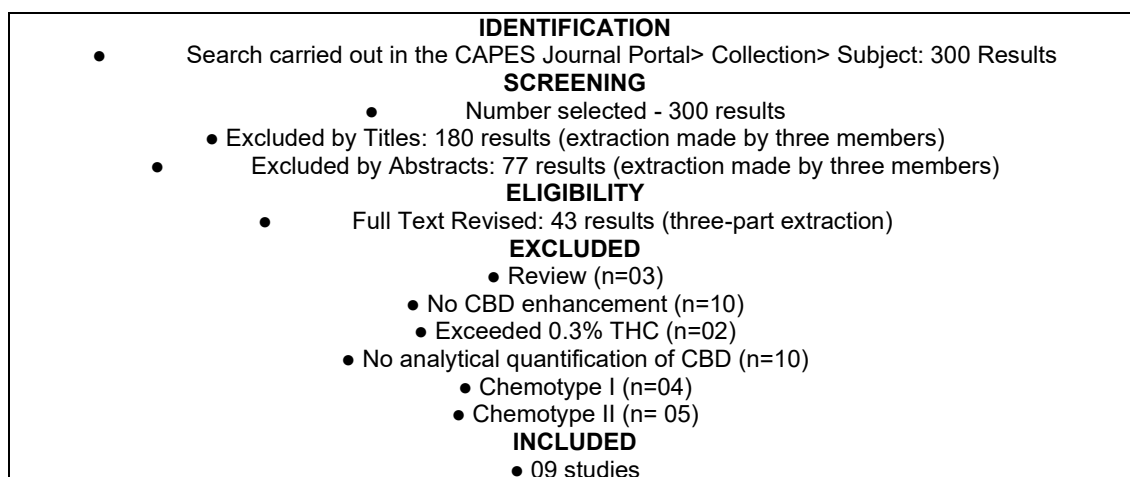
We systematically searched the CAPES Journal Portal> Collection> Subject>, with the search term *Cannabis* and Crop production, with a filter on open-access, original, English, peer-reviewed articles. Scientific articles containing cultivation practices of *Cannabis*, chemotype III in pertinence to the objective, were included. Articles on agricultural production of *Cannabis* without medicinal purpose, review article, non-scientific studies, THC > 0.3%, without CBD improvement, without instrumental analysis of CBD content and *Cannabis* Chemotype I and II were excluded.

3 RESULTS AND DISCUSSIONS

The screening and selection of studies are presented in the flowTable in Table 1.

Table 1

PRISMA FlowTable for Screening and Selection of Studies



Source: Prepared by the authors

The results of the 09 included studies are described below, presenting scientific studies with presentation of methodology, study design and statistical analysis.

POPULATION: The study by Cockson *et al.* (2020) used strains of *Cannabis sativa* BaOx (high CBD content), grown from rooted cuttings. The total cultivation period from taking the cuttings to harvesting was approximately 134 days (from July 24 to December 5, 2019). The study was carried out in Raleigh, North Carolina, in the United States of America (USA).

INTERVENTION: Six doses of Phosphorus (P), a fertilizer vital for plant development and the production of secondary metabolites, ranging from 3.75, 7.50, 11.25, 15.0, 22.50 to 30.0 mg/L, were tested using a modified Hoagland solution. The cultivation was carried out in a glass greenhouse with average temperatures of 25.8 (day) and 21.3 °C (night). The Critical Night Length (NLC) was reached in the pre-flowering stage consisting of 9 to 10 hours of darkness with 14 to 15 hours of light. The plants for treatment were arranged in a randomized block design (DBC) divided between three benches. At the flowering stage, flower buds (n = 5) were harvested for cannabinoid analysis in Ultra High Performance Liquid Chromatography equipment coupled to Tandem Mass Spectrometry. (UHPLC/MS/MS) Triple Quadrupole. For statistical analysis to compare the differences between concentrations, the F test (GLM PROC) and the LSD test with Tukey-Kramer adjustment were used, where the significance level was defined as ($p \leq 0.05$).

CONTROL GROUP: The study compared the results obtained at six P concentrations, the lowest being the one that served as a point of comparison within the experiment.

OUTCOME: In the Flowering Stage, plants with higher P concentrations (22.5 and 30.0 mg/L) were more branched and had larger diameters, when compared to the lowest P concentration of 3.75 mg/L ($p \leq 0.001$). The highest floral fresh weight was also observed at the concentration of P 22.50 mg/L, compared to the concentration of 3.75 and 7.50 mg/L, ($p \leq 0.001$), this fact occurred due to the increase in the branching of the *Cannabis plant* at the highest concentration of P, in which it produces inflorescences at each node, increasing the floral biomass of the plant. Also at this stage, there was a significant difference ($p \leq 0.001$) in the production of the cannabinoids CBDA, CBGA, THCA, total THC, and total CBD when compared to the lowest concentrations of P in relation to the highest concentrations. Their production reached a plateau in the P concentration at 11.25 mg/L P and, after this rate was reached, an increase in the P concentration did not produce statistically higher or lower levels of cannabinoids. At this P concentration, the analysis of total CBD resulted in 140.09 mg/g ± 10.49 .

POPULATION: The study by Poniatowska *et al.* (2022) used strains of *Cannabis sativa* L Futura 75, KC Dora and Tygra (fibrous and monoecious hemp) germinated through

sowing in the open field. The *cannabis* was harvested by hand at the beginning of seed ripening and occurred in September of each year. The study was conducted in Pytkowo, Wielkopolska, Poland, during the years 2014 to 2016.

INTERVENTION: Use selected cultivars, with determined factors of sowing density and fertilization with nitrogen (N), a fertilizer vital for plant development and the production of secondary metabolites. Densities of 60 seeds/m² and density of 180 seeds/m² were tested. The nitrogen fertilization rates tested were: 0, 30, 60 and 90 kg/ha. The average air temperature during the vegetation period of the study ranged from 8.3 °C to 22.2 °C. The samples of the inflorescences used for the chemical analysis were obtained by choosing 10 plants randomly selected from each replicate in all tested combinations. The experimental design was the randomized complete block (DBC) method of three factors (Cultivar; Sowing density and N fertilization), split-plots, with four replications. The cannabinoids were analyzed by gas chromatograph with flame ionization detector (GC-FID). Statistical analysis of the results recorded was performed by analysis of variance (ANOVA) in a split-split-plot design.

CONTROL GROUP: In the study, the control group refers to fertilization with 0 kg N/ha nitrogen to evaluate the effect of nitrogen.

OUTCOME: Regarding sowing density, only Tygra obtained an increase in density from 60 to 180 seeds/m², significantly increasing the yield of CBD by 0.97 g/m², which corresponds to 8.8%. At the highest doses of N, the yield of CBD increased significantly compared to the control (zero N dose). For the cultivars, Futura 75 and KC Dora, the highest yield of CBD was obtained with 90 kg N/ha. And for Tygra, the highest yield (12.68 g/m²) was expected with 44.5 kg N/ha. The result of the work regarding the improvement of CBD production demonstrated that the optimization of productivity depends crucially on nitrogen fertilization and, to a lesser extent, on the cultivar and the interaction between nitrogen and sowing density.

POPULATION: The study by Senkyřík *et al.* (2023) used two strains of *Cannabis sativa* L., the cultivar USO-31, hemp of Ukrainian origin, germinated *in vitro* through seeds and the cultivar Tatanka Pure CBD, hybrid and rich in cannabidiol (CBD) germinated *in vitro* from rooted cuttings. The study was carried out in the Czech Republic, by Palacký University and the Institute for Research and Culture located in Olomouc.

CONTROL GROUP: Medium containing the treatment with the auxin antagonist, α -(2-oxo-2-phenylethyl)-1H-indole-3-acetic (PEO-IAA) and the medium without PEO-IAA.

INTERVENTION: Application of the auxin antagonist, PEO-IAA under *in vitro* conditions. This intervention sought to increase the rate of sprout multiplication *in vitro*, since auxin is an essential phytohormone that regulates apical dominance, by interrupting this

apical dominance with PEO-IAA, it was hoped to improve the multiplication of plant material and investigate the influence of this antagonist on the relative gene expression (GER) of cannabinoid genes and cannabinoid content. The conditions of the *in vitro* experiment were the same for both cultivars. The nodal segments were cultured in a 100mL erlenmeyer flask containing five to six nodal segments grown under standardized conditions in a phytotron at 22 °C, 40% relative humidity and photoperiod of 16/8 ($36 \mu\text{mol}\cdot\text{m}^{-2} \cdot \text{s}^{-1}$) for 4 weeks. After the cultivation period, the biomass was harvested, frozen in liquid nitrogen and then used for Relative Gene Expression (GER) analysis, and the phytochemical analysis of the cannabinoids, the latter being carried out in the UHPLC-MS/MS equipment. The *in vitro* experiment was carried out for each cultivar in three or four biological replications. Statistical analysis was determined by the *t-test* method to compare samples with PEO-IAA and controls in terms of cannabinoid content. To investigate the relationship between gene expression and cannabinoid concentration, regression analysis was used.

OUTCOME: The Tatanka Pure CBD cultivar showed a statistically significant increase ($p < 0.05$) in the concentration of the cannabinoid CBDA (approximately 1.47 times compared to the control). This was the only statistically significant increase found. The study suggests that the use of PEO-IAA is an appropriate condition for the formation of multiple shoots and that its presence in the culture medium probably does not significantly disrupt the gene expression of key genes related to the biosynthetic pathway of the main cannabinoids, nor does it reduce cannabinoid concentrations. However, the study recognizes the need for additional research into other genotypes and monitoring of plants after transfer to *ex vitro* conditions and the flowering stage to gain more valuable information.

POPULATION: The García-Tejero *et al.* (2020) used new varieties of hemp (*Cannabis Sativa* L.). Three CBD chemotype varieties (Sara, Pilar, Theresa) and two CBG chemotype varieties (Aida and Juani). The form of planting used was through rooted apical cuttings. The trial was carried out during two consecutive seasons (2014 and 2015), with the growing period from May to October. The study was carried out in the Guadalquivir River basin in southwestern Spain belonging to the Andalusian Institute for Agricultural Training and Development and Research (IFAPA, in Spanish). Country Spain.

CONTROL GROUP: The study did not use a control group, but a comparative study between the varieties and densities of plants tested.

INTERVENTION: Combination of cultivar selection, optimized agronomic practices, highlighting plant density (PD) and a controlled cultivation environment. The plants were grown in polyethylene-lined tunnel structures. The environment inside these tunnels had an average temperature between 23 and 35 °C and relative humidity around 65%. Three

densities were tested: PD1 (9,777 plants $\cdot$ ha $^{-1}$), PD2 (7,333 plants $\cdot$ ha $^{-1}$) and PD3 (5,866 plants $\cdot$ ha $^{-1}$). In the 2014 season (Sara, Pilar, Aida) a randomized block design was performed, considering four replicates per variety. The plant density used was PD1. In 2015 (Sara, Theresa, Aida, Juani) the design and replicates per variety were the same as in the previous year, except that three different densities were tested. Harvest was defined by weekly observations of the change in stigma color from white/yellow to orange/brown, harvested when approximately 80% of the shoots reached this maturity. Cannabinoid analysis was performed by gas chromatography. In 2014, the statistical analyses of the data were submitted to one-way analysis of variance (ANOVA), with Tukey's test for separation of means ($p < 0.05$). In 2015, the statistical analysis of the subjects underwent a two-way ANOVA, evaluating the effects of the cultivar, PD and their interactions. A Levene test was previously applied to verify the homogeneity of the variances.

OUTCOME: The Sara cultivar stood out as the most effective strain in terms of CBD cannabinoids in the 2014 and 2015 seasons. It is distinguished by its relevant volume and pronounced lateral growth, with a high capacity to develop inflorescences. The highest CBD yields were obtained with Sara under PD1 and PD3, (many plants in PD1 or higher individual development in PD3). Sara reached dry weight values of flowers and leaves, DW(F+L) between 3,478 and 3,307 kg $\cdot$ ha $^{-1}$, surpassing the values of Pilar and Theresa. CBD yields have reached up to 350 kg $\cdot$ ha $^{-1}$. This value is significantly higher (almost four times higher) than that reported in indoor conditions controlled by other studies (about 84 kg $\cdot$ ha $^{-1}$ in six annual production cycles). In short, the combination of new hemp cultivars genetically selected for CBD (especially Sara), propagated by clones, grown in macrotunnels in a Mediterranean semi-arid environment and with plant density optimization, resulted in a substantial and cost-effective increase in CBD production.

POPULATION: The study Kotiranta *et al.* (2024) used the cultivar called FINOLA, a hemp genotype of *the C. sativa* dominant in cannabidiol (CBD). Its seeds were sown in peat, grown in different pot sizes during the growing season. The study was conducted from April to September. The work was carried out at the Department of Agricultural Sciences, Viikki Plant Science Centre, University of Helsinki, Helsinki, Finland.

CONTROL GROUP: Treatment of opposite lights High and Low, R:FR Ratio (Red to Far Red) and another treatment used the original white LED spectrum (control), in which it excludes BlueL, UV-A and UV-B light, in which they were used in the comparative treatment.

INTERVENTION: Strategic manipulation of the light spectrum, focusing on two main areas: the Red to Far Red ratio (long wavelength) (R:FR) and the short wavelength radiation (Blue, UV-A and UV-B. The light factor is considered one of the main factors for the successful

cultivation of *Cannabis* indoors, with the photoperiod, light quality and intensity being significant factors. The plants were grown on benches (blocks) inside a research greenhouse compartment, closed environment, blackout curtains were implanted on all walls and roof continuously during the experiments to exclude external radiation and maintain photoperiods. The ambient temperature (Day 24 °C and Night 22 °C), relative humidity (Day 60% and Night: 50%) and CO₂ concentration in the air was 386 ± 14 ppm when the lights were on, were automatically controlled by the greenhouse control system. In addition, the light (photoperiod, quality and intensity) was precisely controlled using LED luminaires. The study was divided into two separate experiments, Experiment A used a HIGH R:FR white LED spectrum (Ratio 11) and used the same white LED spectrum as the HIGH R:FR treatment, but with the addition of LOW R:FR far red LED fixtures (Ratio 1) The plants were under the light treatments (HIGH R: FR and LOW R:FR) for 48 days until harvest 70 days after sowing (DAS). Experiment B included the treatments: Control, Blue, UV-A and UV-B in which 78 DAS were applied to the plants for 50 days until harvest. The experiments were organized in a randomized complete block design with three replicated blocks. Fifteen plants were randomly chosen from each light treatment, five per repetition plot for analysis of the cannabinoid constitution, which were performed through the high-performance liquid chromatography (HPLC) equipment, coupled to the Diode Array Detector (DAD). For the statistical analysis, the mixed-effects ANOVA model was used, in which the light treatment was defined as a fixed factor and the block of replicas as a random effect.

Outcome: The HIGH R:FR treatment (ratio of 11) resulted in higher total yield of inflorescences per plant, increased branching, demonstrated by the higher number of internodes, and the plants were thicker, avoiding the shade avoidance syndrome induced by LOW R:FR (ratio of 1), which causes stem elongation and decreased yield. The HIGH R:FR treatment increased CBD concentrations compared to the LOW R:FR treatment. Experiment B did not impact the total yield of the inflorescence, and the concentration of CBD.

POPULATION: The study by Folina *et al.* (2020) used two monoecious industrial hemp cultivars originating in France, Fedora 23 and Futura 75. The sowing of the cultivars was carried out through a standard grain seeder. The field experiment was carried out in Farsala, Central Greece. Sowing on May 11 and harvesting on August 14, 2019.

INTERVENTION: The main agronomic intervention adopted was *topping*. Stressful conditions such as environmental factors and pruning can increase the synthesis and accumulation of cannabinoids. Topping was performed by cutting the main bud of the *Cannabis* plants 40 cm from the top of the plants, carried out at 40 days after sowing in the open field. Climatic data were recorded daily, average temperature for the month of May

18.4°C, June 24.8°C, July 25.5°C, August 25.7°C The experimental design used was split-plot, containing three replications. The factors tested were main plots containing the two European hemp cultivars Fedora 23 and Futura 75 and subplots with *the topping and non-topping* treatments. Plant sampling was carried out at harvest time, on August 14, 2019, when the trichomes of the inflorescence changed from white to milky white. Samples of 10 plants were randomly selected from the middle rows of the plots, and cut above ground level. Five samples of harvested plants were subjected to the measurement of the CBD content in fresh Cannabis inflorescences using the GemmaCert equipment (GemmaCert Ltd., Israel) and after the fresh inflorescences were dried in an oven at 60 °C for 48 hours and weighed to determine the dry matter of the inflorescence. The experimental data were submitted to statistical analysis according to the split-plot design. The differences between the means were separated using the Least Significant Difference (LSD) test. All comparisons were made at the significance level of 5%.

CONTROL GROUP: The *non-topping group* functioned as the control group, being compared with the group that received the intervention (*topping*).

OUTCOME: The application with the *topping* treatment exerted a significant and positive effect on both the cannabinoid content and the yield attributes of the flowers ($p < 0.05$). In the cultivars tested, the CBD content (%) was significantly higher in the *toppings* than in the *non-toppings*, with Futura 75 being covered: 2.32% vs. uncovered: 1.9% and Fedora 23 covered: 2.2% vs. uncovered: 1.7%. In the *toppings*, the values of total dry matter (DM) productivity of the inflorescences were significantly higher (206.3 g/plant in Futura 75 and 156.3 g/plant in Fedora 23) than in the *non-topping* plants (179.7 and 131.8 g/plant in Futura 75 and Fedora 23). The number of inflorescences was higher in topping, which is attributed to the high number of secondary shoots that develop after removal of the main shoot (pruning).

POPULATION: The study by Mishchenko *et al.* (2022) used seeds of the USO 31 variety, monoecious industrial hemp (*Cannabis sativa* L.) of the Central European type. The experiment was carried out in the field in a region that presented a temperate/continental climate with a tendency to be warmer and drier. The growing season analyzed runs from April (early spring) to September (late summer and early fall), harvesting occurs at maturation (BBCH 89) is the thrashing phase, which represents biological maturation. The field research, which lasted from 2016–2019, was conducted in northeastern Ukraine.

INTERVENTION: Use of exogenous growth regulators (phytohormones and vitamins), and one of the objectives of the study was to evaluate the result of exogenous growth regulators on cannabinoid content. To evaluate the feasibility of epigenetic effects under the

influence of growth regulators, mature seeds were collected from treated plants. These seeds were then sown again in the fourth year (2019) for the offspring to be analyzed for their cannabinoid content. The climatic conditions fluctuated during the period of the experiment, thus being able to broadly evaluate the content of cannabinoid compounds. The substance 6-benzylaminopurine (BAP), a phytohormone of the cytokine group has been identified as the most effective growth regulator for increasing CBD. The content of cannabinoid compounds was determined by a gas chromatograph. Statistical analysis used the least significant difference test (LSD) and Student's t-test, with statistical significance determined at the level of $p < 0.05$.

CONTROL GROUP: Control group without treatment for comparison purposes with plants that received treatment with exogenous growth regulators.

Outcome: Treatment with the cytokinin BAP was the most efficient growth regulator to increase CBD content. The concentration of CBD in the plants treated with BAP (0.2654%) is significantly higher than the average value found in the untreated group (control) (0.1271%). From the point of view of epigenetic effects, a promising direction to increase the level of non-psychoactive cannabinoids is the treatment of vegetative plants with cytokinin BAP, and the concentration of CBD in the offspring of plants treated with this regulator resulted in the content of (0.2540%) significantly higher than the average value found in the untreated group, control (0.1323%). Under the influence of BAP, the highest content of cannabinoid compounds (including CBD) manifested steadily during each of the three processing years (2016–2018). These changes were inherited by at least one generation of descendants.

POPULATION: The study by Campbell *et al.* (2019) used a diverse set of 13 industrial hemp cultivars (*Cannabis sativa* L.), these strains are not considered CBD-rich, originating in Europe and Asia. The cultivars CS 45; Eletta Campana 45y; Tiborszallasi 46 are dioecious and the other cultivars are monoecious, Carmaleonte 45; Diana, 45; Monoica 46 ; Phedora 17; Féline, 32; Férimon 12; Futura 75; Santhica 27; Bialobrzeskie 52; USO 31 Ukraine. The field study that resulted in the analysis of CBD was in Colorado, United States, in Fort Collins, which we are analyzing in this study. The duration between planting and harvesting was measured as days to Duration of Maturity (TMD). The mean days to maturity was 116 days for the limited irrigation treatment ("dry") and 117 days for the fully irrigated treatment ("wet").

INTERVENTION: Use several cultivars (genotypes) for planting in two types of irrigation treatment to test germplasm imported from Europe and Asia. The study evaluates how genetic effects between cultivars, environmental effects, and genotype × environment (GEI) interactions influence traits such as cannabinoid content such as THC and CBD. Water

availability was an important environmental factor manipulated in the experiment. In Fort Collins, two irrigation treatments were used, through an overhead linear sprinkler irrigation system, being "Limited irrigation" (dry) and "Fully irrigated" (wet), the cultivars were replicated four times in the experiment. In Fort Collins, a Latinized row and column design was used. The cannabinoid profiles and quantification were analyzed by UHPLC/ coupled to a photodiode array detector (PDA), using 10 cm upper than the female flowers, three random plants were collected per plot at maturity. Variance (ANOVA) was used to define the effects appropriate to genotype, environment and GEI by linear regression.

CONTROL GROUP: The study compares the performance of the cultivars with each other and under different water management conditions

OUTCOME: The study resulted in average total CBD content: 2.24% under full irrigation conditions ("wet") and 1.43% under limited irrigation conditions ("dry"). The relationship between maturity (phenology) and Cannabidiol (CBD) production is of a positive and significant correlation ($p \leq 0.001$). This means that, generally speaking, hemp cultivars that have late flowering (i.e., take more days to reach maturity) tend to produce higher levels of total CBD. The number of days to maturity (DTM) was significantly correlated with the total CBD content. Pearson's correlation coefficient (r) between TMD and total CBD was 0.68, indicating a positive relationship. The genotype $\times$ environment (GEI) relationship was not significant for the increase in CBD. The percentage variance of the trait explained by the $G \times E$ interaction was only 1.7% This suggests that the cultivars, in general, maintained their relative classifications of CBD production in the different environments tested (limited irrigation and complete irrigation), demonstrating stability in relation to this interaction. Genotype was by far the most important factor, explaining 82.7% of the variation in CBD content ($p \leq 0.001$). To achieve a specific CBD content, cultivar selection is the most important decision. Although the interaction (GEI) was not significant, the regression model detected significant effects of the environment ($p \leq 0.001$) for total CBD. However, the magnitude of this effect was small, with only 6% of the variation attributed to environmental effects. The TMD had a negative correlation with grain yield ($r = -0.53$), indicating that, in general, cultivars that took longer to mature produced fewer grains. In summary, the lack of significance of the Genotype $\times$ Environment (GEI) interaction for total CBD indicates that the observed differences in CBD content between cultivars are predominantly determined by plant-specific genetics rather than by how the cultivar uniquely reacts to a specific environment (such as irrigation).

POPULATION: The study by Giupponi *et al.* (2020) used *Cannabis sativa* L strain . Kompolti is a dioecious industrial hemp variety developed in Hungary. The cuttings were

taken from the parental pistillate plant. The study was conducted in Italy, during the 2018 growing season, in two locations in the Piedmont region of northern Italy.

INTERVENTION: Clones of the Kompolti variety were cultivated in two distinct ecological environments — mountain and plain, in order to evaluate the impact of this environmental condition on the chemical composition (cannabinoids) of the inflorescences. To ensure that the observed differences in secondary metabolites were due solely to altitude-related ecological conditions, the uniform clones were grown in pots with a uniform substrate. The material of the inflorescences of each clone was sampled five times to perform the analyses. The quantification of cannabinoids used the average of four biological samples and they were analyzed by HPLC/MS with a quaternary pump. To compare the two groups, the two-tailed Student's t-test was used. A p-value lower than 0.05 was statistically significant.

CONTROL GROUP: The study compared the results of plants grown in the plains with plants grown in the mountains.

OUTCOME: CBDA was the most abundant cannabinoid, with significantly higher concentrations in the mountain samples ($p < 0.01$) compared to the plain. Although the natural process of decarboxylation of CBDA into Cannabidiol (CBD) occurs under the action of heat and light, the geographic location of the crop (mountain versus plain) did not significantly influence the decarboxylation of CBDA in the production of CBD in the samples studied. The Kompolti strain has a predisposition to have prolonged flowering in late summer/early autumn, when average daily temperatures are moderately higher, it may have led to a partial conversion of CBDA to its neutral form (CBD) in both locations.

The included studies showed significant results in increasing CBD, with variations when compared between the cultivars and intervention of the same study. In Cockson *et al.* (2020) the treatment performed on the BaOx cultivar (high CBD content) at the intermediate dose of P caused a greater increase in the concentration of total CBD compared to the higher doses of P that produced a more branched plant, with higher floral weight. The highest nutritional dose is not always the best dose to promote increased synthesis of secondary metabolites (Troncoso *et al.* 2022). In the study by Poniatowska *et al.* (2022) the application of higher N doses resulted in a significant increase in CBD in the cultivars, Futura 75 and KC Dora. There are studies that show that an increase in the content of mineral macronutrients can produce an increase in the production of inflorescences and phytocannabinoids (Shiponi, S.; Bernstein, N., 2021). In the study by Senkyřík *et al.* (2023) with the application of the auxin antagonist PEO-IAA, there was a significant increase in CBDA in the CBD-rich cultivar, Tatanka Pure CBD this study was considered in the work because it is a phytocannabinoid precursor of CBD, which through decarboxylation in the extraction process can become rich

in CBD and the application of PEO-IAA in the culture medium presented an important result as it did not affect the relative gene expression (GER) of cannabinoid genes and in the Mishchenko *study et al.* (2022) cytokinin application BAP, resulted in a significant increase in CBD and its offspring as well (epigenetics). Both interventions alter the hormones auxin and cytokine respectively and thus stimulate the development of lateral shoots (Crispim Massuela, D. *et al.*, 2022). In the study by García-Tejero, *et al.* (2020) the cultivar Sara (rich in CBD) showed a significant increase in CBD in PD1 and PD3, and in the study by García-Tejero, *et al.*, (2019), with another cultivar, Ermes, also rich in CBD, there was also an increase in CBD in PD1 and PD3, corroborating the importance of choosing the CBD-rich genotype for agronomic practices in controlled environments. In the study Kotiranta *et al.* (2024) strategic manipulation of the LED light spectrum (red: far red) resulted in an increase of inflorescence and CBD in the ALTO R:FR treatment (ratio of 11) in Finola cultivar (rich in CBD). According to Lefsrud, M. G.; Kopsell, D. A.; Sams, C LED lamps make it possible to present specific wavelengths, facilitating research on the impact of wavelength on the production of secondary metabolites. In the study by Folina *et al.* (2020) the topping performed on the Fedora 23 and Futura 75 cultivars resulted in a significant increase in the increase of inflorescences and CBD. According to Verma, N.; Shukla, S., (2015) pruning is a common intervention in Cannabis to increase the production of inflorescences and induce hormonal changes that cause metabolic changes. In the study by Campbell *et al.* (2019) the selection of 13 cultivars and water management resulted in a significant increase in CBD in complete irrigation. The relationship between late maturity and CBD production was significant, this may have interfered with the different result of Caplan, D.; Dixon, M.; Zheng, Y. (2019), in which on the contrary water restriction increased CBD yield by stress. In the study by Giupponi *et al.* (2020) there was a significant increase in CBDA in cultivation in a mountainous region, this study was considered in the work to be a phytocannabinoid precursor of CBD, which through decarboxylation in the extraction process can become rich in CBD. According to Jin, D. *et al.* (2020) in their study deduced that plants grown in regions with higher altitude and temperature exhibited higher density and increased trichomes. The study was limited to the search for open access articles. In addition, there was no expansion of the databases consulted, which made it impossible to exhaust the search.

4 CONCLUSION

Our study showed that the lack of CBD analysis in 10 excluded studies and 10 studies without CBD improvement corroborates with the information that there is a lack of studies for improvements in CBD production. Increased inflorescence production is not always indicative

of increased CBD. The objective of planting must be well defined, as the production of seed and inflorescence can occur in opposite ways in the maturation of the plant. Cultivars of CBD-rich genotypes seem to show more significant results in increasing CBD when the interventions, so the choice of the CBD-rich genotype is a better way to produce CBD for medicinal purposes. For greater success in increasing CBD without increasing THC, it is essential to choose the Chemotype III strain for medicinal purposes.

REFERENCES

- Agarwal, R., Burke, S. L., & Maddux, M. (2019). Current state of evidence of cannabis utilization for treatment of autism spectrum disorders. *BMC Psychiatry*, 19(1), Article 328. <https://doi.org/10.1186/s12888-019-2352-5>
- Berman, P., Fineschi, M., et al. (2018). A new ESI-LC/MS approach for comprehensive metabolic profiling of phytocannabinoids in Cannabis. *Scientific Reports*, 8(1), Article 14280. <https://doi.org/10.1038/s41598-018-22794-4>
- Black, N., Stockings, E., Campbell, G., Tran, L. T., Zagic, D., Hall, W. D., Farrell, M., & Degenhardt, L. (2019). Cannabinoids for the treatment of mental disorders and symptoms of mental disorders: A systematic review and meta-analysis. *The Lancet Psychiatry*, 6(12), 995–1010. [https://doi.org/10.1016/S2215-0366\(19\)30401-8](https://doi.org/10.1016/S2215-0366(19)30401-8)
- Bonini, S. A., Premoli, M., Tambaro, S., Kumar, A., Maccarinelli, G., Memo, M., & Mastinu, A. (2018). Cannabis sativa: A comprehensive ethnopharmacological review of a medicinal plant with a long history. *Journal of Ethnopharmacology*, 227, 300–315. <https://doi.org/10.1016/j.jep.2018.09.004>
- Campbell, B. J., Gillett, S., & Mactavish, D. (2019). Genotype × environment interactions of industrial hemp cultivars highlight diverse responses to environmental factors. *AgroSystems, Geosciences & Environment*, 2(1), 1–11. <https://doi.org/10.2134/age2019.06.0014>
- Caplan, D., Dixon, M., & Zheng, Y. (2017). Optimal rate of organic fertilizer during the flowering stage for cannabis grown in two coir-based substrates. *HortScience*, 52(12), 1796–1803. <https://doi.org/10.21273/HORTSCI12498-17>
- Caplan, D., Dixon, M., & Zheng, Y. (2019). Increasing inflorescence dry weight and cannabinoid content in medical cannabis using controlled drought stress. *HortScience*, 54(5), 964–969. <https://doi.org/10.21273/HORTSCI14112-19>
- Carvalho, V. M., Júnior, A. A. S., & Carvalho, M. G. (2020). Quantificação de canabinoides em extratos medicinais de Cannabis por cromatografia líquida de alta eficiência. *Química Nova*, 43(1), 90–97. <https://doi.org/10.21577/0100-4042.20170457>
- Cherney, J. H., & Small, E. (2016). Industrial hemp in North America: Production, politics and potential. *Agronomy*, 6(4), 58. <https://doi.org/10.3390/agronomy6040058>
- Citti, C., Ciccarella, G., Braghiroli, D., Raggi, M. A., Cannazza, G., & Vandelli, M. A. (2018). Pharmaceutical and biomedical analysis of cannabinoids: A critical review. *Journal of Pharmaceutical and Biomedical Analysis*, 147, 565–579. <https://doi.org/10.1016/j.jpba.2017.06.003>

- Cockson, P., Giese, M. W., Carline, J., & McMahon, M. (2020). Impact of phosphorus on *Cannabis sativa* reproduction, cannabinoids, and terpenes. *Applied Sciences*, 10(21), Article 7875. <https://doi.org/10.3390/app10217875>
- Crispim Massuela, D., et al. (2022). Impact of harvest time and pruning technique on total CBD concentration and yield of medicinal cannabis. *Plants*, 11(1), Article 140. <https://doi.org/10.3390/plants11010140>
- De Prato, L., et al. (2022). The cannabinoid profile and growth of hemp (*Cannabis sativa* L.) is influenced by tropical daylengths and temperatures, genotype and nitrogen nutrition. *Industrial Crops and Products*, 178, Article 114605. <https://doi.org/10.1016/j.indcrop.2022.114605>
- Figueiredo, E., Policarpo, F., & Veríssimo, M. (2017). A “fumaça do bom direito”: Demandas pelo acesso legal à maconha na cidade do Rio de Janeiro. *PLATÔ_ DROGAS & POLÍTICAS*. *Revista da Plataforma Brasileira de Política de Drogas*, 1, 13–38. <https://pbpd.org.br/wp-content/uploads/2016/11/PLATO-.compressed-1.pdf>
- Folina, A., et al. (2020). Evaluation of the effect of topping on cannabidiol (CBD) content in two industrial hemp (*Cannabis sativa* L.) cultivars.
- García-Tejero, I. F., et al. (2019). Seeking suitable agronomical practices for industrial hemp (*Cannabis sativa* L.) cultivation for biomedical applications. *Industrial Crops and Products*, 139, Article 111524. <https://doi.org/10.1016/j.indcrop.2019.111524>
- García-Tejero, I. F., et al. (2020). Yield of new hemp varieties for medical purposes under semi-arid Mediterranean environment conditions. *Comunicata Scientiae*, 11, Article e3264. <https://doi.org/10.14295/cs.v11i0.3264>
- Giupponi, L., et al. (2020). Influence of altitude on phytochemical composition of hemp inflorescence: A metabolomic approach. *Molecules*, 25(6), Article 1381. <https://doi.org/10.3390/molecules25061381>
- Glivar, T., et al. (2020). Cannabinoid content in industrial hemp (*Cannabis sativa* L.) varieties grown in Slovenia. *Industrial Crops and Products*, 145, Article 112082. <https://doi.org/10.1016/j.indcrop.2020.112082>

FROM STANDARD TO TERRITORY: THE ROLE OF NURSES IN IMPLEMENTING THE "NOW THERE ARE SPECIALISTS" PROGRAM IN THE BRAZILIAN AMAZON – AN EXPERIENCE REPORT IN HUMAITÁ/AM, LÁBREA/AM AND THE DISTRICT OF SANTO ANTÔNIO DO MATUPI (MANICORÉ, AM)

DA NORMA AO TERRITÓRIO: ATUAÇÃO DO ENFERMEIRO NA IMPLEMENTAÇÃO DO PROGRAMA AGORA TEM ESPECIALISTAS NA AMAZÔNIA BRASILEIRA – RELATO DE EXPERIÊNCIA EM HUMAITÁ/AM, LÁBREA/AM E NO DISTRITO DE SANTO ANTÔNIO DO MATUPI (MANICORÉ, AM)

DEL ESTÁNDAR AL TERRITORIO: EL PAPEL DE LAS ENFERMERAS EN LA IMPLEMENTACIÓN DEL PROGRAMA "AHORA HAY ESPECIALISTAS" EN LA AMAZONÍA BRASILEÑA – UN RELATO DE EXPERIENCIA EN HUMAITÁ/AM, LÁBREA/AM Y EL DISTRITO DE SANTO ANTÔNIO DO MATUPI (MANICORÉ, AM)



<https://doi.org/10.56238/sevened2026.008-113>

José Maria Viana dos Santos¹

ABSTRACT

Introduction: Timely access to specialized care remains one of the main challenges of the Brazilian Unified Health System (SUS), particularly in Amazonian territories marked by long distances, care gaps, and weaknesses in the regional organization of health networks (Giovanella et al., 2020; Garnelo et al., 2017). In response to this scenario, the Ministry of Health instituted, through Provisional Measure No. 1,301 of May 30, 2025, subsequently regulated by Ordinance GM/MS No. 7,266 of June 18, 2025, and in the context of the Public Health Emergency declared by Ordinance GM/MS No. 7,061 of June 6, 2025, the Agora Tem Especialistas Program, with operational support from the Brazilian Agency for Support to SUS Management (AgSUS). The program is structured around regulated access, comprehensive care, and the use of mobile specialized care units (Brasil, 2025a; Brasil, 2025b; Brasil, 2025c).

Objective: To report and analyze the role of nurses in the implementation of the Agora Tem Especialistas Program in Amazonian territories, emphasizing processes of intergovernmental articulation, organization of access regulation through SISREG and e-SUS Regulação, community mobilization, and the operation of mobile units structured according to the logic of the Integrated Care Offer (Organização da Oferta do Cuidado Integrado – OCI).

Methods: A descriptive qualitative study in the form of an experience report, based on participant observation and reflective systematization of activities carried out between 2025 and 2026 in the municipalities of Humaitá and Lábrea and in the district of Santo Antônio do Matupi, in the municipality of Manicoré, Amazonas. Field notes, regulatory documents,

¹ Doctoral student in Medical Sciences. Universidade de Brasília (UnB). Universidade de Brasília (UnB).
E-mail: vianasauade.com@gmail.com

meeting minutes, institutional instruments, and evidence of formal recognition by local managers were used.

Results: The experience highlighted the central role of nurses as technical-political articulators in translating national guidelines into territorial practices, with emphasis on: organization of access exclusively through regulation systems (SISREG and e-SUS Regulação); adoption of the OCI logic (consultation, examination, and follow-up); implementation of mobile units characterized as customized trailers equipped with waiting areas, medical offices, ultrasound and mammography rooms, elevators for accessibility, climate-controlled and computerized environments; articulation with health surveillance and patient safety; and the innovative strategy of community mobilization through Community Health Workers. The case of Santo Antônio do Matupi stands out as the first district in the state of Amazonas to receive the Program, as well as the replicability of the experience, evidenced by a formal request for technical support from the municipality of Lábrea.

Conclusion: Nurses emerged as strategic actors in the implementation of the Agora Tem Especialistas Program in Amazonian territories, mediating the articulation between public policy, health management, and the community, and contributing to the consolidation of a model of regulated and humanized specialized care oriented toward the quality of the clinical encounter, in line with the principles of equity and comprehensiveness of the SUS.

Keywords: Nursing. Public Health Policies. Specialized Care. Programa Agora Tem Especialistas. Amazon.

RESUMO

Introdução: O acesso oportuno à atenção especializada permanece como um dos principais desafios do Sistema Único de Saúde (SUS), particularmente em territórios amazônicos marcados por grandes distâncias, vazios assistenciais e fragilidades na organização regionalizada da rede (Giovanella et al., 2020; Garnelo et al., 2017). Em resposta a esse cenário, o Ministério da Saúde instituiu, por meio da Medida Provisória nº 1.301, de 30 de maio de 2025, posteriormente regulamentada pela Portaria GM/MS nº 7.266, de 18 de junho de 2025, e no contexto da Situação de Urgência em Saúde Pública declarada pela Portaria GM/MS nº 7.061, de 6 de junho de 2025, o Programa Agora Tem Especialistas, com apoio da Agência Brasileira de Apoio à Gestão do SUS (AgSUS), estruturado sobre a lógica de acesso regulado, cuidado Integrado e utilização de unidades móveis de atenção especializada (Brasil, 2025a; Brasil, 2025b; Brasil, 2025c).

Objetivo: Relatar e analisar a atuação do enfermeiro na implementação do Programa Agora Tem Especialistas em territórios amazônicos, enfatizando os processos de articulação interfederativa, organização da regulação por meio do SISREG e do e-SUS Regulação, mobilização comunitária e operacionalização de unidades móveis estruturadas segundo a lógica da Oferta do Cuidado Integrado (OCI).

Método: Estudo descritivo, de abordagem qualitativa, na modalidade relato de experiência, fundamentado na observação participante e na sistematização reflexiva das atividades desenvolvidas entre 2025 e 2026 nos municípios de Humaitá e Lábrea e no distrito de Santo Antônio do Matupi, no município de Manicoré (AM). Utilizaram-se registros de campo, documentos normativos, atas de reuniões, instrumentos institucionais e evidências de reconhecimento formal por gestores locais.

Resultados: A experiência evidenciou o papel central do enfermeiro como articulador técnico-político na tradução das diretrizes nacionais em práticas territoriais, destacando-se: a organização do acesso exclusivamente por meio da regulação (SISREG/e-SUS

Regulação); a adoção da lógica da OCI (consulta, exame e retorno); a implantação de unidades móveis caracterizadas como carretas customizadas, com salas de espera, consultórios, salas de ultrassonografia e mamografia, elevador para acessibilidade, ambiente climatizado e informatizado; a articulação com a vigilância sanitária e a segurança do paciente; e a estratégia inovadora de mobilização por meio dos Agentes Comunitários de Saúde. Ressalta-se, ainda, o marco de Santo Antônio do Matupi como primeiro distrito do estado do Amazonas a receber o Programa e a replicabilidade da experiência, atestada por solicitação formal de apoio técnico no município de Lábrea.

Conclusão: O enfermeiro configurou-se como ator estratégico na implementação do Programa Agora Tem Especialistas em território amazônico, mediando a articulação entre política pública, gestão e comunidade, e contribuindo para a consolidação de um modelo de atenção especializada regulada, humanizada e orientada pela qualidade do encontro clínico, em consonância com os princípios de equidade e Integrado idade do SUS.

Palavras-chave: Enfermagem. Políticas Públicas de Saúde. Atenção Especializada. Programa Agora Tem Especialistas. Amazônia.

RESUMEN

Introducción: El acceso oportuno a la atención especializada sigue siendo uno de los principales desafíos para el Sistema Único de Salud (SUS) de Brasil, particularmente en territorios amazónicos marcados por grandes distancias, brechas en la atención y debilidades en la organización regionalizada de la red (Giovannella et al., 2020; Garnelo et al., 2017). En respuesta a este escenario, el Ministerio de Salud instituyó, mediante la Medida Provisional nº 1.301, de 30 de mayo de 2025, posteriormente reglamentada por la Ordenanza GM/MS nº 7.266, de 18 de junio de 2025, y en el contexto de la Emergencia de Salud Pública declarada por la Ordenanza GM/MS nº 7.061, de 6 de junio de 2025, el Programa "Ahora Hay Especialistas", con apoyo de la Agencia Brasileña de Apoyo a la Gestión del SUS (AgSUS), estructurado en la lógica del acceso regulado, la atención Integrado y el uso de unidades móviles de atención especializada (Brasil, 2025a; Brasil, 2025b; Brasil, 2025c).

Objetivo: Informar y analizar el rol de las enfermeras en la implementación del Programa "Agora Tem Especialistas" en territorios amazónicos, con énfasis en los procesos de articulación interfederativa, organización de la regulación a través del SISREG y la Regulación e-SUS, movilización comunitaria y operacionalización de unidades móviles estructuradas según la lógica de la Oferta Integrado de Atención (OCI). Método: Estudio descriptivo, con enfoque cualitativo, en forma de relato de experiencia, basado en la observación participante y la sistematización reflexiva de actividades desarrolladas entre 2025 y 2026 en los municipios de Humaitá y Lábrea y en el distrito de Santo Antônio do Matupi, en el municipio de Manicoré (AM). Se utilizaron registros de campo, documentos normativos, actas de reuniones, instrumentos institucionales y evidencia de reconocimiento formal por parte de los gestores locales.

Resultados: La experiencia destacó el rol central de la enfermera como articuladora técnico-política en la traducción de las directrices nacionales a las prácticas territoriales, con énfasis en: la organización del acceso exclusivamente a través de la regulación (SISREG/Regulación e-SUS); La adopción de la lógica OCI (consulta, examen y seguimiento); la implementación de unidades móviles caracterizadas como remolques personalizados, con salas de espera, consultorios, salas de ecografía y mamografía, ascensor para accesibilidad, ambiente climatizado e informatizado; la coordinación con la vigilancia sanitaria y la seguridad del paciente; y la innovadora estrategia de movilización a través de Agentes Comunitarios de Salud. Cabe destacar también el hito de Santo Antônio

do Matupi como el primer distrito del estado de Amazonas en recibir el Programa y la replicabilidad de la experiencia, avalada por una] solicitud formal de apoyo técnico en el municipio de Lábrea.

Conclusión: La enfermera se configuró como un actor estratégico en la implementación del Programa "Ahora Hay Especialistas" en el territorio amazónico, mediando la articulación entre las políticas públicas, la gestión y la comunidad, y contribuyendo a la consolidación de un modelo de atención especializada regulada, humanizada y de calidad, de acuerdo con los principios de equidad e Integrabilidad del SUS (Sistema Único de Salud).

Palabras clave: Enfermería. Políticas de Salud Pública. Atención Especializada. Programa Agora Tem Especialistas. Amazon.

1 INTRODUCTION

Timely and equitable access to specialized care is one of the main structural challenges of public health systems and is recognized as a central component for the effectiveness of Health Care Networks and for the reduction of inequities (Giovanella et al., 2020; Mendes, 2011). In Brazil, the persistence of long queues for consultations, exams, and specialized procedures expresses historical limits in installed capacity, weaknesses in regionalization, and difficulties in the organization of care regulation (Paim et al., 2011; Travassos, Oliveira; Viacava, 2006).

In the Amazon region, these challenges are more complex due to the large territorial extension, low population density, logistical barriers, and the scarcity of specialists, which accentuates care gaps and compromises comprehensive care (Garnelo et al., 2017; Schweickardt et al., 2019). The organization of strategies capable of integrating primary care, regulation and specialized supply in regional networks becomes, therefore, a fundamental condition for the effectiveness of the principles of the Unified Health System (SUS).

2 TERRITORIAL AND DEMOGRAPHIC CHARACTERIZATION OF THE MUNICIPALITIES AND DISTRICT STUDIED

The municipality of Humaitá, located in the south of the state of Amazonas, on the banks of the Madeira River, registered 57,473 inhabitants in the 2022 Demographic Census of the Brazilian Institute of Geography and Statistics (IBGE), with a demographic density of 1.74 inhabitants/km², which expresses its extensive territorial area and the challenges associated with the provision of specialized health services in this region.

The municipality of Lábrea, also in the south of Amazonas, had 45,448 inhabitants in 2022, with a demographic density of 0.67 inhabitants/km², indicating a scenario even more marked by low population concentration and large internal distances, which historically influences the organization of health care in a network and the need for itinerant strategies to expand access.

The district of Santo Antônio do Matupi, which is part of the municipality of Manicoré (AM), has its oldest demographic data detailed by census sector in the 2010 IBGE Demographic Census, the last source of official data subdivided by district, and registered 9,139 inhabitants that year, of which 5,870 lived in the urban area. The release of specific district data from the 2022 Census by the IBGE is still in the process of consolidation in official tabulated databases, which generates discrepancies between current estimates and historical data. It is worth mentioning that local management, based on operational surveys and territorial coexistence, still refers to the district as close to 9 thousand inhabitants, which,

although not formalized in a consolidated IBGE tabular publication for 2022, constitutes an approximate parameter used in municipal administrative practices. This demographic and territorial configuration — with municipalities of large size and low density, and a district with difficulties in measuring the population up to date — reflects a scenario in which the provision of specialized care faces logistical challenges, geographic distances, and specific needs for regulation and interfederative articulation.

In this context, the Ministry of Health instituted, through Provisional Measure No. 1,301, of May 30, 2025, later regulated by Ordinance GM/MS No. 7,266, of June 18, 2025, and in the context of the Public Health Emergency Situation declared by Ordinance GM/MS No. 7,061, of June 6, 2025, the *Agora Tem Especialistas* Program, which defines guidelines for expanding and qualifying access to specialized care, with emphasis on the use of installed capacity, the strengthening of regulation systems, interfederative articulation, and the adoption of innovative care devices, including the mobile specialized care units, with operational support from the Brazilian Agency for Support to SUS Management (AgSUS) (Brazil, 2025a; Brazil, 2025b; Brazil, 2025c).

The Program is structured on the logic of exclusively regulated access, through the Regulation System (SISREG) and e-SUS Regulation, ensuring nominal lists, prior scheduling and organization of appointments according to the Integrated Care Offer (OCI), understood as the articulated performance of an initial consultation, exam or procedure and return consultation, ensuring continuity, clinical quality and patient safety. Such a model conceptually distances itself from actions of a massive or episodic nature, prioritizing the centrality of the clinical encounter, the humanization of care and the problem-solving capacity of care.

The mobile units used under the Program are configured as customized truck-type vehicles, equipped with waiting rooms, medical offices, ultrasound and mammography rooms, elevators for accessibility for people with reduced mobility, in addition to air-conditioned and computerized environments, with infrastructure equivalent to that of fixed services of medium complexity. These devices are integrated into the SUS information and regulation systems and submitted to health inspection, patient safety protocols, and equipment calibration routines, ensuring technical and care standards compatible with specialized care.

The literature on public policies and health management highlights that the effectiveness of programs of this nature depends, in addition to the normative design, on the performance of professionals capable of articulating the implementation in the territory, mediating the relationship between national guidelines, local management and the needs of

the population (Hartz; Silva, 2005; Peters et al., 2013). In this process, nurses occupy a strategic position in the SUS, due to their historical insertion in care coordination, health surveillance, service organization, and interprofessional and community articulation (Kurcgant, 2016; Peduzzi et al., 2011).

In view of this scenario, it is relevant to systematize concrete experiences of implementation of the Agora Tem Especialistas Program in Amazonian territories, based on the role of nurses as agents of interfederative articulation and organizer of regulation and care processes. This study aims to report and analyze this performance in the municipalities of Humaitá and Lábrea and in the district of Santo Antônio do Matupi, in the municipality of Manicoré, state of Amazonas, highlighting the institutional arrangements, the organization of regulation, community mobilization and the operationalization of mobile units of specialized care.

The period of planning, agreement and execution of actions linked to the modality of Mobile Units of the Program is adopted as an analytical approach, with emphasis on the flows of regulation via e-SUS Regulation and/or SISREG, on the articulation between municipal managers, the State Department of Health and the Ministry of Health, and on the role of the nurse in the coordination of care, in the logistical organization and in the mediation between the different levels of care. The analysis seeks to highlight both the advances in the expansion of access to specialized care and the structural and operational limits imposed by the Amazonian territorial dynamics, marked by long distances, care gaps and weaknesses in the regionalized network.

3 METHODOLOGY

This is a descriptive and analytical study, with a qualitative approach, in the form of an experience report, developed from the author's professional experience in institutional support activities related to the Agora Tem Especialistas Program in the municipalities of Humaitá, Lábrea and in the district of Santo Antônio do Matupi, in the municipality of Manicoré (AM), from October 2025 to January 2026.

The experience report, as a methodological strategy in Collective Health, is recognized as a legitimate device for the production of knowledge about work processes, organization of services and implementation of public policies, to the extent that it allows the articulation of the empirical dimension of professional practice with the critical-reflexive analysis of its institutional, territorial and political-organizational determinants (Minayo, 2014; Deslandes & Gomes, 2016; Ceccim & Feuerwerker, 2004).

The production of information was based on participant observation, field records, records of interinstitutional meetings, public records and normative documents of the Ministry of Health, as well as observational information related to the regulation flows (e-SUS Regulation and SISREG), as recommended by qualitative approaches that value the immersion of the researcher in the investigated context and the understanding of the processes in their historicity and complexity (Minayo, 2014; Gil, 2019).

The analysis was guided by the references of the regionalization of the Unified Health System, the organization of Health Care Networks and care management, understanding the territory as a central category for the interpretation of the dynamics of access, care flows and interfederative articulation, especially in Amazonian contexts marked by great geographical distances, care gaps and structural inequalities (Mendes, 2011; Santos & Silveira, 2006).

The data were organized into analytical axes that include: (i) institutional articulation and interfederative agreement; (ii) organization of regulation flows; (iii) community mobilization and integration with Primary Care; and (iv) operationalization of the Mobile Specialized Care Units, seeking to highlight advances, limits and challenges in the implementation of the Program in hard-to-reach territories.

As it is an experience report based on work processes and institutional documents, without the use of identifiable user data or sensitive information, the study does not require consideration by the Research Ethics Committee, according to CNS Resolution No. 510/2016. Institutional anonymity and confidentiality of information were preserved.

It should be noted that this manuscript is an experience report based on the author's professional experience and documents in the public domain, and is not characterized as an institutional position or disclosure of internal administrative information. The analyses and interpretations presented are the sole responsibility of the author, having used only public, normative or observational data, without access or use of restricted institutional databases.

4 RESULTS AND DISCUSSION

4.1 INSTITUTIONAL ARTICULATION AND INTERFEDERATIVE AGREEMENT

The implementation of the Agora Tem Especialistas Program in the municipalities of Humaitá, Lábrea and in the district of Santo Antônio do Matupi showed, from the initial phase, the centrality of interfederative articulation as a condition for the operational viability of the Mobile Specialized Care Units. Considering the Amazonian territorial configuration, marked by long river and road distances, low density of specialized services and historical weaknesses in regionalization, the agreement between the Ministry of Health, the Amazonas State Department of Health and municipal administrations assumed a strategic character.

The process was conducted through technical meetings, definition of sanitary responsibilities, adequacy of the local infrastructure to receive the trucks and organization of reference and counter-reference flows. In this context, the role of nurses as institutional supporters and technical-political articulators proved to be fundamental to mediate interests, translate federal regulations into the local reality, and enable operational arrangements compatible with the installed capacities of the municipalities.

It is noteworthy that the agreement was not restricted to logistical aspects, but also involved the definition of criteria for access to services, integration with Primary Health Care and the operationalization of regulation systems (e-SUS Regulation and SISREG), ensuring that all users served by the Mobile Units were previously regulated, in line with the principles of equity, comprehensiveness and ordering of care in the Health Care Network.

In this context, monitoring assumes a central role as a management and articulation tool in the territory, as it enables the systematic monitoring of the agreed actions, the verification of their execution and the correction of directions throughout the process, an indispensable condition for inter-institutional strategies to achieve effectiveness and not be restricted to the normative plan. As Santos (2019) points out, it is through continuous monitoring that the co-responsibility between the actors involved is strengthened and that the planned actions are, in fact, implemented and consolidated in the daily routine of the services.

The experience in the municipalities of Humaitá, Lábrea and in the district of Santo Antônio do Matupi evidenced the complexity of the process of implementing the Mobile Units, since, in all territories, intersectoral articulation was necessary to define adequate physical areas, guarantee of continuous supply of electricity, connectivity for access to computerized systems, in addition to community mobilization to clarify the users about the criteria for scheduling and operation of the services.

In the district of Santo Antônio do Matupi, in particular, the role of Community Health Agents in mobilizing users in urban, rural and riverside areas was highlighted, considering that there was no structured waiting list for specialized procedures in women's health, since such services were not part of the municipality's regular offer. When necessary, the users were included in the state regulation and frequently referred to the capital, with trips that could exceed a day and a half by river and land, or to neighboring municipalities with limited supply, such as Humaitá, and, in extreme situations, to philanthropic services in other states, such as the Hospital de Amor, in Porto Velho (RO), highlighting the multiple geographical, economic, and institutional barriers to timely access.

4.2 ORGANIZATION OF REGULATION AND CARE FLOWS

The organization of access to the services offered by the Mobile Units of the Agora Tem Especialistas Program was structured based on the official regulation systems, notably the e-SUS Regulation and the SISREG, reaffirming the centrality of regulation as a device that organizes care and guarantees the principles of equity and Integradoity within the scope of the Health Care Networks.

All users assisted in the trucks were previously registered and regulated, based on requests from Primary Health Care, based on clinical protocols and prioritization criteria agreed between the municipal teams, the State Department of Health and the Ministry of Health. This process made it possible to organize waiting lists, stratify risks, optimize the use of the installed capacity of the Mobile Units and ensure that the most vulnerable cases and clinical need had timely access to consultations and specialized exams.

In the municipalities of Humaitá and Lábrea, as well as in the district of Santo Antônio do Matupi, regulation has taken on an even more strategic role due to the historical scarcity of local supply of medical specialties and diagnostic support, which traditionally forces users to travel long distances to regional centers. The insertion of the Mobile Units in the network required the construction of specific referral and counter-referral flows, articulating the Primary Care teams, the state services of medium complexity and the temporary structures installed by the trucks.

In this context, the nurse's work stood out in the coordination of work processes related to regulation, including technical support to the teams in the qualification of requests, dialogue with regulatory centers, monitoring of agendas and mediation of necessary adjustments in the face of connectivity limitations, system instabilities and logistical challenges typical of the Amazon territory. Such action contributed to reducing absences, reorganizing priorities and strengthening the integration between the points of care, bringing daily practice closer to the normative principles of regionalization and care management in the SUS.

4.3 COMMUNITY MOBILIZATION AND INTEGRATION WITH PRIMARY HEALTH CARE

The effectiveness of the implementation of the Mobile Units of the Agora Tem Especialistas Program in the territories studied was directly related to the capacity for community mobilization and the articulation with Primary Health Care (PHC), recognized as the preferential gateway and coordinator of care within the scope of the Unified Health System (Starfield, 2002; Mendes, 2011; Giovanella et al., 2020). In Amazonian contexts, marked by population dispersion, difficulties in geographic access and communication

limitations, the prior preparation of the territory proved to be a fundamental step for the adequate use of the specialized offer.

The PHC teams played a central role in identifying users with indication for consultations and specialized exams, updating registration, providing guidance on regulation flows, and preparing patients clinically and administratively for care in the trucks. The mobilization involved educational actions in health units, telephone contacts, articulation with community health agents and local leaders, seeking to reduce absences, clarify access criteria and strengthen the bond between users and the care network.

In the district of Santo Antônio do Matupi, territorial conditions, long distances between communities, and the predominance of productive activities linked to family subsistence imposed additional challenges to the organization of agendas and user attendance. The nurse's performance, in interface with the local teams and with the district management, which was performed by a nursing professional, proved to be strategic in the coordination of these actions, both in the planning of communication strategies and in the adequacy of service schedules, in the organization of reception and in the intersectoral articulation for logistical support.

This integration between PHC, regulation and Mobile Units contributed to the construction of more problem-solving care flows, favoring the continuity of care through counter-referral and longitudinal follow-up of users after consultations and specialized exams. This dynamic reinforces the understanding of Primary Care not only as an instance of referral, but as a structuring axis of the Health Care Network, even when the specialized offer is provided by itinerant devices.

4.4 OPERATIONALIZATION OF THE MOBILE UNITS OF SPECIALIZED CARE

The operationalization of the Mobile Units of the Agora Tem Especialistas Program in the municipalities of Humaitá, Lábrea and in the district of Santo Antônio do Matupi highlighted the logistical and organizational complexity involved in the itinerant provision of specialized care in Amazonian territories. The trucks, designed as temporary care structures of medium complexity, were equipped with waiting rooms, offices, environments for performing imaging exams (ultrasonography and mammography), elevator for accessibility for people with disabilities or reduced mobility, air conditioning and computerized systems integrated with SUS databases, with infrastructure equivalent to that of fixed services of medium complexity.

In addition, the implementation of the Mobile Units required permanent articulation with the service provider responsible for their operation, a company hired by the Ministry of Health,

through the Brazilian Agency for Support to SUS Management (AgSUS), for the provision and maintenance of customized trucks. This interface involved the systematic monitoring of structural conditions, equipment operation, accessibility, air conditioning, connectivity and adequacy of work processes, as well as the daily requirement of compliance with established technical, sanitary and contractual requirements. Such articulation proved to be fundamental to ensure that the provision of specialized care occurred in accordance with the standards of quality, patient safety and problem-solving capacity recommended by the Program, ensuring the effectiveness of care for the population in the Amazonian territories.

The installation of these units required the prior adaptation of physical areas, with a guarantee of continuous supply of electricity, connectivity for access to the regulation systems and medical records, health safety conditions and logistics for the reception of users. In Santo Antônio do Matupi, for example, intense articulation with the municipal management and other sectors of the local administration was necessary to enable land, support infrastructure and organization of the flow of people, considering the expected volume of services and the structural limitations of the district.

With regard to the work process, the presence of the Mobile Units implied the reorganization of the routines of the local teams, the integration between professionals from the trucks and the municipal network, and the definition of protocols for reception, referral and counter-referral. Nurses played a central role in the coordination of these activities, acting both in care management and in service management, articulating agendas, monitoring the functioning of agendas and care flows, mediating flows between regulation, PHC and specialized care, and ensuring the conformity of processes with the regulations of the Ministry of Health.

The challenges observed included connectivity instabilities, the need for continuous adjustments in supply logistics, adapting service times to the specificities of the local population, and overcoming barriers related to the transportation of users, especially those living in rural or riverside areas. Even so, the experience demonstrated the potential of the Mobile Units as a strategy for reducing care gaps and expanding access to medium complexity, as long as they are organically integrated into the regionalized network and supported by robust processes of regulation and coordination of care.

5 DISCUSSION

The experience of implementing the Agora Tem Especialistas Program in the municipalities of Humaitá, Lábrea and in the district of Santo Antônio do Matupi evidences, in a concrete way, the historical challenges of the regionalization of specialized care in

Amazonian territories and, simultaneously, the potential of innovative strategies, such as the Mobile Units, to reduce care gaps. The literature points out that ensuring timely access to medium complexity in regions of great territorial dispersion depends less on the mere expansion of supply and more on the ability to articulate networks, order flows, and integrate levels of care (Mendes, 2011; Viana et al., 2015).

In this sense, the centrality of regulation, operationalized through e-SUS Regulation and SISREG, is confirmed as a structuring element of equity and comprehensiveness of care, as it allows clinical prioritization, rationalization of the use of resources, and integration between Primary Care and specialized services, even when these are materialized in itinerant devices. The experience analyzed reinforces the findings of studies that highlight regulation as a strategic component of the governance of Health Care Networks, particularly in contexts of scarcity and asymmetry in the distribution of services (Silva et al., 2017; Santos & Campos, 2019).

Another relevant aspect concerns the role of nurses as agents of technical-political articulation and coordinator of work processes. In addition to its care attributions, the observed performance is inserted in the field of care management and institutional support, approaching the formulations of Ceccim and Feuerwerker (2004) on the inseparability between clinical, management and education in health work. In Amazonian territories, where the fragmentation of the network is intensified by geographical and institutional barriers, this mediating function proves to be even more strategic, contributing to the translation of federal regulations into territorially situated organizational arrangements.

The operationalization of the Mobile Units, in turn, shows both potentialities and limits. If, on the one hand, it expands access to specialized consultations and exams and reduces long-distance travel, on the other hand, it exposes the dependence on local infrastructure, connectivity, logistics, and effective integration with the fixed network. Such ambivalence dialogues with critical analyses of itinerant provision policies, which warn of the risk of punctual and discontinued solutions when not accompanied by the structural strengthening of regional networks (Paim, 2018; Giovanella et al., 2020).

Thus, the reported experience indicates that the effectiveness of the Mobile Units lies not only in the embedded technology, but above all in the capacity for interfederative articulation, in the coordination of care by Primary Care, in the robustness of the regulation systems and in the protagonism of professionals with a technical-political profile, such as nurses, in the conduction of the processes.

It is worth recognizing some limitations of this account. The situated character of the experience is highlighted, restricted to three Amazonian territories and based predominantly

on the author's experience, which may limit the generalization of the findings. In addition, comparative quantitative indicators of access before and after the intervention were not used, restricting causal inferences about the impact of care. Even so, the systematization presented contributes to the understanding of organizational processes and institutional arrangements in contexts of difficult access, offering subsidies for the management of specialized care in the SUS.

The text does not propose to carry out an evaluation of institutional performance or analysis of administrative indicators, limiting itself to the reflective description of organizational processes observed in professional practice.

6 CONCLUSION

The systematization of the experience of implementing the Agora Tem Especialistas Program in Humaitá, Lábrea, and the district of Santo Antônio do Matupi, from October 2025 to January 2026, shows that expanding access to specialized care in Amazonian territories requires more than the availability of itinerant structures. It requires solid institutional arrangements, effective interfederative agreement, organic integration with Primary Care, and regulation capable of ordering flows according to criteria of necessity and equity.

The nurse's role proved to be central in this process, both in the technical coordination of regulation and care flows, as well as in the mediation between managers, teams and the community, configuring themselves as a strategic agent in the implementation of public policies in contexts of high territorial and organizational complexity.

It is concluded that the Program's Mobile Units, when integrated into the Health Care Networks and supported by robust processes of regulation and care management, constitute an important device for the reduction of care gaps and for the realization of the right to health in regions historically marked by inequities of access. However, its results depend on the continuity of actions, the strengthening of local installed capacity and the consolidation of interfederative articulation practices, under penalty of being configured as episodic responses to structural problems.

This experience contributes to the debate on regionalization, access, and organization of specialized care in the Amazon, offering subsidies for the improvement of public policies and for the training of health professionals, especially nurses, with skills focused on the management of care in territories of great vulnerability and socio-spatial complexity.

REFERENCES

Brasil. (2025a). Medida Provisória nº 1.301, de 30 de maio de 2025. Institui o Programa Agora Tem Especialistas. Diário Oficial da União, Seção 1.

- Brasil. Ministério da Saúde. (2025b). Portaria GM/MS nº 7.061, de 6 de junho de 2025. Declara Situação de Urgência em Saúde Pública. Diário Oficial da União, Seção 1.
- Brasil. Ministério da Saúde. (2025c). Portaria GM/MS nº 7.266, de 18 de junho de 2025. Regulamenta o Programa Agora Tem Especialistas. Diário Oficial da União, Seção 1.
- Ceccim, R. B., & Feuerwerker, L. C. M. (2004). O quadrilátero da formação para a área da saúde: Ensino, gestão, atenção e controle social. *Physis: Revista de Saúde Coletiva*, 14(1), 41–65.
- Deslandes, S. F., & Gomes, R. (2016). Pesquisa qualitativa em serviços de saúde (2ª ed.). Vozes.
- Garnelo, L., et al. (2017). Atenção Primária à Saúde e organização de redes em regiões remotas da Amazônia. *Ciência & Saúde Coletiva*, 22(4), 1141–1154.
- Gil, A. C. (2019). Métodos e técnicas de pesquisa social (7ª ed.). Atlas.
- Giovanella, L., et al. (2020). Política e sistema de saúde no Brasil (2ª ed.). Fiocruz.
- Hartz, Z. M. A., & Silva, L. M. V. (2005). Avaliação em saúde: Dos modelos teóricos à prática na avaliação de programas e sistemas de saúde. EDUFBA; Fiocruz.
- Instituto Brasileiro de Geografia e Estatística. (2011). Censo Demográfico 2010: Resultados por setor censitário. <https://www.ibge.gov.br>
- Instituto Brasileiro de Geografia e Estatística. (2023). Censo Demográfico 2022: Resultados preliminares de população por município. <https://www.ibge.gov.br>
- Kurcgant, P. (2016). Gerenciamento em enfermagem (3ª ed.). Guanabara Koogan.
- Mendes, E. V. (2011). As redes de atenção à saúde (2ª ed.). Organização Pan-Americana da Saúde.
- Minayo, M. C. S. (2014). O desafio do conhecimento: Pesquisa qualitativa em saúde (14ª ed.). Hucitec.
- Paim, J. S. (2018). O que é o SUS. Fiocruz.
- Paim, J. S., et al. (2011). O sistema de saúde brasileiro: História, avanços e desafios. *The Lancet*, 377(9779), 1778–1797.
- Peduzzi, M., et al. (2011). Trabalho em equipe na perspectiva da gerência e da clínica. *Revista de Saúde Pública*, 45(4), 784–792.
- Peters, B. G., et al. (2013). Implementation and public policy (2ª ed.). Routledge.
- Santos, J. M. V. (2019). Matriciamento e monitoramento como ferramentas de gestão para diminuição das subnotificações relacionadas às doenças e agravos à saúde dos trabalhadores. *Saúde & Transformação Social*, 10(1/2/3), 235–242.
- Santos, M., & Silveira, M. L. (2006). O Brasil: Território e sociedade no início do século XXI. Record.
- Santos, L., & Campos, G. W. S. (2019). Regulação em saúde: Fundamentos, desafios e perspectivas. *Ciência & Saúde Coletiva*, 24(6), 2161–2170.
- Schweickardt, J. C., et al. (2019). Regionalização da saúde na Amazônia: Limites e possibilidades. *Saúde em Debate*, 43(Esp. 6), 91–104.

- Silva, L. M. V., et al. (2017). Regulação assistencial e equidade no SUS. *Revista de Saúde Pública*, 51(Supl. 1), 1–10.
- Starfield, B. (2002). *Primary care: Balancing health needs, services and technology*. Oxford University Press.
- Travassos, C., Oliveira, E. X. G., & Viacava, F. (2006). Desigualdades geográficas e sociais no acesso aos serviços de saúde no Brasil. *Ciência & Saúde Coletiva*, 11(4), 975–986.
- Viana, A. L. D., et al. (2015). Regionalização e redes de atenção à saúde no Brasil. *Ciência & Saúde Coletiva*, 20(8), 2309–2316.

**PROPERTY REGISTRATION AND ENVIRONMENTAL PROTECTION IN BRAZIL:
CONTRIBUTIONS TO THE IMPLEMENTATION OF THE PRINCIPLE OF THE SOCIAL
FUNCTION OF PROPERTY**

**O REGISTRO DE IMÓVEIS E A PROTEÇÃO AMBIENTAL NO BRASIL:
CONTRIBUIÇÕES PARA EFETIVAÇÃO DO PRINCÍPIO DA FUNÇÃO SOCIAL DA
PROPRIEDADE**

**REGISTRO DE LA PROPIEDAD Y PROTECCIÓN AMBIENTAL EN BRASIL:
CONTRIBUCIONES A LA IMPLEMENTACIÓN DEL PRINCIPIO DE LA FUNCIÓN
SOCIAL DE LA PROPIEDAD**



<https://doi.org/10.56238/sevened2026.008-114>

Guiomar Rocha Pereira Magalhães Bittencourt¹, Luciana Turatti²

ABSTRACT

The Real Estate Registry emerged, in Brazil, as a way to guarantee the legal security of real estate relations and the right to property, taking as inspiration the French and German real estate registration systems. In 1988, the Federal Constitution dealt with the right to property, conditioning its exercise in the service of the social function, and this, in turn, covers the protection and defense of the environment. In other words, there must be a conditioning between the exercise of the right to property and the preservation of the environment. The combination of environmental standards with the registration principles, in turn, favors the publicity and security that are expected of legal businesses whose object is immovable. Thus, the aim of this study is to analyze the reflexes derived from the Forest Code in real estate records. The methodological procedures adopted are bibliographic and documentary research. The method was deductive and the qualitative approach. This research aims to contribute to the elucidation of practical aspects of environmental legislation applicable to the registration of Brazilian real estate, serving as a basis for further studies and consisting of a catalyst for changes in the public records area.

Keywords: Real Estate. Environmental Law. Social Role. Real Estate Registrar. Legal Certainty.

RESUMO

O Registro de Imóveis surgiu, no Brasil, como forma de garantir a segurança jurídica das relações imobiliárias e o direito de propriedade, tendo como inspiração os sistemas registrares imobiliários francês e alemão. Em 1988 a Constituição Federal tratou do direito de propriedade condicionando seu exercício ao atendimento da função social, e esta, por sua vez, abrange a proteção e defesa do meio ambiente. Em outros termos, deve haver um

¹ E-mail: guiomarbittencourt@yahoo.com.br Orcid: <https://orcid.org/0009-0008-8689-1911>
Lattes: <http://lattes.cnpq.br/4073862295365523>

² E-mail: lucianat@univates.br Orcid: <https://orcid.org/0000-0002-6684-1422>
Lattes: <http://lattes.cnpq.br/5819588394882211>

condicionamento entre o exercício do direito de propriedade e a preservação do meio ambiente. A conjugação das normas ambientais com os princípios registrais, por sua vez, favorece a publicidade e a segurança que se esperam dos negócios jurídicos cujo objeto seja bem imóvel. Em assim sendo, o objetivo deste estudo é analisar os reflexos oriundos do Código Florestal nos registros de imóveis, orientando a abordagem do presente estudo sob a perspectiva desse Diploma. O problema que envolve o desenvolvimento dessa pesquisa é esclarecer se, na prática, as funções desenvolvidas pelo Registro de Imóveis consagram e influenciam, de fato, na efetivação da função social da propriedade. Os procedimentos metodológicos adotados são a pesquisa bibliográfica e documental. O método foi o dedutivo e a abordagem qualitativa. Pretende-se com esta pesquisa poder contribuir para a elucidação de aspectos práticos da legislação ambiental aplicáveis ao registro de imóveis brasileiro, servindo de base para novos estudos e consistindo em catalisador para mudanças na seara dos Registros Públicos.

Palavras-chave: Bens Imóveis. Direito Ambiental. Função Social. Registrador Imobiliário. Segurança Jurídica.

RESUMEN

El Registro de la Propiedad Inmueble surgió en Brasil como forma de garantizar la seguridad jurídica de las relaciones inmobiliarias y el derecho a la propiedad, inspirándose en los sistemas inmobiliarios francés y alemán. En 1988 la Constitución Federal reglamentó el derecho de la propiedad condicionando su ejercicio a atender a la función social, y esta, a su vez, comprende la protección y defensa del medio ambiente. En otros términos, debe haber un condicionamiento entre el ejercicio del derecho de la propiedad y la preservación del medio ambiente. La conjugación de las normas ambientales con los principios registrales, a su vez, favorece la publicidad y la seguridad que se esperan de los negocios jurídicos cuyo objeto sea el bien inmueble. Por lo tanto, el objeto de este estudio es el de analizar los reflejos derivados del Código Forestal en los registros de inmuebles. Los procedimientos metodológicos adoptados son la investigación bibliográfica y documental. El método fue el deductivo y el abordaje cualitativo. Con esta investigación se pretende poder contribuir para elucidar aspectos prácticos de la legislación ambiental aplicables al registro de inmuebles brasileño, sirviendo como base para nuevos estudios y consistiendo en catalizador para cambios en el ámbito de los Registros Públicos.

Palabras clave: Bienes Inmuebles. Derecho Ambiental. Función Social. Registrador de la Propiedad. Seguridad Jurídica.

1 INTRODUCTION

The use of natural resources has been widely disseminated throughout the recent history of humanity, with its main milestone defined with the advent of the French Revolution (1789) and, more specifically, the Industrial Revolution that followed. Since then, we have witnessed the parallel evolution of two faces of the same phenomenon in the world, that is, the alarming pressure on the environment, with successive demands for all kinds of consumer goods, coming from the progressive demographic increase; and, on the other hand, heavy investments in technological innovations, whose advances are surpassed in increasingly shorter cycles of novelty and, subsequently, of obsolescence, thus leading to environmental degradation.

Specifically in Brazil, the concern with the protection of the environment reached an unprecedented level with the promulgation of the Constitution of the Federative Republic of Brazil of 1988 (CF/1988), which dealt with the matter in its own chapter (Chapter VI – On the environment), in the penultimate of the nine titles (Title VIII – On the social order) which, together with the Preamble and the Act of Transitory Constitutional Provisions (ADCT), compose it, even if it has done so in a single article, 225, caput and §§ 1 to 7 (BRASIL, 1988, digital text). In this article, the Constituent Assembly first established the right to an ecologically balanced environment and included it among the fundamental rights of the third generation, or dimension; later, he established that the environment was a good for the common use of the people; and, finally, it determined not only to the Public Power, but also to the entire community the duty to defend and preserve it, for present and future generations (CF/1988, art. 225, caput, third part).

Based on these three constitutional premises, it is up to the Real Estate Registrar to ³ govern its performance, since it performs a function with a public purpose, in strict compliance with environmental legislation, in addition to ensuring compliance with this regulation by third parties, in order to, in so doing, protect, in a direct and equally reflexive way, the healthy and balanced environment.

The activity of the Real Estate Registrar must also be exercised according to the principle of strict legality (which underpins the Real Estate Registry), since, in the view of Dip (1993, p. 17), this principle would come from the very "theology of the registry institution", which, according to the author, would be found, in turn, in the reason for the existence of the

³ Real Estate Registrar is understood to be a legal professional who is a delegate, by the Brazilian State, of a public function corresponding to the exercise, by him, in a private character and in collaboration with the Public Administration, of extrajudicial services of technical organization and of a registry nature, in a real estate district for which he has been previously invested by the Public Power, after being duly approved in a public examination of tests and titles, in order to, with his performance, provide publicity, authenticity, security and effectiveness of the legal acts entered in the royal folio.

Public Registries, which is the granting of legal certainty. Brazilian environmental legislation, in simple definition, corresponds to the gathering of legal norms aimed at regulating human activity, in order to make it compatible with environmental protection.

Thus, when guiding their professional performance, with a preliminary focus on the constitutional premises, the Real Estate Registry officer will be responsible, for example, for making public, among others, information related to permanent preservation areas, environmental protection areas, soil contamination areas, as well as areas included in the Rural Environmental Registry (CAR) (provided for in Law No. 12,651, of May 25, 2012, art. 29, caput), in addition to those on which there are environmental licenses.

Such information appears to be of paramount social importance, both for individuals in defense of their respective private interests, and for the Public Power, in scrutiny of public policies under their responsibility, since, depending on the existence of certain environmental facts, real rights may be limited or restricted, among which is the right to property.

What is intended to be discussed from the analyses carried out concerns the strategies that could be developed by the Real Estate Registrar, so that the principle of publicity could be achieved, thus contributing to expand the environmental protection provided for in the rules. It is up to the Real Estate Registrar to observe the environmental legislation, to make third parties observe it, in the exercise of the real estate registration activity, so that, thus, the social function of constitutional and infra-constitutional protection is exercised.

The method of the present study was that of theoretical research, so classified because it focuses on the conceptual, legal and bibliographic aspects of the proposed theme. This is a bibliographic research on the theme addressed, which can be included, conceptually, as explanatory research, within the teachings of Gil (2008). The approach, in turn, is qualitative, which predisposes attention to the systematic analysis of nature and, consequently, to the understanding of what will be extracted from the interpretations of the investigated phenomenon.

The combination of environmental rules with registration principles, in turn, favors the publicity and security that are expected from legal transactions whose object is immovable property. Therefore, the objective of this study is to analyze the effects of the Forest Code on real estate records, guiding the approach of this study from the perspective of this Diploma. The problem that involves the development of this research is to clarify whether, in practice, the functions developed by the Real Estate Registry consecrate and influence, in fact, the effectiveness of the social function of property.

2 THE ROLE OF THE LAND REGISTRAR IN THE APPLICATION OF ENVIRONMENTAL LEGISLATION

In the explanation of Borges (2014, p. 21), with the advance promoted by modernity, some information has become vital for society, such as knowing the real owner of a certain property, "his rights and obligations or encumbrances, the real estate registry coated with his public faith that is inherent to it, plays the noble role of registering real estate property". This means demonstrating the registration status of the same, being able to carry out all changes, alterations and extinction of the rights related to the property. The services of the services are essential, acting as a "repository of all real estate property information, with authenticity, security and legal effectiveness".⁴

According to Álvares and Cunha (2018), it can be understood that the function reserved by the legal system to the Registrars was fundamental, regarding the preservation of the environment, which, through the publicity of the annotations made in the registry books, offered society essential environmental information about the property, also allowing to check whether or not the social function is being fulfilled by the property owner.

It is important to point out the principle of concentration, a provision launched by Federal Law 13,097/2015, establishing the obligation to include, in real estate registrations throughout the country, the registrations and annotations related to legal acts entered into prior to the effectiveness of said law, and such acts must seek due adaptation to the provisions determined by this legislation.

With the expanded view of the concept of property, and with limitations to its use in view of the function of social, environmental and economic requirements, it was also necessary to have a new posture of the Registration Officer, meeting the established responsibilities related to the preservation of the environment, aiming to promote a better quality of life, also serving the needs of current and future generations, according to constitutional commandment (ÁLVARES and CUNHA, 2018).

The authors also argue that the Registrar, when making available to the general public the relevant information about a certain property, applying the principle of concentration, must do so based on the current legislation, in an incisive legal text, which gives it the breadth and

⁴ Santos (2010, p. 327) observes about the challenges imposed on Real Estate Registrars: "The primordial nature of the registry activity stems from its vocation to stabilize social harmony, real estate business relations and the incidents arising from them, through the registry publicity that emerges from the foundations of the Democratic Rule of Law with erga omnes effect in search of the maintenance or restoration of social peace. [...] It is within this context that the Real Estate Registry books are open as repositories, notorious and accessible, of acts and facts that in some way may have repercussions on the right to property and on the social function of real estate, whose pronouncement is marked by a peremptory sign by virtue of the so-called registration principles".

recognition that it really needs, starting to promote a true revolution in the scope of Brazilian Real Estate Registry Law.

The Registration Officer who performs a public function, by delegation of the State and on behalf of the State, also has the obligation for environmental protection, not only for the function he performs, but also for the fact that he is Brazilian and is inserted in society.

The Real Estate Registry is an instrument of environmental inspection and also of planning because, at the moment when the real estate registrations contain all the environmental information of a given property, the Public Power, as well as society, have access to this information and from this scenario can outline more specific environmental policies by region, creating legal certainty in real estate business relationships, and an expanded environmental balance (HELLSTROM, 2016).

3 REAL ESTATE REGISTRATION AS A MEANS OF LEGAL CERTAINTY FOR ENVIRONMENTAL PROTECTION

According to Álvares and Cunha (2018, p. 33), it is possible to observe that the changes that occurred in society and in the Law were significant, accommodating here, in the present study, the essential change in the function of property, as it was imposed on it to meet the needs of the collectivity, and not only, to observe the interest of its owner. In a similar sense and as a collective right that it is, the preservation of the environment must be juxtaposed with the individual right, being the "first category of individual goal interests to deserve attention from society and the legislator. It is a right to be protected and that the Real Estate Registry can contribute".

The authors note that the Federal Constitution of 1988 guaranteed the right to private property, since, by establishing that "property shall serve its social function", the Constituent Assembly did not have the scope of excluding the right to private property, but tried to provide for its social function. It maintained, however, the private character, with its use also serving the common good. The obligations to the community, established by law, are no longer absolute the use, enjoyment and enjoyment of the property by its holder as provided for in the Brazilian Civil Code of 1916 (ÁLVARES and CUNHA, 2018, p. 33).

In line with the Federal Constitution of 1988, the first paragraph of article 1,228 of the Civil Code (CC) clearly expresses the consecration of such conception, by determining:

The right to property must be exercised in accordance with its economic and social purposes and in such a way that flora, fauna, natural beauty, ecological balance and historical and artistic heritage are preserved, in accordance with the provisions of a special law, as well as avoiding air and water pollution (BRASIL, 2002).

In this sense, in order to fulfill the social function of property, its holder must preserve the environment, a requirement of this function, also provided for in articles 182 and 186 of the 1988 Magna Carta, remembering, inclusively, that there is a legal warning and jurisprudential decision leading to the penalization of the owner who degrades the environment, even if he has not been the direct author of the damage⁵.

The social purpose attributed to property was reinforced in the Forest Code, which provided that the right to property must be exercised in accordance with its social purpose, which extends to the preservation of "flora, fauna, natural beauty, ecological balance and historical and artistic heritage, as well as avoiding air and water pollution". In article 2 of this legal diploma, it is established that the exercise of property must observe the limitations established by the legislation (BRASIL, 2012).

According to the provisions of paragraph 2 of the aforementioned article: "the obligations provided for in this law have a real nature and are transmitted to the successor, of any nature, in the event of transfer of ownership or possession of the rural property". By stipulating that environmental obligations have a real nature, the legislator meant that these are *propter rem* obligations⁶, accessory to the right in *rem* or property.

Noronha (2010, p. 317) teaches in this sense that such obligations impose on the owner of the thing the "duty to perform a service necessary for the harmonization of the exercise of his real right with that of another real right, of a different person, incident on the same thing, or on a neighboring thing".

Melo (2010, p. 29) understands that the structure presented by the Real Estate Registry "is one of the most important aspects that must be taken into account for the availability of environmental information", and lists its characteristics:

- a) the Real Estate Registry is a body that performs public service, constitutionally mentioned in article 236: "notarial and registry services are exercised in a private capacity, by delegation of the Public Power". The regulation, in turn, is contained in article 3 of Law No. 8,935/94, which defined: "Notary, or notary, and registration officer, or Registrar, are legal professionals, endowed with public faith, to whom the exercise of notarial and registration activity is delegated". Acting as a holder of public faith,

⁵ In this sense, ADI 5623 – STF - Judging body: Full Court - Rapporteur: Justice CÁRMEN LÚCIA - Judgment: 11/28/2022 - Publication: 12/01/2022
AP 470 – Judging body: Full Court - Rapporteur: Justice JOAQUIM BARBOSA - Judgment: 12/17/2012
Publication: 04/22/2013

⁶ *Propter rem* obligation, or obligation proper to the thing, is an obligation that arises from the simple acquisition of a real property right. That is, when acquiring a property, the financial obligations related to that property are also acquired. Available at: <https://www.google.com/search?q=propter+rem&oq=propter+rem&aqs=chrome..69i57j0i512l9.2146j0j7&sourceid=chrome&ie=UTF-8>. Accessed on: 12 jul. 2022.

- acting in conjunction with the Public Administration, the Registrar is attested to make environmental information public through registration in its books;
- b) organized territorially, the Real Estate Registry offices are in all counties of the country, and it is possible to find in most places, a service.
 - c) the Real Estate Registry has a relationship with all Public Administration bodies, maintaining a close relationship with them. The agencies sign agreements that result in the exchange of information between them, which also helps with tax information. It also maintains a direct relationship with the Brazilian Federal Revenue Service (SRFB), in the Declarations on Real Estate Operations (DOI) – established in article 8 of Federal Law 426/2002, and which are carried out monthly on the internet and the Federal Heritage Secretariat (SPU), according to article 3-A of Decree Law No. 2,398/87, in the case of acts performed in federal real estate;
 - d) the professionals who perform the services provided in the Real Estate Registry are technically qualified after being approved in a competition of tests and titles, when then, the Real Estate Registrar is declared qualified to perform the function, legitimizing him to the service related to property rights and also to environmental limitations.
 - e) another relationship maintained by the Real Estate Registry is the connection with the Brazilian Geodetic System, created in Law No. 267/2001, generating a way to manage and describe real estate property, making use of geographic coordinates fixed with the help of satellites.

Even in the face of such attributions and characteristics, the author (2010) understands that the relevant changes brought about by the progress of urban and environmental legislation are not reflected with the same advance in registration legislation. Therefore, it is essential in matters that deal with the environment, to pay attention to the need for effective precision in the inspection and identification of the owner of the property so that civil, criminal and administrative obligations can be imposed, in addition to the need for cadastral accuracy to the legal situation of the property.

In order to materialize the social function of property from a sustainable perspective, the development of urban policies must be complete, in the indispensable sense of combining efforts between public entities and real estate registry services, "accommodated in restricted areas of Civil Law, ignoring the need for interface with Public Law, showing that adequate planning is necessary to achieve this end" (MELO, 2010, p. 30).

The Law must protect property, because, as this is a constitutional guarantee, it is necessary to offer security to the citizen's assets. In this context, it is indisputable that the Real Estate Registry Offices provide such security, producing an important and complex function, in addition to being "the controlling body of its formal aspects, applying the registry principles, ensuring legal certainty, the reliability of the system and wide publicity, since most of the patrimonial relations involving real estate are controlled by it". In this role, notary offices cover the economic, legal and social scenario, in view of "their finalistic attribution, which is the static and dynamic legal certainty of the right to real estate property and other real or obligatory rights related to their competence" (MELO, 2010, p. 30).

The author has the view that there are three fundamental factors to the legal dimension, within the scope of Real Estate Registry Law:

- a) control over the legal situation of the property: an element that considers the previous analysis of the history of the property, as well as that of the mutations of its legal situation, by means of registration acts to be performed;
- b) the production of qualified legal information about the property is the element that examines the precision and exact scope of each change that occurs in the legal situation of the property;
- c) the provision of qualified information about the property to interested parties.

Santos (2010, p. 328) recalls that the conception of the Real Estate Registry being a simple repository of titles cannot be maintained, on the contrary, since "this centennial institution is a mechanism that provides for the permanent observance of human rights, fundamental principles and other constitutional dictates, with effective application in the field of private property". From this and other statements, it can be seen that, in order to meet the social function of property, it is essential to register the property in the Real Estate Registry Office of the competent district, limiting the domains of private property and intensifying the importance of the Real Estate Registry itself.

According to Santos (2010, p. 330), there is a socioeconomic dimension to the services provided by extrajudicial real estate services, in the sense that continuous urban growth generates complex and unbridled social problems and, sometimes, chaotic urbanization, with the lack of decent housing and the poor distribution of land to those who truly need to produce. In this perspective, being the instrument able to provide legal certainty to real estate business, Registry Law promotes economic stability, "enabling the best circulation of real estate, since society believes that real estate investment is the safest means of accumulating wealth,

through the protection conferred by the Federal Constitution", which, safeguarding the right to property, generated reflections "throughout the country's economic and social chain".

Regarding the role of the Real Estate Registry in the preservation of natural resources, Gonçalves (2011), director of development at the Mato Grosso do Sul Environmental Institute, states that the publicity of the law is not enough. It emphasizes the need for real estate advertising as a way to ensure legal certainty and compliance with the obligations contained in the legislation, which contributes, in particular, to the knowledge about the existing limits on the use of the property and the binding of future buyers of the properties.

Hellstrom (2016) comments that the theme of the annotations in the registration of the property has, as a central point of discussions, the principle of concentration, oriented to the real estate registration system. This principle can be understood from its link to the acts of registration, clarifying the situation of the registration of the property, as a support "in which any and all situations that may influence the property or the person of its owner must be publicized", dispensing with other steps that, otherwise, would be necessary to reach the real legal situation of the property.

In this area, legal certainty would be extended only to those acts registered or annotated in the registration of the property, that is, "only the situations contained in the Real Estate Registry, which plays an important role in the systematic transmission of data related to the property" that may generate foreseeable and imminent environmental damage. Hence, the relevance of monitoring such information, as such registration monitoring would enable the application of concrete measures in a timely manner, "preventing damage and/or the aggravation of environmental degradation" (STIFELMAN, 2012, p. 583).

The imposition of real estate property having to fulfill its social function, incorporated by the Federal Constitution and the Civil Code of 2002, has clearly linked it to environmental preservation, making it one of the premises for the fulfillment of the social function.

The legal system has granted a relevant role to the Real Estate Registry, in view of this new socio-environmental practice, this role being that of releasing important environmental information related to real estate property, giving it greater publicity and, due to the structure and reliability enjoyed by the Real Estate Registry system, checking whether environmental and social obligations are being fulfilled. The Real Estate Registry has a broad structure, which favors access to registration and environmental information to the local population, which must be clear and precise to facilitate understanding (HELLSTROM, 2016).

The author adduces that the understanding remains evident that, in the use of its structure and territorial competences, the services of the Real Estate Registry, exercising their functions, can reach the effective preservation of the environment. And that the

contribution of the right to information is to allow any citizen to exercise their right and duty to be informed and to be informed. Such practice leads to the realization of the socio-environmental function of the property. And effective environmental publicity occurs through the acts of concentration of the registration.

In Special Appeal (REsp) No. 1857098, from the State of Mato Grosso do Sul (MS) (2020/0006402-8), the prosecutor from Mato Grosso do Sul Edmir Fonseca Rodrigues explained to the Superior Court of Justice (STJ) that, in order to comply with Principle 10 of the Rio Declaration, through various norms, there is international recognition of the right of access to environmental information. Continuing his presentation, the Prosecutor narrated seeing, in this right, just mentioned, the existence of a two-way street: the right "of the individual to have access to the requested public information (passive transparency) and the state's duty to publicize the public information it holds (active transparency)". This author also reminds us that, even though it is constituted as an autonomous right, it is a right that is intrinsic to democracies, as it acts as a function of the right to social participation in public affairs (BRASIL, STJ, 2022).

Referring to the content of the aforementioned Special Appeal, the prosecutor stated that the Brazilian environmental and registry system determines the adequacy of the registration of the Environmental Protection Area (APA) in the Rural Property Registry. It also stated that there is no exhaustive provision for optional registrations, pointing to the fact that the Public Prosecutor's Office is expressly entitled to request, including directly to the Real Estate Registry officer, notes linked to its institutional function, among which, unequivocally, is environmental protection (BRASIL, STJ, 2022).

It is also stated in his arguments that the previous publicity of administrative acts "in no way prevents registration, even if it also meets this same principle", citing the various public acts, including judicial acts, which are compulsory annotation or registration (such as sentences, expropriations and listings). And it also reports that the Brazilian registry regime admits the registration of optional information about the property, of public interest, including environmental information (emphasis not present in the original) (BRASIL, STJ, 2022).

It also clarifies that, even if it is not internalized, "pending ratification, national law reflects similar principles throughout the legal system, from the constitutional level, which are spread across various federal laws".

It also teaches that the Principle of Maximum Disclosure is the one followed in the Brazilian transparency regime, that is, "publicity is the rule, and secrecy, the exception, without subterfuge, legal anachronisms or half-measures", and it is the duty of the State "to

demonstrate consistent reasons to deny active publicity and, even stronger, to reject compliance with the duty of passive transparency" (BRASIL, STJ, 2022).

Having evidenced the need to promote environmental encumbrances in the registration of real estate, the main environmental limits imposed by the legislation are discussed below, as a way to contribute and guide the registration of real estate.

4 THE ENCUMBRANCES THAT CONTRIBUTE TO ENVIRONMENTAL PROTECTION

4.1 LEGAL RESERVE

Law No. 12,651/2012, known as the New Forest Code, as already mentioned, provides in its article 2, paragraph 2 that the obligations provided for in this Law have a real nature and are transmitted to the successor.

To avoid any doubts about what would be a legal reserve, the legislative diploma thus conceptualized the legal reserve in its article 3, III, "having the function of ensuring the economic use in a sustainable way of the natural resources of the rural property", as well as "assisting the conservation and rehabilitation of ecological processes and promoting the conservation of biodiversity", in addition to sheltering and protecting wildlife and native flora.

From this perspective, it can be seen that the idea of the national legislator was, in the words of Miranda (2010, p. 347), "to protect Brazilian forests, especially the Amazon, due to the great limitation it imposes on properties located in the Legal Amazon, its application has been responsible for the genesis of a good part of the tensions" in these areas, because the use of the discourse of regional development directly collides with the preservation of the forest.

The concern with forests in Brazil dates back to the times of Colonial Brazil, but it was only with the CF/88 that new contours were achieved. However, Silva and others (2010, p. 272) assert that "forests and other forms of vegetation existing on private lands are not yet defined as public goods", and it is clear that the legislation (general or specific) should also be applied to private properties, since there was no distinction between public and private, but only the delimitation of the region, so that these private assets "are already considered to be of common interest to all the inhabitants of the country", and, for this reason, will also have their property rights limited, according to the Federal Constitution and §1 of article 1,228, of the Civil Code (SILVA et al., 2010, p. 272).

With the advent of the current Forest Code, the competence for the registration of the Legal Reserve area was transferred to the Rural Environmental Registry (CAR), under the terms of article 18,

Paragraph 4, "which exempted the registration in the Real Estate Registry Office", establishing the free practice of the act to the rural owner or possessor who wishes to do so, in the period between the date of publication of the Law and the registration in the CAR.

Silva (2021, p. 250) criticizes the aforementioned paragraph stating that it would be better if the environmental agency, whether municipal or state, responsible for receiving the information, made "the communication directly to the real estate registry, considering that it is an obligation of the Government to defend the environment, especially when it comes to an area already established as a mandatory protection". For him, the importance of the institute's registration "would greatly facilitate not only the establishment, in fact and in law, of the Legal Reserve, but would also result in greater environmental effectiveness through the publicity conferred by the Real Estate Registry" (SILVA, 2021, p. 251).

However, there are rural properties that do not have Legal Reserves for numerous reasons or these are partially deforested and/or occupied by pastures, developing livestock activities or with plantations, for agricultural activities. These situations are justified because when the legislative change in the boundaries established mainly for the Amazon region, countless rural properties were opened in violation of the maintenance of the legal reserve (MIRANDA, 2010, p. 372).

The owners or possessors of rural properties with deforested or partially deforested areas, whose Legal Reserve area is less than the limits defined in article 12 of the Forest Code, were left with three options: recomposition, natural regeneration of vegetation or compensation, which can be used separately or together.

In view of the importance of the legal reserve and the legislative impositions in the face of its total or partial absence, there is no doubt that the registration publicity of these obligations in any of the three modalities listed (recomposition, regeneration or compensation), which by their nature accompany the property, would induce the owners and possessors of rural properties to voluntarily comply with these measures, as well as making the future purchasers of the environmental obligations assumed scientific, since, as stated elsewhere, these would also be transmitted, thus allowing the institute of the Legal Reserve to be better disseminated, ensuring biodiversity and an ecologically balanced environment (SILVA, 2021, p. 253).

4.2 ENVIRONMENTAL EASEMENT

The institute of environmental easement was not conceptualized by the Brazilian legislator, who, in the wording given by article 9-A of Law No. 11,284/2006, presented only the criteria for its constitution, establishing that it would be instituted by the rural owner, with

the consent of the environmental agency, with the voluntary waiver, on a permanent or temporary basis, totally or partially, of the right of use, exploitation or suppression of natural resources existing on the property⁷.

Thus, the environmental easement does not apply to Permanent Preservation Areas and the minimum required Legal Reserve, as provided for in paragraph 2 of the aforementioned article. It should be noted, as appropriate, that the restriction on the use or exploitation of the vegetation of the area under environmental easement must be, at least, the same as that established for the Legal Reserve. The environmental easement can also be used as an instrument of compensation for the legal reserve, at which time it must be recorded in the registrations of all properties involved, as provided for in paragraph 5 of article 9-A. It should be noted that the rural owner continues to be able to exercise his right of disposal, in such a way that he may alienate, assign or transfer the environmental easement. However, in cases of transfer of rural property, for any reason, dismemberment or rectification of the boundaries of the property, it is prohibited, during the term of the environmental easement, to change the destination of the area (CARDOSO, 2010).

The holder of the environmental easement may alienate, assign or transfer it, in whole or in part, for a fixed period or definitively, in favor of another owner or a public or private entity that has environmental conservation as its social purpose. However, the temporary environmental easement cannot be established with a term of less than 15 years, given the objectives of environmental preservation. On the other hand, the perpetual environmental easement is equivalent, for credit, tax and access to public funds purposes, to the Private Natural Heritage Reserve (RPPN), defined in article 21 of Law No. 9,985, of July 18, 2000, which will not be the object of our study.

In cases of alienation, assignment or transfer of the environmental easement, article 9-C of Law No. 11,284/2006 states that the contract must be recorded in the registration of the property (EL DEBS, 2021).

Although the institute of environmental servitude is an important instrument of environmental preservation, the legislator was wrong to not stipulate any economic or tax benefit in return, considering that its institution restricts property, constituting an obligation that accompanies the property, regardless of the owner. In international law, the rights and benefits linked to this type of system encourage the creation of easements, ensuring more effective environmental protection, as is the case in the United States with conservation easement and ecological servidumbres in Costa Rica (CARDOSO, 2010, p. 389-390).

⁷ It should be noted that the environmental easement may be instituted by an individual or legal entity, free of charge or for a fee, by means of a public or private instrument, or even by an administrative term that must contain the elements described in paragraph 1 of article 9-A (EL DEBS, 2021, p. 839).

However, it should be recognized that by establishing the registration of the environmental easement in the registrations of real estate, as provided for in article 167, II, of Law No. 6015/73, the legislator recognized the competence of the real estate registrar to centralize information on environmental issues of great importance, "preserving effects over time and publicizing the easement to interested third parties, more efficiently to the institute of Environmental Law." (SILVA, 2021, p. 254)

4.3 CONSERVATION UNITS

Conservation Unit – U.C., as provided for in article 2, I, of Law No. 9,985/2000, is the territorial space and its environmental resources, including jurisdictional waters, with relevant natural characteristics, legally established by the Government, with conservation objectives and defined limits, under a special administration regime, to which adequate protection guarantees apply.

Conservation units are divided into two large groups: a) Full Protection Units; and b) Sustainable Use Units. The difference between these groups lies in the fact that the former aim to keep ecosystems free from alterations caused by human interference, admitting only the indirect use of their natural attributes, while the latter, although there is exploitation of the environment, this exploitation must be sustainable, ensuring the continuity of renewable environmental resources and ecological processes. maintaining biodiversity and other ecological attributes, in a socially just and economically viable way.

Although the majority of conservation units are in public areas, the legislator was right to establish that the areas around them are subject to specific rules and restrictions "to protect and guarantee the purpose of their creation" (MELO, 2010, p. 70), minimizing the negative impacts on the unit.

Regarding the entry of conservation units in the real estate registry, Silva (2021, p. 237) is categorical in stating that the effectiveness of the rules and restrictions related to each Conservation Unit will only be successful with their publicity in the real estate registry. The zoning, or the geographical delimitation containing the limits of the U.C. is mandatory because it implies the regulation of economic activities in the area and in the surroundings. Hence the importance of information related to the U.C.s to be part of the registration of the property and receive registration publicity, as a way to portray to future buyers of real estate the restrictions on the use of the property.

For Silva (2021, p. 239) the annotation of this environmental information would be of such relevance that "even a private individual, an association, a non-governmental

organization, or any interested party can provoke it", once the inertia of the Government or the administration of the conservation unit is verified.

4.4 CONTAMINATED AREAS

The 1988 Constituent Assembly advocated the responsibility of society with the Government for the preservation of the environment for present and future generations. In this sense, each generation is obliged to deliver the environment in conditions to be enjoyed by the next generation, hence the idea of sustainable development, linked to the rational use of natural resources, considering their finitude (NALINI, 2010, p. 91-92).

The present study is interested in contaminated areas resulting from soil pollution, which occur for the most diverse reasons. For Silva (2021, p. 265) "the management of contaminated areas begins with the identification of suspicious sites and, once the hypothesis is confirmed, intervention measures, damage control measures and environmental remediation measures must be adopted".

The identification of the area is of total importance, as well as its delimitation, since, depending on the degree of contamination, it generates restrictions on the use of the property, in addition to the duty to repair the damage, which in some situations is irreversible.

Thus, Silva (2021) suggests that when the inspection body investigates the existence of a contaminated area, it is up to it to immediately inform society, in order to prevent access to such properties, which can be done with the installation of fences and signs, through radio and television advertising, and also through registry advertising.

The Code of Standards for Notarial and Registration Services of the State of Roraima, representing the pioneering spirit in the treatment of the matter, in the Legal Amazon region, establishes in its article 668, b, items 39 to 41, that the information on the classification of the area, by the competent Body, as a Contaminated Area under Investigation (ACI), the information on the classification of the area, Competent Body, such as Contaminated Area with Confirmed Risk (ACRI) and the classification information of the area, by the competent Body, as a Rehabilitated Area for Declared Use (AR) must be recorded in the registration of the properties.⁸

This attitude enshrines the principle of information and recognizes the structure of the real estate registry as the guardian of the royal folio, responsible for also concentrating environmentally relevant information. It should also be added that "the registrar is responsible

⁸ The aforementioned state law of Roraima also advances that in case of omission by the bodies legally responsible for the contaminated areas to proceed with the annotations referred to in article 668, paragraph "b", items 39, 40 and 41, these may be carried out upon provocation by any person.

for the preservation of the vegetation cover in the district to which he is delegated" (NALINI, 2010, p. 96).

In turn, in addition to the educational nature of the measure, these annotations put citizens in a position to discuss and demand from the Government the institution/execution of Public Policies that are necessary in the affected areas (SILVA, 2021, p.103).

At the federal level, Conama Resolution No. 420/2009, in article 37, established the competence of the environmental agency, when verifying the existence of a contaminated or rehabilitated area for declared use, to formally communicate to the Real Estate Registry offices of the District where such areas are inserted, as well as to the real estate registry of the municipalities and the Federal District.

It should be noted that the ideal would be for this information to be passed on to real estate notaries as soon as possible or at the beginning of the "contaminated area identification procedures" (SILVA, 2021, p. 266), in order to avoid the irreversibility of the damage, as well as to enable environmental information to reach public knowledge in a timely manner, and may also prevent socio-environmental impacts of large proportions.

5 FINAL CONSIDERATIONS

In the course of this study, it was possible to verify the presence, increasingly, in the lives of citizens, of a healthy interference in the relationship between man and the environment, as well as it was clear that using the right to property in a way that causes damage to the environment is what causes ecological disasters, usually originated by the disorderly occupation of the land.

The publicity promoted by the Real Estate Registry provides the desired and necessary legal certainty to the institutes of Environmental Law, which aim to protect the environment, as the information released by the Registry can prevent the harmful use of the property. In other words, the Real Estate Registry may contribute favorably, in addition to the protection of private property, also to the publicity of the institutes of Environmental Law that aim to modify the owner's behavioral attitudes in relation to the environment, a function that the Public Registries already perform efficiently.

Despite having promulgated so many historical milestones in terms of fundamental rights, the drafting of the current Federal Constitution also expresses the interests of several different objectives. The aspiration demonstrated in the norm contained in its article 225, to provide everyone with the right to an ecologically balanced environment, has already proven to be essential to a healthy quality of life.

It is evident that this benefit can only occur with the collaboration of the Government and society, in order to protect, defend and preserve this healthy environment for present and future generations. The most efficient way to more easily achieve this objective may be the collaboration of the Real Estate Registry, through the publicization of rights and environmental restrictions that may fall on real estate, which will contribute to the guarantee of the right to property to the citizen and will also serve to assist in the inspection of the rational exercise of the right to property. preventing abuses that, coming from the owner, may lead to environmental degradation.

By the way, Post-Modernity has brought the publicization of rights as a trend, becoming necessary and useful to the environmental controls carried out through the Real Estate Registry system, which makes use of its essence, translated into publicity and legal certainty, in the prevention of environmental damage.

This link formed between Environmental Law and Real Estate Registration resulted in benefits for the whole society, which now has more effective instruments in the control and rational and sustainable use of private property, meeting its social function.

REFERENCES

- Álvares, A. de C. B., & Cunha, R. H. A. (2018). A proteção do meio ambiente pela publicidade imobiliária. *Revista Científica Multidisciplinar Núcleo do Conhecimento*, 3(7, v. 1), 31–56. <https://www.nucleodoconhecimento.com.br/lei/publicidade-imobiliaria>
- Borges, A. M. (2014). *Registro de imóveis no direito brasileiro* (4^a ed.). Contemplar.
- Brasil. (1988). *Constituição da República Federativa do Brasil de 1988*. http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (1890). Decreto n. 451-B, de 31 de maio de 1890. Estabelece o registro e a transmissão.
- Brasil. (2012). Lei n. 12.651, de 25 de maio de 2012. Dispõe sobre a proteção da vegetação nativa (Código Florestal). http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm
- Brasil. Superior Tribunal de Justiça. (2022). REsp n. 1.857.098/MS (2020/0006402-8). Relator: Min. Og Fernandes, julgado em 18 de maio de 2022. https://scon.stj.jus.br/SCON/GetInteiroTeorDoAcordao?num_registro=202000064028&dt_publicacao=24/05/2022
- Cardoso, S. L. de M. (2010). A servidão ambiental segundo a Lei n. 11.284/2006. In S. Jacomino, M. A. S. de Melo, & F. de A. P. Criado (Orgs.), *Registro de imóveis e meio ambiente* (pp. ?–?) (Série Direito Registral e Notarial). Saraiva.
- Dip, R. H. M. (1993). Sobre o saber registral: Da prudência registral. *Revista de Direito Imobiliário*, 31/32, 5–21.
- El Debs, M. (2021). *Legislação notarial e de registros públicos: Comentada artigo por artigo* (5^a ed. rev., ampl. e atual.). JusPodivm.

- Gil, A. C. (2008). Métodos e técnicas de pesquisa social (6ª ed.). Atlas.
- Gonçalves, R. R. M. (2011). A importância do Registro de Imóveis na preservação dos recursos naturais. *Boletim IRIB em Revista*, 341, 24.
- Hellstrom, L. (2016). O registro de imóveis como um instrumento de fiscalização de meio ambiente. *Jus Brasil*. <https://hellstrom.jusbrasil.com.br/artigos/325838251/oregistro-de-imoveis-como-uminstrumento-de-fiscalizacao-de-meio-ambiente>
- Melo, M. A. S. de. (2021). O Código Florestal e o Registro de Imóveis. In *Artigos 2021 do Boletim Eletrônico do Instituto de Registro Imobiliário do Brasil*. IRIB. <https://irib.org.br/obras/3974>
- Miranda, M. A. (2010). A importância da atividade notarial e de registro no processo de desjudicialização das relações sociais. *Revista Âmbito Jurídico*, 13(73). <https://ambitojuridico.com.br/cadernos/direito-processual-civil/a-importancia-da-atividade-notarial-e-de-registro-no-processo-de-desjudicializacao-das-relacoes-sociais/>
- Nalini, J. R. (2010). O ambiente e Registro de Imóveis. In S. Jacomino, M. A. S. de Melo, & F. de A. P. Criado (Orgs.), *Registro de imóveis e meio ambiente (Série Direito Registral e Notarial)*. Saraiva.
- Noronha, F. (2010). *Direito das obrigações (3ª ed. rev. e atual.)*. Saraiva.
- Santos, F. A. dos. (2010). Registro de Imóveis e meio ambiente: Uma reflexão intraorganizacional necessária. In S. Jacomino, M. A. S. de Melo, & F. de A. P. Criado (Orgs.), *Registro de imóveis e meio ambiente (1ª ed., Série Direito Registral e Notarial)*. Saraiva.
- Silva, A. F. S. do A. e. (2021). *Registro de imóveis e meio ambiente: Princípios e interações em prol da sustentabilidade*. Alteridade.
- Silva, S. T., Figueiredo, G. J. P., Leuzinger, M. D., & Neto, J. N. (2010). Código Florestal: Em defesa das nossas florestas e do nosso futuro. In P. Lavratti et al. (Orgs.), *Direito e mudanças climáticas – A reforma do Código Florestal: Limites jurídicos*. Instituto “O Direito por um Planeta Verde”.
- Stifelman, A. G. (2010). O registro de imóveis e a tutela do meio ambiente. *Revista de Direito Imobiliário*, 69, 337–350.

POST MORTEM PROTECTION OF PERSONALITY RIGHTS IN THE TECHNOLOGICAL SOCIETY

A TUTELA POST MORTEM DOS DIREITOS DE PERSONALIDADE NA SOCIEDADE TECNOLÓGICA

PROTECCIÓN POST MORTEM DE LOS DERECHOS DE LA PERSONALIDAD EN LA SOCIEDAD TECNOLÓGICA



<https://doi.org/10.56238/sevened2026.008-115>

Manuela Ithamar Lima¹, Joaquim Ribeiro de Souza Junior²

ABSTRACT

This article is based on the following research question: to what extent is the post mortem protection of personality rights affected in a technological society? To address this question, the article is divided into two parts. The first presents an overview of *Post mortem* protection in Brazil, and the second explores the controversies surrounding such protection in a technological society. The methodological approach is deductive, and the research techniques employed are exploratory and bibliographic.

Keywords: *Post mortem* Protection. Personality Rights. Technological Society.

RESUMO

Este artigo parte da seguinte pergunta problema: em que medida a tutela post mortem dos direitos de personalidade resta impactada na sociedade tecnológica, para tanto, ele é dividido em duas partes, a primeira oferta um panorama da tutela *Post mortem* no Brasil e a segunda que se debruça as controvérsias dessa tutela na sociedade tecnológica. O método de abordagem é o dedutivo e as técnicas de pesquisa são a exploratória e bibliográfica.

Palavras-chave: Tutela *Post mortem*. Direitos de Personalidade. Sociedade Tecnológica.

RESUMEN

Este artículo parte de la siguiente pregunta de investigación: ¿en qué medida se ve afectada la protección post mortem de los derechos de la personalidad en la sociedad tecnológica? Para ello, se divide en dos partes: la primera ofrece una visión general de la protección *Post mortem* en Brasil y la segunda aborda las controversias en torno a esta protección en la sociedad tecnológica. El método de enfoque es deductivo y las técnicas de investigación son exploratorias y bibliográficas.

¹ Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: manuela.ithamar@gmail.com

² Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: joaquimjunior33@gmail.com Orcid: <https://orcid.org/0000-0003-3488-5508>

Palabras clave: Protección *Post mortem*. Derechos de la Personalidad. Sociedad Tecnológica.

1 INTRODUCTION

Technology acts as a driving force for change, creating interconnected networks that transcend geographical and cultural boundaries. The convergence of smart devices, artificial intelligence, big data, and instant connectivity reshapes the way we relate to the world and to each other. In the face of this dynamic panorama, the technological society is not only a reflection of scientific progress, but an entity in constant transformation, influencing and being influenced by the expectations, values and challenges of a globalized community.

On the other hand, the issue of *post-mortem* protection of personality rights has always presented theoretical and practical controversies in Civil Law, despite its express provision in the Civil Code of 2002.

Thus, this article has the following problem question: to what extent is the *post-mortem* protection of personality rights impacted in the technological society? To this end, it seeks to offer a first-time overview of the *post-mortem* protection of personality rights in the Brazilian legal system, and in a second moment to focus specifically on the challenges of this protection in contemporary society, going through the phenomena of *deepfake* and digital inheritance.

The method of approach is deductive, that is, a reasoning that starts from general principles or broad premises to reach specific conclusions, and the research techniques are exploratory and bibliographic.

2 THE POST-MORTEM PROTECTION OF PERSONALITY RIGHTS IN THE BRAZILIAN LEGAL SYSTEM

Personality rights began to be highlighted in private law with the codifications of the twentieth century, such as the Italian Code of 1942 and the Portuguese Civil Code of 1966, however, parallel to this, there was an expansive development of personality rights in Public Law (ANDRADE, 2012).

For no other reason, within the scope of Brazilian law, the 1988 Constitution contemplates in its article 5, item X, different personality rights, such as intimacy, private life, image, among others, ensuring their inviolability, in addition, in its article 1, item III, in turn, establishes the dignity of the human person among the foundations of the Republic (ANDRADE, 2012).

In the scope of private law, the Brazilian Civil Code of 2002 included in its general part an entire chapter to deal with personality rights, evidencing the importance that the legal system attributes to the protection of the human person (DONEDA, 2005).

Structurally, the Civil Code of 2002 dealt with personality rights in 11 articles, so that articles 11³ and 12 deal with the nature and protection of these rights, the others contemplate personality rights in kind, such as: the right to psychophysical integrity (articles 13 to 15), the right to name and pseudonym (articles 16 to 19), the right to image (art. 20) and the right to privacy (art. 21).

With regard to the ownership of personality rights, it is observed that the Civil Code of 2002 in its article 20, sole paragraph, contemplates the possibility of protection of these rights in the case of a deceased person (ANDRADE, 2013), conceiving that: "In the case of a dead or absent person, the spouse, the ascendants or the descendants".

It is clear that according to article 6 of the Civil Code, it asserts that the existence of the natural person ends with death and consequently the civil personality as well, allowing the person to be the subject of rights, however, it does not mean that personality rights cannot endure in legal relationships (BELTRÃO, 2015).

In this sense, in the lessons of Pontes de Miranda, death consists of a natural human legal fact, in the strict sense, as it arises from a natural and ordinary fact, since it is a common occurrence, generating effects in the civil order and manifesting itself in legal relationships, in order to extinguish or modify them (MENEZES, 2023).

Therefore, considering that death is a legal fact and that personality ends with death, the doctrine seeks to explain the post-mortem protection of personality rights, with at least six theories, the first of which is that of the new law, which argues that personality is extinguished with death and from this arises a new right of family members to demand respect for the rest and memory of the deceased; the second theory, called the theory of the transmission of personality rights, contemplates that with the advent of death, there is a transmission of the protection of honor, which is not to be confused with the transmission of the deceased's own honor; the third theory is that of the memory of the deceased, which ensures that memory is an autonomous legal asset that extends after death and needs to be protected (MENEZES; CHACON, 2020).

The fourth theory consists of the theory of the prolongation of personality, denying that personality is extinguished at death and prolonging it until after death; the fifth theory is that of post-mortem guardianship as a general legal duty, which argues that said guardianship is a general legal duty that must be fulfilled by all, that is, any person, whether family or not, can defend the honor of the deceased; finally, the sixth theory conceives that with death the

³ "In article 11, it is verified that personality rights are attributed the characteristics of non-transferability and non-renounceability, in addition to the impossibility of voluntary limitation of their exercise", in: DONEDA, Danilo. The rights of personality in the Civil Code. **Journal of the Faculty of Law of Campos**, year VI, n. 6, p. 71-99, 2005, p. 71.

personality is extinguished, but its emanation is not extinguished (MENEZES; CHACON, 2020).

Among the theories discussed, it seems, based on the provisions of the Civil Code, the one that is most aligned with the Brazilian legal system and the one adopted in the present work is the theory of the transmission of the right of personality.

Within the scope of Brazilian jurisprudence, it is observed that the Superior Court of Justice sought not to effectively focus on any of the theories, in Special Appeal No. 268660/RJ, the 4th Panel of the STJ recognized the possibility of protection of the right to the image after the death of its holder, in order to obtain the right to compensation, oscillating between two theories, that of the transferability of personality, since it argues that the successor can protect the image of the deceased relative and of another is affiliated to the theory of new law, considering that because the image of the deceased person has economic effects beyond death, the successors, in their own right, can postulate in court (ANDRADE, 2013).

Thus, despite the doctrinal controversies, the post-mortem protection of personality rights in Brazilian law is already something consolidated and provided for in the Civil Code, which does not fail to imply discussions on the subject.

The controversies become even more present considering the peculiarities of contemporary society, called technological society, which results from the interaction between technology and pre-existing contexts (CASTELLS, 2008), being characterized by amplitude, depth and speed, causing transformation in entire systems, such as legal, social, economic, among others (SCHWAB, 2016).

The legal system is entirely impacted, so that

the implications of the Knowledge Society in law can be systematically outlined as follows: (a) the new factual parameters for the application of the law already in place, requiring its readjustment; (b) the existence of facts that become legally relevant due to technical-scientific advances; (c) the need for legal decision-making in a scenario of uncertainty and risk, as well as; (d.) the elaboration of legal norms has gradually been conditioned to meet the interests of an innovation guided by the economy (LIMA; DA COSTA, 2019, p. 173).

Regarding the post-mortem screen of personality rights it is no different, it must be said, there are so many problems: the post-mortem protection of personality rights, people, the so-called digital inheritance and deep fakes, something that will be discussed in the next chapter.

3 THE CONTROVERSIES OF THE POST-MORTEM PROTECTION OF PERSONALITY RIGHTS IN THE TECHNOLOGICAL SOCIETY

Law in the technological society remains modified, due to the systemic impact of the Technological Society, thus, to the extent that law regulates social relations and these are influenced by innovation and technology, inevitably the parameters of regulation and judicial decisions change (PARDO, 2000).

In the post-mortem protection of personality rights it is no different, innovation and technology cross this context. Among so many phenomena, attention is paid to the posthumous projection of personal data, the conception of digital inheritance and artificial intelligence, which will be discussed below.

Personal data figure as the true projection of the human personality, if expanded beyond the life of the subject (RODODÁ, 2012), in this sense, the electronic body even after death continues to appear as a representation of the subject's personality in the virtual space (COLOMBO; GOULART, 2019).

Therefore, the protection of the personality of the deceased exercised by relatives necessarily involves the control of the personal data that sustain the digital body of the *deceased* (COLOMBO; GOULART, 2019).

It turns out that the General Law for the Protection of Personal Data is silent on the data of deceased people, having this gap that generates controversy. On this issue, it is worth paying attention to the French law that conceives that subjects in life may define general or particular directives on the storage, deletion and communication of their personal data after death. French law allows a specific person to be defined to enforce the will of the deceased and in the absence of such a person, the heirs can exercise the rights delimited by law, with some limitations, such as: a. possibility of accessing personal data for probate purposes or arising from family memories; b. making the request for closure of the digital account or c. opposing the continuation of personal data processing and demanding the updating of data (COLOMBO; GOULART, 2019).

There are those who argue that when the projection of the deceased's personal data has patrimonial content, it is necessary to speak of the so-called digital inheritance and when it comes to personal data without patrimonial content in posthumous protection of personal data (COLOMBO; GOULART, 2019), however, there is another part of the doctrine that considers that the Civil Code of 2002, in its article 1,857, paragraph 2, admits that the will has off-balance sheet content, thus, when talking about digital inheritance, it is actually speaking in a broad sense, having a patrimonial or off-balance sheet character, which seems to be the most correct position (TARTUCE, 2018).

In this sense, it is questioned whether the digital data of the deceased person can compose the inheritance to be transmitted to the successors, following the line of article 1791 of the Civil Code (TARTUCE, 2018). Thus, as the LGPD and the Civil Code are silent on this issue, there are bills on the subject in progress in the National Congress.

Of note are Bill No. 4,099-B, of 2012 and Bill No. 4,847/2012, the first, seeks to include a single paragraph in article 1,788 of the Civil Code to contemplate that the digital files of the author of the inheritance will be automatically transferred to the heirs (TARTUCE, 2018).

The second that is currently being processed together with a more recent one, Bill No. 7,742/2017, intends to include articles 1,797-A to 1,797-C in the Civil Code, conceiving that digital inheritance is all "intangible content of the deceased, everything that can be stored or accumulated in a virtual space, under the following conditions: I – passwords; II – social networks; III – Internet accounts; IV – any virtual and digital good and service owned by the deceased". It also deals with the possibility that if the deceased does not have the capacity to test on their digital assets, these will be transmitted to their legitimate heirs, who may: "a) – define the destination of the deceased's accounts; b) turn them into a memorial, leaving access restricted to confirmed friends and keeping only the main content or; c) delete all user data or; c) remove the account of the former user (TARTUCE, 2018)".

It can be seen that both bills attribute to the heirs of the *deceased* the decision about the fate of the digital inheritance, however, these are essential and very personal rights of the deceased that cannot be automatically transferred to the heirs, and must be extinguished with death (TARTUCE, 2018).

It should be noted that in an opinion prepared by the Institute of Lawyers of Brazil (IAB), Professor Pablo Malheiros Frota expressed himself unfavorable to the legislative proposals, listing that (TARTUCE, 2018, p. 875):

- a) the two bills authorize the entire digital collection of the deceased to be automatically transmitted to the heirs, violating the fundamental rights to freedom and privacy, notably in cases where the digital asset is a projection of privacy and there has been no express declaration of will or conclusive behavior of its owner, authorizing any heir or third party to access and manage it; b) third parties who interacted with the deceased during life will also have their privacy exposed to the heirs; c) it is necessary to respect the personal, interpersonal and social efficacy of private life, which concretizes the positive freedom of each one to decide the course of his or her life, "without undue external interference from the community, private or the State, in which this freedom is intersubjectively linked to the community, the State and the individual"; d) the bills intend to transmute the property right regime from the Law of Things to personality rights, since the personality right of the deceased is transformed into a patrimonial asset, since the intimacy and image of the deceased person serve as a source of economic wealth; e) family members or third parties should only have the right to manage the digital collection if there is an express declaration by the deceased,

by public or private instrument, including in fields intended for such purposes in the electronic environments themselves, without the need for witnesses, or if there is conclusive behavior in this regard; f) if such statement or behavior is not present, or is affected by a problem related to its validity or effectiveness; all digital collection that is an expression of personality must not be altered, seen or shared by anyone; g) intangible assets that project the privacy of the deceased should not and should not be accessed by the heirs or by third parties, in the absence of a manifestation of will by the author of the inheritance.

In this way, the proposals are not in line with the dignity of the human person and the very personal rights of the deceased, and there should be a legislative proposition that proportionally balances the interests of the heirs with the personality rights of the deceased that are extinguished with death.

Another controversy about the *post-mortem protection* of personality rights consists of the impact of artificial intelligence in this field. It is explained.

Artificial Intelligence (AI) takes place in the innovation and technological process of contemporary society, being a branch of computer science that proposes to develop devices that seek to simulate some of human capabilities, such as making decisions and solving problems (SARLET, 2021).

Thus,

Artificial intelligence (AI) proposes to handle devices that simulate the human ability to reason, perceive, make decisions and solve problems, in short, the ability to be intelligent. It should be noted that the basic element for a characterization of artificial intelligence is found in the learning dimension and, therefore, is situated in the formation of taxonomic profiles that, in other words, are based on a first stage in the production of large analyses from large databases, orienting themselves at the present time more and more towards granulation (GUIMARÃES, 2023, p. 331).

In this scenario, the impact of artificial intelligence on personality rights in general is observed, thus, artificial intelligence (AI) starts to be used in profiling and monitoring the behaviors of individuals (SARLET, 2021), but, in addition, there is the phenomenon of *deepfakes*.

Deepfake consists of the technique through artificial intelligence that builds the fusion of moving images, generating new content with a high degree of reliability (AFFONSO, 2021), in this scenario,

Whatever the technological means adopted to create a false image, two characteristic traits can already be pointed out, namely, the use of advanced computational techniques, commonly artificial intelligence, as well as the high degree of reality that makes it almost impossible to detect fraud, which is especially dangerous in current times. marked by the "attention economy" (AFFONSO, 2021, p. 263).

The risk of deepfake ranges from its use to generate disinformation and impact the democratic process, to its criminal use through advertising. In this line, attention is paid to the violation of the personality rights of deceased people with the use of digital reconstruction, that is, through an image bank of the deceased person, their image is recreated for current times (AFFONSO, 2021).

A case involving the theme of reconstruction was the recent commercial released in July 2023 by Volkswagen, on the occasion the singer Maria Rita is next to her mother, Elis Regina, who died in 1982 and was recreated by artificial intelligence, singing together the song by composer Belchior, entitled "Like our parents" (FIGUEIRA; RENZETTI FILHO; DE LUCA, 2023). Thus, several ethical and legal discussions arose about the commercial, among which was the fact of the contradiction of linking the image of Elis Regina and the music of Belchior, who were openly against the military dictatorship, to an advertising campaign by a company that supported the regime (CONAR, 2023).

In fact, based on the Brazilian Civil Code, considering that the daughter and the other heirs participated in the advertising campaign, there is manifest authorization by the heirs in the use of the image of the singer Elis Regina, which removes possible legal obstacles in the matter (FIGUEIRA; RENZETTI FILHO; DE LUCA, 2023).

However, the case fell on the National Council for Advertising Self-Regulation through Representation No. 134/23, due to consumer complaints that raised three points: a. the ethical use of AI in the reproduction of an image of a deceased person; b. whether it would be up to the heirs to authorize such a practice and c. the lack of information to the public about the use of AI in the creation of the scene (CONAR, 2023).

It so happens that the 7th Chamber of Conar considered items a and b unfounded, as the use of the image would have been with the consent of the heirs, under the terms of the Civil Code and as for item c, it decided to archive the representation, considering the lack of regulation on the subject (CONAR, 2023).

It should be noted that in Brazil, Bill No. 759/2023 is being processed, which deals with the use of Artificial Intelligence in Brazil, being an intimate project that does not scrutinize this use, declining the details of the subject to the Union, which should create a National Policy on Artificial Intelligence, under the terms of article 5 of the aforementioned project.

It is important that, considering the peculiarities of the theme, it is important that, with regard to the *post-mortem protection* of personality rights and the use of Artificial Intelligence, the legislation considers "(i) the provision expressed in the contract during life and authorization of the family, (ii) the purpose of the recreation of the image and (iii) the adequacy

of the image created post-mortem to the image-attribute constructed in life by the person" (AFFONSO, 2021, p, 269).

Therefore, the challenges of *post-mortem tutelage* in the technological society are not limited to the phenomenon of *deepfake* and digital inheritance, the present article sought, however, to bring these two phenomena as examples to demonstrate the transformative character of technology in the social environment and the need to make the hermeneutic effort to protect and promote personality rights and the dignity of the human person.

4 FINAL CONSIDERATIONS

This article sought to answer the following problem question: to what extent the *post-mortem* protection of personality rights remains impacted in the technological society, reaching the conclusion that the very legitimacy of the heirs in protecting personality rights must be reread based on the dignity of the human person of the deceased, considering categories such as consent in life for certain activities and interactions with technology and the context itself social of the deceased.

The *post-mortem* protection of personality rights in a technological society represents a complex and multifaceted challenge that requires careful consideration of the intersections between law, ethics and rapid technological transformations. This article has highlighted the need to adapt existing laws to address emerging issues related to the preservation and management of personality rights after death in a digital context. The increasing ubiquity of digital technologies and social media amplifies concerns about privacy, misuse of information, and the preservation of posthumous identity.

In this scenario, it is imperative that legislators, jurists, and society as a whole promote in-depth discussions to develop legal frameworks that are sensitive to the specific challenges posed by the digital age. Ensuring that personality rights continue to be respected after death not only preserves individual dignity but also protects the memory of the deceased and provides comfort to loved ones.

In addition, the implementation of ethical and transparent technological solutions is crucial to balance individual and collective interests in this context. Reflection on the post-mortem protection of personality rights in the technological society not only promotes legal development, but also contributes to the construction of an ethical framework that respects the integrity of individuals even after their departure, thus shaping a more just and compassionate environment for future generations.

REFERENCES

- Affonso, F. J. M. (2021). O direito à imagem na era das deep fakes. *Revista Brasileira de Direito Civil*, 27(1), 251–277. <https://doi.org/10.33242/rbdc.2021.01.011>
- Andrade, F. S. de. (2013). A tutela dos direitos da personalidade no direito brasileiro em perspectiva atual. *Revista de Derecho Privado*, 24, 81–111.
- Andrade, F. S. de. (2012). O desenvolvimento da tutela dos direitos da personalidade nos dez anos de vigência do Código Civil de 2002. In *Temas relevantes do direito civil contemporâneo: Reflexões sobre os* (Vol. 10, p. 83).
- Beltrão, S. R. (2015). Tutela jurídica da personalidade humana após a morte: Conflitos em face da legitimidade ativa. *Revista de Processo*, 177–195.
- Castells, M. (2008). *La era de la información: Economía, sociedad y cultura. La sociedad red* (Vol. 1). Siglo Veintiuno.
- Colombo, C., & Goulart, G. D. (2019). Direito póstumo à portabilidade de dados pessoais no ciberespaço à luz do Direito brasileiro. In F. B. P. Polido & L. C. dos Anjos (Eds.), *Fabício Bertini Pasquot Polido Lucas Costa dos Anjos* (p. 55).
- Conselho Nacional de Autorregulamentação Publicitária. (2023, 22 de agosto). Conar recomenda arquivamento da representação "VW Brasil 70: o novo veio de novo". <http://www.conar.org.br/>
- Doneda, D. (2005). Os direitos da personalidade no Código Civil. *Revista da Faculdade de Direito de Campos*, 6, 71–99.
- Figueira, H. L. M., Renzetti Filho, R. N., & De Luca, G. D. (2023). Herança digital e o caso Elis Regina: Implicações jurídicas no uso da imagem de pessoas mortas pela inteligência artificial. *Revista Jurídica*, 3(75), 527–545. <https://revista.unicuritiba.edu.br/index.php/RevJur/article/view/6421>
- Guimarães, M. R. (2023). IA, profiling e direitos de personalidade. In *Direito e inteligência artificial* (pp. 331–332).
- Lima, M. I., & Da Costa, S. M. (2019). Direito, inovação e ciência: Possibilidades e desafios da sociedade do conhecimento/Law, innovation and science: Society of knowledge possibilities and challenges. *Revista Jurídica Eletrônica da UFPI*, 6(1), 186–187.
- Menezes, R. O. A. (2023). A proteção jurídica da memória do morto e a titularidade do interesse tutelado. *Revista da Faculdade de Direito da Universidade de Lisboa*, 64(3), 1913–1934.
- Pardo, R. H. (2000). Verdad e historicidad. El conocimiento científico y sus fracturas. In E. Díaz (Org.), *La posciencia: El conocimiento científico en las postrimerías de la modernidad*. Biblos.
- Rodotá, S. (2008). A vida na sociedade de vigilância: A privacidade hoje. *Renovar*.
- Sarlet, G. B. S. (2021). A inteligência artificial no contexto atual: Uma análise à luz das neurociências voltada para uma proposta de emolduramento ético e jurídico. *Direito Público*. <https://www.portaldeperiodicos.idp.edu.br/direitopublico/article/view/5214>
- Schwab, K. (2016). *A quarta revolução industrial* (D. M. Miranda, Trad.). Edipro.

Tartuce, F. (2018). Herança digital e sucessão legítima: Primeiras reflexões. *Revista Jurídica do Centro de Investigação de Direito Privado*, 5, 871–878.
https://www.cidp.pt/revistas/rjlb/2019/1/2019_01_0871_0878.pdf

SOCIO-EMOTIONAL SKILLS OF SCHOOL MANAGERS: OPENING PATHWAYS FOR TRAINING AND DEVELOPMENT FOR THE TEAM

HABILIDADES SOCIOEMOCIONAIS DO GESTOR ESCOLAR: ABRINDO CAMINHOS DE FORMAÇÃO E DESENVOLVIMENTO PARA A EQUIPE

HABILIDADES SOCIOEMOCIONALES DEL DIRECTOR ESCOLAR: ABRIENDO CAMINOS DE FORMACIÓN Y DESARROLLO PARA EL EQUIPO



<https://doi.org/10.56238/sevened2026.008-116>

**Mabel Montecinos-Bustos¹, Giza Guimarães P. Sales², Betania Jacob Stange Lopes³,
Rosane Michelli de Castro⁴**

ABSTRACT

The construction of a healthy educational environment does not depend exclusively on pedagogical and administrative aspects, but also on the ability of school leaders to establish interpersonal relationships grounded in empathy, effective communication, and emotional balance. This article investigates the influence of school administrators' socioemotional skills on the organizational climate and on the professional performance of education practitioners. Based on a qualitative, exploratory, and bibliographic approach, the study draws on authors such as Vitor Paro, Heloísa Lück, and Daniel Goleman, and seeks to present a humanized perspective of school leadership, viewed from both social and educational standpoints, presenting results that validate this management approach. The findings indicate that humanized management strengthens collaboration, reduces conflicts, and enhances team engagement. A scarcity of literature focused on the socioemotional development of educational leaders was identified, highlighting the need for further studies that integrate management practices and emotional development in school leadership.

Keywords: Socioemotional Skills. School Management. Organizational Climate.

RESUMO

A construção de um ambiente educacional saudável não depende exclusivamente dos aspectos pedagógicos e administrativos, mas também da capacidade dos gestores de estabelecer relações interpessoais pautadas na empatia, comunicação eficaz e equilíbrio emocional. Este artigo investiga a influência das habilidades socioemocionais dos gestores escolares no clima organizacional e na atuação dos profissionais da educação. Pautado em abordagem qualitativa, exploratória e bibliográfica, o estudo baseia-se em autores como Vitor

¹ Master's degree in Education. Centro Universitário Adventista de São Paulo (UNASP).
E-mail: mabelmontecinos@gmail.com Orcid: <https://orcid.org/0009-0000-6422-1556>

² Dr. in Education. Centro Universitário Adventista de São Paulo (UNASP). E-mail: giza.sales@gmail.com
Orcid: <https://orcid.org/0000-0002-6452-5047>

³ Dr. in Education. Centro Universitário Adventista de São Paulo (UNASP). E-mail: bstangelopes@gmail.com
Orcid: <https://orcid.org/0000-0001-6471-5791>

⁴ Dr. in Education. Universidade Estadual Paulista (UNESP). E-mail: r.castro@unesp.br
Orcid: <https://orcid.org/0000-0002-7383-4810>

Paro, Heloísa Lück e Daniel Goleman e busca trazer uma visão humanizada da liderança escolar vista tanto do ponto de vista social como escolar e apresenta resultados que validam essa forma de fazer gestão. Os resultados apontam que a gestão humanizada fortalece a colaboração, reduz conflitos e engaja as equipes. Constatou-se uma escassez de literatura voltada para a formação socioemocional de líderes educacionais, indicando a necessidade de mais estudos que integrem práticas de gestão e desenvolvimento emocional na liderança escolar.

Palavras-chave: Educação. Habilidades Socioemocionais. Gestão Escolar. Clima Organizacional. Educação Humanizadora.

RESUMEN

La construcción de un entorno educativo saludable no depende exclusivamente de los aspectos pedagógicos y administrativos, sino también de la capacidad de los gestores escolares para establecer relaciones interpersonales basadas en la empatía, la comunicación eficaz y el equilibrio emocional. Este artículo investiga la influencia de las habilidades socioemocionales de los gestores escolares en el clima organizacional y en el desempeño de los profesionales de la educación. Fundamentado en un enfoque cualitativo, exploratorio y bibliográfico, el estudio se apoya en autores como Vitor Paro, Heloísa Lück y Daniel Goleman, y busca presentar una visión humanizada del liderazgo escolar, considerada tanto desde la perspectiva social como educativa, y expone resultados que validan esta forma de gestión. Los resultados indican que la gestión humanizada fortalece la colaboración, reduce los conflictos y promueve el compromiso de los equipos. Se constató una escasez de literatura orientada a la formación socioemocional de los líderes educativos, lo que señala la necesidad de más estudios que integren las prácticas de gestión y el desarrollo emocional en el liderazgo escolar.

Palabras clave: Habilidades Socioemocionales. Gestión Escolar. Clima Organizacional.

1 INTRODUCTION

The performance of the school manager exerts a direct influence on different dimensions of the educational environment, including the organizational climate, continuing education, teaching practice and, especially, the learning processes and human development of students. In this sense, school management goes beyond the technical-administrative sphere, assuming a decisive role in the quality of interpersonal relationships and in the construction of institutional environments favorable to pedagogical work.

With the approval of the National Common Curriculum Base (BNCC) (Brasil, 2018), the development of socio-emotional skills became mandatorily part of Brazilian school curricula as of 2020. Although the regulation highlights the student as the focus of this process, this guideline also involves teachers, managers and administrative teams, since the socio-emotional climate of the school is constituted from the daily interactions between all subjects. Thus, analyzing the influence of the school manager in the construction of this climate is relevant, considering the impacts that their performance can generate both in institutional relations and in the implementation and strengthening of innovative pedagogical practices.

From this perspective, Lück (2006) emphasizes the importance of the systematic evaluation of the organizational climate through appropriate instruments, in order to identify potentialities and aspects that require improvement. For the author, the leadership exercised by the manager is essential to guide planned actions that contribute to the strengthening of the institutional climate, promoting greater engagement, self-esteem and self-confidence among the members of the school community.

In a convergent way, Paro (2001) emphasizes the central role of the school manager in promoting participatory and democratic management, based on dialogue, cooperation and co-responsibility. According to the author, the coherence between educational objectives and the mediations adopted to achieve them is an indispensable condition, since democratic purposes cannot be achieved through authoritarian practices. Thus, the school space, as the *locus* of systematized education, must be constituted as an environment conducive to the exercise of democracy.

This conception assigns to the school manager the responsibility of creating and sustaining a positive socio-emotional climate, based on welcoming, respect and inclusion, essential elements for the well-being of students and educators and for the success of educational processes.

The institutional climate directly influences academic performance and the level of satisfaction of students with the school, to the extent that environments based on safety,

motivation and support favor learning and human development. At the same time, these environments significantly impact the work of the school team, strengthening professional engagement, cooperation, and a sense of belonging, essential elements for collective development and for the consolidation of quality educational practices.

2 THE VIEW ON EMOTIONAL INTELLIGENCE

The term emotional intelligence was initially introduced into the academic field by Salovey and Mayer (1990), who conceived it as a subset of social intelligence, related to the ability to monitor one's own feelings and emotions, as well as those of others, using this information to guide thoughts and actions. As Régo and Fernandes (2005) point out, this conception establishes an articulation between emotion and cognition, as opposed to dualistic approaches that have historically separated reason and emotion as dissociated dimensions of human behavior.

The notion of emotional intelligence gained greater visibility after the publication of the work *Emotional Intelligence*, by Daniel Goleman (1995), in which the author expanded the concept by including aspects of personality and defending the possibility of developing these skills throughout life. Goleman (1995) describes five fundamental dimensions of emotional intelligence: self-knowledge, related to the perception of one's emotions; self-control, linked to the ability to manage feelings and impulses; self-motivation, associated with the orientation of emotions towards the achievement of goals; empathy, understood as the ability to recognize and understand the emotions of others; and social skills, related to the effective management of interpersonal relationships.

When presented, the theory of emotional intelligence was initially interpreted as contradictory to traditional conceptions based on intellectual quotient (IQ). However, over time, this perspective has gained theoretical and empirical consistency, as studies have shown that individuals with greater interpersonal relationship capacity and emotional balance tend to have better professional and social performance than those who stand out only for specific cognitive abilities (Goleman, 1998).

Intrapersonal intelligence refers to the individual's ability to understand themselves, involving self-knowledge, recognition of their own emotions, and the ability to regulate them. Interpersonal intelligence, on the other hand, refers to the ability to understand the other, their intentions, feelings, and needs, as well as to establish healthy relationships, maintain constructive dialogues, and interact in a socially effective way. These conceptions extend the traditional understanding of intelligence, overcoming the exclusive centrality of logical-mathematical skills. In this sense, Gardner (2001) defines intelligence as a biopsychological

potential to process information, which can be activated in certain cultural contexts to solve problems or create socially valued products.

In this context, a leadership profile different from the traditional one emerges, both in the business and educational spheres. Effective leaders are now recognized as those who are able to establish closer relationships, promote environments of trust, tranquility and well-being, favoring the development of the individual and collective potential of their subordinates. According to Goleman (1998), this paradigm shift inaugurates a new understanding of administration and management, in which emotional competencies play a central role.

Although academic selection processes traditionally emphasize IQ as a performance indicator, this factor alone is insufficient to explain professional success or failure. Research cited by Goleman (1998) indicates that the correlation between IQ and effectiveness in professional practice rarely exceeds 25%, and in many cases may be less than 10% or even 4%. These data show that a large part of success at work is associated with non-cognitive factors. An example of this is the study carried out with graduates in Law, Medicine, Education and Business Sciences at Harvard University, in which it was found that the scores in the entrance exams did not present a significant correlation with professional success (Goleman, 1998, p. 26).

Based on these findings, Goleman (1998) demonstrates that socio-emotional skills play a more relevant role than isolated intellectual capacities, which has driven the development of numerous studies, both in the international scenario and in the Brazilian context.

College admissions tests highlight the importance of IQ, but on its own, it can hardly explain success or failure in life. Research has shown that the correlation between IQ and the level of effectiveness that people have in the exercise of their profession does not exceed 25%, although a more detailed analysis reveals that this correlation does not usually exceed 10% and is sometimes even less than 4%. This means that, in the best case, IQ leaves 75% of success at work unexplained, and in the worst case, 96%, or, in other words, IQ does not allow you to determine in advance who will succeed and who will fail. For example, a study of graduates in law, medicine, education, and business at Harvard University found that entrance exam scores—an imitation of IQ—had no correlation with professional success (Goleman, 1998, p. 26).

Such studies have reinforced the importance of emotions in leadership and, in particular, in school management.

In Brazil, recent investigations have also shown this relationship.

[...] the construction of transformative theories and practices, which do not privilege only the cognition of contents, but which instigate a new look at teaching with sensitivity to the learner and the importance of the development of socio-emotional aspects as paths to learning, school quality and especially quality of life (Lobo; Ferraz da Silva, 2021 p.144).

The study developed by Lobo and Ferraz da Silva (2021), from the University of Paraíba, highlights the need to build transformative educational theories and practices that do not exclusively privilege content cognition, but that promote a sensitive pedagogical look at the learner, recognizing the development of socio-emotional aspects as fundamental paths for learning, especially the quality of life of the entire school team

2.1 MORE THAN EMOTIONAL INTELLIGENCE: SOCIO-EMOTIONAL SKILLS

In addition to emotional intelligence, it is essential to highlight the importance of the school manager promoting a quality institutional climate in educational units. In this sense, Abrucio (2018) emphasizes that management occupies a central place in the success of pedagogical action, especially in aspects such as teacher training, the quality of the school climate, curriculum implementation, the encouragement of good pedagogical practices and innovation in the classroom, as well as in the strengthening of relationships between the school and the community.

The relevance of emotional self-knowledge and the ability to regulate emotions has been increasingly questioned, both on the part of the manager and with regard to the recognition of the emotional dimensions of his subordinates. In this context, it is essential that the manager develops awareness of his own limitations and potentialities, while getting to know his team, exercising attentive listening to the difficulties faced, the feelings involved and the challenges experienced in the school routine. Such an attitude contributes to the construction of a healthy and collaborative work climate, favoring the well-being of both the leader and the professionals under his leadership.

For Lück (2006), the organizational climate is a fundamental element for the proper functioning of the educational institution, exerting a direct influence both on the performance of students and on the satisfaction and engagement of the professionals who work there. This climate is built from the interactions established between the different subjects of the educational community, such as managers, teachers, students and employees. In this process, school leadership plays a central role in creating a positive institutional environment, in which members feel valued, motivated, and committed to educational objectives. The author also points out that a favorable organizational climate strengthens trust, mutual respect, effective communication and collaboration among those involved, creating

conditions conducive to learning, personal and professional development and the achievement of the school's educational goals. Lück (2006) also warns that "the mere presence of a person in an environment with non-verbal pressures of apathy and indifference to the sociocultural dimension of their reality has a negative impact on this context" (p. 37), thus evidencing the role of individual attitudes and postures in the constitution of the institutional climate.

Bisquerra and Pérez-Escoda (2007) mention the *five elements* of socio-emotional competence. The *first element*, according to the authors, is *emotional awareness*, described as the ability to become aware of one's own emotions and the emotions of others, including the ability to perceive the emotional climate of a specific context. The *second element* is *emotional regulation*, which concerns the ability to deal appropriately with emotions, to be aware of the relationship between emotion, cognition and behavior, to develop coping strategies and to elicit positive emotions. The *third element* is *emotional autonomy (self-management)*, formed by a group of characteristics related to emotional self-control, such as self-esteem, responsibility, critical view of social norms, positive attitude, recognizing when you need help and asking for support. The *fourth element* is *interpersonal intelligence or social communication*, which deals with the ability to maintain good relationships with other people, the ability to communicate, to be respectful, to be assertive and to have a prosocial behavior. The *fifth element* is composed of *life skills and well-being*, represented by the ability to adopt appropriate and responsible behaviors to solve personal, family, professional and social problems, aiming to obtain improvements in personal and social well-being.

Guerra (2020) argues that school learning goes beyond the development of students, requiring the constant involvement of the entire team in formative processes and the resignification of pedagogical work. In this way, the school needs to develop the capacity to create, review consolidated practices, listen to teachers, students and the community, as well as maintain a permanent dynamic of reflection, focused on both the internal context and external transformations. In this movement, it is essential to keep up with social and economic changes, new educational trends, and the advancement of technologies. The author emphasizes the need for school managers who are attentive to the demands of the present time, not restricting themselves to the knowledge prescribed in the national curricula, but also valuing the relational and emotional dimensions that give meaning to the contents worked on in everyday school life (Guerra, 2020).

It is not, therefore, through external measures, external agents, imposed advisors, inspections of hierarchies, authoritarian principals, that a school can change in an

enriching way. Because then teachers become cogs in a gear that they do not believe in and do not love (Guerra, 2020, p. 6).

It is possible to see that the authoritarian school manager no longer corresponds to the profile of the manager expected for the current context, that is, that profile of the manager who strictly followed the rules established by the government's educational guidelines, which arbitrarily marked the rhythm and method of work, no longer has space today. The contemporary manager fulfills his duty, but knows how to be understanding, foster an environment of tranquility in which each member of the team feels part of a gear, feels comfortable, valued and heard, thus generating a better quality of education for his students, and a work climate suitable for the integral growth of the school unit.

Through in-depth studies on the subject, authors such as Lotz and Gramms (2012) demonstrate that professionals with emotional potential are an advantage for organizations, being able to offer conditions for learning and development of human formation.

Emotionally intelligent professionals have the ability to manage conflicts, increased employability, and, in addition, they present a key differential between effective and mediocre employees: they are important sources of competitive advantage (Lotz; Gramms, 2012, p. 54).

In the context of education and management of confessional institutions, Menslin (2012) addresses a series of topics that are necessary for the school manager to develop a good administrative work. One of the topics is to create a climate of friendship in the school environment. The author considers it an important point to maintain this good environment for the development of healthy management, and points out one more detail: the character of the director must be one of trust and friendship; it must fulfill what it promises and provide the working group with security (Menslin, 2012).

Also according to the same author:

If the manager is someone who does not commit to what he says to his assistants, who does not expose himself in favor of his group and does not reveal in his actions what he is as a person, the work climate will hardly be one of trust and friendship (Menslin, 2012, p. 35).

The manager must, therefore, identify with the group, support, and they need to feel part of the team, for a good functioning, generating well-being. The Christian author Ellen White (2008) also highlights the importance of the influence that one person exerts on another, due to loving, caring, and empathetic treatment. How this generates a pleasant atmosphere in any convivial situation.

The need to be an educational leader who points out mistakes with love and care, generating changes in work behaviors; otherwise, many employees will feel unable to give their best and will feel excluded from that team. If the manager has the real notion that his influence reaches even the most innermost, such as the human mind, he can develop not only the best at work, but also the best of the human beings who work with him.

White highlights the influence people have on the lives and emotions of others:

Every soul is surrounded by an atmosphere of its own, which may be charged with the life-giving power of faith, of courage, of hope, and perfumed with the fragrance of love. Or it may be heavy and cold with the clouds of discontent and selfishness, or intoxicated with the deadly contact of a cherished sin. By the atmosphere that surrounds us, every person with whom we communicate is consciously or unconsciously affected (White, 2005, p. 207).

In view of these reflections, it is understood that the leadership of the school manager exerts a direct influence on the institutional climate and on the human development of the team. An action based on care, empathy and respect favors healthier relationships, strengthens the sense of belonging and creates conditions for professionals to express their potential. Thus, by recognizing the scope of their emotional and relational influence, the manager contributes not only to the improvement of work practices, but also to the construction of a more humanized, collaborative school environment conducive to collective well-being.

2.2 SOCIO-EMOTIONAL SKILLS AND SCHOOL MANAGEMENT

Institutions are formed by individuals with an increasing diversity of thoughts and ways of acting in an environment full of intellectual differences, beliefs, values, among others, and to deal with conflicts within organizations, whether small or large, leaders are needed who manage socio-emotional skills and competencies. In this sense, investment in studies and research on the subject is of paramount importance so that organizational objectives are achieved, and the main asset of an institution, which is its personnel, can be valued, and, in the same way, the main asset of each person must also be taken into account, which is their professional competence (Santos, 2008).

For Soares (2015), a good manager influences and directs a team in an ethical and positive way, day after day, year after year, in various situations. Leadership requires patience, discipline, humility, respect, and commitment when dealing with people of the most different types and mediating relationships within the team. To discuss the manager's socio-emotional skills that most contribute to team development, we will focus on *five main areas*

that the scientific literature generally highlights. According to Goleman (1995), the *five* most important competencies are: *emotional intelligence, empathy and acceptance, self-control and resilience, conflict resolution and transformational leadership*.

2.2.1 Emotional Intelligence

The work environment can take on positive or negative characteristics, varying between calmer and more welcoming contexts or, on the contrary, environments marked by agitation, tension and high levels of stress. From Kantor's (2019) perspective, in many organizational scenarios, especially in the educational field, daily demands impose intense work rhythms, rigid deadlines, and pressure for results, which can directly affect the well-being of professionals and the quality of interpersonal relationships. In this context, Emotional Intelligence is an essential tool to support management and professional practices, since it favors the recognition, understanding and proper management of one's own emotions and the emotions of others. Emotionally intelligent individuals tend to have greater balance in the face of adverse situations, demonstrate ease of teamwork, greater ability to adapt to changes and competence to deal with conflicts, whether internal or external to the organization. In this way, Emotional Intelligence contributes not only to the emotional health of professionals, but also to the construction of a healthier, more collaborative organizational climate that is conducive to achieving institutional objectives.

2.2.2 Empathy and Acceptance

The acceptance of the individual in his or her entirety, including his or her limitations and potentialities, is a fundamental element for the construction of organizational environments in which professionals feel safe, recognized and valued. When leadership adopts an empathetic posture — understanding and respecting the feelings, experiences, and perspectives of others — a favorable space is created for personal and professional growth, in which subjects perceive themselves supported in their development processes. In this context, leaders who exercise empathy and listening are often recognized as more competent and upright in their performance. This conception dialogues with the idea that the role of the leader consists of helping his subordinates to reach their potential, not through disqualifying criticism, but through follow-up practices and constructive feedback. As Scharmer (2014) points out, "two leaders, in the same circumstances, doing the same things, can generate completely different results, depending on the inner place from which each of them acts" (p. 85), evidencing the centrality of the emotional and reflective dimension in the exercise of leadership. From this perspective, emotional leadership is an important form of

influence in the educational context, since it involves practices to support the emotional well-being of teachers and other school professionals. As Bercovitch and Eyal (2021) point out, this type of leadership produces significant effects on the affection, engagement, and quality of teaching work, contributing to positive results in teaching and in the functioning of educational organizations

2.2.3 Self-control and resilience

School managers need to develop the ability to deal with both their own emotions and the emotions of team members, since their performance directly influences the organizational climate and work relationships. This dynamic becomes especially challenging when the manager is unable to maintain emotional balance in the face of everyday situations or more sensitive contexts, which require greater stability and emotional discernment. For Machado et al. (2024), in the process of managing emotions, the leader must strengthen his personal skills, developing the ability to recognize, understand, and regulate his own emotional states. Such competence is fundamental for the personal and professional growth of the manager, in addition to contributing significantly to the improvement of intrapersonal and interpersonal relationships in different contexts of coexistence, such as work, family and social relationships in general. In a complementary way, Agüera (2008) highlights that personal competencies and skills are related to the way the individual relates to his emotions and feelings, directly influencing the way he perceives himself and establishes bonds with others.

2.2.4 Conflict Resolution

Conflict resolution skills, especially in the context of socio-emotional leadership, have been shown to be fundamental for reducing teacher turnover and strengthening the permanence of school teams. Emotionally engaged and empathetic leaders tend to manage conflicts more effectively, contributing to the construction of more resilient, cooperative, and cohesive school environments. In the organizational context, marked by cultural, social and political diversity, it is natural for different interests, values and aspirations to emerge, which can lead to cooperation as well as to competition or conflict (Andrade et al., 2004). Conflict, therefore, is an inherent element of human relations and work processes, and should not be understood exclusively as something negative. In this sense, Burbridge and Burbridge (2012) state that conflict is natural and, in many situations, necessary, as it can act as a catalyst for change and innovation. However, when poorly managed, conflicts can become unproductive, generate emotional exhaustion, compromise professional relationships, and destroy institutional value. Thus, one of the main challenges of school management is to recognize

the nature of conflicts — distinguishing those that are productive from those that are harmful — and to intervene ethically, empathetically and strategically. The manager's socio-emotional competencies and skills, especially active listening, empathy and emotional balance, play a central role in this process, directly articulating with the promotion of a healthy organizational climate and the sustainable development of the school team.

2.2.5 Transformational Leadership

Transformational leadership, pointed out by Goleman, is characterized by the ability to inspire, motivate and mobilize people, exerts a direct influence on the constitution of the school's organizational climate and on the professional development of the teaching team. This leadership model presupposes that the manager mobilizes skills linked to emotional intelligence, such as self-knowledge, self-regulation, and empathy, which are fundamental for building healthy interpersonal relationships, for mediating conflicts, and for making balanced decisions in everyday school life. In this sense, the strengthening of the manager's socio-emotional skills is reflected in the quality of institutional interactions, promoting an environment of trust, collaboration, and belonging. In line with this perspective, the *Collaborative for Academic, Social, and Emotional Learning* (CASEL) highlights self-awareness, self-management, and social awareness as essential competencies for school leaders, since they sustain collaborative practices, favor collective engagement, and contribute to the consolidation of an organizational climate conducive to team development and the effectiveness of educational processes.

Figure 1

Socio-emotional skills



Source: Prepared by the authors

Emotional intelligence within socio-emotional skills is one of the fundamental pillars for the development and effective practice of leadership skills. As evidenced in the figure presented above, a leader's ability to manage their own emotions and specifically influence the team they lead depends directly on this emotional competence. Emotional intelligence not only facilitates self-awareness and emotional self-regulation, but also plays a crucial role in creating a harmonious and productive work environment by promoting empathy, intrinsic motivation, and the ability to establish and maintain healthy interpersonal relationships.

As highlighted by the specialized literature, social-emotional skills encompass a set of five key skills, which are essential for a leader's effectiveness. These skills have their own characteristics, but they are deeply interconnected and complementary in the leader's development process. Each of them contributes to building a leader who is more aware, resilient, and capable of facing challenges, as shown in the following table.

Table 1

Manager's Socio-emotional Skills

Ability	Definition	Practices to develop
Emotional Intelligence	Ability to recognize, understand, and manage one's own and others' emotions to create a balanced environment.	Develop self-knowledge, practice self-control, demonstrate empathy, improve social skills.
Empathy and Acceptance	Ability to understand the emotions of others, accept differences, and create an environment of trust.	Active listening, recognizing human imperfections, giving constructive feedback, creating an inclusive environment.
Self-Control and Resilience	Ability to remain calm under pressure, control impulses, and bounce back from adversity.	Strategic breaks, mindful breathing, self-reflection, growth mindset, support networks.
Conflict Resolution	Ability to mediate and resolve conflicts in a collaborative and constructive manner.	Practice active listening, stay calm, focus on the problem and not on the people, promote collaborative solutions.
Transformational Leadership	Ability to inspire, motivate and engage the team, promoting personal and professional growth.	Inspire with a clear vision, act as a model, invest in team development, stimulate innovation.

Source: Prepared by the authors with data from the research.

3 FINAL CONSIDERATIONS

This text aimed to understand the main socio-emotional skills of the school manager and their influence on the team, analyzing how skills and competencies have repercussions on the organizational climate and on the performance of education professionals. From a brief literature review carried out, it was possible to identify consistent evidence about the centrality of the socio-emotional dimension in the exercise of contemporary school leadership.

The findings indicate that emotional intelligence is a determining factor for the effectiveness of school management and highlight the need for school managers to develop socio-emotional skills such as *emotional intelligence, empathy and acceptance, self-control and resilience, conflict resolution and transformational leadership* among others. The studies analyzed reinforce that effective leaders are not limited to the management of institutional processes and routines, but act in the construction of positive interpersonal relationships, directly influencing the motivation of the team, professional engagement and, consequently, the quality of the pedagogical work developed in the school.

Another relevant aspect identified refers to the disparity between academic production focused on school leadership and that dedicated to business management. This scenario shows a mismatch in the scientific valuation of educational management, indicating the need for greater investment in research that considers the specificities of the school context and the challenges inherent to leadership in educational institutions.

Based on the results of this investigation, it is suggested that the theme be deepened in future studies, contemplating, among other aspects: the impact of the manager's emotional intelligence on the academic performance of students; the influence of emotionally intelligent leadership on student motivation and learning; the relationship between administrative overload and the development of socio-emotional skills; as well as the identification of continuing education models capable of effectively promoting the development of these skills in school managers.

In this way, the research revealed through this text demonstrates that school management goes beyond the bureaucratic and administrative dimension, requiring a broad and articulated set of socio-emotional skills to face the daily challenges of education. Social-emotional leadership contributes not only to the improvement of the organizational climate and to the strengthening of teams, but also to the promotion of the well-being of professionals and to the improvement of the quality of the educational process.

Given this scenario, it is essential that educational policies encourage training programs aimed at the development of emotionally intelligent leadership, as well as foster research that deepens the understanding of this theme in the educational context. Only through a collective effort involving researchers, managers and educators will it be possible to build more humanized, inclusive and effective school management models, aligned with the demands of the school and contemporary society.

REFERENCES

- Agüera, L. G. (2008). Além da inteligência emocional: As cinco dimensões da mente. Cengage Learning.
- Andrade, R. O. B. de, Alyrio, R. D., & Macedo, M. A. da S. (2004). Princípios de negociação: Ferramentas e gestão. Atlas.
- Bailey, J., & Weiner, R. (2022). Interpreting social-emotional learning: How school leaders make sense of SEL skills for themselves and others. *School Leadership Review*, 16(2), Article 4. <https://scholarworks.sfasu.edu/slr/vol16/iss2/4>
- Bardin, L. (2016). Análise de conteúdo. Edições 70.
- Bisquerra Alzina, R., & Pérez Escoda, N. (2007). Las competencias emocionales. *Educación XX1*, 10(1), 61–82. <https://doi.org/10.5944/educxx1.1.10.297>
- Brasil. Ministério da Educação. (2018). Base Nacional Comum Curricular. <http://basenacionalcomum.mec.gov.br/>
- Burbridge, R. M., & Burbridge, A. (2012). Gestão de conflitos: Desafios do mundo corporativo. Saraiva.
- Gardner, H. (2001). Inteligência: Um conceito reformulado. Objetiva.
- Goleman, D. (1995). Emotional intelligence: Why it can matter more than IQ. Bantam Books.
- Goleman, D. (1998). La práctica de la inteligencia emocional. Editorial Kairós.
- Goleman, D., Boyatzis, R., & McKee, A. (2002). Primal leadership: Realizing the power of emotional intelligence. Harvard Business School Press.
- Guerra, M. Á. (2020). La escuela que aprende. Morata.
- Lobo, A. R., & Ferraz da Silva, C. H. (2021). Habilidades socioemocionais no âmbito escolar: Desenvolver para a vida. *Ivy Enber Scientific Journal*, 1(1), 146–158. <https://enber.edu.eu/revista/index.php/ies/article/view/10>
- Lotz, E. G., & Gramms, L. C. (2012). Gestão de talentos [Livro eletrônico]. InterSaberes.
- Lück, H. (2009). Dimensões de gestão escolar e suas competências. Editora Positivo.
- Lück, H. (2017). Gestão da cultura e clima organizacional da escola (4ª ed.). Vozes.
- Machado, E., et al. (2024). Resiliência e inteligência emocional no contexto organizacional. *Revista Tópicos*, 2(11). <https://revistatopicos.com.br/artigos/resiliencia-e-inteligencia-emocional-no-contexto-organizacional>
- Menslin, D. (2012). O que esperam de mim na gestão escolar. Editora MM.
- Paro, V. (2001). Escritos sobre educação. Xamã Editora.
- Piaget, J. (1994). O juízo moral da criança. Summus. (Obra original publicada em 1932)
- Piaget, J. (2014). Relações entre afetividade e a inteligência no desenvolvimento mental da criança. Wak. (Obra original publicada em 1954)
- Rêgo, A., & Fernandes, C. (2005). Inteligência emocional: Contributos adicionais para a validação de um instrumento de medida. *Psicologia*, 19(1/2), 139–167. <https://doi.org/10.17575/rpsicol.v19i1/2.401>

- Salovey, P., & Mayer, J. D. (1990). Perceiving affective content in ambiguous visual stimuli: A component of emotional intelligence. *Journal of Personality Assessment*, 54(3-4), 772–781. https://doi.org/10.1207/s15327752jpa5403&4_29
- Santos, P. R. (2014). Desenvolvimento e aprendizado escolar: Uma proposta de mensuração para apoiar políticas públicas. OCDE, SEEDUC, Instituto Ayrton Senna.
- Scharmer, O. (2014). Liderar a partir do futuro que emerge: A evolução do sistema econômico egocêntrico para o ecocêntrico. Como aplicar a Teoria U para contribuir com a transformação de indivíduos, organizações e sociedades. Elsevier.
- Vygotsky, L. S. (1991). A formação social da mente. Editora Martins Fontes.
- White, E. G. (2005). Mente, caráter e personalidade (Vol. 1). Casa Publicadora Brasileira.
- White, E. G. (2008). Testemunhos para ministros e obreiros evangélicos. Casa Publicadora Brasileira.

LIBERTARIANISM OR PROPERIALISTISM? SELF-OWNERSHIP AS THE FOUNDATION OF ROBERT NOZICK'S LIBERTARIAN THEORY (2024)

LIBERTARIANISMO OU PROPERTARIANISMO? A PROPRIEDADE DE SI MESMO COMO FUNDAMENTO À TEORIA LIBERTÁRIA DE ROBERT NOZICK (2024)

¿LIBERTARISMO O PROPERIALISTISMO? LA AUTOPROPIEDAD COMO FUNDAMENTO DE LA TEORÍA LIBERTARIA DE ROBERT NOZICK (2024)



<https://doi.org/10.56238/sevened2026.008-117>

Victor Henrique Ahlf Gomes¹

ABSTRACT

The present work aims to understand the theoretical foundations of the famous political philosophy developed by Robert Nozick in his work *Anarchy, State and Utopia*, addressing and defining the nature of the concept of self-ownership and the role it plays in libertarian argumentation, as well as the way in which the author is able to extract his “strong theory of rights” from it. During this study, we propose the thesis that self-ownership is seen in Nozick as a *quaestio facti*, and not just as a principle subordinate to the Kantian categorical imperative, as his critics claim. Important conclusions will emerge from this thesis, which, in our view, make the author's libertarian theory much more attractive and appealing than if we take his fundamental position as a mere principle. Among these lessons is that, although *Anarchy, State and Utopia* is routinely defined as libertarian, an epithet that suggests freedom with an unparalleled status in his work, its true foundation is found in self-ownership as a fact, in the private property rights arising from it and in the negative rights (side constraints) that arise from both.

Keywords: Nozick. Self-Ownership. Libertarianism. Property. Rights. Individual. Theory of Rights. Philosophy of Law. Political Philosophy.

RESUMO

O presente trabalho busca compreender as fundações teóricas da célebre filosofia política desenvolvida por Robert Nozick em sua obra *Anarquia, Estado e Utopia*, abordando e definindo a natureza do conceito de autopropriedade e o papel por ele desempenhando na argumentação libertária, bem como a forma pela qual o autor é capaz de dela extrair sua “teoria forte de direitos”. No curso do trabalho, propomos a tese de que a autopropriedade é encarada em Nozick como uma *quaestio facti*, e não apenas como princípio subordinado ao imperativo categórico kantiano, como pretendem seus críticos. Desta tese decorrerão conclusões importantes, que, a nosso ver, tornam a teoria libertária do autor muito mais atrativa e apelativa do que se tomassemos sua premissa fundamental por mero princípio. Dentre tais conclusões está a de que, embora *Anarquia, Estado e Utopia* seja rotineiramente

¹ Postgraduate Student in Philosophy and Theory of Law. Pontifícia Universidade Católica de Minas Gerais (PUC-MG). Universidade de São Paulo (USP). E-mail: victorahlf@gmail.com Lattes: <http://lattes.cnpq.br/5536658657539234>

classificada como libertária, epíteto que sugere a liberdade com status inigualável na obra, seu verdadeiro fundamento se encontra na autopropriedade enquanto fato, nos direitos de propriedade privada dela adivindos e nos direitos negativos (side constraints) que de ambos decorrem.

Palavras-chave: Nozick. Autopropriedade. Libertarismo. Propriedade Privada. Indivíduos. Teoria de Direitos. Filosofia do Direito. Filosofia Política.

RESUMEN

Este artículo busca comprender los fundamentos teóricos de la célebre filosofía política desarrollada por Robert Nozick en su obra *Anarquía, Estado y Utopía*, abordando y definiendo la naturaleza del concepto de autopropiedad y su papel en la argumentación libertaria, así como la manera en que el autor logra extraer de él su "teoría fuerte de los derechos". En este trabajo, proponemos la tesis de que Nozick considera la autopropiedad como una *quaestio facti*, y no simplemente como un principio subordinado al imperativo categórico kantiano, como afirman sus críticos. De esta tesis se desprenden importantes conclusiones que, en nuestra opinión, hacen la teoría libertaria del autor mucho más atractiva y atractiva que si tomáramos su premisa fundamental como un mero principio. Entre estas conclusiones se encuentra que, si bien *Anarquía, Estado y Utopía* se clasifica habitualmente como libertaria —un epíteto que sugiere una libertad con un estatus incomparable en la obra—, su verdadero fundamento reside en la autopropiedad como un hecho, en los derechos de propiedad privada que de ella se derivan y en los derechos negativos (restricciones colaterales) que resultan de ambos.

Palabras clave: Nozick. Autopropiedad. Libertarismo. Propiedad Privada. Indivíduos. Teoría de los Derechos. Filosofía del Derecho. Filosofía Política.

1 INTRODUCTION

1.1 A LIBERTARIANISM WITH SOLID FOUNDATIONS

The choice of this theme stems from a sad observation about the academic treatment (or lack thereof) that many authors and researchers, especially in Brazil, have given to libertarian theories of justice, often considering them, in a shallow and unreflective way, as theories that have the sole purpose of justifying and perpetrating the status quo, which is why they are not even mentioned in the current progressive context of Brazilian Universities.

Proof of this is the significant disparity between the number of academic works produced within the scope of egalitarian theories of justice - which are very concerned with themes such as "distributive justice" or "social justice" - compared to the tiny amount of works produced within the scope of libertarian theories of justice - which are more concerned with the guarantee of individual rights and "natural justice".

Having verified this disparity, the present work proposes to study and understand the most influential - and probably the most serious - libertarian theory of justice already developed, especially with regard to its moral foundations, which seek to justify and legitimize the right to private property through what its author called "theory of ownership", the main unfolding of his "strong theory of rights".

It is, in this sense, a study whose object falls on the fundamental premises of Robert Nozick's political philosophy, formulated and developed by the author in his famous work *Anarchy, State and Utopia*, namely: (i) premise of self-ownership, or "ownership of oneself", his "major premise"; (ii) premise of legitimacy for original acquisition of external goods as a logical corollary of the premise of self-ownership, its "minor premise"; and (iii) deductive conclusion from the first two premises according to which any distributive policy would be illegitimate, as it would violate natural rights².

As we will see, the premise of self-ownership, a premise from which Nozick starts in his argumentative task of justifying private property as a natural and inviolable right, stems from a factual observation of the author, or, as some of his critics prefer, from a "basic intuition", according to which we have "distinct existences" that can be verified from the fact that each and every one of us is capable of controlling our bodies, minds, talents, and actions, which makes us, by definition, "owners of ourselves."

It should be noted, however, that this is one of the most relevant interpretative proposals about Nozick's work that the present work intends to propose. This is because, when we look at the writings of his greatest critics, notably Kymlicka, Wolff and Gargarella,

² GARGARELLA, R. *The Theories of Justice After Rawls: A Brief Manual of Political Philosophy*. 1st Ed. São Paulo: Martins Fontes, 2008. p. 35.

they see Nozick's self-ownership as a mere principle that, among others, would have been "chosen" by the author because it better suited the Kantian categorical imperative.

As we intend to demonstrate, however, in spite of the admitted absence of theoretical treatment of the premise in Nozick, it is not difficult to perceive that logic is, in fact, inverse to that intended by his critics, and the categorical imperative is rather a logical consequence of the premise of self-ownership, and not the other way around. Such a premise thus acts in Nozick's theory not as a principle, but as a true *quaestio facti*.

It goes without saying that attributing to the fundamental premise of a theory, whatever it may be, the character of a factual premise, verifiable from the very "nature of things", gives it a much more appealing character than principled theories, which depend first and foremost on a minimum consensus of their interlocutors as to the validity and breadth of the fundamental premise.

The facticity of a non-principled premise, however, does not depend on the acceptance of its interlocutors, and it is enough that it is impossible, from an epistemological point of view, for such a premise to be proven false. As we will see, this is exactly the case of self-ownership, a self-evident premise, empirically and rationally verifiable, since it is impossible to find in nature any human being who is not born with the ability to control himself exclusively.

And, although Kymlicka, Wolff, Gargarella and even Rawls also assume the premise of self-ownership in their respective theories, they do so by making use of it as a mere principle, which can, therefore, be relativized or weighed against other principles depending on the circumstances, making it truly possible, as Nozick will demonstrate, to invariably lead to the violation of rights.

Thus, despite Kymlicka's argumentative effort to the effect that "self-ownership would not in itself lead to a defense of capitalism, since capitalism requires not only the ownership of itself, but also the ownership of external resources," Nozick will be able to demonstrate that any attempt at forced redistribution of such legitimately obtained resources will necessarily imply a denial of human nature and a violation of self-ownership.

From this demonstration of the violation of rights by redistributive policies will follow the second Nozickean premise, that is, that of legitimacy in the original acquisition of external resources as a logical corollary of human nature capable of controlling and, therefore, possessing itself, individually and exclusively. To do so, the author will make use of the so-called Lockean proviso, that is, the moral foundations for the original acquisition of private property developed by John Locke.

In the end, we will see that it was precisely at this point that Nozick sinned by not remaining faithful to the deontic nature of his philosophy, when he tried to transpose a theory

of original acquisition that, although quite meritorious in certain aspects, is the result of an eminently theological, albeit empiricist, political philosophy, whose main purpose was to justify private property from the perspective of Christianity, and not from a strictly rationalist perspective.

Luckily for us, and for Nozickeans in general, Edward Feser perceived this exact same problem of the pure and simple transposition of Lockean proviso to Nozick's theory and, making punctual and necessary criticisms of it, proposed a brilliant alternative entitled self-ownership proviso², which, in our view, proves not only to be more convincing but also to be more convincing.

Thus, from a detailed examination of the fundamental premise (self-ownership) and the minor premise (legitimacy for the original acquisition of external resources), we intend to demonstrate that Nozick's libertarianism not only has moral foundations, but also that such foundations, precisely because they are factual and not merely principled, are the most solid that any political philosophy could have.

1.2 LIBERTARIANISM OR PROPERTARIANISM?³

But, already from this brief introduction, the reader could ask himself here: if, as we have been saying, the foundation for Nozick's libertarianism lies in self-ownership, initially, and in the private ownership of external resources, later, and not in some abstract concept of freedom, then why do we call it a libertarian theory and not a proprietary theory?

This question, made quite emphatically by Bresolin, Kymlicka and Wolff, is usually directed from the outset in a critical way, pointing to the true pretensions that Nozick's libertarianism would be trying to hide, since, contrary to what his epithet suggests, he would not be so much concerned with freedom in itself, but rather with a "freedom of a certain type", that is, freedom delineated by self-ownership and private property rights⁴.

Thus, the most forceful criticisms directed at Nozick will be in the sense that it is egalitarian liberalism, rather than libertarianism, that would be truly concerned with the guarantee and maximization of individual freedom.

Among the arguments put forward by egalitarians, the most relevant - and to which we will pay more attention, therefore - will be that, if the premise of self-ownership is adopted in an absolute way, as Nozick proposes, there will be cases in which certain individuals will

³ FESER, E. There is no such Thing as an Unjust Initial Acquisition. In: Natural Rights Liberalism from Locke to Nozick. New York: Cambridge, 2005.

⁴ BRESOLIN, K. The property of oneself and property in Robert Nozick. *Philosophos - Revista de Filosofia*, Goiânia, v. 25, n. 1, 2020. p. 161.

accumulate so many goods in certain societies that they will leave little or nothing for others, so that this, by itself, it would greatly restrict the freedom of the less fortunate.

That is to say: in order to be truly free, according to egalitarians, we must have access to a minimum of goods, whether to move around (property over land), or to communicate (ownership of media), or even to survive (ownership of consumer goods).

That is why, although they agree with the premise of self-ownership, adopting it as a principle, the real concern of the egalitarians would lie rather in the guarantee of individual freedoms, private property being only one of the various means of guaranteeing it, so that, consequently, it cannot be absolute, since it is a means and not an end.

Thus, Nozick's right to freedom (at least in the way it is conceived by him) would be, in fact, a mere logical consequence of self-ownership, which, at the same time, would ground and limit him.

For Bresolin:

ASU is routinely characterized as libertarian, an epithet that suggests liberty with unequaled status in libertarian political philosophy. Such a statement, according to Cohen, is trampled and does not demonstrate Nozick's most important thesis. According to him, the commitment of Nozick's political philosophy is not primarily to freedom, but to the thesis of Self-Ownership. The thesis argues that each person is the morally legitimate owner of his or her own person, powers, and talents and, consequently, each person is morally free to use these powers and talents as he or she wishes, as long as it does not harm the self-ownership of others. Thus, Nozick's libertarianism does not affirm freedom as such, but freedom of a certain kind, that is, freedom outlined by the Self-Ownership thesis. The lack of Self-Ownership implies the lack of freedom.

That is to say: if freedom derives from self-ownership, then it is subordinated to it, so that only he who is, first and foremost, master of himself can be free.

But if this is true, and if we know that, for Nozick, self-ownership is a fact arising from our own rational human condition, then are we not all equally free as well?

In a first stage of civilization, in fact, freedom and self-ownership seem to be confused, to the extent that both occupy the same space of action, both being circumscribed only to the other rights of self-ownership of third parties.

Thus, the theoretical distinction between freedom as an autonomous right and freedom as a right subordinated to self-ownership lacks, in the state of nature, any practical relevance,

a relevance that will arise only when self-ownership is transposed to the right to property of external resources, which, in principle, would not be possessed by anyone⁵.

Thus, the main question that the present work will propose to answer will be, precisely, to know if those who affirm that Nozick would not be truly concerned with "freedom" per se, but only with the unrestricted rights to private property, and, therefore, if his theory really lives up to the nickname of a libertarian theory.

2 LIBERTARIANSIMO WITHOUT FOUNDATIONS? THE FUNDAMENTAL PREMISE OF SELF-OWNERSHIP IN NOZICK

As we stated in our introductory chapter, the main focus of the criticisms attributed to Nozick's libertarian philosophy resides, precisely, in its alleged absence of moral foundation, which, although in fact little explained – and, therefore, little developed – does not mean, however, that it is not present.

In this sense, a large part of the debates about Nozick continue to gravitate around the theme, some seeking to extract and justify its moral foundations, and others, in a way that is in our view quite mistaken, simply limiting themselves to attributing to him the nickname of a "libertarianism without foundations".⁶

Distancing ourselves from such radicalisms, it will not be difficult to demonstrate that Nozick's libertarian argumentation, as it could not be otherwise, starts from a fundamental premise, even if it is not itself endowed with an eminently moral character, but merely factual, rationally extractable from the human condition as such⁷.

This does not mean, however, that this theory is intended to be amoral, but only that its fundamental premise (and only it) is amoral, because it is factual. It is not by chance that Wolff will say that it is from this factual premise that Nozick will extract all his moral and political philosophy⁸, of an eminently deontological character.

It is, therefore, a political theory that has as its argumentative starting point a factual premise, but which is developed from an ethical background based on Kantian deontology, from which Nozick derives his "strong theory of rights".⁹

⁵ On the discussion between an initially inappropriate world and a world collectively possessed by all, see: FESER, E. There is no such Thing as an Unjust Initial Acquisition. In: *Natural Rights Liberalism from Locke to Nozick*. New York: Cambridge, 2005.

⁶ NAGEL, T. *Libertarianism without Foundations*, in Jeffrey Paul, ed., *Reading Nozick: Essays on Anarchy, State and Utopia*. Totowa, NJ: Rowman and Littlefield, 1981.

⁷ GARGARELLA, R. *The Theories of Justice After Rawls: A Brief Manual of Political Philosophy*. 1st Ed. São Paulo: Martins Fontes, 2008. p. 35.

⁸ WOLFF, J. *Robert Nozick*. Stanford University Press, 1991. P. 7.

⁹ BRESOLIN, K. The property of oneself and property in Robert Nozick. *Philosophos - Revista de Filosofia*, Goiânia, v. 25, n. 1, 2020. p. 154.

Thus, when Nozick asserts, already in the preface to *Anarchy, State, and Utopia*, that "individuals have rights, and there are things that no person or group can do against them (without violating their rights)," ¹⁰ it is not because he merely presupposes the existence of these rights and refrains from justifying them, as some of his careless critics seem to suggest. but because they are logical consequences of the fact that each person "is a distinct person, that his life is the only one he possesses", ¹¹ so that this, or the rights that derive from it, can never be used as means to ends desired by others.

That is to say: because it is verifiable from the factual world that human beings - unlike tools and animals, for example - are capable of controlling their own actions and the uses they make of their bodies, gifts and talents, that we can conclude that each of us leads an independent life (or existence), and that, therefore, any attempt to use our fellow human beings as means to our ends would be to deny our "independent existence". ¹²

This factual finding of independent existence has been conventionally called "self-ownership", or "self-ownership", a characteristic inherent to each and every human being. It is important to emphasize, however, that it is precisely because such a premise is verifiable in the factual world that Nozick did not bother so much to justify it, or even to mention it expressly.

That is why, being a purely factual matter, self-ownership cannot be enunciated as a norm or principle, since it does not command something, nor does it have axiological content, but only enunciates a fact of nature, namely, that we control ourselves and therefore possess independent existences, which is why self-ownership can also be seen as an axiom ¹³.

Kymlicka, in turn, understands that Nozick presents us with the "principle" of self-ownership as an interpretation given by the author to the second formulation of Kant's categorical imperative, according to which we should always treat people as "ends in themselves". ¹⁴ Kymlicka's critique, however, presupposes that Nozick has "chosen" the "principle" of self-ownership among several possible ones, as he understands it to be the one that best fits the categorical imperative.

Thus, Kymlicka understands that the fundamental premise in Nozick would be the categorical imperative itself, and not self-ownership, which would be its mere logical

¹⁰ NOZICK, R. *Anarchy, State and Utopia*. 1st Ed. São Paulo: WMF Martins Fontes, 2018. P. IX.

¹¹ NOZICK, R. *Anarchy, State and Utopia*. 1st Ed. São Paulo: WMF Martins Fontes, 2018. p. 40.

¹² WOLFF, J. Robert Nozick. Stanford University Press, 1991. P. 7.

¹³ In this sense, the "axiom of self-ownership" reached its maximum theoretical development in Hoppe, constituting a central and indispensable concept for the development of his famous "argumentative ethics by performative contradiction", according to which for any rational subject to even be able to argue, he has to presuppose his self-ownership, that is, the internal control of his body and mind. See: Leonardi da Silva, R. *Ética Argumentativa Hoppeana*. Law, Philosophy, Libertarianism. Libertarian University, 2019.

¹⁴ KYMLICKA, W. *Contemporary Political Philosophy*. 2nd Ed. Oxford University Press, 2002. p. 107.

consequence. As we intend to demonstrate, however, self-ownership is not a "choice" that is more adapted to the conception of individuals as ends in themselves, but rather it is the only alternative capable of guaranteeing such a conception, since it stems from the very factuality of independent human existence.

2.1 SELF-OWNERSHIP: PRINCIPLE OR FACT?

As said, although Kymlicka, Rawls and Nozick share Kant's influence on their respective thoughts, as well as the premise of self-ownership, they do so to different extents and for different reasons.

Kymlicka and Rawls take the categorical imperative as the fundamental premise of their argumentative constructions, from which they extract, by mere judgment of convenience and adequacy, the "principle" of self-ownership, which, like others, can be weighed and, therefore, limited in relation to other "principles".

In Rawls, for example, this is expressly present in the constant conflict between freedom and equality in his work, a conflict that, according to the author, should always be resolved in favor of the former.

In Nozick, on the other hand, self-ownership is not treated as a "principle", nor is it subordinated to some other primary foundation, as occurs in Rawls in relation to the Kantian categorical imperative. Self-ownership is actually a fact, a fact, a realization, or, as modern libertarians prefer, a true axiom.

Thus, if the right to property can be defined as the power of exclusive control of a certain good, then the simple fact that each and every human being, since rational, can control his body and his actions exclusively, makes it evident that they have property (the power of exclusive control) over their bodies, gifts and talents.

It is not denied that a certain individual is capable of imprisoning another in a cell, in a to cut off a part of his body, to torture or threaten him to work for him, but this does not imply a factual external control over someone, but only a physical control, and not a mental or volitional control, which will always reside exclusively with each one of us internally, until the day of our deaths.

Self-ownership, therefore, is prior to the categorical imperative, and not the other way around. It is not necessary to commit ourselves to the Kantian principle that commands us to act towards our fellow human beings always and simultaneously as an end and never only as means, in order to attribute to the human being a "right of self-ownership".

It is, in fact, self-ownership that commands the human being never to use his fellow men as means, but always and simultaneously as ends, because no human being belongs

to the other so that he can make use of him. Therefore, contrary to what Kymlicka claims, it is not "rights that affirm our 'separate existence'", ¹⁵but it is our separate existence that requires the recognition of rights.

This inversion of premises made by Kymlicka leads to an unequivocal and relevant distortion of Nozick's argument, making his criticism fallacious from the beginning, as it seeks to justify that self-ownership is a principle and not a fact, and that the true premise to which Nozick would be committed would be that of the Kantian categorical imperative, and not that of self-ownership. which leads to both criticism and very mistaken conclusions from his work.

The true relationship between self-ownership and the categorical imperative in Nozick seems to have been better understood by Wolff, who defined the former as the finding according to which it is the individual himself who holds power over "his life, his liberty and his body", so that, for Nozick, unlike other liberal authors, such a finding acquires the character of a fact, whose rights deriving from it cannot be relativized in any way, under penalty of denying the very nature of things¹⁶.

Another very convincing way of attributing to self-ownership the status of fact - or axiom - as it appears in Nozick, can be found in Hoppe, according to which the very act of arguing already presupposes it, because without there being exclusive ownership over our own bodies, brains, vocal cords, mouths or any other means of communication, Argumentation would be impossible¹⁷.

Thus, whatever the view may be, whether from the very examination of Nozick's argumentation, or from a systematic interpretation of the theories of his libertarian colleagues, one cannot conceive of self-ownership as a mere "principle" in Nozick, nor as a "rule", since it does not have a moral character, but rather a mere *quaestio facti*.

It is a fact that we control our bodies, minds, talents and actions. And if we control our bodies, minds, talents and actions, then we are independent beings, with "distinct existences", which is why we must be recognized certain rights that guarantee us the maintenance and integrity of our distinct existences¹⁸.

From a fact (self-ownership), norms (individual rights) are extracted, whose argumentative process of justification we will focus on below.

¹⁵ KYMLICKA, W. *Contemporary Political Philosophy*. 2nd Ed. Oxford University Press, 2002. p. 108.

¹⁶ WOLFF, J. *Robert Nozick*. Stanford University Press, 1991. P. 7.

¹⁷ HOPPE, H. *The Economics and Ethics of Private Property: Studies in Political Economy and Philosophy*. 2nd ed. Auburn, Ala.: Ludwig von Mises Institute.

¹⁸ KYMLICKA, W. *Contemporary Political Philosophy*. 2nd Ed. Oxford University Press, 2002. p. 107.

2.2 FROM FACT TO NORM: WHY SELF-OWNERSHIP DEMANDS THE RECOGNITION OF NATURAL RIGHTS

In the first year, not to say in our first class, we learned that law is "fact, value and norm". It is a succinct definition at first glance, but it brings with it the accurate notion that the norm starts from facts, just as facts are shaped by norms, and that, in this mutual relationship, values play a central role.

And if this is true, if it is verifiable in any and all legal practice, then it must also be true for philosophies of law. In Nozick, especially, the relationship between fact and norm appears quite evident when we analyze the passage from self-ownership to his "strong theory of rights".

This is because, a priori, facts are naturally amoral, and it is we, human beings, who value them and attribute meaning to them. Thus, the fact that we are masters of ourselves (since we control our bodies, minds, and actions), by itself, does not lead to any conclusions, and it is necessary before we value this fact and attribute meaning to it.

Thus, for example, we are more susceptible today to killing and eating animals because we do not see them as our equals, especially because of their inability to reason and express themselves. But if this fact were to change, if animals were suddenly capable of reasoning and communicating, surely our actions towards them would be different, for we attribute to the lives of beings who factually possess such characteristics a higher moral value than to those who do not.

In the same way, if we find that we are able to control our bodies, minds, and talents, and are also capable of guiding and guiding our actions in the factual world, we can consider ourselves as equal and independent beings, and from this we can formulate a duty according to which no one can morally claim our bodies, minds, talents, and actions without violating in this way.

In this sense, the distinction between fact and norm resides mainly in the nature of the restrictions that one and the other impose on our conduct. In the first case, the facts restrict our conduct physically, while in the second, our conduct is restricted only morally. Thus, we are not free to deny gravity physically, because nature does not allow us to do so, while I am free to kill others from the physical point of view, because it is possible to do so, although the law (norm) forbids me to do so.

The fact, therefore, cannot be denied, since it is impossible to act contrary to it. The norm, however, is liable to be violated, and only morally limits the field of possible and justified

actions, so that "rights are a moral concept that establishes the borderline conditions of justified action (as opposed to the borderline conditions of physically possible action)".¹⁹

That is why, by sharing the premise of self-ownership, even if mistakenly taking it as a principle and not as a fact, Kymlicka, Rawls and Dworkin are still able to develop a very convincing theory of rights within the scope of liberal philosophy, because although they consider it as one principle among others, they are always concerned with trying to justify their redistributive policies from the perspective of self-ownership.

If this were not the case, if these authors, as well as the utilitarians and Marxists, completely disregarded the premise of self-ownership, there is no doubt that they would be doomed to the condition of utopian authors, the only possible destiny for those who ignore – if not completely despise – the very nature of things.

This is not the case with Nozick's greatest opponents, the egalitarian liberals, whose greatest challenge is precisely the transposition of self-ownership into the natural rights deriving from it.

Thus, for both Nozick and Rawls, the fact that we have distinct existences and are able to guide our own actions, exclusively, leads to a necessary recognition that the rational being can - or "has the right to" - prevent third parties from arbitrarily interfering in the conduct of our lives, because such arbitrary interferences do not find a reason for being in the nature of things.

And it is precisely because we are distinct individuals, with our own distinct claims, that there are limits to the sacrifices that can be required of one person for the benefit of others, limits that can be expressed, precisely, in the form of a theory of rights²⁰.

Rawls, for example, will say that these limits are not absolute, and there are cases in which it is even necessary (and therefore legitimate) to demand from certain people certain sacrifices for the good of others, for without such sacrifices the self-ownership of the less favored would be even more gravely injured than that of the more favored whose sacrifices were demanded of them.

In Nozick, on the other hand, since self-ownership is a fact and not a principle, the rights arising from it do not allow for weighting, especially when such weighting takes into account consequentialist premises, so that they are truly absolute and inviolable, and to deny them this condition would be to deny the fact itself. It would be the same as saying, for example, that gravity does not exist.

¹⁹ SKOBLE, A. J. The Essential of Robert Nozick. São Paulo: Faro Editorial, 2021. P. 14.

²⁰ KYMLICKA, W. Contemporary Political Philosophy. 2nd Ed. Oxford University Press, 2002. p. 108.

Thus, one can perceive here one of the main practical-argumentative relevance of the distinction between self-ownership as a fact in Nozick and self-ownership as a principle in Rawls, who admits its weighting in relation to other principles – such as freedom and equality, for example – or even its weighting in terms of maximizing the principle itself collectively considered²¹.

It is thus concluded that Nozick seeks the norm from the fact, creating a theory of rights that intends to respect and allow the development of human nature at the same time. In the justification of his theory of rights, therefore, is implicit the premise that moral philosophy must try to recognize rights and duties without which our rational nature would not be respected, which would be unnatural and, therefore, morally and politically undesirable²².

2.3 THE THEORY OF RIGHTS AS INDIRECT MORAL CONSTRAINTS

Now, if it is true that Nozick considers self-ownership a fact, and if it is also true that from this fact norms can be extracted that aim to guarantee and respect this same fact, then the development of a theory of rights is both possible and necessary for political philosophy.

With this in mind, Skoble teaches that rights in Nozick should be understood as a moral concept that creates restrictions on human actions beyond those already imposed by nature. In this sense, it is true that we are not free to be in two places at the same time, because physics does not allow us to do so, but if we do not have a theory of rights, then we would be free, from this point of view, to kill and rob each other, for example.

A theory of rights arises, therefore, to establish "the borderline conditions of justified action", that is, to dispose of what we can or cannot do without violating the rights of others, so that we can conduct our lives respecting the lives of our equals, given that we are all equally owners of ourselves.

Thus, Nozick's theory of rights is based on "the fact that our existences are distinct", and aims precisely to ensure that such existences are in fact respected, and it is not lawful for any of us to subjugate others to our private interests through the use of force.

That is why Nozickean libertarian rights are usually defined as indirect moral constraints, since such rights impose on others only negative duties, that is, duties to refrain

²¹ The theories that defend the collective maximization of rights Nozick called "utilitarianism of rights", according to which individual rights could be violated only in cases where such violations were the only alternative capable of ensuring these same rights to a greater number of people, so that the collective balance of the violated right would be, in fact, maximized (NOZICK, R. *Anarquia, Estado e Utopia*. 1st Ed. São Paulo: WMF Martins Fontes, 2018. P. 34)

²² In this sense, Gargarella understands that Nozick's theory of rights is constituted by a series of "natural" rights, that is, "rights common to all men, in their condition as such, and which do not depend, for their creation or granting, on the will of any person" (GARGARELLA, R. *As Teoria da Justiça Depois de Rawls: Um Breve Manual de Filosofia Política*. 1st Ed. São Paulo: Martins Fontes, 2008. P. 35.)

from certain behaviors, in this case, to arbitrarily interfere with the "independent existences" of others.

For Nozick, no human being has the right to demand something from others by nature, not even by "necessity," since, if we consider the fact that our lives are distinct and that, therefore, "there can be no gesture of moral compensation between us," then "nothing justifies some of us sacrificing ourselves in the name of others."²³

Thus, Skoble concludes, "the rights of one person are only the inverse of the restrictions of others,"²⁴ so that there are no positive duties by nature, which can only arise by consensus (in a contract, for example). In other words, no one is naturally obligated before another to give or lend him his goods, his body, his hours of work or anything else.

Wolff, following the same line, prefers to call Nozick's libertarian rights "rights of non-interference", whose underlying idea is essentially the same as that of indirect moral restrictions, in the sense that Nozick's theory of rights would be proposing only negative rights and duties to life, liberty and property.

In other words, Wolff explains, "negative rights are rights that cannot be violated, or cannot be interfered with, while positive rights are, in general, rights to be helped [by others] in some way."²⁵ Therefore, to say that I have a positive right to life would be to say that I can force others to provide for my basic needs to live (by providing me, for example, with food and water), whereas a negative right to life would be limited to affirming my right not to be murdered.

With this theory of rights, then, Nozick seeks to ensure that our human nature is not disrespected, thus ensuring that we can conduct our distinct lives without others arbitrarily interfering with it (negative rights), while we are also not obligated to help others lead their own lives, unless we have committed ourselves to doing so through consensus (positive rights).²⁶

As we will see later in Chapter 4, this distinction between positive rights and negative rights is what will lead to the conclusion about the real concern and scope of the criticisms formulated against Nozick's libertarianism by egalitarian liberals, ultimately leading to a dispute between the concepts of "positive freedom" and "negative freedom".

²³ NOZICK, R. *Anarchy, State and Utopia*. 1st Ed. São Paulo: WMF Martins Fontes, 2018. p. 41.

²⁴ SKOBLE, A. J. *The Essential of Robert Nozick*. São Paulo: Faro Editorial, 2021. P. 15.

²⁵ WOLFF, J. *Robert Nozick*. Stanford University Press, 1991. P. 19.

²⁶ In this sense, as already said, Wolff admits that "Nozick allows us to have positive rights. But only in exceptional cases do they exist only as a result of people voluntarily assuming obligations that correspond to these rights – for example, entering into a contract" (WOLFF, p. 19)

3 THEORY OF OWNERSHIP AND ORIGINAL ACQUISITION OF PRIVATE PROPERTY

From Nozick's theory of negative rights will follow the theory of ownership, according to which, if we are in fact owners of our bodies, minds, talents and actions, then we will also be legitimately owners of everything we obtain from their uses, whether from the original acquisition of resources, or from the derived acquisition. through exchanges.

Thus, the theory of ownership seeks to justify private property rights by abstracting any moral considerations about the way in which goods are distributed in a given society, provided that such distribution has resulted exclusively from legitimate original acquisitions and voluntary exchanges.

In the first case, Nozick will say, what legitimizes someone to become the owner of an asset initially not possessed will be the observance of the requirements of the Lockean proviso, namely: (i) if the subject factually employed some kind of work on the asset in order to "contaminate" it and make it something different from what it was in nature; and (ii) that this appropriation does not worsen the situation of other individuals.

In the second case, once a certain good is appropriated by someone, it can only be obtained by a third party through consensus, either by exchange or donation. In other words, after a certain good has been legitimately appropriated by a subject A, a subject B can only legitimately obtain this same good if he is able to convince A to donate it to himself or exchange it for some other good of B.

To better exemplify his theory of ownership, Nozick uses the famous Wilt Chamberlain argument, through which the author asks us to imagine a situation in which a certain ideal conception of justice is realized, resulting in a distribution of possessions that we consider fair. In this fair distribution, called D1, there is a basketball player named Wilt Chamberlain, who is highly sought after by teams due to his ability to attract audiences to games.

In this, Chamberlain signs a contract with a certain team and receives 25 cents for each ticket sold. Suppose that, over the course of the season, 1 million tickets are sold, resulting in a \$250,000 gain for Wilt Chamberlain, an amount far higher than that of anyone else in that same society.

Faced with this example, Nozick asks: Would Wilt Chamberlain be entitled to this income? Is this new distribution, D2, unfair? Nozick argues that if people are free to decide to transfer that 25 cents to someone else voluntarily, thus creating a new distribution of possessions, then that new distribution should also be considered fair.

Through this argument, Nozick tries to prove that it is impossible to stipulate a standardized theory of justice without denying the right of each individual to make their own choices and, with that, decide to spend their money as they please, since naturally when

people are free to make choices it is impossible to reach a pre-established final pattern of distribution of goods.

Therefore, if we are willing to commit ourselves to the premise of self-ownership and, consequently, to Nozick's theory of rights, then we have to accept the theory of ownership, because only it prevents a third party (in this case, the State) from directly and arbitrarily interfering in society to redistribute the goods legitimately acquired and voluntarily exchanged.

3.1 LEGITIMACY FOR THE ORIGINAL ACQUISITION

In view of the theory of ownership, and having already overcome the stir regarding the recognition of self-ownership as a fact, Nozick will go on to argue - and we will now analyze - that one of the inevitable logical consequences of the recognition of this fact will be, precisely, the possibility of individuals, owners of themselves, legitimately acquiring property rights also over external resources. provided that certain requirements are observed²⁷.

In short, Nozick's central thesis to justify the legitimacy of the original acquisition of external resources will be that, taking as a premise the fact that we are all owners of ourselves – and, therefore, owners of our bodies, powers and talents – then we will also be owners of the fruits of our labor.

But how can something that is not owned become a person's rightful property? To explore this question, Nozick examines Locke's attempts to define his principle of fairness in acquisition. Thus, according to Locke, "the property rights of an unowned object arise from the combination of a person's labor with that object."²⁸

It is, in short, the "theory of mixed labor", which seeks to legitimize the original acquisition of external goods based on the notion that two goods, one already appropriated and the other not yet appropriated, when mixed in such a way that the first transforms the second, generates in the latter a relationship of submission that can be characterized as their appropriation.

In this way, in both Locke and Nozick we are able to "contaminate" external resources from the use we make of them, thus projecting our self-ownership over them. As a result, resources that previously belonged to no one are appropriated by those who contaminate

²⁷ It is precisely at this point that the influence of John Locke can be most felt in Nozick's libertarian theory, since the requirements presented by the author as both necessary and sufficient to legitimize the original acquisition of ownership of external resources will be, precisely, those set forth in the Second Treatise on Civil Government, namely: (i) that the individual "contaminates" the good with his labor to the point of making it a truly distinct good from that of the it was in nature; and (ii) that the removal of this asset from "common use" does not worsen the situation of other individuals.

²⁸ NOZICK, R. *Anarchy, State and Utopia*. 1st Ed. São Paulo: WMF Martins Fontes, 2018. p. 224.

them with their work, in order to legitimately remove them from "general use", with the only condition that this does not materially worsen the situation of other individuals²⁹.

In sum, Kymlicka illustrated the argument underlying Lockean proviso as follows³⁰:

1. People are masters of themselves;
 2. The world is initially owned by no one;
 3. You can acquire absolute rights over a disproportionate share of the world, provided you do not worsen the condition of others;
 4. It is relatively easy to acquire absolute rights over a disproportionate share of the world;
- So:
5. Once people have appropriated private property, a free market for labor and capital is morally demanded.

As exposed, the problem of Lockean proviso is that, despite its meritorious formulation about the "contamination" of external resources as a legitimate means of acquiring private property, the imposition of a utilitarian restriction ("3") on such appropriation does not conform, but rather departs from, the Kantian-deontological nature of Nozickian philosophy.

3.2 CRITICISM OF LOCKEAN PROVISO

This inherent contradiction, of course, could not go unnoticed by its critics, who, like Kymlicka, knew very well how to exploit the weakness of the argument with regard to the difficulty of justifying, on the basis of it, the morality of a unilateral original acquisition of a certain common good, even when the requirements of the Lockean Proviso were met.

In this sense, let us imagine, for example, an individual A and an individual B who, from a certain age, plant on the same land and divide the results of the harvest between them. After a while, both begin to realize that it may not be so worthwhile to continue working hard, as they can still enjoy the fruits of their partner's work, with less effort.

As a result, productivity starts to decrease exponentially, and neither A nor B are in a favorable situation anymore. This is the result of what has come to be called the "tragedy of the commons", a state in which the absence of private ownership of collectively owned goods generates an unsustainable deficit in productivity, due to the natural lack of individual incentives.

In this situation, according to the Lockean proviso, both A and B could legitimately claim the right to private ownership of the land, since whichever of the two did so first - considering that their partner would no longer be producing on it, due to the aforementioned

²⁹ In this sense, see KYMLICKA: "Nozick's answer is that appropriation of a particular object is legitimate if its withdrawal from general use does not make people worse off in material terms than they had been when in general use" (KYMLICKA, P. 115)

³⁰ KYMLICKA, W. Contemporary Political Philosophy. 2nd Ed. Oxford University Press, 2002. p. 116.

lack of incentives - would certainly lead to an increase in their productivity, improving both his own condition and that of his companion.

This is because, with the privatization of the common land, not only the original acquirer will have incentives to produce, aiming at the accumulation of goods, but also his non-owner companion, since the acquirer will probably need his

work to increase the productivity of the land, offering him, in exchange, part of the harvest as payment or consideration.

In this case, as it is easy to see, both A and B will have their condition improved, and this is enough to satisfy the lockean proviso.

But, Kymlicka asks, why A and not B (or, why B and not A)? After all, although both will benefit from the unilateral appropriation of the land by either of them, the one who becomes the owner will certainly benefit more, as he will be able to keep most of the resources produced and exercise greater control over both the land itself and his non-owner partner.

Such criticism seems to us, in fact, quite valid and forceful, insofar as the requirement of "not getting worse" of the other individuals compared to the original acquisition does not seem to provide any moral basis capable of justifying the legitimacy of appropriations that, despite improving the situation of those involved, occur contrary to the wishes expressed by them, a fact that, By itself, it would violate individual rights.

But if we accept Kymlicka's critique, then must we necessarily discard Nozick's libertarian theory? Would there not be, in this sense, another kind of theory of original acquisition equally compatible with self-ownership, but without the limitations inherent in Lockean proviso?

A very satisfactory answer to these questions can be found in a recent article published by the American philosopher Edward Feser, who, influenced by the thought of Eric Mack, proposed a solid alternative to the Lockean Proviso, according to which the original acquisitions would not involve moral valuations, but rather a mere factual question.

3.3 ORIGINAL ACQUISITION AS A FACTUAL ISSUE – SELF-OWNERSHIP PROVISIO

In his article *There Is No Such Thing As An Unjust Initial Acquisition*, Feser will state that, in lockean provision, in addition to a first stage of verifying the occurrence or not of the acquisition of the good, in factual terms, there would also be a second stage of verifying the legitimacy of this appropriation, which would act as a kind of resolute condition for the acquisition of the right, namely: that the situation of other individuals excluded from the common use of the appropriate good is not worsened.

For Feser, however, injustices could only occur at a time after the acquisition of the property, in cases where its use by the owner prevented the exercise of the minimum powers inherent to the self-ownership of other individuals.

Think, for example, of the famous hypothesis in which a certain individual is lost in the desert and, after days without access to water or food, ends up finding an oasis. Let us imagine, however, that another individual has built pipes, wells and a sophisticated water collection system around this same oasis, thus contaminating it with his work, and thereby appropriating it for himself, in a legitimate way.

In this scenario, for Feser, there is no doubt that the owner of the oasis is its legitimate owner, since he exercised his work over it to the point of transforming it into a distinct asset from what it was in nature, taking control of it. But would it still be lawful to deny the lost traveler access to water or to part of the food he has, or to charge him too much for it?

The answer is negative. Just as Nozick states that "the property rights I have to my knife allow me to leave it wherever I want, but not stuck in someone else's chest," so I cannot use my assets, such as the oasis, in a way that hurts to deny the self-ownership of others, which would certainly occur if the owner in our hypothetical scenario denied access to the resources that the lost traveler needs to survive in that extreme situation and specific.

Thus, just as the present work proposes to conceive self-ownership no longer as a principle, but as *quaestio facti*, Feser also proposed that we conceive the appropriation of external goods from a strictly factual perspective, empirically verifiable and therefore devoid of any axiological value as to its adequacy or convenience.

The valuation of private property should not, therefore, focus on the moment of appropriation of the asset, but should be limited to verifying only the legitimacy of the uses that are made of this asset. Thus, what Feser proposes to us is the maintenance of the first requirement of the Lockean proviso, but not of the second.

The title of his article is, in this sense, quite suggestive. If there is nothing like an "unfair initial acquisition", which is why the author proposes that "original acquisitions are neither fair nor unfair; the proposal is that, in fact, the effort or control employed [over a certain asset] constitutes an acquisition, period".³¹

But, someone might say, why does the fact that you have exercised control over a certain asset give you a subjective right to demand that other individuals refrain from using your asset without your consent? Does the simple coincidence that you arrived earlier and exercised power over the asset give you the right to it?

³¹ FESER, E. There is no such Thing as an Unjust Initial Acquisition. In: *Natural Rights Liberalism from Locke to Nozick*. New York: Cambridge, 2005. p. 66.

The answer to this question is actually quite simple, and quite consistent with the fundamental premise of self-ownership. Yes, as Nozick proposes, and Feser admits, randomness is amoral, for in the same way that Wilt Chamberlein may have "been lucky" to inherit the talent of being an excellent basketball player, we may also "be lucky" to find certain goods before others.

This, however, does not mean that I will be able to appropriate the good completely, as some critics usually suggest. To exemplify, Feser brings us the hypothesis of tomato sauce and the ocean, according to which if the tomato sauce belongs to me and I throw it into the ocean, does this mean that the ocean has become mine?

Obviously the answer is negative. Not because allowing such an acquisition to occur would not satisfy the second condition of the Lockean Proviso, according to which one must leave goods of similar quality and quantity to other individuals, but because there was simply no takeover over of the ocean, nor did tomato sauce transform it into something completely different from what it was in nature.

In this sense, it is easy to see that the self-ownership provided by Feser demands a true transformation and significant control over the appropriate good so that it can be said that someone has appropriated it, and it is not enough, for example, that I build a house in a certain valley for the entire valley to become mine, since I have not significantly transformed or controlled it.

However, as with self-ownership, although it is a mere factual issue, this does not prevent the formulation of theories of law (norms) that deal with the possible and desirable uses that are made of the appropriate resources.

In the same way that it is not lawful for us to use our body, our self-ownership, to hit someone, we also cannot use our kitchen knives to stick them in someone else's body, or to scratch someone's car.

Transposing the moral examination to the uses that are made of goods and, thus, treating the original acquisition as a mere *quaestio facti*, empirically verifiable from the observation of the control that the subject exercises over a given good, proves to be more adequate not only from the argumentative and epistemological point of view, but is also much more compatible with the rest of Nozick's political philosophy.

After all, the actual acquisition of private property is merely an extension of our natural condition as owners of ourselves.

4 LIBERTARIANISM OR PROPRIETARIANISM? FREEDOM AS A LOGICAL CONSEQUENCE OF SELF-OWNERSHIP

As we have been discussing in the present work, there is no doubt that the true foundation of Nozick's libertarian theory is found in the factual premise of self-ownership. From this premise, Nozick extracted certain norms whose purpose would be precisely to guarantee and preserve human nature, thus allowing each of us to lead our distinct lives in a meaningful way³².

From this point of view, certain critics point quite emphatically to a supposed incongruity between the nickname of "libertarian" attributed to Nozick's political philosophy and his lack of concern with the guarantee of freedom itself. In this sense, Kymlicka turns almost all his argumentative efforts in an attempt to demonstrate that the true concept of freedom can only be achieved if we relax the premise of self-ownership and admit certain natural positive rights.

For Kymlicka, denying the existence of natural positive rights, among which the so-called "minimum existential rights", would be to deny freedom itself, since it considers a certain subject all the freer the more properties it has. Such an argument stems from a basic intuition, according to which in order to be able to move, express ourselves and even survive, it is obvious that we must have access to land, means of communication and food, respectively, and the more of each we have, the more "free" we will be, because the greater our possible alternatives will be.

That is, the more land I have, the farther I can go. The more access to food I have, the longer I can live and therefore enjoy my freedom. In short, the more money I have, the more things I can do.

It is, in this sense, the expression of one of the ways in which the traditional distinction between "positive freedom" and "negative freedom" is manifested in the philosophical debate, given that, even without expressly saying so, when Kymlicka criticizes a supposed lack of concern of libertarianism with the very concept of freedom (which would be contradictory) what he has in mind is, in fact, the distorted concept of positive freedom.

It is true that, although it is not within the scope of this work to examine such concepts in detail, the author himself provides us with very convincing answers to the defenders of positive liberty, notably the egalitarians, exposing the paradoxical nature that the concept affirms. This is because, in short, any positive rights by their very nature require equally positive consideration (duties).

³² For more in-depth and problematized discussions about what Nozick means by the concept of "meaningful life", see Kymlicka and Wolff.

That is, if in order to achieve the ideal of positive freedom it is necessary to attribute to certain subjects positive rights (such as the aforementioned minimum existential rights, for example), then it is necessary that we attribute to other subjects positive duties opposed to such rights (such as, in our example, the duty to provide the existential minimum to them).

Now, Nozick will tell us, to impose a natural duty to do or give something to another, without such duty deriving from consensus, is, by definition, to force someone to do something against his will, and it is no exaggeration to call such duties forced labor or even slavery. It is, in other words, to demand the sacrifice of some on behalf of others.

In view of this, we conclude that, although the argumentative effort made by Kymlicka is remarkable, in the sense that Nozick's libertarianism would not be in any way concerned with individual freedoms, it stems first and foremost from the author's use of a teratological concept of freedom, that is, the concept of "positive freedom".

And even if this were not the case, even if we were to admit that Nozick's theory is not concerned with a broader concept of freedom, but only with "freedom of a certain kind", as said by Bresolin, such a criticism does not refute in any way the argument developed by Nozick, since, as said, the only true verifiable fact of nature is that we are masters of ourselves and, therefore, free to act within our spheres of self-ownership and private property.

Precisely because it is not a consequentialist philosophy, but a deontological one, such criticisms do not even make sense, because at no time does Nozick intend to defend an abstract and ideal concept of freedom. He only starts from a factual premise (self-ownership), irrefutable therefore, and from it extracts norms that correspond to the reality of human nature (theory of rights).

For all these reasons, regardless of how we classify it, whether as a libertarian theory or not, the fact is that Nozick's political philosophy, despite the various attacks and criticisms received, continues to remain largely an extremely solid political philosophy that is difficult to contest without, in one way or another, if it ends up "rejecting the idea of the reality of the uniqueness of each person".³³

REFERENCES

- Atienza, M. (2022). *As razões do direito: Teoria da argumentação jurídica* (2ª ed.). Editora GEN.
- Berlin, I. (1980). Dois conceitos de liberdade. In P. King (Org.), *O estudo da política* (J. L. P. de Magalhães, Trad.). Editora Universidade de Brasília.
- Bobbio, N. (1997). *Locke e o direito natural* (S. Bath, Trad.). Editora UnB.

³³ SKOBLE, A. J. *The Essential of Robert Nozick*. São Paulo: Faro Editorial, 2021. P. 15.

- Bresolin, K. (2020). A propriedade de si mesmo e a propriedade em Robert Nozick. *Philosophos – Revista de Filosofia*, 25(1), 161–181.
- Cohen, G. A. (2010). *Self-ownership, freedom and equality: Studies in Marxism and social theory*. Cambridge University Press.
- Feser, E. (2005). There is no such thing as an unjust initial acquisition. In *Natural rights: Liberalism from Locke to Nozick*. Cambridge University Press.
- Gargarella, R. (2008). *As teorias da justiça depois de Rawls: Um breve manual de filosofia política* (A. R. Freire, Trad.). Martins Fontes.
- Hoppe, H.-H. (1993). *The economics and ethics of private property*. Kluwer Academic Publishers.
- Hoppe, H.-H. (2014). *Democracia: O Deus que falhou* (1ª ed.). Instituto Ludwig von Mises.
- Kant, I. (2009). *Fundamentação da metafísica dos costumes* (1ª ed.). Edições 70.
- Kymlicka, W. (2002). *Contemporary political philosophy: An introduction* (2nd ed.). Oxford University Press.
- Lagier, D. G. (2022). *Quaestio facti: Ensaio sobre prova, causalidade e ação*. Editora JusPodivm.
- Locke, J. (2019). *Segundo tratado sobre o governo* (1ª ed.). Editora Vozes.
- Macedo Jr., R. P. (2008). *Curso de filosofia política* (1ª ed.). Editora Atlas.
- Mill, J. S. (2018). *Sobre a liberdade* (1ª ed.). Vide Editorial.
- Mill, J. S. (2020). *Utilitarismo* (2ª ed.). Iluminuras.
- Nozick, R. (2018). *Anarquia, Estado e utopia* (1ª ed., 3ª tiragem). WMF Martins Fontes.
- Rothbard, M. N. (2013). *Por uma nova liberdade: O manifesto libertário* (1ª ed.). LVM Editora.
- Rothbard, M. N. (2022). *A ética da liberdade* (2ª ed.). LVM Editora.
- Skoble, A. J. (2021). *O essencial de Robert Nozick* (1ª ed.). Avis Rara.
- Wolff, J. (1991). *Robert Nozick: Property, justice and the minimal state*. Stanford University Press.

ACCOUNTING AND FISCAL INFORMATION QUALITY INDEX (ICF) IN MUNICIPALITIES OF RONDÔNIA: PERFORMANCE OF THE FIVE MOST POPULOUS MUNICIPALITIES

ÍNDICE DE QUALIDADE CONTÁBIL E FISCAL (ICF) EM MUNICÍPIOS DE RONDÔNIA: DESEMPENHO DOS CINCO MUNICÍPIOS MAIS POPULOSOS

ÍNDICE DE CALIDAD CONTABLE Y FISCAL (ICF) EN LOS MUNICIPIOS DE RONDÔNIA: DESEMPEÑO DE LOS CINCO MUNICIPIOS MÁS POBLADOS



<https://doi.org/10.56238/sevened2026.008-118>

Dante Matheus de Almeida dos Reis¹, Gustavo Viana de Lima², Leonardo Pastorin Vieira Costa³, Natália Talita Araújo Nascimento⁴

ABSTRACT

This study analyzes the quality of accounting and fiscal information of the five most populous municipalities in Rondônia through the Accounting and Fiscal Information Quality Index (ICF), an instrument that evaluates the consistency, timeliness, and compliance of the data submitted to the Brazilian Public Sector Accounting and Fiscal Information System (SICONFI). The research is descriptive, with a quantitative and documentary approach, based on data from the 2023 fiscal year, and considers Porto Velho, Ji-Paraná, Ariquemes, Vilhena, and Cacoal as the units of analysis. The results indicate that Ji-Paraná achieved the best performance, while Vilhena ranked lowest, with the remaining municipalities clustered in an intermediate range of the ranking. The analysis of the four dimensions of the index reveals greater homogeneity in some cases and significant variation in others, pointing to specific weaknesses—particularly in consistency and timeliness—as well as differences in compliance with SICONFI's technical checks.

Keywords: Accounting and Fiscal Information Quality Index (ICF). Public Sector Accounting and Fiscal Information System (SICONFI). Municipalities of Rondônia.

RESUMO

Este estudo analisa a qualidade das informações contábeis e fiscais dos cinco municípios mais populosos de Rondônia à luz do Índice de Qualidade Contábil e Fiscal (ICF), instrumento que avalia a consistência, a tempestividade e a conformidade dos dados enviados ao Sistema de Informações Contábeis e Fiscais do Setor Público Brasileiro (SICONFI). Trata-se de pesquisa descritiva, de abordagem quantitativa e documental, baseada em dados referentes ao exercício de 2023, tendo como unidades de análise Porto

¹ Graduated in Science in Accounting. Universidade Federal de Rondônia (UNIR).
E-mail: dantmatt123@gmail.com

² Graduated in Science in Accounting. Universidade Federal de Rondônia (UNIR).
E-mail: gustavovianalima@outlook.com

³ Master's degree in Regional Development and Environment. Universidade Federal de Rondônia (UNIR).
E-mail: leonardopvc.engamb@gmail.com

⁴ Dr. in Regional Development and Environment. Universidade Federal de Rondônia (UNIR).
E-mail: natalia.araujo@unir.br

Velho, Ji-Paraná, Ariquemes, Vilhena e Cacoal. Os resultados indicam melhor desempenho de Ji-Paraná e pior posicionamento de Vilhena, com os demais municípios concentrados em faixa intermediária do ranking. A análise das quatro dimensões do índice revela maior homogeneidade em alguns casos e variações relevantes em outros, apontando fragilidades pontuais, especialmente nos aspectos de consistência e tempestividade, bem como diferenças no atendimento às verificações técnicas do SICONFI.

Palavras-chave: Índice de Qualidade Contábil e Fiscal (ICF). Sistema de Informações Contábeis e Fiscais (SICONFI). Municípios de Rondônia.

RESUMEN

Este estudio analiza la calidad de la información contable y fiscal de los cinco municipios más poblados de Rondônia a la luz del Índice de Calidad Contable y Fiscal (ICF), instrumento que evalúa la consistencia, la oportunidad y la conformidad de los datos enviados al Sistema Brasileño de Información Contable y Fiscal del Sector Público (SICONFI). Se trata de una investigación descriptiva, con enfoque cuantitativo y documental, basada en datos correspondientes al ejercicio fiscal de 2023, y que considera como unidades de análisis a Porto Velho, Ji-Paraná, Ariquemes, Vilhena y Cacoal. Los resultados indican un mejor desempeño de Ji-Paraná y la peor posición de Vilhena, con los demás municipios concentrados en un rango intermedio del ranking. El análisis de las cuatro dimensiones del índice revela mayor homogeneidad en algunos casos y variaciones relevantes en otros, señalando debilidades puntuales —especialmente en los aspectos de consistencia y oportunidad—, así como diferencias en el cumplimiento de las verificaciones técnicas del SICONFI.

Palabras clave: Índice de Calidad Contable y Fiscal (ICF). Sistema de Información Contable y Fiscal (SICONFI). Municipios de Rondônia.

1 INTRODUCTION

The Brazilian Public Administration has undergone profound transformations, driven by social and economic demands that require greater efficiency, transparency and responsibility in the management of public resources. In this context, the debate on instruments for assessing fiscal and accounting quality becomes central, considering that the quality of accounting and fiscal information has a direct impact on public trust and social control (Silva; Soares; Barbosa Neto, 2025).

In Brazil, the importance of the topic has intensified especially with the establishment of the Siconfi Accounting and Tax Information Quality Ranking, established by STN/MF Ordinance No. 807, of July 25, 2023. This ranking allows for a standardized assessment of federative entities, encouraging consistent practices for collecting, disclosing and correcting accounting and tax data, in addition to reinforcing transparency and accountability mechanisms (National Treasury, 2023; Lima et al., 2024).

The analysis of the fiscal and accounting performance of municipalities becomes even more relevant in the face of the growing complexity of public management in a scenario of budget restrictions and social pressures for quality services. According to IBGE data (2024), about 80% of Brazilian municipalities mostly depend on intergovernmental transfers, which highlights the need for accurate accounting information to ensure financial sustainability and fiscal balance. In this sense, the use of indicators such as the ICF represents an effective alternative to support diagnoses and comparisons between different administrative realities (Lima et al., 2024).

Despite institutional advances, studies indicate that challenges still persist regarding the standardization of accounting information, the timeliness of the data disclosed, and the technical qualification of the professionals responsible for its production (Machado; Pereira, 2021; Silva; Soares; Barbosa Neto, 2025). Such limitations compromise comparability between federative entities and weaken social control mechanisms, especially in municipalities with greater population and economic weight. In this context, it is relevant to investigate how the most populous municipalities in Rondônia have positioned themselves in the ICF Ranking, seeking to identify patterns, weaknesses and good practices.

In view of this, the following research question arises: what is the performance of the five most populous municipalities in Rondônia in the Accounting and Fiscal Quality Index (ICF), considering their socioeconomic and institutional particularities?

This study is justified by its academic, practical and social relevance. From an academic point of view, it contributes to expanding the literature on public accounting and quality of tax information, focusing on a regional context that is still little explored. From a

practical perspective, it offers subsidies to municipal managers and control bodies by highlighting the strengths and weaknesses of fiscal management in the most populous municipalities in the state. Finally, from a social point of view, the work strengthens the instruments of transparency and social control, allowing the population to monitor the use of public resources in a more critical way (Lima et al., 2024; National Treasury, 2023).

Thus, the general objective of this work is to analyze the performance of the five most populous municipalities in Rondônia in the Accounting and Fiscal Quality Index (ICF), using data from the Accounting and Fiscal Information System of the Brazilian Public Sector (Siconfi).

2 THEORETICAL FRAMEWORK

The evaluation of the capacity of federative entities to comply with legal standards and the principles of public transparency has been consolidated as an essential instrument, made possible by measuring the quality of accounting and tax information. According to Slomski (2005), the availability of reliable and timely information strengthens accountability and enables greater social control over public management.

As Lopes and Martins (2005) point out, the quality of accounting information depends on the relevance, reliability, and consistency of the data made available, fundamental characteristics also provided for in the Conceptual Framework of the Brazilian Accounting Standards Applied to the Public Sector (CFC, 2023).

2.1 ACCOUNTING AND TAX QUALITY INDEX (ICF)

Based on Ordinance/MF No. 807, of July 25, 2023, the Ranking of the Quality of Accounting and Tax Information in the Accounting and Tax Information System of the Brazilian Public Sector (Siconfi) (Brazil, 2023) is hereby established. The Ranking aims to: evaluate the quality and consistency of the accounting and tax data sent by the entities of the Federation to Siconfi, and to foster transparency and the improvement of the quality of the information sent by the entities of the Federation to Siconfi (Santos; Coronel, 2024).

The calculation of the Accounting and Tax Quality Index (ICF) is based on the percentage of correct answers in the technical "checks", that is, the higher the percentage of correct answers that the entity obtains, the better its classification in the ranking will be (Brasil, 2025). In this way, the verifications are technical analyses that portray compliance with the legislation, instructions and guides for filling out Siconfi, as well as the rules established in the Manual of Accounting Applied to the Public Sector - MCASP and in the Manual of Fiscal Statements - MDF (Barra De São Francisco, 2023).

In essence, the Ranking seeks to score the information provided by local federated entities based on the accounting concepts provided for in the Brazilian Accounting Standards Applied to the Public Sector (NBC TSP), especially in the Conceptual Framework (NBC TSP EC). This regulation presents the qualitative characteristics of accounting information, highlighting, from the perspective of the Ranking, the timeliness and consistency of the data (Lima et al., 2024).

For the calculation of the Siconfi Ranking, a simplified ranking methodology was chosen, using the percentage of correct answers of the entities in the verifications. Entities that obtained a score higher than 95% in A; score between 85% and 95% in B; score between 75% and 85% in C; score between 65% and 75% in D; and a score of less than 65% in E (Goularte, 2026).

In addition, the STN performs checks grouped into four dimensions: information management, accounting information, tax information, and consistency data between Accounting Information x Tax Information (Brazil, 2025). These dimensions are described in Table 1.

Table 1

Evaluation Dimensions

Dimension	Description:
Dimension I - Information Management	It groups the verifications that evaluate the performance of the federative entity in relation to the submission and maintenance of information in SICONFI. For this dimension, all statements and matrices of accounting balances sent by the entities are analyzed.
Dimension II – Accounting Information	It comprises the checks that evaluate the accounting data received in relation to the adequacy to the rules of the Manual of Accounting Applied to the Public Sector - MCASP, consistency between the statements. The data analyzed are those that were approved through the Annual Accounts Statement (DCA) and sent through the closing MSC.
Dimension III – Tax Information	It groups the checks that involve the analysis of the tax data contained in the statements, such as compliance with the provisions of the Fiscal Statements Manual (MDF), consistency between statements, among others.
Dimension IV – Accounting Information x Tax Information	Accounting Information x Tax Information: Verifies the equality of values between different accounting and tax statements, cross-referencing these data.

Source: Adapted from Brazil (2025).

The Accounting and Tax Quality Index (ICF) seeks to show whether Brazilian states and municipalities have been improving the level of quality of accounting and tax information sent to the National Treasury throughout the editions of the Ranking (Bernardo et al., 2024). This analysis is made possible by the implementation of the Ranking, whose purpose is to evaluate the veracity and consistency of the information sent by the federative entities

through the Accounting and Tax Information System of the Brazilian Public Sector (Siconfi) (Goularte, 2025). Thus, in order to understand more broadly the functioning of the Accounting and Tax Quality Index (ICF), it is necessary to examine Siconfi itself, a platform that concentrates, organizes and makes available this information.

2.2 ACCOUNTING AND TAX INFORMATION SYSTEM OF THE BRAZILIAN PUBLIC SECTOR (SICONFI)

Siconfi is a system developed by the Federal Data Processing Service - Serpro in state-of-the-art Information Technology (IT) to provide the desired automation of the receipt of qualified and reliable information (Brasil, 2025). This system aims to receive, validate, store, and make available accounting and tax information from Brazilian public sector entities (Brígida, 2023).

The consolidation of Siconfi occurred in response to the need to modernize and standardize the flow of accounting and tax information in Brazil. In order to replace the old Accounting Data Collection System (SISTN), which was not able to keep up with the demands related to transparency in the availability of data, in addition to presenting problems related to the validation and processing of information (CNMP, 2015), the system was deactivated in 2015. The National Treasury Secretariat (STN), in partnership with the Federal Data Processing Service (Serpro), created the new system (Brasil, 2025).

Siconfi is composed of two interfaces with different purposes: the public area, with free access, which allows the verification accessible to any interested party of accounting information from the Brazilian public sector, news, videos and calendars (Brigido, 2023); and the restricted area, intended for the submission of information by registered public entities, accessible only to users responsible for sending the information, which encompasses the functionalities related to the management of the submission of information by the federative entity, later made available to the public (CNMP, 2015).

Siconfi began to centralize the collection of this information, with the progressive adoption of the Accounting Balances Matrix (MSC). As of 2017, it began to receive the information in this format, still on an optional basis, and as of 2018, the municipalities of capitals, the states, the Federal District and the Union began to send the MSC on a mandatory basis to Siconfi, while for the other municipalities the submission became mandatory in 2019 (Brasil, 2025). The MSC is a structure that groups a list of accounting accounts and complementary information and is produced from the PCASP, that is, it is integrated into the Table of accounts. Its complementary information corresponds to controls of a budgetary or managerial nature that allow an individualized control associated with the

PCASP accounts (Machado; Theóphilo, 2020).

In 2018, a Technical Cooperation Agreement was signed between the National Treasury Secretariat (STN), the Rui Barbosa Institute (IRB) and the Association of Members of the Audit Courts (ATRICON), with the aim of harmonizing understandings and practices between the STN and the subnational audit courts. The STN points out that Siconfi, when used by Brazilian public managers, will gradually contribute to the modernization of accounting practices underway in Brazil, bringing them closer to those in use in the developed world (Brasil, 2025). In this sense, Slomski (2005) highlights that the consolidation of integrated information systems and the standardization of accounting procedures are fundamental to ensure efficiency, accountability and greater comparability between public entities.

Thus, Siconfi is not limited to gathering accounting and tax information, but provides data that becomes fundamental for the analysis and monitoring of public management, reinforcing its role as a strategic instrument of transparency and accountability.

2.3 GOVERNMENT ACCOUNTING AND DATA AS AN ANALYSIS TOOL IN THE PUBLIC SECTOR

To understand the role of the Accounting and Fiscal Quality Index (ICF) in the evaluation of municipal fiscal management, it is necessary to analyze government accounting from the perspective of the use of data as a strategic tool in the public sector (Nascimento, 2022; Janssen et al., 2017).

The use of data as an instrument to support public management has been consolidated as one of the pillars of evidence-based decision-making. According to Janssen et al. (2017), the ability to collect, process, and interpret relevant information allows the public administration to improve the efficiency of its policies, reduce waste, and raise the quality of services provided to the population. From this perspective, government accounting plays a strategic role by transforming accounting records into structured data, capable of supporting administrative, fiscal, and budgetary decisions, expanding the rationality and transparency of public management (Nascimento, 2022).

In the accounting and fiscal field, the systematic use of data makes it possible to assess the fulfillment of fiscal targets, the sustainability of public finances, and the performance of government management. According to Lemos and Aquino (2020), the integrated analysis of revenues, expenses, and budget results contributes to the identification of deviations, the prediction of fiscal risks, and the correction of routes in budget execution. In addition, Ribeiro et al. (2023) highlight that the analysis of financial statements through

financial and budgetary indicators allows understanding the patrimonial evolution of public entities and evaluating the efficiency and effectiveness of municipal management, reinforcing the active role of government accounting in the decision-making process.

The usefulness of public data for analysis and control purposes is directly associated with the quality of accounting and tax information. Hendriksen and Breda (2019) emphasize that accounting information must present attributes such as relevance, reliability, consistency, and timeliness, in order to reduce informational asymmetry and support effective decisions. These attributes are also emphasized by the Federal Accounting Council (CFC, 2021), when it establishes that relevant information must be able to influence the evaluation of past, present, and future events, while reliability ensures that the data adequately represent the economic and financial reality of the public entity.

Transparency and data governance are central in this context, since public access to information strengthens social control and the accountability of managers. The Federal Court of Accounts (TCU, 2022) highlights that the clear and timely disclosure of accounting and tax information allows society to assess the compliance of public management and fosters trust in institutions. In addition, Freitas and Souza (2019) argue that data governance in the public sector requires well-defined processes of standardization, security, and interoperability between systems, in order to ensure the integrity and reliability of the information used for decision-making purposes.

In Brazil, the Brazilian Public Sector Accounting and Tax Information System (Siconfi) is the main database for monitoring budget execution and compliance with the requirements of the Fiscal Responsibility Law. According to the official definition, Siconfi is the platform for the centralized reception of accounting, budgetary, and tax information from the Union, the States, the Federal District, and the Municipalities (Brasil, 2023). The standardization promoted by the system enables the consolidation of national public accounts and enables comparative analyses between federative entities, expanding the use of accounting data as an instrument for evaluating fiscal management (Lima et al., 2024).

In this context, the Accounting and Tax Quality Index (ICF) emerges as an instrument that operationalizes the evaluation of the quality of the data sent to Siconfi, by measuring aspects such as consistency, regulatory compliance and timeliness of accounting and tax information. Studies show that municipalities with better performance in the ICF have greater financial balance, fiscal responsibility and capacity to comply with their legal obligations, evidencing the direct relationship between the quality of accounting information and the efficiency of public management (Frank; Goularte, 2025; Gomes; Silva, 2022).

2.4 CONTEXT OF THE MOST POPULOUS MUNICIPALITIES IN RONDÔNIA

According to population estimates released by the Brazilian Institute of GeoFigurey and Statistics (IBGE) with a reference date of July 1, 2024, Rondônia had a population of approximately 1,746,227 inhabitants, distributed in 52 municipalities. Among these, Porto Velho, Ji-Paraná, Ariquemes, Vilhena, and Cacoal stand out, which are among the most populous and economically relevant (AROM, 2024; IBGE, 2024).

Porto Velho, the state capital, has an estimated population of 514,873 inhabitants and a territorial area of 34,091.146 km², making it the Brazilian capital with the largest territorial extension (IBGE, 2024a). The city is the main administrative and economic center of the state, housing government agencies, headquarters of strategic companies and relevant logistics infrastructure, such as the Madeira River Organized Port. Its role as a center of commerce, services and electricity, due to the Santo Antônio and Jirau hydroelectric plants, reinforces its centrality in the state economy.

Ji-Paraná, with 139,359 inhabitants, is considered the "heart of Rondônia" due to its central location and importance as a transport and distribution hub. The municipality is a reference in the sectors of commerce, agroindustry and services, with consolidated urban infrastructure and a significant share in the state GDP (AROM, 2024).

Ariquemes, with 108,573 inhabitants, has consolidated itself as an agricultural and commercial center in the northern region of the state. The municipality has a total GDP of R\$ 3.2 billion and GDP per capita of R\$ 28.9 thousand, with emphasis on the sectors of services (46.9%), public administration (28%), industry (14.6%) and agriculture (10.5%) (SEPOG, 2020). Its strategic location on BR-364 facilitates the flow of agricultural production and integration with other economic centers.

Vilhena, with a population of 108,528 inhabitants, is one of the most important economic centers in the Southern Cone of Rondônia. Recognized for its high Municipal Human Development Index (MHDI), the second highest in the state, the municipality has a diversified economy, with a strong presence of mechanized agriculture, commerce and educational services. It is also an important point of connection with the state of Mato Grosso, playing a relevant logistical role (SEPOG, 2020).

Cacoal, with approximately 86,887 inhabitants (IBGE, 2022), stands out as a regional hub for health, education, and industry. Known as the "Coffee Capital" of Rondônia, its economy combines agro-industrial production and specialized services, serving neighboring municipalities and playing a central role in the micro-region (SEPOG, 2020).

2.5 CHALLENGES IN ACCOUNTING AND TAX MANAGEMENT

The fiscal management of Brazilian municipalities faces a series of obstacles arising from both administrative complexity and the structural limitations that mark the public sector. According to Pires and Gomide (2016), institutional design and the state's capacity to implement policies are directly associated with fiscal performance and the effectiveness of local management. In this sense, medium and large municipalities, such as the most populous in Rondônia, have greater complexity in their administrative processes, requiring robust internal controls, adequate monitoring systems, and a qualified technical staff to deal with the growing demand for accounting and tax information.

In addition to the administrative aspects, the literature shows that fiscal challenges are strongly linked to the financing structure of municipalities. According to Rezende (2020), the dependence on intergovernmental transfers, combined with limitations in their own collection and deficiencies in transparency mechanisms, makes local entities more susceptible to financial imbalances and governance vulnerabilities. Thus, the population and economic magnitude of these municipalities imposes relevant challenges to accounting and fiscal management. Among the main ones, the following stand out: Table 2.

Table 2

Main challenges relevant to accounting and tax management

Budget complexity:	A greater number of programs, secretariats and management units, which increases the need for efficient internal controls.
Own storage:	Dependence on revenues from intergovernmental transfers, which can generate fiscal vulnerability in periods of economic downturn.
Data infrastructure:	Need for integrated computerized systems for collecting, processing and disseminating tax information in a timely and transparent manner.
Social control:	Growing demand for active transparency and effectiveness in accountability, especially in municipalities with greater visibility.

Source: Adapted from Pires and Gomide (2016); Rezende (2020).

According to Rezende (2020), fiscal assessment instruments allow us to understand not only the immediate financial situation of public entities, but also their medium and long-term sustainability, contributing to more consistent and transparent decisions.

Considering the expressive demographic and economic dimension of these five municipalities, its detailed analysis offers subsidies to understand how different structural realities impact fiscal management. In this sense, the use of Siconfi data, treated in a standardized way, allows the identification of performance patterns, weaknesses and good practices, strengthening the capacity for diagnosis and the formulation of more effective public policies. This perspective is in line with the notes of Pires and Gomide (2016), for whom

the strengthening of state capacities and governance mechanisms is indispensable to the improvement of local public management.

3 METHODOLOGY

The research was classified as descriptive in nature, as it seeks to establish relationships between variables through standardized techniques of collection and systematic observation. In this sense, it analyzes the performance of the municipalities in relation to the Accounting and Fiscal Quality Index (ICF), offering a description of the situation at the time of the survey (Farias Filho; Arruda Filho, 2021).

As for the methodological approach, the quantitative approach is adopted, as the investigation uses numerical data extracted from the Accounting and Fiscal Quality Index (ICF) Ranking, allowing its measurement and objective interpretation. This approach, according to Proetti (2017), seeks to quantify data and accurately measure phenomena, enabling more consistent and comparative analyses

With regard to the scientific method, it is a documentary research, based on the analysis of official reports of the National Treasury Secretariat (STN), as well as on legislation and technical manuals applicable to public accounting. This type of research consists of the examination of official and institutional documents, allowing the researcher to understand phenomena based on existing records (Silva; Grigolo, 2002).

Data collection in this research was carried out from secondary sources, specifically from official records made available by the Brazilian Public Sector Accounting and Tax Information System (Siconfi), a platform managed by the National Treasury Secretariat (STN). According to Gil (2019), documentary research is based on the use of materials that have not yet received in-depth analytical treatment, allowing the researcher to reinterpret information in the light of a new scientific problem. In this sense, the reports and spreadsheets extracted from Siconfi are institutional documents of a public nature, providing standardized data validated by the central accounting body of the Union.

The collection instrument consisted of a systematic consultation of the Siconfi electronic database, in the module referring to the Accounting and Fiscal Quality Index (ICF). This index is built from specific dimensions: consistency, completeness, compliance, and timeliness, thus representing a consolidated parameter to assess the quality of accounting and tax information sent by federative entities (Brasil, 2023). The time frame delimited for this study corresponds to the 2023 fiscal year, as it reflects the most current fiscal situation of the municipalities analyzed, while the unit of analysis falls on the five most populous municipalities in Rondônia.

The definition of the unit of analysis of this study took into account the five most populous municipalities in the state of Rondônia, namely Porto Velho, Ji-Paraná, Ariquemes, Vilhena and Cacoal. The choice of these municipalities was not based only on the demographic criterion, but also on their economic and administrative relevance in the state context. Because they concentrate a significant portion of the population and have more complex administrative structures, these entities have a greater volume of accounting and tax information forwarded to Siconfi. Thus, this cut allowed a more representative analysis of the quality of the information provided, in addition to ensuring greater coherence with the objectives proposed in this work.

According to Marconi and Lakatos (2017), the use of secondary data requires strict selection criteria, such as the reliability of the source and the timeliness of the information, in order to ensure the scientific validity of the study. In this context, the choice of Siconfi is justified because it is the official basis used by the National Treasury to monitor the budgetary and fiscal execution of all federative entities, having a compulsory nature and national coverage.

After collection, the data were organized in electronic spreadsheets to enable treatment and comparative analysis. According to Prodanov and Freitas (2013), the systematization stage is essential to transform raw information into organized data, enabling the construction of inferences. In this sense, the variables corresponding to the four dimensions of the ICF were tabulated, as well as the scores assigned to each municipality were consolidated.

The analysis adopted was of a descriptive statistical nature, through which trends, averages and variations in performance were observed among the municipalities studied. According to Barbetta (2014), descriptive statistics aims to summarize and present the data in a clear way, allowing the identification of patterns that could not be perceived in direct observation. According to the author, the use of this type of analysis is particularly suitable for comparative studies in applied social sciences, since it makes it possible to highlight the similarities and differences between the units observed.

Technical support for data treatment was provided with the help of electronic spreadsheet tools (Microsoft Excel), which allowed the preparation of tables. This procedure reinforces clarity and objectivity in the presentation of results, in addition to facilitating interpretation through visual resources, as defended by Hair et al. (2009).

The interpretation of the findings was not restricted to the description of the results, but sought to establish relationships with theoretical references on transparency, quality of accounting information and fiscal management. Such an approach is compatible with what

Flick (2009) states, for whom data analysis in social research should articulate empirical results with conceptual foundations, in order to broaden the understanding of the investigated phenomenon. Thus, the indicators extracted from the ICF were not analyzed in isolation, but contextualized in the light of the academic and normative literature that discusses the challenges of accounting and tax management in the Brazilian public sector.

Additionally, the support of the artificial intelligence tool ChatGPT was used in the elaboration of the images generated from the collected data and in the preliminary organization of the biblioFigureic references. All the content produced by the tool was fully reviewed by the researcher, ensuring fidelity to the original information, methodological rigor and compliance with ABNT standards.

4 RESULTS

4.1 MOST POPULOUS MUNICIPALITIES IN RONDÔNIA IN THE ICF RANKING

In the ICF, the Overall Score of each municipality is the result of the sum of performance in the four dimensions evaluated by the index. Each dimension has its own set of indicators, and each indicator assigns points according to the degree of service or quality of the information presented by the municipality. Thus, municipalities with complete, coherent, consistent data delivered on time have higher fiscal and accounting quality. To meet the first objective of this work: to identify the position of the five most populous municipalities in Rondônia in the ICF ranking, the following table presents the general position of these municipalities in the Accounting and Fiscal Quality Index (ICF) for the year 2024, accompanied by the respective scores achieved.

Table 3

Performance of Municipalities in the ICF 2024

Municipality	Position in the Ranking (ICF 2024)	General Note (ICF 2024)
Ji-Paraná	78	168
Cacoal	187	166,217
Porto Velho	229	165,722
Ariquemes	232	165,667
Vilhena	4501	125,846

Source: Adapted from SICONFI (2024).

The results show that Ji-Paraná had the best performance among the municipalities analyzed, occupying the 78th position in the national ranking of the ICF 2024. Next come Cacoal, Porto Velho and Ariquemes, with positions close to each other, ranging between 187th and 232nd place. On the other hand, the municipality of Vilhena had the worst performance of the group, standing in the 4501st position. The direct comparison shows a

significant difference between the best and the worst placed, while the other municipalities have a relatively concentrated performance in an intermediate range of the ranking.

4.2 ICF DIMENSIONS

The second objective of this work is to compare the performance of the five most populous municipalities in Rondônia in the four dimensions evaluated by the Accounting and Fiscal Quality Index (ICF). This stage seeks to highlight how Porto Velho, Ji-Paraná, Ariquemes, Vilhena, and Cacoal positioned themselves, in 2024, in the different criteria that make up the index, allowing us to understand nuances of compliance with accounting, tax, consistency, and timeliness requirements.

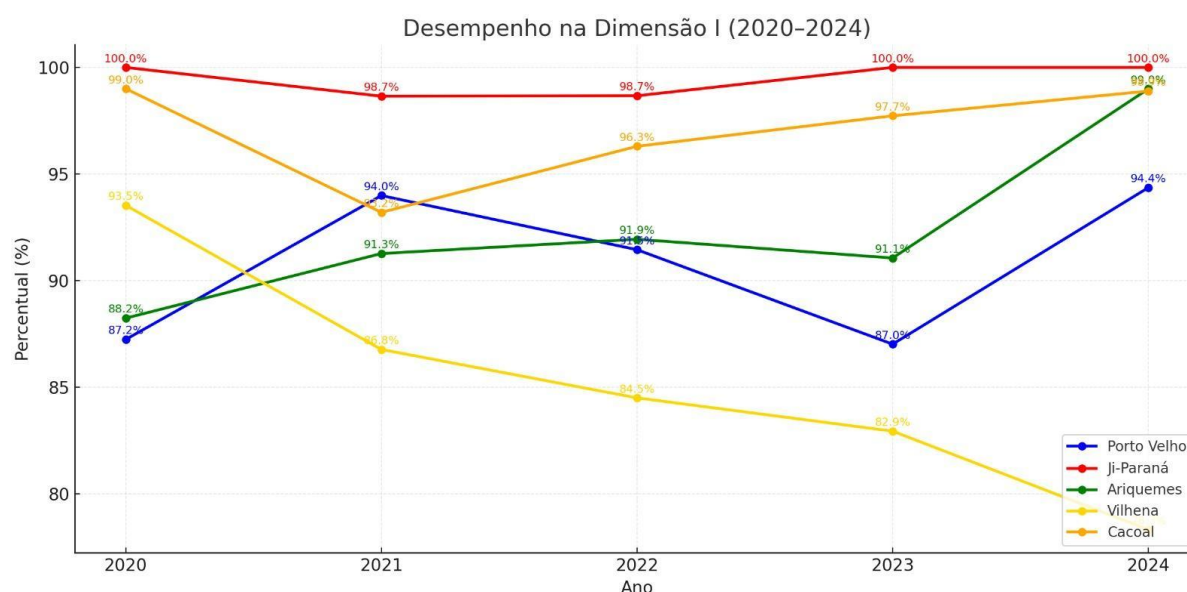
To facilitate the interpretation of the results, each dimension is contextualized directly in the introductory paraFigure that precedes the respective Figure, highlighting its main components and what it evaluates within the scope of the information sent to SICONFI. The performances recorded in each dimension are presented below, accompanied by synthetic comments that describe the patterns observed among the municipalities analyzed.

4.2.1 Accounting Dimension

The ICF Accounting Dimension evaluates the quality, compliance and consistency of the information presented by the municipalities in their financial statements, including the structure of the statements, the alignment with the applicable standards, the coherence between records and the completeness of the data sent to the system. In this context, the following Figure presents the scores obtained by the five most populous municipalities in Rondônia in 2024, allowing us to directly visualize how each one positioned itself in the set of criteria of this dimension.

Figure 1

Performance of municipalities in dimension I



Source: Adapted from SICONFI (2020 to 2024).

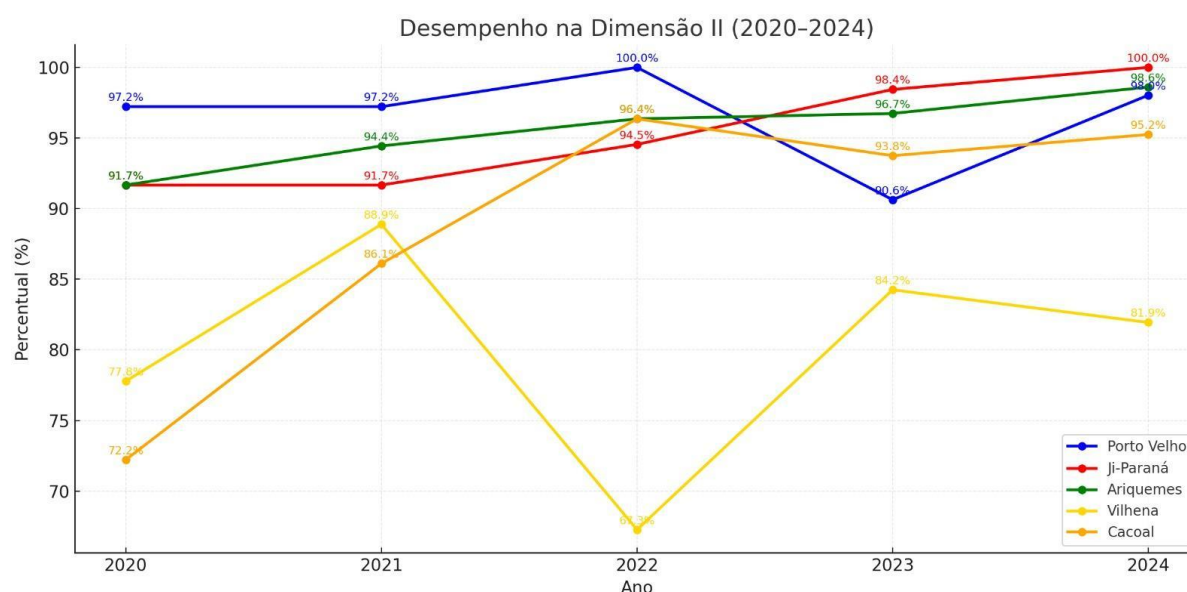
In 2024, Ji-Paraná recorded the highest score in the accounting dimension, reaching 100%. Next come Ariquemes (98.99%), Cacoal (98.89%) and Porto Velho (94.36%), with a performance close to each other. Vilhena had the lowest score in the group, with 78.32%, configuring the greatest distance in relation to the other municipalities.

4.2.2 Fiscal dimension

The ICF's Fiscal Dimension brings together indicators linked to the preparation and dissemination of the Summary Budget Execution Reports (RREO) and the Fiscal Management Reports (RGF), as well as compliance with legal requirements and the degree of transparency of the fiscal information presented by the municipalities. This dimension reflects the ability to demonstrate, clearly and regularly, the budget and fiscal execution throughout the year. Figure 2 presents the scores obtained by the five most populous municipalities in Rondônia in 2024, allowing us to observe, in a comparative way, the performance of each entity in these criteria.

Figure 2

Performance of municipalities in dimension II

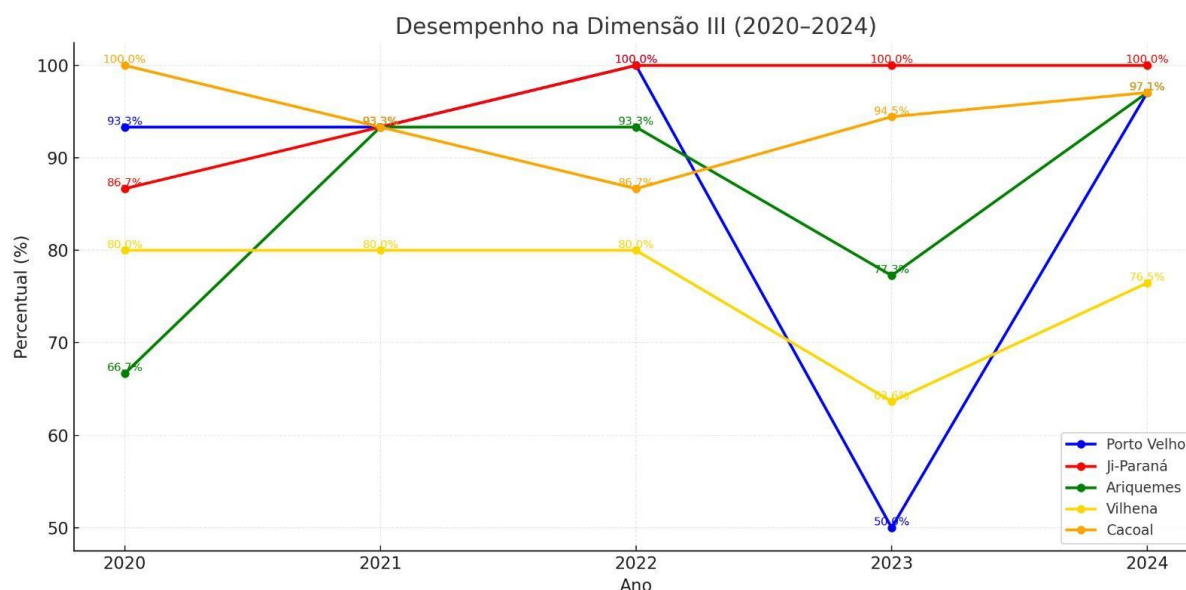


Source: Adapted from SICONFI (2020 to 2024).

In 2024, Ji-Paraná obtained the highest score in the fiscal dimension, reaching 100%. Ariquemes appears next, with 98.61%, followed by Porto Velho, with 98.03%. Cacoal registered 95.25%, maintaining a high performance, while Vilhena had the lowest score in the group, with 81.94%, configuring the greatest distance in relation to the other municipalities.

4.2.3 Dimension Consistency

The ICF Consistency Dimension evaluates the degree of coherence between different sets of accounting and tax information, especially between the Accounting Balance Matrices (MSC), the Financial Statements Applied to the Public Sector (DCASP) and the fiscal reports (RREO and RGF). This dimension verifies that the data converge with each other, without internal contradictions, ensuring that the accounting adequately reflects the budget and financial execution. The Figure presented below shows the scores achieved by the five most populous municipalities in Rondônia in 2024, allowing you to visualize the alignment and stability of the information provided by each of them.

Figure 3*Performance of municipalities in dimension III*

Source: Adapted from SICONFI (2020 to 2024).

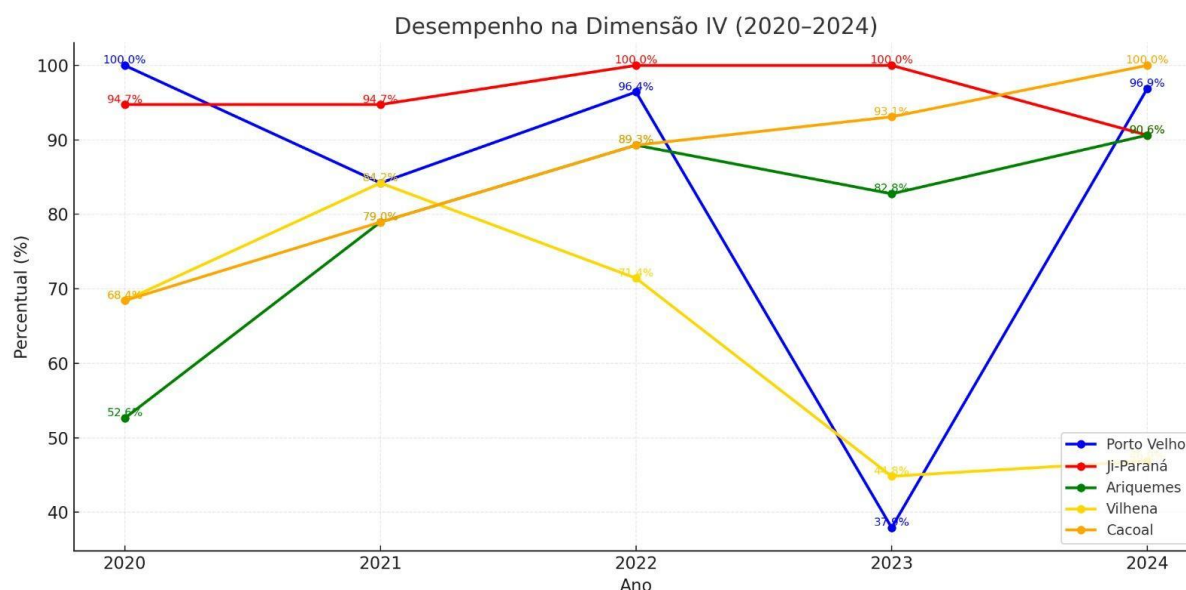
In the performance of this dimension, Ji-Paraná led with the maximum score (100%). Then, Porto Velho, Ariquemes and Cacoal showed very close results, all with 97.06%. Vilhena, in turn, obtained the lowest score among the five municipalities, registering 76.47%, which shows the greatest difference observed in the Consistency dimension in relation to the other entities analyzed.

4.2.4 Timeliness dimension

The ICF's Timeliness Dimension evaluates whether municipalities deliver their accounting and tax information within the deadlines established by the National Treasury, in addition to verifying the regularity and timely updating of the data entered in the official systems. This is a dimension directly related to compliance with legal obligations and the ability to keep the flow of information up to date, which impacts both the transparency and reliability of records. The following Figure presents the performance of the five most populous municipalities in Rondônia in 2024, allowing us to observe the degree of punctuality in the delivery of the required information.

Figure 4

Performance of municipalities in dimension IV



Source: Adapted from SICONFI (2020 to 2024).

Compared to 2024, Cacoal had the best performance, reaching 100% in the Timeliness dimension. Porto Velho appears next, with 96.88%, demonstrating regularity in deliveries. Ariquemes and Ji-Paraná maintained equal scores (90.63%), appearing at an intermediate level, while Vilhena recorded the lowest result among the municipalities analyzed, with 46.88%, evidencing the biggest difference observed in this dimension.

4.3 PERFORMANCE DIFFERENCES AND STANDARDS: FACTORS THAT IMPACT QUALITY

4.3.1 Synthesis of Observed Patterns Between Dimensions

The comparison of the four dimensions of the ICF allows us to identify relevant patterns among the municipalities analyzed, evidencing both consistencies and oscillations in performance. It is observed that some municipalities present more homogeneous performances between the dimensions, indicating greater regularity in the conformity of information, an aspect aligned with the criteria of quality and reliability highlighted by the NBC TSP and the Conceptual Framework of Public Accounting.

On the other hand, there are cases in which the scores vary significantly between dimensions, revealing specific weaknesses in attributes such as consistency or timeliness, characteristics pointed out by Hendriksen and Breda (2019) and by the CFC (2021) as fundamental for useful and transparent information. In addition, there is a greater concentration of scores in certain dimensions, suggesting that some technical requirements are more widely met by the entities, while specific dimensions present greater dispersion,

reflecting different challenges in meeting the Siconfi verifications.

4.3.2 Identifying Trends and Performance Differences

The results point to trends that are directly related to the structural and operational characteristics of the municipalities. In some cases, larger municipalities demonstrate relatively superior performance, which may be associated with more developed institutional capacities, as highlighted by Pires and Gomide (2016) when discussing the relationship between institutional design and administrative performance.

It is also observed that certain dimensions present more accentuated disparities, especially those related to consistency and cross-referencing between accounting and tax statements, which reinforces the relevance of integration between systems and procedures, as highlighted by Slomski (2005) and by the logic of SBC itself described in the framework.

A recurring pattern is also identified in which timeliness tends to be more uniform, indicating that municipalities, even with different sizes and capacities, have sought to meet the established deadlines, an aspect consistent with Siconfi's function of standardizing and automating the flow of information.

4.3.3 Possible Explanatory Factors

The patterns identified allow us to relate some factors that, based on the components of the ICF themselves, help to understand the results obtained. The greater breadth of differences in the consistency dimension, for example, suggests that its indicators are more sensitive to accounting and tax integration practices, which is related to the standardization and interoperability challenges highlighted by Machado and Theóphilo (2020) and Freitas and Souza (2019).

Likewise, higher scores in timeliness indicate greater regularity in the submission of returns, in line with Siconfi's role as a structured platform for receiving and continuously validating data (Brígida, 2023). On the other hand, uneven performance in accounting or tax information reveals possible technical and operational limitations, an aspect discussed by Rezende (2020), for whom the qualification of managers, the technological infrastructure, and the dependence on transfers directly influence the quality of fiscal management.

It should also be noted that failure to comply with certain Siconfi checks, whether accounting, tax or consistency, directly impacts the final grade, reinforcing the importance of full adherence to official manuals, such as MCASP and MDF.

In general, the results allow the identification of consistent patterns among the municipalities, revealing both strengths and weaknesses in the compliance of the information

sent to Siconfi. The differences observed reflect not only the variation in technical performance between the dimensions, but also structural and operational characteristics that influence local fiscal management.

During the analysis process, a relevant limitation was also found: the absence of justifications for the non-compliance with certain sub-dimensions, which made it difficult to understand more precisely the causes of some inferior performances. This lack of clarification on the part of municipal administrations restricts the ability to deepen the interpretation of data and highlights the need for greater transparency in the communication of the responsible bodies.

Thus, objective (c) demonstrates that the quality of accounting and tax information is directly related to the administrative capacity of the municipalities, reinforcing the importance of governance, standardization and systemic integration practices, as discussed in the theoretical framework.

5 CONCLUSION

The present study aimed to analyze the performance of the five most populous municipalities in Rondônia, namely Porto Velho, Ji-Paraná, Ariquemes, Vilhena and Cacoal in the Accounting and Fiscal Quality Index (ICF), considering their general results, the differences observed between the four dimensions evaluated by the index and the possible factors that influence the quality of the information sent to Siconfi. The research made it possible to understand, in a systematized way, how these municipalities have positioned themselves in the national scenario in terms of compliance, consistency, timeliness and fiscal quality.

Regarding the first objective, which consisted of identifying the position of the municipalities in the ICF ranking, there was a heterogeneous performance among the entities analyzed. Ji-Paraná was the best placed, placing itself in a prominent position in the national ranking, while Vilhena presented the lowest performance, appearing in a significantly lower position than the others. This wide variation shows that, even among municipalities with larger populations in the state, structural and operational differences persist that directly affect the quality of accounting and tax information.

When meeting the second objective, referring to the comparison of performance in the four dimensions of the ICF, it was observed that each municipality presented different scoring patterns. In general, the Accounting, Fiscal and Consistency dimensions revealed greater approximation between four of the municipalities, while Vilhena showed a more accentuated distance in all of them. On the other hand, the Timeliness dimension proved to be the most

variable, presenting both fully satisfactory performances and results significantly below expectations, especially in the case of Vilhena, which obtained the lowest score in the entire set of analyses.

The third objective, aimed at identifying patterns, differences and possible explanatory factors of performance, allowed us to verify that institutional characteristics, technical capacities and operational conditions directly influence the quality of the information sent by the municipalities. Among the factors with the greatest explanatory potential are: the technical capacity of the accounting and finance teams; the level of integration between accounting and tax systems; adherence to official standards, manuals and procedures; and the degree of modernization of internal processes. In addition, an important limitation was verified: the absence of justifications for non-compliance with certain verifications and sub-dimensions, which restricted a deeper understanding of the causes of inferior performance in some municipalities.

In general, the results obtained reinforce that the quality of accounting and tax information is directly associated with the administrative capacity of municipal entities, including elements such as governance, process management, institutional structure and regulatory compliance. The findings show that, although some municipalities present satisfactory and relatively uniform performance between the dimensions, others show relevant weaknesses that deserve attention from local public management.

Finally, this research contributes to the field of public administration by offering a comparative analysis based on official and recent data, allowing us to understand how municipalities with greater population relevance in Rondônia position themselves in relation to the criteria of fiscal quality established nationally. It is hoped that the results presented here can support public managers, researchers and control bodies in the reflection and continuous improvement of the processes related to the production and disclosure of accounting and tax information, strengthening transparency, responsibility in management and society's confidence in public governance mechanisms.

REFERENCES

AROM – Associação Rondoniense de Municípios. (2024). Estimativa populacional dos municípios de Rondônia com base em dados do IBGE (2024). <https://arom.org.br/arom-divulga-estimativa-populacional-dos-municipios-de-rondonia-com-base-em-dados-oficiais-divulgados-pelo-ibge/>

Barbetta, P. A. (2014). Estatística aplicada às ciências sociais (8ª ed.). UFSC.

Barra de São Francisco (ES). Prefeitura Municipal. (2023). Gestão municipal recebe nota A no Ranking Municipal do Tesouro Nacional.

<https://www.pmbes.gov.br/noticia/ler/4091/gestao-municipal-recebe-nota-a-no-ranking-municipal-do-tesouro-nacional>

Bernardo, C. M. D., Pereira, B. M., Filho, M. M. C., & Costa, A. R. R. (2024). Análise das informações contábeis e fiscais do Ranking ICF dos estados da região Norte do Brasil no período de 2019 a 2023. *RevistaFT – Ciências Sociais Aplicadas*, 28(136). <https://revistaft.com.br/analise-das-informacoes-contabeis-e-fiscais-do-ranking-icf-dos-estados-da-regiao-norte-do-brasil-no-periodo-de-2019-a-2023/>

Brasil. Ministério da Fazenda. Secretaria do Tesouro Nacional. (2023). Sistema de Informações Contábeis e Fiscais do Setor Público Brasileiro – Siconfi. <https://siconfi.tesouro.gov.br>

Brasil. Secretaria do Tesouro Nacional. (2023). Portaria STN/MF nº 807, de 25 de julho de 2023. <https://www.in.gov.br/en/web/dou/-/portaria-stn/mf-n-807-de-25-de-julho-de-2023-498835822>

Brasil. Secretaria do Tesouro Nacional. (2025). Metodologia do ranking da qualidade da informação contábil e fiscal no Siconfi. <https://ranking-municipios.tesouro.gov.br/metodologia>

Brasil. Secretaria do Tesouro Nacional. (2025). Ranking da qualidade da informação contábil e fiscal no Siconfi. <https://ranking-municipios.tesouro.gov.br/>

Brígido, J. S. (2023). Análises do ranking da qualidade da informação contábil e fiscal no Siconfi dos municípios da Região Metropolitana de Natal – RN (2019–2021) (Trabalho de Conclusão de Curso, Universidade Federal do Rio Grande do Norte). <https://repositorio.ufrn.br/server/api/core/bitstreams/6e787b90-5e75-4c1b-b6c2-273ed46c7673/content>

CFC – Conselho Federal de Contabilidade. (2021). Normas brasileiras de contabilidade aplicadas ao setor público (NBC TSP).

CNMP – Conselho Nacional do Ministério Público. (2015). Siconfi é tema de debate no 6º Congresso Brasileiro de Gestão do MP. <https://www.cnmp.mp.br/portal/todas-as-noticias/8705-siconfi-e-tema-de-debate-no-6-congresso-brasileiro-de-gestao-do-mp>

Confederação Nacional dos Municípios. (2020). Ranking da qualidade da informação contábil e fiscal no Siconfi: Análise e desafios. <https://www.cnm.org.br/>

FACER – Federação das Associações Comerciais e Empresariais de Rondônia. (2019). Cinco maiores municípios de Rondônia representam 61,1% do PIB estadual. <https://facer.org.br/cinco-maiores-municipios-de-rondonia-representam-611-do-pib-estadual/>

Farias Filho, M. C., & Arruda Filho, E. J. M. (2021). Planejamento da pesquisa científica (2ª ed.). LTC.

Flick, U. (2009). Introdução à pesquisa qualitativa (3ª ed.). Artmed.

Frank, C., & Goulart, J. (2025). Qualidade da informação contábil e fiscal e sua relação com indicadores financeiros municipais. *Revista de Gestão e Contabilidade*, 16(3).

- Freitas, C. A., & Souza, M. P. (2019). Governança de dados no setor público: Desafios e perspectivas. *Revista de Administração Pública*, 53(2), 401–421.
- Gil, A. C. (2019). Métodos e técnicas de pesquisa social (7ª ed.). Atlas.
- Gomes, L. P., & Silva, A. L. (2022). Indicadores fiscais e desempenho da gestão pública municipal. *Revista de Administração Pública*, 56(4), 789–808.
- Goulart, J. L. L. (2026). Análise da evolução do ranking do Indicador da Qualidade da Informação Contábil e Fiscal da Secretaria do Tesouro Nacional. *Contabilometria*, 13(1), 125–138. <http://periodicos.fucamp.edu.br/index.php/contabilometria/article/view/3354>
- Hair, J. F., et al. (2009). Análise multivariada de dados (6ª ed.). Bookman.
- Hendriksen, E. S., & Van Breda, M. F. (2019). Teoria da contabilidade (7ª ed.). Atlas.
- IBGE. (2024). Estimativas da população residente no Brasil e unidades da federação em 1º de julho de 2024. <https://www.ibge.gov.br>
- IBGE. (2024). Perfil dos municípios brasileiros 2024. <https://www.ibge.gov.br>
- IBGE. (n.d.). Cacoal – RO. <https://cidades.ibge.gov.br/brasil/ro/cacoal>
- IBGE. (n.d.). Porto Velho – RO. <https://www.ibge.gov.br/cidades-e-estados/ro/porto-velho.html>
- Janssen, M., et al. (2017). Big and open linked data (BOLD) to create smart cities and citizens. *Energy Procedia*, 134, 13–22.
- Lakatos, E. M., & Marconi, M. A. (2017). Fundamentos de metodologia científica (8ª ed.). Atlas.
- Lemos, K. C., & Aquino, A. C. B. (2020). Transparência fiscal e qualidade do gasto público. *Revista Contabilidade & Finanças*, 31(82), 215–232.
- Machado, J. L., & Pereira, R. M. (2021). Desafios da análise de dados no setor público. *Cadernos de Administração Pública*, 7(1), 55–78.
- Machado, N., & Pereira, J. M. (2021). Governança, transparência e qualidade da informação contábil e fiscal. *Revista de Administração Pública*, 55(4), 987–1005.
- Nascimento, E. (2022). O papel da contabilidade na administração pública. *REASE*, 8(8), 379–387. <https://periodicorease.pro.br/rease/article/view/6510/2520>
- Pires, R., & Gomide, A. (2016). Capacidades estatais e democracia. *Revista de Sociologia e Política*, 24(58), 121–143.
- Prodanov, C. C., & Freitas, E. C. (2013). Metodologia do trabalho científico (2ª ed.). Feevale.
- Rezende, A. J., Slomski, V., & Corrar, L. J. (2005). A gestão pública municipal e a eficiência dos gastos públicos. *Revista Universo Contábil*, 1(1), 24–40.
- Rezende, F. A. (2020). Finanças públicas: Problemas, desafios e perspectivas (3ª ed.). FGV.

Rondônia. Secretaria de Estado do Planejamento, Orçamento e Gestão. (2016). Dez municípios concentram mais de 74% do PIB de Rondônia. <https://rondonia.ro.gov.br>

Rondônia. Secretaria de Estado do Planejamento, Orçamento e Gestão. (2020). PIB dos municípios de Rondônia – 2020. https://observatorio.sepog.ro.gov.br/Uploads/PIB/PIB_Munic_2020.pdf

Silva, M. A. C., Soares, C. S. A., & Barbosa Neto, J. E. (2025). Qualidade da informação contábil e fiscal no Brasil. *Ambiente Contábil*, 17(1), 330–347.

Slomski, V. (2005). Accountability e governança no setor público. Atlas.

Tribunal de Contas da União. (2022). Diretrizes de transparência e governança no setor público. <https://www.tcu.gov.br>

BETWEEN REFLECTION AND ACTION: POSTPONEMENT OF RETIREMENT AND INCIPIENT PREPARATION AMONG TECHNICAL-ADMINISTRATIVE STAFF AGED 60+ AT A FEDERAL UNIVERSITY

ENTRE A REFLEXÃO E A AÇÃO: ADIAMENTO DA APOSENTADORIA E PREPARAÇÃO INCIPIENTE ENTRE TAEs 60+ EM UMA UNIVERSIDADE FEDERAL

ENTRE LA REFLEXIÓN Y LA ACCIÓN: POSTERGACIÓN DE LA JUBILACIÓN Y PREPARACIÓN INCIPIENTE ENTRE EL PERSONAL TÉCNICO-ADMINISTRATIVO DE 60 AÑOS O MÁS EN UNA UNIVERSIDAD FEDERAL



<https://doi.org/10.56238/sevened2026.008-119>

Regiane Vieira Silva¹, Simone Martins², Stefania Becattini Vaccaro³, Alejandro Pérez-Duarte Fernández⁴, Josieli Moris Gomes Calderano⁵

ABSTRACT

This article presents the results of a study investigating how technical-administrative staff in education at a public university perceive and prepare for retirement, as well as how the institution contributes to this process. The theoretical framework is based on the Transtheoretical Model of Behavior Change, by Prochaska and DiClemente (1983), used as an analytical lens to understand the different positions of employees regarding the decision to retire. A qualitative approach was adopted, involving 76 semi-structured interviews and two focus groups, with eight participants each, whose data were analyzed using the content analysis technique (Bardin, 2011). The results indicate that continued employment is sustained by fear of idleness and loss of an active routine, concern about the disruption of social ties, and threats to professional identity, positioning work as the central axis of daily life and institutional belonging. Low preparation for retirement and the absence of structured institutional policies are also evidenced, factors that contribute to insecurity and the postponement of the decision to leave work. It is concluded that retirement is experienced in an ambivalent manner, marked by insecurity, low readiness, and postponement of the decision, aggravated by the absence of structured institutional support. The study contributes

¹ Master's student in Public Administration. Universidade Federal de Viçosa (UFV).

E-mail: rvieira2004@yahoo.com.br Orcid: <https://orcid.org/0009-0000-2493-8835>

Lattes: <http://lattes.cnpq.br/0014139605043952>

² Postdoctorate fellow in Business Administration. Universidade Federal de Viçosa (UFV).

E-mail: simmone.martins@gmail.com Orcid: <https://orcid.org/0000-0002-6614-4811>

Lattes: <http://lattes.cnpq.br/5311862771207808>

³ Dr. in Legal and Social Sciences. Universidade Federal de Lavras (UFLA).

E-mail: becattinivaccaro@gmail.com Orcid: <https://orcid.org/0000-0003-0184-0020>

Lattes: <http://lattes.cnpq.br/5837401267565300>

⁴ Dr. in Theory and History of Architecture. Universidad Jesuita de Guadalajara (ITESO).

E-mail: apdf@iteso.mx Orcid: <https://orcid.org/0000-0001-5500-9828>

Lattes: <http://lattes.cnpq.br/4327656434093082>

⁵ Master's student in Public Administration. Universidade Federal de Viçosa (UFV).

E-mail: josielimoris@yahoo.com.br Orcid: <https://orcid.org/0009-0009-3856-8877>

Lattes: <http://lattes.cnpq.br/0668298157701934>

to the academic debate on aging, work, and human resource management in the public sector, in addition to offering support for reflection on institutional policies to support the transition from work to retirement in the context of public universities.

Keywords: Human Resource Management. Retirement. Retirement Preparation. Public Service.

RESUMO

Este artigo apresenta o resultado de um estudo que investiga como servidores técnico-administrativos em educação de uma universidade pública percebem e se preparam para a aposentadoria, bem como de que forma a instituição contribui para esse processo. O referencial teórico fundamenta-se no Modelo Transteórico de Mudança de Comportamento, de Prochaska e DiClemente (1983), utilizado como lente analítica para compreender os diferentes posicionamentos dos servidores diante da decisão de se aposentar. Adotou-se uma abordagem qualitativa, com a realização de 76 entrevistas semiestruturadas e dois grupos focais, com oito participantes cada, cujos dados foram analisados por meio da técnica de análise de conteúdo (Bardin, 2011). Os resultados indicam que a permanência no trabalho é sustentada pelo medo da ociosidade e da perda da rotina ativa, pelo receio com o rompimento dos vínculos sociais e pela ameaça à identidade profissional, posicionando o trabalho como eixo central da vida cotidiana e do pertencimento institucional. Evidencia-se, ainda, a baixa preparação para a aposentadoria e a ausência de políticas institucionais estruturadas, fatores que contribuem para a insegurança e o adiamento da decisão de desligamento. Conclui-se que a aposentadoria é vivenciada de forma ambígua, marcada por insegurança, baixa prontidão e adiamento da decisão, agravados pela ausência de suporte institucional estruturado. O estudo contribui para o debate acadêmico sobre envelhecimento, trabalho e gestão de pessoas no setor público, além de oferecer subsídios para a reflexão sobre políticas institucionais de apoio à transição trabalho–aposentadoria no contexto das universidades públicas.

Palavras-chave: Gestão de Pessoas. Aposentadoria. Preparação para a Aposentadoria. Serviço Público.

RESUMEN

Este artículo presenta los resultados de un estudio que investiga cómo los servidores técnico-administrativos en educación de una universidad pública perciben y se preparan para la jubilación, así como de qué manera la institución contribuye a este proceso. El marco teórico se fundamenta en el Modelo Transteórico de Cambio de Comportamiento, de Prochaska y DiClemente (1983), utilizado como lente analítica para comprender las diferentes posiciones de los servidores frente a la decisión de jubilarse. Se adoptó un enfoque cualitativo, con la realización de 76 entrevistas semiestruturadas y dos grupos focales, con ocho participantes cada uno, cuyos datos fueron analizados mediante la técnica de análisis de contenido (Bardin, 2011). Los resultados indican que la permanencia en el trabajo se sustenta en el miedo a la inactividad y a la pérdida de una rutina activa, en la preocupación por la ruptura de los vínculos sociales y en la amenaza a la identidad profesional, posicionando el trabajo como eje central de la vida cotidiana y del sentido de pertenencia institucional. Asimismo, se evidencia la baja preparación para la jubilación y la ausencia de políticas institucionales estructuradas, factores que contribuyen a la inseguridad y al aplazamiento de la decisión de desvinculación laboral. Se concluye que la jubilación se vive de forma ambigua, marcada por inseguridad, baja preparación y postergación de la decisión, agravadas por la ausencia de apoyo institucional estructurado. El estudio contribuye al debate académico sobre envejecimiento, trabajo y gestión de personas en el sector público, además de ofrecer insumos para la reflexión sobre políticas institucionales

de apoyo a la transición entre trabajo y jubilación en el contexto de las universidades públicas.

Palabras clave: Gestión de Personas. Jubilación. Preparación para la Jubilación. Servicio Público.

1 INTRODUCTION

Population aging and the growth of the elderly population have promoted significant transformations in the social, economic, and political spheres in several countries, including Brazil. This process results from the increase in longevity, the reduction in birth rates and advances in living conditions and medicine, producing an accelerated change in the age composition of the population, with proportionally greater growth in the older age groups (Nascimento; Rabelo, 2008). Such a scenario imposes pressures on the social security and social protection systems, requiring revisions in public policies related to social security, health, and work, as well as the incorporation of strategies aimed at promoting healthy aging and the productive inclusion of older people (Pazos, 2020). In the context of public organizations, this context is expressed in the need to manage the aging of the workforce and to qualify the work-retirement transition processes, given its impact on well-being, continuity of services, and retention/transfer of institutional knowledge.

In this context, healthy aging, as defined by the World Health Organization (2005), refers to the process of developing and maintaining the functional capacities that enable well-being in old age. This perspective shifts the focus from chronological age to the social, institutional, and organizational conditions that favor autonomy, social participation, and the continuity of meaningful roles throughout the life course, including work. In the case of economically active elderly people, the maintenance of functional capacity is also influenced by working conditions, work organization and the way the transition to retirement is conducted, which reinforces the centrality of institutional management in this process.

In the workplace, these transformations contribute to resignifying retirement, which is no longer understood only as a functional disconnection and starts to configure a complex transition process, crossed by personal, social, economic and identity dimensions. Retirement can be experienced in an ambivalent way: at the same time that it represents the possibility of greater autonomy, realization of personal projects and reorganization of life outside work, it can also be perceived as rupture, loss of bonds, unproductivity and intensification of the feeling of aging, especially when work occupies a central role in the construction of identity (Zanelli; Silva; Soares, 2010; Myrtle; Leandro-França; Seidl, 2014; Silva; Helal, 2018).

In the context of public universities, this ambivalence manifests itself in a significant way. Studies indicate that, even after acquiring the right to retirement, many civil servants choose to remain in activity, evidencing positive and/or negative attitudes towards dismissal from work (Bressan *et al.*, 2013; Nascimento; Polia, 2019). Such permanence reveals that the decision to retire involves factors that go beyond legal or financial aspects, being related

to institutional ties, meanings attributed to work and organizational conditions (Silva; Sousa, 2023). In this scenario, retirement is not only presented as an administrative event, but as a situated decision, influenced by expectations of continuity, working conditions and concrete opportunities to reorganize post-career life.

The absence of individual planning or structured institutional policies to prepare for retirement can make it difficult for civil servants to adapt to this new stage of life. In this sense, public universities, in the exercise of their social responsibility, can play an important role in supporting more planned and healthy transitions, through retirement preparation programs. This need becomes even more evident in the public service, where stability and certain incentives contribute to the postponement of this decision (Fonseca, 2019). Despite the progress of studies on retirement, there are still fewer frequent investigations that examine, in the context of public universities, how civil servants at an advanced age are in the process of preparing for retirement and how they perceive the institutional support offered, especially among technical-administrative staff in education.

According to Macêdo, Bendassolli and Torres (2019), prolonged stay at work may be associated with the emotional costs involved in dismissal and insecurity regarding the construction of new post-career life alternatives. Added to this is the lack of information and institutional support that helps civil servants in the decision-making process, which can generate a feeling of frustration and devaluation (Carvalho; Costa; Pimenta, 2013; Bressan *et al.*, 2013). This picture reinforces the importance of understanding not only "if" the civil servant intends to retire, but "how" he prepares for this transition and what institutional conditions facilitate or hinder this path.

In this context, the study seeks to answer the following research question: to what extent are technical-administrative employees in education aged 60 years or older, already eligible for voluntary retirement, prepared for the work-retirement transition and how do they evaluate the institutional support offered? Thus, the objective of the article is to present the results of the investigation on the modes of preparation for retirement and the perceptions about institutional support among technical-administrative employees 60+, recognizing the heterogeneity of trajectories, conditions and expectations. The choice of technical-administrative staff is justified because it covers different occupational profiles, with different experiences of aging at work, which can produce equally varied needs and preparation strategies.

To this end, the Transtheoretical Model of Behavior Change was adopted as an analytical framework, as it allows the identification of stages of readiness and understanding the process of decision and preparation for retirement (for example, from pre-contemplation

to concrete planning actions), contributing to interpret the postponement of dismissal and guiding institutional strategies that are more adherent to different profiles of civil servants.

The research was developed through semi-structured interviews and focus groups with technical-administrative employees of the Federal University of Viçosa (UFV), aged 60 years or older, who already meet the requirements for voluntary retirement. By analyzing their perceptions, concerns, and practices related to retirement, the article contributes to the academic debate on aging, work, and people management in the public sector, in addition to offering subsidies for reflection on institutional policies to support the work-retirement transition in the context of public universities. In addition, by explaining the needs and barriers perceived by the civil servants themselves, the research offers elements applicable to the formulation and improvement of retirement preparation programs, strengthening the professionalizing dimension of the study. In addition to this introduction, the article presents the theoretical framework, the methodological procedures, results and analyses and, finally, the conclusions.

2 THEORETICAL FRAMEWORK

The theoretical framework of this study is organized into two central analytical axes. The first addresses the preparation for retirement in the context of the public service, with emphasis on policies, institutional practices and the challenges faced by workers in the transition between working life and retirement. The second axis discusses the decision-making process of retiring, interpreted in the light of the Transtheoretical Model of Behavior Change, proposed by Prochaska and DiClemente (1983), which offers subsidies to understand retirement as a gradual process, marked by different stages of reflection, preparation and action. In articulation with the objectives of the article, these axes support the analysis of two empirical dimensions: (a) the practices of preparation for retirement (e.g., financial planning, health, life projects, and reorganization of roles) and (b) the perception of institutional support (policies, communication, people management actions, and preparation programs), allowing the interpretation of the work-retirement transition as a multidimensional and socially situated phenomenon.

For analytical purposes, the distinction is made between: decision to retire (intention, readiness and motivational positioning), preparation for retirement (actions and practices carried out before dismissal) and post-retirement adaptation (experiences and well-being after leaving work). Thus, the focus of this study falls on decision and preparation, as well as on the institutional role perceived in the pre-retirement phase.

2.1 PREPARATION FOR RETIREMENT IN THE PUBLIC SERVICE

Recent international studies have deepened the understanding of the relationship between retirement and well-being, highlighting the ambiguous and non-linear nature of this transition. A systematic review with meta-analysis carried out in European countries shows that the effects of retirement vary according to the institutional context, the level of prior planning and the possibility of maintaining social roles after leaving work. The results indicate that retirement can generate both subjective gains and losses, reinforcing that post-career well-being depends less on the leave itself and more on the social, organizational and individual conditions that sustain this process (Teques *et al.*, 2025). Although produced in European contexts, these findings reinforce a relevant conclusion for the Brazilian public service: the work-retirement transition tends to be more adaptive when there is prior planning and organizational support, which makes the institutional dimension especially decisive in organizations with long careers and a strong symbolic link with work.

This perspective converges with approaches that conceive retirement as a gradual process of behavioral and identity change, in which prior preparation and institutional support play a central role. In this sense, the literature suggests that pre-retirement preparation should be understood as a set of practices and resources that precede the dismissal and that influence the transition, including financial and social security planning, health care and self-care, reconstruction of sociability networks, and development of post-career projects. In the Brazilian context, the postponement of retirement is recurrent in the public service, influenced by stability, social security rules and the symbolic bonds built throughout the professional career. Evidence indicates that this decision goes beyond economic factors, involving emotional costs associated with the rupture of institutional bonds, the loss of professional identity, and insecurity regarding the construction of new life projects (Macêdo; Bendassolli; Torres, 2019), often aggravated by the lack of information and organizational support (Carvalho; Costa; Pimenta, 2013). These characteristics of the public service, such as stability, long-term careers, institutionalization of roles and lower turnover, tend to intensify the identity weight of work and make retirement a socially negotiated decision, and not just an administrative event.

In this scenario, the Retirement Preparation Programs (PPAs) are an important institutional strategy to support the work-retirement transition. Although initially restricted to financial aspects, these programs began to incorporate, from the 1980s and 1990s, a broader approach, recognizing retirement as a multidimensional process, involving psychological, social, family, and health dimensions (França; Soares, 2009; Zanelli; Silva; Soares, 2010). From the point of view of the design of interventions, the literature indicates that more

comprehensive PPAs tend to combine: social security/financial guidance; health promotion and self-care; development of life projects and reorganization of roles; psychosocial support and identity discussion; and information on alternatives for social participation and work (when desired). In Brazil, PPAs have gained visibility, especially in the context of public organizations, aligning with people management policies and the promotion of active aging. Studies indicate that participation in preparatory actions contributes to a more positive experience of retirement and influences the way this transition is perceived and planned (Bressan *et al.*, 2013; Silva; Helal, 2018). In addition to the individual benefit, such programs can favor organizational dimensions, such as succession planning, knowledge management, and reduction of institutional uncertainties associated with the departure of experienced civil servants, reinforcing their relevance in public universities.

From a normative point of view, preparation for retirement is provided for in the Statute of the Elderly Person – Law No. 10,741 (Brasil, 2003). Despite this legal support, the literature points out that the initiatives effectively implemented in public organizations are still limited (France; Soares, 2009). Empirical research reveals that many civil servants do not systematically prepare for retirement and tend to postpone this decision because they perceive themselves to be still productive, evidencing the fragility of the institutional support available (Gvozdz; Sakai; Haddad, 2015; Amorim *et al.*, 2018). This gap between normative foresight and practical implementation suggests that retirement preparedness remains, in many contexts, individual-centered, even when there is evidence that organizational support functions as a relevant facilitator of transition.

Studies in the context of federal universities corroborate this diagnosis, by highlighting the need for institutional policies aimed at active aging and prior retirement planning (Nascimento; Polia, 2019; Oliveira; Almeida, 2021). Despite this, ambiguity persists regarding organizational responsibility in this process, since part of the civil servants understands preparation as an individual attribution, in contrast to approaches that defend institutional engagement in the management of aging at work (Bressan *et al.*, 2013; France; Soares, 2009). In general, the literature suggests that the absence of consistent institutional policies contributes to the postponement of retirement and to the feeling of insecurity in the post-career transition. At the same time, the prolonged stay of experienced civil servants can represent a relevant strategy for public organizations, as long as it is accompanied by policies that adequately support the transition process to retirement (Pereira, 2017).

Thus, preparation for retirement is configured as a field of tensions between individual choices, institutional conditions and the meanings attributed to aging and work. For this study, this field of tensions is operationalized in the analysis of the perceived institutional support

(existence/absence of PPAs, communication and orientation), the planning practices mobilized by the civil servants and the meanings attributed to the permanence at work in the face of the possibility of dismissal.

2.2 THE DECISION TO RETIRE AND THE TRANSTHEORETICAL MODEL OF BEHAVIOR CHANGE

The decision to retire is crossed by personal, institutional and psychological factors. For some civil servants, continuity in work is associated with the maintenance of professional identity, financial stability and social ties; For others, the proximity of retirement is experienced in a negative way, marked by doubts and insecurities. It is, therefore, a process permeated by contradictory perceptions, which can be interpreted as both opportunity and loss (Murta; Leandro-França; Seidl, 2014). This decision, however, should not be reduced to a specific moment, as it involves the gradual construction of readiness, the negotiation of perceived gains and losses, and the evaluation of concrete conditions to reorganize post-career life.

The transition from working life to retirement involves significant behavioral and symbolic changes, configuring itself as a dynamic process, marked by resistance, advances and adaptations. To understand this complexity, this study adopts the Transtheoretical Model of Behavior Change as an analytical lens, due to its ability to interpret the different positions of civil servants in the face of the decision to retire. In particular, the model is used to understand the postponement of retirement as permanence in early stages (pre-contemplation and contemplation) or as difficulty in advancing to stages of preparation and action, a scenario that can be aggravated by the absence of information and structured institutional support.

Developed by Prochaska and DiClemente (1983), the model conceives behavioral change as a gradual process, composed of different motivational stages. Although it originated in the field of psychology, the model has come to be widely used in organizational studies and in the Social Sciences, especially in the analysis of decision-making processes and behavioral changes in institutional contexts (Matta, 2012). In addition to the stages, the model incorporates constructs that help explain complex transitions, such as decisional balance (evaluation of pros and cons), self-efficacy (perception of the ability to change), and change processes (cognitive and behavioral strategies mobilized along the way). Although this study focuses mainly on identifying the stages of readiness, such constructs guide the interpretation of the narratives, especially when the servers describe ambivalence, insecurities and barriers to planning.

According to the model, change occurs over six stages: pre-contemplation, contemplation, preparation, action, maintenance, and completion or termination (Myrtle; Leandro-França; Seidl, 2014). To avoid simplifying readings, it should be noted that not all applications use the finishing stage, and the paths may involve regressions and advances, especially in changes associated with identity and life cycle, such as retirement. These stages make it possible to understand the extent to which individuals recognize the need for change, reflect on its implications, and engage in concrete actions. In the context of retirement, the model allows interpreting everything from the denial or resistance to the idea of retiring to the consolidation of the decision and the adaptation to the new condition. In the pre-retirement context, which is the focus of this article, the emphasis is especially on the passage from contemplation to preparation and action, that is, on the transformation of intention into planning and concrete practices.

Applied to the context of public service, the Transtheoretical Model of Behavior Change makes it possible to analyze the postponement of retirement not as an exclusive result of individual choices, but as a situated process, influenced by organizational characteristics, the stability of the bond and the meanings attributed to work and aging. This allows us to understand that the readiness to retire can be facilitated or inhibited by institutional factors (existence of PPAs, quality of internal communication, support from the people management sector, opportunities for gradual transition and recognition of the trajectory), acting as conditions that favor or hinder progression between stages.

In this way, the model contributes to understanding how civil servants construct, negotiate and resignify their decision to remain or leave the public service, offering analytical subsidies to interpret retirement as a gradual and socially mediated transition, and not as a one-off event.

In summary, by articulating the axis of preparation (practices and institutional support) with the axis of decision (stages and constructs of the model), this framework guides the qualitative analysis of the narratives of technical-administrative employees 60+, allowing us to identify: (i) in which stage of readiness they are; (ii) which pros and cons are mobilized in the decisional balance; (iii) what preparatory actions have already been initiated; and (iv) how they evaluate the role of the university in offering information, support and conditions for a more planned work-retirement transition.

3 METHODOLOGICAL PROCEDURES

The research was carried out at the Federal University of Viçosa (UFV), a federal institution of higher education located in the municipality of Viçosa, Minas Gerais. The unit of

analysis corresponded to the university's main campus, having as subjects the technical-administrative employees in education aged 60 years or older (TAEs 60+) who, although they already met the legal requirements for voluntary retirement, chose to remain in professional activity.

A qualitative approach was adopted, appropriate to the understanding of the experiences, perceptions and meanings attributed by the participants to retirement and preparation for this stage of life, dimensions of a subjective nature that are not accessible by quantitative methods. As for the objectives, the study is characterized as descriptive and exploratory, as it seeks to understand and analyze a phenomenon that is still little investigated in the context of public universities, from the perspective of the social actors involved. It is, additionally, a qualitative study of institutional focus, in which the UFV is taken as an empirical case to examine, in depth, the process of preparation for retirement and the perception of institutional support among eligible TAEs 60+.

For the purposes of analytical delimitation, this study differentiates: (a) decision to retire (intention and readiness) and (b) preparation for retirement (practices and actions carried out in the pre-retirement period). Thus, the focus is on decision and preparation in the pre-retirement period, as well as on perceived institutional support.

3.1 PARTICIPANT

The study had the participation of 76 technical-administrative employees of UFV, all with an acquired right to voluntary retirement. The inclusion of these participants allowed different functional categories of the TAEs' careers to be contemplated, ensuring diversity of professional trajectories and perceptions related to the object investigated. A total of 76 individual interviews were conducted (n=76), and the focus groups were conducted with the same people interviewed, characterizing an intentional overlap between the stages of collection for deepening and interpretative validation of the emerging themes. The selection of participants followed the snowball sampling strategy, associated with the criterion of theoretical saturation. It was considered that saturation was reached when the reports began to present recurrence of information, without the incorporation of new elements for the analysis (Vinuto, 2014). Saturation was monitored by successive blocks of interviews, through the verification of stabilization of codes and themes (thematic recurrence), recording the absence of new relevant codes in the final stages of data collection.

Five initial "seeds" (n=5) were used, defined in order to contemplate different levels of the technical-administrative career, seeking to reduce the homophily bias characteristic of the snowball. Diversity was pursued especially by career level/category and by positions.

Regarding the characterization of the group, there was a predominance of males, with an average of 40 years of service, an average of approximately 10 years of permanence in activity after the acquisition of the right to retirement, participation of civil servants belonging to all functional categories (A-E) and variation in schooling from elementary school to higher education. The characterization also considered the positions held, as the selection was not organized by sectors, but by positions identified as relevant to contemplate occupational diversity within the technical-administrative career.

Inclusion criteria: TAEs employees aged 60 or over, eligible for voluntary retirement, working at the UFV headquarters campus, who accepted to participate and signed the ICF. Exclusion criteria: civil servants on extended leave, on assignment, on sick leave, or who did not wish to participate in the research.

3.2 DATA COLLECTION INSTRUMENTS AND PROCEDURES

Primary data collection took place between July and September 2025 and was carried out in two complementary stages: semi-structured interviews and focus groups. The adoption of combined instruments sought to strengthen the methodological triangulation, by articulating the depth of the individual interviews with the interactional dynamics of the focus groups, allowing the examination of convergences, divergences and shared meanings about retirement and preparation.

3.2.1 Semi-structured interviews

In the first stage, 76 semi-structured face-to-face interviews were conducted, carried out in the participants' workplaces, in reserved environments, in order to ensure privacy and comfort. The interviews lasted an average of approximately 1 hour, were fully transcribed, and the transcriptions were checked by the authors, as a measure of quality control of the corpus.

The interview script was structured based on the Transtheoretical Model of Behavior Change, seeking to capture elements associated with retirement readiness and preparation practices (e.g., reflection and intention, ambivalences and balance between pros and cons, planning actions, resources and perceived barriers, in addition to the perception of institutional support).

Before the beginning of the interviews, all participants signed the ICF, guaranteeing anonymity, use of the data exclusively for scientific purposes and commitment to confidentiality. To mitigate risks of inhibition associated with the work environment, additional care was adopted: the place and times were adjusted as indicated by the participants,

favoring moments and conditions perceived as more appropriate to ensure comfort and freedom of expression.

3.2.2 Focus groups

The second stage consisted of two focus groups, each composed of eight participants, totaling 16 participants. The realization of two groups resulted from the indication of interest and availability of the interviewees to participate in this stage, and the composition was defined in order to enable in-depth and comparable discussions between groups.

The meetings took place in September 2025, in the meeting room of the Department of Administration and Accounting at UFV, and the discussions were recorded with the express authorization of the participants, as provided for in the ICF. Each focus group lasted approximately two hours.

The composition of the groups sought to ensure diversity in terms of gender and occupational profiles, combined with the care of forming groups with relatively similar profiles, favoring the fluidity of the discussions and the safety of the participants. To reduce hierarchical asymmetries, the heads were grouped into the same group.

For each focus group, a follow-up team was formed by a moderator and two observers, strengthening the systematic recording of the process and the quality of the material.

3.2.3 Ethical procedures

As this is a research involving human beings, the study was submitted to the Human Research Ethics Committee of the Federal University of Viçosa (CEP/UFV), and was approved under opinion No. 7.664.570 and CAAE 87902325.2.0000.5153, issued on June 25, 2025.

In order to preserve the identity of the participants, a coding system was adopted in the citations, identified by the structure [Professional Category – Number], in which the letters A, B, C, D or E correspond to the functional categories of the career of TAEs, followed by sequential numbering. Categories A-E correspond to the career classes provided for in the Career Plan for Technical-Administrative Positions in Education (PCCTAE), presenting different levels of complexity/qualification.

3.2.4 Secondary data (desk research)

In a complementary character, it carried out the collection of secondary data, through documentary research in institutional records, legislation, scientific articles and administrative documents made available by the Dean of Personnel Management at UFV. The documents

were used, especially, to identify potential research subjects (eligible employees) and to map the positions to be contemplated to ensure occupational diversity in the study.

3.3 DATA ANALYSIS PROCEDURES

The textual and verbal data were submitted to content analysis, according to the proposal of Bardin (2011). This technique involves a systematic and objective set of procedures aimed at identifying, coding, categorizing and interpreting units of meaning, making it possible to make inferences about the meanings and contexts of speech production.

The analytical process was developed in successive stages, including floating reading of the corpus, codification and construction of thematic categories. The unit of registration adopted was thematic (discursive excerpts with unity of meaning), and the coding was conducted in an inductive way, guided by the Transtheoretical Model of Behavior Change, in order to organize and interpret narratives related to retirement readiness, preparation practices and perceived institutional support

The resulting categories were interpreted in the light of the Transtheoretical Model of Change, adopted as an analytical framework to understand the different positions of civil servants in relation to the decision to retire.

To strengthen the credibility of the findings, triangulation between interviews and focus groups and peer review of the categorical scheme and interpretations (e.g., discussion between authors/orientation) were adopted, seeking to reduce individual biases and increase analytical consistency.

4 RESULTS AND ANALYSIS

This section presents the analyses and results obtained from the 76 individual semi-structured interviews and the two focus groups carried out with technical-administrative employees in education at UFV, all aged 60 years or older, eligible for voluntary retirement and in activity. The focus groups were conducted with participants who had already been interviewed, with the aim of deepening interpretations, exploring convergences and divergences, and strengthening the triangulation of evidence.

The data show the heterogeneity of the group in terms of age, length of service and functions performed, with participants distributed among different levels of the technical-administrative career. There is a predominance of civil servants classified in Level C, which concentrates 35 participants (46% of the total), most of them linked to technical and operational support activities.

The age range of the participants varies between 60 and 74 years old, with the highest concentration between 62 and 69 years old. There was a significant predominance of males (89.5%). With regard to racial self-declaration, there was a predominance of civil servants who identified themselves as white (48.7%), followed by those who declared themselves brown (36.8%), indicating low racial diversity in the group analyzed.

Regarding education, the high percentage of civil servants with a *lato sensu* postgraduate degree (47.4%) stands out, followed by those with complete high school (21%) and undergraduate (14.5%). Most participants have an institutional link with UFV for more than 30 years, evidencing long and consolidated professional trajectories. Regarding remuneration, 53.9% are in the range of three to four minimum wages, among TAEs 60+. Regarding marital status, 75% declared themselves married or in a stable union, indicating the presence of stable marital ties.

In general, this set of characteristics delineates a group marked by extensive professional experience, strong institutional ties and relevant qualifications. This profile is consistent with the literature that points out, in the public service, the presence of intense symbolic and identity links with work, which can sustain permanence in office even in the face of legal eligibility for retirement (Silva; Sousa, 2023).

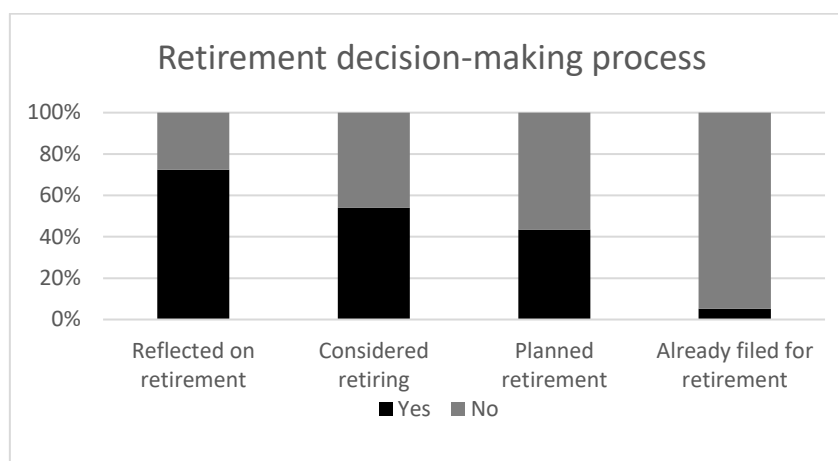
Although the study has a qualitative approach, the interview script included some structured questions (for example, "did you reflect on retiring?", "did you consider retiring and gave up?", "did you perform any preparatory action?"), allowing frequencies and percentages to be presented as descriptive support. When it comes to topics such as "concerns" and "motivations", the answers can be multiple and overlapping, and the percentages should be interpreted as presence/mention of the theme and not as exclusive categories, unless otherwise indicated.

4.1 RETIREMENT AS AN AMBIVALENT DECISION: PRESENT REFLECTION, LIMITED ACTION

The results indicate that 72.4% of TAEs 60+ stated that they had already reflected on the moment of retirement, showing that retirement is present in the horizon of consciousness of the majority, Figure 1. However, when asked about the possibility of retirement in recent years, 53.9% reported that they had considered this decision, but later gave up, while 46.1% said they had not considered retiring.

Figure 1

Decision process for the retirement of TAEs 60+ employees



Source: Survey data (2025).

When asked about the possibility of retirement in recent years, 53.9% of the participants reported that they had considered this decision, but later gave up, while 46.1% said they had not considered retiring. The proximity between the percentages suggests not only punctual indecision, but a dynamic of "prolonged contemplation", in which thinking and postponing coexist as an adaptive response in the face of personal, family and institutional uncertainties. This pattern is compatible with the literature that describes retirement as an ambiguous and non-linear transition, with gains and losses perceived simultaneously (Zanelli; Silva; Soares, 2010; Myrtle; Leandro-França; Seidl, 2014).

With regard to planning, only 43.4% of the civil servants declared that they had adopted some type of preparation, while 56.6% stated that they had not taken any action in this regard. This finding is central to the purposes of the article, as it points to a mismatch between the reflection/intention on retirement and the implementation of concrete measures, which refers directly to the reference of the Transtheoretical Model and to the discussion about institutional support gaps (Bressan *et al.*, 2013; France; Soares, 2009). The distance between intention and action appears to be linked to the meanings attributed to retirement. For part of the civil servants, it is perceived as an opportunity for freedom and the construction of new projects; for others, it takes on contours of rupture, uncertainty and loss of meaning (Zanelli; Silva; Soares, 2010). Among the positive perceptions, retirement appears linked to rest, to the realization of personal projects and to the strengthening of family life, as illustrated by the statement: *"I see retirement as an opportunity to travel more, I like it a lot! Also dedicate more to the site. I have 2 children [...] I intend to spend more time with them"* (E3).

On the other hand, fears related to health, social isolation and the emotional effects resulting from absence from work emerge, as expressed in the report below:

I'm in good health, it's not the case with my father, who, unfortunately, when he retired, soon after came Alzheimer's. [...] I know that this disease is often hereditary, and I don't want it for me, he suffers from this disease. So I think my head is busy. So, if I retire today, my wife working, I will stay at home idle (C10).

These narratives reinforce the ambivalent character of the transition already described in the literature: retirement can represent the achievement of autonomy and new projects, but also the rupture of bonds and a threat to identity when work occupies a central role (França; Soares, 2009; Carvalho; Costa; Pimenta, 2013; Oliveira; Almeida, 2021). Empirical evidence also dialogues with the perspective that the impacts of retirement are heterogeneous and conditioned by planning and organizational support (Teques *et al.*, 2025).

It is also observed that only 5.3% of the civil servants had formalized the request for retirement, while 94.7% remained in activity, which reinforces the tendency to postpone the decision, even among those who already meet the legal requirements.

In general, the results indicate that the TAEs 60+ at UFV reflect on retirement, although few adopt concrete planning strategies for this stage. The testimonies reveal concerns, expectations and ambivalences that permeate the decision-making process, confirming the subjective, complex and multifaceted character of the transition between working life and retirement (Zanelli; Silva; Soares, 2010).

4.2 MAIN CONCERNS UNDERPINNING THE POSTPONEMENT: IDENTITY, FINANCES, HEALTH, AND INSTITUTIONAL CONTEXT

The most recurrent concern (53.9%) refers to idleness and the loss of an active routine, often associated with fear of social isolation, loss of meaning and the emergence of unwanted behaviors. The statements express fear of rupture with the collective and with interpersonal bonds built throughout the work trajectory: *"Not knowing what to do when you get up in the morning is very sad. The routine at home is different. I value coexistence in the service a lot and losing it worries me a lot"* (D8) and *"Idleness and the fear of having some addiction that worries me the most if I retire"* (C3).

These testimonies show that work remains a structuring element of the daily life and social identity of the civil servants. It indicates that, for many civil servants, work operates as a "structure of life" (organizes time, sociability, meaning and recognition). Withdrawal from work activities is perceived as a risk of loss of meaning and rupture with the professional role, as discussed by Oliveira and Almeida (2021) and Silva e Sousa (2023). Thus, retirement is interpreted as a risk of symbolic rupture with the professional role, which can generate a feeling of uselessness and isolation, a phenomenon consistent with studies on the centrality of work and identity costs of dismissal (Zanelli; Silva; Soares, 2010; Bressan *et al.*, 2013).

In addition to the subjective dimension, part of the participants expressed financial concern (19.7%), associating retirement with reduced income and loss of benefits: *"What worries me about retiring is a decrease in salary, I lose the hazard, food vouchers, night bonus which is 10%, in the end I lose about 24% of my salary"* (D2) and *"I am very afraid that the retirement salary will not cover the expenses"* (D12).

These manifestations corroborate findings that the loss of income and benefits tends to influence the postponement of retirement in the public service, especially when retirement is perceived as a deterioration in the standard of living (Silva; Helal, 2018; Fonseca, 2019; Oliveira; Almeida, 2021).

A smaller portion of the civil servants (18.4%) declared that they do not have significant concerns about retirement, which suggests greater acceptance and emotional preparation for this transition: *"I don't worry too much. I think about retiring and going to take care of the farm, so I'll have another activity"* (B7) and *"Nothing worries me! I already have plans for retirement"* (C31).

These reports signal greater readiness for the transition, compatible with profiles in more advanced stages of the Transtheoretical Model (preparation/action), especially when there are clear alternative projects.

Another smaller group (9.2%) highlighted health-related concerns, especially regarding the fear of illness or the perception of not being emotionally and physically prepared for retirement: *"I am afraid of depression. I am not yet mentally and physically prepared to retire"* (C31).

This concern dialogues with the concept of active aging, proposed by the World Health Organization (WHO, 2005), which emphasizes the maintenance of health, autonomy and functional capacities as central conditions for productive engagement throughout aging.

Other concerns were also mentioned by 14.5% of the civil servants, related to the absence of substitutes and the institutional uncertainties provided by the work: *"I worry because there is still no one to replace me in the service. I need to pass on my knowledge and this bothers me a little"* (D9) and *"I am concerned about the uncertainties regarding future administrations such as the external one in Brasília and the internal one at UFV"* (C14),

In the focus groups, these perceptions were reinforced, especially with regard to the lack of replacement of personnel and the understanding that permanence does not always generate institutional damage:

My position is already extinct. I won't be occupying anyone's place. Because if it hadn't been extinguished, if I had the position in force, I'd go out and ask for my days off. I understand that I can even support the institution for a long time to come (C7).

This finding broadens the interpretation of postponement, because in addition to personal factors, there are dimensions of the organizational context such as replacements, extinct positions, continuity of services, which modulate decisions and reinforce bonds of belonging, in line with the argument that retirement is a socially mediated and institutionally situated transition.

4.3 FACTORS THAT CAN "TURN THE KEY": HEALTH, CHANGES AT WORK AND CLOSING THE CYCLE

When asked about factors capable of influencing the decision to retire, the participants indicated multiple personal and professional aspects. The most cited factor was impairment of physical or psychological health (26.3%), showing that well-being is a central element for permanence at work. This finding reinforces the understanding that, although work is a source of fulfillment and belonging, its continuity depends on the preservation of health conditions (Zanelli; Silva; Soares, 2010).

Another group of civil servants (21%) pointed out that changes in the routine or organization of work could motivate them to leave, which highlights the value attributed to stability, predictability of activities and the known environment. Changes in these elements tend to generate discomfort and can accelerate the decision to dismiss (França; Soares, 2009). The same proportion of participants (21%) understand retirement as the "end of a cycle", interpreting the end of the professional career as a natural stage of life, marked by the conclusion of a productive path and the opening to new experiences (Silva; Helal, 2018).

This pattern suggests that the decision to retire is often conditioned by thresholds: as long as the health and stability of daily work are preserved, permanence is maintained; When these conditions change, retirement is considered a viable and even desirable alternative. This finding reinforces the literature by indicating that dismissal tends to occur when the perceived costs of staying and/or the perceived benefits of leaving change (França; Soares, 2009; Zanelli; Silva; Soares, 2010).

On the other hand, a smaller portion of the participants (18.4%) stated that they did not identify specific factors that influence the decision to retire, which may indicate greater detachment from work or an attitude of acceptance in the face of the transition. In addition, 11.8% reported the intention to retire only after the consolidation of a plan, emphasizing the importance of prior preparation for this process.

In summary, it is observed that the decision to retire among the TAEs 60+ of UFV is not guided by a single factor, but results from the articulation of multiple interdependent conditions. In this sense, the balance between health, stability, professional recognition and

financial security is decisive for the dismissal to occur in a planned, conscious and satisfactory way.

4.4 POST-CAREER PREPARATION AND PLANS: LOW LEVEL OF OPERATIONALIZATION AND INFORMAL STRATEGIES

The results indicate a low level of planning for the post-career period. Among the 76 participants, 60.5% declared that they did not have any planning, while 39.5% mentioned plans aimed at leisure, rest, family life and, to a lesser extent, productive activities (self-employed, small businesses, rural properties). The absence of planning appears explicitly in the reports: *"I don't have any activity in mind, in case I decided to retire at this time"* (D6) and *"I didn't think about my retirement. I don't think about her today. If I retire, I'll just be idle [...]. So, my pleasure is to be working"* (C3).

Among those who mentioned some plan, projects related to family, leisure, nature and productive continuity predominate. A relevant element is the presence of post-retirement "testing" strategies (e.g., time off as a routine rehearsal), which can be interpreted as a process of change in the transtheoretical sense:

I have the days off to take and so does my wife. Let's take this time to see if you get used to it. We have a farm, we have a house in Espírito Santo to move, so we have other activities to continue after retirement. [...] So, do this so that we can have a new life (D5).
I'm about to leave. I'm setting up my business, at home. A small engine mechanic shop [...] (C7).

These manifestations are similar to approaches that associate active aging with the maintenance of significant social roles after disconnection from formal work (França; Soares, 2009). However, low adherence to planning corroborates findings that the absence of prior preparation can hinder a more positive transition and increase insecurity and a sense of loss of purpose (Bressan *et al.*, 2013; Gvozdz; Sakai; Haddad, 2015).

4.5 PERCEIVED INSTITUTIONAL ROLE: ABSENCE OF STRUCTURED PPA, REACTIVE COMMUNICATION AND SYMBOLIC TENSION

The analysis revealed a widely shared perception regarding the inexistence or insufficiency of institutional initiatives aimed at preparing for retirement at UFV. Most stated that they had not participated in or were aware of systematic actions, indicating limited provision of formal guidance. This finding appears in the interviews and was reinforced in the focus groups: *"The university could (...) a course (...) to prepare you for retirement"* (C4) and

"UFV could invite the person to do a training, a lecture (...) I did not receive this invitation" (A1).

Although some participants mention specific actions, they are described as discontinued and insufficient to constitute a program: *"I participated in a course (...) but (...) it is not a program"* (B7) and *"Before I had a preparation (...) today there is no longer that"* (A1).

A particularly relevant finding is the symbolic tension associated with PPAs: part of the civil servants fear that formal programs may be interpreted as pressure to retire: *"I think that participating in a formal program may seem like pressure to retire"* (C3).

This point is crucial to align results and reference: in the public service, where work can be highly identitarian, institutional actions aimed at retirement can be interpreted ambivalently — as support and, simultaneously, as a sign of replacement and dismissal. The literature on emotional costs and post-career insecurity helps to interpret this phenomenon (França; Soares, 2009; Macêdo; Bendassolli; Torres, 2019).

Another recurring aspect refers to the weaknesses of institutional communication. Even recognizing that there are sectors capable of supporting (such as the Dean of People Management), the civil servants indicate that access to information depends on individual effort, which tends to penalize those who have technological difficulties or less informational capital: *"It is up to each of us to seek information (...) there are many who don't even access emails"* (C3) and *"The server goes after it. UFV does not approach the server"* (C4).

This pattern suggests a reactive rather than a proactive institutional model, which becomes especially problematic when the study itself shows a high prevalence of contemplation without action: without accessible communication and structured policies, progression to preparation/action tends to be hampered.

In addition, a demand for integrated and continuous support emerged, including actions also for post-retirement and maintenance of bonds: *"The university could think about activities also for post-retirement (...) maintain bond and purpose"* (C10).

The civil servants recognize the existence of institutional structures, but point out failures in articulation and dissemination: *"You want to know about retirement, just go to the PGP (...) but (...) the Human Resources coming to us didn't have that moment"* (C4) and *"If you want to know something about physical activity, you go to the PWD"* (C16).

This finding converges with studies that describe PPAs as fundamental instruments to reduce insecurity, structure planning, and support financial, psychosocial, and post-career project dimensions (França; Soares, 2009; Zanelli; Silva; Soares, 2010; Bressan *et al.*, 2013; Silva; Helal, 2018; Oliveira; Almeida, 2021). Therefore, the UFV case highlights a gap

between what the literature recommends and what the civil servants perceive as available and accessible.

4.6 INTERPRETATIVE INTEGRATION WITH THE TRANSTHEORETICAL MODEL: WHY DOES REFLECTION NOT BECOME PREPARATION?

The application of the Transtheoretical Model contributes to interpreting the findings by showing that many civil servants are in a pattern compatible with intermediate stages of readiness, in which reflection on retirement is frequent, but has not yet translated into planned action (Prochaska; Diclemente, 1983; Myrtle; Leandro-França; Seidl, 2014).

Three mechanisms stand out in the narratives:

1. **Unfavorable decisional balance:** the "cons" (idleness, loss of bonds, fear of illness, financial loss) appear with great weight, while the "pros" (free time, projects, coexistence) are more present when there is already a plan.
2. **Limited self-efficacy to reorganize post-career life:** reports such as "I'm going to be idle" indicate low confidence to build routine and substitute roles, making it difficult to advance to preparation.
3. **An institutional environment that is not very facilitating:** the absence of structured PPA and reactive communication reduce opportunities for information, support and planning.

Thus, the postponement of retirement emerges as a socially mediated process, supported by subjective (identity and fear of idleness), material (income/benefits) and institutional (information, replacement, recognition and support) dimensions, in coherence with the review presented.

4.7 RETIREMENT READINESS MARKERS

Next, the table is presented as "readiness markers", as the data indicate overlap between reflection, intention and initial actions, and it is not methodologically consistent to add percentages as mutually exclusive stages without individual classification rule. The percentages correspond to the number of participants who presented the marker at least once, in structured questions and/or mentions in the narratives, and can coexist in the same participant.

Table 1

Markers of retirement readiness according to the Transtheoretical Model (TAEs 60+)

Stages of the transtheoretical model of behavior change	Key features	Behaviors observed in TAEs 60+	No. of servers	Percentage (%)
Precontemplation	They do not recognize the need for change or avoid thinking about retirement.	They did not reflect on the moment of retirement and avoid discussing or planning to leave work.	21	27,6
Contemplation	They recognize the need for change, but they do not yet make decisions; experience ambivalence between staying and retiring.	They reflected on retirement and consider this possibility, but without a consolidated decision.	55	72,4
Preparation	They demonstrate an intention to change and initiate some level of organization or initial planning.	Declare intention to retire in the future and/or report some level of initial organization (e.g., routine rehearsals, information seeking, idea development).	43	56,5
Action	They effectively implement the behavior of change.	They formalized the retirement process with the institution.	4	5,3

Source: Research data (2025), based on Murta, Leandro-França and Seidl (2014).

The markers show that, although reflection is broad (contemplation), formalization (action) is rare. This pattern reinforces the need for institutional strategies that facilitate the transition from contemplation to preparation, through proactive information, psychosocial support and structuring of post-career projects, as discussed by França and Soares (2009) and Bressan *et al.* (2013).

In light of the results, it is observed that TAEs 60+ at UFV prepare little and unevenly for retirement: although most reflect on the topic, more than half do not carry out planning actions, and many do not have defined post-career plans. The postponement is mainly supported by concerns about idleness and loss of meaning, followed by financial insecurity, health fears and institutional factors (absence of replacements, organizational uncertainties and extinct positions).

As for the institutional role, the civil servants perceive the absence or insufficiency of structured PPAs, predominantly reactive communication (dependent on individual initiative) and disarticulation between sectors, in addition to a relevant symbolic tension: formal actions can be interpreted as pressure for dismissal. Thus, the results reinforce the understanding of retirement as a gradual and socially mediated transition and point to the need for institutional

approaches that are more integrated, visible and sensitive to the multiple dimensions involved.

5 CONCLUSION

This article presents the results of the study, which investigated the factors that influence the postponement and preparation for retirement among active technical-administrative employees in education aged 60 years or older. Through a qualitative approach, based on semi-structured interviews, focus groups and document analysis, it showed how individual, organizational and institutional dimensions are articulated in the decision-making process related to the transition between work and retirement, focusing on the pre-retirement phase.

The results demonstrate that, although retirement is present in the reflective field of most civil servants, it is not perceived as an immediate action, revealing a mismatch between reflection and effective planning. It was observed the predominance of markers associated with the stages of contemplation and incipient preparation, according to the Transtheoretical Model of Behavior Change, indicating that the decision to retire is configured as a gradual process, socially mediated and conditioned by mechanisms such as decisional balance (perceived pros and cons) and self-efficacy (confidence to reorganize post-career life), which help to explain why reflection does not always turn into planning effective.

Among the factors that sustain permanence in work are the fear of idleness, the loss of active routine, the rupture of social ties and the threat to professional identity, which position work as the central axis of daily life and institutional belonging. Although financial concerns are present, they do not act in isolation, being combined with subjective dimensions related to recognition, social utility and the maintenance of roles built throughout the work trajectory. In this sense, the postponement of retirement emerges as a result of the articulation between identity, material and relational dimensions.

Retirement is perceived in an ambiguous way, associated simultaneously with the possibility of rest and new projects and with rupture, uncertainty and loss of meaning, which contributes to low adherence to prior planning. The presence of alternative life projects (such as productive activities, structured leisure and strengthening of social networks) proved to be a potentially facilitating element of readiness for the transition.

Another relevant finding refers to the perception of absence or insufficiency of structured institutional policies for retirement preparation. The reports indicate punctual, little publicized and disjointed initiatives, in addition to a predominantly reactive communication and a symbolic tension in which institutional actions can be interpreted as pressure for

dismissal. These factors reinforce the individual responsibility of the civil servant and contribute to insecurity and postponement of the decision.

From a theoretical point of view, the study demonstrates the applicability of the Transtheoretical Model of Behavior Change to the understanding of retirement in the public service, expanding the debate by incorporating subjective, identity, and organizational dimensions, beyond exclusively normative or economic explanations. On the practical level, the results point to the need for structured institutional programs to prepare for retirement, which integrate accessible social security/financial guidance; psychosocial support and identity discussion; encouragement to build post-career projects; and proactive and inclusive communication strategies. In addition, attention is recommended to the mode of presentation and language of the program, in order to reduce the perception of "pressure" for retirement and reinforce its function of care and support for planning.

As limitations, the institutional focus of the study, restricted to a federal university, the male predominance in the sample, and the absence of retired civil servants stand out, which limits the direct transfer of results to other contexts.

Future research can expand this analysis through comparative studies between different public institutions, as well as longitudinal investigations that follow civil servants throughout the process of preparation, decision, and adaptation to retirement. It is also recommended to explore differences by gender, occupation and working conditions, in addition to evaluating the implementation and effectiveness of PPAs in IFES, considering indicators of readiness, well-being and maintenance of bonds.

By highlighting the meanings attributed to the permanence in work and retirement by TAEs 60+ civil servants, this study contributes to the advancement of the academic and institutional debate on aging, work and people management in the public sector, offering subsidies for the development of proactive strategies to support the work-retirement transition in public universities.

REFERENCES

- Amorim, T. N. G. F., Carvalho, D. G. S., Oliveira, R. R., & Silva, L. B. (2018). Aposentar-se ou continuar trabalhando? Decisão difícil para servidores públicos. *Revista Gestão Universitária na América Latina - GUAL*, 11(4), 231–255. <https://doi.org/10.5007/1983-4535.2018v11n4p231>
- Bardin, L. (2011). *Análise de conteúdo*. Edições 70.
- Brasil. (2003). Lei nº 10.741, de 1º de outubro de 2003. Dispõe sobre o Estatuto da Pessoa Idosa e dá outras providências. Presidência da República. https://www.planalto.gov.br/ccivil_03/leis/2003/l10.741.htm

- Bressan, M. A. L. C., Mafrá, S. C. T., França, L. H. F. P., Melo, M. S. S., & Loretto, M. D. S. (2013). Bem-estar na aposentadoria: O que isto significa para os servidores públicos federais? *Revista Brasileira de Geriatria e Gerontologia*, 16(2), 259–272. <https://doi.org/10.1590/S1809-98232013000200006>
- Carvalho, C. L. S., Costa, I. S. A., & Pimenta, R. C. (2013). A percepção de servidores públicos sobre o momento da aproximação de sua aposentadoria: O caso do PRODERJ. *Reuna*, 18(3), 21–40.
- Fonseca, A. G. (2019). Programas de preparação para aposentadoria: Instrumentos efetivos de responsabilidade social nas universidades públicas federais de ensino superior [Dissertação de mestrado, Universidade Tecnológica Federal do Paraná]. Repositório UTFPR. <http://repositorio.utfpr.edu.br/jspui/handle/1/4129>
- França, L. H. F. P., & Soares, D. H. P. (2009). Preparação para a aposentadoria como parte da educação ao longo da vida. *Psicologia Ciência e Profissão*, 29(4), 738–751. https://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1414-98932009000400007
- Gvozđ, R., Sakai, A. M., & Haddad, M. C. L. (2015). Sentimentos e perspectivas de trabalhadores de instituição universitária pública frente à aposentadoria. *REME-Revista Mineira de Enfermagem*, 19(1), 79–83. <https://doi.org/10.5935/1415-2762.20150007>
- Macêdo, L. S. S., Bendassolli, P. F., & Torres, T. L. (2019). Preditores do adiamento da aposentadoria por servidores públicos federais. *Avances en Psicología Latinoamericana*, 37(1), 153–167. <https://doi.org/10.12804/revistas.urosario.edu.co/apl/a.4556>
- Matta, R. O. B. (2012). Aplicação do modelo transteórico de mudança de comportamento para o estudo do comportamento informacional de usuários de informação financeira pessoal [Tese de doutorado, Universidade Estadual Paulista]. Repositório UNESP. <http://hdl.handle.net/11449/103354>
- Murta, S. G., Leandro-França, C., & Seidl, J. (2014). Programas de educação para aposentadoria: Como planejar, implementar e avaliar. *Sinopsys*.
- Nascimento, A. J. R., & Rabelo, F. C. E. (2008). Memória e envelhecimento: Narrativas sobre questões de gênero e do mundo do trabalho. *Sociedade e Cultura*, 11(2), 333–342. <https://doi.org/10.5216/sec.v11i2.5291>
- Nascimento, P. D. M., & Polia, A. A. (2019). Planos para o futuro: Uma análise da perspectiva ocupacional de professores universitários para o período da aposentadoria. *Caderno Brasileiro de Terapia Ocupacional*, 27(2), 390–402. <https://doi.org/10.4322/2526-8910.ctoAO1647>
- Oliveira, P. K. Q., & Almeida, A. N. (2021). Determinantes da decisão de aposentadoria no serviço público. *Revista Administração em Diálogo-RAD*, 24(1), 25–39. <https://doi.org/10.21118/apgs.v13i1.8895>
- Pazos, P. F. B. (2020). Velhice e trabalho: Um estudo sobre o trabalhador idoso [Dissertação de mestrado, Fundação Oswaldo Cruz]. Arca Fiocruz. <https://arca.fiocruz.br/handle/icict/46198>
- Pereira, G. R. (2017). Abono de permanência [Trabalho de Conclusão de Curso, Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa]. Repositório IDP. https://repositorio.idp.edu.br/bitstream/123456789/3775/1/ARTIGO_GERSON%20RODRIGUES%20PEREIRA_2017.pdf

- Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, 51(3), 390–395. <https://doi.org/10.1037/0022-006X.51.3.390>
- Silva, A. C. C., & Helal, D. H. (2018). Sessão especial-Fast Track SEMEAD: Compreendendo a aposentadoria: Um estudo de caso em uma instituição pública do Estado de Pernambuco. *REGE-Revista de Gestão*, 24, 316–324. <https://doi.org/10.1016/j.rege.2017.07.003>
- Silva, A. E., & Sousa, J. L. R. (2023). Motivos-causas da escolha e permanência para o trabalho em uma instituição de ensino público. *Revista Ciências Administrativas*, 29, 1–15. <https://doi.org/10.5020/2318-0722.2023.29.e13464>
- Teques, A. P., Carreiro, J., Duarte, D., & Teques, P. (2025). Wellbeing and retirement in Europe: A systematic review with meta-analysis. *Healthcare*, 13(2), Article 100. <https://doi.org/10.3390/healthcare13020100>
- Vinuto, J. (2014). A amostragem em bola de neve na pesquisa: Um debate aberto. *Temáticas*, 22(44), 203–220. <https://dx.doi.org/10.20396/tematicas.v22i44.10977>
- World Health Organization. (2005). Envelhecimento ativo: Uma política de saúde (S. Gontijo, Trad.). Organização Pan-Americana da Saúde. https://bvsms.saude.gov.br/bvs/publicacoes/envelhecimento_ativo.pdf (Obra original publicada em 2002)
- Zanelli, J. C., Silva, N., & Soares, D. H. P. (2010). Orientação para aposentadoria nas organizações de trabalho: Construção de projeto após-carreira. *Artmed*.

THE IMPORTANCE OF CASH FLOW IN THE FINANCIAL MANAGEMENT OF MICRO AND SMALL ENTERPRISES: A LITERATURE REVIEW

A IMPORTÂNCIA DO FLUXO DE CAIXA NA GESTÃO FINANCEIRA DE MICRO E PEQUENAS EMPRESAS: UMA REVISÃO DA LITERATURA

LA IMPORTANCIA DEL FLUJO DE CAJA EN LA GESTIÓN FINANCIERA DE MICRO Y PEQUEÑAS EMPRESAS: UNA REVISIÓN DE LA LITERATURA



<https://doi.org/10.56238/sevened2026.008-120>

Camila Silva Campos¹, Larissa de Macedo Câmara², Leonardo Pastorin Vieira Costa³, Natália Talita Araújo Nascimento⁴

ABSTRACT

The research aims to analyze the importance of cash flow in the financial management of micro and small enterprises, based on a review of the scientific literature from 2020 to 2025. The following specific objectives are proposed: (1) to identify recommended practices for controlling and using cash flow in micro and small enterprises; (2) to survey the main benefits and challenges highlighted in recent literature regarding cash flow management; and (3) to analyze the relationship between the effective use of this tool and the financial sustainability of these organizations. The research problem is centered on answering the following question: what is the importance of cash flow for the financial management of micro and small enterprises in light of recent literature? Regarding the methodology, the study is qualitative in nature, with an exploratory-descriptive approach and based on a bibliographic review. Thirteen articles were selected through Google Scholar, using filters for the terms “cash flow,” “micro and small enterprises,” and “financial management.” The analysis was conducted through systematic summaries organized into three categories: recommended practices, benefits, and challenges of cash flow management. The results indicate that cash flow is a fundamental tool for financial control, decision-making, and short- and long-term planning. A lack of managerial training, informality, and the use of intuitive management methods were also identified. Although there is consensus on the importance of cash flow, a gap still exists between theoretical knowledge and its application in everyday practice.

Keywords: Cash Flow. Micro and Small Enterprises. Financial Management.

¹ Graduated in Science in Accounting. Universidade Federal de Rondônia (UNIR).
E-mail: camilasc128@gmail.com

² Graduated in Science in Accounting. Universidade Federal de Rondônia (UNIR).
E-mail: larissamacedocamara@hotmail.com

³ Master's degree in Regional Development and Environment. Universidade Federal de Rondônia (UNIR).
E-mail: leonardopvc.engamb@gmail.com

⁴ Dr. in Regional Development and Environment. Universidade Federal de Rondônia (UNIR).
E-mail: natalia.araujo@unir.br

RESUMO

A pesquisa visa analisar a importância do fluxo de caixa na gestão financeira das micros e pequenas empresas, com base na revisão de literatura científica de 2020 a 2025. Propõe-se como objetivos específicos: (1) identificar as práticas recomendadas para o controle e a utilização do fluxo de caixa em micro e pequenas empresas; (2) levantar os principais benefícios e desafios apontados pela literatura recente no que se refere à gestão do fluxo de caixa e (3) analisar a relação entre o uso eficaz dessa ferramenta e a sustentabilidade financeira dessas organizações. A problemática da pesquisa está centrada em responder: qual é a importância do fluxo de caixa para a gestão financeira das micro e pequenas empresas, à luz da literatura recente? Quanto à metodologia, é de natureza qualitativa, com abordagem exploratório-descritiva e baseada em levantamento bibliográfico. Foram selecionados 13 artigos através do Google Acadêmico, com filtros para as palavras “fluxo de caixa”; “micro e pequenas empresas” e “gestão financeira”. A análise foi feita por meio de fichamentos com três categorias: práticas recomendadas, benefícios e desafios da gestão do fluxo de caixa. Constatou-se nos resultados que o fluxo de caixa é uma ferramenta fundamental para o controle financeiro, a tomada de decisão e o planejamento de curto a longo prazo. Foram identificados também, falta de capacitação dos gestores, informalidade e uso de métodos intuitivos de gestão. Embora exista um consenso sobre a importância do fluxo de caixa, ainda existe uma lacuna entre o conhecimento teórico e a aplicação no cotidiano.

Palavras-chave: Fluxo de Caixa. Micro e Pequenas Empresas. Gestão Financeira.

RESUMEN

La investigación tiene como objetivo analizar la importancia del flujo de caja en la gestión financiera de las micro y pequeñas empresas, con base en una revisión de la literatura científica de 2020 a 2025. Se proponen como objetivos específicos: (1) identificar las prácticas recomendadas para el control y el uso del flujo de caja en micro y pequeñas empresas; (2) identificar los principales beneficios y desafíos señalados por la literatura reciente en lo que respecta a la gestión del flujo de caja; y (3) analizar la relación entre el uso eficaz de esta herramienta y la sostenibilidad financiera de estas organizaciones. La problemática de la investigación se centra en responder: ¿cuál es la importancia del flujo de caja para la gestión financiera de las micro y pequeñas empresas a la luz de la literatura reciente? En cuanto a la metodología, la investigación es de naturaleza cualitativa, con enfoque exploratorio-descriptivo y basada en una revisión bibliográfica. Se seleccionaron trece artículos a través de Google Académico, con filtros para los términos “flujo de caja”, “micro y pequeñas empresas” y “gestión financiera”. El análisis se realizó mediante fichas de lectura organizadas en tres categorías: prácticas recomendadas, beneficios y desafíos de la gestión del flujo de caja. Los resultados muestran que el flujo de caja es una herramienta fundamental para el control financiero, la toma de decisiones y la planificación a corto y largo plazo. También se identificaron la falta de capacitación de los gestores, la informalidad y el uso de métodos intuitivos de gestión. Aunque existe un consenso sobre la importancia del flujo de caja, todavía hay una brecha entre el conocimiento teórico y su aplicación en la práctica cotidiana.

Palabras clave: Flujo de Caja. Micro y Pequeñas Empresas. Gestión Financiera.

1 INTRODUCTION

The evolution of financial statements in Brazil shows how financial information has become increasingly valued in managerial decision-making. For decades, the Statement of Sources and Applications of Resources (DOAR) was the main instrument used to demonstrate where the company's resources came from and how they were applied. However, with the enactment of Law No. 11,638/2007, which promoted the convergence of Brazilian standards to international accounting standards (IFRS), the DOAR was replaced by the Cash Flow Statement (DFC). The DFC, regulated by NBC TG 03, now offers a more dynamic, clear and useful view for users of accounting information, by evidencing the inflows and outflows of funds in three distinct activities: operational, investment and financing. This change marked a breakthrough in detailing the financial health of organizations, which is especially relevant for micro and small businesses, which often face liquidity and planning challenges.

According to AASB 03, cash flow is a financial report that demonstrates how a company's cash is used over the course of an accounting period. Therefore, managing it effectively is essential for the survival and development of any company. Cordeiro & Marquez (2024) highlight that "cash flow should be seen as a continuous practice and integrated into strategic business decisions, in order to ensure long-term sustainability". The actors' statement reiterates that cash flow is an instrument to support decision-making and capital control of these companies. According to Sá 2008; Strobel, 2014, the lack of financial control is one of the most common causes of bankruptcy of micro and small companies, even in the face of positive accounting results.

A study carried out with managers in the city of João Pessoa – PB, showed that even recognizing the importance of cash flow, a significant portion is still unaware of its use, Almeida and Valentim (2024). Formenti and Martins (2015) pointed out that microentrepreneurs, even having theoretical knowledge about the importance of cash flow, few implement the practice in their daily lives. In view of the above, this distance between what happens in practice and what is learned in theory only shows how difficult it is to make the financial management of micro and small companies effectively professional.

In this sense, when determining the basis for this work, it is possible to see that the adoption of a well-structured cash flow offers more than accounting control, it is an efficient tool to prevent crises, sustain the growth of companies and promote liquidity. Under this bias, focusing on the literature review of the last five years, the following research problem is formulated: **what is the importance of cash flow for the financial management of micro and small companies, in the light of recent literature?** Its general objective is to analyze

the importance of cash flow in the management of micro and small companies, based on a literature review of the last five years. The following specific objectives were also defined: (i) to identify the best practices for the control and use of cash flow in micro and small companies; (ii) to raise the main benefits and challenges pointed out by the recent literature regarding cash flow management; and (iii) analyze the relationship between the effective use of this tool and the financial sustainability of these organizations.

2 THEORETICAL FOUNDATION

2.1 MICRO AND SMALL ENTERPRISES IN THE ECONOMIC CONTEXT

According to the MPE Statute, micro enterprises (ME) and small businesses (EPP) are defined based on annual gross revenue. Micro companies are those whose gross revenue does not exceed the limit of R\$ 360,000.00, while small companies are those with revenues greater than R\$ 360,000.00 and equal to or less than R\$ 4,800,000.00. These limits are periodically updated by the Simples Nacional Management Committee (CGSN), with the objective of adjusting the values to the current economic reality (Brasil, 2006)

The classification as ME or EPP allows access to simplified tax regimes, such as the Simples Nacional, which unifies taxation in a single collection document and reduces the tax burden of companies, enabling them to remain in the market and increase their competitive capacity (Brasil, 2006).

The classification criteria established by Complementary Law No. 123/2006 consider the annual gross revenue as the main parameter for the classification of companies. However, the statute also provides for specific conditions for the classification, such as the exclusion of certain activities, the verification of equity participation and the analysis of the form of taxation (Brasil, 2006).

2.2 ROLE OF SMES IN THE BRAZILIAN ECONOMY

Small and micro enterprises contribute a relevant portion to the growth of the economy in the country (André, 2021). According to Sebrae (2022), SMEs represent more than 99% of the total companies in Brazil and are responsible for approximately 30% of the national Gross Domestic Product (GDP). MSEs boost the economy, growth, innovation, and new job creation in a remarkable way (Ribaski, 2024). Machado (2016) states that MSEs play a fundamental role in reducing social inequalities, promoting economic development in regions of low industrial density.

The importance of MSEs can also be observed in the strengthening of the local economy, especially in economically less developed regions. According to Duarte de Jesus

and Marinho (2023), these companies act as dynamic agents of the local economy, promoting the circulation of income and stimulating the growth of strategic sectors, such as commerce and services. According to Xavier and Bertaci (2023), they highlight that MSEs play a relevant role in structuring supplier networks, fostering partnerships between companies of different sizes and contributing to the consolidation and boosting local producers. This movement generates a virtuous cycle, in which the development of MSEs positively impacts the regional market and, consequently, the national market.

Another aspect that highlights the importance of SMEs is their contribution to innovation and the diversification of the economy. Although they are often associated with traditional businesses, many micro and small companies have stood out for the adoption of innovative strategies, whether in the offer of differentiated products or in the implementation of more efficient processes (Alves *et al.*, 2025). For Polastrini, Saraiva and Silva (2023), the ability to identify market niches and develop customized solutions allows SMEs to occupy spaces that large corporations, with more rigid structures, can hardly reach. This innovative potential not only increases the competitiveness of the segment, but also strengthens the national economy, diversifying the production matrix and encouraging the creation of new businesses.

2.3 FINANCIAL MANAGEMENT IN SMES

In the context of Brazilian micro and small enterprises (MSEs), the evolution of financial management reflects a continuous process of adaptation to market demands and economic transformations. Historically, many SMEs have faced serious difficulties, mainly due to the absence of financial planning and the lack of adequate management practices. The lack of effective cost management compromises the competitiveness and sustainability of these companies (Costa *et al.*, 2022). Informality and the lack of accurate financial information make it difficult to make strategic decisions (Lima *et al.*, 2021), making it essential to adopt financial management practices that ensure their survival and growth.

Financial management consists of a set of practices and processes aimed at optimizing the use of financial resources, ensuring sustainability and organizational growth. It involves the planning, execution and control of financial activities, providing a clear view of the company's economic situation (Silva *et al.*, 2020). For MSEs, financial management is fundamental, as it facilitates the identification of investment opportunities and the mitigation of risks (Fonseca *et al.*, 2022). The adoption of appropriate financial practices also contributes to the improvement of business performance and to more assertive decision-making (Souza *et al.*, 2023).

MSEs, however, have specific characteristics that directly impact their financial management. One of the most relevant aspects is the centralization of financial decisions in the hands of the owners, which can lead to the absence of planning and strict controls (Castro and Silva, 2020). Many of these companies also fail to use accounting and financial tools effectively, hindering performance analysis and results projection (Dias e Silva, 2023). Difficulties in accessing credit and financial resources significantly limit the capacity for investment and expansion (Lima *et al.*, 2021).

The adoption of good practices in financial management can be decisive for the success of MSEs. An example is presented by Gomes *et al.* (2021), which describe the implementation of a financial management model in a microenterprise in the service sector, with an emphasis on working capital planning and cash flow control. Similarly, Souza *et al.* (2023) identify the need for more effective collection policies as a means of improving accounts receivable management. These examples demonstrate that the implementation of financial controls and the use of appropriate tools are crucial for the sustainability and growth of MSEs.

Effective financial management in SMEs must be based on principles capable of ensuring the sustainability and growth of the business. Financial planning is essential to establish goals and strategies that guide business decisions (Silva *et al.*, 2020). Financial control allows for constant monitoring of operations, identifying possible deviations that may compromise the company's financial health (Castro and Silva, 2020). In addition, financial analysis, based on accurate and up-to-date data, is essential to evaluate the company's performance and identify opportunities for improvement (Fonseca *et al.*, 2022).

2.4 CASH FLOW IN THE MANAGEMENT OF MICRO AND SMALL COMPANIES

Cash flow is one of the most relevant instruments in the financial management of micro and small enterprises (MSEs), being essential to ensure economic balance and guide strategic decisions. In its most elementary function, this tool enables the systematic monitoring of financial inflows and outflows, allowing the manager to anticipate situations of insufficiency or surplus of capital *Manual de técnicas e práticas do CRCSP* (2011).

In MSEs, the effective use of cash flow can be decisive for the survival of the business, especially in the face of constant market fluctuations and typical restrictions on access to credit. As stated by Carvalho *et al.* (2022), many microenterprises face financial difficulties precisely because of the absence of formal cash control practices, which compromises planning and increases exposure to operational risks. The lack of this control undermines the

predictability of financial commitments, resulting in poorly founded decisions that can culminate in default or bankruptcy.

Contemporary literature shows that cash flow goes far beyond a merely accounting function, assuming a strategic role in supporting investment and financing decision-making. As Morellato and Nascimento (2016) point out, proactive cash flow management enables not only the identification of working capital needs, but also the definition of more appropriate strategies for the sustainable growth of the business. Such a perspective reinforces the idea that, in MSEs, cash flow should be conceived as a dynamic tool, constantly fed and analyzed, and not as a merely occasional report.

However, several studies show that resistance to the adoption of systematic financial management practices remains a reality among MSEs. Research carried out by Bernardes et al. (2020) revealed that a significant portion of managers in this segment still rely on informal or intuitive methods for managing financial flow, disregarding the importance of structured analyses. This behavior can be attributed, in part, to the lack of management training, but also to the mistaken perception that strict control of finances is an exclusive need of larger companies.

In the current context, marked by digitalization and the growing availability of technological tools, the incorporation of financial management software has been pointed out as a viable and necessary solution for improving cash flow control. According to Albino (2003), the use of integrated systems provides greater agility and precision in the preparation of financial projections, providing managers with more adequate conditions to face uncertainties and identify investment opportunities.

Thus, it is observed that efficient cash flow management is a competitive advantage that can enhance the sustainability and development of micro and small companies. As summarized in the study by the University Center 7 de Setembro (2011), the ability to anticipate scenarios and manage financial resources in a balanced way depends, to a large extent, on the manager's competence to use cash flow as a planning and control instrument, and not just as a historical record. In this way, the need to promote the training of entrepreneurs and to encourage the adoption of modern financial management practices, essential for the strengthening of the MSE segment, is reinforced.

3 METHODOLOGY

This research is qualitative in nature, with an exploratory-descriptive approach, with the objective of understanding, from the recent scientific literature, the main challenges and good practices related to financial management in micro and small enterprises (MSEs), with

emphasis on cash flow. The qualitative approach allows the interpretative and contextualized analysis of the phenomena studied, especially suitable for topics involving managerial behavior, administrative practices and decision-making processes in small organizations (Godoy, 1995).

The scientific method adopted was the bibliographic survey, considering as the main source scientific articles published between the years 2020 and 2025, selected through the Google Scholar database, using the terms "cash flow", "micro and small companies" and "financial management" as search criteria. The collection was carried out during the month of May 2025. The selection of materials followed criteria of thematic relevance, timeliness and methodological rigor, prioritizing recognized academic journals in the area of Applied Social Sciences and Administration.

The analysis of the bibliographic data was guided by the objectives of the study, being structured around three main axes: (i) best practices for the control and use of cash flow in MSEs; (ii) benefits and challenges pointed out by the recent literature on cash flow management; and (iii) the relationship between the effective use of this tool and the financial sustainability of the companies analyzed.

The methodology of this study is based on the analysis of academic productions that address financial management and cash flow in micro and small enterprises (MSEs), constituting the universe of the research. The sampling was non-probabilistic, adopting criteria of thematic relevance and timeliness of the selected studies. 13 scientific articles that meet the established criteria were analyzed, in order to ensure the relevance and representativeness of the results in relation to the proposed objectives. The articles used were duly identified and systematized according to author, title, year and journal of publication.

Then, they were organized by means of files containing the objectives, methodology, results and main conclusions. From this, thematic content analysis was carried out, aiming to identify patterns, challenges and good practices that are recurrent in the literature on the subject. Manual analysis was performed with the support of spreadsheets to systematize the extracted data.

4 RESULTS

The analysis of the 13 scientific articles that were selected and organized, as shown in Table 1, showed that financial management in micro and small enterprises (MSEs) has been widely debated in the recent literature, especially with regard to the importance of cash flow as an instrument of control, planning and decision-making. Most studies propose

recommended practices, recognize the strategic role of this tool in financial sustainability, in the organization of finances and in the prevention of operational imbalances. The articles highlight common benefits and challenges faced by these companies, such as informality in management, difficulty in accessing credit, and the lack of financial training of managers. This set of works offers a solid theoretical basis to understand both the obstacles and the good practices recommended to strengthen the financial management of MSEs in the Brazilian context.

Table 1

Scientific Articles Used in Research

Articles	Author(s)	Title	Year	Periodical
1	Gabriela de Figueiredo Goes de Almeida; Isabella Christina Dantas Valentim	Cash flow management: an analysis of micro and small companies in the city of João Pessoa/PB.	2020	Campo do Saber Magazine
2	Danimélia Martins Teixeira	Importance of financial management for the survival of micro and small companies in atypical scenarios.	2021	Interdisciplinary Journal Scientific Thought
3	Jefferson Manosso de Castro; Alessandro Lepchak; Flávio Ribeiro; Willson Gerigk	Cash flow and financial controls applied to microenterprises.	2020	UEPG Connection Magazine
4	Lucas de Araujo Machado	The importance of cash flow statements as a decision tool for microenterprises.	2020	Pontifical Catholic University of Goiás (PUC Goiás)
5	José Vinícius Sento-Sé de Moura Aquino; Raimundo Nonato Lima Filho	Management tools for micro and small enterprises: a study in the city of Petrolina-PE.	2021	Management in Analysis Magazine
6	Antonio Oliveira de Carvalho; Sabrina Oliveira Santos; Mércia Freitas Limeira; Hoton José Almeida Santana Júnior	The importance of cash flow for micro and small companies.	2025	Lumen and Virtus
7	Tiago Fernandes da Silva; Vanderlane da Silva Pereira; Zenóbia Menezes de Brito	Financial sustainability in small and medium-sized companies: challenges and accounting strategies.	2024	Online Academic Journal
8	Antonio Oliveira de Carvalho; Sabrina Oliveira Santos; Mércia Freitas Limeira; Hoton José Almeida Santana Júnior	The importance of cash flow and its application in micro and small companies.	2024	Lumen and Virtus
9	Iani Francieli Camargos Ferreira; Fabiana Kely dos Santos Reis; Francisco Eudes Gomes de Lima; Diego Campos Pereira	Cash flow of a small business in the musical instrument retail business.	2023	Electronic Scientific Journal of Applied Social Sciences EDUVALE

10	André Soares de Oliveira	Cash flow and financial management in micro and small companies	2023	Pontifical Catholic University of Goiás
11	Brenda Ketheleen Oliveira Ramos da Silva	Cash flow management and the importance of its use in micro and small companies.	2023	Pontifical Catholic University of Goiás
12	Jaqueline Ferreira Souza; Juliana Dos Santos Souza; Marcelo da Silva Pessoa; José Carlos Alves Roberto; Zuila Paulino Cavalcante.	The importance of cash flow for a microenterprise in Manaus.	2025	Cuadernos de Educación Y Desarrollo
13	Ricardo Machado Fidêncio	The Importance of Cash Flow as a Management Tool.	2023	FAAT, Londrina

Source: Prepared by the authors.

The analysis of the articles reveals that most of the studies make some kind of practical recommendation on financial management and, especially, on the use of cash flow in micro and small enterprises (MSEs). However, some articles are limited to theoretical analysis or exposition of the importance of cash flow, without presenting specific practical recommendations. Table 2 presents the recommendations made in the analyzed articles.

Table 2

Recommended practices by the authors

Articles	Year	Best practices
1	2020	The daily monitoring of inflows and outflows allows managers to identify possible imbalances in advance and make more assertive decisions, as highlighted by Carvalho et al. (2025), when they stated that this constant control is essential for the company's financial health. There is also a strong recommendation for the adoption of technological tools, since financial management systems provide greater agility, accuracy, and security in data analysis, reducing errors and increasing efficiency in processes. Another recurring recommendation is the separation between personal and business finances, considered essential to avoid confusion in the analysis of results and ensure the sustainability of the business, as highlighted by Ferreira and Almeida (2020). In addition to operational control, the articles emphasize that cash flow should be used as a strategic instrument, allowing not only to visualize the current financial situation, but also to plan future scenarios and guide investments.
3	2020	
5	2021	
6	2025	
8	2024	
9	2023	
10	2023	
11	2023	
12	2025	

Source: Prepared by the authors.

Of the 13 articles analyzed, 9 articles present practical recommendations for financial management, especially in the use of cash flow, and 4 articles do not make direct recommendations, limiting themselves to the exposition of the importance of the theme or theoretical analysis. Therefore, it can be observed that, although most of the studies recognize and suggest practices applicable to the financial management of MSEs, there is still a relevant portion of the literature that lacks concrete proposals to guide entrepreneurs

in practice. Table 3 summarizes the most recurrent recommendations in the articles presented in Table 2, as can be seen below:

Table 3

Most recurrent practical recommendations

Articles	Recommendations
1, 6, 9, 11, 10, and 12	Continuous and constant use of cash flow and periodic financial control.
1, 3, 6, and 11	Financial planning and control through cash flow.
5	Adoption of management tools, including cash flow.
8	Applying cash flow efficiently.

Source: Prepared by the authors.

It can be observed that the effective management of cash flow in micro and small enterprises (MSEs) is directly associated with the adoption of practices that allow not only control, but also short, medium and long-term financial planning. Among the main recommendations found in the literature, the need for managers to adopt daily control of financial inflows and outflows, using cash flow as a continuous monitoring tool, stands out. In this sense, Carvalho *et al.* (2025) state that "the preparation and constant monitoring of cash flow allows the manager to identify possible financial imbalances in advance, enabling more assertive decision-making to ensure the company's financial health".

The articles also suggest that cash flow should not be seen solely as an operational instrument, but rather as a strategic tool. The literature analyzed makes it clear that effective practices in cash flow management involve not only routine control, but also the adoption of management tools and discipline in relation to financial control. Such practices are seen as fundamental to strengthen the financial sustainability of micro and small companies, reducing risks and increasing the chances of success in the market.

4.1 POSITIVE AND LIMITING ASPECTS OF CASH FLOW MANAGEMENT IN MICRO AND SMALL COMPANIES

Cash flow management has been consolidated as an indispensable tool for sustainability and decision-making in micro and small companies (Pereira *et al.*, 2023). However, the academic literature reveals a series of obstacles that still hinder its full application in the daily life of these enterprises. The following is an analysis, based on 13 scientific studies published between 2020 and 2025, in order to identify the main benefits and challenges related to cash flow management in this business segment.

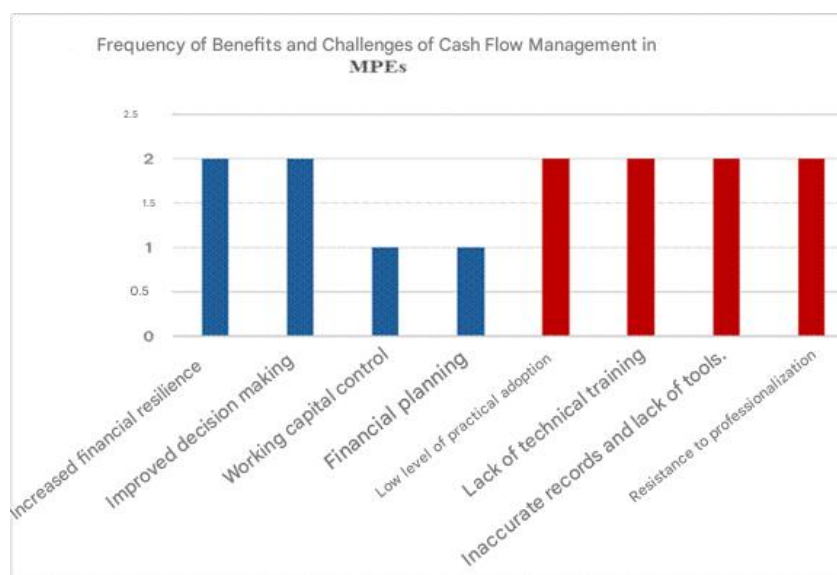
As evidenced by Teixeira (2020), SMEs that adopt cash flow as a routine practice face crises with greater resilience and adaptability. From a managerial point of view, authors such

as Machado (2020) and Castro *et al.* (2020) highlight the strategic role of this tool to guide financial and operational decisions based on real data. Almeida and Valentim (2020) point out that, when well implemented, cash flow contributes directly to the control of working capital and to medium and long-term planning.

On the other hand, the studies also highlight relevant obstacles. One of the main ones refers to the lack of technical training of managers, making it difficult to understand and properly operationalize cash flow (Carvalho *et al.*, 2024; Teixeira, 2021). Added to this is the low degree of practical adoption, the predominant informality in many businesses, and the lack of organized financial records (Almeida and Valentim, 2020; Castro *et al.*, 2020). This distance between theoretical knowledge and its practical application shows a structural weakness that limits the positive results expected from the use of the tool.

Figure 1

Benefits and challenges identified in the articles analyzed



Source: Prepared by the authors.

Table 4

Benefits and challenges identified

Identified Benefits	Challenges Faced
Increased financial resilience and crisis preparedness (Teixeira, 2021; Carvalho et al., 2025).	Low level of practical adoption, despite theoretical knowledge (Almeida & Valentim, 2020; Castro et al., 2020).
Improvement in decision-making, based on up-to-date and reliable data (Machado, 2020; Castro et al., 2020).	Lack of technical training of managers to interpret the data (Teixeira, 2021; Carvalho et al., 2024).
More effective control of working capital and reduction of illiquidity risks (Almeida & Valentim, 2020).	Inaccurate financial records and absence of computerized tools (Castro et al., 2020; Silva et al., 2024).

Encouragement of short, medium and long-term financial planningKGKHK (Aquino & Filho, 2021).

Cultural resistance to the professionalization of financial management (Machado, 2020; Almeida & Valentim, 2020).

Source: Prepared by the authors.

4.2 FINANCIAL SUSTAINABILITY

Financial sustainability in micro and small enterprises (MSEs) is recurrently addressed in the articles analyzed, although with different depths. In some studies, the theme appears as the central focus of the research, with direct reflections on strategies that promote the continuity and financial balance of companies. In others, sustainability is addressed indirectly, linked to practices such as the use of cash flow, the professionalization of management, and the adoption of management tools.

The articles by Carvalho *et al.* (2025), Ramos e Silva (2021), and Ferreira *et al.* (2023), for example, make an explicit connection between financial sustainability and the implementation of sound control and planning practices, such as the continuous use of cash flow and the separation of personal and business finances. The study by Silva, Pereira and Brito (2024) discusses financial sustainability as a central theme, but adopts a more theoretical approach, focusing on the challenges faced by MSEs without proposing detailed solutions.

Some articles mention the concept of sustainability in a secondary way, as a natural consequence of good financial management, but without deepening the debate or presenting recommendations. Others don't even mention the term directly, focusing solely on cash flow functionality or the operational difficulties of financial management.

Table 5

Financial sustainability

Article s	Year	Best practices
1	2020	Financial sustainability is directly related to the proper use of management tools, especially cash flow, strict control of finances, and the professionalization of management. According to Silva, Pereira, and Brito (2024), financial sustainability depends on accounting strategies that help in decision-making, although the article focuses more on exposing challenges than on indicating specific practices. Other studies, such as those by Carvalho <i>et al.</i> (2025) and Ramos and Silva (2021), reinforce that financial predictability, combined with short and long-term planning, is essential to keep the company financially healthy, in addition to highlighting that the absence of control leads to instability and increased risk of insolvency.
3	2020	
5	2021	
6	2025	
7	2024	
8	2024	
9	2023	
10	2023	
11	2023	

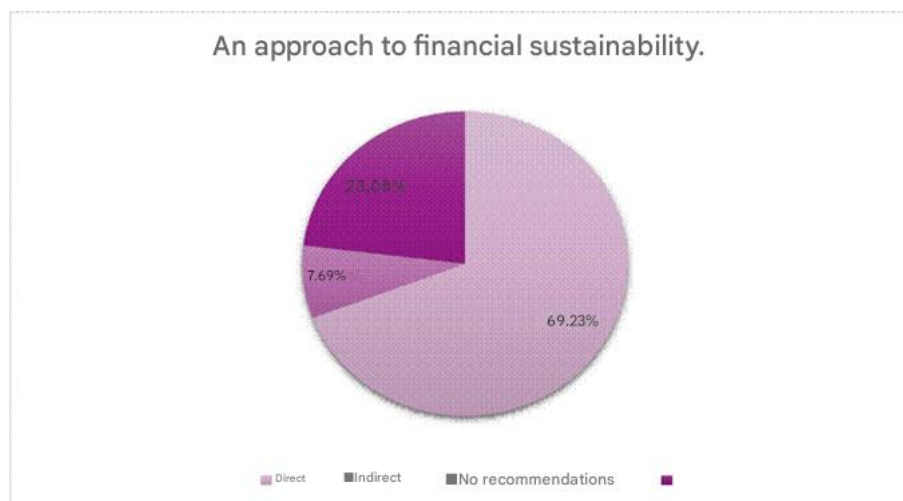
Source: Prepared by the authors.

Of the articles analyzed, 9 articles present direct recommendations on practices related to financial sustainability, generally linked to the use of cash flow, planning and strict

control of finances, 1 article brings partial recommendations, discussing accounting strategies without detail, and 3 articles do not offer recommendations, limiting themselves to the conceptual or descriptive discussion of the topic. As shown in the Table below:

Figure 2

Recurrence of the Financial Sustainability Approach in Articles



Source: Prepared by the authors.

Among the studies that address financial sustainability, there is a distinction between direct and indirect approaches. The articles by Carvalho *et al.* (2025), Silva, Pereira and Brito (2024), Carvalho *et al.* (2024) and Oliveira (2023) take a straightforward approach, treating financial sustainability as an explicit objective and linking it to efficient cash flow management, overcoming accounting challenges, and implementing structured financial control practices.

Several authors opt for an indirect approach, in which sustainability is treated as a result or consequence of the adoption of good management practices. This is the case of the studies by Almeida and Valentim (2020), Castro *et al.* (2020), Aquino and Lima Filho (2021), Ferreira *et al.* (2023), Souza *et al.* (2025). In these surveys, although the concept of financial sustainability is not the central focus, it appears associated with business continuity, operational stability, or the benefits of using cash flow.

Finally, three studies – Teixeira (2021), Machado (2020) and Fidêncio (2023) – do not address financial sustainability, focusing on technical or descriptive aspects related to cash flow, without establishing connections with the continuity or financial balance of MSEs. These studies offer relevant contributions, but do not directly explore the strategic consequences of financial management for the sustainability of companies.

5 FINAL CONSIDERATIONS

Through the recent literature highlighted throughout this work, it was possible to outline the importance of cash flow for the financial management of micro and small companies. Authors such as Pereira *et al.*, 2023, demonstrate that cash flow is essential for financial sustainability, for capital control, for decision-making, and indispensable for good strategic planning.

Regarding the specific objectives, it was possible to analyze the identification of best practices regarding what comes in and goes out of cash, such as the use of technological tools, the separation of personal and company finances and the correct use of cash flow as a planning tool. It was possible to identify significant benefits in these practices, such as improved responsiveness to problems within SMEs, support for business sustainability, and greater financial predictability. On the other hand, there are numerous difficulties in the application of these practices, the main ones being the low technical qualification on the part of managers, the informality of the negotiations and the resistance to the adoption of more structured financial practices.

Most of the articles that were analyzed, such as Teixeira (2020), propose actions to improve the use of cash flow, but there are still some gaps in the literature when it comes to the practical applicability of the recommendations. It was evidenced by authors such as Castro *et al.*, (2020), that many entrepreneurs in Brazil recognize the importance of the tool, but do not use it in their daily lives, which reinforces the need for actions for this knowledge to be disseminated and applied.

As this is a literature review, without direct application and analysis with entrepreneurs, the conclusions are restricted to a theoretical study. Even so, there is a consensus within the scope exposed regarding the importance of cash flow in micro and small companies. It is hoped that the findings presented can stimulate support institutions and researchers, and managers to deepen the debate on practical solutions to strengthen the sector, promoting longevity for MSEs in Brazil.

REFERENCES

- Alves, T. C., & de Souza Neto, B. (2023). Políticas públicas para desenvolvimento econômico através das micro/pequenas empresas e startups: Uma análise com base no novo marco legal. *Revista Livre de Sustentabilidade e Empreendedorismo*, 8(5), 134–154. <https://doi.org/10.55905/revconv.18n.2-140>
- Bernardes, J. H., Gomes, G. P., Spironelli, F. C., & Avelino, C. H. (2020). Fluxo de caixa como ferramenta gerencial na administração financeira de micro e pequena empresa. *Revista Científica do Centro Universitário Salesiano Auxilium – UniSalesiano Campus Araçatuba*,

1(1). <https://unisalesiano.com.br/aracatuba/wp-content/uploads/2020/08/Revista-eHumanitas-6-2-semester-2019.pdf>

Brasil. (2006). Lei Complementar nº 123, de 14 de dezembro de 2006. Institui o Estatuto Nacional da Microempresa e da Empresa de Pequeno Porte. Presidência da República. https://www.planalto.gov.br/ccivil_03/leis/LCP/Lcp123.htm

Brasil. (2007). Lei nº 11.638, de 28 de dezembro de 2007. Altera e revoga dispositivos da Lei nº 6.404/1976 e da Lei nº 6.385/1976, com a finalidade de atualizar a legislação societária brasileira. Presidência da República. https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/l11638.htm

Castro, J. C. A., & Silva, V. G. M. (2020). Análise da gestão financeira das micro e pequenas empresas do setor varejista da Cidade de Cláudio. *Research, Society and Development*, 9(12), Article e31391210952. <https://doi.org/10.33448/rsd-v9i12.10952>

Conselho Federal de Contabilidade. (2016). NBC TG 03 (R3) – Demonstração dos Fluxos de Caixa. [https://www1.cfc.org.br/sisweb/SRE/docs/NBCTG03\(R3\).pdf](https://www1.cfc.org.br/sisweb/SRE/docs/NBCTG03(R3).pdf) (Original work published 2006)

Conselho Regional de Contabilidade de São Paulo. (2011). Manual de técnicas e práticas de elaboração de fluxo de caixa para pequenas e médias empresas e sua interpretação. https://www.crcrs.org.br/arquivos/livros/crcsp_m06.pdf

Costa, W. P. L. B., Lima, O. C. de, Silva, S. L. P., & Silva, J. D. (2022). Determinantes da gestão de custos nas micro e pequenas empresas. *Revista Brasileira de Contabilidade e Gestão*, 11(21), 38–59. <https://doi.org/10.5965/2764747111212022038>

da Silva, T. F., da Silva Pereira, V., & de Brito, Z. M. (2024). Sustentabilidade financeira em pequenas e médias empresas: Desafios e estratégias contábeis. *Revista Acadêmica Online*, 10(52), Article e217. <https://revistaacademicaonline.com/index.php/rao/article/view/217>

de Almeida, G. de F. G., & Valentim, I. C. D. (2020). Gestão do fluxo de caixa: Uma análise das empresas de micro e pequeno porte na cidade de João Pessoa/PB. *Revista Campo do Saber*, 6(2). <https://periodicos.iesp.edu.br/campodosaber/article/view/351>

de Carvalho, A. O., et al. (2025). A importância do fluxo de caixa para as micro e pequenas empresas. *ARACÊ - New Science*. https://www.researchgate.net/publication/390188688_A_IMPORTANCIA_DO_FLUXO_DE_CAIXA_PARA_AS_MICRO_E_PEQUENAS_EMPRESAS

de Castro, J. M., et al. (2020). Fluxo de caixa e controles financeiros aplicados às microempresas. *Revista Conexão UEPG*, 16(1), 1–18. <https://dialnet.unirioja.es/servlet/articulo?codigo=7605045>

de Jesus, N. D., & Marinho, G. (2019). Microempresas brasileiras: Entendendo seu papel socioeconômico. *REMIPE-Revista de Micro e Pequenas Empresas e Empreendedorismo da Fatec Osasco*, 5(1), 165–177. <https://doi.org/10.21574/remipe.v5i1.196>

de Moura, J. V. S.-S., & Lima Filho, R. N. (2021). Ferramentas gerenciais para micro e pequenas empresas: Um estudo na cidade de Petrolina-PE. *Revista Gestão em Análise*, 10(1), 76–88. <https://unichristus.emnuvens.com.br/gestao/article/view/3201>

de Souza, L. dos S., et al. (2023). Gestão financeira em pequenas empresas: Um estudo de caso para identificar possíveis ferramentas de melhorias. *Caderno de Graduação-*

- Dias, E., & Silva, G. A. (2023). A aplicação da educação e gestão financeira nas microempresas e empresas de pequeno porte. *Revista Foco*.
<https://doi.org/10.54751/revistafoco.v16n11-131>
- Ferreira, I. F. C., et al. (s.d.). Fluxo de caixa de uma pequena empresa no ramo de comércio varejista de instrumentos musicais. [Documento não publicado ou relatório].
http://eduvalesl.revista.inf.br/imagens_arquivos/arquivos_destaque/l3ucliJQ55JRJue_2024-10-3-17-51-2.pdf
- Fidêncio, R. M. (2023). A importância do fluxo de caixa como ferramenta gerencial. FAAT.
https://cdn.administradores.com.br/app/uploads/2022/01/29181711/academico_7172_190226_180046.pdf
- Fonseca, N. E. S. F., et al. (2022). Gestão financeira em micro e pequenas empresas: Conceitos básicos de gestão financeira para micro e pequenas empresas de Bom Jesus do Amparo-MG. *LIBERTAS: Revista de Ciências Sociais Aplicadas*, 12(1).
<https://www.periodicos.famig.edu.br/index.php/libertas/article/view/204>
- Formenti, M. C. L., & Martins, I. C. S. (2015). Análise da gestão financeira nas micro e pequenas empresas de Osasco. *REMIPE-Revista de Micro e Pequenas Empresas e Empreendedorismo da Fatec Osasco*, 1(1), 40–61.
- Gomes, J. C. A., Tachizawa, T., & Picchiali, D. (2014). Modelo de gestão financeira no contexto das micro e pequenas empresas: Estudo de caso em uma empresa de prestação de serviços. *Revista Reuna*, 19(2), 23–46.
<https://revistas.una.br/reuna/article/view/601/563>
- Hortela, T. (2022). Sebrae em dados - Sobrevivência de empresas. Sebrae.
<https://sebraepr.com.br/comunidade/artigo/sebrae-em-dados-sobrevivencia-de-empresas>
- Machado, H. P. V. (2016). Crescimento de pequenas empresas: Revisão de literatura e perspectivas de estudos. *Gestão da Produção*, 23(2), 419–432.
<https://doi.org/10.1590/0104-530X1759-14>
- Machado, L. de A. (2020). A importância das demonstrações de fluxo de caixa como ferramenta de decisão para microempresas [Trabalho de conclusão ou monografia, Pontifícia Universidade Católica de Goiás]. Repositório PUC Goiás.
<https://repositorio.pucgoias.edu.br/jspui/handle/123456789/1349>
- Morellato, D. P., & Nascimento, E. R. do. (2016). Fluxo de caixa e sua utilização para auxílio na gestão financeira das micro e pequenas empresas. *Revista Científica da Faculdade de Educação e Meio Ambiente*, 7(1), 201–217.
<https://revista.unifaema.edu.br/index.php/Revista-FAEMA/article/view/376>
- Oliveira, A. S. de. (2023). Fluxo de caixa e gestão financeira nas micro e pequenas empresas. Pontifícia Universidade Católica de Goiás.
<https://repositorio.pucgoias.edu.br/jspui/handle/123456789/6684>
- Polastrini, A., da Silva Saraiva, A. F., & da Rocha Silva, M. A. (2023). Políticas públicas direcionadas às micro e pequenas empresas no Brasil na pandemia da Covid-19. *Informe Gepec*, 27(1), 100–122. <https://doi.org/10.48075/igepec.v27i1.29518>

- Ribaski, N. G., & de Oliveira, M. (2024). Inovando para o futuro: O papel das pequenas empresas na adoção do ESG. *Caderno Pedagógico*, 21(3), Article e3268. <https://doi.org/10.54033/cadpedv21n3-125>
- Sá, A. L. (2008). *Fundamentos da gestão financeira* (2ª ed.). Atlas.
- Sebrae. (2025). O que é o fluxo de caixa e como aplicá-lo no seu negócio. <https://sebrae.com.br/sites/PortalSebrae/artigos/fluxo-de-caixa-o-que-e-e-como-implantar,b29e438af1c92410VgnVCM100000b272010aRCRD>
- da Silva, B. K. O. R. (2023). A gestão do fluxo de caixa e a importância da sua utilização nas micro e pequenas empresas. Pontifícia Universidade Católica de Goiás. <https://repositorio.pucgoias.edu.br/jspui/handle/123456789/6280>
- Souza, J. F., et al. (2025). A importância do fluxo de caixa para uma microempresa em Manaus. *Cuadernos de Educación y Desarrollo*, 17(4), Article e8236. <https://ojs.cuadernoseducacion.com/ojs/index.php/ced/article/view/8236/5698>
- Strobel, S. (2014). Fluxo de caixa e o fracasso das pequenas empresas: Uma abordagem gerencial. *Revista de Finanças e Contabilidade Empresarial*, 3(1), 91–104.
- Teixeira, D. M. (2020). Importância da gestão financeira para a sobrevivência das micro e pequenas empresas em cenários atípicos. *Revista Interdisciplinar Pensamento Científico*, 6(3). <https://reinpec.cc/index.php/reinpec/article/view/597>
- Uni7 – Centro Universitário 7 de Setembro. (2011). A importância do fluxo de caixa na tomada de decisão. <https://www.uni7.edu.br/ic2011/79.pdf>
- Xavier, V. F., & Bertaci, M. J. (2018). A importância das micro e pequenas empresas para o crescimento do país. *Revista Interface Tecnológica*, 15(2), 161–173. <https://doi.org/10.31510/infa.v15i2.392>

BETWEEN SPEECH AND WRITING: LINGUISTIC-RHETORICAL ANALYSIS OF THE WORDPLAYING GENRE IN THE NORTHEASTERN CANTORIA DE VIOLA IN BRAZIL

ENTRE A FALA E A ESCRITA: ANÁLISE LINGÜÍSTICO-RETÓRICA DO GÊNERO TEXTUAL/DISCURSIVO TROCADILHO NA CANTORIA DE VIOLA NORDESTINA

ENTRE EL HABLA Y LA ESCRITURA: UN ANÁLISIS LINGÜÍSTICO-RETÓRICO DEL GÉNERO TEXTUAL/DISCURSIVO DE LOS JUEGOS DE PALABRAS EN LA CANTORIA DE VIOLA DEL NORESTE DE BRASIL



<https://doi.org/10.56238/sevened2026.008-121>

Antonio Marinho do Nascimento¹, Benedito Gomes Bezerra²

ABSTRACT

The Brazilian northeastern cantoria de viola, orally improvised but often recorded in writing, has aroused the interest of many scholars, from different perspectives, from literary and cultural studies to musical and sociological approaches. Few studies, however, have been conducted from a strictly linguistic perspective. In this article, our aim was to conduct an exploratory study of the wordplaying genre in the cantoria de viola under the perspective of the Language for Specific Purposes, based on the theoretical and methodological contribution of Genre Analysis (Swales, 1990). Methodologically, the study consisted of applying move analysis to a *corpus* of twenty stanzas of sextilhas, a typical genre of the cantoria de viola, authored by Louro do Pajeú, focusing on the use of wordplaying by the poet. As a result, rhetorical moves were found that are both typical of the universe of the cantoria and specific to the poet's poetics. These moves are more general, relating to the aspects of introduction, development and conclusion of the text in any genre, as well as specific moves in the world of oral literature, which lead to its aesthetic prism and its playful context. Such results may contribute to shedding more light on the genre of cantoria and on Louro's creative work, including highlighting the non-formal literacies typical of the activities of viola singers.

Keywords: Move Analysis. Cantoria de Viola. Wordplaying. Rhetorical Strategies.

RESUMO

A cantoria de viola nordestina, improvisada oralmente, mas muitas vezes registrada por escrito, tem despertado o interesse de muitos estudiosos, em diferentes perspectivas, desde os estudos literários e culturais até as abordagens musicais e sociológicas. Poucos, entretanto, são os estudos realizados a partir de uma perspectiva propriamente linguística.

¹ Doctoral student in Language Sciences. Universidade Católica de Pernambuco (UNICAP).

E-mail: marinhosje@gmail.com Orcid: <https://orcid.org/0009-0003-7046-9410>

Lattes: <http://lattes.cnpq.br/9374576160422518>

² Dr. in Linguistics. Universidade Católica de Pernambuco (UNICAP). Universidade de Pernambuco (UPE).

E-mail: beneditobezerra@gmail.com Orcid: <https://orcid.org/0000-0002-7382-0937>

Lattes: <http://lattes.cnpq.br/7286734462024652>

Neste artigo, nosso objetivo foi realizar um estudo exploratório do gênero trocadilho na cantoria de viola à luz da perspectiva de Língua para Fins Específicos, sob o aporte teórico-metodológico da Análise de Gêneros (Swales, 1990). Metodologicamente, o estudo consistiu na aplicação da análise de movimentos retóricos a um *corpus* de vinte estrofes de sextilhas, gênero típico da cantoria de viola, de autoria de Louro do Pajeú, com foco no uso do trocadilho pelo poeta. Como resultado, foram constatados movimentos retóricos próprios tanto do universo da cantoria como específicos da poética do cantador. Esses movimentos podem ser mais gerais, guardando relação com os aspectos de introdução, desenvolvimento e conclusão do texto em qualquer gênero, assim como movimentos específicos do mundo da literatura oral, que desembocam em seu prisma estético e em seu contexto lúdico. Tais resultados poderão contribuir para lançar mais luzes sobre o gênero da cantoria e sobre a obra criativa de Louro, inclusive ressaltando os letramentos não formais típicos das atividades dos cantadores de viola.

Palavras-chave: Análise de Movimentos. Cantoria de Viola. Trocadilhos. Estratégias Retóricas.

RESUMEN

La cantoria de viola del noreste de Brasil, improvisada oralmente pero a menudo registrada por escrito, ha despertado el interés de muchos académicos desde diferentes perspectivas, que abarcan desde estudios literarios y culturales hasta enfoques musicales y sociológicos. Sin embargo, pocos estudios se han realizado desde una perspectiva estrictamente lingüística. En este artículo, nuestro objetivo fue realizar un estudio exploratorio del género del juego de palabras en la cantoria de viola desde la perspectiva del Lengua para Fines Específicos, utilizando el marco teórico y metodológico del Análisis de Género (Swales, 1990). Metodológicamente, el estudio consistió en aplicar el análisis de movidas a un *corpus* de veinte estrofas de seis versos (sextilhas), un género típico de la cantoria de viola, escritas por Louro do Pajeú, centrándose en el uso de juegos de palabras por parte del poeta. Como resultado, se observaron movidas retóricas características tanto del mundo de la cantoria de viola como de la poética del cantante. Estas movidas pueden ser más generales, relacionadas con la introducción, el desarrollo y la conclusión de un texto de cualquier género, así como movidas específicas dentro del mundo de la literatura oral, que culminan en su perspectiva estética y contexto lúdico. Estos resultados pueden contribuir a arrojar más luz sobre el género de la cantoria y la obra creativa de Louro, destacando las prácticas informales de alfabetismo típicas de las actividades de los cantadores de viola.

Palabras clave: Análisis de Movidas. Cantoria de Viola. Juegos de Palabras. Estrategias Retóricas.

1 INTRODUCTION

The singing of the northeastern viola is an important cultural phenomenon, which has aroused the interest of many scholars, from different perspectives, including literary, cultural, musical, historical, folkloric and sociological studies, among others. Several themes are explored when dealing with viola singing: biographies, narratives and testimonies of singers/repentistas (Silva, 2006a; Silva, 2006b; Araújo, 2010; Lima, 2018), conceptions about women in singing (Oliveira, 2010), the role of music in singing (Tavares, 2011) and, more recently, the poetics of singing (Santos, 2020), viola singing mediated by social networks (Nóbrega, 2020), singing as a semiotic and cognitive system (Atã; Queiroz, 2021) and changes and continuities in viola singing (Diniz, 2022), just to mention a few examples.

Articles, dissertations, and theses on viola singing have also been developed from graduate programs in linguistics, as is the case of Nóbrega's thesis (2020). The term *genre* is quite frequent in works in general, usually from a literary perspective that tends to emphasize formal elements such as meter, rhyme, and regular characteristics of the stanzas, as in Atã and Queiroz (2021). We did not find studies on viola singing as a genre from the point of view of rhetorical-linguistic theories. In fact, the work of Santana and Aguiar (2008) is very close, as it is based on contributions from Rhetorical Studies of Gender, via Marcuschi (2002, 2008). However, it discusses the genre of "virtual fighting" on the internet, in which poetry, although it dialogues with the genre of viola singing, is not characterized by suddenness or improvisation.

In view of these considerations, our objective is to undertake an exploratory study of the genre of northeastern viola singing in the light of the perspective of Language for Specific Purposes, under the theoretical-methodological framework of Gender Analysis (Swales, 1990), in dialogue with the approach of Rhetorical Gender Studies (Miller, 2012). This dialogue is also justified by the possibility of describing Swales' (1990) analytical methodology as a "linguistic-rhetorical" approach (Devitt, 2015; Bezerra, 2022).

Particularly, we intend to focus, from the perspective of gender studies, on aspects of the work of the famous viola singer Lourival Batista, Louro do Pajeú, a unique master in his craft, recognized as such by the discursive community of Brazilian oral poetry. The approach, which seems to us unprecedented for the genre of singing, consists of outlining a model for the analysis of the rhetorical and discursive functioning of sextillas built on the basis of puns, a peculiar mark of Louro do Pajeú's poetry. We arrived at this model through the application of the methodology of analysis of movements and rhetorical steps based on Swales (1990), originally illustrated by his CARS (*Create a Research Space*) model.

The work will be organized into seven topics, including this introduction. In the second

topic, we describe and discuss viola singing and one of its best-known genres, the sextile. In the third, we present brief information about the singer Louro do Pajeú and the pun technique as a characteristic of his poetry. The fourth topic is dedicated to the presentation of the concept of gender, with emphasis on the Gender Analysis based on Swales (1990). In the fifth topic, we present the methodological procedures of this study, supported by the methodology of analysis of rhetorical movements. The sixth topic is the place where the results are presented and discussed. We conclude the work, in the seventh topic, with some considerations and reflections on the study.

2 ON THE SINGING OF THE NORTHEASTERN VIOLA AND THE GENRE OF THE SEXTILE

Explicitly refuting folklorist approaches that treat it as something exotic and unused, Nóbrega (2020, p. 25) describes viola singing "as a present, living art, in constant dialogue with the world, a spokesperson for the people's yearnings and, in effect, a culture of resistance, and not as a residue of the past". In the definition of Tavares (2011, p. 31), viola singing consists of "poetry sung improvised in the interior of the Brazilian Northeast", in which typically two singers, accompanied by violas, but in a show "more poetic than musical", sing improvised verses, often on themes suggested by the audience. Although it began with simple poetic quatrains (stanzas of four verses), pé de parede singing, as viola singing is also called, today has "about 80 genres of improvisation" (Araújo, 2010, p. 30).

As for the poetic form of the sextile, a genre in which all the stanzas analyzed in this work participate, it is the introductory genre of singing. Any viola singing in the Northeast begins with a baião of sextillas. In the words of Tavares (2016, p. 33), "the sextile is the standard style of singing. The violists always start singing sextillas, and it is possible that, if no one requests another style, or no one delivers mottos, they will be singing sextile all night". The sextile, according to the author, is a stanza that is "malleable and solid: easy to manipulate, and capable of producing remarkable effects" (p. 33).

As for their formal aspects, the genres of singing have considerable structural stability. Named after the number of verses it contains, the sextile is composed of six verses of seven syllables, in which the second, fourth and sixth verses rhyme with each other, while the others do not have rhymes (with the exception that the first verse has to "take the cue" of the other singer, that is, the singer is forced to use the last rhyme left by the singing partner). In traditional notation, the rhyme scheme of the sextile can be described either as ABCBDB (indicating that only the verses "B" rhyme with each other) or XAXAXA, indicating the same

organization and emphasizing that the rhymes of the others, indicated by X, are "blank" (Tavares, 2016, p. 33).

Considered not only in its form, but also in its rhetorical component, in the social actions that the singers carry out through it, the sextile is the genre common to all the puns under analysis in this work. In this sense, the adoption of the sextile genre confers uniformity to our *corpus*, ensuring a common basis for the analysis of the textual and contextual elements of each stanza.

3 LOURO DO PAJEÚ, THE MASTER OF PUNS

The term *pun* today takes on different meanings, and can often be used to classify word games and sounds capable of generating pejorative, creative, funny meaning effects, depending on the situation. However, in this study, the term refers to the poetic, textual-discursive, aesthetic and stylistic resource used in a unique way by the poet singer of São José do Egito Lourival Batista, Louro do Pajeú.

The pun is not only one of the constructions present in the poet's work, it is the creative resource that distinguishes nature from his verve. According to Araújo (2010, p. 30), "old lovers of singing regret that puns are not made anymore, for example, such as those of the incomparable Lourival Batista Patriota, the Pernambuco native 'Louro do Pajeú'". In this respect, Louro was unique not only among his peers in viola singing, but also within a broader group of poets, so rare is the practice of this form of verse.

In the elaboration of the puns, improvised, let us remember, the poet goes beyond obeying the rules of rhyme and meter typical of the genres of viola singing. Louro's puns consist of playing with one's own language, with speech and writing, exploring pronunciation, spelling, polysemy and alliteration in letters, syllables, words, concepts and ideas. This characteristic was highlighted in Lourival Batista, according to the scholar of viola singing José Rabelo de Vasconcelos, "not only for the perfection of the puns but also for their quantity. In this aspect he is Louro of an impressive fecundity" (Vasconcelos, 1982, p. 3).

It is important to make it clear that we will not be here analyzing the cold text, the literal materiality of the planned text. It is necessary to remember that all the stanzas were built improvised, in the heat of the challenges suddenly, in the adrenaline of the singer who has in front of him an attentive and demanding audience, waiting for his desire to be satiated by the verses that are improvised according to the circumstances of the event. In all the stanzas to which we refer, the poet interacts directly with real characters who are present in the singing, a fact that reaffirms the concept of text as action and social interaction. Here, more than a physical artifact, we focus on the real encounter between the audience's expectation and the

rhetorical strategies that the poet uses to, in addition to achieving the purpose of the formal and aesthetic construction of the stanza, be able to involve his listener as the theme of the poem.

All this happens watered by true linguistic adventures among the infinite possibilities that language gives us when it is combined with the total freedom of the word transformed into poetry. Leite Filho (1982), in whose work the stanzas that we have selected for analysis are recorded, clarifies the value of the context in which the stanzas were elaborated and the unique content they bring. According to this author, it is a "poetics of light verse, a technique", in which the poet goes beyond the trivial, since, "because he better impresses the audience with the dexterity of his thought, in addition to improvising, he also does so by exchanging words, meaning, syllables, letters, etc." (Leite Filho, 1982, p. 6).

Improvising verses and improvising puns within those verses, that's what it's all about. Later on, the researcher returns to the theme, detailing and detailing the characteristics of singing suddenly:

To reach the merit of these verses, with the exception of the less informed; it is to be agreed how they were made: improvised, joining, at the same time, meter, rhyme, form, comparative sense in some, satirism and malice in others; this in the same intonation, without stopping to think or memorize beforehand, since in many of them the scarcity of time could not condition this hypothesis (Leite Filho, 1982, p. 9).

These details accentuate the understanding of the phenomenon of the use of puns as a singular mark of the creative genius of the poet and singer Lourival Batista Patriota. In the next topic, we will see the bases of the gender theory used in our analysis.

4 GENRES FROM A LINGUISTIC-RHETORICAL PERSPECTIVE: JOHN SWALES' THEORY

Well known, studied and influential within the field of research of genres in the area of linguistics, the theory and model of analysis constructed by John Swales (1990) were our basis, our reference element and the starting point for the investigation reported in this article. According to Swales (1990), the genre is associated with two other important concepts: discursive community and communicative purpose. First, the discursive community is defined as a socio-rhetorical network formed by participants who have common goals. Next, the genres practiced by the discursive community are endowed with communicative purposes, which consist of the functions or actions that each genre allows to be performed within a communicative situation. Genre is, after all, seen as a concept that encompasses a class of

communicative events, representative of the practices of discursive communities and mobilized by them to achieve their common goals.

From the methodological point of view, the classic contribution of Swales (1990) was the proposition of the CARS Model, an acronym for *Create a Research Space*. As can be seen from the terminology, the model refers to academic writing, and seeks to represent in the form of movements and steps the strategies used by researchers in the preparation of the introduction section of scientific articles. However, the model proved to be productive to the point of inspiring analyses of rhetorical movements of genres in different discursive domains, such as the literary domain and viola singing, to which we are now dedicated.

In the Brazilian context, as Bezerra (2022, p. 76) describes, "John Swales' thinking has grounded and influenced the work of Brazilian researchers at least since the 1990s, when the first gender studies appeared in the country." As the author points out, the methodology of analysis of rhetorical movements (*move analysis*) proposed by Swales has inspired numerous works on various genres.

In a nutshell, the CARS Model suggests the existence of three rhetorical movements in the construction of introductions to research articles, which would be: (1) Establish a research territory, (2) Establish a research niche, and (3) Occupy the niche. This ecological metaphor is proposed as representative of the linguistic-rhetorical strategies employed by researchers when writing their texts, in compliance with the conventions that confer stability to the genre.

In an illustrative way, Bezerra (2017) presents an application of the movement analysis model, based on the particularities of each discursive community and the rhetorical movements used to achieve the conventional communicative purposes of the genre. Bezerra's (2017) analysis is based on a *corpus* of 235 texts, called introductory genres of academic books, such as the introduction, introduction, and preface, which are analyzed together from the perspective of the phenomenon of the colony of genres (Bhatia, 2004). The texts are representative of three different disciplinary areas, namely, Linguistics, Theology and Biology.

Based on this analysis of the more than two hundred texts, Bezerra (2017) elaborates a descriptive model for each introductory genre, inferred from its data. It can be seen that the three models identify the composition of the genres presentation, introduction and preface as constituted by the same set of communicative purposes. However, the description of the genres varies, in subtle differences, when we look at the rhetorical movements carried out in each one. These differences are responsible for the uniqueness of each genre, justifying its mutually distinct existence, although closely related to the others.

Below we reproduce the descriptive models of each of the three genres, and then weave some reflections.

Table 1

Rhetorical organization of introductory genres of academic books

	GÊNERO APRESENTAÇÃO	GÊNERO INTRODUÇÃO	GÊNERO PREFÁCIO
PROPÓSITO COMUNICATIVO	JUSTIFICAR A OBRA	JUSTIFICAR A OBRA	JUSTIFICAR A OBRA
Movimentos retóricos	1. Definir o tópico central 2. Informar sobre o autor 3. Estabelecer o campo de estudo 4. Indicar os objetivos do livro 5. Informar sobre a origem do livro 6. Indicar lacuna a preencher	1. Definir/discutir o tópico central 2. Informar sobre o autor 3. Estabelecer o campo de estudo 4. Indicar os objetivos do livro 5. Informar sobre a origem do livro 6. Indicar lacuna a preencher	1. Definir/discutir o tópico central 2. Informar sobre o autor 3. Estabelecer o campo de estudo 4. Indicar os objetivos do livro 5. Informar sobre a origem do livro 6. Indicar lacuna a preencher
PROPÓSITO COMUNICATIVO	RESUMIR O CONTEÚDO	RESUMIR O CONTEÚDO	RESUMIR O CONTEÚDO
Movimentos retóricos	7. Apresentar/discutir o conteúdo	7. Apresentar/discutir o conteúdo	7. Apresentar/discutir o conteúdo
PROPÓSITO COMUNICATIVO	CONCLUIR A APRESENTAÇÃO	CONCLUIR A INTRODUÇÃO	CONCLUIR O PREFÁCIO
Movimentos retóricos	8. Fazer avaliação/recomendação final 9. Expressar desejos/votos de sucesso 10. Indicar potenciais leitores 11. Convidar à leitura 12. Felicitar o autor/edição/ outros 13. Fazer agradecimentos	8. Indicar potenciais leitores 9. Fazer agradecimentos 10. Felicitar o autor/edição/ outros	8. Indicar potenciais leitores 9. Fazer recomendação/ avaliação final 10. Fazer agradecimentos 11. Expressar desejo/ votos de sucesso

Source: Prepared from Bezerra (2017, p. 68, 73, 77)

From the table, we can observe how the close relationship between discursive community, communicative purpose and genres easily decants from this list of possible rhetorical actions. Let us see that, in the case analyzed, the communicative purposes do not change either from one genre to another, nor from one disciplinary field to another. This stability of communicative purposes characterizes the respective genres as practices legitimized by the discursive communities in which they are inserted. The importance of communicative purposes is such that it functions as a constitutive principle of the genre, determining other equally constitutive aspects, such as the style and structural organization of texts. It is defended by specialists in genre analysis, such as Bhatia (1993), that the differentiation of communicative purposes works as an indication that genres also become mutually distinguishable.

In the table under discussion, we note that the verbs "justify", "summarize" and "conclude" remain as an expression of the communicative purposes of genres linked to the discursive community of academia. Although the rhetorical movements may vary among the genres of the colony, as well as in the respective disciplinary areas, the communicative purposes permeate with some common measure the genres that circulate in this milieu. This happens because they use a similar lexicon, with differences typical of each disciplinary context, and make use of the relationships, traditions, and values of the same academic discourse, or of the same discursive community in a broad sense.

It is interesting that they are introductory genres from the point of view of the whole work (book), but internally, as autonomous texts that they are, they need to unite basic

elements of introduction, development and conclusion, the basic structure for the formation of a, let's say, coherent text. The verbs that assume the internal structural role of symbolizing this set of intratextual movements are in the rhetorical movements and not in the communicative purposes, which designates being in more flexible parts of the genres, those that can change according to the disciplinary field. But at the same time that they can float, they need to draw the aforementioned classic structure of introducing, developing, and concluding. Define, establish, inform. They are verbs linked to the introductory part of the genres.

Presenting and discussing is the duo that is repeated throughout the frame as a single rhetorical movement of the communicative purpose of summarizing the content, in principle, the central part and core of the general purpose of the introductory genre, the core of the presentation and promotion discourse that is intended to be carried out. The centrality of this unique movement is interesting. While the introduction and conclusion sessions are populated by various rhetorical movements, the development brings only one movement as the main action. It is as if plurality diluted its importance and singularity intensified its function and responsibility, reserving for entry and closure fewer roles than that of the center, where the real meaning of the text that is constructed is kept.

In the rhetorical movements, however, we easily see differences. Although they are not exacerbated distances, since they are located in the same discursive community, each of the genres and each of the areas brings particularities. The former, due to the precise function they perform individually, although related to the other texts, within the book support; these, by the customs, traditions and values defined by their members as appropriate for each of the sciences and each of the collectivities that locally carry out their activities.

It is this dynamic in the realization of communicative purposes through rhetorical strategies that we seek to capture in our analysis of the stanzas of viola singing, as a sign of the practices of the discursive community of repentista poets and their audiences.

5 METHODOLOGICAL PROCEDURES

For our study, we used the logic of the analysis of rhetorical movements, under the analogy of previously established models, such as the descriptive models of introductory genres exposed and discussed above. These, in turn, as mentioned, have already been built from empirical data and under the original inspiration of the CARS Model (Swales, 1990).

From the analogy with previous models of movement analysis, we sought to elaborate our own model, capable of responding to the unprecedented dimensions of this study, regarding the application of the methodology to verses of popular singing. With the caution

that the situation requires, we make use of such resources as if to try, from something put, consolidated and almost peacefully accepted, to undertake the elaboration of the initial draft of a model that suits our object of study.

As we have already made clear, the models or comparative starting points that we adopt originate in the studies of analysis of rhetorical movements initially outlined by Swales (1990) and Bhatia (2004), illustrated by their application in Bezerra's (2017) study on introductory academic genres. And what we pursue, from an analogical perspective and comparative investigation, is to analyze the rhetorical movements of a *corpus* of stanzas by the poet Louro do Pajeú in which the resource of puns was used.

20 stanzas were analyzed that internally and externally contain some elements of homogeneity. These elements of unification and homogeneity allow us to seek the regularity necessary for the deduction of a model of analysis of rhetorical movements appropriate to the object. These are stanzas that have already gone through a selection screen, which led them to be included in the work entitled *Louro do Pajeú: o rei dos pundilhos*, an independent publication of 1982, the result of research carried out by the poet, folklorist and researcher Aleixo Leite Filho.

All the texts are characterized as sextillas, the most characteristic genre of viola singing, and all were elaborated in some moment of direct and real-time interaction between Lourival and the audience. Almost always, a listener is the theme or even an important part of the stanza. It is worth noting that the fact that all stanzas have the same length sets a non-negotiable limit of six verses of seven poetic syllables for each set of rhetorical movements, which guarantees a structural element common to all texts and a consequent equality of realization for all utterances in which the common movements of construction and achievement of each communicative purpose will be sought.

6 THE RHETORICAL ORGANIZATION OF SEXTILLAS AND LOURIVAL BATISTA'S PUNS

As a result of the analysis of the stanzas that make up our *corpus*, we arrived at a descriptive picture of the communicative purposes and rhetorical movements manifested in the sextiles built on the basis of puns, improvised, by the poet Lourival Batista. At first glance at the picture, however, it is clear that we were faced with the need to propose some innovations or adaptations in the identification of peculiarities of purposes and movements.

Table 2

Rhetorical organization of the sextiles with puns by Lourival Batista

PRIOR COMMUNICATIVE PURPOSE	START THE PUN
Introductory rhetorical movements (1 and 2)	Choose a word, a concept, an idea or even a scene that is happening as a reference for the textual construction
Accessory or structural rhetorical movements (3)	Establishing a lexical and semiotic zone Build one or more of the six mandatory lines by finding the rhyme and meter that fit the pun
CORE COMMUNICATIVE PURPOSE	MAKE THE PUN
Major rhetorical movements (4 to 12)	Turning one word into another Turn two words into one Turn one word into two
Accessory or structural rhetorical movements (13)	Remove and add syllables, letters and accents. Use of alliterations Using paradoxes between ideas and words Using phonetic approximations Polysemy using Use of paronyms and homonyms Build one or more of the six mandatory lines by finding the rhyme and meter that fit the pun
ULTIMATE COMMUNICATIVE PURPOSE	PRESENT THE PUN
Final rhetorical moves (14 to 19)	Present the new formed word or the new made words Display the redone expression Present the inverted idea
Accessory or structural rhetorical movements (20)	Present the concepts in a different relationship from the one they had before the pun Present a new way of looking at a certain person, place or thing Present the deconstruction of something initially said Build one or more of the six mandatory lines by finding the rhyme and meter that fit the pun

Source: Elaboration by the authors

In order to understand these adaptations, some observations seem necessary to us. Unlike the descriptive models of the analysis of introductory academic genres, in which the central communicative purpose was reduced to a single rhetorical movement, in our case it is precisely the central communicative purpose that is carried out by a wider range of rhetorical strategies. We can understand this difference if we take into account that, unlike the academic domain, art, poetry, is significantly open to the boldness and innovation of its enunciator, the poet of the sudden, who is a master of the word.

Equally diverse are the rhetorical possibilities for the realization of the final communicative purpose, in which the poet can choose one or exceptionally more than one among a series of rhetorical movements. This fact is also understood when one notes the plurality of possibilities of the movements of the central purpose, with their consequences for the final communicative purpose. If for each action we have a result or consequence, the diversity of the second communicative purpose is reflected in the movements of the third. It is important to remember that only very parsimoniously will more than one movement be used to achieve each purpose, since six verses of seven syllables configure little space for such possibilities. The aspect of stability in the length of the text is responsible for the imagetic synthesis of poetry, an element that aesthetically highlights its value as a form of language.

Finally, we call attention to the existence, in all communicative purposes, of what we call accessory or structural rhetorical movements. It is important not to forget that we are dealing with an environment of aesthetic creation, which requires observing syllabic, phrasal and lexical conditions. This fulfillment is guaranteed by the rhetorical movement that enables the poet to give due attention to the formal singularities of the genre in which he is participating, as well as keeping it connected with the liturgy of singing. This rhetorical movement, possible in the initial, central and final communicative purposes, is described as accessory because it does not directly contribute to the elaboration of the pun, and it is also structural, or even structuring, because it helps the poet to formally organize the verses according to the structure and stabilized conventions of the sextile genre. Also in this accessory or structural/structuring movement are the episodes of the poet's praise of his own verve and capacity, in addition to the requests for payment directed to the listener. This aspect also reverberates the promotional discourse identified by Bezerra (2017) in his work on academic genres.

Let us see, below, some examples in which, to facilitate the understanding of our analytical procedures, the colors used in Table 2 are resumed in the verses of each stanza.

In this way, the color of the line or verse signals the respective communicative purpose and rhetorical movement.

Example 1: Stanza 4 (p. 12-13)

After the praise of the violists to a sergeant, promoting him to Lieutenant and Captain, without any result, the poet reacted:

This one will never be
Neither captain nor lieutenant
The gal he deserves
It's a different gallon
It's a dick with two cans
One behind the other in front

As the colors suggest, the first two verses serve as a preparation for the poet to find the rhyme and meter on which the pun will be based. It is movement 3, seen as accessory or structural/structuring of what follows. The third line expresses movement 1, in which the poet selects an idea or concept to erect the pun on it. The fourth line explores the homonymy of the term "galão", already within the scope of the central communicative purpose, performing the rhetorical movement 12. Concluding the stanza, the last two verses correspond to the final communicative purpose of presenting the pun, which is done through the rhetorical movement of re-presenting the concept of gallon in a different way than originally mentioned (movement 17).

A similar structure is verified in the next stanza, as indicated by our color code, which somehow points to a certain stability of the rhetorical strategies employed by the singer:

Example 2: Stanza 9 (p. 15)

In the city of Teixeira, when he was singing with the famous singer Severino Pinto, a driver named Pedro Compasso entered the hall, making a racket and getting drunk.

Ô Pinto pays attention
How the world is changing
Look there Pedro Compasso
How it comes with the wrong step
The other bars scratch
But this one arrived scratched.

However, the poet has a variety of strategies for the construction of his project of saying. Example 3, for example, shows a different rhetorical organization. Let's see:

Example 3: Stanza 19 (p. 24)

Lourival and Pinto sang in the presence of Gilberto Freyre, Câmara Cascudo, Germano da Hora and Aldemar Paiva, at Sítio da Trindade, in 1963, when Pinto asserted:

From Gilberto to us
Big difference has

Laurel:

The difference it has
From Freyre to Lourival:
He, the greatest Sociologist
From our homeland.
I'm also a partner soon
Entering without capital.

Once again, the poet begins the stanza with preparatory verses for the rhyme and the pun he will make in its development (lines in yellow). Then, he presents the initial rhetorical movement in which he categorizes Gilberto Freyre as "He, the greatest Sociologist". Accomplishing communicative purpose 2, the central purpose, he inserts another preparatory line, "From our homeland", and completes the rhetorical movement with the strategy of decomposing the term "sociologist" into "sociologo" (movement 6). Finally, the poet masterfully leads the stanza to the end with the verse "Entering without capital", representative of the rhetorical movement 18 (To present a new way of looking at a certain person, place or thing). In this case, it should be noted, the poet speaks of his own person. However, it also traces a relationship between "capital" and "homeland", in an allusion to the immediate context of the singing.

Table 3 presents the total occurrences of each rhetorical movement classified as the main one in the *corpus* of twenty texts analyzed, and may indicate the rhetorical and creative strategies preferred by the poet.

Table 3

Total occurrences of the rhetorical movements

Prior communicative purpose START THE PUN	Occurrences
M1 Choose word, concept, idea, or scene	18
M2 Choose lexical-semantic zone	03
Core communicative purpose MAKE THE PUN	

M4 Transform one word into another	02
M5 Turn two words into one	--
M6 Turn one word into two	06
M7 Remove and place syllables, letters, and accents	05
M8 Use of alliterations	02
M9 Using paradoxes between ideas and words	04
M10 Using Phonetic Approximations	01
M11 Use of polysemy	07
M12 Use of paronyms and homonyms	02
Final communicative purpose PRESENT THE PUN	
M14 Display the new word(s) made	06
M15 Display the redone expression	02
M16 Display the reversed idea	05
M17 Present the concepts in a different relationship from the one they had before the pun	04
M18 Present a new way of looking at a certain person, place or thing	03
M19 Present the deconstruction of something initially said	05

Source: Elaboration by the authors

As can be seen, we exclude from the picture the accessory or structural rhetorical movement, which is categorical in the *corpus*, except for a single stanza in which it does not occur. We will return to it later.

In the occurrences as a whole, we noticed a preference for the selection of a lexical item as the basis of the pun, a fact understandable by the very nature of the phenomenon, which is a game, a joke or an experiment with the use of language. It is also important to highlight that the sum of the rhetorical movements exceeds the number of stanzas in the *corpus*, since each stanza includes the realization of three or more movements for the poet's work to be carried out. By way of example, the initial communicative purpose of the twenty stanzas is accomplished, in total, by twenty-one occurrences of the two possible movements, excluding from this account the accessory or structural movement.

In the realization of the central communicative purpose, the rhetorical movements are more diversified in their occurrences, with a slight predominance of movements 6 and 11, namely, "transform one word into two" and "use polysemy", respectively. In the general framework of the central communicative purpose, to "make the pun, the sum of the rhetorical movements is more expressive than in the initial purpose. We perceive, therefore, the mobilization, on the part of the poet, of two or more rhetorical movements for the construction of a single pun. This aspect seems remarkable to us, considering the small space it has in the stanza, as it highlights the dynamic character of rhetorical and aesthetic creation.

The final communicative purpose, in which the pun is presented in its creative fullness, becomes evident as the place of the new, avoiding the mere exercise of verbal juggling. It is not a simple play on words, but the construction of coherence in the artistic discourse. The pun, in this way, is configured as a sophisticated enhancement for what the singer intends to say or, in terms consistent with our theory of genres, for the realization of the social action represented by singing as a linguistic and cultural activity.

In short, in just one stanza, the poet establishes himself in the essential pun, in him and for him. The ultimate communicative purpose of the pun-based sextile represents the apex of the creative process, in which the pun constitutes the new born of the artistic experiment. Also in this final communicative purpose, the rhetorical movements occur in greater quantity than the stanzas, combining to make it possible to carry out the action of presenting the finished pun.

Finally, it is worth making some observations about the rhetorical movement that we call accessory or structural, which can occur together with any of the three communicative purposes, be it initial, central or final. Table 4 presents a mapping of how many lines per stanza are used to perform this basic movement.

Table 4

Occurrences of the accessory rhetorical movement

Accessory or structural rhetorical movement Build one or more of the six mandatory lines in the stanza, finding the rhyme and meter that fit the pun	
Number of lines per stanza	Occurrences
No line	01
01 line	04
02 lines	07
03 lines	08

Source: Elaboration by the authors

It is immediately noteworthy that the singer dedicates considerable space in most of the stanzas to the structuring and preparation of the pun: in fifteen stanzas, two or three lines are dedicated to this purpose. A smaller number of stanzas, only four, uses only one line for accessory movement. And an apparently atypical case is represented by Stanza 3, in which the accessory rhetorical movement does not occur:

Example 4: Stanza 3 (p. 12)

From one of his calls to the listeners, this sudden suddenness originated:

I put the "d" and I put the "e"
 I put the "c" and I put the "a"
 Then an acute accent
 Instead of Deca it's deca;
 I take the "d" and I take the "e"
 Be Deca, come here!

In this stanza, everything is game and pun, without the use of accessory verses. The rhetorical movements related to the initial, central and final communicative purposes follow one another, totally supported by the creative work of the pun.

As a general rule, however, because it is the movement responsible for the poet's obedience to the literary and aesthetic demands of this genre of poetry, our *corpus* indicates that it is exceptional that it is not present, because although it does not constitute the pun itself, it guarantees it the formal (structural) basis, while serving its realization, conditioned by the poet's rhyming options and lexical choices. Let us think that, when it occupies three lines of the stanza, this means half of the sextile, which demonstrates its importance for the realization of the communicative purposes of the genre. Thus, it is possible to affirm that this movement constitutes the foundation for the construction of the others.

We will then see how the preparation for the pun occurs in rhetorical movements of different lengths, starting with the one in which the poet dedicates only one verse to this purpose.

Example 5: Stanza 13 (p. 18)

At the time of the death of St. John XXIII, he was singing with his other brother, Otacilio, when he commented:

The month has come to an end
 And the Pope no longer exists.

Lourival:

In all this, the saddest,
They both died at once;
The month is over with the Pope
And the Pope at the end of the month!
The month being thirty-one
And the Pope was twenty-three.

As can be seen, only the initial line, "in all this, the saddest", is dedicated to the accessory/structural movement. About this introduction, within the previous communicative purpose of starting the pun, the singer builds all his reasoning around a game between the end of the month and the end of the pope's life. In the following example, however, Lourival Batista dedicates not just one, but two lines of the stanza to the same purpose.

Example 6: Stanza 18 (p. 22)

At the house of the poet João Batista de Siqueira (Cancão), the celebration was animated by the presence of several singers, including: Manoel Chudú, Jó Patriota, Lourival Bandeira and Lourival Batista. The last two were exchanging friendly matches when Dr. José Gomes dos Passos arrived at the venue.

Bandeira finished the stanza:

The Prosecutor has arrived
To bring us the best

Batista added:

I myself have perked up now
Spotting the Prosecutor:
Because we know it ourselves,
Pro is in our favor,
With the dynamo of Law
He starts the engine.

In this example, the accessory rhetorical movement is distributed between the first and third lines of the stanza, maintaining its function of supporting the elaboration of the pun. Finally, in the next example, this function extends over three lines, half of the stanza.

Example 7: Stanza 10 (p. 16)

Severino Pinto was comparing himself to a painter, in relation to his verses, when he finished:

Regarding the landscape,
It is a fruitful idea

Then Louro replied:

Saturday, Sunday, Monday
Tuesday, Wednesday and Thursday
On Friday not missing me

The canvas, the brush, the paint
Paint painting what I paint
I paint what Pinto paints

The dynamic and flexible way in which rhetorical movements are manifested, in order to enable the realization of the respective communicative purposes, in the case of our *corpus*, is consistent with what the literature predicts, as shown by some considerations made by Bezerra (2017). According to the author, the simultaneous occurrence of movements is not mandatory, given the only relative stability of any and all genders, but it is possible, as we have seen. Also according to the researcher, there are cases in which movements are presented "in very different and variable ways, denoting the use of diversified rhetorical strategies, which seek to meet different demands related to social practices implied by the production, use, and reception of gender" (Bezerra, 2017, p. 67). In the social practice of viola singing, and particularly in the construction of sextiles based on puns on Louro do Pajeú, we find that this is exactly what it is about.

Since the text is a dynamic process and the genre is a plastic and malleable communicative event, there is nothing that guarantees an absolute order of realization of rhetorical movements, despite the stability of the communicative purposes in our *corpus*. The dynamic character of the language in use, the particularities of the contexts and, in our case, the creative freedom of poetry, generate movements that accompany subjectivity and singularity and do not only reproduce conventions. Rather, they stamp the novelty of the moment lived between the artist and his audience, responsible for the multiplicity and plurality of rhetorical movements mobilized for interaction.

7 FINAL CONSIDERATIONS

In this study, our objective was to carry out an exploratory study of the pun genre in viola singing in the light of the gender theory based on Swales (1990), applying the method of analysis of rhetorical movements to a *corpus* of sextillas, a very typical and popular genre in viola singing. In addition, we directed the focus of the analysis to the work of the poet Lourival Batista Patriota, Louro do Pajeú, selecting the sextiles by the criterion that they were built based on puns and, of course, made improvised.

Thus, what we did in this work, in a way, as far as we know, unprecedented, was to apply to a genre of the poetic discursive domain a theory of genres and a methodology usually used for the study of genres of academic writing. We understand that this analytical exercise proved to be fruitful and productive, with the potential to shed new light on the study of the poetic text and particularly of viola singing.

The look at Louro's sextiles, and particularly at the way in which the poet constructs the puns in them, from the perspective of the communicative purposes and rhetorical movements of the genre, reinforces the particularities of the artistic creative process, emerging from the concrete situations in which the stanzas were made. These situations, on the other hand, are tributaries of the complexity and dynamism of the contexts in which the social practices of the discursive community that loves viola singing are developed, which will ultimately contribute to shaping the communicative purposes carried out by the genre.

As for the analysis of rhetorical movements in the stanzas of sextillas based on puns, we found that the dynamism and versatility of the poetic work are maintained and stand out even in the face of the considerable formal stability of the genre, translated into the requirement of meter, rhyme and number of verses. With the support of a structural/structuring rhetorical movement, the initial, central and final movements of the sextile are constituted, in Louro do Pajeú's work, in an innovative way and always capable of surprising the audience present at the singing. According to the records made of the oral event of the singing, a later and potentially larger audience, formed by listeners of eventual audio recordings or by readers of anthologies such as that of Leite Filho (1982), will continue to be surprised by the poet's creative strategies, strategies that are also of a constitutively rhetorical nature.

Because we recognize the inexhaustibility of poetic talent and the inexhaustible capacity for reinvention of artistic language, we do not intend, with this study, to offer a ready-made and finished model of analysis. We believe, however, that the analysis presented here constitutes a starting point and a sign that new perspectives on the genres of singing are possible. These new perspectives may be extended, in future studies, including to test the effectiveness of the model, to the rest of Lourival Batista's work and, of course, to the work of other memorable names in northeastern oral poetry.

REFERENCES

- Araújo, J. M. B. de. (2010). *Voz, viola e desafio: Experiências de repentistas e amantes da cantoria nordestina* [Dissertação de mestrado, Universidade de São Paulo]. Repositório USP. <https://repositorio.usp.br/item/002131842>
- Askhave, I., & Swales, J. M. (2009). Identificação de gênero e propósito comunicativo: Um

- problema e uma possível solução. In B. G. Bezerra, B. Biasi-Rodrigues, & M. M. Cavalcante (Eds.), *Gêneros e sequências textuais* (pp. 221–247). Edupe.
- Atã, P., & Queiroz, J. (2021). O externalismo semiótico ativo de C. S. Peirce e a cantoria de viola como signo em ação. *Trans/Form/Ação*, 44(3), 177–204.
- Bawarshi, A. S., & Reiff, M. J. (2013). *Gênero: História, teoria, pesquisa, ensino*. Parábola Editorial.
- Bezerra, B. G. (2017). *Gêneros no contexto brasileiro: Questões (meta)teóricas e conceituais*. Parábola Editorial.
- Bezerra, B. G. (2022). *O gênero como ele é (e como não é)*. Parábola Editorial.
- Bhatia, V. K. (1993). *Analysing genre: Language use in professional settings*. Longman.
- Bhatia, V. K. (2004). *Worlds of written discourse: A genre-based view*. Continuum.
- Devitt, A. J. (2015). Genre performances: Genre analysis and rhetorical-linguistic genre studies. *Journal of English for Academic Purposes*, 19, 44–51.
- Diniz, J. J. O. (2022). *Entre repentes e sertões: Presença, mudanças e continuidades da cantoria de viola no Seridó potiguar* [Dissertação de mestrado, Universidade Federal do Rio Grande do Norte]. Repositório UFRN. <https://repositorio.ufrn.br/handle/123456789/52160>
- Leite Filho, A. (1982). *Louro do Pajeú: O rei dos trocadilhos*. Ed. do Autor.
- Lima, M. V. S. (2018). Nas trilhas da poesia e cantoria de viola nordestina: Memórias do poeta e cantador Alberto Porfírio. *História e Culturas*, 6(12), 134–153.
- Miller, C. R. (2012). *Gênero, agência e tecnologia*. Parábola Editorial.
- Nóbrega, M. V. (2020). *A cantoria de viola na contemporaneidade: Seus poetas em performance e memórias; estratégias para formação poética de apologistas e repentistas* [Tese de doutorado, Universidade Federal da Paraíba]. Repositório UFPB. <https://repositorio.ufpb.br/jspui/handle/123456789/18545>
- Oliveira, L. N. (2010). *Figuras do feminino na cantoria nordestina* [Dissertação de mestrado, Universidade Estadual da Paraíba]. TED-e UEPB. <http://tede.bc.uepb.edu.br/jspui/handle/tede/2615>
- Santana, D. P., & Aguiar, M. A. M. (2008). *Peleja virtual: Um novo gênero do discurso?* [Comunicação apresentada no Colóquio de Análise do Discurso]. Universidade Federal de Pernambuco.
- Santos, M. E. A. (2020). *Circularidade das vozes: A poética da cantoria de viola no Ceará* [Tese de doutorado, Universidade Federal da Paraíba]. Repositório UFPB. <https://repositorio.ufpb.br/jspui/handle/123456789/18358>
- Silva, M. I. (2006a). “O rei dos cantadores de viola nordestina”: Sua história e sua glória. *Boitatá*, 1(2), 62–77.
- Silva, M. I. (2006b). *Cantoria de viola nordestina: Narrativas sobre a vida e a performance dos repentistas* [Dissertação de mestrado, Universidade Federal da Bahia]. Repositório UFBA. <https://repositorio.ufba.br/handle/ri/29727>
- Swales, J. M. (1990). *Genre analysis: English in academic and research settings*. Cambridge University Press.

- Swales, J. M. (2004). *Research genres: Exploration and applications*. Cambridge University Press.
- Tavares, B. (2011). Função da música na cantoria de viola. *Synergies Brésil*, 9, 31–37.
- Tavares, B. (2016). *Arte e ciência da cantoria de viola: Cantoria: Regras e estilos (Vol. 1)*. Bagaço.
- Vasconcelos, J. R. (1982). Prefácio. In A. Leite Filho, *Louro do Pajeú: O rei dos trocadilhos* (pp. 3–4). Ed. do Autor.

PROBLEM-BASED LEARNING: TEACHING EXPERIENCE IN THE CONTEXT OF THE WATER CRISIS

APRENDIZAGEM BASEADA EM PROBLEMAS: EXPERIÊNCIA DE ENSINO NO CONTEXTO DA CRISE HÍDRICA

APRENDIZAJE BASADO EN PROBLEMAS: EXPERIENCIA DE ENSEÑANZA EN EL CONTEXTO DE LA CRISIS HÍDRICA



<https://doi.org/10.56238/sevened2026.008-122>

Francisca Marli Rodrigues de Andrade¹, Daniela Faria de Souza², Wendel Mattos Pompilho³

ABSTRACT

The water crisis represents one of the main contemporary socio-environmental challenges, associated with climate change, environmental degradation, and unsustainable models of water use. In the Brazilian context, despite the country's wide water availability, these processes occur unevenly across the territory, intensified by deforestation, water pollution, and structural deficiencies in basic sanitation. Within this framework, this article analyzes the application of the Problem-Based Learning (PBL) methodology in teaching about the water crisis in the municipality of São José de Ubá, in the state of Rio de Janeiro, with ninth-grade elementary school students. The study adopts a qualitative, exploratory, and descriptive approach, using participant observation and field diary records throughout a pedagogical project developed over six in-person meetings. The results indicate that PBL promotes meaningful learning by articulating scientific knowledge with local experiences, fostering autonomy, collaboration, and critical thinking. A cognitive shift was observed, as students moved from fragmented explanations toward a broader understanding of the water crisis, incorporating structural factors such as deforestation, pollution, and the lack of sanitation. The study concludes that PBL has significant potential for addressing environmental themes in elementary education by integrating school, community, and territory, thus reaffirming the transformative role of education.

Keywords: Water. Active Methodologies. Water Crisis. Elementary School.

RESUMO

A crise hídrica constitui um dos principais desafios socioambientais contemporâneos, associada às mudanças climáticas, à degradação ambiental e aos modelos insustentáveis de uso da água. No contexto brasileiro, apesar da ampla disponibilidade hídrica, esses processos se manifestam de forma desigual, agravados por desmatamento, poluição dos

¹ Dr. in Education, Culture of Sustainability and Development. Universidade de Santiago de Compostela (USC). Universidade Federal Fluminense (UFF). E-mail: marli_andrade@id.uff.br

² Master's degree in Teaching. Universidade Federal Fluminense (UFF). E-mail: danielafa-ouza@hotmail.com

³ Dr. of Science (Agricultural Biochemistry). Universidade Federal Fluminense (UFF). E-mail: danielafa-souza@hotmail.com

corpos d'água e fragilidades no saneamento básico. Diante desse cenário, este artigo analisa a aplicação da metodologia Aprendizagem Baseada em Problemas (ABP) no ensino da temática da crise hídrica no município de São José de Ubá, no estado do Rio de Janeiro, com estudantes do 9º ano do Ensino Fundamental. A pesquisa adota uma abordagem qualitativa, de caráter exploratório e descritivo, utilizando a observação participante e registros em diário de campo ao longo de um projeto pedagógico desenvolvido em seis encontros presenciais. Os resultados indicam que a ABP favorece a aprendizagem significativa ao articular conhecimentos científicos às vivências locais, promovendo autonomia, colaboração e pensamento crítico. Observou-se um deslocamento cognitivo dos estudantes, que passaram de explicações fragmentadas para uma compreensão mais ampla da crise hídrica, incorporando fatores estruturais como desmatamento, poluição e ausência de saneamento. Conclui-se que a ABP apresenta elevado potencial para o ensino de temáticas ambientais na Educação Básica, ao integrar escola, comunidade e território, reafirmando o caráter transformador da educação.

Palavras-chave: Água. Metodologias Ativas. Crise Hídrica. Ensino Fundamental.

RESUMEN

La crisis hídrica constituye uno de los principales desafíos socioambientales contemporáneos, vinculada al cambio climático, a la degradación ambiental y a modelos insostenibles de uso del agua. En el contexto brasileño, a pesar de la amplia disponibilidad hídrica, estos procesos se manifiestan de forma desigual en el territorio, agravados por la deforestación, la contaminación de los cuerpos de agua y las deficiencias estructurales en el saneamiento básico. En este marco, el presente artículo analiza la aplicación de la metodología de Aprendizaje Basado en Problemas (ABP) en la enseñanza de la crisis hídrica en el municipio de São José de Ubá, en el estado de Río de Janeiro, con estudiantes de noveno grado de la educación primaria. La investigación adopta un enfoque cualitativo, de carácter exploratorio y descriptivo, utilizando la observación participante y registros en un diario de campo a lo largo de un proyecto pedagógico desarrollado en seis encuentros presenciales. Los resultados indican que el ABP favorece el aprendizaje significativo al articular el conocimiento científico con las experiencias locales, promoviendo la autonomía, la colaboración y el pensamiento crítico. Se observó un desplazamiento cognitivo de los estudiantes, quienes pasaron de explicaciones fragmentadas a una comprensión más amplia de la crisis hídrica, incorporando factores estructurales como la deforestación, la contaminación y la ausencia de saneamiento. Se concluye que el ABP presenta un alto potencial para el abordaje de temáticas ambientales en la educación primaria, al integrar escuela, comunidad y territorio, reafirmando el carácter transformador de la educación.

Palabras clave: Agua. Metodologías Activas. Crisis Hídrica. Educación Primaria.

1 INTRODUCTION

Water is a universal common good, essential for the maintenance and balance of ecosystems in general and the planet itself (Rhoden *et al.*, 2016). According to the National Water and Basic Sanitation Agency (ANA), it is estimated that of all the vast amount of water that exists in the world, 97.5% is salt and 2.5% is fresh water; However, of this 2.5%, only 1% corresponds to the resource of rivers and lakes, the most accessible form for human consumption⁴. The rest of the fresh water is mostly in the polar caps and on mountains in the form of snow and ice. These quantities focus on other important issues for the balance of the planet and the future of humanity, such as: scarcity, power, food sovereignty, among others. In 2015, data from the Food and Agriculture Organization of the United Nations (FAO) indicated that more than 40% of the world's population already suffered from water shortage, and with the weather forecasts, this percentage would tend to jump to 2/3 of the population in 2050 (FAO, 2015).

Over the years, there has been an increase in the complexity of the various uses of water and, with it, a wide dimension of pollution and degradation (Soares; Souza, 2020). In the last century, "freshwater consumption has increased 6-fold [...] and continues to advance at a rate of 1% per year, as a result of population growth, economic development, and changes in consumption patterns" (UNESCO, 2021). On this argument, the conclusions of Tundisi and Matsumura-Tundisi (2011) and the ANA report (2023) highlight that some of the fundamental factors responsible for the water crisis in the world are associated with population growth. Added to this, there is still the loss of water containment instruments that occur through some situations such as: deforestation, elimination of flooded regions, reduction in the volume of rivers and lakes due to the accumulation of sediments, among others.

In view of this scenario, the scientific literature has widely pointed out the need for improvements in the models of planning and management of water use. In general, studies highlight that the planning and management of water resources aim to promote the sustainable use of this asset, mitigate the impacts associated with changes in land use and occupation, and strengthen conservation practices, in order to reduce waste and inappropriate use of water (Locke, 2024; Wang, 2025). To this end, it is important to preserve water resources, based on the promotion of educational, constructive and awareness-raising activities (Balbinot *et al.*, 2008; Lanes *et al.*, 2022a). In this sense, a notable progress for the management of water resources in Brazil was Law No. 9,433/97, which established the

⁴ More information on this topic is available at <https://www.gov.br/ana/pt-br/aceso-a-informacao/acoes-e-programas/cooperacao-internacional/agua-no-mundo>.

National Water Resources Policy and instituted, in Brazil, the National Water Resources Management System, based on its article 1:

- I - Water is a good in the public domain;
- II - Water is a limited natural resource, endowed with economic value;
- IV - The management of water resources must always provide for the multiple use of water;
- V – The hydrographic basin is the territorial unit for the implementation of the National Water Resources Policy and the performance of the National Water Resources Management System;
- VI – The management of water resources must be decentralized and count on the participation of the Government, users and communities. (Brazil, 1997)

Within the scope of recent international policies and treaties on water, the new political approach of the Sustainable Development Goals (SDGs) comprises the economic, social and environmental spheres, as part of a new sustainable development program, called the 2030 Agenda (UN, 2019). The 2030 Agenda is an action plan that points out the 17 SDGs and, in detail, their 169 goals to end poverty and provide dignity for all within the limitations of the planet. These are objective goals for all countries to integrate water management among their priorities and also to work in universal cooperation to benefit people's lives in the present and future (UN, 2020).

According to the 2030 Agenda, among the 17 SDGs is goal 6 "Drinking Water and Sanitation", which aims to ensure the availability and sustainable management of water and sanitation for all. Based on this objective, this article focuses primarily on target 6.7b: "to support and strengthen the participation of local communities to improve water and sanitation management" (UN, 2019). Therefore, this article places at the center of the discussions some ways to stimulate the participation of students in the management of water resources, based on an environmental demand in the city of São José de Ubá, in the state of Rio de Janeiro.

With this contextualization, this article aims to analyze the application of the Problem-Based Learning (PBL) methodology in the teaching of the water crisis theme, in the municipality of São José de Ubá, with a class of the 9th grade of Elementary School at the Maria Leny Vieira Ferreira Silva State School. The proposition of the use of this methodological approach takes place within a panorama of problematization and obligation to address the environmental themes provided for in the National Policy of Environmental Education, Law No. 9.795 of April 27, 1999 and in the National Common Curricular Base (BNCC), among other normative frameworks of Brazilian education.

In this sense, the educational approach to water resources and other environmental components should be present in school educational curricula and, therefore, in all stages of

school education (Lanes *et al.*, 2022a). Therefore, the relevance of this article is to contribute to the strengthening of active methodologies in Basic Education, expanding the debate on the role of the teacher as a mediator of knowledge. In addition, the article highlights the need for pedagogical practices that integrate cognitive, ethical, and socio-environmental dimensions of school education, in which water can be understood as a central element for the promotion of critical education that allows the articulation of scientific content, social issues, and contemporary challenges related to sustainability. The inclusion of the theme of water in the school daily life favors the development of socio-environmental awareness and the responsible use of this resource (Lanes *et al.*, 2022b).

2 PROBLEM-BASED LEARNING (PB): METHODOLOGICAL DESIGN OF THE RESEARCH

Problem-Based Learning (PBL) is a type of active methodology, through which students act in a participatory way in the construction of their own knowledge, with all attention focused on their learning (Glasgow, 2019). According to Moran (2018, p. 4) "active methodologies emphasize the student's leading role, their direct, participatory and reflective involvement in all stages of the process, experimenting, drawing, creating, with the guidance of the teacher". In PBL, students relate collaboratively with a view to the elaboration of knowledge and, therefore, attribute to the teacher the role of mediator who intervenes in their group dialogues. In this process, the focus is on the students' learning independence and not on the practice of teaching, as knowledge is built as a result of this relationship (Maidame, 2018; Alves *et al.*, 2025).

To contextualize, it is important to emphasize that PBL was initially implemented by the McMaster University School of Medicine in Canada in 1969, and by the University of Maastricht, in the Netherlands in the 70s (Souza; Dourado, 2015; Pereira Ronn *et al.*, 2019). After that, this methodology underwent modifications to adapt to other teaching contexts, being built as a result of the efforts of professors and coordinators of these institutions to fill some gaps in traditional teaching, especially those related to learning in medical courses and professional medical practice (Souza; Dourado, 2015). In Brazil, the State University of Londrina (UEL) and the Faculty of Medicine of Marília (FAMEMA) were the first institutions to apply this methodology, and then other institutions also adopted it (Araújo; Arantes, 2009).

For a differentiation between PBL and traditional teaching, the literature indicates that in traditional methodological perspectives the teacher occupies the center of the pedagogical process, transmitting knowledge considered finished and students assimilate it in a passive position and, thus, thinking and taking initiative are not encouraged (Glasgow, 2019).

Regarding passive learning, Ribeiro (2010, p. 9) points out that "there is a consensus that this (traditional) methodology is no longer able to promote the meaningful learning of conceptual knowledge". For this reason, the author adds that such a methodology cannot encourage the development of other types of knowledge and skills, valued and demanded in professional and social life (Ribeiro, 2010).

Based on the theoretical debate presented, the research understands that traditional teaching methods do not favor the confrontation of the problems of our time, especially environmental problems. Thus, school educational processes need to stimulate the strengthening of participatory societies and, with this, develop responsible, scientific, critical and creative thinking, committed to the civilizing process. In the search for these competencies, the National Common Curricular Base (BNCC) emphasizes the importance of exercising intellectual curiosity in Elementary School, using the approach of Science (Brasil, 2017). In other words, to include "inquiry, reflection, critical analysis, imagination, and creativity, to investigate causes, to elaborate and test hypotheses, to formulate and solve problems, and to create solutions [...] based on the knowledge of different areas" (Brasil, 2017, p. 9).

Within this context, PBL has been gaining ground as an active methodology that has shown important results in the process of knowledge production, particularly in higher education (Maidame, 2018; Pereira Ronn *et al.*, 2019; Alves *et al.*, 2025). However, this methodology is still little known in the context of Basic Education in Brazil and, when known, it continues to be little implemented and explored (Lopes *et al.*, 2019). This means a loss of opportunity to address environmental problems of everyday reality, in a contextualized and territorialized way, without losing sight of the central element of the teaching-learning process; that is, the applicability of knowledge in the reality experienced by students.

Research carried out both in Higher Education and in Basic Education – by Sales, Del and Sales (2013), Maidame (2018), Pereira Ronn *et al.* (2019), Alves *et al.* (2025) – positively evaluated the use of PBL. The results of these studies showed that the participants showed acceptance of the methodology, as well as that it enabled the development of problem-solving skills, allowed self-learning and encouraged the search for knowledge. In turn, in the studies of Borochovcicius and Tortella (2014) the results highlight that the conquest of knowledge begins with the presentation of a problem-situation, very close to the reality of the students. Therefore, the fact that there is no predetermined resolution leads to the emergence of doubts and questions, which stimulate reflective activity that, at the same time, will direct the student to a probable solution of the proposed problem.

The possibilities of developing the scientific, critical and creative thinking of students

was decisive for the choice of the methodological approach of PBL in this research. Although this methodology has its origin in teaching in the medical field, its foundations are consistent for it to be worked on at other levels of education and areas of knowledge (Ribeiro, 2010; Borochovcicius; Tassoni, 2021). In this adaptation, the research that originated this article took place at the Maria Leny Vieira Ferreira Silva State School, located in the city of São José de Ubá, in the Northwest region of the state of Rio de Janeiro. The empirical work was carried out from the execution of a research project entitled "Our daily water: preserving the life of tomorrow",⁵ which included 6 face-to-face meetings lasting three hours each, totaling 18 hours of activities.

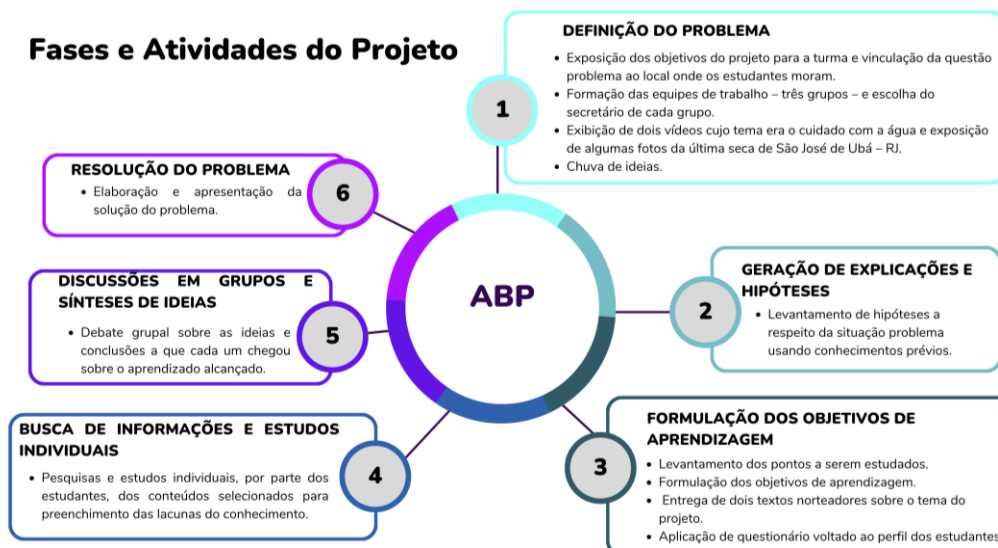
In accordance with the qualitative approach, of an exploratory and descriptive nature, in addition to the objective already presented, this article seeks to explore the understanding of the meanings attributed by students to the learning experience, rather than to quantify its results (Mónico *et al.*, 2017). Likewise, this article aims to fill an existing gap regarding the low use of APB in Basic Education and, consequently, the low scientific production on its use in this educational stage (Borochovcicius; Tassoni, 2021). For this reason, it assumes the exploratory approach as an empirical horizon, given the low expressiveness of research of this nature (Lopes *et al.*, 2019). Additionally, it assumes a detailed description of the actions, procedures, stages and results, in order to provide a broad overview of the process of applying PBL in Elementary School, based on an environmental problem. This description will not only allow the analytical construction of the results, but will also allow the replication of the research in other contexts and with other themes within the scope of Basic Education.

The empirical work of the research had the participation of 21 students from the 9th grade of Elementary School. The criteria for selecting the subjects included: a) voluntary participation in the activity; b) regular attendance in Science classes; c) authorization of those responsible, as determined by Resolution No. 510/2016 of the National Health Council (Brasil, 2016). These 21 students were protagonists in the two stages of the study: a) *theoretical approach* – active construction of knowledge about the water issue of the municipality made possible by the PBL; b) *practical activities* – dissemination of some of the results obtained in the first phase of the project through posters, making of a handmade dripper and distribution of tree seedlings for reforestation. The first stage of the research was structured based on two main questions, which constitute the main results of this article. The organization overview of this step can be seen in Figure 1.

⁵ This research meets all ethical protocols for research involving human beings, being registered under CAAE 38937320.8.0000.5288 and with project approval by opinion 4.323.811.

Figure 1

Problem-Based Learning: phases and activities carried out



Source: Elaboration by the authors (Research data, 2025).

The six phases of the first stage of the research, as described in Figure 1, were planned and executed according to the literature that studies the applicability of APB (Borochovicius; Tortella, 2014; Conrado *et al.*, 2014; Silva *et al.*, 2015). Methodologically, the research was built based on the descriptive qualitative approach, precisely: on the observation, description and interpretation of the phenomenon studied (Mónico *et al.*, 2017). For this, we used the field diary as an instrument for data production, complemented by a record of the students' speeches and observations of the researchers recorded at each stage of the development of the research. For the organization and interpretation of the material, the methodological approach of Thematic Analysis was used, since it allows the identification of relevant patterns and themes from the textual data, that is, it enables the identification of deep meanings in the descriptions of the phenomena (Braun; Clarke, 2006). Therefore, the Thematic Analysis allowed the organization of the thematic categories related to the perception and response of students about the water crisis, group work and interdisciplinary learning.

In order to ensure the reliability and validity of the data, the triangulation of the information was adopted, taking as reference: observations, statements, written records and results achieved with the application of PBL. Such triangulation met the functionality of seeking convergences and divergences in the meanings expressed by the research participants (Flick, 2018). In this sense, following the steps indicated by the theoretical framework adopted in the article, the process of applying PBL was guided by the following problem questions: What are the possible reasons for the lack of water in the municipality of

São José de Ubá? And what are the possible ways to solve these problems?

Both questions subsidized the development of the research, whose scientific relevance is inscribed in the scope of environmental studies and active methodologies. In a broader perspective, the results were organized into three emerging thematic categories, based on thematic analysis: *understanding the environmental problem*; *autonomy* and *collaboration in learning*. Each of these categories reflects the way students experienced PBL and articulated knowledge with their daily experiences.

3 RESULTS AND DISCUSSIONS

In PBL, the presentation of the problem, associated with the students' reality, is essential for the success of the later stages (Silva *et al.*, 2015; Borochovcicius; Tassoni, 2021). With this, the students who led the research discussed the problem in small groups – in this case, in 3 groups of 7 students – where they raised hypotheses to explain the problem, and such assumptions were based on the use of previous knowledge. After these two stages, presentation of the problem and formation of the working groups, a survey was carried out of the gaps that still needed to be studied, as well as the formulation of the new learning objectives, which will be detailed in Figure 1.

Subsequently, the students followed the following steps: *a)* they sought different sources of information; *(b)* they made individual studies on the selected themes; *(c)* discussed these contents in groups; and, *d)* established a consensus regarding the resolution of the problem. During the development of all stages, periodic evaluations were carried out through observation about the development of the methodology, since "in PBL, evaluation is part of the learning process and the production of individual and group knowledge" (Souza; Dourado, 2015, p. 196). Likewise, the role of tutor teachers in all stages of PBL was maintained; that is, the role of mediator and facilitator, guiding the students' activities and valuing the cooperative elaboration of knowledge, where each student contributes to the construction of learning processes on the topic studied (Maidame, 2018).

3.1 BRAINSTORMING: UNDERSTANDING THE ENVIRONMENTAL PROBLEM

In PBL, the *Brainstorming stage* – in this article, showers of ideals – is presented as an essential element to encourage divergent thinking and cognitive collaboration about the problem to be solved. The term brainstorming refers to one of the stages of the PBL methodology where students must expose their flow of ideas in relation to the exposed theme, and this flow is based on previous knowledge and common sense (Conrado *et al.*, 2014). In this stage of the empirical work, we showed two videos, whose theme was the care of water:

the episode of Chaves in cartoon and Juca Pingo D'água. In the mediation process, we presented the objectives of the project to the class and associated the problem issue with the city where the adolescents live. After that, we exhibit some photos of the region of São José de Ubá demonstrating the last drought that the municipality and region went through. Afterwards, the students were encouraged to debate about the central issues related to the videos and photos, and received a sheet to write down their ideas while debating as a group. Based on the information obtained, we prepared a word cloud graph, the results of which can be seen in Figure 2.

Figure 2

Brainstorming: students' perceptions of the lack of water



Source: Elaborated by the authors. Research Data (2025).

The data shown in Figure 2 represent the words most cited by the students in the brainstorm and, therefore, these themes began to guide the development of the project, namely: drought and lack of water; pollution and springs. Regarding the first, drought and lack of water, it is worth mentioning that the municipality of São José de Ubá has a dry tropical climatic type, presenting a negative annual water balance. In the period from February to October, evapotranspiration is greater than precipitation, causing water shortage for most of the year, in addition to the occurrence of dry spells with a notable frequency (Lumbreras *et al.*, 2011). The average annual rainfall in the municipality is 1172 mm (Gonçalves *et al.*, 2006; Noronha *et al.*, 2016).

In addition to the significant dry season, the region still has vast areas predominantly occupied by pastures, few forest remnants and a high degree of soil degradation, which characterizes environmental problems (Lumbreras *et al.*, 2011). Historically, the practice of deforestation in recharge regions, as well as in soil areas with low agricultural propensity and

in riparian forest regions, causes relevant losses of soil, nutrients, organic material and, especially, water, which is closely related to the drought of numerous springs in the municipality (Freitas *et al.*, 2001). Vegetation destruction in the region is worrying, since in the period between 2013 and 2014 only 5% of the extension of the municipality of São José de Ubá was covered by Atlantic Forest, which is equivalent to 1,205 hectares (TCE-RJ, 2016).

With regard to water pollution in the city of São José de Ubá, a theme often evoked in the students' brainstorming, as it is a mostly agricultural area, there are diffuse sources of water contamination in the municipality. Conventional tomato cultivation is significant in this city, associated with the use of pesticides that, in most cases, are applied inappropriately, contaminating rivers and springs (Carneiro *et al.*, 2015). Remnants of these products are retained in the soil and, with rain, they can reach the groundwater and/or be carried to surface waters, thus causing their pollution and degradation (Soares; Souza, 2020). These elements reveal that the students were able to associate everyday issues with the study problem in the first stage of PBL – *brainstorming*.

The research data reveal that the central themes of the environmental problems of São José de Ubá were evoked by the students, which demonstrates that these situations are part of their realities and that they were contextualized in the development of the methodology. Still on the pollution of water, rivers and springs, the ABRASCO dossier released in 2015 warns about the impacts of pesticides on health and the environment (Carneiro *et al.*, 2015). Despite the warnings, between 2019 and 2022, Brazil experienced the highest number of registrations of new pesticides for a presidential administration, since 2003; that is, the release of 2,182 new pesticides (Firmino *et al.*, 2024).

Additionally, among the various forms of water pollution and contamination listed by the students, in the municipality of São José de Ubá sewage treatment is not carried out in urban and rural spaces. Therefore, the waste is dumped *in natura in the* floodplains and water bodies of the municipality, and can even affect the water located in the wells, especially in the rural area, with a view to the domestic supply of residents (Rio de Janeiro, 2015). Thus, the data presented in this article, obtained through the brainstorming, reveal that the students are not oblivious to the environmental problems of the municipality, since pollution appears at the center of their concerns.

The main results in this stage indicate that the students, initially, presented a fragmented understanding of the water crisis, attributing it to the lack of rain or domestic waste. However, throughout the process, the broader structuring dimensions of the problem were integrated, such as: deforestation, contamination of rivers and inequality in access to water. This cognitive displacement demonstrates the power of PBL as a mediator of

meaningful learning, since the students reformulated their hypotheses based on dialogue and collaborative research. This corroborates the idea that learning occurs when new information is integrated, in a non-arbitrary way, into the pre-existing cognitive structure (Silva *et al.*, 2015). During the group discussions, one of the students said: "*we always think that there is a lack of water because the people spend a lot, but now I understand that the problem is bigger, it comes from the companies and the forests that have been cut down.*" This statement translates the conceptual advance provided by the method, revealing the transition from common sense to a critical reading of reality.

3.2 GENERATION OF HYPOTHESES AND OBJECTIVES: AUTONOMY AND COLLABORATION IN THE ABP

In *the second* and *third* phases of the research, the students were invited to develop hypotheses for the problem questions, create learning objectives and, thus, achieve these objectives through research. After the brainstorming, the students began to debate, in their respective working groups, the two central issues to be solved. At this stage of the research, students were invited to answer the problem questions only using their previous knowledge, without using any means of research, as adopted in the studies by Borochovcicius and Tortella (2014), Silva *et al.* (2015), Maidame (2018). During this phase, one of the students in group 2 asked if she could write something that she believed "did not make much sense", showing insecurity in relation to her previous knowledge. Such an occurrence is possibly associated with the absence of protagonism in learning itself, as one of the striking characteristics of traditional teaching. Figure 1 shows the hypotheses raised by the students in each group, as well as the other research questions.

Figure 1

Hypotheses and learning objectives: group responses

Groups	Hypotheses	Questions	Group responses
Group 1	One of the first reasons for the lack of water is the lack of rain and intense heat; the pollution of rivers; lack of basic sanitation; the rise in deforestation, etc. The ways to solve it would be to make more (artificial) rivers; new management to capture rainwater; nets at the mouths of the manholes; turn off the tap at bath time (soaping); turn off the tap when brushing our teeth and when washing the car (or any other car). In 2017 there was one of the biggest droughts in São José de Ubá, many animals died, with the devaluation of the government.	1) Why do they still throw garbage in rivers, lakes and beaches?	1) Because it is not the people who throw the garbage, it is the government that does not know how to provide the preparations where they are going to dump so much material that can be reused.
		2) Why is there no more basic sanitation in São José de Ubá?	2) The government says it does not have the money for quality basic sanitation for the city.
		3) Why don't they still wash the	3) Because they think it is easier and more practical to wash with a

		cars with the buckets?	hose, but they do not know that they use liters of water just in washing a car.
Group 2	Irresponsibility; pollution; deforestation; waste; lack of rain; fires; throwing garbage on the streets and in the seas; Do not use disposable straws and cups. The ways to solve it would be to have responsibility (save water); do not throw oil into the sink drain; do not throw garbage on the ground; do not cut down trees; not to set fire to the forest and to make people aware of the lack of water on the planet; use reusable straws and cups; stop polluting the rivers in order to be able to continue with the life of the beings that live on planet Earth.	4) Why doesn't it rain as often as before in my city?	4) The region's rainfall regime is characterized by long periods of drought, low rainfall and maximum peak rainfall.
		5) Why are there places that rain more than others?	5) Because there are places close to the sea or with a lot of exposed water and in others they are drier.
Group 3	Lack of rain; the waste of water; the pollution of rivers with sewage. The ways to solve it would be: reuse the waters of the river; we try to avoid waste in the gardens; try to avoid the use of pesticides that pollute the water table; when brushing the tooth, turn off the tap; reduce shower time; improve sanitation, trying to take their path to the rivers.	6) Why doesn't it rain like it did in Ubá?	6) Due to global warming, climate change, deforestation, among other factors.
		7) Does the weather interfere?	7) Yes, climate change interferes with everything in our lives.
		8) Are we far from sea level, so are we without rain?	8) Not only for that, but for other reasons as well.

Source: Elaborated by the authors. Survey data (2025).

The process of generating hypotheses within the PBL methodology is of great importance, given that through this process it is possible to awaken creativity and increase the motivation of students, since the hypotheses of resolution are problems linked to everyday life (Souza; Dourado, 2015; Silva *et al.*, 2015). In addition, because it involves students' previous knowledge, the generation of hypotheses expands the critical capacity for analyzing problems and developing solutions. In addition, the joint construction of hypotheses leads to interaction between students and the acquisition of interpersonal skills, such as respect and cooperation. Such abilities were also verified in the studies carried out by Souza and Dourado (2015), Silva *et al.* (2015), Borochovcicius and Tassoni, (2021), Alves *et al.* (2025) as well as in the behavior of students during the development of this research. During the elaboration of the hypotheses, it was possible to perceive a collaborative and friendly relationship between the students, so that they were motivated to solve the questions, demonstrating autonomy and curiosity in relation to the resolution of the problem.

The research data indicate that two, out of a total of three groups, were more successful in generating hypotheses. Regarding the applicability of PBL, Ribeiro (2010, p. 89) mentions that this transition requires time, understanding and adaptation from students,

in the "passage from passive to active learning". The author also points out that "it is necessary to take into account the effects of the adoption of PBL in view of the years of schooling of students in conventional teaching environments" (Ribeiro, 2010, p. 76). In turn, the results obtained with the majority of students corroborate that the structuring of questions, during the dynamics of problem discussion, collaborates positively for the development of autonomy, critical and reflective capacity of students (Silva *et al.*, 2015).

According to the data shown in Figure 1, in relation to the hypotheses, the data indicate that the students used daily issues observed in their daily experiences, as a way to justify the environmental problems of São José de Ubá, linking the responsibility that society should have in relation to environmental degradation. After this phase of the research, the groups of students wrote down the points that they believed still needed to be studied. Then, they took these to their homes to be researched and studied individually, with a period of one week for this research. With regard to the points to be studied, we observed, in part of the participants, a certain restlessness and desire to understand the following issues: *a)* society's contemptuous behavior towards water; *(b)* the climatic phenomena that govern rainfall in the municipality.

At this stage of the PBL methodology, we advise you to read two texts: "Water: without it we will be the planet Mars of tomorrow", by the author Marco Antônio Ferreira Gomes (2011); a news article⁶ in which he states that the Chamber of Deputies created a commission to evaluate a project that intends to classify the North and Northwest of the state of Rio de Janeiro as a semi-arid area. Such texts had the purpose of subsidizing students in the search for information. Remembering that the main points that the groups mentioned in the elaboration of hypotheses are related to: public policies; climate issues; habits and behaviors of society.

Regarding public policies, the students accessed information about the Municipal Basic Sanitation Plan (2015 – 2034) of the city of São José de Ubá, whose actions were designed to generate short, medium and long-term impacts. Such actions are mainly linked to the municipality's water supply, and some of the objectives of this plan consist of the "protection of springs used for public supply [...]; recomposition of riparian forest at the source [...]; preparation of periodic campaigns and activities with the participation of the community related to the rational use of water" (Rio de Janeiro, 2015, p. 79). Although the students did not mention this plan in their written answers, they pointed out the main issues linked to it, such as the fight against waste, the protection of water bodies and the need for sanitation.

⁶ Available at: <<https://g1.globo.com/rj/norte-fluminense/noticia/2019/08/07/camara-cria-comissao-para-avaliar-projeto-que-quer-classificar-norte-e-noroeste-do-rj-como-area-de-semiarido.ghtml>>. Accessed on: September 22, 2020.

In turn, on climate issues, the participants mentioned various aspects related to climate and its relationship with water resources. This aspect is relevant considering that the climate changes that have been occurring and intensifying in recent years can cause very significant consequences for the global supply of drinking water (UNESCO, 2015; FAO, 2015). Climate change can influence the natural water cycle, since phenomena such as unusual temperature and precipitation patterns, increased frequency of disastrous meteorological episodes involving water resources such as cyclones, and long periods of drought, have an impactful influence on freshwater systems (Tundisi; Matsumura-Tundisi, 2011).

In relation to the changes in habits and behaviors on the part of the population, mentioned by the students, the literature indicates that the way water is treated by society in general is closely linked to a crisis triggered by a worldview centered on the utilitarianism of natural goods and on the form of development defined by society (Soares, 2022). This crisis is a consequence of an extensive process of appropriation and exploitation of nature, which has been accentuated with the evolution of industrial capitalism, generating a socio-environmental crisis (Andrade 2020; Lanes *et al.*, 2022b).

After the elaboration of the hypotheses, studies of the suggested texts and autonomous research carried out by the students, the three groups met again, exchanged ideas about the individual study in their homes and their conclusions were noted, as shown in Figure 1. Before the elaboration of the final solution of the problem questions, we held a debate with the students, aiming to make some considerations about the discussions of some groups. The purpose of this debate was, as Maidame (2018) points out, to avoid misunderstandings in relation to the central issues to be solved. Some examples of these misconceptions were: *"it is not the people who throw the garbage in the water bodies, but the government that does not know how to take the necessary measures regarding the disposal of the waste"* (G1-R1⁷). Often, public agencies are omissions, but this does not exempt society and companies from the duty to seek the appropriate way to dispose of waste, so that water bodies would be an unjustifiable alternative.

One of the mistakes made by the students refers to the rainfall characteristics of the region, without mentioning the changes that these patterns have been undergoing (G2-R4); as well as, *"because there are places close to the sea or with a lot of exposed water and in others they are drier"* (G2-R5). In this case, the influence of maritimity and continentality on the rainfall regime was cited, as claimed by Armond (2015) and Diniz *et al* (2014), however, São José de Ubá is not close to the sea. Following misconceptions we have: *"we are far from sea level, so we are without rain"* (G3-R8), which indicates that we would be at high altitudes

⁷ Code used to identify the workgroup and response number.

and, consequently, in conditions of low atmospheric pressure most of the time. As low atmospheric pressure conditions favor precipitation, according to the National Institute for Space Research (INPE, 2020), we should not suffer, therefore, from the scarcity of rainfall.

Another mistake discussed in this phase of application of the PBL methodology is related to the altitude of São José de Ubá itself, in this case, low altitude – 120m (Gonçalves; Nobleman; Bastos, 2006). Thus, since atmospheric pressure is inversely proportional to altitude, high pressure conditions disfavor the formation of clouds, and, consequently, precipitation in the region (INPE, 2020). After these elucidations and discussions, the students jointly reached the solution of the questions. In this way, they realized that the possible reasons for the lack of water in the municipality of São José de Ubá are:

- ✓ R1 – Rampant deforestation with a view to agriculture. Such practice has seriously harmed the water infiltration process, due to the significant lack of vegetation and soil exposure. Therefore, the limited amount of rainfall that falls on the region cannot be stored for later use during the months with no precipitation.
- ✓ R2 – The pollution caused by numerous factors, such as pesticides, sewage, garbage, among others.
- ✓ R3 – The waste practiced by the inhabitants, who are often unaware of the water situation in which the municipality has found itself in recent years and treat water as an infinite resource. (Survey data, 2025)

Regarding the possible ways to solve these problems, the students mentioned: *a)* the reforestation of devastated areas, especially regions close to the springs, aiming to increase the process of recharging the groundwater in an attempt to revitalize water bodies that have been drying up; *(b)* the need to sensitize the community as a whole so that everyone is aware of the situation in which the city of São José de Ubá finds itself, with regard to its water resources. With these answers, it is evident the importance of the school developing educational practices about water beyond its walls, involving the community and seeking the possibilities of solving the problem (Lanes *et al.*, 2022a). In this sense, the data obtained in this research are significant in view of the reality of the city, since significant learning is also characterized by the interaction between knowledge in the transitory and non-asymmetric evolutionary relationship.

The research data highlight that through PBL it was possible to stimulate reflective and critical thinking, considering previous knowledge and the reality that constitutes the daily life of students. The development of the PBL methodology, associated with the water crisis in the city, promoted an interrelationship between the school and the community and, therefore, should be encouraged through pedagogical activities that portray the needs of society. The use of PBL makes it evident that the theoretical knowledge formulated by students can be

applied in their contexts and, in this way, allow the occurrence of meaningful learning. Possibly, the pedagogical gains obtained through PBL will help in the construction of a new vision of the socio-environmental reality of students.

In this context, the students' considerations and notes highlight: *a)* the need for efficient public policies, aimed at environmental and water management in the municipality; *(b)* effective reforestation policies and actions aimed at the protection of riparian forests; *(c)* an operating basic sanitation program; *(d)* permanent partnerships with school units, aiming at new project proposals, with regard to environmental issues. These data reinforce the idea that intellectual autonomy and cooperation are fundamental principles of PBL (BorochoVICIUS; Tortella, 2014; Conrado *et al.*, 2014). This is because, by being invited to build hypotheses, test ideas and discuss solutions, the students exercised investigative thinking and collective argumentation. In other words, they collectively built precise strategies that enabled self-education processes.

4 CONCLUSION

The research aimed to analyze the application of the Problem-Based Learning (PBL) methodology to address the water problem in the municipality of São José de Ubá, with an Elementary School class. The main results of the research indicate that in the brainstorming phase, the participants mostly mentioned the lack and pollution of water in the municipality, exemplifying such problems from the experiences of daily life. These findings corroborate the literature used in this article, with regard to the understanding of the problem situation, from the perspective of the students' reality. In other words, these results highlight that PBL favors the construction of meanings based on the concrete experience of students, that is, they validate the theoretical assumption that knowledge is an active, social and contextual process.

With regard to autonomy and collaboration among the members of the groups, the results indicate that the pedagogical experiences built by two groups, out of a total of three, were more expressive based on the essence of PBL. The students in these groups were more open to PBL, showed greater commitment and curiosity in relation to the development of the methodology. In turn, one group had lower adherence to the research, since some of its members had difficulties adapting to PBL, especially during the second phase – generation of hypotheses. In all three groups, some students received the methodology, at first, with trepidation. However, during the course of the project, most of them did not present any difficulty in adapting. On the contrary, a significant part of the students seemed enthusiastic about their own evolution in the construction of knowledge about their reality. This can be

explained by the autonomy and collaboration they experienced during the process; Something that, until then, in the words of the students, was not part of the pedagogical processes adopted by the school.

On the one hand, these results highlight the central role of the teacher as a mediator and facilitator of learning, within the scope of PBL. On the other hand, the findings reveal the structural limits of public schools, such as: lack of pedagogical time and scarcity of didactic resources, elements that restrict the full application of active methodologies such as PBL. Even in the face of these situations, the most expressive results of the research indicate that the PBL methodology is appropriate and efficient to work on environmental issues with elementary school students, including water resources, in its multiple approaches. This is because the students were able to transport this acquired learning capacity to their daily lives, transcending the school environment. In addition, the students developed other skills essential to the exercise of citizenship, especially those necessary for an active participation in the spaces and debates that involve current environmental problems.

For this reason, the analyses highlight the contribution of PBL to the debate on the role of the school in the formation of subjects concerned with current environmental problems, capable of recognizing the links and dimensions that associate environment, politics and citizenship. In addition, the results show that practices based on autonomy, investigation and cooperation can awaken in students a sense of belonging and socio-environmental responsibility. However, the research indicates some limitations observed, among them: the short period of application of the methodology, organized in six meetings, which suggests the need for long-term studies that can explore the permanence of the effects of PBL over time. Even so, the article highlights that PBL integrates scientific knowledge with local experiences and, therefore, reaffirms the transformative potential of education.

REFERENCES

- Alves, C. L., et al. (2025). Aprendizagem baseada em problemas no ensino básico: Aplicação em feiras de ciências. *Revista Práxis*, 17(31), 1–8. <https://revistas.unifoa.edu.br/index.php/praxis>
- Agência Nacional de Águas e Saneamento Básico. (2023). Conjuntura dos recursos hídricos no Brasil 2023: Informe anual. <https://www.gov.br/ana/pt-br/centrais-de-conteudos/publicacoes/conjuntura-dos-recursos-hidricos>
- Andrade, F. M. R. de. (2020). Desenvolvimento sustentável na Amazônia brasileira: Significados e conceitos. *Education Policy Analysis Archives*, 28, Article 187. <https://epaa.asu.edu/index.php/epaa/article/view/5117>
- Araújo, U. F., & Arantes, V. A. (2009). Comunidade, conhecimento e resolução de problemas: O projeto acadêmico da USP Leste. In U. F. Araújo & G. Sastre (Eds.), *Aprendizagem baseada em problemas no ensino superior* (pp. 101–122). Summus.

- Armond, N. B. (2015). A dinâmica horária da chuva no município do Rio de Janeiro: Contribuições para a análise geográfica dos episódios extremos. In Anais do XI Encontro Nacional da ANPEGE. ANPEGE.
- Balbinot, R., et al. (2008). O papel da floresta no ciclo hidrológico em bacias hidrográficas. *Ambiência*, 4(1), 131–149. <https://revistas.unicentro.br/index.php/ambiencia/article/view/294/1892>
- Borochovcicius, E., & Tortella, J. C. B. (2014). Aprendizagem baseada em problemas: Um método de ensino-aprendizagem e suas práticas educativas. *Ensaio: Avaliação e Políticas Públicas em Educação*, 22(83), 263–294. <https://doi.org/10.1590/S0104-40362014000200002>
- Borochovcicius, E., & Tassoni, E. C. M. (2021). Aprendizagem baseada em problemas: Uma experiência no ensino fundamental. *Educação em Revista*, 37, Article e20706. <https://doi.org/10.1590/0102-469820706>
- Brasil. (1997). Lei nº 9.433, de 8 de janeiro de 1997. Institui a Política Nacional de Recursos Hídricos e cria o Sistema Nacional de Gerenciamento dos Recursos Hídricos. Presidência da República. https://www.planalto.gov.br/ccivil_03/leis/l9433.htm
- Brasil. (2016). Resolução nº 510, de 7 de abril de 2016. Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais.... Conselho Nacional de Saúde. <https://www.gov.br/conselho-nacional-de-saude/pt-br/atos-normativos/resolucoes/2016/resolucao-no-510.pdf>
- Brasil. Ministério da Educação. (2017). Base Nacional Comum Curricular (BNCC). http://basenacionalcomum.mec.gov.br/images/BNCC_EI_EF_110518-versaofinal_site.pdf
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa> (ou link alternativo: https://elearning.unimib.it/pluginfile.php/1495342/mod_resource/content/1/Using-thematic-analysis-in-psychology-1.pdf)
- Carneiro, F. F., et al. (Eds.). (2015). Dossiê ABRASCO: Um alerta sobre os impactos dos agrotóxicos na saúde. EPSJV; Expressão Popular.
- Conrado, D. M., Nunes-Neto, N. F., & El-Hani, C. N. (2014). Aprendizagem baseada em problemas (ABP) na educação científica como estratégia para formação do cidadão socioambientalmente responsável. *Revista Brasileira de Pesquisa em Educação em Ciências*, 14(2), 77–87. <https://doi.org/10.5216/bgg.v34i1.29313>
- Flick, U. (2018). Triangulation in data collection. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (pp. 527–544). SAGE.
- Food and Agriculture Organization of the United Nations. (s.d.). Rumo a um futuro de segurança hídrica e alimentar. <http://www.fao.org.br/2050eavpmasams.asp>
- Firmiano, F. D., et al. (2024). A reiteração permanente do modelo predatório do agronegócio brasileiro: O caso dos agrotóxicos. *Retratos de Assentamentos*, 27(2).
- Freitas, P. L., Manzato, C. V., & Coutinho, H. L. C. (2001). A crise de energia e a degradação dos recursos naturais: Solo, ar, água e biodiversidade. *Boletim Informativo, Sociedade Brasileira de Ciência do Solo*, 26, 4–7.

- Glasgow, N. A. (2019). Ensino e aprendizagem hoje: Modelos básicos e opções. In R. M. Lopes, M. V. S. Filho, & N. G. Alves (Eds.), *Aprendizagem baseada em problemas: Fundamentos para a aplicação no ensino médio e na formação de professores* (pp. 17–46). Publiki.
- Gonçalves, A. O., Fidalgo, E. C. C., & Bastos, C. L. (2006). Caracterização climática do município de São José de Ubá, Estado do Rio de Janeiro. Embrapa Solos.
- Instituto Nacional de Pesquisas Espaciais. (2020). Glossários: Princípios de meteorologia e meio ambiente. <https://www.cptec.inpe.br/glossario.shtml>
- Lanes, D. M., Andrade, F. M. R. de, & Miranda, J. C. (2022a). Abordagens educativas da água e BNCC: Potencialidades pedagógicas de uma cartilha didática. *Ciência Geográfica*, 26(3), 1675–1704.
- Lanes, D. M., Miranda, J. C., & Andrade, F. M. R. de. (2022b). Recursos didáticos e educação ambiental. *Revista Educação Pública*, 22(22).
- Locke, K. A. (2024). Integrated water resources management and the land-water nexus: A South African perspective. *World Water Policy*, 10(3), 755–779.
- Lumbreras, J. F., et al. (2011). Levantamento de reconhecimento de média intensidade dos solos da bacia hidrográfica do rio São Domingos - municípios de São José de Ubá e Itaperuna, RJ. Embrapa Solos.
- Maidame, G. F. (2018). *Aprendizagem baseada em problemas no Ensino Fundamental II: Aplicabilidade, potencial e reflexões de uma adaptação sob perspectivas geocientíficas* [Tese de doutorado, Universidade Estadual de Campinas].
- Moran, J. (2018). Metodologias ativas para uma aprendizagem mais profunda. In L. Bacich & J. Moran (Eds.), *Metodologias ativas para uma educação inovadora: Uma abordagem teórico-prática* (pp. 1–24). Penso.
- Mónico, L., et al. (2017). A observação participante enquanto metodologia de investigação qualitativa. *CIAIQ*, 3, 724–733.
- Noronha, G. C., Hora, M. A. G. M., & Silva, L. P. (2016). Análise do índice de anomalia de chuva para a microbacia de Santa Maria/Cambiocó, RJ. *Revista Brasileira de Meteorologia*, 31(1), 74–81.
- Organização das Nações Unidas. (s.d.). Objetivos de Desenvolvimento do Milênio. <https://nacoesunidas.org/tema/odm/>
- Organização das Nações Unidas. (s.d.). PNUD explica transição dos Objetivos do Milênio aos Objetivos de Desenvolvimento Sustentável. <https://nacoesunidas.org/pnud-explica-transicao-dos-objetivos-do-milenio-aos-objetivos-de-desenvolvimento-sustentavel/>
- Pereira Ronn, A., et al. (2019). Evidências da efetividade da aprendizagem baseada em problemas na educação médica: Uma revisão de literatura. *Revista Ciência e Estudos Acadêmicos de Medicina*, 1(11), 23–42.
- Rhoden, A. C., et al. (2016). Importância da água e da gestão dos recursos hídricos. *Revista Ciências Agroveterinárias e Alimentos*, 1(1).
- Ribeiro, L. R. C. (2010). *Aprendizagem baseada em problemas (PBL): Uma experiência no ensino superior (1ª reimpr.)*. EduFSCar.

- Rio de Janeiro. Secretaria de Estado do Ambiente. (2015). Plano Municipal de Saneamento Básico de São José de Ubá - PMSB. <https://pmsbguanabara.files.wordpress.com/2017/03/sc3a3o-josc3a9-de-ubc3a1.pdf>
- Sales, A. B., Del, A. M., & Sales, M. B. (2013). Avaliação da aplicação da aprendizagem baseada em problemas na disciplina de interação humano e computador de curso de engenharia de software. *RENOTE*, 11(3), 1–10.
- Silva, S. L., et al. (2015). Estratégia educacional baseada em problemas para grandes grupos: Relato de experiência. *Revista Brasileira de Educação Médica*, 39(4), 607–613.
- Soares, A. F. S., & Souza, L. P. S. (2020). Contaminação das águas de abastecimento público por poluentes emergentes e o direito à saúde. *Revista de Direito Sanitário*, 20(2), 100–133.
- Soares, D. F. H. (2022). Precarização do acesso à água no município de Jaboatão dos Guararapes, Pernambuco [Dissertação de mestrado, Universidade Federal de Pernambuco].
- Souza, S. C., & Dourado, L. (2015). Aprendizagem baseada em problemas (ABP): Um método de aprendizagem inovador para o ensino educativo. *Holos*, 5, 182–200.
- Tribunal de Contas do Estado do Rio de Janeiro. (2016). Estudos socioeconômicos dos municípios do estado do Rio de Janeiro – São José de Ubá – 2016. <http://www.tce.rj.gov.br>
- Tundisi, J. G., & Matsumura-Tundisi, T. (2011). Recursos hídricos do século XXI (2ª ed.). Oficina de Textos.
- United Nations Educational, Scientific and Cultural Organization. (2015). Relatório mundial das Nações Unidas sobre desenvolvimento dos recursos hídricos 2015. Água para um mundo sustentável. Sumário executivo. <https://www.unwater.org/publications/un-world-water-development-report-2015>
- United Nations Educational, Scientific and Cultural Organization. (2021). Relatório Mundial das Nações Unidas sobre Desenvolvimento dos Recursos Hídricos 2021 – O valor da água. Resumo executivo. https://unesdoc.unesco.org/ark:/48223/pf0000375750_por
- Wang, D., et al. (2025). Impacts of water conservation, wastewater treatment, and reuse on water quantity and quality stress mitigation in China. *Journal of Industrial Ecology*, 29(3), 777–793.

SPECIAL AND INCLUSIVE EDUCATION IN THE 21ST CENTURY: CHALLENGES AND POSSIBILITIES WITH THE USE OF NEW TECHNOLOGIES IN TEACHING AND LEARNING

EDUCAÇÃO ESPECIAL E INCLUSIVA NO SÉCULO XXI: DESAFIOS E POSSIBILIDADES COM O USO DAS NOVAS TECNOLOGIAS NO ENSINO-APRENDIZAGEM

EDUCACIÓN ESPECIAL E INCLUSIVA EN EL SIGLO XXI: RETOS Y POSIBILIDADES CON EL USO DE NUEVAS TECNOLOGÍAS EN LA ENSEÑANZA Y EL APRENDIZAJE



<https://doi.org/10.56238/sevened2026.008-123>

Adilson Oliveira Cruz¹, Áquila Jerard Moulin Ditzz², Athyla Caetano³, Camila Bruschi Tonon⁴, Eglalciane de Lyrio Tongo Castro⁵, Evelyn de Oliveira Vieira da Silva⁶, Renata Perozini⁷, Renato Kohler Zanqui⁸, Rosieli Geraldina Merotto Foletto⁹, Silvana Beatriz D'Ávila Costa Lenzi¹⁰, Thayna da Silva Raymundo¹¹

ABSTRACT

The consolidation of inclusive education as a guiding principle of contemporary educational policies poses significant challenges to schools, particularly regarding the guarantee of learning rights for students with disabilities in mainstream education settings. In this context, digital technologies emerge as potential resources for overcoming pedagogical, communicational, and attitudinal barriers. This article aims to analyze the challenges and possibilities of using digital technologies within special and inclusive education, focusing on their role in mediating the teaching-learning process. This qualitative study is based on a critical literature review, grounded in national authors and official legal documents that guide inclusive education policies in Brazil. The analysis indicates that although digital and assistive

¹ Master's degree in Computer Science. Libera Università di Bolzano.

² Master's degree in Teaching. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

³ Master's degree in Science and Mathematics Education. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

⁴ Master's degree in Science and Mathematics Education. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

⁵ Master's degree in Business Administration. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

⁶ Master's degree in Physics Teaching. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

⁷ Master's degree in Science and Mathematics Education. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

⁸ Master's degree in Science and Mathematics Education. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

⁹ Master's degree in Science and Mathematics Education. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

¹⁰ Specialization certificate in School Environmental Education. Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo (IFES).

¹¹ Master's degree in Entomology. Universidade Federal de Viçosa (UFV).

technologies expand access, participation, and personalized learning opportunities, their effectiveness depends on structural, pedagogical, and professional development factors, such as continuous teacher training, intentional instructional planning, and the transformation of exclusionary conceptions still present in school culture. It is concluded that the critical and contextualized use of technologies can significantly contribute to building a truly inclusive school when aligned with an emancipatory and equitable pedagogical project.

Keywords: Inclusive Education. Digital Technologies. Teaching and Learning. Disability. Teacher Education.

RESUMO

A consolidação da educação inclusiva como princípio orientador das políticas educacionais contemporâneas impõe desafios significativos à escola, especialmente no que se refere à garantia do direito à aprendizagem de estudantes com deficiência em contextos regulares de ensino. Nesse cenário, as tecnologias digitais emergem como recursos potenciais para a superação de barreiras pedagógicas, comunicacionais e atitudinais. O presente artigo tem como objetivo analisar os desafios e as possibilidades do uso das tecnologias digitais no âmbito da educação especial e inclusiva, com foco na mediação do processo de ensino-aprendizagem. Trata-se de uma pesquisa de natureza qualitativa, desenvolvida por meio de uma revisão bibliográfica crítica, fundamentada em autores nacionais e em documentos legais que orientam as políticas de inclusão no Brasil. A análise evidencia que, embora as tecnologias digitais e assistivas ampliem as possibilidades de acesso, participação e personalização do ensino, sua efetividade depende de fatores estruturais, formativos e pedagógicos, como a formação continuada dos professores, o planejamento didático intencional e a superação de concepções excludentes ainda presentes na cultura escolar. Conclui-se que o uso crítico e contextualizado das tecnologias pode contribuir para a construção de uma escola verdadeiramente inclusiva, desde que integrado a um projeto pedagógico comprometido com a equidade, a diversidade e a justiça social.

Palavras-chave: Educação Inclusiva. Tecnologias Digitais. Ensino-Aprendizagem. Deficiência. Formação Docente.

RESUMEN

La consolidación de la educación inclusiva como principio rector de las políticas educativas contemporáneas plantea importantes desafíos a las escuelas, especialmente en lo que respecta a garantizar el derecho al aprendizaje del alumnado con discapacidad en contextos educativos regulares. En este escenario, las tecnologías digitales emergen como recursos potenciales para superar barreras pedagógicas, comunicacionales y actitudinales. Este artículo busca analizar los desafíos y las posibilidades del uso de las tecnologías digitales en el contexto de la educación especial e inclusiva, centrándose en la mediación del proceso de enseñanza-aprendizaje. Se trata de una investigación cualitativa, desarrollada a través de una revisión crítica de la literatura, basada en autores nacionales y documentos legales que orientan las políticas de inclusión en Brasil. El análisis muestra que, si bien las tecnologías digitales y de asistencia amplían las posibilidades de acceso, participación y personalización de la enseñanza, su eficacia depende de factores estructurales, formativos y pedagógicos, como la formación continua del profesorado, la planificación didáctica intencional y la superación de las concepciones excluyentes aún presentes en la cultura escolar. Se concluye que el uso crítico y contextualizado de las tecnologías puede contribuir a la construcción de una escuela verdaderamente inclusiva, siempre que se integre en un proyecto pedagógico comprometido con la equidad, la diversidad y la justicia social.

Palabras clave: Educación Inclusiva. Tecnologías Digitales. Enseñanza-Aprendizaje. Discapacidad. Formación del Profesorado.

1 INTRODUCTION

Special education has undergone profound transformations over the last decades, especially from the consolidation of the inclusive education paradigm, which defends the right of all students to learn, participate and live in regular education classes. This paradigm breaks with the historical logic of institutionalized segregation and proposes a school that recognizes and values human diversity as a structuring principle of the educational process. It is a change that goes beyond the pedagogical dimension, assuming an ethical, political and social character, by repositioning disability not as an individual limitation, but as a result of the interaction between subjects and social, cultural and educational barriers.

However, despite the legal and normative advances that ensure the right to inclusive education in Brazil, it is observed that the realization of this right still faces significant obstacles in the daily school routine. The presence of students with disabilities in ordinary classrooms challenges traditional pedagogical practices, rigid curricula and homogenizing teaching models. As Mantoan (2006) argues, inclusion is not limited to physical access to school, but requires the guarantee of real conditions of participation and learning for all students, which implies the revision of the conceptions of teaching, evaluation and school organization.

At the same time, the expansion of digital information and communication technologies (DICTs) has caused significant changes in educational processes, expanding the forms of access to knowledge, communication and expression. When critically integrated into pedagogical planning, these technologies can favor the personalization of teaching, the mediation of physical and cognitive barriers, and the construction of more interactive and collaborative learning environments. In this sense, as Garcia (2013, p. 1) points out, "the teacher needs to use resources that transform his classes, in order to instigate the search for knowledge, teaching dynamic, motivating and attractive classes".

However, the incorporation of technologies in the school context does not always result in inclusive pedagogical practices. In many cases, the instrumental and decontextualized use of these resources is observed, disconnected from a pedagogical project committed to equity and diversity. Thus, the following research problem emerges: how can the use of digital technologies effectively contribute to the promotion of special and inclusive education, considering the pedagogical, formative and structural challenges present in Brazilian schools?

In view of this problem, the general objective of this article is to analyze the challenges and possibilities of using digital technologies in the context of special and inclusive education, understanding their role as mediators of the teaching-learning process. In a complementary

way, the specific objectives are: (a) to discuss the historical and political foundations of special and inclusive education in Brazil; (b) reflect on the role of the teacher in the construction of inclusive pedagogical practices; and (c) analyze the potential and limits of digital and assistive technologies in the context of school inclusion.

The scientific justification of this study lies in the need to deepen the theoretical debate on the articulation between inclusive education, digital technologies and teacher training, especially in view of the gaps between the legal discourse of inclusion and its effectiveness in everyday pedagogical practices. By addressing this theme, the article contributes to the field of education by problematizing naturalized conceptions about technology and inclusion, reinforcing the importance of a critical, pedagogical and contextualized approach.

This article is organized as follows: initially, the historical and political foundations of special and inclusive education are discussed; then, the role of the teacher in the construction of the inclusive school is analyzed; subsequently, the contributions of digital technologies in the teaching-learning process and their challenges in the educational context are examined; Finally, the final considerations are presented, in which the main reflections and contributions of the study are systematized.

2 METHODOLOGY

The present study is characterized as a qualitative research, developed through a critical bibliographic review. The review focused on classic and contemporary works that address inclusive education, educational technologies, and teacher training, as well as legal and normative documents that guide public inclusion policies in Brazil.

Productions published mainly between the years 2000 and 2024 were analyzed, prioritizing reference authors in the field of inclusive education and educational technologies, such as Mantoan, Kenski, Moran, Garcia, and Schlünzen, as well as official documents such as the Brazilian Inclusion Law (2015), the National Policy on Special Education in the Perspective of Inclusive Education (2008), and the National Education Plan (2014–2024).

The analysis of the materials was guided by an interpretative and critical reading, seeking to identify convergences, tensions and gaps between normative discourses, theoretical approaches and educational practices. As a limitation of the study, the absence of empirical research is recognized, which points to the need for future research that explores concrete experiences of the use of technologies in inclusive education in different school contexts.

3 SPECIAL AND INCLUSIVE EDUCATION: HISTORICAL AND POLITICAL FOUNDATIONS

Historically, the education of people with disabilities in Brazil has been structured under a welfare and segregating logic, strongly marked by philanthropic practices and the separation of these subjects from common educational spaces. During much of the twentieth century, educational services took place predominantly in specialized institutions, far from regular schools, which reinforced a conception of disability associated with disability, abnormality and the need for correction or treatment, to the detriment of the recognition of difference as a constitutive dimension of the human condition.

This perspective was aligned with the so-called medical model of disability, which centers its analysis on clinical diagnosis and individual limitations, disregarding the social, pedagogical and structural factors that produce and reinforce barriers to school participation. In this model, educational failure was often attributed to the student himself, exempting the school and the educational system from their responsibility in guaranteeing the right to learning. As a result, the schooling processes of people with disabilities have historically been restricted, fragmented and devoid of a critical perspective focused on citizenship formation.

The transition to a new paradigm began to consolidate in the 1990s, driven by important international milestones, such as the World Conference on Education for All (Jomtien, 1990) and the Salamanca Declaration (1994). These documents promoted a significant inflection in the educational field by stating that special education should be part of the common educational system, defending the right of all children, regardless of their conditions, to attend quality regular schools. This movement contributed to the shift of the focus from disability to the existing barriers in the school environment, approaching a social and inclusive perspective.

In the Brazilian context, this new understanding gained legal support with the Federal Constitution of 1988, which recognized education as a social right and duty of the State, ensuring specialized educational service preferably in the regular school system. The Law of Guidelines and Bases of National Education (Law No. 9,394/96) deepened this principle by defining special education as a transversal modality at all levels and stages of education, guaranteeing the right to access, permanence and learning of students with disabilities.

Normative progress was significantly strengthened with the enactment of the Brazilian Law for the Inclusion of Persons with Disabilities (Law No. 13,146/2015), which consolidated the principles of equal opportunities, accessibility, and non-discrimination. By recognizing people with disabilities as subjects with full rights, the LBI reaffirms the obligation of educational systems to offer the necessary support for school participation, including

adequate teacher training, accessible teaching resources and assistive technologies, definitively shifting the responsibility of adaptation from the individual to the transformation of educational contexts.

In this same horizon, the National Policy on Special Education in the Perspective of Inclusive Education (2008) constitutes a fundamental political and pedagogical milestone by redefining the role of special education as complementary and supplementary to common education, through Specialized Educational Service (SES). The policy emphasizes the importance of continuing education of education professionals, curricular flexibility and the guarantee of architectural, communicational and pedagogical accessibility as indispensable conditions for school inclusion.

Despite this robust legal and normative framework, the Brazilian educational reality still reveals numerous challenges for the effectiveness of inclusive education. Gaps persist related to school infrastructure, the supply of accessible materials, teacher training and, above all, the overcoming of exclusionary conceptions and practices rooted in school culture. The transition from an exclusionary educational model to an inclusive model therefore requires more than legal changes: it requires a continuous ethical and political commitment to valuing diversity as an educational principle and to building a school capable of teaching everyone, without exception.

4 THE ROLE OF THE TEACHER IN THE CONSTRUCTION OF THE INCLUSIVE SCHOOL

The consolidation of inclusive education in the school routine is intrinsically related to the performance of the teacher, who assumes a central role in the mediation of the teaching-learning process. It is in the classroom space that inclusive policies materialize — or not — through pedagogical practices, teaching strategies, forms of evaluation, and relationships established with students. In this sense, the teacher is a fundamental agent in the construction of a school that recognizes and values diversity, ensuring real learning conditions for all.

However, several studies and official documents point out that many teachers still face difficulties in working in inclusive contexts. Among the main challenges are the gaps in initial training, which historically has little contemplated the theme of inclusion, and the insufficiency of continuing education policies that articulate theory and practice. As a consequence, it is common for teachers to feel insecure in the face of the presence of students with disabilities in regular classes, resorting to homogeneous practices that have little dialogue with the specific educational needs of these subjects.

According to the document *Training of Educators and the Construction of the Inclusive School* (IFES, 2020), teacher training needs to be rethought in the light of the inclusive paradigm, understanding that teaching in contexts of diversity requires more than mastery of curricular content. It requires, above all, an ethical, political and pedagogical stance committed to human rights, equity and social justice. In this context, the teacher is no longer a mere transmitter of knowledge and starts to act as a mediator, facilitator and organizer of meaningful learning experiences.

This perspective dialogues with the understanding of Garcia (2013, p. 1), when he states that "the teacher is no longer a simple transmitter of knowledge. Today, he is a mediator, facilitator of the teaching-learning process and students are the active subjects of this process". Such a conception implies the adoption of active methodologies, multisensory strategies, collaborative practices and technological resources that expand the possibilities of access to knowledge and participation of students, respecting their different rhythms, styles and ways of learning.

Another fundamental aspect of teaching in inclusive contexts refers to curricular flexibility. Inclusive education presupposes the adaptation of objectives, contents, strategies and assessment tools, in order to ensure that all students have real learning opportunities. However, as Azevedo and Passeggi (2015) point out, many teachers report difficulties in making such adaptations, especially when they do not have institutional support, collaborative work and continuing education to support these practices.

The construction of an inclusive school also requires the teacher to be able to act in an articulated way with other education professionals, such as teachers of the Specialized Educational Service (AEE), Libras interpreters, support professionals and multiprofessional teams. This collaborative action is essential for accessible pedagogical planning and for monitoring the school trajectories of students with disabilities, avoiding isolated and fragmented practices.

In addition to pedagogical skills, teaching in inclusive contexts requires the development of socio-emotional skills, such as empathy, sensitive listening, flexibility, resilience, and willingness to work collectively. Such competencies are fundamental for the construction of more humane and democratic pedagogical relationships, capable of welcoming differences as a constitutive part of the educational process.

As Mantoan (2006) emphasizes, inclusion is not achieved through specific actions or superficial adaptations, but through a profound transformation of the school culture. In this process, the teacher occupies a strategic position, as he is the one who leads the construction or denial of inclusive practices on a daily basis. Thus, ensuring adequate working conditions,

consistent continuing education and institutional support for teachers is an indispensable requirement for the school to stop reproducing inequalities and become, in fact, a learning space for all.

5 NEW TECHNOLOGIES AND THE TEACHING-LEARNING PROCESS

Digital information and communication technologies (DICTs) have caused significant transformations in the ways of teaching and learning, changing the forms of access to knowledge, interaction between subjects and production of meanings in the educational context. Such transformations directly impact the teaching-learning process, requiring the school to review pedagogical practices historically centered on the transmission of content and the homogenization of educational processes.

In the context of inclusive education, digital technologies assume even greater relevance, as they can act as mediators of learning and as instruments for overcoming pedagogical, communicational and cognitive barriers. As Garcia (2013) points out, when used in a planned and intentional way, technologies contribute to making classes more dynamic, attractive and contextualized, favoring student engagement and expanding the possibilities of participation, especially for those who have historically faced processes of school exclusion.

The incorporation of technologies into the teaching-learning process, however, should not be restricted to the replacement of traditional resources by digital devices. As Almeida and Valente (2007) warn, the pedagogical use of technologies needs to be anchored in conceptions that understand these resources as mediators of the construction of knowledge, and not as ends in themselves. In this sense, the presence of computers, tablets or digital platforms is only justified when integrated into a pedagogical project that promotes meaningful learning and the development of student autonomy.

Pedagogical mediation with the use of DICTs involves the careful selection of resources such as educational software, learning platforms, digital games, virtual learning environments, multimodal resources (audio, video, images, animations) and collaborative tools. These resources, when articulated with active methodologies, enable multiple forms of access to content, expression of learning and social interaction, respecting the different styles and rhythms of learning of students.

However, as Moran (2000) points out, the mere presence of technologies in the school environment does not guarantee innovation or quality in teaching. There is a risk that the apparent technological modernization will only reproduce traditional practices, centered on memorization and passive reception of information. Thus, it is essential that the teacher

understands the role of technologies as allies of pedagogical action, capable of expanding possibilities, but not replacing didactic planning, pedagogical intentionality and teacher mediation.

In the context of inclusive education, the use of technologies is also directly related to the promotion of autonomy, authorship, and protagonism of students. By allowing different forms of communication, production and participation, DICTs contribute to the valorization of singularities and to the construction of more democratic learning environments. This perspective is close to an emancipatory conception of education, in which subjects not only consume information, but also produce, reinterpret and share it in a critical way.

Finally, it is highlighted that the effectiveness of technologies in the teaching-learning process is directly related to teacher training. Training in technologies cannot be limited to the technical mastery of the tools, but must include reflection on their pedagogical, ethical and political foundations. Only in this way will it be possible to overcome the instrumental use of technologies and enhance their role in the construction of inclusive pedagogical practices, capable of meeting the diversity present in contemporary classrooms.

6 TECHNOLOGIES AND SCHOOL INCLUSION: ADVANCES AND CHALLENGES

In the context of inclusive education, digital and assistive technologies have been consolidated as important allies in overcoming pedagogical, communicational, physical and attitudinal barriers. These resources, when used in a planned and contextualized way, expand the possibilities of access to the curriculum and participation of students with disabilities, contributing to the construction of more equitable pedagogical practices.

Among the most significant advances, assistive technologies stand out, such as screen readers for visually impaired students, speech synthesis software, text magnifiers, adapted keyboards, alternative communicators, and augmented reality-based resources. As Passerino (2001) points out, these technologies not only compensate for functional limitations, but also enhance unique forms of interaction with knowledge, favoring students' autonomy and expression.

However, despite the recognized inclusive potential of technologies, their implementation in everyday school life still faces significant challenges. The scarcity of equipment, the precariousness of technological infrastructure, the absence of adequate connectivity and the insufficiency of pedagogical planning are recurrent obstacles, especially in public schools. Schlünzen (2005) points out that, without consistent policies for teacher training and pedagogical monitoring, technologies tend to be underused or used in a merely instrumental way.

Another relevant challenge refers to the risk of the so-called "exclusionary inclusion", when technology is introduced in the school only to comply with normative requirements, without effective transformation of pedagogical practices. In these cases, it is observed that technological resources are made available without the proper adequacy of the didactic material or without the contextualization of the proposed activities, which limits the inclusive potential of these tools and can reinforce exclusion processes.

As Kenski (2007) points out, technology should not be conceived as a substitute for the teacher, but as a resource that expands and enriches the pedagogical action. This understanding requires that technologies be integrated into the curriculum in a critical way, considering the specificities of the students and the sociocultural contexts in which they are inserted. In addition, it is essential to recognize the regional and social inequalities that impact access to technologies, highlighting the need for public policies that articulate educational inclusion and digital inclusion.

Thus, technological advances will only translate into effective school inclusion when accompanied by investments in infrastructure, continuing teacher training and changes in pedagogical conceptions. Technology, in isolation, does not promote inclusion; It is the pedagogical intentionality and the ethical commitment to diversity that give meaning to its use in the educational context.

In addition to national production, international studies have highlighted the role of digital technologies as mediators of educational inclusion, especially with regard to accessibility, personalization of learning, and universal design for learning (UDL). Reports from international organizations, such as UNESCO and the OECD, reinforce that the integration of technologies into inclusive education must be associated with consistent public policies, teacher training and ensuring equity in digital access, avoiding the expansion of educational inequalities. These debates broaden the understanding of school inclusion as a global challenge, reinforcing the need for articulation between local contexts and international agendas.

7 TEACHERS' EXPERIENCES WITH TECHNOLOGIES IN INCLUSIVE EDUCATION

Reports of teaching experiences show that the pedagogical use of technologies can promote significant transformations in educational practices, especially in contexts marked by diversity. When incorporated in a creative and planned way, technologies favor student engagement, expand the possibilities of expression, and contribute to the construction of more participatory and inclusive learning environments.

In the work organized by Azevedo and Passeggi (2015), several reports of basic education teachers who used digital tools such as blogs, virtual learning environments, video production and collaborative networks to enhance teaching are presented. These experiences demonstrate that the use of technologies can strengthen students' authorship, value their cultural identities and promote the development of communicative skills, including among students with learning difficulties or disabilities.

An emblematic example refers to the "TV Cedro Rosa" project, in which children from socially vulnerable contexts participated in the production of videos about their own reality, favoring inclusion processes through audiovisual language. Another relevant report concerns the use of online simulations in preparatory assessments of SARESP, presented by Santos (2015), which showed greater autonomy of students and greater involvement with the learning process.

Experiences with the use of digital games have also shown positive results in the context of inclusive education. As reported by Tani (2015), the use of games in Philosophy classes enabled the mediation of knowledge through play and visual language, benefiting students with cognitive difficulties and expanding access to curricular content. Gamification, in this sense, proved to be a powerful strategy to promote student participation and interest.

These experiences reinforce the importance of spaces for continuing education that value reflection on teaching practice and encourage the sharing of successful experiences. The socialization of these practices contributes to the construction of a school culture that is more open to pedagogical innovation and inclusion, demonstrating that, even in contexts with material limitations, it is possible to develop significant educational actions when there is intentionality, creativity and commitment to learning for all.

8 RECENT PUBLIC POLICIES AND THE DIGITAL INCLUSION AGENDA

In recent decades, Brazil has experienced important normative advances in the field of inclusive education and the integration of digital technologies into the educational process. The incorporation of these agendas into public policies reflects the recognition that the right to full education, especially for students with disabilities, is intrinsically related to equitable access to educational technologies and teacher training for their pedagogical use.

The approval of the National Education Plan (PNE – Law No. 13,005/2014) represented a strategic milestone by establishing goals aimed at the universalization of school attendance and the promotion of the quality of education, including the expansion of the pedagogical use of digital technologies. In this context, Goal 4 stands out, which deals with ensuring access to education for students with disabilities, global developmental

disorders, and high abilities or giftedness, and goals related to teacher training, pedagogical innovation, and the improvement of the technological infrastructure of schools.

However, the achievement of these goals has been compromised by structural and institutional obstacles, such as the discontinuity of government programs, political and economic instability, and insufficient public investments. Programs aimed at integrating technologies in schools, such as ProInfo, faced difficulties related to equipment maintenance, connectivity, and teacher training, limiting their impact on daily school life.

The Covid-19 pandemic (2020–2022) highlighted and deepened the existing digital inequalities in the country, revealing the fragility of the technological infrastructure of public education networks and the insufficiency of digital inclusion policies. At the same time, this context has accelerated the debate on the centrality of technologies in education and reinforced the urgency of public policies that guarantee connectivity, digital accessibility, and teacher training, especially for the educational service of students with disabilities.

In this scenario, more recent initiatives, such as programs aimed at expanding school connectivity and digital teacher training, indicate a resumption of the digital inclusion agenda. However, for such policies to result in effective educational inclusion, it is essential that they are articulated with the National Policy on Special Education from the Perspective of Inclusive Education, ensuring that investments also include assistive technologies, digital accessibility and specialized pedagogical support.

As pointed out by Almeida and Schlünzen (2007; 2005), effective public policies in the field of education and technologies should consider local realities and promote the active participation of school communities in their implementation. Digital inclusion, in this sense, cannot be understood only as access to equipment, but as a formative and pedagogical process that involves planning, monitoring and continuous evaluation.

Thus, the consolidation of the digital inclusion agenda in Brazil requires integrated, sustainable public policies committed to equity, recognizing that the use of technologies in inclusive education depends both on material conditions and on changes in pedagogical conceptions and teaching practices.

9 FINAL CONSIDERATIONS

Inclusive education is configured as an ethical, political and pedagogical commitment to the construction of a more just and democratic society, in which human diversity is recognized as an educational value and principle. Throughout this study, it was evidenced that the implementation of this commitment, especially in the context of special education,

requires the overcoming of historically ingrained exclusionary practices and the construction of pedagogical strategies capable of guaranteeing the right to learning of all students.

The use of digital technologies, when guided by a critical and pedagogical perspective, presents itself as an important mediator in the teaching-learning process, contributing to the expansion of access to knowledge, participation and autonomy of students with disabilities. However, the study demonstrates that technologies alone do not ensure inclusion. Its effectiveness is conditioned to pedagogical intentionality, continuous teacher training and the integration of these resources into an educational project committed to equity and social justice.

It is noteworthy that teacher training is a central axis for the consolidation of inclusive practices mediated by technologies. Teaching performance, supported by flexible methodologies, accessible resources and collaborative work, proves to be decisive for the construction of democratic learning environments that are sensitive to the singularities of students. In this sense, public policies that value teachers and ensure adequate working and training conditions are indispensable for the advancement of school inclusion.

As a limitation of this study, its predominantly bibliographic character is recognized, which points to the need for empirical research that investigates concrete experiences of the use of technologies in inclusive education, considering different educational contexts. Future studies can deepen the analysis of the impact of emerging technologies, such as artificial intelligence and immersive environments, in the promotion of inclusive pedagogical practices.

It is concluded that the construction of a truly inclusive school involves the articulation between consistent public policies, critical teacher training and intentional pedagogical use of digital technologies. It is up to educational systems, school institutions, and education professionals to collectively assume this responsibility, in order to ensure that digital and educational inclusion materializes as an effective right, and not just as a normative discourse.

REFERENCES

- Almeida, M. E. B. de. (2007). Tecnologias digitais na educação: O futuro é hoje. In Anais do 5º Encontro de Educação e Tecnologias de Informação e Comunicação. <https://etic2008.files.wordpress.com/2008/11/pucspmariaelizabeth.pdf>
- Azevedo, A. B. de, & Passeggi, M. C. (Eds.). (2015). Narrativas das experiências docentes com o uso de tecnologias na educação. Editora Metodista.
- Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996. Lei de Diretrizes e Bases da Educação Nacional. Presidência da República. https://www.planalto.gov.br/ccivil_03/leis/l9394.htm

- Brasil. (2015). Lei nº 13.146, de 6 de julho de 2015. Lei Brasileira de Inclusão da Pessoa com Deficiência. Presidência da República. https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13146.htm
- Brasil. Ministério da Educação. Secretaria de Educação Especial. (2008). Política Nacional de Educação Especial na Perspectiva da Educação Inclusiva. <https://www.mec.gov.br> (ou link oficial equivalente do MEC)
- Brasil. (2014). Lei nº 13.005, de 25 de junho de 2014. Plano Nacional de Educação – PNE 2014-2024. Presidência da República. https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2014/lei/l13005.htm
- Garcia, F. W. (2013). A importância do uso das tecnologias no processo de ensino-aprendizagem. *Educação a Distância*, 3(1), 25–48.
- Kenski, V. M. (2007). Educação e tecnologias: O novo ritmo da informação. Papirus.
- Mantoan, M. T. E. (2006). Inclusão escolar: O que é? Por quê? Como fazer? Moderna.
- Moran, J. M. (2000). Ensino e aprendizagem inovadores com tecnologias. *Informática na Educação: Teoria & Prática*, 3(1). <https://moran10.blogspot.com> (ou link para o artigo no blog/revista)
- Passerino, L. M. (2001). Informática na Educação Infantil: Perspectivas e possibilidades. In E. D. Roman & V. E. Steyer (Eds.), *A criança de 0 a 6 anos e a Educação Infantil* (pp. [páginas não fornecidas]). Editora da ULBRA.
- Santos, F. F. dos. (2015). Ações tecnológicas para o Saresp: A prática do uso de simulados online. In A. B. de Azevedo & M. C. Passeggi (Eds.), *Narrativas das experiências docentes com o uso de tecnologias na educação* (pp. [páginas não fornecidas]). Editora Metodista.
- Schlünzen, E. T. M. (2005). Escola inclusiva e as novas tecnologias. In M. E. B. de Almeida & J. M. Moran (Eds.), *Integração das tecnologias na educação* (pp. [páginas não fornecidas]). MEC/SEED. <https://portal.mec.gov.br/seed/arquivos/pdf/2sf.pdf>
- Tani, Z. R. (2015). O uso de jogos nas aulas de filosofia: O lúdico tecnológico. In A. B. de Azevedo & M. C. Passeggi (Eds.), *Narrativas das experiências docentes com o uso de tecnologias na educação* (pp. [páginas não fornecidas]). Editora Metodista.

APPLICATION OF MACHINE LEARNING ALGORITHMS FOR DAILY SALES FORECASTING IN A BRAZILIAN BREWING INDUSTRY

APLICAÇÃO DE ALGORITMOS DE APRENDIZADO DE MÁQUINA NA PREVISÃO DE VENDAS DIÁRIAS DE UMA INDÚSTRIA CERVEJEIRA BRASILEIRA

APLICACIÓN DE ALGORITMOS DE APRENDIZAJE AUTOMÁTICO EN LA PREDICCIÓN DE VENTAS DIARIAS DE UNA INDUSTRIA CERCERA BRASILEÑA



<https://doi.org/10.56238/sevened2026.008-124>

Rodrigo Ribeiro Salgado César¹, Allana Eduarda Braga Iquegami², Nelson Marinelli Filho³, Gil Eduardo Guimarães⁴, Geraldo Nunes Corrêa⁵

ABSTRACT

Sales forecasting is a strategic element for the brewing industry, a sector characterized by high seasonality and significant fluctuations associated with weekends, holidays, and festive events. Traditional statistical models, although widely applied, present limitations in capturing nonlinear relationships and complex patterns inherent to demand time series. In this context, this study aims to evaluate the application of machine learning algorithms for daily sales forecasting in a Brazilian brewing industry. To this end, a historical dataset of daily sales covering the period from May 2024 to May 2025 was used, adopting a temporal split in which data from 2024 were employed for model training and data from 2025 were reserved for testing. Temporal feature engineering was performed, including calendar variables, holiday indicators, lagged variables, and moving statistics. Four tree-based algorithms were evaluated: Decision Tree, Random Forest, XGBoost, and LightGBM, using the coefficient of determination (R^2), mean absolute error (MAE), and root mean squared error (RMSE) as performance metrics. The results indicate that ensemble models significantly outperform the single decision tree, with XGBoost achieving the best predictive performance, explaining approximately 89.9% of the variance in daily sales. It is concluded that the application of machine learning algorithms combined with temporal feature engineering constitutes an

¹ Undergraduate student in Information Systems. Universidade do Estado de Minas Gerais (UEMG). E-mail: rodrigo.2411093@discente.uemg.br Orcid: <https://orcid.org/0009-0008-1119-3369> Lattes: <http://lattes.cnpq.br/3527280447737544>

² Undergraduate student in Information Systems. Universidade do Estado de Minas Gerais (UEMG). E-mail: allana.2511001807@discente.uemg.br Orcid: <https://orcid.org/0009-0005-5208-8758> Lattes: <http://lattes.cnpq.br/6255602665290316>

³ Dr. in Mechanical Engineering. Instituto de Tecnologia e Educação Galileo da Amazônia (ITEGAM). E-mail: nelson.marinelli@itegam.org.br Orcid: <https://orcid.org/0009-0005-4362-0132> Lattes: <http://lattes.cnpq.br/9077460245811758>

⁴ Dr. in Mechanical Engineering. Instituto de Tecnologia e Educação Galileo da Amazônia (ITEGAM). E-mail: gil.guimaraes@itegam.org.br Orcid: <https://orcid.org/0000-0003-2800-4620> Lattes: <http://lattes.cnpq.br/8142709905105377>

⁵ Dr. in Production Engineering. Universidade do Estado de Minas Gerais (UEMG). E-mail: geraldo.correa@uemg.br Orcid: <https://orcid.org/0000-0001-5477-6953> Lattes: <http://lattes.cnpq.br/6713336620979877>

effective approach for demand forecasting in the brewing sector, providing relevant support for production, inventory, and logistics planning.

Keywords: Demand Forecasting. Machine Learning. Time Series. Brewing Industry.

RESUMO

A previsão de vendas constitui um elemento estratégico para a indústria cervejeira, setor caracterizado por elevada sazonalidade e variações significativas associadas a fins de semana, feriados e eventos festivos. Modelos estatísticos tradicionais, embora amplamente utilizados, apresentam limitações na captura de relações não lineares e padrões complexos presentes em séries temporais de demanda. Diante desse contexto, o presente estudo objetiva avaliar a aplicação de algoritmos de aprendizado de máquina na previsão de vendas diárias de uma indústria cervejeira brasileira. Para tanto, utilizou-se um conjunto de dados históricos de vendas diárias referente ao período de maio de 2024 a maio de 2025, adotando-se uma divisão temporal, na qual os dados de 2024 foram empregados para treinamento dos modelos e os de 2025 para teste. Procedeu-se à engenharia de atributos temporais, incluindo variáveis de calendário, indicadores de feriados, defasagens e estatísticas móveis. Foram avaliados quatro algoritmos baseados em árvores de decisão: Decision Tree, Random Forest, XGBoost e LightGBM, utilizando como métricas de desempenho o coeficiente de determinação (R^2), o erro absoluto médio (MAE) e a raiz do erro quadrático médio (RMSE). Os resultados evidenciam que os modelos de ensemble superam significativamente a árvore de decisão isolada, com destaque para o XGBoost, que apresentou melhor desempenho preditivo, explicando aproximadamente 89,9% da variância das vendas diárias. Conclui-se que a aplicação de algoritmos de aprendizado de máquina, aliada à engenharia de atributos temporais, constitui uma abordagem eficaz para a previsão de demanda no setor cervejeiro, oferecendo subsídios relevantes para o planejamento de produção, estoques e logística.

Palavras-chave: Previsão de Demanda. Aprendizado de Máquina. Séries Temporais. Indústria Cervejeira.

RESUMEN

La previsión de ventas constituye un elemento estratégico para la industria cervecera, un sector caracterizado por una elevada estacionalidad y por variaciones significativas asociadas a fines de semana, feriados y eventos festivos. Los modelos estadísticos tradicionales, aunque ampliamente utilizados, presentan limitaciones para capturar relaciones no lineales y patrones complejos presentes en las series temporales de demanda. En este contexto, el presente estudio tiene como objetivo evaluar la aplicación de algoritmos de aprendizaje automático en la predicción de ventas diarias de una industria cervecera brasileña. Para ello, se utilizó un conjunto de datos históricos de ventas diarias correspondiente al período de mayo de 2024 a mayo de 2025, adoptándose una división temporal en la que los datos de 2024 se emplearon para el entrenamiento de los modelos y los de 2025 se reservaron para la prueba. Se llevó a cabo ingeniería de características temporales, incluyendo variables de calendario, indicadores de feriados, variables rezagadas y estadísticas móviles. Se evaluaron cuatro algoritmos basados en árboles de decisión: Decision Tree, Random Forest, XGBoost y LightGBM, utilizando como métricas de desempeño el coeficiente de determinación (R^2), el error absoluto medio (MAE) y la raíz del error cuadrático medio (RMSE). Los resultados evidencian que los modelos de tipo ensemble superan significativamente al árbol de decisión individual, destacándose el XGBoost, que presentó el mejor desempeño predictivo, explicando aproximadamente el 89,9% de la variancia de las ventas diarias. Se concluye que la aplicación de algoritmos de aprendizaje automático, combinada con la ingeniería de características temporales, constituye un

enfoque eficaz para la predicción de la demanda en el sector cervecero, aportando insumos relevantes para la planificación de la producción, los inventarios y la logística.

Palabras clave: Predicción de la Demanda. Aprendizaje Automático. Series Temporales. Industria Cervecera.

1 INTRODUCTION

Sales forecasting plays a central role in the operational and strategic planning of organizations, especially in sectors characterized by high seasonality and strong variability in demand. In the case of the brewing industry, consumption presents cyclical patterns associated with weekends, national holidays, cultural events and climatic conditions, which imposes significant challenges to the management of production, inventories and logistics (ALVES; SILVA, 2023; DE OLIVEIRA DIAS; FALCONI, 2018). Errors in forecasting can result in both stockouts and excess stored products, with direct impacts on operating costs and the level of service to the market.

Traditionally, demand forecasting has been performed using classical time-series statistical models, such as the autoregressive integrated moving average models (ARIMA). Although these models have a solid theoretical foundation and broad application, their effectiveness strongly depends on assumptions of linearity and stationarity, which may limit their ability to capture complex and nonlinear relationships often observed in real sales data (BOX; JENKINS; REINSEL, 2015; HYNDMAN; ATHANASOPOULOS, 2018).

In recent years, machine learning techniques have been widely employed in demand forecasting problems, due to their flexibility to incorporate multiple explanatory variables and model nonlinear patterns without the need for rigid parametric specifications (HASTIE; TIBSHIRANI; FRIEDMAN, 2009). In particular, algorithms based on decision trees and ensemble methods, such as Random Forest and gradient boosting techniques, have demonstrated superior performance in predictive applications in retail and industry, especially when combined with appropriate temporal attribute engineering strategies (BREIMAN, 2001; CHEN; GUESTIN, 2016; KE et al., 2017).

Recent studies indicate that the incorporation of calendar variables, holiday indicators, lagged attributes, and mobile statistics contributes significantly to the increased accuracy of predictive models applied to sales time series, by allowing the explicit representation of seasonal patterns and short- and medium-term temporal dependencies (BERGMEIR; BENÍTEZ, 2012; HYNDMAN; ATHANASOPOULOS, 2018). Despite these advances, empirical studies that comparatively evaluate the performance of different machine learning algorithms applied to the forecast of daily sales in the beer sector, using real data and adequate time validation, are still relatively scarce in the Brazilian context.

In this context, the present study aims to evaluate the application of machine learning algorithms in the daily sales forecast of a Brazilian brewing industry, comparing models based on decision trees, namely: Decision Tree, Random Forest, XGBoost and LightGBM. To this end, a set of historical data of daily sales is used, with a temporal division between training

and testing, and temporal attribute engineering is used to capture seasonal patterns and historical dependencies.

The main scientific contribution of this work consists of providing a comparative empirical analysis of the performance of different machine learning algorithms in a real scenario of the Brazilian brewing industry, evidencing the predictive gains associated with ensemble models and gradient boosting techniques. Additionally, the study contributes to the literature by demonstrating that the use of relatively simple temporal attributes, combined with robust machine learning methods, can produce consistent and relevant predictions to support managerial decisions related to production planning, inventory management, and logistics.

2 THEORETICAL FRAMEWORK

Sales forecasting is a fundamental element for the operational and strategic planning of organizations, especially in sectors marked by high seasonality and marked variability in demand. In the brewing industry, consumption behavior shows cyclical patterns associated with weekends, holidays, and festive events, which imposes relevant challenges to the management of production, inventories, and logistics. In view of this scenario, the literature specialized in demand forecasting has highlighted the relevance of comparative evaluation of predictive methods, pointing out that more flexible approaches tend to have superior performance in modeling time series with complex and nonlinear patterns, especially in short-term forecasting problems (MAKRIDAKIS; BAKAS, 2016).

In the context of the brewing industry, studies indicate that consumption is strongly influenced by temporal factors, such as weekdays, festive periods and long holidays, as well as cultural and climatic aspects (ALVES; SILVA, 2020). These patterns make sales forecasting particularly sensitive to the choice of method and the appropriate incorporation of explanatory variables capable of representing such effects.

2.1 TRADITIONAL TIME SERIES FORECASTING MODELS

Classical statistical models, such as the autoregressive integrated moving average models (ARIMA), have been widely used for time series forecasting in different industrial contexts. These models are based on assumptions of linearity and stationarity and seek to capture temporal dependencies through autoregressive components and moving averages (BOX; JENKINS; REINSEL, 2015). Although they have good interpretability and solid theoretical foundation, their application may be limited when the series presents complex nonlinear patterns or when multiple exogenous variables influence the behavior of demand.

In addition, the manual selection of the model structure and the adjustment of

parameters can make these methods sensitive to noise and structural changes in the behavior of the series, a relatively common phenomenon in dynamic markets and subject to changes in consumption habits (HYNDMAN; ATHANASOPOULOS, 2018). Such limitations have motivated the search for more flexible and adaptive approaches, especially in short-term sales forecasting applications.

2.2 MACHINE LEARNING IN DEMAND FORECASTING

Machine learning techniques have stood out as promising alternatives for demand forecasting, due to their ability to model nonlinear relationships and to simultaneously incorporate a large set of explanatory variables, without the need for restrictive parametric hypotheses (HASTIE; TIBSHIRANI; FRIEDMAN, 2009). Unlike traditional statistical models, machine learning methods are predominantly predictive performance-driven, which makes them especially suitable for scenarios in which prediction accuracy is a priority (FILDES; MAKRIDAKIS; STELLA, 2019).

Among the widely used algorithms, the methods based on decision trees stand out, which partition the space of attributes into homogeneous regions, allowing the capture of complex interactions between variables. However, isolated decision trees tend to present a high risk of overfitting, which compromises their ability to generalize (LIU; WANG; ZHANG, 2012).

To mitigate this problem, ensemble techniques have been proposed, combining multiple models to produce more robust predictions. Random Forest, for example, uses the training of several trees on random subsets of the data and variables, reducing the variance of the model and improving its predictive stability (LIU; WANG; ZHANG, 2012). Gradient boosting methods, on the other hand, build models sequentially, so that each new tree seeks to correct the errors of the previous ones, resulting in high predictive power.

2.3 GRADIENT BOOSTING AND TEMPORAL ATTRIBUTE ENGINEERING

Tree-based gradient boosting algorithms, such as XGBoost and LightGBM, have achieved state-of-the-art performance in several regression and classification problems, including industrial demand forecasting applications. XGBoost stands out for incorporating regularization mechanisms and computational optimizations that contribute to greater efficiency and control of overfitting (CHEN; GUESTRIN, 2016). Similarly, LightGBM was developed with a focus on scalability and memory efficiency, maintaining high accuracy even in large volumes of data (KE et al., 2017).

The literature points out that the performance of these algorithms is strongly influenced

by the quality of attribute engineering, especially in time series problems. The incorporation of calendar variables, holiday indicators, lags, and mobile statistics allows machine learning models to explicitly represent seasonal patterns and temporal dependencies, approximating the underlying structure of the series (BERGMEIR; BENÍTEZ, 2012; HYNDMAN; ATHANASOPOULOS, 2018).

In this sense, empirical studies have shown that the combination of gradient boosting methods with temporal attribute engineering results in significant gains in predictive performance when compared to both traditional statistical models and machine learning approaches without adequate treatment of the temporal dimension (HASTIE; TIBSHIRANI; FRIEDMAN, 2009; KE et al., 2017).

Despite the advances observed in the international literature, there is still a gap in the national context regarding the comparative evaluation of machine learning algorithms applied to the prediction of daily sales in the Brazilian beer sector, especially in studies that use real data and rigorous time validation. As summarized in **Table 1**, different forecasting approaches have distinct characteristics, advantages, and limitations, highlighting the need for empirical analyses that consider both predictive performance and the challenges associated with time series modeling.

Table 1

Comparison between time series forecasting approaches

Approach	Key features	Advantages	Limitations
Statistical Models (ARIMA)	Based on linearity and stationarity	Interpretability; solid theoretical foundation	Difficulty capturing nonlinearities
Decision trees	Recursive Partitioning of Attribute Space	Simplicity; Interpretability	High risk of overfitting
Random Forest	Tree ensemble with random sampling	Reduction of variance; Robustness	Lower overall interpretability
Gradient Boosting (XGBoost / LightGBM)	Sequential Tree Construction with Error Correction	High accuracy; Nonlinear Modeling	Increased computational complexity

Source: Prepared by the authors, based on Breiman (2001), Hastie et al. (2009), Chen and Guestrin (2016) and Ke et al. (2017).

In addition, recent research highlights that the performance of these algorithms is strongly associated with the quality of temporal attribute engineering, including the use of calendar variables, lagged attributes, and mobile statistics, capable of effectively representing temporal dependencies and seasonal patterns (BANDARA et al., 2020). In this sense, the present study positions itself in this context by empirically analyzing the performance of different machine learning algorithms in a real industrial scenario, contributing

to the advancement of knowledge applied to demand forecasting in the brewing sector.

3 METHODOLOGY

The present research is characterized as a quantitative study, of applied nature, with an explanatory approach, whose objective is to evaluate the performance of different machine learning algorithms in the daily sales forecast of a Brazilian brewing industry. The methodological design was structured in order to ensure the replicability of the experiments and the validity of the results, respecting the temporal nature of the data analyzed.

3.1 DATASET AND EXPERIMENTAL DESIGN

The study used a set of historical data of daily beer sales, measured in volume, covering the period from May 1, 2024 to May 31, 2025. The data were organized in a continuous time series, without additional aggregations, preserving the daily granularity necessary for the analysis of short-term patterns.

Data division was performed temporarily, as recommended in the literature for time series problems, in order to avoid information leakage between the training and test sets (HYNDMAN; ATHANASOPOULOS, 2018; BERGMEIR; BENÍTEZ, 2012). Thus, the records referring to the year 2024 were used for training and adjustment of the models, while the data from 2025 were reserved exclusively for the final evaluation of the predictive performance.

3.2 TEMPORAL ATTRIBUTE ENGINEERING

In order to capture seasonal patterns and temporal dependencies inherent to daily sales, the time attribute engineering stage was carried out, considered fundamental in machine learning applications for time series. The predictor variables were organized into the following categories:

- a) Calendar attributes: day of the week, day of the month, month of the year, binary indicator of weekend/working day and indicators of national holidays and relevant festive dates (such as Carnival, Christmas and New Year's Eve), aiming to represent weekly and annual cycles of consumption;
- b) Lag attributes: values of sales observed in previous periods, including short-term (e.g., 1 day) and weekly (e.g., 7 days) lags, allowing modeling the direct temporal dependence between consecutive observations;
- c) Moving statistics: moving averages and standard deviations calculated in 7-day and 30-day sliding windows, in order to smooth out one-off fluctuations and capture recent trends in the series.

Additional exogenous variables, such as climate data or information from promotional campaigns, were not incorporated due to unavailability in the analyzed data set, thus prioritizing temporal attributes widely used and validated in the literature.

3.3 ALGORITHMS EVALUATED

Four algorithms based on decision trees, widely used in regression and demand forecasting problems, were evaluated:

- a) Decision Tree: regression model that partitions the attribute space recursively, serving as a baseline for its simplicity and interpretability;
- b) Random Forest: ensemble method that combines multiple decision trees trained on random subsets of data and variables, with aggregation of predictions by mean, aiming to reduce variance and increase the robustness of the model (BREIMAN, 2001);
- c) XGBoost: gradient boosting algorithm that builds trees sequentially to correct residual errors from previous models, incorporating regularization and computational optimizations to control overfitting and increase efficiency (CHEN; GUESTRIN, 2016);
- d) LightGBM: histogram-based gradient boosting technique, designed for efficient training and reduced memory usage, while maintaining high predictive accuracy (KE et al., 2017).

3.4 TRAINING, VALIDATION, AND EVALUATION OF MODELS

The training of the models was carried out using exclusively the 2024 dataset. For the adjustment of hyperparameters, cross-validation with temporal division was adopted, respecting the chronological order of the observations and avoiding the use of future data in the learning process.

The final evaluation of the predictive performance was conducted on the test set (2025 data), using metrics widely consolidated in the literature for regression problems:

- a) Coefficient of determination (R^2), which measures the proportion of variance explained by the model;
- b) Mean Absolute Error (MAE), which expresses the mean error in absolute terms, facilitating practical interpretation;
- c) Root mean squared error (RMSE), which penalizes larger errors and provides a sensitive measure of extreme deviations.

These metrics allow for a consistent comparative analysis between the models, considering both the accuracy and stability of the forecasts.

3.5 ETHICAL CONSIDERATIONS AND METHODOLOGICAL LIMITATIONS

The data used in this study do not contain personal or sensitive information, and are restricted to aggregated sales records, which does not require formal ethical consent procedures. As methodological limitations, the absence of relevant exogenous variables, such as climate and promotional actions, and the analysis restricted to a single brewing industry stand out, which may limit the generalization of the results. Even so, the adopted design allows for a robust evaluation of the potential of machine learning algorithms in a real industrial application scenario.

4 RESULTS

This section presents the results obtained from the application of the machine learning algorithms proposed for the daily sales forecast of a Brazilian brewing industry. The models were evaluated based on the predictive performance on the test set, corresponding to the data from the year 2025, preserving the temporal integrity of the series.

4.1 PERFORMANCE OF FORECASTING MODELS

Table 2 presents the quantitative results of the four algorithms evaluated — Decision Tree, Random Forest, XGBoost and LightGBM — considering the metrics coefficient of determination (R^2), mean absolute error (MAE) and root mean squared error (RMSE).

Table 2

Comparison of the performance of daily sales forecasting models

Model	R^2	MOTHER	RMSE
Decision Tree	0,700	380,5	480,2
Random Forest	0,850	250,0	320,0
LightGBM	0,880	212,3	275,6
XGBoost	0,899	198,4	263,5

Source: Prepared by the authors.

It is observed that the ensemble models presented superior performance than the isolated decision tree. XGBoost obtained the highest value of R^2 , explaining approximately 89.9% of the variance of daily sales, in addition to presenting the lowest values of MAE and RMSE. LightGBM showed close performance, followed by Random Forest, while Decision Tree showed the highest prediction errors.

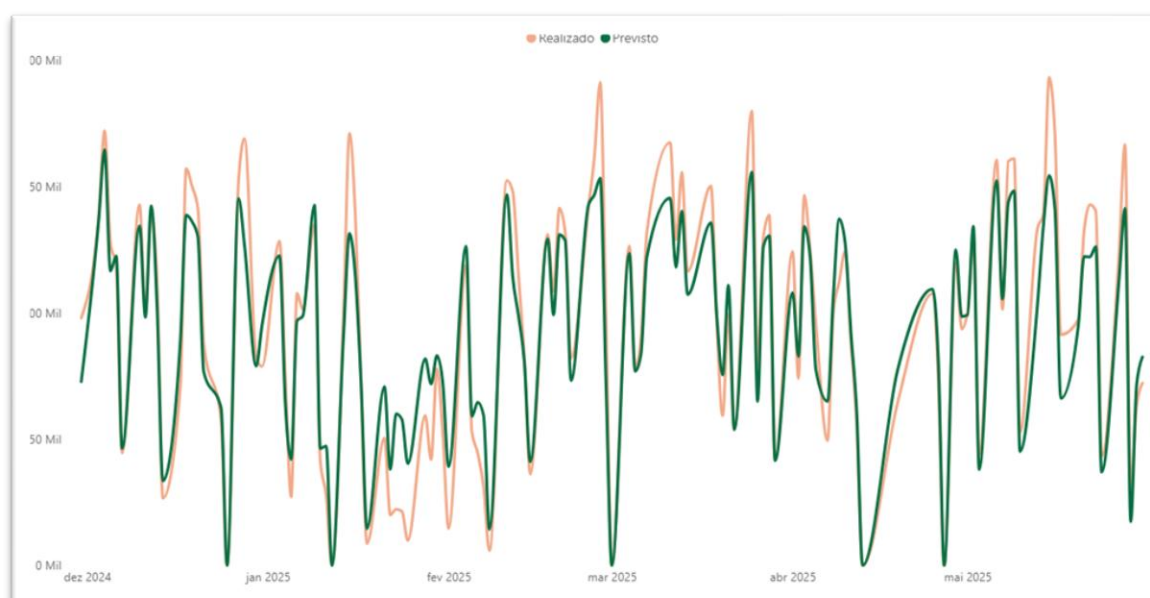
4.2 GRAPHICAL ANALYSIS OF FORECASTS

To complement the quantitative analysis, Figure 1 presents a visual comparison between the actual sales values and the forecasts generated by the best performing model (XGBoost), over the test period.

Visual inspection indicates that the XGBoost model follows the dynamics of the time series over the analyzed period, capturing weekly seasonal patterns and oscillations over the analyzed period. Punctual differences between observed and predicted values are concentrated on atypical days, possibly associated with unmodeled factors, such as specific promotions or climatic variations.

Figure 1

Actual sales and forecasted sales of the XGBoost model in the test period



Source: Prepared by the authors.

5 CONCLUSION

The present study aimed to evaluate the application of machine learning algorithms in the daily sales forecast of a Brazilian brewing industry, comparing the performance of models based on decision trees in a real scenario of historical data. To this end, an experimental design was used that respected the temporal nature of the series, combined with the engineering of temporal attributes to capture seasonal patterns and historical dependencies.

The results obtained showed that the ensemble models presented superior performance to the isolated decision tree, showing greater generalization capacity and predictive accuracy. Among the algorithms evaluated, XGBoost stood out by explaining approximately 89.9% of the variance of daily sales, in addition to presenting the lowest values

of mean absolute error and root mean squared error. LightGBM also showed high performance, reinforcing the adequacy of gradient boosting methods for demand forecasting problems with high seasonality.

From a scientific point of view, the main contribution of this work is to provide a comparative empirical analysis of the performance of different machine learning algorithms applied to the prediction of daily sales in the context of the Brazilian brewing industry, an area still little explored in the national literature. Additionally, the results indicate that the use of relatively simple temporal attributes, when combined with robust machine learning models, can produce consistent predictions, even in the absence of more complex exogenous variables.

From a managerial perspective, the findings suggest that the adoption of machine learning techniques can support decisions related to production planning, inventory management, and logistics, contributing to the reduction of stockouts and overstocks. Although the study is restricted to a single industry, the methodological procedures adopted are replicable and can be extended to other industrial contexts with similar characteristics.

As limitations, the absence of relevant exogenous variables, such as climate data and information on promotional campaigns, as well as the analysis centered on a single set of data, stand out. As future works, it is recommended to incorporate new data sources, evaluate additional algorithms — such as CatBoost and neural networks — and expand the study to multiple product lines or different companies in the sector, in order to broaden the generalization of the results and deepen the understanding of the factors that influence demand in the beer market.

ACKNOWLEDGMENTS

The authors would like to thank the State University of Minas Gerais (UEMG), through the Research Support Program (PAPq/UEMG), for the institutional support granted to the development of this research.

REFERENCES

- Alves, R. M., & Silva, L. F. (2023). Padrões temporais no consumo de bebidas alcoólicas no Brasil. *Revista de Saúde Pública*, 57, Article 17. <https://www.scielo.org/article/rsp/2023.v57/17/pt/>
- Bandara, K., Bergmeir, C., & Smith, R. J. (2020). Forecasting across time series databases using recurrent neural networks on groups of similar series: A clustering approach. *Expert Systems with Applications*, 140, Article 112896. <https://doi.org/10.1016/j.eswa.2019.112896>

- Bergmeir, C., & Benítez, J. M. (2012). On the use of cross-validation for time series predictor evaluation. *Information Sciences*, 191, 192–213. <https://doi.org/10.1016/j.ins.2011.12.028>
- Box, G. E. P., Jenkins, G. M., & Reinsel, G. C. (2015). *Time series analysis: Forecasting and control* (5th ed.). Wiley.
- Breiman, L. (2001). Random forests. *Machine Learning*, 45(1), 5–32. <https://doi.org/10.1023/A:1010933404324>
- Chen, T., & Guestrin, C. (2016). XGBoost: A scalable tree boosting system. In *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 785–794). ACM. <https://doi.org/10.1145/2939672.2939785>
- de Oliveira Dias, M., & Falconi, D. (2018). The evolution of craft beer industry in Brazil. *Journal of Economics and Business*, 1(4), 618–626. <https://doi.org/10.31014/aior.1992.01.04.55>
- Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The elements of statistical learning: Data mining, inference, and prediction* (2nd ed.). Springer. <https://doi.org/10.1007/978-0-387-84858-7>
- Hyndman, R. J., & Athanasopoulos, G. (2018). *Forecasting: Principles and practice* (2nd ed.). OTexts. <https://otexts.com/fpp2/>
- Ke, G., Meng, Q., Finley, T., Wang, T., Chen, W., Ma, W., Ye, Q., & Liu, T.-Y. (2017). LightGBM: A highly efficient gradient boosting decision tree. In *Advances in Neural Information Processing Systems* (pp. 3146–3154). Curran Associates.
- Liu, Y., Wang, Y., & Zhang, J. (2012). New machine learning algorithm: Random forest. In B. Liu, M. Ma, & J. Chang (Eds.), *Information computing and applications* (Lecture Notes in Computer Science, Vol. 7473, pp. 246–252). Springer. https://doi.org/10.1007/978-3-642-34062-8_32
- Makridakis, S., & Bakas, N. (2016). Forecasting and uncertainty: A survey. *Risk and Decision Analysis*, 6(1), 37–64. <https://doi.org/10.3233/RDA-150114>

VIOLATIONS IN THE COMMERCIALIZATION OF INFANT FORMULA FOR INFANTS IN COMMERCIAL ESTABLISHMENTS IN MACEIÓ, ALAGOAS

VIOLAÇÕES NA COMERCIALIZAÇÃO DE FÓRMULAS INFANTIS PARA LACTENTES EM ESTABELECIMENTOS COMERCIAIS DE MACEIÓ- ALAGOAS

VIOLACIONES EN LA COMERCIALIZACIÓN DE FÓRMULAS INFANTILES PARA LACTANTES EN ESTABLECIMIENTOS COMERCIALES DE MACEIÓ, ALAGOAS



<https://doi.org/10.56238/sevened2026.008-125>

Dayse Andrade Romão¹, Isabele Luzia Rodrigues Alves de Freitas², Maria Clara Moreira Calheiros de Novaes³, Giselle Medeiros do Nascimento⁴, Raphaela Farias Rodrigues⁵, Rafaela Andrade de Vasconcelos⁶, Larissa Silveira de Mendonça Fragoso⁷, Mirella Medeiros Reis⁸

ABSTRACT

The Brazilian Standard for the Commercialization of Foods for Infants and Young Children, Nipples, Pacifiers, and Baby Bottles (NBCAL) aims to protect breastfeeding; however, violations have been identified that expose mothers and children to abusive marketing of products that compete with breastfeeding. Objective: To identify infractions of NBCAL in the commercialization of infant formula and follow-on infant formula in commercial establishments in the city of Maceió, Alagoas. Methodology: An observational and descriptive study was conducted through visits and verification of NBCAL violations in commercial establishments (supermarkets and pharmacies) located in different neighborhoods of Maceió, Alagoas. Results: Of the 126 establishments recorded in the study, 27 presented infractions, corresponding to 21.4% of the total. Among the establishments visited, 19.8% of

¹ Dr. in Dentistry with a concentration in Cariology. Universidade Estadual de Campinas (FOP/UNICAMP). Universidade Federal de Alagoas (UFAL). E-mail: dayse.romao@foufal.ufal.br

Orcid: <http://orcid.org/0000-0002-7884-1657> Lattes: <http://lattes.cnpq.br/5555599179091037>

² Dental Surgeon. Universidade Federal de Alagoas (UFAL). Faculdade de Odontologia (FOUFAL). E-mail: isabele.freitas@foufal.ufal.br Lattes: <http://lattes.cnpq.br/8923731324948805>

³ Dental Surgeon. Universidade Federal de Alagoas (UFAL). Faculdade de Odontologia (FOUFAL). E-mail: maria.novaes@foufal.ufal.br Orcid: 0009-0000-0077-0425 Lattes: <http://lattes.cnpq.br/5963065527260547>

⁴ Undergraduate student in dentistry. Universidade Federal de Alagoas (UFAL). Faculdade de Odontologia (FOUFAL). E-mail: gisele.nascimento@foufal.ufal.br Orcid: <https://orcid.org/0009-0009-2126-5298> Lattes: <https://lattes.cnpq.br/0881538776038622>

⁵ Dr. in Applied Dental Sciences (Dentistry). Universidade de São Paulo (FOB-USP). Universidade Federal de Alagoas (UFAL). E-mail: raphaela.rodrigues@foufal.ufal.br Lattes: <http://lattes.cnpq.br/5435582287095469>

⁶ Dr. in Restorative Dentistry. Instituto de Ciência e Tecnologia. Universidade Estadual Paulista (UNESP). Universidade Federal de Alagoas (UFAL). E-mail: rafaela-vasconcelos@foufal.ufal.br Lattes: <http://lattes.cnpq.br/446221184323579>

⁷ Doctoral student in Internal Dentistry. Universidade Estadual de Campinas (UNICAMP). Universidade Federal de Alagoas (UFAL). E-mail: larissa.fragoso@foufal.ufal.br Lattes: <http://lattes.cnpq.br/6965205306801034>

⁸ Undergraduate student in dentistry. Universidade Federal de Alagoas (UFAL). Faculdade de Odontologia (FOUFAL). E-mail: Mirela.reis@foufal.ufal.br Lattes: <http://lattes.cnpq.br/2395719421621921>

pharmacies and 25.7% of supermarkets presented infractions, indicating that supermarkets showed a higher occurrence of improper commercial promotion. The predominant commercial strategy was price discounts, but special product displays and the combination of discounts with special displays were also observed. The two types of formula analyzed in the study presented similar rates of infractions. Conclusion: Noncompliance with regulations aimed at protecting breastfeeding was identified in some commercial establishments in Maceió, Alagoas, highlighting irregularities regarding NBCAL.

Keywords: Breastfeeding. Human Milk Substitutes. Infant Nutrition. Direct-to-Consumer Advertising.

RESUMO

A Norma Brasileira de Comercialização de Alimentos para Lactentes e Crianças de Primeira Infância, Bicos, Chupetas e Mamadeiras (NBCAL), visa proteger o aleitamento materno, porém é verificado que existem violações que expõem mães e crianças ao marketing abusivo de produtos que competem com o aleitamento materno. Objetivo: Identificar infrações à NBCAL na comercialização de fórmulas infantis para lactentes e fórmulas infantis de seguimento para lactentes em estabelecimentos comerciais na cidade de Maceió-AL. Metodologia: Realizou-se uma pesquisa observacional e descritiva por meio de visita e verificação de violação à NBCAL em estabelecimentos comerciais (supermercados e farmácias) localizados em diferentes bairros da cidade de Maceió-AL. Resultados: Dos 126 estabelecimentos registrados na pesquisa, 27 apresentaram infrações, correspondendo a 21,4% do total. Dos estabelecimentos visitados, 19,8% das farmácias e 25,7% dos supermercados apresentaram infrações, constatando que os supermercados revelaram mais promoção comercial indevida. A estratégia comercial predominante foi o desconto no preço, mas também foi evidenciado exposição especial e a associação de desconto e exposição especial. Os dois tipos de fórmulas analisados na pesquisa apresentaram taxas similares de cometimento de infrações. Conclusão: Foi constatada a presença de descumprimento das regulamentações destinadas à proteção do aleitamento materno em alguns estabelecimentos comerciais em Maceió-AL, evidenciando irregularidades em relação à NBCAL.

Palavras-chave: Aleitamento Materno. Substitutos do Leite Humano. Nutrição do Lactente. Publicidade Direta ao Consumidor.

RESUMEN

La Norma Brasileña para la Comercialización de Alimentos para Lactantes y Niños de Primera Infancia, Tetinas, Chupetes y Biberones (NBCAL) tiene como objetivo proteger la lactancia materna; sin embargo, se han verificado violaciones que exponen a madres y niños al marketing abusivo de productos que compiten con la lactancia materna. Objetivo: Identificar infracciones a la NBCAL en la comercialización de fórmulas infantiles para lactantes y fórmulas infantiles de continuación en establecimientos comerciales de la ciudad de Maceió, Alagoas. Metodología: Se realizó un estudio observacional y descriptivo mediante visitas y verificación de violaciones a la NBCAL en establecimientos comerciales (supermercados y farmacias) ubicados en diferentes barrios de la ciudad de Maceió, Alagoas. Resultados: De los 126 establecimientos registrados en la investigación, 27 presentaron infracciones, lo que corresponde al 21,4% del total. De los establecimientos visitados, el 19,8% de las farmacias y el 25,7% de los supermercados presentaron infracciones, constatándose que los supermercados mostraron mayor promoción comercial indebida. La estrategia comercial predominante fue el descuento en el precio, pero también se evidenció exhibición especial y la asociación de descuento con exhibición especial. Los dos tipos de fórmulas analizados en el estudio presentaron tasas similares de infracciones. Conclusión: Se constató el incumplimiento de las normativas destinadas a la protección de

la lactancia materna en algunos establecimientos comerciales de Maceió, Alagoas, evidenciando irregularidades en relación con la NBCAL.

Palabras clave: Lactancia Materna. Sustitutos de la Leche Humana. Nutrición del Lactante. Publicidad Directa al Consumidor.

1 INTRODUCTION

According to the World Health Organization (WHO), exclusive breastfeeding consists of feeding the child only with breast milk, offered directly from the breast, through pumping or from human milk banks, and the offer of other liquids or foods is not allowed (WHO, 1995). This practice is considered the most complete form of infant feeding during the first six months of life, since human milk provides all the necessary nutrients in adequate proportions for the growing organism. It is also recommended that after the introduction of complementary feeding, breastfeeding should be maintained until at least two years of age or more (Ministry of Health, 2009; Moraes et al., 2021).

Breastfeeding transcends the simple supply of nutrients to the baby, configuring itself as a complex process that involves physical, emotional and social interaction between mother and child. Scientific evidence demonstrates positive impacts of breastfeeding on the nutritional, cognitive, and emotional status of the child, as well as protection against infections and reduction of infant mortality, including a decrease in the risk of sudden infant death syndrome. The benefits also extend to women's physical and mental health, contributing to the reduction of the risk of various diseases (Sousa et al., 2021; Moraes et al., 2021; Ministry of Health, 2009).

However, in certain circumstances, the infant's access to breast milk may be limited by biological, social, or structural factors, making it necessary to use nutritional supplements, such as infant formulas (Silva, 2023).

According to Collegiate Board Resolutions (RDC) No. 43/2011 and No. 44/2011, infant formulas for infants are intended for children from birth to the sixth month of life, while follow-up infant formulas are indicated for infants from the sixth month to twelve months of incomplete age (ANVISA, 2011a; ANVISA, 2011b). These products are made from cow's milk, other animals or mixtures thereof, and may contain other ingredients considered suitable for infant feeding, with the aim of resembling human milk as far as possible.

However, the composition of infant formulas does not fully reproduce the physiological properties of human milk, which has specific characteristics from each mother to her own child. The sources of carbohydrates, proteins, and other components present in the formulas differ in identity, quality, and bioavailability when compared to human milk (Ministry of Health, 2014). Thus, such products must meet the guidelines established by the Codex Alimentarius, which defines international standards related to composition, safety, labeling, and other technical requirements (Boatwright et al., 2022).

In Brazil, there are legal guidelines that regulate the commercial dissemination and labeling of foods and products intended for infants and young children, including those up to

three years of age. The Brazilian Standard for the Commercialization of Food for Infants and Early Childhood Children, Nipples, Pacifiers and Bottles (NBCAL), instituted by Law No. 11,265, of 2006, and later regulated in 2015 and 2018 (Brasil, 2024), stands out. This legislation prohibits promotional practices in any media, including merchandising, electronic, print, sound or visual advertising.

In addition, marketing strategies that encourage direct sales to consumers in retail are prohibited, such as special exhibitions, granting discounts, pricing below cost, offering gifts, prizes, tied sales, or differentiated promotional presentations (Brasil, 2024). In this context, NBCAL is an important instrument for protecting children and their caregivers from harmful commercial practices, contributing to the preservation, promotion and protection of breastfeeding (Peres; Rinaldi, 2023).

Despite the existing legal framework, food producing and distributing companies that compete with breastfeeding recurrently develop abusive marketing strategies, which negatively influence the decisions of mothers and family members regarding infant feeding. These practices compromise adherence to the recommendations of the World Health Organization and favor a significant increase in sales and profits of the breastmilk substitute industries (Victoria et al., 2016; Silva et al., 2020; Piwoz; Huffman, 2015).

The weakness in the regular inspection of commercial establishments and the scarcity of effective educational actions about NBCAL can be attributed, among other factors, to the limited coverage of specific surveillance by the competent bodies, as well as to the influence of lobbying exercised by the infant food industry. These conflicts of interest contribute significantly to the current scenario of non-compliance with the legislation (Silva et al., 2020). In addition, insufficient knowledge of NBCAL by managers of commercial establishments, health professionals, and mothers creates an environment favorable to the perpetuation of abusive marketing, exposing families to practices that compromise breastfeeding (Boccolini et al., 2021; Piwoz; Huffman, 2015).

In this context, the present study aimed to evaluate violations of the NBCAL related to the sale of infant formulas and follow-up infant formulas in commercial establishments in the city of Maceió, Alagoas, aiming to contribute to the promotion of healthy eating practices and the protection of breastfeeding.

2 METHODOLOGY

This is an observational and descriptive study with the aim of evaluating compliance with the Brazilian Standard for the Commercialization of Foods for Infants and Early Childhood Children, Nipples, Pacifiers and Bottles (NBCAL), focusing on infant formulas for

infants and follow-up infant formulas for infants, in commercial establishments (pharmacies and supermarkets) distributed in several neighborhoods of the city of Maceió, Alagoas.

Data collection was carried out by five dental students in January and February 2024 through face-to-face visits and observation of the forms of commercial promotion practiced in commercial establishments. The choice of neighborhoods was planned and made in a way that allowed the socioeconomic representativeness of the different regions that comprise the city of Maceió-AL, including neighborhoods considered more elite and more popular. In this context, the total number of commercial establishments included 91 pharmacies and 35 supermarkets, totaling 126 establishments visited in 20 neighborhoods.

The data on infant formulas found with a marketing violation were cataloged according to the type of formula for each age group, the commercial name of the product and the name of the manufacturer, obtained from the label, the place where it was found and the type of violation committed. The following inclusion factors were considered: infant formulas for infants (0-6 months) and follow-up infant formulas for infants (6-12 months); and exclusion: follow-up infant formulas for children in early childhood (1-3 years of age), infant formulas indicated for high-risk newborns, and dairy compounds.

The type of trade promotion infringement has been specified in the table of results in:

1. Special exhibition;
2. Price discount;
3. Gift or sample associated with the sale of the product;
4. Special exhibition and price discount;
5. Price discount and gift;
6. Special exhibition and toast;
7. All strategies.

3 RESULTS

The final sample was visited by 126 commercial establishments in the city of Maceió-AL, 91 (72.22%) pharmacies and 35 (27.77%) supermarkets distributed in 20 neighborhoods of the city. The data collected regarding the types of formulas sold, type of establishment and neighborhood, and the types of commercial promotions are described in Table 1.

Regarding the visited regions of the city, there were similar numbers of total locations in each neighborhood, in order to promote a greater likelihood of the results by region. However, the results of the findings of the infractions were predominant in certain neighborhoods, which made it evident in the present study that in the most popular neighborhoods these violations were more prevalent.

Of the 126 establishments analyzed, 27 sold products with commercial promotion prohibited by NBCAL, which corresponds to 21.4% of the establishments (Figure 1), and of these, 19.8% of the pharmacies and 25.7% of the supermarkets evaluated presented infractions (Figure 2), which indicates that supermarkets were the places that most failed to comply with the rule.

Regarding the most frequent commercial promotion strategies, it was evident that price discount was the most common, followed by special exposure and special exposure associated with price discount, with no infraction of the type of gift or sample, price discount associated with gift, special exposure associated with gift and all strategies together at the same time (Figure 3). There was a difference in the percentage of undue commercial promotion in the different types of formulas, with more infractions in infant formulas compared to follow-up formulas.

Table 1

Description in relative and absolute numbers, of the type of formulas sold, the types of establishment and neighborhood, and type of commercial promotion of the establishments surveyed. Maceió, Alagoas, 2024

Image of the infraction	Formula Type	Establishment and neighborhood	Type of infraction
	Infant formula	Supermarket - Lighthouse	Price discount
	Infant follow-up formula	Supermarket - University City	Price discount

	Infant formula	Pharmacy - University City	Price discount
	Infant follow-up formula	Pharmacy - University City	Price discount
	Infant formula	Pharmacy - University City	Price discount
	Infant follow-up formula	Pharmacy - University City	Price discount
	Infant formula	Pharmacy - Benedito Bentes	Discount on the price + special exhibition

	Infant follow-up formula	Pharmacy - Benedito Bentes	Discount on the price + special exhibition
	Infant formula	Pharmacy - Benedito Bentes	Price Discount
	Infant follow-up formula	Pharmacy - Benedito Bentes	Price Discount
	Infant formula	Pharmacy - Benedito Bentes	Price Discount
	Infant formula	Pharmacy - Benedito Bentes	Price Discount

	Infant formula and infant follow-up	Pharmacy - Benedito Bentes	Price Discount
	Infant formula and infant follow-up	Pharmacy - Cruz das Almas	Price Discount
	Infant formula and infant follow-up	Pharmacy - Cruz das Almas	Price Discount
	Infant formula	Pharmacy - Benedito Bentes	Price Discount
	Infant formula	Pharmacy - Benedito Bentes	Price Discount

	Infant formula and infant follow-up	Pharmacy - Benedito Bentes	Price Discount
	Infant formula and infant follow-up	Pharmacy - Cave	Price Discount
	Infant formula	Pharmacy - Tabuleiro do Martins	Price Discount
	Infant formula and infant follow-up	Pharmacy - Tabuleiro do Martins	Price Discount

	Infant formula	Pharmacy - Tabuleiro do Martins	Price Discount
	Infant formula and infant follow-up	Pharmacy - Tabuleiro do Martins	Price Discount
	Infant formula	Pharmacy - Tabuleiro do Martins	Price Discount
	Infant follow-up formula	Pharmacy - Ponta Verde	Special exhibition
	Infant follow-up formula	Pharmacy - Amélia Rosa	Special exhibition

	Infant formula for and follow-up for infant	Pharmacy - Prado	Special exhibition
	Infant formula	Supermarket - Trapiche	Price discount
	Infant formula	Supermarket - Trapiche	Price discount
	Infant formula	Supermarket - Board of the Martins	Price discount
	Infant follow-up formula	Supermarket - Board of the Martins	Price discount

	Infant formula	Supermarket - Board of the Martins	Price discount
	Infant follow-up formula	Pharmacy - Good Climate	Special exhibition
	Infant formula	Supermarket - Board of the Martins	Price discount
	Infant formula	Pharmacy - Cave	Discount on the price + special exhibition
	Infant formula	Supermarket - Antares	Discount on the price
	Infant follow-up formula	Pharmacy - Antares	Discount on the price
	Infant formula	Pharmacy - Antares	Price discount

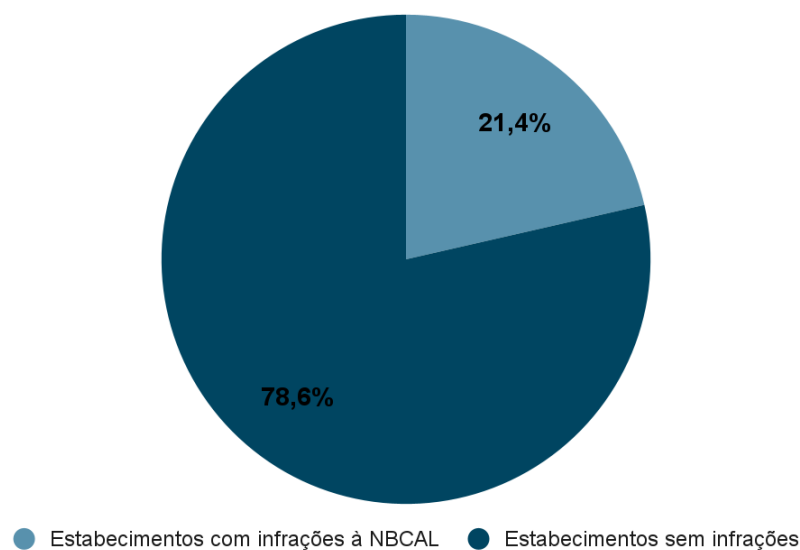
	Infant formula	Pharmacy - Sawmill	Special exhibition
	Infant formula	Supermarket - Sawmill	Price discount
	Infant follow-up formula	Pharmacy - Sawmill	Price discount
	Infant follow-up formula	Pharmacy - Sawmill	Price discount
	Infant formula	Pharmacy - Sawmill	Price discount
	Infant formula	Pharmacy - Sawmill	Price discount
	Infant formula	Pharmacy - Sawmill	Price discount

	Infant follow-up formula	Supermarket - Sawmill	Price discount
	Infant follow-up formula	Pharmacy - Jacintinho	Special exhibition
	Infant follow-up formula	Pharmacy - Jacintinho	Price discount
	Infant formula	Pharmacy - Jacintinho	Price discount
	Infant formula	Pharmacy - Jacintinho	Price discount
	Infant formula	Pharmacy - Jacintinho	Price discount
	Infant follow-up formula	Pharmacy - Jacintinho	Price discount

Source: Authors (2024)

Figure 1

Number (%) of establishments in relation to compliance with the items surveyed referring to Law No. 11,265/2006 in the city of Maceió (AL)

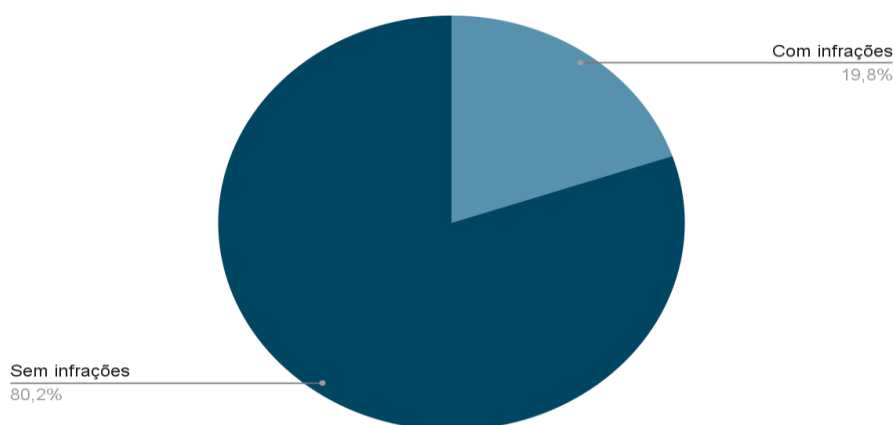


Source: Authors (2024).

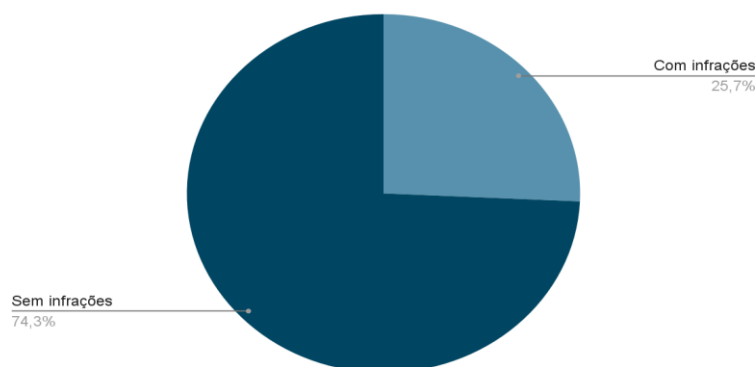
Figure 2

Quantity (%) of infractions found according to the type of commercial establishment (pharmacy and supermarket) visited

Farmácias



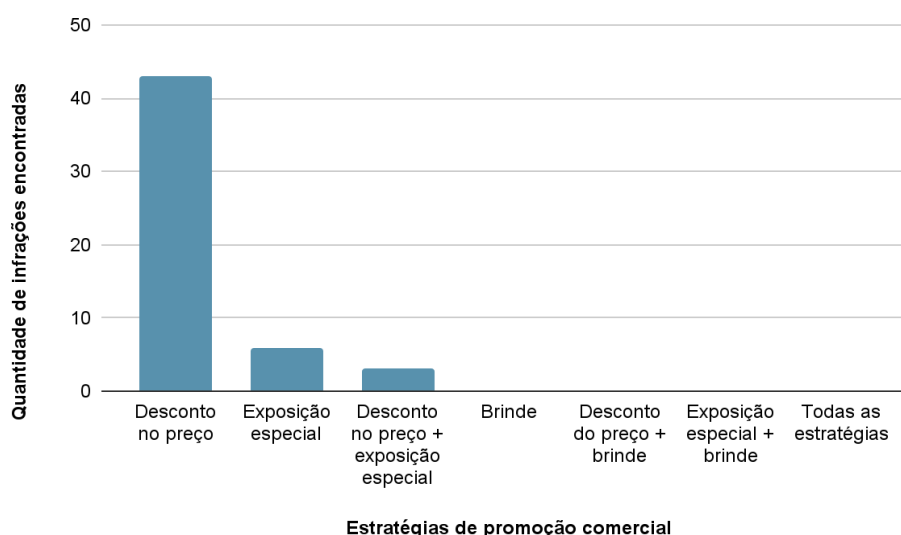
Supermercados



Source: Authors (2024).

Figure 3

Quantity (nº) of the types of commercial promotion violations found in the commercial establishments visited



Source: Authors (2024).

4 DISCUSSION

According to Law No. 11,265, of January 3, 2006, which regulates the commercialization of foods for infants and young children, as well as related childcare products, Article 4 expressly prohibits the commercial promotion of infant formulas for infants and follow-up for infants in any means of communication (BRASIL, 2006). However, according to the results of the present study, carried out in the municipality of Maceió, Alagoas, this legislation has been violated in part of the commercial establishments evaluated, in which infractions related to promotional strategies, such as price discounts and special exhibitions, were identified in approximately 21.4% of the places inspected.

Corroborating these findings, the 2022 NBCAL Monitoring Report, prepared by IBFAN Brasil, which includes all products subject to inspection, identified 864 records of infractions, 34.7% of which corresponded to the illegal commercial promotion of infant formula (IBFAN BRASIL, 2022). Similarly, the study by Baldani et al. (2018), carried out in commercial establishments in the municipality of Uberlândia, Minas Gerais, showed that 46.8% of the infant formulas analyzed had commercial promotion in disagreement with the legislation. These data demonstrate that, despite the decades of validity of the NBCAL, a significant number of violations persist, which can compromise the promotion, protection and support of breastfeeding.

Regarding the type of commercial establishment with the highest frequency of non-compliance with the NBCAL, supermarkets had the highest proportion of infractions (25.7%), followed by pharmacies (19.8%). These findings are in line with the study by Padilha (2011), carried out in the municipality of Recife, Pernambuco, which also identified supermarkets as the main places of non-compliance with the legislation, followed by grocery stores and pharmacies. However, these results differ from those found by Silva et al. (2020), in a study carried out in the South Zone of Rio de Janeiro, in which pharmacies had a higher prevalence of illegal promotions (19%) compared to supermarkets (2%).

Also according to Silva et al. (2020), when evaluating 352 commercial establishments, 20.3% of the places that sold products covered by the NBCAL had illegal promotions, with price discounts being the most frequently observed strategy. These data are similar to those found in the present study, in which the price discount was also configured as the main infraction strategy, being present in 21.4% of the establishments visited. In addition, strategies such as special exposure and the association between price discount and special exposure were identified, to a lesser extent, practices also described by Silva et al. (2021) in a study conducted in the cities of Belém and São Paulo, as well as by Lima et al. (2023) in the municipality of Toledo, Paraná.

Regarding the types of formulas analyzed, Silva et al. (2021) observed a higher prevalence of infractions in infant formulas when compared to follow-up formulas, both in Belém and São Paulo. This finding converges with the results of the present study, in which formulas intended for infants also presented a higher number of infractions in relation to follow-up formulas. These results reinforce the relevance of NBCAL as an essential instrument of public policy to promote breastfeeding and control the commercialization of products that compete directly with this practice.

The benefits of breastfeeding are widely recognized, as it constitutes the most complete food for the baby and involves a significant interaction between mother and child,

with positive impacts for both the child and the woman. In addition to its influence on nutritional status, breastfeeding contributes to the physical, emotional and cognitive development of the child, in addition to strengthening protection against infections (MINISTRY OF HEALTH, 2009; MORAES et al., 2021). In addition, the benefits of breastfeeding extend to the mother's physical and mental health (SOUSA et al., 2021). On the other hand, infant formulas do not reproduce most of these effects and may be associated with risks such as gastrointestinal alterations, contamination during preparation, food allergies related to cow's milk protein, and respiratory alterations (MINISTRY OF HEALTH, 2014). Thus, despite their usefulness in specific situations that make breastfeeding impossible, infant formulas should only be used as a dietary supplement, as indicated appropriately (SILVA, 2023).

Despite efforts to promote breastfeeding and regulate the sale of infant foods, irregularities persist in commercial establishments. The insufficiency of supervision and application of sanctions contributes to a scenario in which practices harmful to public health remain recurrent (PIWOZ; HUFFMAN, 2015; VICTORA et al., 2016). This context highlights the need for intensified monitoring by inspection agencies, as well as educational actions aimed at the appropriate advertising of these products and the valorization of breastfeeding.

In this scenario, one of the factors that can explain the non-compliance with the NBCAL is the lack of knowledge of the legislation on the part of professionals who work in commercial establishments. Lima et al. (2023) observed that 50% of the pharmacists interviewed in the municipality of Toledo, Paraná, were unaware of NBCAL. Similarly, Silva et al. (2020) reported that 50.8% of those responsible for commercial establishments in the South Zone of Rio de Janeiro were not aware of the standard, while Rodrigues et al. (2021) found that 53.7% of pharmacy employees interviewed in the same region were also unaware of the current legislation.

In view of this, it is essential that owners of supermarkets, grocery stores and pharmacies pay attention to compliance with the NBCAL. The importance of the ethical and responsible performance of the pharmacist in establishments that sell infant formulas is also highlighted, since it is the duty of this professional to know and respect the applicable health legislation.

Therefore, it is necessary to foster an ethical commitment to compliance with the NBCAL, both on the part of manufacturers and distributors, who have the obligation to disseminate the standard, and on the part of health professionals and traders. In addition, it is essential that the government implements public policies that strengthen the effectiveness of legislation, through continuous educational and inspection actions.

Although it is complex to accurately measure the direct impact of adherence to the NBCAL on breastfeeding indicators, it is recognized that the standard plays an essential role as one of the pillars of the policy of promotion, protection and support of breastfeeding, acting as a safeguard against abusive marketing practices.

For future studies, it is suggested to investigate the level of knowledge of managers and employees of commercial establishments about NBCAL, as well as to analyze the impact of marketing strategies on the target audience, evaluating their influence on purchasing decisions. It is also recommended that evaluations be carried out in conjunction with NBCAL management groups, in order to analyze the effectiveness of the inspection and the outcome of the complaints registered.

With regard to the registration of complaints, according to the NBCAL information booklet: to know the law, made available by IBFAN Brasil, infractions must be reported to the municipal Health Surveillance, and can also be registered with the Anvisa Ombudsman, the Food Advertising Observatory, Procon and the Public Prosecutor's Office (IBFAN BRASIL, 2021). Complaints must be accompanied by evidence of the infraction and, in view of the scenario of misinformation, direct contact with those responsible for the establishments is recommended to clarify the irregularities identified.

In cases of non-compliance with the NBCAL, Law No. 6,437 of 1977 characterizes violations of federal health legislation and establishes the corresponding sanctions, including fines that vary according to the severity of the infraction, and may be doubled in cases of recidivism (BRASIL, 1977). The responsibility for the sanitary infraction falls on those who, directly or indirectly, have contributed to its occurrence.

Thus, it is recommended to strengthen inspections and continuous monitoring, considering the time the legislation has been in force, as well as the prioritization of educational actions aimed at advertising children's products and the promotion of breastfeeding as fundamental instruments for promoting the health of the population.

5 CONCLUSION

The results of the present study reveal that there are places that do not comply with the regulations aimed at the protection of breastfeeding in some commercial establishments in the city of Maceió-AL, evidencing irregularities in relation to the NBCAL.

REFERENCES

Agência Nacional de Vigilância Sanitária. (2011a). Resolução RDC nº 43, de 19 de setembro de 2011. Dispõe sobre os requisitos para a comercialização de alimentos para lactentes

e crianças de primeira infância. Diário Oficial da União. <https://www.gov.br/anvisa/pt-br/centraisdeconteudo/legislacao/alimentos/rdc-43-2011.pdf>

Agência Nacional de Vigilância Sanitária. (2011b). Resolução RDC nº 44, de 19 de setembro de 2011. Dispõe sobre os requisitos para a rotulagem de alimentos para lactentes e crianças de primeira infância. Diário Oficial da União. <https://www.gov.br/anvisa/pt-br/centraisdeconteudo/legislacao/alimentos/rdc-44-2011.pdf>

Boatwright, M., et al. (2022). The politics of regulating foods for infants and young children: A case study on the framing and contestation of Codex standard-setting processes on breast-milk substitutes. *International Journal of Health Policy and Management*, 11(11), 2422–2439. <https://doi.org/10.34172/ijhpm.2021.109>

Boccolini, C. S., et al. (2021). Metodologia e indicadores para monitoramento da NBCAL em estabelecimentos comerciais e serviços de saúde: Estudo multicêntrico (Multi-NBCAL). *Cadernos de Saúde Pública*, 37(Suppl. 1), Article e00272920. <https://doi.org/10.1590/0102-311X00272920>

Brasil. Ministério da Saúde. (2009). Saúde da criança: Nutrição infantil – Aleitamento materno e alimentação complementar. Editora do Ministério da Saúde.

Brasil. Ministério da Saúde. (2014). Aleitamento materno, distribuição de leites e fórmulas infantis em estabelecimentos de saúde e a legislação. Ministério da Saúde.

Brasil. Ministério da Saúde. (2024). Norma Brasileira de Comercialização de Alimentos para Lactentes e Crianças de Primeira Infância, Bicos, Chupetas e Mamadeiras (NBCAL). <https://www.gov.br/saude/pt-br/composicao/saps/promocao-da-saude/controle-e-regulacao-dos-alimentos/nbcald>

Moraes, B. A., Strada, J. K. R., Gasparin, V. A., et al. (2021). Breastfeeding in the first six months of life for babies seen by lactation consulting. *Revista Latino-Americana de Enfermagem*, 29, Article e3412. <https://doi.org/10.1590/1518-8345.3412.3412>

Peres, M. N., & Rinaldi, A. E. (2023). Relato de experiência da ação de proteção ao aleitamento materno: A NBCAL. *EmExt*, 22(1), 174–183.

Piwoz, E. G., & Huffman, S. L. (2015). The impact of marketing of breast-milk substitutes on WHO-recommended breastfeeding practices. *Food and Nutrition Bulletin*, 36(4), 373–386. <https://doi.org/10.1177/0379572115605819>

Silva, K. B., et al. (2020). Illegal commercial promotion of products competing with breastfeeding. *Revista de Saúde Pública*, 54, Article 10. <https://doi.org/10.11606/s1518-8787.2020054001570>

Silva, M. G. (2023). Prescrição de fórmulas infantis para recém-nascidos a termo em maternidades brasileiras: Uma revisão integrativa da literatura [Trabalho de Conclusão de Curso, Universidade Federal de Pernambuco]. Repositório Institucional UFPE. <https://repositorio.ufpe.br/handle/123456789/51173>

Sousa, F. L. L., et al. (2021). Benefícios do aleitamento materno para a mulher e o recém-nascido. *Research, Society and Development*, 10(2), Article e12710211208. <https://doi.org/10.33448/rsd-v10i2.11208>

Victora, C. G., Bahl, R., Barros, A. J. D., França, G. V. A., Horton, S., Krasevec, J., Murch, S., Sankar, M. J., Walker, N., Rollins, N. C., & The Lancet Breastfeeding Series Group. (2016). Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *The Lancet*, 387(10017), 475–490. [https://doi.org/10.1016/S0140-6736\(15\)01024-7](https://doi.org/10.1016/S0140-6736(15)01024-7)

BIOLOGICAL APPROACHES TO SILYMARIN AND ITS ASSOCIATION WITH METALLIC COMPOUNDS AND ZN(II)

ABORDAGENS BIOLÓGICAS DA SILIMARINA E SUA ASSOCIAÇÃO COM COMPOSTOS METÁLICOS E ZN (II)

ENFOQUES BIOLÓGICOS DE LA SILIMARINA Y SU ASOCIACIÓN CON COMPUESTOS METÁLICOS Y ZN(II)



<https://doi.org/10.56238/sevened2026.008-126>

Daniela Braga de Sousa¹, Luzia Débora Saldanha Marques², Jordana Lima Braga³, Wildson Max Barbosa da Silva⁴, Solange de Oliveira Pinheiro⁵, Francisco Ernani Alves Magalhães⁶

ABSTRACT

This study presents a qualitative literature review on silymarin, a complex of flavonolignans extracted from milk thistle, with emphasis on its biological studies and its association with metallic compounds, highlighting the zinc (II) ion. Silymarin exhibits antioxidant, anti-inflammatory, and hepatoprotective properties; however, its clinical application is limited by factors such as low aqueous solubility, rapid elimination, and reduced cellular permeability. Research involving silymarin in inorganic compounds is relatively recent, particularly studies associated with the zinc (II) ion. This association emerges as a promising strategy to improve bioavailability, chemical stability, and pharmacological activity of the compound. The literature review was conducted across different databases, covering publications from 2021 to 2025. Original articles, case reports, and experimental studies addressing mechanisms of association, chelation, bioavailability, biological activity, or therapeutic applications of silymarin, either alone or combined with metallic ions, were included. After screening titles and abstracts, 14 articles were selected for full analysis. The results indicate that the association of silymarin with metallic ions, especially zinc (II), may positively influence its biological and pharmacological properties, reinforcing its therapeutic potential.

Keywords: Silymarin. Metallic Compounds. Biological Potential.

¹ Graduated in Biological Sciences. Universidade Estadual do Ceará (UECE). E-mail: 01danielabraga@gmail.com Orcid: <https://orcid.org/0000-0002-2289-8320> Lattes: <http://lattes.cnpq.br/4617491622997731>

² Master's degree. Universidade Estadual do Ceará (UECE). E-mail: debora.saldanha@aluno.uece.br Orcid: <https://orcid.org/0009-0008-7518-1260> Lattes: <http://lattes.cnpq.br/6502904453633455>

³ Graduated in Chemistry. Universidade Estadual do Ceará (UECE). E-mail: jordanalimabr@gmail.com Orcid: <https://orcid.org/0009-0001-9518-9461> Lattes: <http://lattes.cnpq.br/5368892491757183>

⁴ Doctorate. Universidade Vale do Acaraú (UVA). E-mail: wildson_max@uvanet.br Orcid: <https://orcid.org/0000-0002-4494-7605> Lattes: <http://lattes.cnpq.br/0983778965244237>

⁵ Doctorate. Universidade Estadual do Ceará (UECE). E-mail: Solange.pinheiro@uece.br Orcid: <https://orcid.org/0000-0001-9063-2877> Lattes: <http://lattes.cnpq.br/9351322395472113>

⁶ Doctorate. Universidade Estadual do Ceará (UECE). E-mail: ernani.magalhaes@uece.br Orcid: <https://orcid.org/0000-0002-4924-2882> Lattes: <http://lattes.cnpq.br/5147244041651721>

RESUMO

Este trabalho apresenta uma revisão bibliográfica qualitativa sobre a silimarina, um complexo de flavonolignanas extraído do cardo-mariano, com ênfase em seus estudos biológicos e em sua associação com compostos metálicos, destacando o íon zinco (II). A silimarina apresenta propriedades antioxidantes, anti-inflamatórias e hepatoprotetoras, entretanto, sua aplicação clínica é limitada por fatores como baixa solubilidade em meio aquoso, rápida eliminação e reduzida permeação celular. As pesquisas envolvendo a silimarina em compostos inorgânicos são relativamente recentes, destacando-se aquelas associadas ao íon zinco (II). Essa associação surge como uma estratégia promissora para melhorar a biodisponibilidade, a estabilidade química e a atividade farmacológica do composto. O levantamento bibliográfico foi realizado em diferentes bases de dados, abrangendo publicações no período de 2021 a 2025. Foram incluídos artigos originais, relatos de caso e estudos experimentais que abordassem mecanismos de associação, quelação, biodisponibilidade, atividade biológica ou aplicações terapêuticas da silimarina, tanto isolada quanto associada a íons metálicos. Após a triagem dos títulos e resumos, 14 artigos foram selecionados para análise completa. Os resultados indicam que a associação da silimarina com íons metálicos, especialmente o zinco (II), pode influenciar positivamente suas propriedades biológicas e farmacológicas, reforçando seu potencial terapêutico.

Palavras-chave: Silimarina. Compostos Metálicos. Potencial Biológico.

RESUMEN

Este trabajo presenta una revisión bibliográfica cualitativa sobre la silimarina, un complejo de flavonolignanos extraído del cardo mariano, con énfasis en sus estudios biológicos y en su asociación con compuestos metálicos, destacando el ion zinc (II). La silimarina presenta propiedades antioxidantes, antiinflamatorias y hepatoprotectoras; sin embargo, su aplicación clínica está limitada por factores como baja solubilidad en medio acuoso, rápida eliminación y reducida permeabilidad celular. Las investigaciones que involucran la silimarina en compuestos inorgánicos son relativamente recientes, destacándose aquellas asociadas al ion zinc (II). Esta asociación surge como una estrategia prometedora para mejorar la biodisponibilidad, la estabilidad química y la actividad farmacológica del compuesto. La revisión bibliográfica se realizó en diferentes bases de datos, abarcando publicaciones del período 2021 a 2025. Se incluyeron artículos originales, reportes de caso y estudios experimentales que abordaran mecanismos de asociación, quelación, biodisponibilidad, actividad biológica o aplicaciones terapéuticas de la silimarina, tanto aislada como asociada a iones metálicos. Tras la revisión de títulos y resúmenes, se seleccionaron 14 artículos para análisis completo. Los resultados indican que la asociación de la silimarina con iones metálicos, especialmente el zinc (II), puede influir positivamente en sus propiedades biológicas y farmacológicas, reforzando su potencial terapéutico.

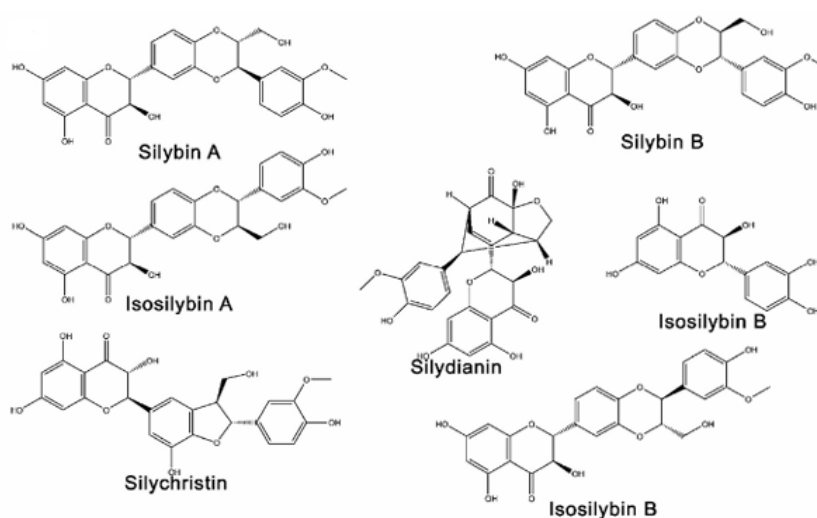
Palabras clave: Silimarina. Compuestos Metálicos. Potencial Biológico.

1 INTRODUCTION

Silymarin is a compound consisting of seven flavolignans (silybin A, silybin B, isosilybin A, isosilybin B, silychristin, isosilychristine and silidianine), Figure 01, extracted from *Silybum marianum* (milk thistle), has stood out as one of the main agents studied in hepatoprotective and neuroprotective therapies, due to its antioxidant and anti-inflammatory properties (Sayyad et al., 2025). In addition, it is widely used in traditional medicine in several European countries, which reinforces its historical and therapeutic value.

Figure 1

Structure and nomenclature of the main compounds found in silymarin



Source: Sayyad et al., 2025.

In recent years, it has aroused growing scientific interest due to its protective effect on several organs, such as the stomach, lungs, kidneys, pancreas, colon, skin, prostate, bladder, and central nervous system (CNS), and these effects reflect its broad therapeutic potential, encompassing anticancer, hepatoprotective, cardioprotective, hypocholesterolemic, neuroprotective activities, among others (Almutary et al., 2025; Macit et al., 2023).

Despite these advantages, the therapeutic application of silymarin is limited by factors such as low solubility in aqueous media, rapid elimination, and reduced permeation by intestinal cells, which compromises its bioavailability and clinical efficacy (Aboshanab et al., 2020). In view of these limitations, alternative strategies have been explored to improve their pharmacokinetic properties, especially the development of nanostructured systems and the association with metal ions.

Among the metal ions of biological interest, zinc(II) (Zn^{2+}) stands out for its broad participation in physiological processes, acting as a structural and functional element of

numerous enzymes, regulatory proteins, and transcription factors (Thompson et al., 2022). A key characteristic of Zn^{2+} is its tendency to form highly soluble positively charged ions in biological fluids, which favors its interaction with natural ligands and its bioavailability in living systems (Oliveira et al., 2022).

In this context, the association of silymarin with zinc(II) (Zn^{2+}) emerges as a promising strategy to overcome its pharmacokinetic limitations. The formation of silymarin- Zn^{2+} complexes/associates can result in greater chemical stability, increased solubility, better biological permeation, and potentiation of the compound's pharmacological activity (Halevas et al., 2021). In general, the interaction between natural ligands and metal ions can confer greater stability, solubility, lipophilicity, and biological activity, in addition to enabling new mechanisms of pharmacological action (Silva et al., 2021).

Metal ions play a key role in biological systems, being widely recognized for their participation in processes such as enzymatic catalysis, signal transduction, electron transfer, and synaptic transmission (Walencik et al., 2024). In addition to acting as biological cofactors, these ions are considered strategic components in the construction of advanced supramolecular systems, both of natural and synthetic origin.

This is due to the fact that the properties of metal compounds can be rationally modulated through the choice of ligands/molecules, the functionalization of the associated groups, and the oxidation state of the metal, factors that directly influence the dosage, bioavailability, and therapeutic efficacy of the compounds (Unavane et al., 2025). In this way, the metallic association is consolidated as an effective strategy to improve the pharmacokinetic performance of natural compounds with inherent limitations, such as silymarin.

In this sense, this work aims to carry out a literature review on silymarin, with emphasis on its interactions with metallic compounds, especially zinc(II), highlighting the role of these complexes in the modulation of its biological and pharmacological properties.

2 DEVELOPMENT

This is a literature review, with a qualitative approach, aimed at gathering, analyzing and synthesizing recent scientific evidence about silymarin, as well as its interactions with the zinc(II) ion and its association with metallic compounds.

The bibliographic survey was carried out in the following electronic databases: World Wide Science, Scientific Electronic Library Online (SciELO), Integrated Library System (SiBi), ScienceDirect, Google Scholar and PubMed. These databases were selected for their

comprehensiveness and relevance in the indexing of national and international scientific journals in the areas of health sciences, pharmacology, chemistry and biotechnology.

The following terms were used as descriptors in Portuguese and English: "silymarin", "silymarin and metallic compounds", "silymarin and zinc", as well as their English counterparts ("silymarin", "silymarin and metallic compounds" and "silymarin and zinc"). The descriptors were combined using Boolean operators ("AND" and "OR"), in order to increase the sensitivity of the search and ensure the retrieval of relevant studies.

As inclusion criteria, original articles, case reports, and experimental studies published between 2021 and 2025, available in full, that addressed silymarin alone or in association with metals, with an emphasis on association mechanisms, chelation, bioavailability, biological activity, or therapeutic applications, were considered.

Duplicate studies, publications outside the delimited period, studies that did not address the area of human health, reviews, and articles without access to the full text were excluded.

After the search stage, the selected studies were submitted to the reading of the titles and abstracts for initial screening. Then, 14 articles were chosen and read in full, and information was extracted as shown in Table 01. Data analysis was performed in a descriptive and interpretative manner, allowing the organization of the findings into thematic axes, according to the descriptors, subdividing them into three: Silymarin, Silymarin and Metallic Compounds and Silymarin with Zinc (II).

Table 1

Articles analyzed in the integrative review on the subject

Silymarin (Silymarin)						
Title	Authors	Year	Objective	Magazine/periodical	Database	DOI
Antioxidant actions of thymoquinone, silymarin and curcumin in an experimental model of aortic ischemia-reperfusion in albino Wistar rats.	Mustafa Yardımcı, Mustafa Göz, Mehmet Salih Aydın, Nazım Kankılıç and Ebru Temiz.	2023	To determine the antioxidant effects of thymoquinone, silymarin and curcumin against ischemia-reperfusion injury associated	Brazilian Journal of Cardiovascular Surgery	Scielo	10.21470/1678-9741-2021-0462

			with the abdominal aorta.			
Effects of Silymarin Plus Glutathione on the Prevention of Hepatic Ischemia-Reperfusion Injury.	Dilara Aliyeva, Ramazan Amanvermez, Kağan Karabulut and Seda Gün.	2022	To examine the therapeutic effects of silymarin (SM) plus glutathione (GSH) on IR liver injury using a rat model of hepatic IR.	Brazilian Journal of Pharmaceutical Sciences	Scielo	10.1590/s2175-97902022e20561
Increasing the bioavailability of silymarin using natural bioenhancers: an in vivo pharmacokinetic study.	Shamama Javed, Kanchan Kohli and Waquar Ahsan.	2022	Explore the use of three natural bioenhancers, namely lysergol, piperine and fulvic acid, which are used in a variety of fixed-dose combinations with silymarin for the preparation of oral formulations.	Brazilian Journal of Pharmaceutical Sciences	Scielo	10.1590/s2175-97902022e20160
Efficacy of Silymarin in the Treatment of COPD via P47phox Signaling Pathway.	Lin XU, Qingying Song, Zhanghong Ouyang, Mengning Zheng, Xiangyan Zhang and Cheng Zhang.	2022	To confirm the important role and prospect of application of silymarin in the treatment of COPD in clinical practice.	Food Science and Technology	Scielo	10.1590/fst.52821
Investigating the anticancer and antimetastatic effect of silymarin	Srithika Srinivasan, Aruchamy Mohanpranth, Ahmed	2024	To investigate the impact of silymarin on A549	Toxicology Reports	Science Direct	10.1016/j.toxrep.2024.101746

against lung cancer.	Nadeem and Muthupandian Saravanan		lung cancer cell proliferation, particularly by examining its impact on MMP-2 and MMP-9 expression and activity.			
Evaluation of the efficacy of oral nano-silymarin formulation in hospitalized COVID-19 patients.	Hossein Aryan, Ramin Hamidi Farahani, Mohsen Chamanara, Sepideh Elyasi, Mahmoud Reza Jaafari, Mahboubeh Haddad, Ashraf Tavaneae Sani, Mohamed Afshar Ardalan and Reza Mosaed	2022	To investigate the efficacy of oral nano-silymarin in hospitalized COVID-19 patients.	Phytotherapy Research	Pubmed	10.1002/PTR.7537
Silymarin supplementation in active rheumatoid arthritis.	Georgeta Stefanovici Zugravu, Carmen Pintilescu, Carmen-Marinela Cumpat, Sorin Dan Miron and Anca Miron	2024	To evaluate the impact of silymarin on rheumatoid arthritis.	Medicine	Pubmed	10.3390/medicine60060999
Silymarin and metallic compounds.						
Title	Author(s)	Year	Objective	Magazine/periodical	Database	DOI
Therapeutic potential of silymarin as a natural iron	Nahid Reisi, Nafiseh Esmaeil, Marjan	2022	To demonstrate the iron-chelating	Clinical Case Reports	World Wide Science	10.1002/ccr3.5293

chelating agent in β -thalassemia intermedia.	Gharagozlo and Behjat Moayed		effects of silymarin monotherapy on β -thalassemia, suggesting that silymarin can be used safely and effectively in the treatment of iron overload conditions.			
Synthesis, characterization, and toxicity evaluations of silymarin-laden Ni-Fe metal-organic structures: Evidence from <i>in vitro</i> and <i>in vivo</i> evaluations.	Fatemeh Rahimi, Sheida Shahraki, Mohammad Reza Hajinezhad, Sonia Fathi-Karkan, Shekoufeh Mirinejad, Saman Sargazi, Mahmood Barani and Ramin Saravani	2024	To seek to synthesize, describe and analyze <i>in vivo</i> and <i>in vitro</i> the biological consequences of Silymarin-loaded Ni-Fe MOFs.	Journal of Drug Delivery Science and Technology	Google Scholar	10.1016/j.jddst.2024.105372
Silymarin-encapsulated liposomal formulation: an effective treatment modality against liver dysfunction associated with copper toxicity and neurobehavioral abnormalities in Wistar rats.	Tuba Maryam, Nosheen Fatima Rana, Sultan M. Alshahrani, Tahreem Tanweer, Salma Saleh Alrdahe, Yasmene F. Alanazi, Farhat Batool, Misha Fatima, Ifat Alsharif, AmerSohail	2023	To assess the beneficial properties of silymarin against copper toxicity, the phenotypic pathological condition of WD, and whether it can be used as supportive therapy for these patients.	Molecules	Google Scholar	10.3390/molecules28031514

	Kashif and Farid Menaa					
Silymarin with Zinc(II)						
Title	Author(s)	Year	Objective	Magazine/periodical	Database	DOI
Enhanced burn healing by multifunctional alginate-chitosan hydrogel involving silymarin and zinc oxide nanoparticles.	Moein Valadi Maryam Doostan, Kamyar Khoshnevisan, Mahtab Doostan and Hassan Maleki	2024	Manufacture a biocompatible hydrogel composed of alginate and chitosan loaded with silymarin NPs and green ZnO.	Burns	Science Direct	10.1016/j.burns.2024.07.021
Silymarin Dehydroflavonolignans Chelate Zinc and Partially Inhibits Alcohol Dehydrogenase.	Václav Tvrdý, Marcel Hrubša Katerina Valentová, Eduard Jirkovský, David Biedermann, Vladimír Kren and Premysl Mladenka	2021	To test whether (a) silymarin flavonolignans can chelate zinc ions and (b) whether such chelating capacity can be biologically relevant.	Nutrients	Google Scholar	10.3390/nu13124238
The protective effect of different combination doses of zinc sulfate and silymarin against toxicity induced by antituberculosis drugs.	Wardah Siddique, Nazia Rashid, Muhammad Asif Faheem, Iram Kamal, Fouzia Kanwal and Gulpash Saghir	2025	To induce hepatotoxicity with Rifampicin and INH in albino rats, to estimate the histoprotective effect of the combination of ZnSO ₄ and Silymarin.	Journal of Islamabad Medical & Dental College	Google Scholar	10.35787/jimdc.v14i1.1296
Beneficial effects of silymarin in combination with zinc against radiation.	Roghayeh Javan, Ayoob Rostamzadeh, Mohammad	2021	To evaluate the radioprotective effects of silymarin (SIL) and zinc, alone	International Journal Morphology	Google Scholar	10.4067/S0717-95022025000301070

	-Shafi Mojadadi, Kosar Hosseinpur, Davood Nasiry and Amir Raoofi		and in combination, against radiation-induced testicular toxicity (IR) in mice.			
--	--	--	---	--	--	--

Source: Prepared by the authors.

The analyzed studies convergently demonstrate that silymarin exerts relevant antioxidant and anti-inflammatory effects, which manifest themselves in a manner dependent on the pathophysiological context and the experimental model adopted, as well as interactions with metal ions, such as zinc(II) that can modulate its biological properties, either through direct complexation, interference in zinc-dependent enzymatic systems or functional synergy in delivery systems and formulations advanced.

In experimental ischemia-reperfusion models, silymarin significantly reduced systemic oxidative stress, as well as modulating inflammatory pathways associated with tissue injury, with superior or comparable performance to other antioxidant phytochemicals, such as thymoquinone and curcumin (Yardimci et al., 2023). In association with glutathione, a synergistic effect on liver protection was observed, with a reduction in inflammatory cytokines, lipid peroxidation, and histopathological damage, reinforcing the role of silymarin as a cytoprotective agent in conditions of acute oxidative stress (Aliyeva et al., 2022). In the randomized controlled trial conducted by Aryan et al. (2022), the administration of nano-silymarin in hospitalized patients with COVID-19 did not result in a significant improvement in overall clinical outcomes, only in ALT levels, which reinforces its hepatoprotective effect.

On the other hand, in oncological models, silymarin showed a selective cytotoxic effect, through the inhibition of the metalloproteinases MMP-2 and MMP-9, zinc-dependent enzymes, promoting apoptosis, cell cycle blockade, and inhibition of tumor migration and metastasis, which evidences its ability to act antagonistically according to cell status (Srinivasan et al., 2024). This mechanistic versatility is clinically supported by the randomized trial conducted in patients with active rheumatoid arthritis, in which silymarin supplementation as an adjuvant therapy resulted in a significant reduction in disease activity and functional and psychosocial improvement, even in the absence of significant changes in classic inflammatory markers, suggesting that clinical benefits may precede detectable biochemical changes (Zugravu et al., 2024).

Additionally, pharmacokinetic studies point to the low oral bioavailability of silymarin as a cross-sectional limitation, although the effects observed in humans indicate that

prolonged exposures or pharmaceutical optimization strategies may be sufficient to promote relevant therapeutic benefits, such as nanoformulations or complexation/association with other metals, especially zinc (II) (Javed et al., 2022). In the study by Reisi et al. (2022), patients treated with silymarin significantly reduced serum ferritin levels after six months of supplementation of patients with β -thalassemia intermedia.

In addition, studies evaluating silymarin combined with zinc(II) show a mechanism where derivatives of silymarin, specifically dehydroflavonoligans, have the ability to chelate Zn^{2+} ions, forming stable complexes under physiological conditions, with significant affinity for zinc(II), resulting in partial inhibition of the enzyme alcohol dehydrogenase (Tvrđý et al., 2021). In consonance, in the study by Siddiqui et al., (2025), in a model of hepatotoxicity by isoniazid and rifampicin, robust results show better results from the association of silymarin-zinc, with a more pronounced reduction in ALT, AST, FA and bilirubins, better histological preservation of the liver, compared to administration alone. Reinforcing this metallic interaction, in the study with liposomal encapsulation of silymarin (SLNPs) associated with zinc in copper toxicity (Maryam et al., 2023), demonstrating that zinc (II) acts synergistically, enhancing the antioxidant and cellular stabilizing action of silymarin, evidenced by greater efficacy in reducing liver enzymes (ALT and AST), histopathological improvement of the liver, and attenuation of neurobehavioral changes.

In the studies by Javan et al. (2025) demonstrated that silymarin and zinc ion, especially in combined administration, can improve sperm parameters and radiation-related infertility problems. The improvement of sperm parameters and testicular cell structure in zinc ion receptor groups can be attributed to the protective properties and increased levels of antioxidants in the cells, the authors report that zinc ion protects normal cells through mechanisms, increased sperm DNA integrity, decreased ROS content, and also improves reproductive function during the prepubertal period with cisplatin administration.

3 CONCLUSION

The present literature review shows that silymarin has a complex and multifactorial pharmacological profile, whose biological activity cannot be attributed exclusively to its classical antioxidant properties. The analyzed data consistently demonstrate that silymarin interacts functionally with metal ions, highlighting the zinc (II) ion as the central element, configuring itself as a phytocomplex with the ability to form metal complexes and associates, which play a relevant role in the modulation of its biological and pharmacological properties.

In addition, the association of silymarin with zinc(II) demonstrated a synergistic effect, resulting in greater therapeutic efficacy when compared to the isolated use of each agent, especially in models of liver toxicity and inflammatory processes.

Finally, silymarin is a pleiotropic, safe and promising phytochemical with antioxidant, anti-inflammatory and cellular stress modulating actions, whose efficacy depends on the pathological context, route of administration and duration of exposure, presenting high translational potential.

REFERENCES

- Aboshanab, M. H. A., et al. (2020). Fabrication, characterization and biological evaluation of silymarin nanoparticles against carbon tetrachloride-induced oxidative stress and genotoxicity in rats. *International Journal of Pharmaceutics*, 587, Article 119639. <https://doi.org/10.1016/j.ijpharm.2020.119639>
- Aliyeva, D., et al. (2022). The effects of silymarin plus glutathione on the prevention of liver ischemia–reperfusion injury. *Brazilian Journal of Pharmaceutical Sciences*, 58, Article e20561. <https://doi.org/10.1590/s2175-97902022e20561>
- Almutary, A. G., et al. (2025). Unlocking the neuroprotective potential of silymarin: A promising ally in protecting the brain against Alzheimer’s disease and other neurological disorders. *Molecular Neurobiology*, 62, 7975–7997. <https://doi.org/10.1007/s12035-024-04654-y>
- Aryan, H., et al. (2022). Evaluation of the efficacy of oral nano-silymarin formulation in hospitalized patients with COVID-19: A double-blind placebo-controlled clinical trial. *Phytotherapy Research*, 36, 3924–3931. <https://doi.org/10.1002/ptr.7537>
- Halevas, E., et al. (2021). Structurally characterized zinc complexes of flavonoids chrysin and quercetin with antioxidant potential. *Inorganica Chimica Acta*, 523, Article 120407. <https://doi.org/10.1016/j.ica.2021.120407>
- Javan, R., et al. (2025). Ameliorating effects of silymarin in combination with zinc against radiation. *International Journal of Morphology*, 43(3), 1070–1081.
- Javed, S., et al. (2022). Bioavailability augmentation of silymarin using natural bioenhancers: An in vivo pharmacokinetic study. *Brazilian Journal of Pharmaceutical Sciences*, 58, Article e2020160.
- Macit, M., et al. (2023). Formulation development of *Silybum marianum* seed extracts and silymarin nanoparticles, and evaluation of hepatoprotective effect. *Journal of Drug Delivery Science and Technology*, 83, Article 104378.
- Maryam, T., et al. (2023). Silymarin encapsulated liposomal formulation: An effective treatment modality against copper toxicity associated liver dysfunction and neurobehavioral abnormalities in Wistar rats. *Molecules*, 28(3), Article 1514. <https://doi.org/10.3390/molecules28031514>
- Oliveira, F. C. H. A., et al. (2022). Íon zinco e ácido ascórbico, uma combinação de seus efeitos imunológicos na prevenção da COVID-19: Um referencial teórico. In *Open science research II* (Vol. 2, pp. 594–603). Editora Científica Digital.

- Rahimi, F., et al. (2024). Synthesis, characterization, and toxicity assessments of silymarin-loaded Ni–Fe metal-organic frameworks: Evidence from in vitro and in vivo evaluations. *Journal of Drug Delivery Science and Technology*, 92, Article 105372.
- Reisi, N., et al. (2022). Therapeutic potential of silymarin as a natural iron-chelating agent in β -thalassemia intermedia. *Clinical Case Reports*, 10, Article e05293.
- Sayyad, M., et al. (2025). Silymarin as a phytopharmaceutical agent: Advances in mechanistic insights, formulation strategies, and pre-clinical applications. *Frontiers in Pharmacology*, 16, Article 1711653.
- Siddiqui, W., et al. (2025). Protective effect of different doses of zinc sulfate and silymarin combination against anti-tuberculosis drug induced toxicity. *Journal of Islamabad Medical & Dental College*, 14(1), 43–50.
- Silva, W. M. B., et al. (2021). Anacardic acid complexes as possible agents against Alzheimer's disease through their antioxidant, in vitro, and in silico anticholinesterase and ansiolic actions. *Neurotoxicity Research*, 39, 467–476.
- Srinivasan, S., et al. (2024). Exploring the anti-cancer and antimetastatic effect of silymarin against lung cancer. *Toxicology Reports*, 13, Article 101746.
- Thompson, M. W. (2022). Regulation of zinc-dependent enzymes by metal carrier proteins. *Biometals*, 35(2), 187–213.
- Tvrđý, V., et al. (2021). Silymarin dehydroflavonolignans chelate zinc and partially inhibit alcohol dehydrogenase. *Nutrients*, 13(12), Article 4238. <https://doi.org/10.3390/nu13124238>
- Unavane, S., et al. (2025). Exploring the therapeutic potential of copper and cobalt complexes as anticancer agents: A comprehensive review. *Transition Metal Chemistry*, 50, 407–430.
- Valadi, M., et al. (2024). Enhanced healing of burn wounds by multifunctional alginate–chitosan hydrogel enclosing silymarin and zinc oxide nanoparticles. *Burns*, 50, 2029–2044.
- Walencik, P. K., et al. (2024). Metal–flavonoid interactions—From simple complexes to advanced systems. *Molecules*, 29(11), Article 2573.
- Yardimci, M., et al. (2022). Antioxidant actions of thymoquinone, silymarin, and curcumin on experimental aortic ischemia–reperfusion model in Wistar albino rats. *Brazilian Journal of Cardiovascular Surgery*, 37(6), 807–813.
- Zugravu, G. S., et al. (2024). Silymarin supplementation in active rheumatoid arthritis: Outcomes of a pilot randomized controlled clinical study. *Medicina*, 60(6), Article 999.

THE TEXTBOOK AS AN OBJECT OF STUDY FOR ETHNIC-RACIAL THEMES

O LIVRO DIDÁTICO COMO OBJETO DE ESTUDO DE TEMÁTICAS ÉTNICO-RACIAIS

EL LIBRO DE TEXTO COMO OBJETO DE ESTUDIO DE TEMAS ÉTNICO-RACIALES



<https://doi.org/10.56238/sevened2026.008-127>

Tatiane Balbino Cordeiro Tomaz¹, Maria de Lourdes Guimarães de Carvalho²

ABSTRACT

This article presents the results of an investigation conducted to determine whether textbooks address Afro-Brazilian literature in a way that ensures students critically question ethnic-racial issues, and whether the proposed teaching activities are adequate for addressing this theme. Its objectives were: to describe, analytically and critically, the approaches to ethnic-racial themes, especially those related to Afro-Brazilian literature, in a sample of Portuguese language textbooks intended for basic education; and to present contributions to support the deepening of this theme in the classroom at this level of education. It is a qualitative and descriptive research, based on official documents and authors who discuss textbooks and Afro-Brazilian literature. The results demonstrate a lack of a relevant approach to Afro-Brazilian literature, which constitutes a significant flaw, because by ignoring these issues, the work fails to contribute to the formation of an inclusive education capable of fostering critical reflection on racism, social inequalities, and the richness of Afro-Brazilian culture.

Keywords: Afro-Brazilian Literature. Textbook. Inclusive Education. Ethnic-Racial Issues.

RESUMO

Neste artigo são apresentados os resultados de uma investigação realizada a fim de responder se o livro didático contempla a literatura negro-brasileira, de modo a assegurar aos alunos questionamentos críticos sobre as questões étnico-raciais e se as atividades didáticas propostas são adequadas para o tratamento dessa temática. Ele teve como objetivos: descrever, analítica e criticamente, as abordagens de temáticas étnico-raciais, em especial aquelas relativas à literatura negro-brasileira, em uma amostra de livro didático de língua portuguesa destinado à educação básica e, apresentar contribuições para subsidiar o aprofundamento dessa temática em sala de aula desse nível de ensino. É uma pesquisa qualitativa e descritiva, fundamentada em documentos oficiais e em autores que discutem o livro didático e a literatura negro-brasileira. Os resultados demonstram que há falta de uma abordagem relevante da literatura negro-brasileira, o que constitui uma falha significativa, pois, ao ignorar essas questões, a obra deixa de contribuir para a formação de uma

¹ Master's student in Letters. Universidade Estadual de Montes Claros.

E-mail: tatiane.tomaz@educacao.mg.gov.br Orcid: <https://orcid.org/0009-0005-9200-1506>

Lattes: <http://lattes.cnpq.br/9623291941075105>

² Work advisor. Doctor of Letters. Pontifícia Universidade Católica de Minas Gerais (PUC/MG).

E-mail: maria.carvalho@unimontes.br Orcid: <https://orcid.org/0000-0001-6976-6248>

Lattes: <http://lattes.cnpq.br/0180031783903467>

educação inclusiva, capaz de fomentar a reflexão crítica acerca do racismo, das desigualdades sociais e da riqueza da cultura afro-brasileira.

Palavras-chave: Literatura Negro-Brasileira. Livro Didático. Educação Inclusiva. Questões Étnico-Raciais.

RESUMEN

Este artículo presenta los resultados de una investigación realizada para determinar si los libros de texto abordan la literatura afrobrasileña de forma que los estudiantes cuestionen críticamente las cuestiones étnico-raciales, y si las actividades didácticas propuestas son adecuadas para abordar este tema. Sus objetivos fueron: describir, analítica y críticamente, los enfoques de los temas étnico-raciales, especialmente los relacionados con la literatura afrobrasileña, en una muestra de libros de texto en portugués destinados a la educación básica; y presentar contribuciones para apoyar la profundización de este tema en el aula en este nivel educativo. Se trata de una investigación cualitativa y descriptiva, basada en documentos oficiales y autores que abordan los libros de texto y la literatura afrobrasileña. Los resultados demuestran la falta de un enfoque relevante de la literatura afrobrasileña, lo cual constituye una deficiencia significativa, ya que, al ignorar estas cuestiones, el trabajo no contribuye a la formación de una educación inclusiva capaz de fomentar la reflexión crítica sobre el racismo, las desigualdades sociales y la riqueza de la cultura afrobrasileña.

Palabras clave: Literatura Afrobrasileña. Libro de Texto. Educación Inclusiva. Cuestiones Étnico-Raciales.

1 INTRODUCTION

"A book, a pen, a child and a teacher can change the world". Malala Yousafzai - Nobel Peace Prize in 2014.

It is possible to say that the textbook (textbook), which is an essential tool in the schooling process, has the power to transform lives, such as Malala's, mentioned in the epigraph, in which education was fundamental to her struggle for girls' rights and for equal access to learning. In addition, textbook is a resource that plays a central role in the teaching-learning process, because, in addition to functioning as an important tool in the presentation, organization and conduction of classroom activities, it directs the didactic-pedagogical approach, the choice of themes and the way students interact with knowledge.

In Brazil, the National Textbook Program (PNLD), created in 1985, subsidized by the National Fund for the Development of Education (FNDE), was consolidated with the objective of enabling the universalization of basic education, promoting the acquisition, distribution and systematic evaluation of textbooks for students in the public elementary school system, according to the parameters and norms established by the Ministry of Education (MEC). Regarding these criteria, after the approval of the Law of Guidelines and Bases of National Education (LDB 9394/1996), it became necessary to develop didactic materials that met the requirements of Brazilian education, including those that provided for the approach of ethnic-racial themes.

On ethnic-racial issues, for example, in the twenty-first century, it is possible to see that Brazilian society still faces difficulties in combating racism. This perspective is supported by the words of Milton Santos (2000, p.15) when he states that: "To be black in Brazil is, therefore, often to be the object of a biased gaze. The so-called good society seems to consider that there is a predetermined place, down there, for blacks and thus calmly behaves."

This finding and the need to change this reality justify the necessary adoption of anti-racist practices in the texts and activities proposed in the textbooks, in order to ensure that the black population is referred to and portrayed with respect and valued as a constitutive part of the historical, social and cultural formation of Brazil. Thus, it is expected that a didactic material in circulation, as important as the Portuguese-language textbook, not only addresses ethnic-racial issues in a critical way, but also gives visibility to black-Brazilian literature and its authors, in order to promote representativeness and the deconstruction of stereotyped views still naturalized in the school space.

Given these considerations, it was intended in this investigative work to answer, through careful analysis of a sample of textbooks in Portuguese, whether **it contemplates**

black-Brazilian literature with adequate didactic activities for the treatment of this theme, **in order to provide** critical questions about ethnic-racial issues.

The general objective is to describe, analytically and critically, the approaches to ethnic-racial themes, especially those related to black-Brazilian literature, in a sample of Portuguese language textbooks intended for basic education and, specifically, to present contributions to subsidize the deepening of this theme in the classroom of this level of education.

Thus, this is a study justified by the need to consider the contributions of textbooks to the formation of a critical and inclusive view in relation to the cultural and racial diversities present in Brazilian society, towards an education aimed at welcoming, recognizing and fully developing students, respecting their singularities and diversities, as ensured by the BNCC, which he proposes,

Exercise empathy, dialogue, conflict resolution and cooperation, making oneself respected and promoting respect for others and human rights, welcoming and valuing the diversity of individuals and social groups, their knowledge, identities, cultures and potentialities, without prejudice of any kind (Brasil, 2018, p.10).

In view of this importance highlighted by the document, the understanding is that the presence of black-Brazilian literature is essential and necessary, through texts alluding to this theme, explored appropriately in the school environment, and should, therefore, be present in the curricula of basic education. After all, students should and deserve to be introduced to content that favors their citizenship education, in a broader and deeper way, under penalty of suffering symbolic violence.

2 METHODOLOGY

Considering the methodology as the set of systematic and rational activities that the researcher uses to obtain and to present, with greater security, the data, towards the achievement of his objectives, this research is qualitative and, as proposed by Minayo (2004, p. 21-22), "[...] works with the universe of meanings, motivations, beliefs, values and attitudes, which corresponds to a deeper space of relationships, processes and phenomena that cannot be reduced to operationalization" and, in addition, does not have the objective of obtaining or demonstrating numbers, statistics or percentages through graphs and tables. Thus, empirical materials are studied, such as texts, including multimodal, didactic-methodological activities, and observational, historical, interactive and visual cultural productions present in the analyzed textbook.

According to the more general purposes, as Gil (2022) points out, this is a descriptive research, since one of the objectives was to descriptively present a critical analysis of the approaches to ethnic-racial themes, especially those related to black-Brazilian literature, in a sample of Portuguese-speaking textbooks.

The object of study was the textbook "Portuguese - Languages", 9th grade, 11th ed. (and its respective teacher's manual) by the authors William Cereja and Carolina Dias Vianna, published in 2022 and indicated by the PNLD for the 2024-2027 quadrennium.

Theoretical considerations about textbooks and black-Brazilian literature follow.

3 CONSIDERATIONS ABOUT TEXTBOOKS

Studies show that in Brazil, textbook is still one of the main didactic tools used in the classroom. According to Lajolo (1996, *apud* Michelato and Santana, 2023, p. 25), textbook has consolidated itself as an essential instrument in pedagogical practice, characteristic of school culture, and has become an important "support" for the teacher's work in various areas of knowledge. In certain contexts, this "support" goes further, becoming an essential tool for the development of classes.

In this way, textbook is characterized as a fundamental pedagogical tool, whose main objective is to serve both students and teachers. For students, the textbook plays the role of assisting in the acquisition of knowledge, as it facilitates their approximation with the content to be studied. For teachers, the book works as a teaching guide, presenting methodologies for the application of classes and didactic guidelines for carrying out activities.

In this scenario, it is essential to consider that textbook should be seen as a support for teaching practice, and not as a rigid script of content to be followed in classes, which should be planned according to the needs of the educator based on the characteristics of the students. In addition, it is necessary to consider the particularities of each educational institution, such as the context in which it is inserted, the profile of the students and their level of education. These particularities directly influence the pedagogical choices and adaptations that the teacher must make in the teaching-learning process.

In Rangel's words,

The big difference between the textbook and other didactic materials, especially those that make use of the image, such as film, video, photo and others, lies in the fact that it is, above all, a legitimate product of writing technology. For this very reason, it is possible to have, through it, an effective access to literate culture (Rangel, 2006, p.13).

In view of this, textbook is mainly based on written language, being a structured way of transmitting knowledge, values, practices and forms of communication built through

reading and writing, which constitutes the so-called "literate culture", considered fundamental for the critical and intellectual formation of students. By reading and writing, the student appropriates concepts, develops logical thinking and better understands the world around him.

In view of the above, although other didactic materials that primarily use multimodal languages, such as images, films, videos or photographs are valuable in the learning process, they may not establish the same direct relationship with literate culture, which is centered on written language. Thus, while these resources complement and enrich learning, textbook stands out as a privileged tool for the construction of written knowledge and for a deep understanding of literate culture. For this reason, textbook reflects the organization of the teaching-learning process and plays a fundamental role in transforming the educational reality of students.

In Brazil, the National Textbook Program (PNLD), created in 1985, was consolidated with the objective of enabling the universalization of basic education, promoting the acquisition, distribution and systematic evaluation of textbooks for students in the public elementary school system, according to the criteria and standards established by the Ministry of Education (MEC).

With the approval of the Law of Guidelines and Bases of National Education (LDB 9394/1996), it became necessary to develop didactic materials that would meet the requirements of Brazilian education. Thus, the evaluation of textbooks has become a fundamental criterion in the choice of those to be adopted by educational institutions. After the official evaluation and review in the textbook guide, teachers have the opportunity to choose the work they consider most appropriate to their realities and with which they wish to work. However, it should be noted that although the Federal Government recommends that each public school select three options of textbooks, listing them from the first to the third choice, the teaching experience has already shown that the book chosen as the first option is not always the material actually received by the school and, even if empirically, it is possible to affirm that the approaches to ethnic-racial themes, from the black-Brazilian literature, in textbooks in general, are incipient, since such issues, in most cases, are approached in a superficial way.

The following are considerations about black-Brazilian literature.

4 CONSIDERATIONS ON BLACK-BRAZILIAN LITERATURE

Black-Brazilian literature stands out for its protest character and its importance for valuing historically marginalized experiences and perspectives. In this context, understanding

black literary production allows us to perceive how readers are invited to come into contact with experiences and perspectives different from those traditionally represented in school curricula.

From this point of view, Law 10.639/2003 (Brasil, art. 26), which amends LDB/9.394/96, made the teaching of Afro-Brazilian history and culture mandatory in the national education systems and provides for the inclusion of this theme in the official curriculum of the Education Network:

In elementary and secondary schools, both official and private, the teaching of Afro-Brazilian History and Culture becomes mandatory.

§ 1 The syllabus referred to in the caput of this article will include the study of the History of Africa and Africans, the struggle of blacks in Brazil, black Brazilian culture and blacks in the formation of national society, rescuing the contribution of black people in the social, economic and political areas pertinent to the History of Brazil.

2º The contents related to Afro-Brazilian History and Culture will be taught within the scope of the entire school curriculum, especially in the areas of Art Education and Brazilian Literature and History (Brasil, 2003, art. 26 A).

In this context, it is essential that teachers prepare themselves from a theoretical and methodological point of view to address with students the relevance of Afro-Brazilian culture in the formation of society, recognizing black people as historical subjects and valuing their culture.

Taking into account this perspective, Brandino (2022) states that, "[...] it is the literary production whose subject of writing is the black man himself. It is from the subjectivity of black men and women, their experiences and their point of view that the narratives and poems thus classified are woven." This statement demonstrates that black literature provides a more authentic and diverse representation of the reality of black people, as it highlights their voices and their experiences.

According to the writer Cuti,

Black-Brazilian literature was born in and from the black population that was formed outside Africa, and from its experience in Brazil. The singularity is black and, at the same time, Brazilian, because the word "black" points to a process of participatory struggle in the destiny of the nation and does not lend itself to reductionism that contributes to an alleged whiteness that would encompass it as a whole to receive, from here and there, black and indigenous elements to strengthen itself. Because it is a question of participation in national life, the emphasis on this literary aspect must be referenced to its active social genesis. What there is of a manifestation of demands is based on the word "black" (Cuti, 2010, p.42).

In this context, the origin of black-Brazilian literature is directly associated with the social, historical, and political experience of black peoples, since they act as protagonists of their stories, to the extent that their trajectory is synonymous not only with suffering or subservience, but also with resistance, struggle, and achievements. And it is in this context that the word "negro" must be understood, since, according to Cuti, it should symbolize struggle and resistance within the formation of the Brazilian nation. In this way, black literature is not limited to just contributing to Brazilian culture, instead, it asserts itself as a field of action that has its own voices that fight for its recognition and autonomy.

As is known, the lack of schooling opportunity left negative marks in the history of black people who arrived in Brazil in the colonial period, as the legislation of that time denied schooling to all of them. For this reason, the black population was prevented from registering written literature and, as many were not literate, they were left only with the transmission of oral literature, which was very harmful to the country, since part of its culture and history was forgotten due to lack of registration.

From this point of view, it is evident that the publication of black-Brazilian literature – that written by black authors – is still scarce in Brazil, although there are records of those who, not without conflicts and difficulties, have obtained visibility, such as Maria Firmina dos Reis, Lima Barreto, Luís Gama, Machado de Assis, Conceição Evaristo, Cuti and Carolina Maria de Jesus. In addition, Brazilian literature has stereotyped and even racist representations in relation to black authors. As an example of this, Evaristo writes:

I like to write, most of the time it hurts, but after the written text it is possible to appease the pain a little, I say a little... Writing can be a kind of revenge, sometimes I think about it. I don't know if revenge, perhaps defiance, a way of hurting the imposed silence, or even executing a gesture of stubborn hope. I also like to say that writing is for me the dance-singing movement that my body does not perform, it is the password through which I access the world. [...] Posing the question of identity and difference within language, that is, as acts of linguistic creation, literature, a privileged space for the production and symbolic reproduction of meanings, presents a discourse that excels in proclaiming, in instituting a negative difference for black women (Evaristo, 2005, p. 2).

Based on the author's reflections, it is evident that black literature is perceived as a cry of protest because, thanks to it, the black community is able to reveal its true merit to the world, through discourses that have been silenced over time.

According to Santos,

The black subject, who produces Black Literature, has a point of view that denounces the racism introjected into Brazilian ethnic-racial relations, a critical point of view on

the "false abolition of slavery" that threw the black population into misery, poverty, violence and genocide of the youth of this population. A point of view committed to the exaltation of natural black beauty, free from whitening and the white masks that have always been imposed on subjects who want to be accepted by Eurocentric standards of beauty (Santos, 2021, p.39).

Based on this statement, it is observed, in today's society, that several authors of black-Brazilian literature, such as Luiz Gama, Conceição Evaristo, Geni Guimarães, Midria Silva and many others who propagate black-Brazilian literature, play a fundamental role, which is to denounce, through their writings, the formation of a racist ideology, which originates mainly from those who consider themselves superior in relation to the black population.

In view of these considerations, it is observed that poets adept at writing themes that address ethnic-racial issues exalt the beauty of black people through their characters, deconstructing the negative image of black people that has been, over the centuries, the target of mistreatment in the canonical literature of several white authors. In this current context, black-Brazilian literature, for almost two centuries made invisible in Brazilian society - since the first records of this strand of Brazilian literature that are known date back to the beginning of the second half of the nineteenth century - emerges as a voice for black people.

Furthermore, it is possible to affirm that black-Brazilian literature emerges in the country as an expression of black subjectivity, given that, in Brazil, there is a predominance of the study of canonical literature written by white authors, which demonstrates a type of racism internalized in the approach to literature, based on the reading practices developed within the school space. On the other hand, decolonial philosophy **emerges, understood as a perspective that** questions Eurocentric patterns of knowledge and values historically marginalized knowledge, including Afro-Brazilian culture. About decolonial thought, Colaço states that it

[...] reflects on colonization as a great prolonged event with many ruptures and not as a historical stage that has already been overcome. In this sense, he speaks of 'coloniality'. However, it is not an exclusively academic field, but refers, above all, to a new political and epistemological tendency. It involves several social actors and reflects the unfolding of a process that allows not only the critique of "Western" discourses and modern explanatory models, but also the emergence of different types of knowledge that arise from "other" places of thought (Colaço, 2012, p. 08).

This approach reveals that decolonial thinking goes beyond the academic sphere, engaging multiple social actors and valuing different forms of knowledge. In this context, it is a thought that offers a critical focus for the study of black-Brazilian literature, allowing historically silenced narratives to be recognized and valued.

Therefore, the urgency of rethinking the forms of knowledge production is evident, as Colaço (2012, p.190) points out: "Today, more than ever in the history of the modern/colonial world, there is a need for a process of change in the sense of building knowledge structures that arise from the experience of humiliation and marginalization". In fact, coloniality has left deep marks of exclusion and silencing, and the current challenge is to build knowledge that is born from historically marginalized voices and experiences. In addition, it is necessary to recognize that knowledge is not neutral, but crossed by political, ideological and cultural choices, which makes it essential to value knowledge arising from resistance and pain.

Thus, by examining how ethnic-racial issues are treated, especially with regard to black-Brazilian literature, it becomes possible to identify how the school still reproduces hierarchies of knowledge and restricts access to critical perspectives. Therefore, the investigation of these resources allows us to problematize the limits of the curriculum and point out the need for a pedagogical practice that ensures inclusion, the appreciation of cultural plurality and, as a result, ensures an effective commitment to social justice.

5 RESULTS OF THE ANALYSIS OF THE TEXTBOOK AND THE TEACHER'S MANUAL

The analysis of the textbook and the teacher's manual is essential to understand how the teaching of literature is structured and which discourses are legitimized in these materials, since, in addition to the selected contents, they carry didactic-pedagogical and ideological choices that guide the teaching work. It is considered that in a context in which education seeks to become more inclusive and representative, it is essential to understand how these themes are addressed in pedagogical material.

The analysis was based on the premise of identifying whether the texts and activities proposed promote an education that respects the singularities and diversities of students, favoring their reception, recognition and full development, verifying whether the approach to these themes is in line with the principles of the LDB and the guidelines established by the BNCC. It also evaluates whether the didactic-methodological proposals suggested for the study of the texts propose critical questions to address ethnic-racial issues. Thus, it is an analysis that allows us to understand whether the material contributes to the formation of a critical and inclusive view of the cultural and racial diversities present in Brazilian society.

Addressing teachers in the presentation of the book, Cereja and Vianna (2022) state that the work presents a consistent reading proposal, based on clear and defined pedagogical principles, through a careful selection of texts ranging from the classics of universal literature to the authors of contemporary Brazilian literature, and that it is a work that can collaborate with the formation of competent readers of various genres in social circulation (Cereja,

Vianna, 2022, p. 03). In addition, the authors imply that it is an approach that aims to provide the development of the ability to understand and analyze different types of texts, preparing readers for a critical and diversified reading.

In the first pages of the teacher's manual, the authors highlight that all volumes in the collection (6th to 9th grade) present content related to the skills provided for in the BNCC, in order to ensure that students master the language practices and linguistic strategies necessary to participate, safely and autonomously, in the various social activities.

However, when analyzing the 9th grade textbook of this collection, it is observed the absence of diversity in the perspective of literary reading referring to themes that allude, in an effective and in-depth way, to black-Brazilian literature, which configures a gap in the didactic-pedagogical approach to ethnic-racial issues, and which can hinder the development of a richer and more conscious cultural identity.

Throughout the work "Portuguese: Languages" (9th grade), although there are proposals to approach authors and literary works representative of the Brazilian literary canon, the productions of black writers, who are fundamental for the constitution of a more plural and inclusive Brazilian literature, are not sufficiently contemplated. Thus, by neglecting black literature, this textbook can deprive students of the opportunity to recognize and identify with figures and experiences that are part of the history of Brazil, reinforcing prejudice and social exclusion, by not representing in a fair and visible way the contributions of blacks to national culture.

As an example, it is possible to present the analysis of some activities proposed in the textbook for the 9th grade.

5.1 ANALYSIS 1

On pages 83-84, there is a reference to black women as the outcome of a proposal for the production of a text that does not make an in-depth mention of the theme.

The proposed activity is based on an informative text entitled "With a book club, young people want to inspire the trajectories of black girls", by Helisa Ignácio. The author describes the desire of a group of girls from the Luiz Campo Dall'Orto Sobrinho State School, in Sumaré, São Paulo, who, after watching the short film *Vida Maria*, feel motivated to transform the reality of black women, finding inspiration for this in literature.

The aforementioned activity is shown below, as shown in figure 1.

Figure 1

Pages 83-84 of the textbook

6. Leia o texto a seguir.

Com clube de leitura, jovens querem inspirar trajetórias de meninas negras

Após assistir à animação *Vida Maria* — história de uma menina que é obrigada a largar estudos e sonhos para cuidar dos afazeres de dentro de casa —, um grupo de meninas da Escola Estadual Luiz Campo Dall'Orto Sobrinho, da cidade de Sumaré (SP), percebeu que a narrativa não era ficção. E, por isso, se sentiu provocado a compreender melhor e a mudar esta realidade, que é vivida de forma predominante por mulheres negras.

Vitória Santos, Barbara de Souza e Raissa Batista encontraram, na literatura, um mundo de possibilidades de vida narradas e documentadas por escritoras afro-brasileiras. Criaram, assim, o Club The Readers – Tecnologia e Literatura Libertam, com o apoio da sua professora Eliana Cristo. A iniciativa está entre as 50 premiadas no Desafio Criativos da Escola 2020.

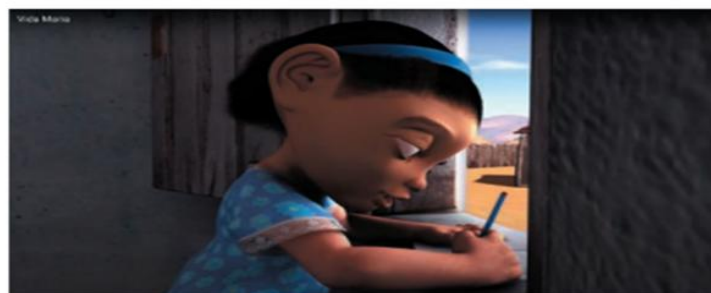
Segundo nota técnica do Instituto de Pesquisa Econômica Aplicada (IPEA), em 2020, mais de 18% das mulheres negras brasileiras têm o trabalho doméstico como ocupação. Enquanto apenas 2% têm cargos executivos e de gerência, de acordo com estudo do Instituto Ethos realizado em 2015. A partir da pesquisa de dados como estes, as adolescentes se perguntaram, então, como poderiam mostrar para outras jovens que é possível criar outras histórias que vão além do estigma da mulher negra em trabalhos subalternizados.

Por meio das redes sociais, de jogos, pesquisas e cafés literários *online*, as alunas dão visibilidade a escritoras negras e estimulam a leitura de seus livros. Além de resgatar a ancestralidade e a história destas mulheres, as adolescentes querem inspirar outras estudantes negras a sonharem com suas trajetórias de vida e a conquistarem novos espaços na sociedade.

"Quando as pessoas tiverem acesso a essa literatura [feita pelas mulheres negras] e virem que podem alcançar seus objetivos e combater as desigualdades que existem no nosso país, vão poder enxergar que nós também somos fortes e que nossas raízes, vidas e histórias podem ser lindas, e inspirar mais outras pessoas". É o que deseja a estudante Vitória, de 16 anos.

[...]

IGNÁCIO, Helisa. Com clube de leitura, jovens querem inspirar trajetórias de menina negras. *Criativos da escola: design for change*. 1º aht. 2021. Disponível em: <https://criativosdaescola.com.br/historia/com-club-de-leitura-jovens-querem-inspirar-trajetorias-de-meninas-negras/>. Acesso em: 5 maio 2022.



► Cena da animação *Vida Maria*, dirigida por Márcio Ramos (Brasil, 2006), que inspirou as meninas da notícia a montar o clube de leitura.

- Nos artigos de opinião "Selfies" e "A convivência com a internet", foca-se bastante nos aspectos negativos do mundo digital. E quanto ao texto "Com clube de leitura, jovens querem inspirar trajetórias de meninas negras", isso se dá também? Explique.

Não. Aqui se destaca um uso muito positivo das redes sociais, pois foi por meio delas que as jovens mencionadas conseguiram criar o Club The Readers, "iniciativa está entre as 50 premiadas no Desafio Criativos da Escola 2020".

Source: Cereja and Vianna (2022, p.83-84). Available at: <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/>. Acesso on: 28 Feb. 2025.

There is even the testimony of one of the students emphasizing the value of access to literature made by black women and expressing her desire:

When people have access to this literature (made by black women) and see that they can achieve their goals and fight the inequalities that exist in our country, they will be

able to see that we are also strong and that our roots, lives and stories can be beautiful and inspire other people more." (Cherry; Viana 2022, p. 83).

It is observed that the student's testimony can generate important discussions about black-Brazilian literature, however, the proposal of the book, which follows the reading, is only: "In the opinion articles "*Selfies*" and "Coexistence with the internet" it focuses a lot on the negative aspects of the digital world. And as for the text "With a book club, young people want to inspire the trajectories of black girls", is this also the case? Explain."

As can be seen, this activity proposal radically changes the course of the approach. It becomes about criticism of the negative aspects of the digital world, a subject present in Marcelo Coelho's opinion article, at the beginning of chapter 3 and in Helisa Ignácio's text.

Students are asked to analyze and reflect on whether these same negative aspects are present in the animation *Vida Maria* – a short cinematographic text that portrays in a sensitive and brief way the realities faced by communities, especially in the Northeast of Brazil, and exposes the harsh reality of a sertanejo region, in which economic, social and cultural resources for subsistence are scarce and educational opportunities are limited –. However, it is a text that does not mention negative aspects of social networks; on the contrary, it points out the positive aspect of them, since it was through social networks that the students created the book club that was even awarded among the 50 best.

It is noted that although Helisa Ignácio's text mentions literature, with an emphasis on the production of black authors, it does so in an incipient, shallow way. In this didactic-methodological activity, there is no allusion to the competencies that provide the recognition of the text as: (i) a place of manifestation and negotiation of meanings, values and ideologies; (ii) opportunity to take an ethical and critical position in relation to discriminatory content related to human and environmental rights; (iii) involvement with greater autonomy and protagonism in social life. Thus, it is evident that the authors missed the opportunity to suggest a work aimed at deeper reflections on ethnic-racial issues and on literature produced by black people, although the texts are highly suggestive and provide the possibility of reflections on these themes.

5.2 ANALYSIS 2

In activity 7, on page 145, students are invited to read the short story "Belinha" by Marcelino Freire, written in 1967. The proposed approach is limited to the exploration of the structure of the short story (whether it is of traditional structure or not, what are the characters and their physical and psychological characteristics, the type of narrator, if there are dialogues, what is the conflict and in which paragraph it is presented, and if the conflict is

ended) in short, only questions related to the interpretation of the short story. To fix the content, the textbook presents a box entitled "Time in fictional narratives" and another with the title "The *flashback technique*".

In figure 2, it is possible to see the proposal.

Figure 2

Time in Fictional Narratives p. 149



O tempo nas narrativas ficcionais

Os fatos de uma narrativa relacionam-se com o tempo em três níveis:

Época em que se passa a história
A época em que se passa a história constitui o pano de fundo para o enredo. No conto "Belinha", a época é a atual. Nem sempre, porém, a época em que se passa a história narrada coincide com aquela em que ocorre sua publicação.

Tempo cronológico
É o tempo que transcorre na ordem natural dos fatos do enredo. É o tempo relacionado ao enredo linear, ou seja, à ordem em que os fatos ocorrem. Chama-se cronológico porque pode ser medido em horas, meses, anos, séculos. No conto "Belinha", os fatos acontecem no período de um mesmo dia, em poucas horas.

Tempo psicológico
É o tempo que transcorre numa ordem determinada pela vontade, pela memória ou pela imaginação do narrador ou de uma personagem. De acordo com esse tempo, os fatos podem ou não aparecer em uma ordem linear, isto é, coincidente com a do tempo cronológico. No conto de Marcelino Freire que foi lido, predomina o tempo psicológico.



A técnica do flashback

O *flashback* é um recurso narrativo que consiste em voltar no tempo. Em nossa literatura, o romance *Memórias póstumas de Brás Cubas*, de Machado de Assis, apresenta essa técnica: o tempo em que se situa o narrador-personagem Brás Cubas é posterior à sua morte, o que lhe permite voltar ao passado recente e contar como morreu, por exemplo, ou voltar ao passado mais distante e contar fatos de sua infância e juventude. Veja um trecho dessa obra.



Alguns tempos hesitei se devia abrir estas memórias pelo princípio ou pelo fim, isto é, se poria em primeiro lugar o meu nascimento ou a minha morte. Suposto o uso vulgar seja começar pelo nascimento, duas considerações me levaram a adotar método diferente: a primeira é que não sou um autor defunto, mas um defunto autor, para quem a campa foi outro berço; a segunda é que o escrito ficaria assim mais galante e mais novo [...].

Dito isto, expirei às duas horas da tarde de uma sexta-feira do mês de agosto de 1869, na minha bela chácara de Catumbi. Tinha uns sessenta e quatro anos...

Retrato de Machado de Assis (1839-1908), aos 57 anos (cerca de 1896).

ASSIS, Machado de. *Memórias póstumas de Brás Cubas*. São Paulo: Ática, 1992. p. 17.

Source: Cereja and Vianna (2022, p. 148). Available at: <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/>. Accessed on: 28 Feb. 2025.

As can be seen, in the first text there is a theoretical explanation about the three levels related to time, in a narrative: (i) the time in which the story takes place; (ii) chronological time and, (iii) psychological time. In the second, there is a theoretical explanation about the *flashback technique* as a literary resource, exemplified with an excerpt from the work *Posthumous Memories of Brás Cubas*.

However, after this moment, there are no more comments on the theme or on the author and his work. There is no reference, for example, to the publication of *Contos Negreiros*, a work of fiction in which Marcelino Freire presents delicate and controversial

themes in 16 narratives of miserable Brazilians who sell everything to survive – such as drugs, the body and even the organs – a work that, published in 2005, provided the author with the 2006 Jabuti Prize for Literature.

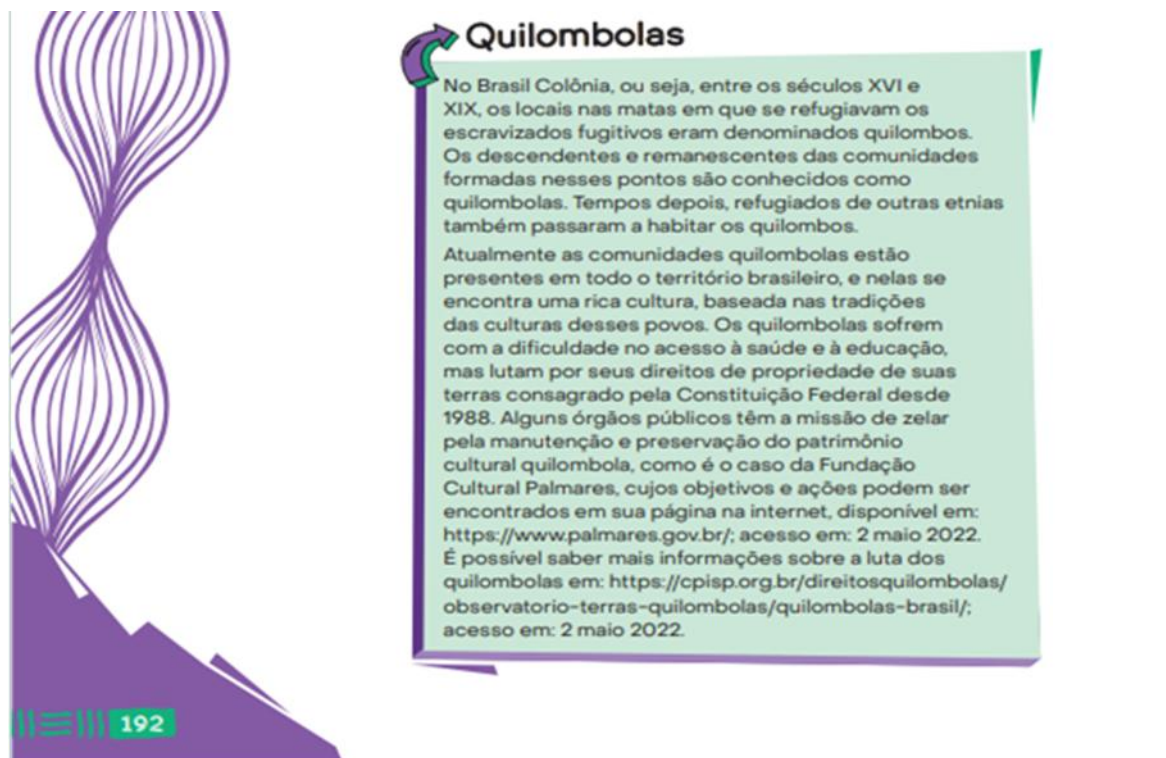
Then, on page 149, three short stories are presented, each accompanied by a succinct explanation about the genre and a question of textual analysis, one for each short story. Again, there is no allusion to the theme under study or whether its authors are black or address issues related to blacks. In addition, it is suggested that students write at least one longer contemporary short story and one short story. The theme is not suggested.

5.3 ANALYSIS 3

On pages 191-192 (unit 3, chapter 2), in the Exercises section, there is an invitation to read a news article about geoparks, highlighting their importance for local enhancement and sustainable development, the criteria for being a geopark according to Unesco and the description of two geoparks. Next, there is a box entitled "Quilombolas" (p. 192), with a summary of the struggle of these peoples in Brazilian territory:

Figure 3

Quilombolas



Source: Cereja and Vianna (2022, p. 192). Available at: <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/> Accessed on: 28 Feb. 2025.

Next, the authors propose four questions related to the text: three of them focused on identifying the characteristics of the news genre and one on verbal and nominal agreement, based on an excerpt extracted from the news. No approach to the theme of the text and no discussion of social issues characteristic of the cultures of quilombola communities.

On page 194, the activity continues with the proposition of four new questions, numbered from five to eight. In question five, a fragment of a news article entitled "Collection of books brings together articles by more than 30 authors on blackness in Rio Grande do Norte", written by Isabela Santos, is presented. This news brings information about the launch of the book collection "Negritude Potiguar", with the aim of giving visibility to black culture: "The titles, organized by anthropologist Geraldo Barboza de Oliveira Júnior, are "Quilombola Communities", "Peoples of African Matrix" and "Black Popular Culture". The e-books were released in October 2021 for free and, this May, Editora Oiticica makes the physical book available. [...]"

It is noted that the proposal of the event "Book launch "Negritude potiguar" as well as the titles of the books, give rise to a very rich opportunity to discuss the theme. However, after reading the report, students are invited to answer two questions: "a) The fact reported is the launch of a collection of books. What information does the first paragraph add about this release?" and "b) What objective of this launch does the consulted expert emphasize?" With the suggested answer: "he emphasizes the objective of informing and democratizing the knowledge generated in quilombola communities." However, there is no allusion to literature by black authorship or to the contribution of this population to the formation of the country.

Next, the other activities are the rereading of an excerpt from the text for exploration and fixation of grammatical knowledge (part of speech, agreement), in addition to a structural activity of agreement through decontextualized sentences.

As can be seen, the authors once again neglect the opportunity to carry out a discussion based on the importance of the Afro-Brazilian population in the history of Brazil, highlighting its contribution to language, culture, literature, cuisine and religion, among other aspects. A curricular silencing is perceived, since the activities are reduced to a mere language exercise, serving as a pretext to work on grammar, and not as a central axis of citizenship education.

In this sense, the two texts, the box "Quilombola" and the news about "Negritude Potiguar", create a false expectation in the reader, who remains waiting for some mention about the thematic axis under analysis. However, there is no deepening of the theme, and this superficiality causes the erasure of black people. In this way, the textbook promotes a

misleading connection with Law 10.639/03, since the legislation requires the approach of Afro-Brazilian history and culture to value and promote recognition.

In view of this, the box should have presented, in addition to basic information about quilombos and quilombola communities, the history, resistance and the feeling of territoriality, through questions that could lead to a more in-depth discussion about the historical relevance of quilombos as spaces of resistance and the right to land. In addition, it would be pertinent to address the identity and cultural heritage of this people and give literary visibility, discussing, for example, the importance of black authorship and the role of the launch of the collection in promoting this production.

Therefore, a more effective pedagogical approach would be to focus on critical reading and engaged textual production, such as writing an opinion article about Law 10.639/03 and traditional communities, allowing students to express their critical, conscious, and participatory position. Another alternative would be to suggest that students research and analyze an excerpt from a book from the Potiguar collection. Certainly, this would be more enriching than focusing on textual genre characteristics or decontextualized grammatical exercises.

5.4 ANALYSIS 4

On page 197, there is an Enem dissertation obtained from the INEP website. Its theme is about the need to combat religious intolerance, exalting the competence of the family and the school to educate about tolerance and respect for beliefs. The fragment ends with a quote from Nelson Mandela: "Education is the most powerful weapon to change the world", followed by the candidate's concluding thought: "In this way, just as the disintegration of an atom has become simple today, prejudices can be broken."

In addition, there is an illustrative image of a person writing and the painting artwork "*Golden Rule*" by Norman Rockwell from 1961, in which the artist pays homage to religious diversity through the figure of the pope flanked by people of different ethnicities/races and, naturally, of different creeds.

The text and its activities follow:

Figure 4

Page 197 of the textbook

Por tudo isso, é imprescindível que todos os segmentos sociais unam-se em prol do combate à intolerância religiosa no Brasil. Assim, cumpre ao governo efetivar de maneira mais plena as leis existentes. Ademais, cabe às escolas e às famílias educarem as crianças para que, desde cedo, aprendam que têm o direito de seguir suas escolhas, mas que devem ser tolerantes e respeitar as crenças do outro, afinal, como disse Nelson Mandela, "a educação é a arma mais poderosa para mudar o mundo". Dessa forma, assim como a desintegração de um átomo tornou-se simples na atualidade, preconceitos poderão ser quebrados.

BRASIL. Ministério da Educação, INEP. Redação no Enem 2017: cartilha do participante. Brasília, DF: MEC/Inep, 2017. p. 36. Disponível em: https://download.inep.gov.br/educacao_basica/enem/guia_participante/2017/manual_de_redacao_do_enem_2017.pdf. Acesso em: 13 maio 2022.



1. Conforme você já observou no capítulo anterior, no texto dissertativo-argumentativo, há três partes: **introdução**, na qual é apresentada a tese ou a ideia principal defendida; **desenvolvimento**, em que, com base em argumentos, é defendida a tese; e **conclusão**, em que o texto é finalizado. No texto lido identifique o(s) parágrafo(s) que forma(m) cada parte:

- a) a introdução; Primeiro parágrafo.
- b) o desenvolvimento; Segundo e terceiro parágrafos.
- c) a conclusão. Quarto parágrafo.

2. Com base no tema **Caminhos para combater a intolerância religiosa no Brasil**, proposto pelo Enem, os participantes podiam defender diferentes teses.

- a) Qual é a tese defendida na redação que você leu nesta seção?
- b) Qual estratégia argumentativa foi utilizada nessa redação para a sustentação da tese defendida?

3. Para fundamentar a tese que defendem, os autores de textos dissertativo-argumentativos mobilizam diferentes tipos de argumento, entre os quais se incluem: exemplos, dados estatísticos, pesquisas, fatos comprováveis, citações ou argumentos de autoridade, alusões históricas, comparações (entre fatos, situações, épocas, lugares).

- a) Identifique, no segundo parágrafo da redação em estudo, um argumento do tipo alusão histórica.
- b) Identifique, também no segundo parágrafo, um argumento do tipo fatos comprováveis. De que maneira o autor refere-se ao fato que cita e à comprovação que pode ser feita dele? O sentido construído pela expressão que introduz esse argumento é o de verdade incontestável ou o de deixar em aberto a possibilidade de controvérsia?

Argumento de fatos comprováveis: "as religiões afro-brasileiras são os maiores alvos de discriminação, com episódios de violência física e moral veiculados pelas mídias com grande frequência". A expressão que introduz o argumento é "É relevante notar", que constrói o sentido de verdade incontestável.



2. a) A tese de que a intolerância religiosa é um comportamento preconceituoso frequente no Brasil e que deve ser erradicado.
- b) O texto foi iniciado com uma citação de Albert Einstein sobre preconceitos em geral e sobre a dificuldade de combatê-los e, a seguir, foi apresentada a tese sobre intolerância religiosa.

3. a) A imposição religiosa, no Brasil, desde a colonização, aos povos indígenas e aos africanos escravizados.



► **Regra de ouro**, de Norman Rockwell, 1961, obra exposta na sede da Organização das Nações Unidas (ONU), em Nova York, Estados Unidos. Nessa pintura, o artista procurou homenagear a diversidade religiosa.

197 |||||

Source: Cereja and Vianna (2022, p. 197). Available at: <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/>. Accessed on: 28 Feb. 2025.

The study activities are proposed in three questions:

- 1- Identify the paragraphs that make up the three parts of the text: a) the introduction, b) the development, and c) the conclusion.
- 2- The candidates could have defended different theses: a) what is the thesis defended in the essay read and, b) what argumentative strategy was used in defense of the thesis?

- 3- The proposition is that students identify, in the second paragraph, an argument of the historical allusion type. In letter b) they must identify an argument of the provable fact type and the way in which the author refers to the fact and its proof and, also, whether the meaning of the expression that introduces the argument is of incontestable truth or leaves open the possibility of controversy.

These are structural issues of understanding and interpretation that do not provoke interactive discussions that lead to a thematic deepening. Furthermore, none of the suggestions for answers presented in the teacher's notebook alludes to the discussion of the theme of religious diversity or ethnicities/races.

For the proposal of the letter 'a' of question 3, identification of a historical allusion, the suggested answer is "The religious imposition, in Brazil, since colonization, to indigenous peoples and enslaved Africans". Just locating this information does not presuppose giving it due importance. The ideal would be to propose a dialogical, interactive approach through the survey of opinions and even research proposals on the subject.

The reading of Norman Rockwell's 1961 painting could also be explored, after all, it portrays not only religious diversity, but also cultural, racial and ethnic diversity.

The analysis of the proposals for activities on this issue allows us to conclude that they do not promote discussions about religious diversity or black literature. The emphasis is on language issues, with a significant number of approaches focused on agreement, morphological function, and textual genres. Again, the theme of black literature ends up being neglected, staying in the background, and when it is addressed, it does not receive the appropriate approach.

5.5 ANALYSIS 5

In chapter 3 (Unit 3), entitled "The young person and consumption", the opening text is the chronicle "The cruelty of young people" by Walcyr Carrasco. After the study of comprehension and interpretation, in the section Crossing Languages (p. 206-207), two texts are presented that comment on funk: the first, an excerpt from a song called "Funk ostentação", and the second, an excerpt from an article published by Revista Piauí in which the singer Emicida talks about funk ostentação.

Below is the activity proposed by the authors. In figure 5 it is possible to see text 1.

Figure 5

Text 1 of the textbook *Crossing Languages*

CRUZANDO LINGUAGENS

O desejo de consumo de produtos de luxo não é exclusividade de adolescentes. No final da década de 2000, um tipo de *funk*, denominado “*funk ostentação*”, ganhou grande popularidade. Leia, a seguir, um trecho de uma letra desse gênero musical e um trecho de um comentário sobre o próprio *funk*, em especial o de ostentação.

Texto 1

[...] E aí, dá licença, suave Corrente, pulseira, <u>dedeira</u>, <u>mó chave</u> Já peguei as chave Da mansão do Guarujá	Mó orgulho, mó felicidade Ver os moleque tudo da <u>vila</u> de <u>nave</u> Diferentes modelos Pra poder acelerar [...]	chave: estiloso, elegante. dedeira: anel. nave: carro de luxo. vila: comunidade.
--	--	---

NA PISTA eu arraso. Intérprete e compositor: MC Guimê. In: EM CASA com MC Guimê (ao vivo). Intérprete: MC Guimê. [S. l.]: Big Bang Music Group, 2020. 1 CD, faixa 4. Letras. Disponível em: <https://www.letras.mus.br/mc-guime/na-pista-eu-arraso/>. Acesso em: 29 maio 2022.



Source: Cereja and Vianna (2022, p. 206). Available at: <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/>. Accessed on: 28 Feb. 2025.

In figure 6, text 2 is verified, which is the continuation of the activity Crossing Languages.

Figure 6

Text 2 of the textbook

Texto 2

1. a) As poses exibidas pelo eu lírico: bens de consumo de alto valor (“Corrente, pulseira, dedeira”, chave da “mansão no Guarujá”).

Sempre admirei o *funk*, o carioca mesmo. O do James Brown também, mas isso é óbvio. Meu pai era DJ de baile de rua, era impossível não ouvir James Brown. [...]

As pessoas se acostumaram a ver os pretos cabisbaixos, sempre tristes nos cantos do mundo. Ao esbarrar com o contrário disso, criminalizam nosso sorriso em vez de desprezar aquilo que gera nossas lágrimas. [...] Isso é *funk*. [...]

Embora seja alvo de muitas críticas recentemente, o *funk ostentação* é também um fruto orgulhoso desta mesma árvore, pois em uma era consumista como a nossa o “ter” virou “ser”, e isso não é culpa da favela. Logo, quando jogam o cordão pra fora e dizem que são “de nave no rasante”, meus irmãos do *funk* estão falando “eu tô bem”. [...] Repito: subversão nem sempre é entendida instantaneamente. Vou além para dizer que no *funk ostentação* também leio que a luta por liberdade vem nesse canto. E quem transformou dinheiro em sinônimo de liberdade não foi a favela.

[...]

1. b) O eu lírico se mostra alegre e satisfeito (“suave”) por possuir EMECIDA. Felicidade ostentação. Piauí, São Paulo, 19 nov. 2013. Disponível em: <https://piaui.folha.uol.com.br/felicidade-ostentacao/>. Acesso em: 29 maio 2022.

2. No texto 2, o autor faz um comentário a respeito do chamado “*funk ostentação*”. Qual é sua posição sobre esse gênero? Enicida contextualiza o *funk ostentação* dizendo que se trata de um espelho da sociedade de consumo em que vivemos.

3. Relação o texto “A crueldade dos jovens”, de Walcy Carrasco, com os textos 1 e 2 desta seção.

a) O que há em comum entre os três textos? Os três abordam o tema da exaltação do consumo de objetos que oferecem status.

b) Que diferença há entre os textos quanto à visão sobre o consumo de bens que têm custo financeiro muito alto?

c) Você concorda com algum dos posicionamentos exibidos nos textos? Por quê? Respostas pessoais.

3. b) No texto de Walcy Carrasco, criticam-se os jovens de todas as classes sociais (menos os extremamente ricos) por fazerem exigências de consumo que estão além das posses de suas famílias. No trecho da letra do *funk*, o eu lírico demonstra não apenas possuir e valorizar esses bens, como gostar de exibi-los e de ver outros “moleques” exibindo-os. Já para Enicida, no texto 2, a vontade de ter e de ostentar bens de consumo é apenas mais uma manifestação de “uma era consumista como a nossa”, em que “o ter” virou “ser”, e comenta que isso “não é culpa da favela”.

James Brown (1933–2006) em concerto na cidade de Milão, na Itália, em julho de 2006.

1. e) Predomina uma variedade que foge à norma-padrão, com uso de muitas gírias (**dedeira**, **chave**, **nave**), abreviações (**pra** e **mó**, abreviação de **molei**) e casos de concordância verbal e nominal muito próximos do modo como parte considerável da população brasileira usa no dia a dia (**os moleque**, **as chave**).

Não escreva no livro.

TROCANDO IDEIAS

1. Você conhece alguma família em que acontece o tipo de pressão sobre os pais descrito no texto de Walcy Carrasco? E caso positivo, conte aos colegas. Respostas pessoais.

2. Você também se sente pressionado, pelo grupo ou pelo meio em que vive, a usar roupas de marca, celulares de última geração e andar na moda para não se sentir diminuído? Resposta pessoal.

Source: Cereja and Vianna (2022, p.207). Available at: <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/>. Accessed on: 28 Feb. 2025.

According to Dantas, official writer of Brasil Escola³, "funk is a musical style that emerged through black American music in the late 1960s." Studies indicate that its arrival in Brazil took place in the favelas of Rio de Janeiro, during the 1970s. Since then, funk has evolved, developing its own style and expanding to other states, gaining more and more followers. This musical genre reflects the reality of the peripheries and their inhabitants, which may explain the resistance it faces from people who belong (or who consider themselves to belong) to the elites.

The focus of the analysis, however, will be text 2, which addresses the relationship between black peoples and favela dwellers, groups that are the main representatives of this musical genre. The excerpt highlights how funk, especially *funk carioca* and *funk ostentação*, connect to black identity and social criticism. From this text, it is evident the prejudiced view that society, particularly in relation to blacks, has about them. Instead of reflecting on the conditions that generate the suffering of these people, society criminalizes the joy and resistance expressed through *funk*. The "smile" and celebration of *funk* is disconcerting to those who expect black people to be submissive or sad, while in fact, *funk* represents a form of subversion and resistance to racism.

In the teacher's manual, the authors recommend that teachers conduct research on three websites to deepen their knowledge of *funk*, a musical genre that has generated controversy since its emergence. The proposal includes readings about the history and evolution of *funk* over the years, its culture, and the questioning of whether or not funk can be considered a legitimate cultural manifestation.

Regarding the competencies of the BNCC (2018) applicable to the approach of the texts under analysis, general competencies 8 and 9, specific competencies of Languages 3 and 4, specific competencies of Portuguese Language 3 and 4, and EF69LP44 and EF89LP27 skills are highlighted. Although all these competencies and skills are pertinent to the study and analysis of texts, the specific competence of Portuguese Language number 7, which emphasizes the importance of recognizing the text as a space for the manifestation and negotiation of meanings, values and ideologies, should also be included. This competence is fundamental for students to understand and respect the various forms of cultural and ideological manifestation present in society.

In chapter 1 (World in motion) referring to unit 4 of this collection, a photo from 2020 (p. 237) is presented, which depicts the image of migrants heading towards the border of Pazarkule, Turkey (called Kastanies, on the Greek side). In the following pages (238-239),

³ DANTAS, Tiago. "Funk"; Brasil Escola. Available at: <https://brasilecola.uol.com.br/artes/funk.htm>. Accessed on February 20, 2025.

the authors address the lyrics of the song "Diáspora", by Arnaldo Antunes, Carlinhos Brown and Marisa Monte, as illustrated in figure 7.

Figure 7

Diaspora

Diáspora

(Citações: trecho do Canto 11 de *O Guesa*, de Joaquim de Sousa Andrade [D.P.] e trecho de *Vozes d'África*, de Castro Alves [D.P.])

"Acalmou a tormenta, pereceram
Os que a estes mares ontem se arriscaram
Vivem os que por um amor tremeram
E dos céus os destinos esperaram"

Atravessamos o mar Egeu
O barco cheio de fariseus
Com os cubanos, sírios, ciganos
Como romanos sem Coliseu
Atravessamos pro outro lado
No rio vermelho do mar sagrado
Nos center shoppings
Superlotados
De retirantes
Refugiados

Where are you?
Where are you?
Where are you?

► Imigrantes chegando ao campo de refugiados de Vinjug, na Macedônia. Foto de 2013.



Foto: RACQUAF



► Migrantes seguindo de Huixtla a Escuintla, Chiapas, México, em direção aos Estados Unidos. Foto de 2022.

238

Source: Cereja and Vianna (2022, p.238). Available at: <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/>. Accessed on: 28 Feb. 2025.

Figure 8 denotes the continuation of the activity proposed on pages 238-239 of the textbook in question.

Figure 8

Page 239 of the textbook

Onde está
Meu irmão
Sem irmã
O meu filho
Sem pai
Minha mãe
Sem avô
Dando a mão
Pra ninguém
Sem lugar
Pra ficar
Os meninos
Sem paz
Onde estás
Meu senhor
Onde estás?
Onde estás?

“Deus! Ó, Deus, onde estás que não respondes?
Em que mundo, em qu'estrela tu t'escondes
Embuçado nos céus?
Há dois mil anos te mandei meu grito
Que **embalde** desde então corre o infinito
Onde estás, senhor Deus?...”

Atravessamos o mar Egeu...

Where are you?
Where are you?
Where are you?

ANTUNES, Arnaldo; BROWN, Carlinhos; MONTE, Marisa. Disponível em: <https://www.arnaldoantunes.com.br/diaspورا>. Acesso em: 21 abr. 2023.

Quem são?



► Da esquerda para a direita: Arnaldo Antunes, Marisa Monte e Carlinhos Brown, integrantes do grupo musical Os Tribalistas. Rio de Janeiro (RJ), 2017.

Tribalistas

Arnaldo Antunes (1960-), **Marisa Monte** (1967-) e **Carlinhos Brown** (1962-) formam o grupo musical **Tribalistas**. O primeiro álbum, *Tribalistas*, lançado pelo grupo em 2002, vendeu mais de 2 milhões de cópias e conquistou o prêmio Grammy latino. Em 2017, o trio tornou a se reunir e lançou o álbum *Tribalistas 2*, do qual faz parte a canção “Diáspora”.



► Mulher refugiada Rohingya toca a areia da praia ao chegar da travessia de barco feita da fronteira Bangladesh-Mianmar, pela baía de Bengala, Bangladesh. Foto de 2017.

diáspora: dispersão de um povo em consequência de preconceito ou perseguição política, religiosa ou étnica. O termo era empregado em referência aos judeus que, por milênios, foram forçados a se deslocar pelo mundo. Mais recentemente, o conceito também é utilizado para se referir aos africanos que foram trazidos para a América na condição de escravizados.

embalde: em vão, inutilmente.

embaçado: encoberto, oculto.

fariseu: integrante de um grupo judaico surgido no século II a.C.

perecer: morrer; acabar-se, extinguir-se.

where are you?: em português, “onde você está?”.

239

Source: Cereja and Vianna (2022, p. 239). Available at: <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/>. Accessed on: 28 Feb. 2025.

The excerpts of this song make references to themes of migration, suffering, identity and resistance. There is also an intertextuality with literature, by incorporating fragments of the epic poem "O Guesa", by Joaquim de Sousa Andrade, and the poem Vozes d'África, by Castro Alves, which deal with the pain and forced displacement of peoples.

To carry out this activity in the classroom, the work selects general competence 3, specific competences of Languages 2 and 5, specific competence of Portuguese Language 3, and skills EF69LP44, EF69LP48, EF89LP32, EF89LP33 and EF89LP37. All these competencies are relevant for the execution of the work with the proposed text, but the

absence of competence 7 of Portuguese Language is observed, which addresses the manifestation of values and ideologies of a people. Thus, it is important that students recognize and respect the diverse knowledge and cultures present in different communities, promoting harmonious coexistence in a democratic society.

In this sense, the song connects these experiences with contemporary diasporas, such as those of refugees and immigrants, who continue to face difficulties in search of a better life. In addition, it criticizes the consumer society and the disparities of power and access, questioning where those who have been marginalized and suffocated by history are.

The question "Where are you?" ("Where are you") shows the absence, the lack of ties, the loss of references and affections of a person in search of identity, dignity and recognition in the midst of a system that often ignores or dehumanizes the most vulnerable.

In the verse "God! Oh, God, where are you that you don't answer? The lyrical self questions the absence of God, referring to human suffering that seems to go unheard or unanswered. This absence of answers reinforces the sense of abandonment that many individuals face, whether due to war, poverty, or forced displacement. In addition, the song points not only to the difficulties faced by immigrants and refugees, but also reflects on broader existential issues, such as the human condition and the search for meaning in the midst of suffering.

Furthermore, the song establishes a connection between historical experiences and contemporary diasporas lived by many immigrants and refugees, who continue to face difficulties in search of a better life. In this way, this lack of answers reinforces the feeling of abandonment, whether due to war, poverty or the forced displacement of these peoples, as occurred with black people who were brought to Brazil in an enslaved way.

Therefore, this analysis allowed us to verify that the textbook under study needs to give more visibility to ethnic-racial issues, through a more in-depth study of the theme. In addition, it must meet the criteria established by law 10639/03, with the intention of providing students with a study that prioritizes diversity and inclusion.

6 FINAL CONSIDERATIONS

Through the analysis of the approaches to the ethnic-racial theme in the textbook, it is found that there are significant gaps that require continuous effort and knowledge on the part of teachers to be overcome.

Considering that such materials are widely used by teachers in different regions of the country, as a support resource in the teaching-learning process, their pedagogical relevance becomes evident. Although the teaching work is not restricted to the exclusive use of the

textbook, it is undeniable that it constitutes a fundamental instrument, both in the organization of activities and in the consolidation of pedagogical practices in the classroom.

In this sense, and in view of the relevance of the textbook, the implementation of Law 10.639/03 has been a challenge for many schools and for the authors of teaching materials, who sometimes resist adapting their content to fully meet this demand. In the case of the book "Portuguese - Languages" (9th grade), by William Cereja and Carolina Dias Vianna, the absence of a robust approach to black Brazilian literature is a clear example of how the work fails to meet the requirements of the Law.

In order for this volume to become more inclusive and representative, it would be important, as of the next editions, to include a more in-depth study of ethnic-racial issues, especially those that contemplate work focused on literature. In this sense, the work could include more black authors, with emphasis on their works and historical contexts, in addition to presenting social and cultural issues pertinent to their universe.

As an example, texts by Carolina Maria de Jesus, Conceição Evaristo, Lima Barreto, among others, could be analyzed in the context of their literary productions and their relationship with racial and identity issues in Brazil. This is a significant flaw, since these voices are essential to bring a critical perspective on racial issues in Brazil.

In addition, the inclusion of debates on the importance of black people in the construction of the country, slavery, the black movement and the resistance of Afro-Brazilians could also be an interesting way to make the work more inclusive, creating a more plural and updated discussion about the challenges of contemporary Brazil, so that students could recognize themselves as part of a multicultural society, that not only minimizes or ignores the contributions of black people, but celebrates them. Thus, including these discussions in the didactic content would be a significant step towards valuing black identity and confronting racial inequalities in Brazil.

Thus, black literature must be presented in all its plurality, addressing not only the fight against racism and slavery, but also issues of identity, culture, religiosity, daily life and resistance. In addition, there are several contemporary black authors in Brazil, such as Djamila Ribeiro, Elisa Lucinda, Itamar Vieira Júnior, Lázaro Ramos, Emeilda, Cuti and many others, who write fundamental themes to provide a more current view of the issues faced by the black population in Brazil and that can contribute significantly to encompass the contents addressed in this work.

In view of the current context of search for greater diversity and representativeness in school content, it is verified that this textbook presents an inadequate approach in relation

to compliance with Law 10.639/03, since it prioritizes, to a large extent, a Eurocentric and monocultural perspective of Brazilian history and literature.

The omission of a relevant approach to black-Brazilian literature in the book "Portuguese - Languages" (9th Grade) is a significant flaw, because by ignoring these issues, the work does not contribute to the formation of an inclusive education, capable of fostering critical reflection on racism, racism, and racism. social inequalities and the richness of Afro-Brazilian culture. Therefore, education should be an environment conducive to the construction of identity, and the lack of these themes can lead to cultural impoverishment, in addition to reinforcing racial stereotypes.

Furthermore, black students, in particular, may feel devalued and marginalized when they do not see their histories and cultures adequately represented in school content. On the other hand, non-black students can be deprived of a broader understanding of the diversity and complexity of Brazilian society, which contributes to the perpetuation of inequalities and prejudices. The lack of historical, aesthetic and political contextualization that the work demands, leads to a curricular silencing that compromises the reading education of students, since it limits access to narratives that enable the recognition of oneself and the other, as well as the appreciation of Brazilian cultural diversity.

In the words of Colaço (2012, p. 8), "the decolonial implies, therefore, a continuous struggle". This conception underlies the pedagogical choices of this research, as it shows that the process of decolonization does not end in a historical moment, but is prolonged in practices of resistance and affirmation.

Therefore, our opinion is that this volume intended for the (9th grade) should be more inclusive and representative, integrating texts by black authors throughout the book, and not just in isolated topics. In addition, this inclusion should be seen as a central element, essential for a more inclusive and egalitarian education. In the twenty-first century, facing this issue is one of the main challenges for the effective application of Law 10.639/03 in educational institutions in Brazil, requiring joint efforts by educators, schools and publishers to ensure that black literature receives adequate recognition and analysis. Thus, problematizing the insertion of this literary production in the didactic material is an essential step for the effectiveness of an anti-racist education.

REFERENCES

- Brandino, L. (n.d.). Literatura negra. Brasil Escola.
<https://brasilecola.uol.com.br/literatura/literatura-negra.htm>
- Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996. Lei de Diretrizes e Bases da Educação Nacional. https://www.planalto.gov.br/ccivil_03/leis/l9394.htm

- Brasil. (2003). Lei nº 10.639, de 9 de janeiro de 2003. Altera a Lei nº 9.394, de 20 de dezembro de 1996, que estabelece as diretrizes e bases da educação nacional, para incluir no currículo oficial da Rede de Ensino a obrigatoriedade da temática "História e Cultura Afro-Brasileira". https://www.planalto.gov.br/ccivil_03/leis/2003/l10.639.htm
- Brasil. (2014). Lei nº 13.005, de 25 de junho de 2014. Aprova o Plano Nacional de Educação - PNE e dá outras providências. <https://pne.mec.gov.br/18-planos-subnacionais-de-educacao/543-plano-nacional-de-educacao-lei-n-13-005-2014>
- Brasil. Conselho Nacional de Educação. Câmara de Educação Superior. (2004). Parecer CNE/CP nº 003/2004. Diretrizes Curriculares Nacionais para a Educação das Relações Étnico-Raciais e para o Ensino de História e Cultura Afro-Brasileira e Africana. http://portal.mec.gov.br/dmdocuments/cnecp_003.pdf
- Brasil. Ministério da Educação. Secretaria de Educação Básica. (2006). Orientações curriculares para o ensino médio: Linguagens, códigos e suas tecnologias (Vol. 1). https://portal.mec.gov.br/seb/arquivos/pdf/book_volume_01_internet.pdf
- Brasil. Ministério da Educação. (n.d.). Base Nacional Comum Curricular (BNCC). <http://basenacionalcomum.mec.gov.br/abase/#fundamental/lingua-portuguesa>
- Cereja, W. R., & Vianna, C. D. (2022). Português linguagens: 9º ano (11a ed.). Saraiva Educação.
- Cereja, W. R., & Vianna, C. D. (2022). Português: Linguagens. <https://www.edocente.com.br/pnld/portugues-linguagens-9o-ano-pnld-2024-objeto-1-anos-finais-ensino-fundamental/>
- Colaço, T. L. (2012). Novas perspectivas para a antropologia jurídica na América Latina: O direito e o pensamento decolonial. Fundação Boiteux.
- Cosson, R. (2014). Círculo de leitura. In Glossário Ceale. Centro de Alfabetização, Leitura e Escrita. <https://www.ceale.fae.ufmg.br/glossarioceale/verbetes/circulo-de-leitura>
- Cosson, R. (2022). Círculos de leitura e letramento literário. Contexto.
- Cosson, R. (2024). Paradigmas do ensino de literatura. Contexto.
- Cuti, L. S. (2010). Literatura negro-brasileira. Selo Negro.
- Dantas, T. (n.d.). Funk. Brasil Escola. <https://brasilecola.uol.com.br/artes/funk.htm>
- Evaristo, C. (2005). Gênero e etnia: Uma escre(vivência) de dupla face. In N. M. de Barros Moreira & L. Schneider (Orgs.), *Mulheres no mundo: Etnia, marginalidade e diáspora* (pp. 219–220). Ideia/Editora Universitária.
- Gil, A. C. (2022). Como elaborar projetos de pesquisa (7a ed.). Atlas.
- Michelato, J. P. B., & Santana, A. da C. M. (2023). O livro didático de português ao longo do tempo: Mais do mesmo. *A Cor das Letras*, 24(2), 23–37. <https://doi.org/10.13102/acordasleytras.v24i2.10130> (ou <https://periodicos.uefs.br/index.php/acordasleytras/article/view/10130>)
- Minayo, M. C. de S., et al. (Orgs.). (2004). *Pesquisa social: Teoria, método e criatividade* (2a ed.). Vozes.
- Rangel, E. de O. (2006). *A escolha do livro didático de português: Caderno do professor*. Ceale.

- Santos, A. P. dos. (2021). Os contos de Conceição Evaristo e a representação da mulher negra: Diáspora, gênero e descolonização [Dissertação de mestrado]. Universidade Federal do Rio Grande do Sul. <https://www.lume.ufrgs.br/handle/10183/225930>
- Santos, M. (2000, maio 7). Ser negro no Brasil hoje. Folha de S. Paulo, Mais!, pp. 15–16. <https://www1.folha.uol.com.br/fsp/mais/fs0705200007.htm>
- Soares Benedito, B., Carneiro, S., & Portella, T. (Orgs.). (2023). Lei 10.639/03: A atuação das Secretarias Municipais de Educação no ensino de história e cultura africana e afro-brasileira. Instituto Alana. <https://alana.org.br/wp-content/uploads/2023/04/lei-10639-pesquisa.pdf>

CREDIT COOPERATIVES AND THEIR STRUCTURE AND DEVELOPMENT: POINTS OF ATTENTION AND OBSERVATION

COOPERATIVAS DE CRÉDITO E SUA ESTRUTURA E DESENVOLVIMENTO: PONTOS DE ATENÇÃO E OBSERVAÇÃO

LAS COOPERATIVAS DE CRÉDITO Y SU ESTRUCTURA Y DESARROLLO: PUNTOS DE ATENCIÓN Y OBSERVACIÓN



<https://doi.org/10.56238/sevened2026.008-128>

Ederaldo José Pereira Lima¹, Jusceliany Rodrigues Leonel Correa², José Ricarte de Lima³, Leonardo Socolott Alvarenga⁴

ABSTRACT

This paper highlights, throughout its topics, the importance of administrative procedures in cooperatives, as well as demonstrating how cooperatives can be linked to the economic, social, and financial development of a given region. Over the years, cooperativism has gained strength and expanded within economic activities, something that promotes many analyses and observations by economists, administrators, managers, and other managerial components. The general objective is to highlight the importance of administrative routines and tools for the development of a cooperative. Secondary objectives include: highlighting the main tools present in the administrative process, emphasizing the positive and negative points related to cooperatives, and analyzing how a cooperative can impact the economic and social development of a given region. The work involved exploratory research, highlighting the main concepts and analyses regarding the evolution or application of cooperatives within the society in which they are embedded. Something that can be proven through the analysis of one of the most renowned credit cooperatives in Brazil, Sicoob, is highlighted throughout the research, emphasizing the main aspects that demonstrate how administrative routines can further consolidate or stabilize the activities and results obtained through cooperatives.

Keywords: Cooperatives. Credit Cooperatives. Economic Development.

RESUMO

O presente trabalho ressalta ao longo de seus tópicos a importância dos procedimentos administrativos nas cooperativas, assim como evidencia de que forma as cooperativas podem estar ligadas ao desenvolvimento econômico, social e financeiro de uma determinada

¹ Dr. in Accounting. Universidade Federal de Mato Grosso (UFMT). E-mail: ederaldo.lima@ufmt.br
Orcid: <https://orcid.org/0000-0002-5830-7887>

² Dr. in Accounting and Administration. Fucape Bussines School, Universidade do Estado de Mato Grosso (UNEMAT). E-mail: jusceliany.correa@unemat.br

³ Dr. in Accounting. Universidade do Estado de Mato Grosso (UNEMAT). E-mail: jrcontabil@unemat.br

⁴ Master's degree in Accounting and Administration. Fucape Business School. E-mail: lsocolott@gmail.com
Orcid: <https://orcid.org/0000-0003-2832-814X>

região. Ao longo dos anos o cooperativismo vem ganhando força e se expandindo dentro das atividades econômicas, algo que promove muitas análises e observações por parte de economistas, administradores, gestores e demais componentes gerenciais. O objetivo geral do mesmo consiste em evidenciar a importância das rotinas e ferramentas administrativas para o desenvolvimento de uma cooperativa, o mesmo apresenta por objetivos secundários: ressaltar as principais ferramentas presentes no processo administrativo, destacar quais os pontos positivos e negativos relacionados as cooperativas, analisar de que forma uma cooperativa pode impactar o desenvolvimento econômico e social de uma determinada região. No processo de elaboração do trabalho foi realizada uma pesquisa exploratória, ressaltando os principais conceitos e análises referente a evolução ou aplicação das cooperativas junto a sociedade onde a mesma está inserida. Algo que pode ser comprovado mediante a análise de uma das mais renomadas cooperativas de crédito presente no Brasil, o Sicoob, são evidenciados ao longo da pesquisa os principais aspectos que ressaltam como as rotinas administrativas podem consolidar ou estabilizar ainda mais as atividades e os resultados obtidos por meio das cooperativas.

Palavras-chave: Cooperativas. Cooperativas de Crédito. Desenvolvimento Econômico.

RESUMEN

Este trabajo destaca, a lo largo de sus temas, la importancia de los procedimientos administrativos en las cooperativas, además de demostrar cómo estas pueden vincularse con el desarrollo económico, social y financiero de una región. Con el paso de los años, el cooperativismo ha cobrado fuerza y se ha expandido en las actividades económicas, lo que ha suscitado numerosos análisis y observaciones por parte de economistas, administradores, gerentes y otros profesionales de la gestión. El objetivo general es destacar la importancia de las rutinas y herramientas administrativas para el desarrollo de una cooperativa. Los objetivos secundarios incluyen: destacar las principales herramientas presentes en el proceso administrativo, destacar los aspectos positivos y negativos relacionados con las cooperativas y analizar cómo una cooperativa puede impactar el desarrollo económico y social de una región. El trabajo consistió en una investigación exploratoria, destacando los principales conceptos y análisis sobre la evolución o aplicación de las cooperativas en la sociedad en la que se insertan. Algo que se puede demostrar a través del análisis de una de las cooperativas de crédito más reconocidas de Brasil, Sicoob, se destaca a lo largo de la investigación, destacando los principales aspectos que demuestran cómo las rutinas administrativas pueden consolidar o estabilizar aún más las actividades y los resultados obtenidos a través de las cooperativas.

Palabras clave: Cooperativas. Cooperativas de Crédito. Desarrollo Económico.

1 INTRODUCTION

With the development of some commercial modalities, administration has become of paramount importance, promoting the development, analysis and studies related to how these new modalities can become a positive component for the national economy. Among these new modalities present in the market, cooperatives can be highlighted, which consist of a way to promote activities through the union of certain professionals or individuals.

According to Costa et. al. (2020) cooperativism became stronger with the commercial development presented through the Industrial Revolution, something that substantiated the relevance of professionals organizing themselves to efficiently promote their activities, as well as being able to achieve their development without the need for some already known business routines.

The present work seeks to relate the importance of management within the routines of cooperatives, as well as to substantiate the economic and social impacts that cooperatives can represent for a given region. Seeking to exemplify more clearly, a case study was carried out with a cooperative that has been providing the economic development of the region where it is located.

The general objective of this work is to highlight the importance of administrative routines and tools for the development of a cooperative, it has secondary objectives: to highlight the main tools present in the administrative process, to highlight the positive and negative points related to cooperatives, to analyze how a cooperative can impact the economic and social development of a given region.

2 THEORETICAL FRAMEWORK

2.1 COOPERATIVISM

Cooperatives in the national environment gained strength with Law 5.764/71, which defines these organizations as providers of services to their members or associates, without aiming at profit in the services provided (Braúna, 2016). In general, cooperatives are focused on supporting workers, with a focus on well-being and assistance, highlighting the relevance of these services in the commercial and business context.

Initially implemented in some regions, cooperatives have gained a prominent position in the market. According to Ouro et al. (2018), this organizational category valued services and workers, filling a historical gap in the national environment. The author argues that the union of companies and workers through cooperatives provided greater stability to their activities.

Currently, cooperatives operate in various segments, such as agriculture and transportation, emphasizing their importance in organizational relations. The increase in the number of people associated and providing services in cooperatives demonstrates that this structure is seen as welcoming and advantageous by workers.

In the current context, cooperatives play a crucial role in the national economy, promoting the circulation of services and contributing to regional development. Costa et al. (2020) explain that the main function of cooperatives is to provide financial services to society, including savings deposits and access to credit. These services should be competitive with those offered by other financial institutions. The author emphasizes that, in order to preserve the character of a non-profit institution, cooperatives should not seek to maximize return on equity, but rather focus on minimizing costs as an appropriate objective.

Braúna (2016) highlights that the basis of cooperatives is the union of individuals with common purposes and interests. In today's age of knowledge and cooperative enterprise, cooperatives must demonstrate economic results, ensure a sustainable social function, and avoid bankruptcies in a highly competitive market. The author observes that, with globalization, cooperatives face challenges related to administrative efficiency and competitive disadvantage due to their characteristics of democratic governance and lack of professional qualification.

2.2 CREDIT UNIONS

Credit unions represent a viable alternative for access to microcredit, offering several benefits. Among them, personalized service, specific products for the demands of members, loans and financing with low interest rates, lower requirements and greater agility in operations stand out. These societies focus on satisfying people's needs, differentiating themselves from commercial banks, which prioritize profit. In addition, the positive results of cooperatives go beyond financial ones, offering advantages that can overcome any differences between fees charged by other financial institutions.

Credit unions are freely admitted financial institutions that aim to effectively meet the needs of their members. They guarantee a personalized service, guided by cordiality, zeal and responsibility, providing members with the experience of feeling like owners of the institution (Sampaio, 2012). In addition, these organizations have the responsibility to offer support, with differentials that attract customers, consolidating themselves as the main financial institution of the members.

In the social field, cooperatives contribute significantly to the improvement of the regions where they are inserted, offering services aimed at health, education and

communication. They promote greater financial stability for individuals, through savings and other initiatives that generate positive impacts, especially in vulnerable communities.

Sá (2018) highlights that cooperativism is intrinsically linked to social development, showing that, through its methods and activities, many cooperatives invest in human and social progress. Social projects carried out by cooperatives, as well as the provision of essential services, are examples of actions that foster social development. These projects serve, above all, the most vulnerable populations, filling gaps in social and cultural assistance.

The impact of cooperatives on social development is amplified by their logic of distribution of results, which differs from the traditional capitalist model. There is no profit or expropriation of the surplus generated by labor; instead, the surplus returns to the cooperative members themselves, promoting a more egalitarian development. This practice eliminates old problems related to social inequality, by reinvesting in those who generated the resources, strengthening equity among individuals.

To promote meaningful local development, cooperatives need executive management focused on both economic efficiency and social management. This approach must prioritize the real needs of members, fostering income, services, and jobs. In this way, cooperatives can contribute to removing individuals from conditions of social exclusion and subhumanity, reintegrating them into society in a dignified and sustainable way (Martins, 2006).

Management plays a fundamental role in all areas in which organizations are inserted. Through its activities, strategic vision, and procedures, management sets goals, outlines objectives, and promotes positive growth, which is especially evident in cooperatives, where proper management results in efficiency and satisfactory results.

According to Matarazzo and Boeira (2016), management is essential for the development of organizational routines, promoting a careful analysis of pertinent information, evaluating methods that can improve performance and, above all, making strategic decisions to balance the activities performed with the resources applied. This balance is crucial to achieving organizational success.

In general, cooperatives stand out as an efficient solution for outsourcing services considered essential in the social context. Their relevance is widely recognized by society, because in many cases, they are created to highlight specific economic or commercial characteristics of a region. These organizations demonstrate to citizens and workers how their activities can boost local development.

Among the main cooperatives developed in Brazil, credit unions occupy a prominent place. These entities are based on the provision of financial services, providing individuals

with an opportunity for economic development and solutions to financial issues that often do not find support in traditional banking institutions.

Goes (2011) observes that many professionals in the financial sector consider credit unions an opportunity to expand the interaction between financial institutions and potential customers. They make financial services more accessible by offering guidance, assistance and support at both the regional and national levels. In addition, these cooperatives promote financial inclusion, strengthening the relationship between the financial market and local communities.

Based on the information presented, it can be concluded that cooperatives represent a significant opportunity for economic and social evolution. They integrate diverse contexts, identifying areas that can be improved through their organizational routines and practices. Cooperatives, especially credit cooperatives, stand out as a valuable alternative for regional workers, contributing to the economic and social development of communities.

Finally, credit unions offer individuals the possibility of working independently, escaping the limitations imposed by conventional labor relations. In this way, they promote consolidation and economic and social stability, evidencing themselves as a mechanism for inclusion and sustainable development.

2.3 COOPERATIVES FOR THE WORKFORCE

Peroni (2020) argues that:

Credit unions are effective both in democratizing credit and in redistributing income. They allow segments of society to organize the search for solutions to problems of access to credit and banking services, autonomously and independently. In addition, the authors point out that this business sector is expanding and so is the demand for management information that allows greater monitoring and control within these organizations.

Thus, taking into account the competitive environment in which the Brazilian banking system is inserted, credit unions seek to act effectively. They aim not only to maximize your results or reduce costs, but also to increase economies of scale. According to Chaves (2011), in recent years the insolvency of financial institutions has worried not only shareholders, but also governments, companies and individuals, who invest their financial resources and trust these institutions.

In this context, considering the social and economic importance of the sector, there is a growing need to evaluate the economic and financial performance of credit unions. Thus, the research question that guides this study is highlighted: what is the economic and financial

performance of the largest credit unions in Brazil? The objective of the survey is, then, to evaluate the economic and financial performance of the largest Brazilian credit unions.

Fernandes et. al., (2022) assure that cooperative business has aroused the interest of many researchers due to its specific type of organization. They include concerns about maintaining democratic decision-making practices and joint efforts. Attention is focused on the need to combine business results with social expectations related to a series of facts: unemployment or underemployment, job and income creation, and sustainable regional development.

Credit unions are financial institutions that facilitate and make it cheaper for members to access credit. They reduce bank interest, especially overdraft and loan rates. However, in relation to financial services, they differ from other financial institutions by their objectives and the audience they wish to reach (Peroni, 2020).

Maffini et. al., (2020) believe that credit unions around the world have demonstrated the effectiveness of cooperative principles in managing the financial affairs of millions of people. Having equal voting rights, member-members participate regardless of the size of their deposits. Its main strength lies in the appeal of this philosophy. The authors add, however, that the relaxation of requirements for certain liabilities has inevitably brought about fiercer competition with other financial institutions, especially retail banks. Banks often complain about current tax exemptions that provide credit unions with an unfair advantage.

Nunes et. al., (2019) defend the impression that cooperative business is fundamental to society. In other words, it is fundamental to the extent that it promotes the use of private resources and assumes these risks on behalf of the community in which it develops and also in favor of local sustainable development. The emphasis is on the formation of savings and the offer of financing for entrepreneurial initiatives, which can bring evident benefits for job creation.

3 METHODOLOGY

Descriptive research aims to describe a certain population or a certain phenomenon; Explanatory research, on the other hand, seeks explanations for a given cause, as well as the causative factors of it; finally, we have that exploratory research aims to understand subjects that have few studies about them or even the understanding of a specific point of an already consolidated concept (Haguet, 2020).

For the development of the research presented, a bibliographic and qualitative survey was carried out on the credit union, highlighting the interaction between both, as well as the

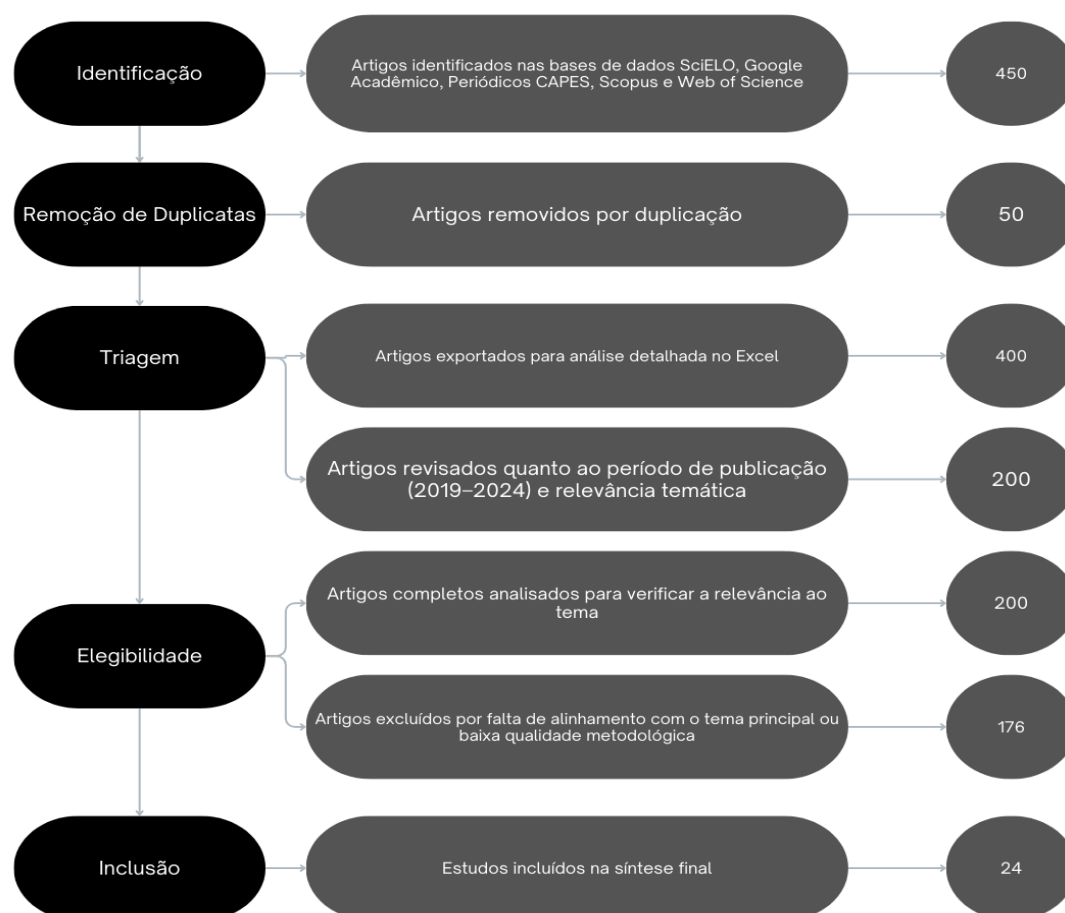
primordial aspects to understand the relevance that cooperatives have in the labor or economic development of a region.

After gathering all the necessary information, a description of all studies related to the topic addressed was promoted, as well as establishing an understanding of the main data collected through the Sicoob case study, consolidating how this enterprise has become a fundamental piece in the economic and labor evolution of some Brazilian regions over the years.

The flowchart of the PRISMA protocol (Figure 1) of this work clearly and systematically describes the steps taken in the literature review on credit and labor cooperatives, focusing on the case study of Sicoob Centro Leste and Norte Maranhense. It presents the phases of identification, screening, eligibility and inclusion of relevant studies for the analysis, ensuring transparency and methodological rigor.

Figure 1

Article selection process



Source: The authors (2024).

Still on the Prisma methodology, demonstrated above, it is worth noting that in the literary field, books, articles and dissertations selected through a search in the following databases *Scientific Electronic Library Online* (SciELO), *Google Scholar*, *Periodicals Portal CAPES* among others available online. To carry it out, works carried out between 2019-2024 were taken into account, with themes that were limited to the theme, therefore works published in the last 05 years (except for classic books), with the defined languages being Portuguese and English.

In total, articles identified in renowned scientific databases, such as SciELO, Google Scholar, CAPES Journals, Scopus, and Web of Science, were analyzed, respecting specific inclusion criteria, such as the period of publication (2019–2024) and thematic relevance. After the removal of duplicates and the exclusion of works outside the defined scope, 24 articles were included that address the role of cooperatives in promoting economic and social development. This flowchart summarizes the review process, providing a visual understanding of the path taken to the final selection of studies.

4 RESULTS AND DISCUSSION

Credit unions play an essential role in local and regional economic development, especially in contexts where financial inclusion and the promotion of economic justice are priority objectives. Sicoob Centro Leste and Norte Maranhense, both founded in 2008, is a representative example of the performance of these cooperatives, which seek to promote a cooperative business model in regions of Maranhão with economic challenges. From the analysis of several graphs that show the evolution of assets, equity and credit, as well as the social performance of the cooperative, it is possible to perceive the positive impact of these institutions on the economic and social development of the region.

Figure 2 shows the evolution of Sicoob Centro Leste and Norte Maranhense assets between 2011 and 2019, showing a substantial increase from 14 million to 120 million. This growth reflects not only the expansion of the member base, but also the cooperative's ability to generate positive financial results. The increase in assets indicates a strong performance in terms of assets and rights that can be converted into liquidity, essential for the financial stability of the cooperative and for the maintenance of a sustainable credit cycle.

Figure 2

Evolution in assets



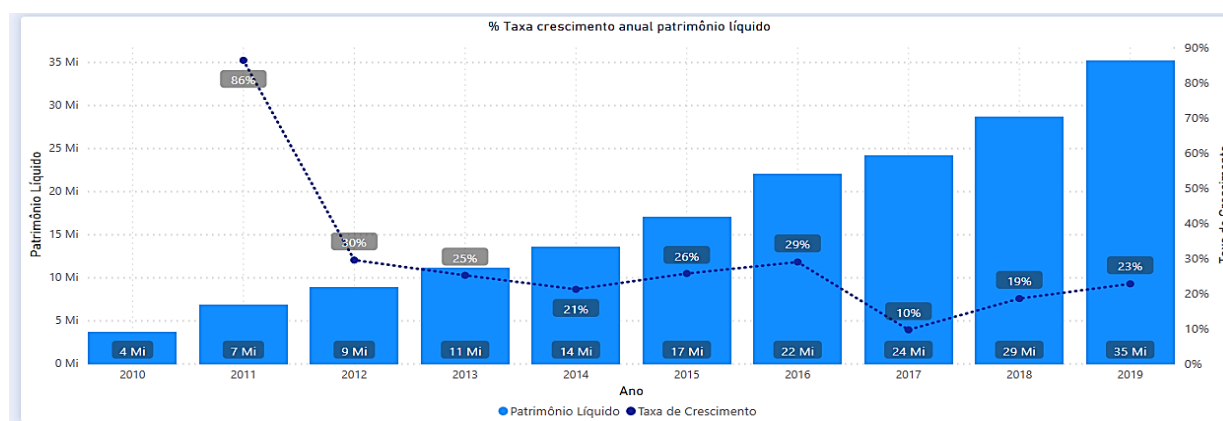
Source: SICOOB (2020a).

According to Bressan et al. (2023), asset growth is an important indicator of a credit union's financial health, as it demonstrates the ability to raise and manage resources efficiently. In the case of Sicoob, the increase in its assets contributes to its competitiveness in the financial market, allowing it to offer more accessible products and services with better conditions for its cooperative members.

Figure 3, in turn, illustrates the evolution of the cooperative's equity, which follows a trajectory similar to that of the assets. With the increase in equity, Sicoob not only improves its position in the market, but can also reinvest profits in new projects, expanding its operations in different municipalities in Maranhão. As Brandt et al. (2021) point out, credit unions that manage to increase their wealth in a sustainable way tend to have a more lasting impact on the communities in which they operate, providing conditions for long-term economic growth.

Figure 3

Evolution in equity

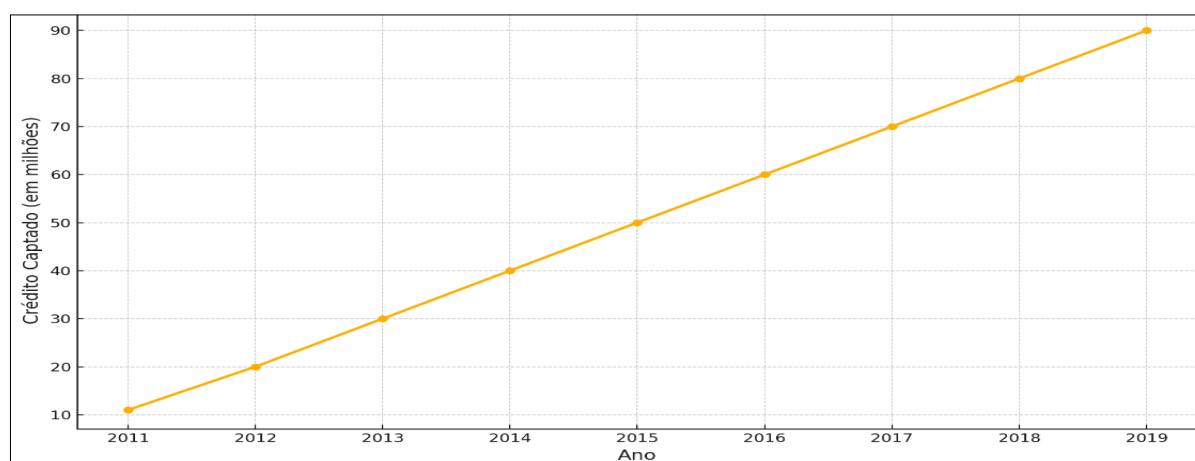


Source: SICCOB (2020a).

Figure 4 shows the increase in fundraising by Sicoob Centro Leste e Norte Maranhense, which grew from 11 million in 2011 to 90 million in 2019. This increase can be explained by the cooperative's strategy of acting as an intermediary between surplus agents (who have surplus resources) and deficit agents (who need credit). The cooperative, by raising funds from the market and passing them on at lower interest rates than those offered by traditional banks, is able to generate a positive spread, which is the difference between what is paid to raise funds and what is charged when granting loans.

Figure 4

Evolution of Credit in Sicoob Centro Leste and Norte Maranhense (2011-2019)



Source: SICCOB (2020b).

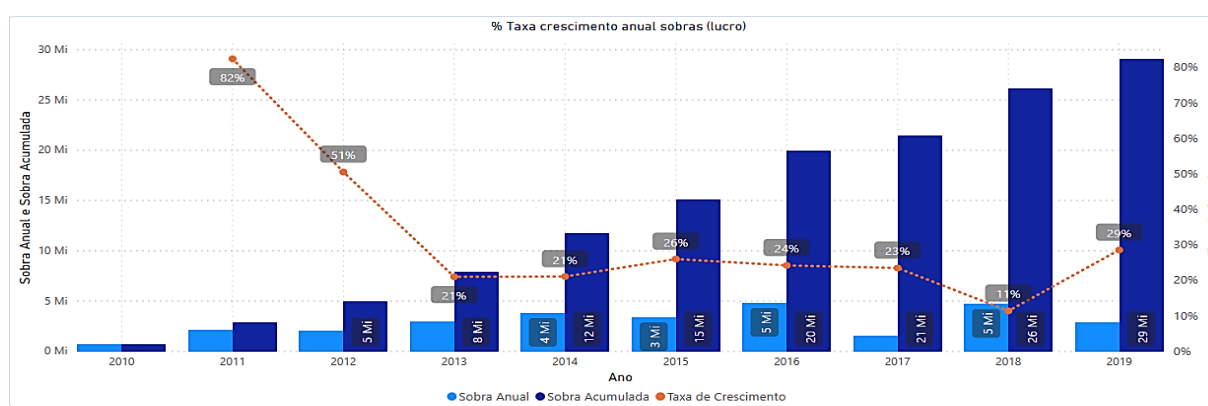
This intermediation model is essential for strengthening the cooperative, as it allows it to finance the local economy and stimulate the growth of small businesses and family farmers. Höher et al. (2019) highlight that this type of operation is one of the biggest

differentials of credit unions, as it promotes financial inclusion, especially in peripheral regions or poorly served by traditional banks.

Figure 5 shows the evolution of the leftovers of Sicoob Centro Leste and Norte Maranhense, an important indicator of the distribution of profits among the cooperative members. After the payment of operating expenses, the surpluses are shared among the cooperative members according to their participation in the transactions carried out with the cooperative. Part of this surplus can be converted into new quotas or transferred to the cooperative members' checking accounts, according to a decision at the general meeting.

Figure 5

Evolution in surpluses (profit)



Source: SICOOB (2020a).

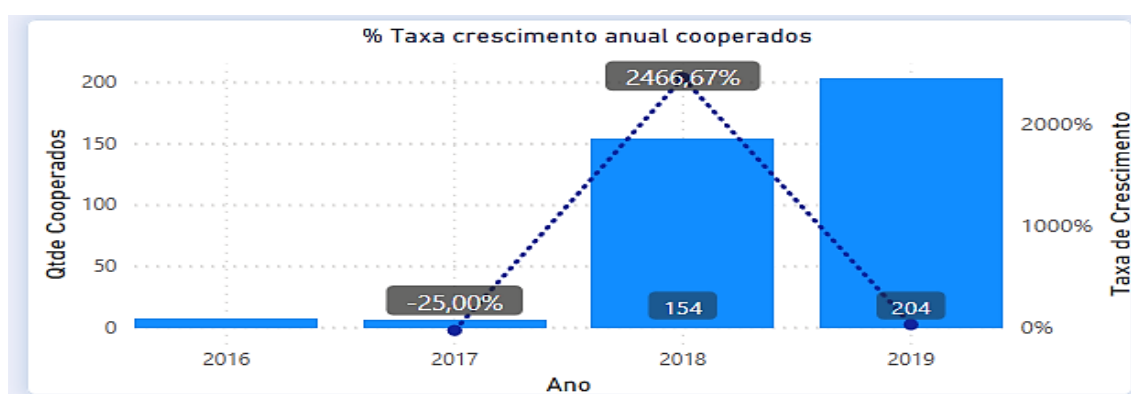
This distribution model reinforces the cooperative character of the institution, which aims not only to generate profits, but also to reinvest in the well-being of its members. The practice of distributing leftovers reflects the cooperative principle of cooperative economic participation, which, as Biolchi et al. (2022) note, is critical to strengthening cooperative identity and member engagement. The return of the leftovers to the cooperative members is a way of repaying the trust placed in the cooperative, creating a virtuous cycle of local development.

With regard to social responsibility, Sicoob Centro Leste e Norte Maranhense has stood out with the implementation of Day C (Day of Cooperating), an action promoted by the OCB System, which aims to engage cooperatives in actions that contribute to the development of communities. Sicoob in Coroatá, for example, has been actively involved in financial education initiatives, promotion of local commerce and carrying out social actions. According to Costa et al. (2020), these initiatives are essential to strengthen the bond between the cooperative and the community, creating a favorable environment for mutual growth.

Figures 6 and 7, which show the growth in the number of cooperative members and female participation, reflect a significant increase in adherence to the cooperative system in Coroatá, with a percentage variation of more than 2,000% between 2018 and 2019. This growth is indicative of the effectiveness of the cooperative's actions in promoting financial inclusion and expanding its member base. In addition, the increase in female participation, which went from 31 to 41 cooperative members in the last four years, demonstrates significant progress in reducing gender inequalities in access to financial services.

Figure 6

Annual growth of Sicoob in Coroatá

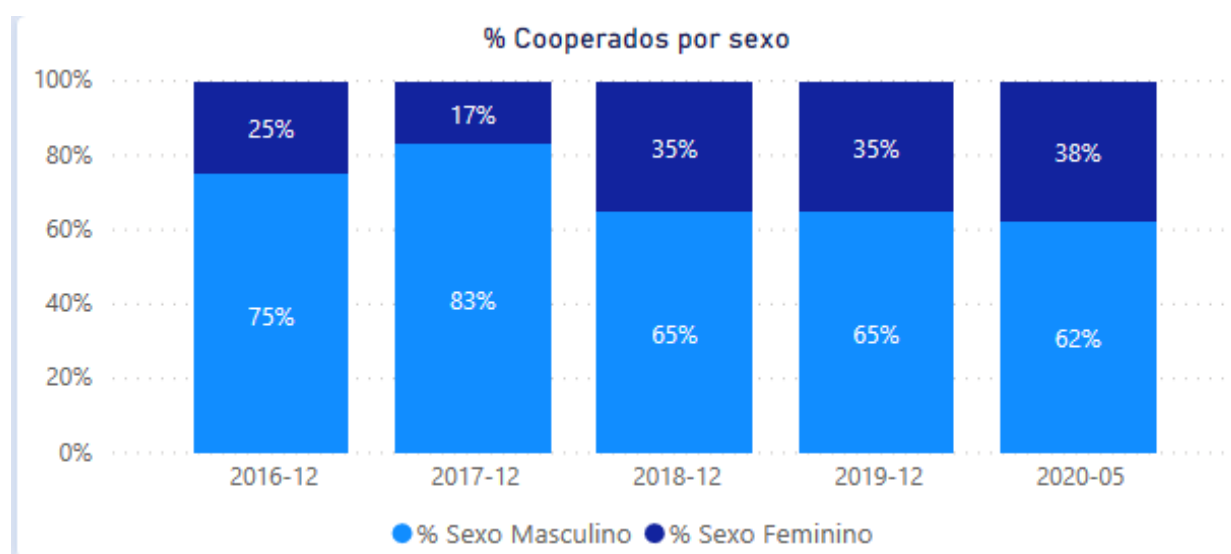


Source: SICOOB (2020a).

It was also observed that the growth rate of female cooperative members has grown gradually in the cooperative, rising from 31 to 41 cooperative members in the last four years, a percentage variation of 32.25% (Figure 6).

Figure 7

Cooperative members by gender. Base year 2019



Source: SICOOB (2020b).

Jesus et al. (2023) discuss the importance of promoting women's financial inclusion, highlighting that increasing female participation in cooperatives contributes to a positive social impact, since women tend to invest more in the education, health, and well-being of their families.

The analysis of the graphs presented reveals that Sicoob Centro Leste e Norte Maranhense has played a fundamental role in the economic and social development of the cities where it operates, especially in Coroatá, promoting not only financial inclusion, but also financial education and the promotion of local entrepreneurship. The growth in assets, equity and credit raising, combined with the distribution of surpluses to cooperative members, demonstrates the success of the cooperative in its business model, which seeks to balance financial growth and social benefit. As Maia et al. (2020) point out, this balance is crucial for the long-term sustainability of credit unions, as it strengthens the trust and engagement of cooperative members, creating a virtuous cycle of growth and development.

Social initiatives, such as C-Day, and the increase in female participation in the cooperative are clear examples of the positive impact that cooperativism can have on the social transformation of communities. Thus, Sicoob Centro Leste e Norte Maranhense is a successful model for other credit unions that seek to integrate the principles of cooperativism with local economic development and financial inclusion.

5 CONCLUSION

One of the main organizations present within the global and national context consists of cooperatives, which are considered one of the main ways to provide interaction between professional and social issues installed in a given region, since most of the cooperatives promote a high valuation of regional workers, as well as seek to outsource services in various areas.

In general, cooperatives can be highlighted as a way to promote outsourcing of services considered essential or important in the social context, which is why they are highly valued by society. In some cases, cooperatives are developed seeking to highlight certain economic or commercial characteristics of a region, presenting to citizens or workers how their activities can promote the evolution of their city.

It is worth mentioning that the impacts promoted or carried out by cooperatives are mainly economic, they are considered a bridge of development in a given location. For some economists and administrators, the development of a cooperative can be something very positive for the regions, something that has underpinned the implementation or development of many cooperatives.

One of the main cooperatives developed and applied in Brazil consists of credit cooperatives, which are fundamentally based on the development of services or procedures related to the financial part, granting individuals an opportunity for financial development or to portray a certain financial issue with banking organizations.

Many financial professionals consider credit unions to be an opportunity to further expand the interaction between financial institutions and potential consumers or customers of financial services. They are presented as an opportunity to improve or make more accessible guidance, assistance and services in the financial field, whether in a particular region or in a country.

Seeking to consolidate the issues they address about credit unions and how they can promote economic and social evolution in the regions where they are installed, information about SICCOB, one of the most important credit unions in Brazil, was highlighted. Granting an opportunity to verify the main services provided by cooperatives in this segment, as well as information regarding the importance of administrative procedures for a consolidation of improvements or expansions with society.

REFERENCES

- Assis, E., & Lopes, A. L. (2020). A intercooperação nas cooperativas de crédito da região do Vale do Aço: Discurso ou efetividade? [Trabalho acadêmico]. <https://repositorio.ufmg.br/handle/1843/XXXX> (ou link alternativo se disponível; o original é local).
- Banco Central do Brasil. (2019a). Modelo de negócios de cooperativas de crédito (Boxe do Relatório de Economia Bancária 2019). https://www.bcb.gov.br/content/publicacoes/relatorioeconomiabancaria/reb_2019.pdf (ou Estudo Especial nº 83/2020: https://www.bcb.gov.br/conteudo/relatorioinflacao/EstudosEspeciais/EE083_Modelo_de_negocios_de_cooperativas_de_credito.pdf)
- Banco Central do Brasil. (2019b). Panorama do sistema nacional de crédito cooperativo: Data-base dezembro/2019. https://www.bcb.gov.br/content/estabilidadefinanceira/coopcredpanorama/panorama_cooperativas_sncc_2019.pdf
- Biolchi, D. de O., Mueller, A. A., Thesing, N. J., & Oliveira, D. de A. (2022). Os princípios cooperativistas e a interdisciplinaridade presentes em uma cooperativa escolar. *Revista Gesto: Revista de Gestão Estratégica de Organizações*, 10(1), 21–35.
- Brandt, V. A., Zambon, A. R., & Pereira, K. L. (2021). Cooperativas de crédito – análise de eficiência baseada na análise envoltória de dados tendo como base as demonstrações financeiras e sociais. *Brazilian Journal of Development*, 7(2), 12647–12667. <https://doi.org/10.34117/bjdv7n2-062>
- Braúna, A. A. (2016). O papel do cooperativismo no desenvolvimento do estado do Tocantins [Dissertação de mestrado, Universidade Federal do Tocantins].

- Bressan, V. G. F., Souza, G. H. D., Santos, M. H. S., & Braga, M. J. (2023). Cooperativas de crédito e competitividade no mercado financeiro brasileiro: Uma análise das taxas de juros. *Revista de Gestão e Organizações Cooperativas*, 10(19), Article e68474. <https://doi.org/10.5902/2359043268474>
- Bressan, V. G. F., Maia, L. L., & Souto, B. A. C. (2020). Política de distribuição de sobras em cooperativas de crédito. *Revista de Gestão e Organizações Cooperativas – RGC*, 7(Edição Especial), 161–180.
- Chaves, S. S. (2011). O cooperativismo de crédito no Brasil: Evolução e perspectivas. In *Desafios do sistema financeiro nacional: O que falta para colher os benefícios da estabilidade conquistada* (pp. 69–97). Elsevier-Campus.
- Costa, R. A., Vizcaino, C. A. C., & Costa, E. M. (2020). Participação em cooperativas e eficiência técnica entre agricultores familiares no Brasil. In *Uma jornada pelos contrastes do Brasil: 100 anos de censo agropecuário*. IPEA.
- Fernandes, T. M., et al. (2022). Análise da satisfação dos funcionários, cooperados de uma cooperativa de Santa Maria-RS. *Research, Society and Development*, 11(17).
- Ferreira, S. N., & Menelau, A. S. (2022). Licenciamento ambiental na contramão das agroindústrias de Alagoas. *Revista Política Agrícola*, 31(2).
- Goes, M. C. de. (2011). Cooperativismo de crédito, intercooperação e performance econômica: O Sicredi (Brasil). <https://repositorio.ufmg.br/handle/1843/XXXX> (ou link alternativo se disponível; o original é local).
- Gretti, L., & Sela, V. M. (2021). Atuação das cooperativas de crédito no processo de inclusão financeira no Brasil. *Enfoque: Reflexão Contábil*, 40(3), 21–37. <https://doi.org/10.4025/enfoque.v40i3.52027>
- Haguette, M. F. (2020). Metodologias qualitativas na sociologia (12a ed., pp. 57–100). Vozes.
- Höher, R., Souza, O. T., & Fochezatto, A. (2019). Análise da eficiência: Um estudo nas cooperativas financeiras do Rio Grande do Sul. *Revista de Gestão e Organizações Cooperativas*, 6(11), 257–276. <https://periodicos.ufsm.br/rgc/article/view/35988/pdf>
- Jesus, L. H. de, Brizolla, M. M. B., Filipin, R., Soschinski, C. K., & Salla, N. M. G. (2023). Controles internos como um instrumento de governança corporativa em uma cooperativa de crédito. *Contribuciones a las Ciencias Sociales*, 16(1), 73–91.
- Júnior, A. C. G., & Tavaré, T. R. (2020). A prática da intercooperação no cooperativismo de crédito: Um estudo de caso de uma agência compartilhada por quatro cooperativas de crédito de Minas Gerais. *Revista de Gestão e Organizações Cooperativas – RGC*, 7(Edição Especial).
- Maffini, M., Wakulicz, G. J., & Alberti, R. (2020). Análise da fidelidade dos associados em uma cooperativa central do Rio Grande do Sul através do modelo sueco. *Research, Society and Development*, 9(12), Article e2439129200.
- Maia, L. L., Santos, L. S. Z., Soares, R. R., Lopes, A. L. M., & Bressan, V. G. F. B. (2020). Análise da eficiência técnica em cooperativas de crédito com base em operação e risco. *Enfoque: Reflexão Contábil*, 39(2), 59–78. <https://doi.org/10.4025/enfoque.v39i2.45808>
- Matos, A. G. de, Gretti, L., & Zampieri, J. V. M. (2022). A atuação das cooperativas de crédito em prol da inclusão financeira: Estudo de caso comparado. *Revista de Gestão e Organizações Cooperativas*, 9(17), Article e12. <https://doi.org/10.5902/2359043263608>

- Nunes, A. de F. P., et al. (2019). Influência da identidade organizacional dos colaboradores de uma cooperativa de crédito da região central do Rio Grande do Sul em relação aos princípios do cooperativismo. *Revista Caribeña de Ciencias Sociales*, 1–16.
- Organização das Cooperativas Brasileiras. (2019). Anuário Brasileiro do Cooperativismo 2018/2019. <https://www.mundocoop.com.br> (ou link atualizado para edições recentes no site oficial OCB).
- Peroni, J. M. (2020, julho). O futuro do cooperativismo de crédito [Entrevista]. *MundoCoop*, 93.
- Silva, A., Santos, J. F., & Ranciaro Neto, A. (2023). Desempenho das cooperativas de crédito brasileiras: Uma análise a partir dos indicadores PEARLS. *Revista de Administração Mackenzie*, 24(1), 1–29. <https://doi.org/10.1590/1678-6971/eRAMR230057.pt>
- Souza, G. H. D., Bressan, V. G. F., & Carrieri, A. de P. (2022). Cooperativas de crédito como negócios de impacto: O caso da Sicoob Credichapada. *Revista Contemporânea de Contabilidade*, 19(20), 36–59. <https://doi.org/10.5007/2175-8069.2022.e78951>
- Teixeira, I. C., Maia, V. M., & Teixeira, R. F. A. P. (2020). Um estudo de risco das cooperativas de crédito brasileiras com base no beta contábil. *Revista Catarinense da Ciência Contábil*, 19, 1–20. <https://doi.org/10.16930/2237-766220203025>
- Torres-Inga, C. S., Velasco-Heras, C., Juana, A. J. A.-d., Guevara-Viera, G. E., & Guevara-Viera, R. V. (2022). Technical efficiency's nonparametric analysis of Ecuadorian saving and credit cooperatives before and during the pandemic. *Economies*, 10(4), Article 82. <https://doi.org/10.3390/economies10040082>
- Viana, M. H., & Moreira, N. P. (2024). Eficiência de cooperativas de crédito: Uma análise da macrorregião do Triângulo Mineiro e Alto Paranaíba-MG. *Revista de Contabilidade da UFBA*, 18(1), Article e2417. <https://doi.org/10.9771/rcufba.v18i1.62291>

EXTRAJUDICIAL DISPUTE RESOLUTION: CONSENSUAL MECHANISMS, EFFECTIVENESS, AND PROTECTION OF HEALTH IN RELATION TO DENTISTRY

RESOLUÇÃO EXTRAJUDICIAL DE CONFLITOS: MECANISMOS CONSENSUAIS, EFETIVIDADE E TUTELA DA SAÚDE EM RELAÇÃO À ODONTOLOGIA

RESOLUCIÓN EXTRAJUDICIAL DE DISPUTAS: MECANISMOS CONSENSUALES, EFICACIA Y PROTECCIÓN DE LA SALUD EN RELACIÓN CON LA ODONTOLOGÍA



<https://doi.org/10.56238/sevened2026.008-129>

Beatriz Andreia Melo Silva Cossaros¹

ABSTRACT

The increasing judicialization of conflicts between dentists and patients highlights the limitations of an exclusively adjudicative approach in disputes characterized by high technical, relational, and informational complexity. This article comparatively analyzes the Brazilian and Argentinian systems of extrajudicial conflict resolution in dentistry, emphasizing mediation and the role of extrajudicial advocacy, evaluating their impacts on the effectiveness of health protection and professional civil liability. It starts from the premise that many controversies do not stem from pure technical error, but from communication and informational failures related to expectations of results, understanding of the therapeutic plan, foreseeable risks, costs, and clinical documentation. In this context, the ancillary duties of objective good faith—information, informed consent, medical records, and cooperation—are examined as structural elements capable of reducing uncertainties and favoring proportionate solutions. It concludes that mediation constitutes an appropriate method, without excluding jurisdiction when necessary.

Keywords: Mediation. Dentistry. Civil Liability. Access to Justice. Prevention of Harm.

RESUMO

A crescente judicialização dos conflitos entre cirurgiões-dentistas e pacientes evidencia as limitações de um enfoque exclusivamente adjudicativo em disputas caracterizadas por elevada complexidade técnica, relacional e informacional. O artigo analisa, de forma comparada, os sistemas brasileiro e argentino de resolução extrajudicial de conflitos na odontologia, com ênfase na mediação e na atuação da advocacia extrajudicial, avaliando seus impactos na efetividade da tutela da saúde e na responsabilidade civil profissional. Parte-se da premissa de que muitas controvérsias não decorrem de erro técnico puro, mas de falhas comunicacionais e informativas relacionadas às expectativas de resultado, à compreensão do plano terapêutico, aos riscos previsíveis, aos custos e à documentação clínica. Nesse contexto, examinam-se os deveres anexos da boa-fé objetiva — informação, consentimento informado, prontuário e cooperação — como elementos estruturais capazes

¹ Doctoral student in Legal Sciences. Universidad del Museo Social Argentino (UMSA).

de reduzir incertezas e favorecer soluções proporcionais. Conclui-se que a mediação constitui método adequado, sem excluir a jurisdição quando necessária.

Palavras-chave: Mediação. Odontologia. Responsabilidade Civil. Acesso à Justiça. Prevenção do Dano.

RESUMEN

La creciente judicialización de los conflictos entre dentistas y pacientes pone de relieve las limitaciones de un enfoque exclusivamente judicial en disputas caracterizadas por una alta complejidad técnica, relacional e informativa. Este artículo analiza comparativamente los sistemas brasileño y argentino de resolución extrajudicial de conflictos en odontología, haciendo hincapié en la mediación y el papel de la defensa extrajudicial, evaluando su impacto en la eficacia de la protección de la salud y la responsabilidad civil profesional. Se parte de la premisa de que muchas controversias no se derivan de errores puramente técnicos, sino de fallos de comunicación e información relacionados con las expectativas de resultados, la comprensión del plan terapéutico, los riesgos previsibles, los costes y la documentación clínica. En este contexto, se examinan los deberes auxiliares de la buena fe objetiva —información, consentimiento informado, historial médico y cooperación— como elementos estructurales capaces de reducir las incertidumbres y favorecer soluciones proporcionadas. Se concluye que la mediación constituye un método adecuado, sin excluir la jurisdicción cuando sea necesario.

Palabras clave: Mediación. Odontología. Responsabilidad Civil. Acceso a la Justicia. Prevención de Daños.

1 INTRODUCTION

The growing judicialization of the relationship between dental professionals and patients is a relevant phenomenon in the contemporary legal scenario, associated with social, economic and cultural transformations that directly impact the provision of health services. The expansion of access to information, the affirmation of the right to health as a fundamental right and the strengthening of consumer protection have contributed to the increase in claims based on allegations of poor dental practice, dissatisfaction with therapeutic results and deficiencies in professional-patient communication.

This scenario highlights the limits of the exclusively adjudicative treatment of disputes characterized by a high technical, subjective and relational load. The jurisdictional response, often centered on expert evidence and the imposition of a binary decision, tends to offer a more appropriate solution for the imputation of responsibility and the quantification of the damage than for the recomposition of the therapeutic bond, the technical clarification and the proportional adjustment of expectations.

The doctrine of access to justice, especially from the debate on "adequate methods" and multi-door justice, points out that the effectiveness of tutelage is not limited to the delivery of a formally correct state decision, requiring mechanisms compatible with the nature of the conflict and capable of producing materially satisfactory responses. Along these lines, Cappelletti and Garth highlight that access to justice must be understood from a functional perspective, oriented to results and the effective protection of rights, and not only as the possibility of resorting to the courts. In a complementary way, the conception of the *multi-door courthouse*, associated with Frank Sander, reinforces the idea that the institutional response to the conflict should privilege the most appropriate method for the specific case, avoiding the exclusive centralization of the litigation process.

In this context, consensual mechanisms — especially mediation and conciliation and, in specific cases, arbitration — gain relevance as instruments for rationalizing the justice system and qualifying health protection, especially in conflicts marked by informational asymmetries and the need for technical dialogue. Mediation, in particular, offers a structured space for communication, the adjustment of expectations and the construction of proportional solutions, preserving, when possible, the care bond.

From a comparative perspective, Brazil and Argentina adopt different institutional designs. In Brazil, consensuality is strongly encouraged by public policy and procedural and substantive legislation, preserving direct access to the Judiciary and the possibility of self-settlement before or during the process. In Argentina, mandatory prior mediation is part of the itinerary of access to jurisdiction in a wide range of civil disputes, with detailed procedural

regulation and mandatory participation of the legal profession, in a dogmatic context that emphasizes the prevention of harm.

This article aims to analyze, from a comparative perspective, the Brazilian and Argentine systems of out-of-court resolution of conflicts between dentists and patients, with special attention to the role of mediation and out-of-court advocacy, as well as the impacts of these models on the effectiveness of health protection and professional civil liability.

2 JUDICIALIZATION OF DENTISTRY AND CRISIS OF EXCLUSIVELY ADJUDICATIVE TREATMENT

The judicialization of health is manifested in a particular way in the dental field. Unlike other areas, in which judicialization is usually oriented towards guaranteeing access to medicines, procedures or hospital beds, many claims in dentistry are concentrated in claims for compensation for material and moral damages resulting from the provision of private services, especially in treatments with an aesthetic-functional component, in controversies related to retreatment, reimbursement, therapeutic continuity and the frustration of expectations.

This pattern reveals a predominantly consumerist logic, in which the dentist-patient relationship is framed as a consumer relationship, subject to consumer protection regulations. Such a framework is relevant to ensure informational transparency, good faith and the prohibition of unfair clauses, but it can reinforce an adversarial dynamic when the judicial process is triggered as an immediate and almost exclusive way to address the conflict.

The centrality of the judicial process in these disputes produces known systemic effects: increased economic and emotional costs, prolongation of the conflict, overload of the Judiciary and decisions that do not always meet the needs of the parties. In health conflicts, as the case may be, expert evidence is indispensable; However, the dependence on expert opinions, added to procedural polarization, can hinder restorative and negotiated solutions, especially when the disagreement stems from communication failures, the absence of adequately documented consent, patient insecurity, or mismatches in expectations regarding the result.

The criticism of the exclusively adjudicative treatment does not imply devaluation of jurisdiction, but reinforces the need to integrate state protection with appropriate methods, privileging communication, cooperation and the prevention of the aggravation of the conflict, according to the nature of each case.

3 DENTAL CIVIL LIABILITY: DOGMATIC FOUNDATIONS AND INFORMATIONAL ELEMENTS OF THE CONFLICT

The civil liability of the dental surgeon, in the Brazilian legal system, is structured mainly from the Consumer Protection Code and the Civil Code. Pursuant to article 14, paragraph 4, of the CDC, the personal liability of liberal professionals is determined by verifying fault, preserving the subjective nature of liability and requiring the demonstration of culpable conduct, damage and causal link. In the Civil Code, arts. 186 and 927 provide the general basis of the unlawful act and the duty to indemnify, and article 932 acquires relevance when the provision occurs in a business context (clinics, societies and acting through dependents), in which case the organizational dynamics can influence the attribution and management of risk.

Although the normative framework is sufficient for the legal framework, practical experience shows that dental disputes often originate less from a "pure technical error" and more from informational and communicational failures: expectations of results, understanding of the therapeutic plan, biological limits, foreseeable risks, alternatives and costs. From this perspective, the contemporary dogmatics of civil liability has reinforced the centrality of the ancillary duties derived from objective good faith — especially the duties of information, loyalty, cooperation, and protection — with a direct impact on the legitimacy of consent and on the degree of predictability of the therapeutic result.

3.1 DUTY OF INFORMATION AND INFORMED CONSENT: CONTENT, FUNCTION AND PROOF

The duty of information in dental services is not reduced to the mere delivery of a form. It is a legal duty that conditions the patient's self-determination and qualifies the rational choice in the context of technical asymmetry. The civil doctrine, when dealing with objective good faith, understands information as an element of correction of the structural imbalance of the relationship: the patient decides based on what he understands; If understanding is incomplete, conflict becomes predictable.

The function of informed consent is twofold: (1) ethical and clinical, as it allows free and informed decision-making, adjusting expectations and preserving autonomy; (2) legal-evidential, as it organizes the standard of transparency required of the professional and documents the informational path.

To avoid weaknesses in any litigation, informed consent must include: description of the procedure and the stages of the therapeutic plan; typical and relevant risks (including complications and limitations of the result); therapeutic alternatives and consequences of not

performing it; aftercare and the need for controls; possibility of retreatment, biological limitations and margins of variation of the result; foreseeable costs and hypotheses of additional costs, with due justification.

The specific literature on dentistry and civil liability highlights that consent should not be "standard and generic", under penalty of losing evidential effectiveness. The document is more robust when it dialogues with the concrete case, uses accessible language and records the doubts clarified.

3.2 DENTAL RECORDS: ETHICAL-LEGAL DUTY, CONTINUITY OF CARE AND EVIDENTIARY SUPPORT

The medical record is a central element of contemporary dental practice for three reasons: (1) it enables continuity of care and clinical safety; (2) evidences diligence, planning, decisions and conduct; (3) it provides evidentiary support in controversies, reducing uncertainty and polarization.

In indemnity claims, the evidence is often structured based on what is documented: anamnesis, examination, treatment plan, evolution, complications, orientations, controls, exams and images. The absence or precariousness of records tends to amplify the conflict, hinder forensic examination, and increase the perception of communication failure — even when the technical conduct was adequate.

Here lies a relevant point: mediation becomes more viable when there is minimally organized clinical documentation, as the parties can discuss solutions without fully depending on a late expert judgment. In terms of preventive policy, an adequate medical record and informed consent work as a true "infrastructure of the agreement": they reduce noise, stabilize the facts and allow proportional proposals.

In view of the growing complexity of professional accountability in dentistry, it is proposed to strengthen the ethical, legal and documentary training of dental surgeons from graduation. The consolidation of educational practices aimed at the correct preparation and use of clinical documentation is essential for the prevention of legal conflicts, for adequate patient information and for the demonstration of professional diligence proper to the obligations of the environment that characterize the dental activity. Thus, it is recommended the incorporation of specific pedagogical strategies that promote the understanding of the evidential role of dental documentation and encourage preventive action by the professional, contributing to greater legal certainty in clinical practice.

3.3 DUTY OF COOPERATION AND MANAGEMENT OF COMPLICATIONS: FROM CONFLICT TO THE DESIGN OF CONSENSUAL SOLUTIONS

Dental litigation often arises from complications, persistent discomfort, recurrences or results below expectations. In these situations, the legally relevant conduct is not only the technical one, but also the communicational management of the intercurrent, the patient's guidance, the offer of alternatives and the recording of the decisions adopted. Objective good faith — understood as a standard of behavior — is the basis for a duty of cooperation that does not imply "assumption of guilt", but transparent and diligent action to reduce damage and avoid the escalation of the conflict.

From a practical point of view, this is directly related to typical consensual solutions: partial retreatment with defined deadlines and clinical milestones; proportional reimbursement conditioned on objective criteria (e.g. steps not taken); independent evaluation (second opinion) agreed; adjustment of the therapeutic plan and economic conditions; closure agreement with preservation of the medical record and reciprocal commitments.

This perspective is consistent with the notion of adequate protection: when the dissent is informational and relational, the appropriate method is the one that allows the reconstruction of expectations and a proportional solution, without reducing the case to the binary logic of "fault versus indemnity".

4 CONSENSUAL MEANS IN HEALTH: DOCTRINAL FOUNDATIONS APPLIED TO DENTISTRY

Consensual means are part of a movement to reconfigure access to justice, in which it seeks to replace the single response of the litigation process with a set of "doors" capable of responding proportionally to different types of conflicts. This logic, associated with the *multi-door courthouse* (Sander) model, finds a privileged field in health, as many care disputes are marked by technical asymmetries and interests that are not resolved only through a conviction.

4.1 NEGOTIATION FOR INTERESTS: WHEN THE CONFLICT IS NOT "MONEY", BUT "RECOGNITION" AND "SECURITY"

Interest-based negotiation, developed by Fisher, Ury, and Patton, is especially useful for understanding dental conflicts. In many cases, the patient's stated position is "indemnity"; The underlying interest may be the recognition of suffering, security as to what has occurred

and what may yet occur, the predictability of costs, the possibility of completing treatment, as well as the preservation of dignity and autonomy.

When the professional responds only in terms of positions ("there was no mistake" versus "there was a mistake"), the conflict tends to escalate. Consensual methods make it possible to work on interests: technical clarification, continuity agreements, proportional compensation and independent evaluation.

4.2 MEDIATION: STRUCTURE, CONFIDENTIALITY AND COMMUNICATIONAL RECONSTRUCTION (MOORE)

Moore describes mediation as a structured process of assisted communication, in which an impartial third party facilitates the identification of issues, interests, and alternatives, without imposing a decision. In dentistry, this design reduces three typical risks of litigation: (1) narrative polarization ("malpractice" versus "inherent risk"); (2) the exclusive dependence on expertise as the only form of technical understanding; (3) emotional crystallization, which transforms therapeutic frustration into permanent hostility.

Confidentiality, when properly agreed, is particularly useful in the health sector, as it protects professional reputation and allows patients to expose their vulnerabilities without fear of being exploited. This favors realistic agreements that would hardly be proposed "under the spotlight" of the judicial process.

4.3 TRANSFORMATIVE MEDIATION: AUTONOMY AND RECOGNITION (BUSH AND FOLGER) IN HEALTH CONFLICTS

The transformative theory (Bush and Folger) is valuable for dental litigation because many conflicts constitute experiences of loss of control: the patient feels that he did not understand the risks, that he did not participate in the decision, or that he was not heard. Mediation can produce: *empowerment*, giving the patient back informed autonomy; and *recognition*, allowing the professional to recognize the patient's experience without necessarily admitting guilt.

This point demonstrates that mediation is not only an "economic agreement", but a mechanism that addresses subjective dimensions of conflict, which are fundamental in the field of health.

4.4 CRITERIA FOR THE ADEQUACY OF THE METHOD: WHEN MEDIATION IS BETTER AND WHEN IT IS NOT

To avoid an "idealization of consensuality", it is necessary to recognize its limits. Mediation is appropriate when: the conflict involves expectations, communication, costs and continuity of care; there is scope for a proportionate solution; the parties have a minimum capacity for dialogue (even if mediated); and the object is predominantly patrimonial or available (or at least negotiable as to the form of compliance).

Mediation tends to be inappropriate when: there are strong indications of violence, coercion or decision-making incapacity; there is urgency for injunctive or anticipatory relief to avoid serious damage; the litigation is essentially probative as to a central technical fact without a minimum documentary basis; or there is absolute resistance to any form of dialogue.

The delimitation avoids the indiscriminate use of mediation for all types of conflicts.

5 THE BRAZILIAN MEDIATION SYSTEM AND EXTRAJUDICIAL ADVOCACY

5.1 PUBLIC POLICY AND NORMATIVITY: CNJ RESOLUTION NO. 125/2010, CPC/2015 AND LAW NO. 13,140/2015

In Brazil, mediation was institutionalized as a public policy from CNJ Resolution No. 125/2010, which instituted the National Judicial Policy for the Adequate Treatment of Conflicts of Interest and structured the NUPEMECs and CEJUSCs. The notion of "adequate treatment of the conflict", associated with the Brazilian doctrine (especially Kazuo Watanabe), presupposes the choice of the method most compatible with the nature of the litigation, overcoming the idea that the litigation process is always the most efficient way.

The 2015 Code of Civil Procedure consolidated this guideline by providing that the State shall promote, whenever possible, consensual settlement and that conciliation, mediation and other methods must be encouraged by magistrates, lawyers, defenders and members of the Public Prosecutor's Office (art. 3, §§ 2 and 3). In theoretical terms, this guideline dialogues with the idea of adequate protection: the effectiveness of access to justice is not to be confused with the simple entry into the courts, but with obtaining a response compatible with the substantive law and with the particularities of the case.

Law No. 13,140/2015 regulated judicial and extrajudicial mediation, consolidating principles such as autonomy of will, confidentiality, and good faith. For Tartuce, mediation is especially appropriate in continuous or asymmetrical relationships, in which the solution constructed tends to be more sustainable and satisfactory than the external imposition of a decision.

5.2 JUDICIAL MEDIATION AND CEJUSCS

Judicial mediation occurs, as a rule, within the scope of the CEJUSCs. In dental conflicts, judicial mediation can be used in compensation claims to discuss reparation alternatives before the production of complex expert evidence, which tends to reduce costs and procedural time. If there is an agreement, judicial approval with the force of an enforceable title is possible.

5.3 EXTRAJUDICIAL MEDIATION AND SPECIALISED PRIVATE CHAMBERS

Extrajudicial mediation depends on the will of the parties and can be carried out in private chambers, specialized institutions or conducted by qualified mediators. Its usefulness in the dental field is high, as it allows: (i) the composition of retreatment and proportional reimbursement; (ii) continuity of care and technical correction agreements; (iii) instruments with confidentiality and non-recognition of guilt clauses, when legally appropriate and without prejudice to inalienable rights.

5.4 ARBITRATION IN DENTAL SERVICES: DOGMATIC AND JURISPRUDENTIAL LIMITS

Arbitration is governed by Law No. 9,307/1996, but in consumer relations, there are relevant limits. The CDC prohibits the clause that determines the compulsory use of arbitration (art. 51, VII) and, in adhesion contracts, it is required that the clause only produce effects if the adherent takes the initiative to initiate arbitration or expressly consents to its institution, with formal requirements.

The case law of the STJ consolidated this orientation, highlighting the need for real voluntariness of the consumer:

1. **STJ, REsp 1.189.050/SP (2010):** admits an arbitration clause in a consumer/adhesion contract as long as it is not imposed; the effectiveness depends on the consumer's initiative or his subsequent express agreement.
2. **STJ, REsp 1.628.819/MG (2016):** reinforces the prohibition of compulsory arbitration and conditions the initiation to the initiative or express agreement of the consumer.
3. **STJ, REsp 1.778.456/SP (2019):** admits arbitration in property disputes, with reinforced caution in health/consumption, prohibiting its use to remove controversies about personal rights and damage to health.

It is necessary to explain that, in dental contracts, arbitration clauses require maximum caution. In general, it is safer to adopt staggered clauses (negotiation → mediation → arbitration/justice), preserving voluntariness and qualified information, which dialogues with

the arbitration doctrine (such as Carmona) and with the consumerist doctrine (such as Cláudia Lima Marques) in the protection of vulnerable consumers.

5.5 EXTRAJUDICIAL ADVOCACY IN BRAZIL: QUALIFICATION AND LIMITS OF OPTIONALITY

In Brazil, the role of the lawyer in mediation is optional, but recommended in complex and technically specialized conflicts. Extrajudicial advocacy contributes to: (1) reducing asymmetries; (2) evaluate risks and alternatives; (3) formalize a valid and enforceable agreement. However, optionality can maintain inequalities when one of the parties has technical or economic superiority, which requires attention to procedural design and informational transparency.

5.6 DENTAL ETHICS AS A PREVENTIVE AXIS

The Code of Dental Ethics (CFO) establishes duties of information, informed consent, maintenance of medical records and professional zeal. These duties act as a preventive axis: they reduce litigation, raise the quality of communication and serve as a reference for proposals for solutions in mediation, in line with the dignity of the patient and with objective good faith.

6 THE ARGENTINE MODEL OF MANDATORY PRIOR MEDIATION, THE DUTY TO PREVENT HARM AND THE CENTRALITY OF EXTRAJUDICIAL ADVOCACY

6.1 MANDATORY MEDIATION AND ACCESS TO JUSTICE: INSTITUTIONAL RATIONALITY

Argentina instituted mandatory prior mediation as a condition of proceeding for the initiation of a wide range of civil actions, through Law 26.589/2010. In this design, mediation is an institutional gateway to the system and formally integrates the itinerary of conflict treatment, without representing a waiver of the right of action.

The normative option shifts the focus from "access to the judge" to "access to the appropriate response", giving centrality to preventive, dialogical and proportional solutions before the initiation of judicial litigation. In health conflicts, including dental ones, this structure can contain the escalation of the conflict, preserve space for recomposition, and reduce the adversarial crystallization of the claim.

6.2 PROCEDURE, CONFIDENTIALITY AND FRUSTRATION CERTIFICATION

The procedure begins with a formal request, with the designation of a hearing before a registered mediator, subject to registration and supervision rules. The initial hearing delimits the conflict, identifies underlying interests and inaugurates an assisted negotiation.

The parties appear assisted by lawyers, and unjustified absence can generate procedural and economic consequences, giving effect to the duty of participation. The procedure is guided by confidentiality, favoring a frank presentation of expectations and possibilities of reparation — a sensitive aspect in dental disputes that may involve reputation, therapeutic frustration and the need for technical clarification.

If there is an agreement, it is formalized in writing; In its absence, a certificate of frustrated mediation is issued, enabling entry into the courts. Even so, the stage tends to qualify the information, reduce the litigious object and stabilize the controversy, making any subsequent process more rational.

6.3 CCYC AND DAMAGE PREVENTION: PREVENTIVE FUNCTION

The Civil and Commercial Code of the Nation (CCyC, Law 26.994) enshrines, in arts. 1710 and following, a general duty to prevent damage. Argentine dogmatics emphasizes a paradigm shift: from a responsibility focused only on reparation to a logic of avoidance and mitigation of harm, especially relevant in professional activities with foreseeable risks, such as health practices.

In dental services, this preventive axis directly focuses on the duties of information, informed consent, follow-up and management of complications. In addition, the CCyC regulates contracts for the provision of services (articles 1641 et seq.), emphasizing ancillary duties such as loyalty, cooperation, and information — dogmatic bases that support both accountability and proportional consensual solutions.

6.4 CENTRALITY OF EXTRAJUDICIAL ADVOCACY: QUALIFICATION OF CONSENSUS AND REDUCTION OF ASYMMETRIES

The mandatory participation of the legal profession in mediation is a distinctive element of the Argentine model. Legal assistance qualifies the proposals, reduces asymmetries and increases the formal security of the agreement.

6.5 APPROVAL AND ENFORCEABILITY

The judicial ratification of the agreements strengthens their enforceability and stability. This mechanism does not denature the extrajudicial nature of mediation, but evidences a

functional integration between consensuality and jurisdiction, preserving autonomy and ensuring effectiveness.

7 MEDIATION, OUT-OF-COURT ADVOCACY AND SYSTEMIC EFFECTS

7.1 OPTIONALITY AND OBLIGATION: IMPACT ON ACCESS TO JUSTICE

In Brazil, self-settlement is encouraged, but does not condition, as a rule, the right of action; Freedom of choice is preserved, although conflicts potentially solvable by consensus may enter directly into the courts. In Argentina, mandatory prior mediation reorganizes the itinerary of the conflict, functioning as an institutional stage aimed at preventing litigation, without suppressing the right of action.

7.2 LEGAL CULTURE AND BEHAVIOR OF ACTORS

In Brazil, the litigation tradition still prevails despite the normative framework of consensuality; The judicial process remains a way perceived as "safer" by many actors. In Argentina, mandatory mediation tends to consolidate a culture of prevention and negotiation, in which consensual settlement constitutes an ordinary stage in the treatment of conflict.

7.3 ROLE OF EXTRAJUDICIAL ADVOCACY AND INFORMATIONAL ASYMMETRY

The optionality of legal assistance in Brazilian mediation can preserve autonomy, but in health conflicts, it can maintain asymmetries and compromise the quality of the agreement. In Argentina, the obligation of legal aid reinforces the technical balance and predictability, attributing to it an institutional function.

7.4 CIVIL LIABILITY AND TIMING OF THE DISPUTE

In Brazil, mediation is usually triggered after a significant rupture and with a predominantly pecuniary expectation. In Argentina, mandatory prior mediation operates before adversarial crystallization, favoring solutions for correcting the service, restoring the bond and proportional reparation, especially in dialogue with the prevention of damage.

7.5 EFFECTIVENESS OF HEALTH PROTECTION

The effective protection of health requires timely, proportional, and humanized responses. Models that expand the space for dialogue tend to reduce costs and time of conflict, but effectiveness depends on institutional quality and professional culture. Thus, the comparison does not authorize an automatic transposition: it allows the identification of functional elements that can inspire improvements in Brazil (qualified pre-procedural

mediation, specialized chambers, strengthening of extrajudicial advocacy), preserving access to justice.

8 MEDIATION, HARM PREVENTION AND PROFESSIONAL ETHICS

The integration between mediation, professional ethics and public health policies is a central element for the effectiveness of consensual mechanisms. In dentistry, conflict prevention depends on clear communication, properly documented consent, a complete medical record, and adequate follow-up of complications.

In Brazil, the ethical duties established by the CFO function as normative parameters that guide the evaluation of professional conduct and can support proposals for solutions in mediation. In Argentina, the duty to prevent positive damage in the CCyC reinforces the ethical-preventive dimension of civil liability, bringing it closer to the logic of mediation: preventing, mitigating and avoiding the aggravation of the damage.

9 IMPACTS ON HEALTH PROTECTION AND PUBLIC POLICIES

9.1 MEDIATION AND EFFECTIVE GUARDIANSHIP IN DENTAL CONFLICTS

Effective protection, in addition to judicial redress, involves informational transparency, preservation of the patient's dignity and solutions compatible with the complexity of the case. Mediation allows for agreements that include retreatment, proportional reimbursement, independent technical evaluation, adjustments to deadlines and reparation modalities, which can be more satisfactory than purely monetary decisions.

9.2 CIVIL LIABILITY AND DAMAGE PREVENTION: POSSIBLE CONVERGENCES

In the Argentine legal system, the duty to prevent harm offers an explicit normative basis for preventive solutions. In Brazil, although without an equivalent systematization, principles such as objective good faith, the social function of the contract and the duty of cooperation provide a dogmatic basis for a preventive reading, reinforcing the legitimacy of consensual mechanisms in the field of health.

9.3 EXTRAJUDICIAL ADVOCACY AS AN ELEMENT OF QUALITY

Extrajudicial advocacy qualifies consensual solutions, reduces asymmetries and strengthens the validity and enforceability of the agreement. The comparative analysis suggests that legal assistance plays an especially relevant role in health conflicts, due to the technical vulnerability of the patient and the sensitivity of the rights involved.

10 SYSTEMATIZED TABLE: WHAT SHOULD GO TO MEDIATION AND WHAT SHOULD GO TO THE JUDICIARY (BASED ON THE STJ)

The systematization seeks to offer a decision-making map applicable to dentist-patient conflicts, preserving jurisdictional protection when necessary and indicating mediation or conciliation as an appropriate way when the object admits a proportional solution. The Brazilian normative-jurisprudential axis requires special attention to consumer protection and the prohibition of undue restrictions on access to the Judiciary, in addition to the limits of arbitration in adhesion contracts.

10.1 SORTING MATRIX: NATURE OF THE ORDER AND AVAILABILITY OF THE OBJECT

1) Conflicts typically suitable for mediation/conciliation (high suitability)

- a) Proportional reimbursement (total or partial) for steps not performed or for partial frustration of expectations, when there is room for adjustment of values and obligations.
- b) Retreatment, including technical adjustments, replacement of materials or partial redoing of the procedure, with a previously agreed schedule and conditions.
- c) Continuity of care, including definition of referral, agreed second opinion, transition of the medical record and agreement to terminate the bond.
- d) Ancillary contractual divergences, such as installments, terms, discounts, additional costs, warranty and maintenance terms.
- e) Requests for clarification and relational recomposition, when satisfaction results from an adequate technical explanation, recognition of the malaise and agreement on the measures to be adopted.

2) Conflicts that can be mediation, but with caution (medium adequacy)

- a) Cases with allegations of moral damage at a negotiable level, without the need for complex technical evidence as a precondition.
- b) Cases in which the expert opinion is relevant, but there is sufficient documentary basis for entering into agreements by bands, such as payment conditioned to an independent report.
- c) Conflicts with high reputational risk, in which confidentiality is decisive, but which require effective legal assistance to preserve the balance between the parties.

3) Conflicts that tend to require judicial action (low suitability for mediation as an exclusive route)

- a) Situations that require urgent relief to avoid serious or irreversible damage, such as immediate need for reparative treatment or removal of materials in critical situations.
- b) Allegations with a strong component of personality rights and damage to health, in which the central technical controversy requires structured judicial expertise.
- c) Hypotheses involving allegations of document fraud, coercion, incapacity or serious violation of rights, which make a minimally safe negotiation unfeasible.

In summary, the classification as "low adequacy" does not imply a prohibition of mediation, but indicates that it cannot replace state jurisdiction when the need for effective judicial protection and the production of robust technical evidence are present.

10.2 ARBITRATION IN DENTAL CONTRACTS: LIMITS IMPOSED BY THE CASE LAW OF THE STJ

In dental contracts, often of adhesion and consumption, arbitration faces relevant limits. The axis is the effective voluntariness of the consumer, according to the jurisprudential interpretation:

1. **REsp 1.189.050/SP (2010)** and **REsp 1.628.819/MG (2016)**: the arbitration clause cannot impose arbitration; it depends on the consumer's initiative or his subsequent express agreement, excluding compulsoriness.
2. **REsp 1.778.456/SP (2019)**: reinforces cautions in health and consumption, distinguishing available property litigation from sensitive issues related to personal rights and damage to health.

Practical consequence:

1. In dentistry, mediation and conciliation tend to be more compatible, as they do not restrict access to the Judiciary and allow proportional solutions.
2. In the case of arbitration, it is recommended to limit it to equity aspects and adopt a staggered clause, with clear information and effective consent.

10.3 "STAGGERED CLAUSE" AND AGREEMENT DESIGN: HOW TO AVOID NULLITIES AND INCREASE ADHERENCE

Based on the consumer system and the precedents of the STJ, the clauses and consensual agreements must:

1. clearly inform the procedure (costs, deadlines, location, choice of mediator);
2. preserve the patient's real faculty (without threat of loss of rights);

3. provide for mediation before any attempt at arbitration;
4. expressly exclude topics not suitable for arbitration (damage to health, personality rights);
5. contemplate evidentiary mechanisms in the agreement: independent report, second opinion, full delivery of the medical record and retreatment schedule.

11 CONCLUSION

The extrajudicial resolution of conflicts between dentists and patients is a legally relevant instrument for the qualification of health protection and for the rationalization of the justice system, especially in view of the growth of the judicialization of dental relations. The technical, relational and subjective nature of these disputes highlights the limits of exclusively adjudicatory responses and reinforces the relevance of mechanisms aimed at qualified communication, proportionality and the prevention of aggravation of damage.

In the Brazilian legal system, the institutionalization of mediation and conciliation as a public policy and normative guideline represents a relevant normative advance. However, cultural factors and the possibility of direct access to jurisdiction still hinder the practical consolidation of consensuality in conflicts involving dental practice, especially in the context of consumer relations and professional civil liability.

In Argentine law, in turn, mandatory prior mediation, articulated with the duty to prevent damage enshrined in the Civil and Commercial Code of the Nation and with the centrality of the practice of law, promotes the reorganization of the conflict itinerary and favors a more dialogical initial treatment. Such an institutional design, however, does not authorize the affirmation of the model's automatic empirical superiority, but rather evidences relevant normative alternatives for the initial treatment of health litigation.

In this context, the improvement of the Brazilian system can be promoted through structural measures, such as the strengthening of pre-procedural mediation, the creation of specialized health chambers, the institutional qualification of extrajudicial advocacy, and the integration between professional ethics, adequate clinical documentation, and damage prevention.

Finally, it is necessary to strengthen the ethical, legal and documentary training of dental surgeons since graduation, as an essential preventive axis for the reduction of conflicts and the promotion of legal certainty in clinical practice, in line with the effectiveness of the fundamental right to health.

REFERENCES

- Achaval, A. (1983). Responsabilidad civil del médico. Abeledo-Perrot.
- Arantes, A. C. (2025). Responsabilidade civil do cirurgião-dentista (3ª ed.). Mizuno.
- Argentina. (2010). Ley Nacional de Mediación y Conciliación n.º 26.589. Boletín Oficial de la República Argentina.
- Argentina. (2011). Decreto n.º 1467/2011 (Reglamentación de la Ley Nacional de Mediación y Conciliación n.º 26.589). Boletín Oficial de la República Argentina.
- Argentina. (2014). Ley n.º 26.994 (Código Civil y Comercial de la Nación). Boletín Oficial de la República Argentina.
- Argentina. (2015). Código Civil y Comercial de la Nación. Ministerio de Justicia y Derechos Humanos.
- Basile, A. (1999). Fundamentos de medicina legal, odontología y bioética (3ª ed., pp. 195–198). El Ateneo.
- BDJur – Superior Tribunal de Justiça. (s.d.). <https://bdjur.stj.jus.br/>
- Biblioteca Virtual em Saúde. (s.d.). <https://bvsaude.org/>
- Boletín Oficial de la República Argentina. (s.d.). <https://www.boletinoficial.gob.ar/>
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República.
- Brasil. (1990). Lei n.º 8.078, de 11 de setembro de 1990 (Código de Defesa do Consumidor). Diário Oficial da União.
- Brasil. (1996). Lei n.º 9.307, de 23 de setembro de 1996 (Lei de Arbitragem). Diário Oficial da União.
- Brasil. (2015a). Lei n.º 13.105, de 16 de março de 2015 (Código de Processo Civil). Diário Oficial da União.
- Brasil. (2015b). Lei n.º 13.140, de 26 de junho de 2015 (Lei de Mediação). Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13140.htm
- Cámara Nacional de Apelaciones en lo Civil. (2022). S. R. c/ O. D.
- Cappelletti, M., & Garth, B. (2002). Acesso à justiça. SAFE.
- Carraro, E. A. S. (2010). O uso do termo de consentimento informado como forma de verificação da responsabilidade civil do cirurgião-dentista (Tese de doutorado). Universidade de São Paulo.
- Carmona, C. A. (2022). Arbitragem e processo: Um comentário à Lei n.º 9.307/1996 (4ª ed.). Atlas.

- Cavaliere Filho, S. (2024). Programa de responsabilidade civil (15ª ed.). Atlas.
- Conselho da Justiça Federal. (2014). Manual de mediação e conciliação na Justiça Federal. CJB.
- Conselho Federal de Odontologia. (2012). Resolução CFO-SEC-118, de 11 de maio de 2012 (Código de Ética Odontológica). CFO.
- Conselho Federal de Odontologia. (2013). Resolução CFO n.º 125/2013 (Código de Ética Odontológica). CFO. https://website.cfo.org.br/wp-content/uploads/2018/03/codigo_etica.pdf
- Conselho Nacional de Justiça. (2010). Resolução n.º 125, de 29 de novembro de 2010. <https://atos.cnj.jus.br/atos/detalhar/156>
- Conselho Nacional de Justiça. (2020). Enunciado n.º 13 da ENFAM. CNJ.
- Didier Jr., F., Braga, P. S., & Oliveira, R. A. de. (2015). Curso de direito processual civil (Vol. 1). JusPodivm.
- Fisher, R., Ury, W., & Patton, B. (2005). Como chegar ao sim: A negociação de acordos sem concessões. Imago.
- Gonçalves, C. R. (2024). Responsabilidade civil (20ª ed.). Saraiva.
- Grinover, A. P., Watanabe, K., & Dinamarco, C. R. (Orgs.). (2015). Conciliação e mediação: Teoria e prática. Revista dos Tribunais.
- InfoLEG. (s.d.-a). Ley Nacional de Mediación y Conciliación n.º 26.589. <https://servicios.infoleg.gob.ar/infolegInternet/verNorma.do?id=166999>
- InfoLEG. (s.d.-b). Texto exacto de la Ley Nacional de Mediación y Conciliación n.º 26.589. <https://servicios.infoleg.gob.ar/infolegInternet/anexos/165000-169999/166999/texact.htm>
- InfoLEG. (s.d.-c). Decreto n.º 1467/2011. <https://servicios.infoleg.gob.ar/infolegInternet/verNorma.do?id=187495>
- Kemelmajer de Carlucci, A. (2015). La responsabilidad civil en el Código Civil y Comercial. Rubinzal-Culzoni.
- Leiva, C. F. (2020). The preventive function of civil liability in the Argentine Civil and Commercial Code. Revista Jurídica.
- Lemes, S. M. F. (2021). Arbitragem no mercado e na administração pública. Quartier Latin.
- Lorenzetti, R. L. (2019). Consumidores (2ª ed.). Rubinzal-Culzoni.
- Lorenzetti, R. L. (2020). Responsabilidad civil y prevención del daño. Rubinzal-Culzoni.
- Mainetti, J. A. (2006). Paradigma bioético de la medicina. Quirón: Revista de Medicina y Bioética, 37(1-2), 7-19.

- Marinoni, L. G. (2017). A tutela adequada dos direitos. Revista dos Tribunais.
- Marques, C. L. (2022). Contratos no Código de Defesa do Consumidor (9ª ed.). Revista dos Tribunais.
- Medeiros, U. V., et al. (2014). Responsabilidade civil do cirurgião-dentista. Revista da Associação Paulista de Cirurgiões-Dentistas.
- Moore, C. W. (1996). The mediation process: Practical strategies for resolving conflict (2nd ed.). Jossey-Bass.
- Moore, C. W. (2004). O processo de mediação: Estratégias práticas para a resolução de conflitos. Artmed.
- Moyano, M. P. (2024). El deber de evitar el daño: El art. 1710 inc. b del CCyC. Revista de la Universidad Nacional de Córdoba.
- Normativa Argentina. (s.d.). Decreto n.º 1467/2011 (actualización). <https://www.argentina.gob.ar/normativa/nacional/decreto-1467-2011-187495/actualizacion>
- Salles, C. A. de (Org.). (2020). Negociação, mediação, conciliação e arbitragem. Revista dos Tribunais.
- Sander, F. E. A. (1976). Varieties of dispute processing. In The Pound Conference: Perspectives on justice in the future. West Publishing.
- SciELO. (s.d.). <https://scielo.org/>
- Stoco, R. (2018). Tratado de responsabilidade civil (10ª ed.). Revista dos Tribunais.
- Superior Tribunal de Justiça. (2010). Recurso Especial n.º 1.189.050/SP.
- Superior Tribunal de Justiça. (2016a). Recurso Especial n.º 1.628.819/MG.
- Superior Tribunal de Justiça. (2016b, 9 de março). Instauração da arbitragem depende de concordância expressa do consumidor.
- Superior Tribunal de Justiça. (2019a). Recurso Especial n.º 1.778.456/SP.
- Superior Tribunal de Justiça. (2019b). Recurso Especial n.º 1.861.603/SP.
- Superior Tribunal de Justiça. (s.d.). <https://www.stj.jus.br/>
- Sistema Argentino de Información Jurídica. (s.d.). <https://www.saij.gob.ar/>
- Tartuce, F. (2024a). Mediação nos conflitos civis (7ª ed.). Método.
- Tartuce, F. (2024b). Manual de direito civil. Método.
- Thebaldi, I. M., & Pena, I. S. (2018). A necessidade do consentimento informado na prática da odontologia e sua relação com a responsabilidade civil do cirurgião-dentista. Revista do CROMG, 15(2).

Tribunal de Justiça do Estado do Rio Grande do Sul. (2021). Apelação Cível n.º 70084567890.

Tribunal de Justiça do Estado de São Paulo. (2022). Apelação Cível n.º 1001234-56.2020.8.26.0002.

Watanabe, K. (2018). Acesso à justiça e solução pacífica dos conflitos de interesses. In H. Zaneti Jr. & T. N. X. Cabral (Orgs.), *Justiça multiportas*. JusPodivm.

Weingarten, C. (1997). Responsabilidad por prestaciones odontológicas. In C. Weingarten (Ed.), *Responsabilidad por prestaciones odontológicas* (pp. 93–98). Astrea.

THERAPEUTIC MANAGEMENT OF CHRONIC KIDNEY DISEASE (CKD) IN CATS

MANEJO TERAPÊUTICO DA DOENÇA RENAL CRÔNICA (DRC) EM GATOS

MANEJO TERAPÉUTICO DE LA ENFERMEDAD RENAL CRÓNICA (ERC) EN GATOS



<https://doi.org/10.56238/sevened2026.008-130>

Átila Bonfim Ferreira Cavalcante¹, Beatriz Silva Freitas², Paula Rejane Leal Ferreira Ramos³, Adria Amanda Carvalho Jacinto⁴, Vitoria Cione Camillo⁵, Laura Gonçalves Maciel⁶, Júlia Mayumi Imamura⁷

ABSTRACT

Chronic Kidney Disease (CKD) is a highly prevalent condition in felines, especially among geriatric patients. This disease is characterized by progressive evolution and has a multifactorial nature, often associated with comorbidities such as hyperthyroidism. The present study aimed to review and synthesize the main recent scientific evidence regarding the therapeutic management of CKD in cats, with emphasis on nutritional, pharmacological, and diagnostic innovations. This study consists of a narrative literature review conducted in the PubMed database, including articles published in the last five years concerning innovations in the treatment of feline CKD. The research findings demonstrated that nutritional management remains the cornerstone of CKD treatment, particularly in controlling mineral metabolism, highlighting the importance of the calcium:phosphorus ratio and appropriate magnesium supplementation in preventing ionized hypercalcemia. A significant advancement was also observed in the treatment of non-regenerative anemia associated with CKD, with the use of hypoxia-inducible factor prolyl hydroxylase inhibitors, such as molidustat. The gut–kidney axis has also been a promising focus of studies, with the development of strategies aimed at modulating the intestinal microbiota to reduce uremic toxins. Staging according to the guidelines of the International Renal Interest Society (IRIS), and the use of CKD biomarkers such as creatinine and SDMA, are essential for the diagnosis and monitoring of the disease. Finally, it is concluded that modern management of feline CKD must be individualized, integrated, and based on continuous clinical and laboratory monitoring, aiming to slow disease progression, minimize systemic complications, and improve the patient's quality of life.

Keywords: Chronic Kidney Disease (CKD). Cats. Nutritional Management. Molidustat. Gut–Kidney Axis.

¹ Graduated in Veterinary Medicine. Centro Universitário Católica do Tocantins (UNICATÓLICA).

² Master's student in Veterinary Medicine. Universidade Estadual de Santa Cruz (UESC).

³ Undergraduated student in Veterinary Medicine. Universidade Iguaçu (UNIG).

⁴ Graduated in Veterinary Medicine. Centro Universitário Mais (UNIMAIS).

⁵ Undergraduated student in Veterinary Medicine. Universidade Federal Rural do Rio de Janeiro (UFRRJ).

⁶ Undergraduated student in Veterinary Medicine. Centro Universitário de Rio Preto (UNIRP).

⁷ Undergraduated student in Veterinary Medicine. Universidade Anhembi Morumbi (UAM).

RESUMO

A Doença Renal Crônica (DRC) é uma enfermidade com alta prevalência em felinos, principalmente dentre os pacientes geriátricos. Esta doença se caracteriza pela evolução progressiva, possuindo caráter multifatorial, estando frequentemente associada à comorbidades, como, por exemplo, o hipertireoidismo. O presente trabalho teve como objetivo revisar e sintetizar as principais evidências científicas recentes a respeito do manejo terapêutico da DRC em gatos, com ênfase nas inovações nutricionais, farmacológicas e diagnósticas. O estudo refere-se à uma revisão bibliográfica narrativa, realizada na base de dados PubMed, contemplando artigos publicados nos últimos cinco anos com relação às inovações no tratamento da DRC felina. Os resultados das pesquisas demonstraram que o manejo nutricional permanece como a base do tratamento da DRC, especialmente no controle do metabolismo mineral, destacando-se a importância da relação cálcio:fósforo e da suplementação adequada de magnésio na prevenção da hipercalemia ionizada. Observou-se, também, um avanço significativo no tratamento da anemia arregenerativa associada à DRC, com o uso de inibidores da enzima prolil hidroxilase do fator induzível por hipóxia, como o molidustat. O eixo intestino-rim também foi alvo promissor de estudos, havendo o desenvolvimento de estratégias voltadas à modulação da microbiota intestinal com redução de toxinas urêmicas. O estadiamento, conforme as diretrizes da IRIS (International Renal Interest Society), e a utilização de biomarcadores da DRC, como a creatinina e SDMA, são fundamentais para o diagnóstico e acompanhamento da doença. Por fim, conclui-se que o manejo moderno da DRC felina deve ser individualizado, integrado e baseado em monitoramento clínico e laboratorial contínuo, visando retardar a progressão da doença, minimizar complicações sistêmicas e melhorar a qualidade de vida do paciente.

Palavras-chave: Doença Renal Crônica (DRC). Gatos. Manejo Nutricional. Molidustat. Eixo Intestino-Rim.

RESUMEN

La Enfermedad Renal Crónica (ERC) es una afección de alta prevalencia en felinos, especialmente entre los pacientes geriátricos. Esta enfermedad se caracteriza por una evolución progresiva y posee un carácter multifactorial, estando frecuentemente asociada a comorbilidades como el hipertiroidismo. El presente trabajo tuvo como objetivo revisar y sintetizar las principales evidencias científicas recientes sobre el manejo terapéutico de la ERC en gatos, con énfasis en las innovaciones nutricionales, farmacológicas y diagnósticas. El estudio corresponde a una revisión bibliográfica narrativa realizada en la base de datos PubMed, incluyendo artículos publicados en los últimos cinco años en relación con las innovaciones en el tratamiento de la ERC felina. Los resultados demostraron que el manejo nutricional continúa siendo la base del tratamiento de la ERC, especialmente en el control del metabolismo mineral, destacándose la importancia de la relación calcio:fósforo y de la suplementación adecuada de magnesio en la prevención de la hipercalemia ionizada. También se observó un avance significativo en el tratamiento de la anemia no regenerativa asociada a la ERC, con el uso de inhibidores de la enzima prolil hidroxilasa del factor inducible por hipoxia, como el molidustat. El eje intestino-riñón también ha sido un objetivo prometedor de investigación, con el desarrollo de estrategias orientadas a la modulación de la microbiota intestinal para reducir las toxinas urémicas. El estadiaje conforme a las directrices de la International Renal Interest Society (IRIS) y la utilización de biomarcadores de la ERC, como la creatinina y la SDMA, son fundamentales para el diagnóstico y seguimiento de la enfermedad. Por último, se concluye que el manejo moderno de la ERC felina debe ser individualizado, integrado y basado en un monitoreo clínico y de laboratorio continuo, con el objetivo de retrasar la progresión de la enfermedad, minimizar las complicaciones sistémicas y mejorar la calidad de vida del paciente.

Palabras clave: Enfermedad Renal Crónica (ERC). Gatos. Manejo Nutricional. Molidustat. Eje Intestino-Riñón.

1 INTRODUCTION

Chronic Kidney Disease (CKD) represents one of the most prevalent pathologies in the clinic of geriatric felines, characterized by a progressive and multifactorial course, which requires integrated therapeutic approaches (Geddes & Aguiar, 2022). The clinical management of these patients is complex, as CKD often coexists with other endocrinopathies common in senior cats, such as hyperthyroidism, which can mask loss of kidney function and complicate laboratory monitoring (Yu et al., 2022).

In addition to the progressive reduction of glomerular filtration, the disease triggers a series of systemic complications, including non-regenerative anemia, mineral and bone disorders (CKD-MBD), and the accumulation of uremic toxins derived from intestinal metabolism (Charles et al., 2024; Tang et al., 2024; Summers & Quimby, 2024).

In recent years, the understanding of the gut-kidney axis and the identification of new biomarkers have allowed the development of more refined nutritional and pharmacological strategies. These range from strict control of the calcium:phosphorus ratio in the diet for the management of ionized hypercalcemia to the use of hypoxia-inducible factor prolyl hydroxylase (HIF-PH) inhibitors for the treatment of anemia associated with renal failure (Ehrlich et al., 2024; Charles et al., 2024). Thus, the modern therapeutic approach to CKD in felines seeks not only to slow the progression of kidney injury, but also to mitigate the deleterious effects of comorbidities and optimize the metabolic homeostasis of geriatric patients.

2 METHODOLOGY

The present study is characterized as a narrative literature review, developed with the objective of synthesizing and analyzing the most recent scientific evidence related to the therapeutic management of chronic kidney disease in cats. The search was carried out in the PubMed database, using the descriptors "Chronic Kidney Disease", "Cats" and "Treatment", combined using the Boolean operator AND, according to the terminology of Medical Subject Headings (MeSH).

Articles published in the last five years, available in full in Portuguese or English, that directly addressed innovations in the treatment of feline CKD, were included. Studies without a direct relationship with the central theme, duplicate publications, and reviews with low methodological rigor were excluded. The selection of studies was conducted in two stages: initial screening of titles and abstracts, followed by careful evaluation of full texts to confirm scientific relevance. The information extracted was organized and discussed in a descriptive way.

3 RESULTS AND DISCUSSION

3.1 NUTRITIONAL MANAGEMENT AND MINERAL METABOLISM

Nutritional management remains the central pillar in the treatment of feline CKD, with significant advances in the control of electrolytes and mineral metabolites. Dietary magnesium supplementation has shown benefits in stabilizing fibroblast growth factor 23 (FGF23) and preventing iatrogenic ionized hypercalcemia in cats fed phosphorus-restricted diets, since magnesium acts as a potent inhibitor of vascular and tissue calcification, contributing to the maintenance of mineral homeostasis (Tang et al., 2024). This effect is related to the fact that magnesium acts as a potent inhibitor of vascular and tissue calcification, reducing ectopic calcium deposition and contributing to the stability of mineral metabolism.

The alterations in mineral metabolism observed in felines with chronic kidney disease reflect the interdependence between renal function, nutritional management, and systemic homeostasis. The dysregulation of these mechanisms favors the development of secondary metabolic disorders, such as hypercalcemia, which are often described in patients undergoing phosphorus-restricted diets (Tang et al., 2024; Ehrlich et al., 2024).

Hypercalcemia is commonly associated with CKD, presenting with often nonspecific clinical signs, such as anorexia, weight loss, gastrointestinal and urinary disorders. Factors that lead to hypercalcemia concomitantly with Chronic Kidney Disease include decreased glomerular filtration, increased renal tubular reabsorption, and increased intestinal and bone absorption (Ehrlich et al., 2024).

At the same time, in felines that already have ionized hypercalcemia (which can be defined as a calcium value above the reference range of the laboratory analyzed) — either due to CKD or idiopathic causes — the transition to diets with controlled calcium concentrations (below 200 mg/100 kcal) and a calcium:phosphorus ratio of less than 1.4:1 has been shown to be effective in restoring normocalcemia in 60% of cases. However, in cats that had partial or no response to nutritional treatment, the addition of chia seeds (1 to 2 grams per day) was shown to be effective in decreasing serum calcium concentration (Ehrlich et al., 2024).

Although phosphorus restriction is widely recommended in feline CKD because it slows the progression of the disease, recent evidence indicates that this strategy may increase the risk of ionized hypercalcemia, especially when associated with diets with low magnesium concentration. These findings reinforce the need for dietary individualization and frequent biochemical monitoring (Ehrlich et al., 2024).

The progression of chronic kidney disease in felines has repercussions on multiple organ systems, reflecting the multifactorial character of the disease. Alterations in mineral metabolism, hematological disorders, and changes in the intestinal environment occur interdependently, reinforcing the need for an integrated therapeutic approach in the follow-up of these patients (Charles et al., 2024; Summers; Quimby, 2024).

3.2 HAEMATOLOGICAL COMPLICATIONS AND EMERGING THERAPIES

In the field of hematological complications, CKD anemia, traditionally treated with recombinant erythropoietin, now has new perspectives with the use of molidustat. This HIF-PH inhibitor stimulates the endogenous production of erythropoietin and has demonstrated the ability to significantly increase hematocrit and cell volume in anemic cats after 21 to 28 days of daily oral administration, presenting itself as a promising alternative to conventional erythropoiesis-stimulating agents, especially by reducing the risk of formation of anti-erythropoietin antibodies; however, long-term studies evaluating its safety and impact on the progression of CKD are still needed (Charles et al., 2024).

3.3 GUT-KIDNEY AXIS AND UREMIC TOXINS

The interaction between the gut microbiome and kidney health, called the gut-kidney axis, has emerged as a crucial therapeutic target. Gut dysbiosis in cats with CKD contributes to the accumulation of uremic toxins, such as indoxyl sulfate, which exacerbate systemic inflammation and renal fibrosis (Summers & Quimby, 2024). Strategies using soluble fiber, probiotics, and specific enteric adsorbents have been explored to reduce the burden of these toxins and preserve residual kidney function (Summers & Quimby, 2024).

3.4 STAGING AND DIAGNOSTIC CONSIDERATIONS

It is recommended that domestic felines (cats) be classified according to the CKD staging system of the Society of Renal Interest (IRIS), initially according to serum creatinine, which may be accompanied by symmetrical serum dimethylarginine concentration, as well as systolic blood pressure and urine protein/creatinine ratio (UPC) (Geddes & Aguiar, 2022).

The diagnosis of chronic kidney disease in cats can be carried out by different methods, mainly based on the reduction of the glomerular filtration rate (GFR). Although there is the possibility of direct measurement, this method can be financially burdensome to the responsible person and stressful to the animal. For this reason, GFR biomarkers such as urea, creatinine, and SDMA are widely used in routine clinical practice (Geddes & Aguiar, 2022).

3.5 CKD AND HYPERTHYROIDISM

Management of cats with CKD and concomitant hyperthyroidism requires extreme caution. Hyperthyroidism creates a hemodynamic and metabolic state that increases the glomerular filtration rate and reduces creatinine due to loss of muscle mass, leading to the disregard of the presence of CKD when creatinine alone is used. In this way, SDMA presents itself as a more promising biomarker because it is less dependent on muscle mass, but its behavior in hyperthyroid cats can be masked by increased glomerular filtration rate in the hyperthyroid state (Yu *et al.*, 2022).

Treatment of hyperthyroidism can "unmask" an underlying CKD by reducing the artificially elevated glomerular filtration rate due to the thyrotoxic state. (Geddes & Aguiar, 2022). In addition, the development of iatrogenic hypothyroidism after radioiodine or methimazole therapy is harmful as it further reduces renal blood flow and is associated with shorter survival times in azotemic cats (Yu *et al.*, 2022). In these cases, levothyroxine replacement is recommended to keep kidney function as stable as possible (Geddes & Aguiar, 2022).

4 CONCLUSION

The present study aimed to analyze and discuss the therapeutic management of CKD in felines, addressing nutritional, pharmacological and complementary strategies based on contemporary scientific evidence. Thus, nutritional intervention constitutes the therapeutic foundation in feline CKD. Diets with controlled phosphorus restriction, balance of calcium:phosphorus ratio and absolute calcium concentration, associated with magnesium supplementation, have been shown to be effective in stabilizing mineral metabolism and reducing the risk of hypercalcemia. Dietary personalization should consider the clinical and biochemical status of the patient, through the analysis of the monitoring of the ionogram, serum phosphorus, and magnesium. Thus, the prescription should be adjusted according to physiological responses.

In the context of hematological complications, non-regenerative anemia associated with CKD requires a pharmacospecific approach. Hypoxia-inducible factor prolyl hydroxylase inhibitors, exemplified by molidustat, emerge as a promising alternative to treatment with exogenous erythropoietin, due to the stimulation of endogenous erythropoiesis, reducing the risk of immunogenicity. However, there are limitations to the clinical incorporation of this agent, as studies are needed to evaluate the safety, effects on blood pressure, renal progression, and long-term outcomes.

Modulation of the gut-kidney axis represents a complementary therapeutic strategy with the potential to reduce the burden of uremic toxins, modulating systemic inflammatory processes. Therefore, interventions involving soluble fibers, specific probiotics, and enteric adsorbents may decrease the production and absorption of toxic uremic metabolites, preserving renal function and reducing renal inflammation and fibrosis. However, studies are needed to define strains, doses, and administration protocols that are effective and safe in felines with CKD.

Laboratory follow-up should follow standardized guidelines, such as those of IRIS, integrating serum creatinine count, SDMA, systolic blood pressure, and urine protein/creatinine ratio. The combined use of these biomarkers allows for greater diagnostic accuracy, minimizing interference from secondary diseases, such as hypothyroidism and hyperthyroidism. In addition, there is a guarantee of precise therapeutic adjustment, improving sensitivity for initial changes in the glomerular filtration rate.

The coexistence of CKD and hyperthyroidism imposes diagnostic and therapeutic challenges, given that the thyrotoxic state can mask renal failure by increasing GFR and reducing creatinine due to loss of muscle mass. In contrast, treating hyperthyroidism can "unmask" an underlying CKD. Therefore, SDMA has advantages in that it is less dependent on muscle mass, although its behavior may be influenced by physiological changes in the hyperthyroid state. Therefore, clinical management should include careful observation before and after treatment, avoiding iatrogenic hypothyroidism, and instituting levothyroxine replacement.

In short, it is recommended that the veterinary clinic adopt personalized therapeutic plans for each case with periodic reassessments. In addition, attention is focused on research, which should prioritize studies capable of validating refined nutritional interventions, confirming the safety and efficacy of new pharmacological therapies, and establishing protocols that result in measurable clinical benefits for the long-term treatment of CKD in felines. [CLICK](#)

REFERENCES

- Charles, S., et al. (2024). Use of molidustat, a hypoxia-inducible factor prolyl hydroxylase inhibitor, in chronic kidney disease-associated anemia in cats. *Journal of Veterinary Internal Medicine*, 38(1), 197–204.
- Ehrlich, M. R., et al. (2024). Ionized hypercalcemia can resolve with nutritional modification in cats with idiopathic hypercalcemia or chronic kidney disease. *Journal of Feline Medicine and Surgery*, 26, 1–8.

- Geddes, R., & Aguiar, J. (2022). Balancing hyperthyroidism and concurrent chronic kidney disease. *Journal of Feline Medicine and Surgery*, 24(7), 641–650.
- Summers, S., & Quimby, J. (2024). Insights into the gut-kidney axis and implications for chronic kidney disease management in cats and dogs. *The Veterinary Journal*, 306, 106181.
- Tang, P. K., et al. (2024). Dietary magnesium supplementation in cats with chronic kidney disease: A prospective double-blind randomized controlled trial. *Journal of Veterinary Internal Medicine*, 38(4), 2180–2195.
- Yu, L., Lacorcchia, L., & Johnstone, T. (2022). Hyperthyroid cats and their kidneys: A literature review. *Australian Veterinary Journal*, 100(9), 415–432.

MILKING HYGIENE AND PHYSICOCHEMICAL QUALITY OF MILK

HIGIENE DE ORDENHA E QUALIDADE FÍSICO-QUÍMICA DO LEITE

HIGIENE DE ORDEÑO Y CALIDAD FISICOQUÍMICA DE LA LECHE



<https://doi.org/10.56238/sevened2026.008-131>

Átila Bonfim Ferreira Cavalcante¹, Mariana Nunes Letieri², Adriana Silva dos Santos³, Bianca Souza Alves França⁴, Luan Costa Ferreira⁵, Maria Eduarda Paixão Lima⁶

ABSTRACT

The present study consists of a narrative literature review that analyzes the relationship between milking hygiene and the physicochemical and microbiological quality of bovine milk. This study was based on the analysis of scientific publications indexed in the PubMed database, selecting articles published between 2021 and 2023, using descriptors related to milking hygiene and physicochemical quality. The results demonstrate that the implementation of control systems, such as Hazard Analysis and Critical Control Points (HACCP), positively impacts milk quality, increasing physicochemical compliance to 78% in the evaluated units. In contrast, a direct correlation was observed between sanitary deficiencies (inadequate cleaning of udders and milking equipment) and the increase in coliform load and pathogens such as *Staphylococcus aureus* and *Listeria monocytogenes*, compromising food safety and the processing of dairy products. It is inferred that, to ensure industrial quality and mitigate public health risks, the adoption of good farm management practices, strict equipment hygiene, and control technologies in dairy product processing is essential.

Keywords: Dairy Products. HACCP. Food Microbiology. Public Health. Pathogens.

RESUMO

O presente trabalho consiste em uma revisão bibliográfica narrativa que analisa a relação entre a higiene de ordenha e a qualidade físico-química e microbiológica do leite bovino. Este estudo foi fundamentado na análise de produções científicas indexadas na base de dados PubMed, sendo selecionados artigos publicados entre 2021 e 2023, utilizando descritores relacionados à higiene de ordenha e qualidade físico-química. Os resultados demonstram que a implementação de sistemas de controle, como a Análise de Perigos e Pontos Críticos de Controle (HACCP), impacta positivamente a qualidade do leite, elevando a conformidade físico-química para 78% nas unidades avaliadas. Em contraste, evidenciou-se uma correlação direta entre as deficiências sanitárias (limpeza inadequada dos úberes e

¹ Graduated in Veterinary Medicine. Centro Universitário Católica do Tocantins (UNICATÓLICA).

² Undergraduated student in Veterinary Medicine. Universidade Salgado de Oliveira (UNIVERSO).

³ Graduated in Veterinary Medicine. Universidade Vila Velha (UVV).

⁴ Undergraduated student in Veterinary Medicine. Universidade Federal de Minas Gerais (UFMG).

⁵ Graduated in Food Engineering. Faculdade Católica Paulista (UCA).

⁶ Undergraduated student in Veterinary Medicine. Centro Universitário Santo Agostinho (UNIFSA).

dos equipamentos de ordenha) e a potencialização da carga de coliformes e patógenos como *Staphylococcus aureus* e *Listeria monocytogenes*, comprometendo a segurança alimentar e o processamento de derivados. Infere-se que para garantir a qualidade industrial e atenuar riscos à saúde pública é indispensável a adoção de boas práticas de manejo na fazenda, higiene rigorosa de equipamentos e tecnologias de controle no processamento dos produtos lácteos.

Palavras-chave: Laticínios. HACCP. Microbiologia de Alimentos. Saúde Pública. Patógenos.

RESUMEN

El presente trabajo consiste en una revisión bibliográfica narrativa que analiza la relación entre la higiene de ordeño y la calidad fisicoquímica y microbiológica de la leche bovina. Este estudio se fundamentó en el análisis de producciones científicas indexadas en la base de datos PubMed, seleccionando artículos publicados entre 2021 y 2023, utilizando descriptores relacionados con la higiene de ordeño y la calidad fisicoquímica. Los resultados demuestran que la implementación de sistemas de control, como el Análisis de Peligros y Puntos Críticos de Control (HACCP), impacta positivamente la calidad de la leche, elevando la conformidad fisicoquímica al 78% en las unidades evaluadas. En contraste, se evidenció una correlación directa entre las deficiencias sanitarias (limpieza inadecuada de las ubres y de los equipos de ordeño) y el aumento de la carga de coliformes y patógenos como *Staphylococcus aureus* y *Listeria monocytogenes*, comprometiendo la seguridad alimentaria y el procesamiento de productos lácteos. Se infiere que, para garantizar la calidad industrial y atenuar los riesgos para la salud pública, es indispensable la adopción de buenas prácticas de manejo en la finca, higiene rigurosa de los equipos y tecnologías de control en el procesamiento de productos lácteos.

Palabras clave: Lácteos. HACCP. Microbiología de Alimentos. Salud Pública. Patógenos.

1 INTRODUCTION

The quality and specificity of bovine milk are modulated by the dynamic interaction between climate, animal breeds and environmental microbiology. These attributes are decisive for obtaining dairy products with specific physicochemical, microbiological, and sensory characteristics (Penna et al., 2021). Therefore, the evaluation of this product of animal origin should not be limited to the basic nutritional value (fat and protein contents) but should also cover critical parameters such as acidity, thermal stability, and hygienic indicators of total bacterial count and somatic cells (Brodziak et al., 2021).

However, the valorization of products with raw milk as raw material and the search for organic production systems coexists in a scenario of critical microbiological vulnerabilities (Sakaridis et al., 2022). Despite the market appreciation of raw milk productions and their traditionality, the control of their microbial load represents a constant concern in the sector, requiring special attention due to the risks associated with contamination. In addition, it is noteworthy that the identification of failures in the sanitary control of these systems demonstrates the need to support producers, especially in small-scale productions, through training in good hygiene practices, to align nutritional quality with microbiological safety (Brodziak et al., 2021; Penna et al., 2021).

In addition, it is notorious that the evaluation of dairy products from small producers highlights the absence of standardization and failures in hygienic control during milking, leading to critical oscillations in physicochemical parameters, such as acidity and fat content, favoring contamination by pathogens such as *Salmonella* and coliforms, negatively impacting the safety and sensory quality of the food offered (Januś et al., 2021). It is emphasized that this scenario becomes even more serious in the informal marketing sector, since the absence of heat treatment and sanitary control exposes consumers to high risks. Investigations in non-regulated sales circuits point to the commercialization of non-standard samples in addition to indications of adulteration by the addition of water, which compromises both the nutritional value and the suitability of the milk for processing (Ariri et al., 2023). In this way, the imperative need for strict implementation of good hygiene practices and government inspection to ensure the quality of milk from the moment it is obtained is made explicit (Penna et al., 2021).

2 METHODOLOGY

This work is a bibliographic review of a narrative nature, elaborated with the aim of compiling and examining contemporary scientific evidence about milking hygiene and its correlation with the physicochemical quality of milk. Data mining was conducted on the PubMed platform, using the descriptors "Milking hygiene" and "Physicochemical quality",

consortium by the Boolean operator AND, in strict compliance with the terminology established in the Medical Subject Headings (MeSH). Articles published between 2021 and 2023, available in full access and written in Portuguese or English, which had direct adherence to the central theme, were included in the corpus of this research. The exclusion criteria were studies that were not related to the theme, duplicate manuscripts, reviews without clear methodological grounds, and non-indexed articles. The selection process was structured in two phases: analysis of titles and abstracts, followed by exhaustive reading of the full texts to ratify their relevance. The findings were synthesized and presented in a descriptive manner.

3 RESULTS AND DISCUSSION

The implementation of strict hygiene protocols and monitoring systems such as HACCP has a direct and positive impact on raw milk quality indicators. In collection units that adopted the HACCP system, it was observed that 78% of the samples achieved full physicochemical compliance, demonstrating that the control of critical points reduces the incidence of unwanted changes (Mannani et al., 2023). Physicochemical parameters such as density (ranging between 1.023 and 1.032 g/cm³) and titratable acidity are sensitive indicators not only of hygiene, but also of possible adulteration of milk in the informal circuit (Ariri et al., 2023).

Regarding composition, milk from organic systems tends to present significant variations when compared to the conventional system, especially in the fatty acid profile and protein content, which directly influences the industrial yield for cheese production (Brodziak et al., 2021). Poor hygiene during milking is the main route of entry for pathogens such as *Staphylococcus aureus* and *Listeria monocytogenes*, microorganisms that have a high survival capacity even in artisanal cheeses with prolonged maturation (Sakaridis et al., 2022; Penna et al., 2021).

Studies carried out in direct sales circuits and informal markets reveal that microbiological contamination, characterized by high counts of total and thermotolerant coliforms, is often associated with inadequate cleaning of udders and milking equipment (Ariri et al., 2023; Januś et al., 2021). In addition, the quality of the final product, such as curd cheese or the "tvarog" type, is severely compromised when the original raw material presents physicochemical deviations, resulting in sensory changes and reduced shelf life (Januś et al., 2021). Thus, the integration between hygienic management on the farm and technological control in processing is indispensable for consumer safety (Penna et al., 2021).

In addition, it is known that the way milk is produced, that is, intensively, traditionally/conventionally or organically, has a direct and significant impact on the quality of raw milk, especially with regard to hygienic, physicochemical, nutritional and technological parameters. According to Hanuš et al. (2021), this is mainly due to feed management, the level of production intensification, access to grazing, and animal welfare conditions, resulting in milk with a composition within the parameters of legislation and the suitability of this product for industrial processing. In this sense, one of the main aspects of hygienic milk quality, the Total Bacterial Count (TBC), was slightly higher, but still within the parameters of the legislation, when the organic production system was analyzed. This is due to the restricted use of antimicrobials and greater access of animals to places with organic matter and clay, which makes it difficult to control mastitis and clean the teats (Hanuš et al., 2021).

The results presented by Ariri et al. (2023) reinforce what has been described above, especially with regard to the physicochemical and technological parameters of milk, which should be mainly related to the interaction between feeding, lactation stage, mammary gland health, and environmental conditions. It is highlighted that the classical parameters of analysis in dairy and processing industry, such as pH, density, cryoscopic index and titratable acidity present low variability between different production systems when milk is obtained through hygienic production methods.

The results obtained by Ariri et al. (2023) regarding the microbial load in milk are suggestive of non-compliance with appropriate procedures during milk processing, from collection to transport. In their research, Mannani et al. (2023), when visiting collection centers and cooperatives, observed failures in the areas of team hygiene, cleaning, and disinfection, resulting from the absence of a control plan.

The authors Mannani et al. (2023) found that it would be necessary to invest in supervision, education, and training, as proposed by Ariri et al. (2023), in addition to raising awareness about the importance of milk quality, aiming to reduce contamination levels and strengthen the production chain.

Still on the work of Sakaridis et al. (2022), the milk analyzed had a bacterial count above the established limits. However, after changes on the farm, from the milking process to the storage of milk, combined with the updating of biosafety practices, improvements were observed in the microbiological quality of the product, reinforcing the adoption of good practices throughout the production chain.

The nutrition and energy balance of lactating animals is a fundamental factor for mammary gland health, milk production and composition of total solids and defatted solids, that is, fat, protein and lactose. This can be observed mainly in intensive systems, in which

diets are more energy-dense and this favors higher levels of total protein and casein, positively impacting industrial yield. On the other hand, grazing-based systems, although they may have lower protein content, tend to produce milk with a differentiated lipid profile, with a higher concentration of unsaturated fatty acids.

Hanuš et al. and Ariri et al. also converge their studies regarding the impact of mammary gland health on milk quality, since the elevation of somatic cells is directly related to the physicochemical composition of milk, such as the reduction of lactose content and changes in the protein fraction, especially in casein.

According to Brodziak et al (2021), specific characteristics of the production environment, including the type and quality of feed offered to the animals, exert a significant influence on the quality of raw milk, which directly impacts the quality of dairy products.

According to Brodziak et al (2021), studies show that the quality of milk when its production is organic is more valuable, in its composition in terms of vitamins, fatty acids, whey proteins and minerals, attributing it to the fact that these animals are raised free and with access to pasture, however, the quality of this raw milk is a cause for concern.

According to the findings of Sakaridis et al (2022), it shows that after the advent of pasteurization, the cheese sector started to adopt the heat treatment of milk, this measure aims to eradicate pathogenic microorganisms, to ensure a quality product for the consumer.

4 CONCLUSION

Based on the literature presented, it was found that hygiene in milking is determinant for the quality of milk and its derivatives. This quality is directly related to the microbiological and sanitary safety of food, since the physicochemical indicators of milk also act as sanitary markers. In addition, it is essential to emphasize that animal health, especially of the mammary gland, is a factor that directly impacts the quality and physicochemical composition of milk, so the evaluation of these parameters must be done holistically and globally by the veterinarian.

With the application of the HACCP system, it becomes possible for the problems identified to be corrected in a more assertive way, whether they are due to hygiene failures or adulteration, thus preventing these products from reaching consumers and causing them losses.

It is the responsibility of the veterinarian and the multiprofessional team to correct and prevent failures in the inspection of food intended for human consumption, ensuring the quality and food health of the consuming public. In this context, they work on rural properties

providing guidance on the standardization of good milking practices, training and recycling of labor, as well as continuous monitoring to identify and correct failures.

Thus, the implementation of good milking practices represents not only a technical criterion, but also an ethical commitment to food safety and the sustainability of the milk production chain.

REFERENCES

- Ariri, N., et al. (2023). Evaluation of the physicochemical and hygienic quality of cow's milk and its derivatives in El Jadida city, Morocco. *Roczniki Państwowego Zakładu Higieny*, 74(1), 19–29.
- Brodziak, A., et al. (2021). Organic versus conventional raw cow milk as material for processing. *Animals*, 11(10), Article 2760. <https://doi.org/10.3390/ani11102760>
- Januś, E., et al. (2021). Microbiological, sensory, and physicochemical quality of curd cheeses originating from direct sales. *Veterinary World*, 14(11), 3038–3047. <https://doi.org/10.14202/vetworld.2021.3038-3047>
- Mannani, N., et al. (2023). Microbiological and physicochemical quality of raw milk of Beni Mellal-Khenifra. *Roczniki Państwowego Zakładu Higieny*, 74(3), 265–274.
- Penna, A. L. B., et al. (2021). Artisanal Brazilian cheeses—History, marketing, technological and microbiological aspects. *Foods*, 10(7), Article 1562. <https://doi.org/10.3390/foods10071562>
- Sakaridis, I., et al. (2022). Hygiene and safety of hard cheese made from raw cows' milk. *Veterinary Sciences*, 9(10), Article 569. <https://doi.org/10.3390/vetsci9100569>

ARTIFICIAL INSEMINATION PROTOCOLS IN CATTLE: TECHNIQUES TO OPTIMIZE CONCEPTION RATES

PROTOCOLOS DE INSEMINAÇÃO ARTIFICIAL EM BOVINOS: TÉCNICAS PARA OTIMIZAÇÃO DAS TAXAS DE CONCEPÇÃO

PROTOCOLOS DE INSEMINACIÓN ARTIFICIAL EN BOVINOS: TÉCNICAS PARA LA OPTIMIZACIÓN DE LAS TASAS DE CONCEPCIÓN



<https://doi.org/10.56238/sevened2026.008-132>

Leandro Giroux Gomes¹, Átila Bonfim Ferreira Cavalcante², Ana Edvirgens Vasconcelos de Souza³, Jessica Saldanha Martins⁴, Henrique Leite França Comes⁵, Otávio Silveira Rizzi⁶

ABSTRACT

Artificial insemination (AI), and especially fixed-time artificial insemination (FTAI), have become established as central biotechnologies to enhance reproductive efficiency and accelerate genetic gain in cattle production systems by reducing dependence on estrus detection. Despite their widespread adoption, reproductive performance achieved under field conditions remains dependent on the interaction between the hormonal protocol, the physiological and metabolic status of the females, and the operational quality of the service. This narrative review synthesizes recent evidence (2021–2025) on estrous cycle synchronization strategies based on progesterone (P4), estrogens, and luteolysis with prostaglandin F2 α (PGF2 α), highlighting the importance of maintaining adequate P4 concentrations during dominant follicle development for oocyte competence and subsequent luteal functionality. Additionally, the use of equine chorionic gonadotropin (eCG) as a supportive tool in cows with low body condition and higher probability of anestrus is discussed, as well as the impact of inseminator training and semen handling (storage, thawing, and intrauterine deposition) on conception rates. Finally, emerging perspectives related to omics sciences are addressed, with emphasis on circulating microRNAs as potential biomarkers for predicting pregnancy success and enabling early diagnosis, with implications for reducing the interval between services and optimizing system profitability. It is concluded that maximizing conception rates in AI/FTAI programs depends on an integrated approach combining protocol design, nutritional management, and technical excellence, in addition to the critical and gradual incorporation of higher-resolution diagnostic tools.

Keywords: Artificial Insemination. FTAI. Estrus Synchronization. Progesterone. PGF2 α . eCG. Biomarkers.

¹ Undergraduated student in Veterinary Medicine. Universidade Federal da Bahia (UFBA).

² Graduated in Veterinary Medicine. Centro Universitário Católica do Tocantins (UNICATÓLICA).

³ Undergraduate student in Animal Science. Universidade Estadual Vale do Acaraú (UVA).

⁴ Undergraduated student in Veterinary Medicine. Universidade Norte do Paraná (UNOPAR).

⁵ Graduated in Veterinary Medicine. Universidade Federal de Sergipe (UFS).

⁶ Master's degree in Genetics and Biochemistry. Universidade Federal de Uberlândia (UFU).

RESUMO

A inseminação artificial (IA) e, sobretudo, a inseminação artificial em tempo fixo (IATF) consolidaram-se como biotecnologias centrais para elevar a eficiência reprodutiva e acelerar o ganho genético em sistemas de produção bovina, ao reduzir a dependência da detecção de estro. Apesar da ampla adoção, o desempenho reprodutivo obtido em campo permanece condicionado à interação entre o protocolo hormonal, o estado fisiológico/metabólico das fêmeas e a qualidade operacional do serviço. Esta revisão narrativa sintetiza evidências recentes (2021–2025) sobre estratégias de sincronização do ciclo estral baseadas em progesterona (P4), estrógenos e luteólise com prostaglandina F2 α (PGF2 α), destacando a relevância da manutenção de concentrações adequadas de P4 durante o desenvolvimento do folículo dominante para a competência oocitária e a subsequente funcionalidade luteal. Discute-se, adicionalmente, a utilização da gonadotrofina coriônica equina (eCG) como ferramenta de suporte em vacas com baixa condição corporal e maior probabilidade de anestro, bem como o impacto da capacitação do inseminador e do manejo do sêmen (armazenamento, descongelação e deposição intrauterina) sobre as taxas de concepção. Por fim, são abordadas perspectivas emergentes associadas às ciências ômicas, com ênfase em microRNAs circulantes como potenciais biomarcadores para predição do sucesso gestacional e diagnóstico precoce, com implicações para a redução do intervalo entre serviços e otimização da rentabilidade do sistema. Conclui-se que a maximização das taxas de concepção em programas de IA/IATF depende de abordagem integrada, combinando desenho protocolar, manejo nutricional e excelência técnica, além de incorporação crítica e gradual de ferramentas diagnósticas de maior resolução.

Palavras-chave: Inseminação Artificial. IATF. Sincronização do Estro. Progesterona. PGF2 α . Ecg. Biomarcadores.

RESUMEN

La inseminación artificial (IA) y, especialmente, la inseminación artificial a tiempo fijo (IATF) se han consolidado como biotecnologías centrales para aumentar la eficiencia reproductiva y acelerar el progreso genético en los sistemas de producción bovina, al reducir la dependencia de la detección del estro. A pesar de su amplia adopción, el desempeño reproductivo obtenido en campo sigue condicionado por la interacción entre el protocolo hormonal, el estado fisiológico y metabólico de las hembras y la calidad operativa del servicio. Esta revisión narrativa sintetiza evidencias recientes (2021–2025) sobre estrategias de sincronización del ciclo estral basadas en progesterona (P4), estrógenos y luteólisis con prostaglandina F2 α (PGF2 α), destacando la relevancia de mantener concentraciones adecuadas de P4 durante el desarrollo del folículo dominante para la competencia ovocitaria y la posterior funcionalidad luteal. Asimismo, se discute la utilización de la gonadotropina coriónica equina (eCG) como herramienta de apoyo en vacas con baja condición corporal y mayor probabilidad de anestro, así como el impacto de la capacitación del inseminador y del manejo del semen (almacenamiento, descongelación y deposición intrauterina) sobre las tasas de concepción. Finalmente, se abordan perspectivas emergentes asociadas a las ciencias ómicas, con énfasis en microARN circulantes como potenciales biomarcadores para la predicción del éxito gestacional y el diagnóstico precoz, con implicaciones para la reducción del intervalo entre servicios y la optimización de la rentabilidad del sistema. Se concluye que la maximización de las tasas de concepción en programas de IA/IATF depende de un enfoque integrado que combine el diseño protocolar, el manejo nutricional y la excelencia técnica, además de la incorporación crítica y gradual de herramientas diagnósticas de mayor resolución.

Palabras clave: Inseminación Artificial. IATF. Sincronización del Estro. Progesterona. PGF2 α . eCG. Biomarcadores.

1 INTRODUCTION

Productivity in modern livestock farming is strongly linked to the reproductive efficiency of the herd, with Artificial Insemination (AI) and, more specifically, Fixed Time Artificial Insemination (TAI), being the most impactful biotechnological tools for genetic and operational progress (Sales et al., 2024). In the last 40 years, the evolution of these techniques has made it possible to overcome one of the biggest obstacles to bovine reproduction: the need for continuous observation of estrus, which often has low detection rates and efficiency in the field (Sartori et al., 2023; Sales et al., 2024).

However, the present presents new challenges. Increased milk production and metabolic changes in high-performance cows have been associated with a reduction in fertility, requiring that the control of the estrous cycle, through the manipulation of follicular development and ovulation, be increasingly precise (Sartori et al., 2023; Ayantoye et al., 2025). The success of these technologies does not depend only on robust hormonal protocols, but on a multifactorial triad that involves nutritional management, semen quality, technical competence, and inseminator training, a variable that is often underestimated, but which determines the correct deposition of semen in the reproductive tract (Dalton et al., 2021; Mathewos et al., 2023).

At the same time, the field of animal reproduction is moving towards a new frontier with the integration of omics technologies. The identification of specific biomarkers, such as serum microRNAs, emerges as a promising tool to predict the success of conception and diagnose pregnancy early, reducing the interval between inseminations and optimizing the profitability of the system (Ayantoye et al., 2025; Tzelos et al., 2023).

In view of this scenario of technical evolution and persistence of production problems, the present narrative review aims to analyze the current synchronization protocols and hormonal manipulation strategies for fertility optimization. In addition, it seeks to discuss critical management factors and explore how new biotechnological tools can transform reproductive prognosis in cattle, offering an integrated vision for maximizing conception rates.

The association of Fixed Time Artificial Insemination (TAI) combined with methods that allow the identification of the estrus period (heat), can enhance reproductive performance, increase productivity and consequently, increasing profits for dairy cow producers, in addition to maximizing reproductive programs, (TAI) also allows contributing to advances in genetic improvement and herd management, being factors that impact profitability and sustainability in dairy production (Ayantoye, et al., 2025).

2 METHODOLOGY

The present investigation is a narrative literature review, structured with the purpose of synthesizing and critically analyzing the main scientific evidence related to the optimization strategies of artificial insemination in cattle. The search for theoretical subsidies was carried out in the PubMed database, using the MeSH descriptors "Artificial Insemination" and "Cattle", articulated by the Boolean operator AND, respecting the terminology of the Medical Subject Headings (MeSH) system. Additionally, filters for period (2021–2025), language (Portuguese or English), and full-text availability were applied, when available on the platform.

Studies published in the period between 2021 and 2025, available in full text and written in Portuguese or English, which dealt directly with synchronization and reproductive efficiency protocols, were selected. Brief communications, duplicate articles, studies without robust methodological foundation, or studies that were outside the central thematic scope were excluded. The selection process involved the preliminary analysis of titles and abstracts, followed by the full analytical reading of the manuscripts to ensure the consistency of the data presented. As this is a narrative review, the selection of studies was based on convenience and thematic relevance, with no prior registration protocol (e.g., PROSPERO) or application of formal instruments for assessing risk of bias. The synthesis of information was conducted in a descriptive and integrative manner, prioritizing convergent findings on: (i) hormonal synchronization protocols (P4, estradiol, PGF2 α and eCG); (ii) management factors (BCS, nutrition and animal category); (iii) operational variables related to semen and insemination technique; and (iv) emerging perspectives with biomarkers (microRNAs).

3 RESULTS AND DISCUSSION

The search for the optimization of conception rates in cattle is based on the strict control of follicular dynamics and the synchronization of endocrine events that determine the emergence of follicular wave, luteolysis and ovulation, pillars that support the efficiency of Fixed Time Artificial Insemination (TAI) programs. Current protocols predominantly use the association between intravaginal progesterone (P4) devices and estrogens (e.g., estradiol benzoate) to synchronize the emergence of a new wave of follicular growth and reduce follicular stage variability at the time of insemination (Sales et al., 2024).

A critical point identified in the literature is that the success of this process depends not only on the presence of progesterone, but also on its circulating concentration during the growth of the dominant follicle. Adequate levels of P4 during follicle development are of great importance to avoid frequent pulses of luteinizing hormone (LH), which could lead to early

oocyte maturation and compromise of its viability (Sartori et al., 2023). Thus, the maintenance of an "adequate progesteronic environment" is interpreted as a determining component for the performance of the protocol, especially in categories with greater physiological variability.

According to the findings of (Mathewos et al., 2023) with the acquisition of semen, contributing to Artificial Insemination (AI), enhances the use of reproductive males, this technology favors the proliferation of superior genetics, as well as accelerates the reproductive process efficiently, (AI) is consolidated as it is the main reproductive biotechnique in developing countries, In dairy farming, it is a strategic management tool, favoring and enabling access to breeding males of high genetic quality.

3.1 EFFICIENCY OF LUTEOLYSIS AND PRE-OVULATORY PROGESTERONE DROP

Complementing this control, the effectiveness of luteolysis, which is the regression of the corpus luteum, emerges as one of the main factors to ensure fertility. Recent strategies indicate that the application of a second dose of prostaglandin F2 α (PGF2 α) can significantly increase conception rates, especially in cows that have more resistant corpora luteum. This practice allows progesterone levels to drop dramatically before insemination, allowing ovulation to occur in a perfectly synchronized manner after the removal of the devices (Sartori et al., 2023; Sales et al., 2024).

From an applied point of view, luteolytic failure should be interpreted as a frequent cause of well-executed protocols with pregnancy below expectations, since the persistence of P4 in the pre-AI period can reduce the LH peak and compromise ovulatory timing.

3.2 METABOLIC STATUS, CCS, AND GONADOTROPHIC SUPPORT WITH ECG

However, the biological response to hormones is directly influenced by the metabolic state of the animal. In scenarios of nutritional restriction, the body condition score (BCS) becomes a limiting factor, often keeping the animals in deep anestrus. To reduce this problem, the use of equine chorionic gonadotropin (eCG) has been shown to be a very efficient optimization technique, as it provides the necessary support for the final growth of the dominant follicle and for the formation of a functional corpus luteum in cows with low energy reserve and lower ovarian responsiveness (Mathewos et al., 2023).

Dominant follicle growth is elevated by eCG due to its affinity for gonadotropin receptors (LH and FSH) present in follicular granulosa cells (Murphy and Martinuk, 1991). Physiologically, LH binds to granulosa cell receptors, causing a cascade of reactions that synthesize catalytic enzymes that promote steroid production and, consequently, stimulate the final growth of the dominant follicle (Carroll et al., 1992). Thus, eCG would act as a

gonadotrophic support, similar to LH, stimulating the growth of the dominant follicle, especially in primiparous females and in anestrus with low body condition score (BCS) (Sales et al., 2024).

It has already been shown that eCG, added to the hormonal protocol at the time of PGF application, helps to increase: follicle size, estrus manifestation, ovulation rate and fertility in beef cattle (Baruselli et al., 2004; Sales et al., 2016). However, it is essential to highlight that the positive effect of the use of eCG on FTAI when used in lactating *Bos taurus* cows is minimal or non-existent, probably because lactating cows have a higher frequency of LH pulses, which provides sufficient stimulus for follicular development (Vasconcelos et al., 2003; Ferreira et al., 2015).

Thus, it can be said that eCG should be understood as an excellent strategic tool for "rescue" in critical categories (e.g., low BCS, recent postpartum, primiparous women challenged), especially in *Bos Indicus* beef cows, rather than a universal addition to all protocols.

3.3 SEMEN QUALITY AND TECHNICAL EXECUTION: IMPACT OF THE INSEMINATOR

In addition to pharmacological rigor and nutritional management, precision in technical execution is a differential in the results obtained. The technical training of the inseminator, involving everything from the correct thawing of the semen to its exact deposition in the body of the uterus, is a variable that can cause considerable variations in pregnancy rates (Dalton et al., 2021). Operational aspects such as time between thawing and insemination, keeping the straw at the appropriate temperature, applicator hygiene, and efficient transposition of the cervix are critical points, as failures in this step can nullify the benefits of a well-planned hormonal protocol (Dalton et al., 2021; Mathewos et al., 2023). Therefore, the standardization of the procedure (checklists, periodic recycling, and technical supervision) constitutes a cost-effective intervention to increase reproductive efficiency in the field.

To achieve success in reproduction, the health and physiology of the cow, the time for insemination and the quality of the semen are conditioned (Ayantoye et al., 2025).

3.4 BIOMARKERS AND PRECISION REPRODUCTION: MICRORNAS AS EMERGING TOOLS

Finally, the transition to a phase of precision reproduction is being driven by the sciences. The discovery of molecular biomarkers, such as serum microRNAs, represents a significant advance in pregnancy monitoring. The increase in miR-26a levels around the eighth day after insemination has been shown to be directly correlated with pregnancy

maintenance (Tzelos et al., 2023). The integration of these early diagnosis tools with traditional protocols allows for early identification of failures in maternal signaling, enabling rapid and individualized interventions and reducing the interval between services in non-pregnant females (Ayantoye et al., 2025). However, the broad applicability of these markers still depends on analytical standardization, validation in different herds/breeds and cost-benefit evaluation under commercial conditions, so that their use goes beyond the experimental environment.

3.5 INTEGRATIVE SYNTHESIS

In general, the studies analyzed indicate that the result of FTAI does not depend only on the hormonal protocol, but on the combination of several factors. Among the main ones are: (i) the proper functioning of the endocrine protocol, with adequate levels of progesterone and efficient luteolysis; (ii) the metabolic status and category of the animal, especially the body condition score and the presence or absence of cyclicity; and (iii) the correct execution of the insemination, including semen management and deposition in the appropriate place. Thus, improving conception rates requires joint attention to these points, as hormonal adjustments may have little effect if the overall management and technique applied in the field are not satisfactory.

4 CONCLUSION

When analyzing the current panorama of bovine reproduction, it is clear that the optimization of conception rates does not depend on a single solution, but rather on fine-tuning between the animal's biology and the precision of human interventions. The advancement of FTAI protocols has brought essential predictability to the sector, however, the review of the data shows that we still face fundamental problems. Hormonal control, although increasingly sophisticated with the strategic use of PGF2 α and eCG, often comes up against issues such as animal nutrition and the technical preparation of those who perform the insemination at the end of the process.

The integration of omics sciences and the use of biomarkers such as miR-26a open a valuable door to what we can call precision reproduction. This technology should not be seen only as a futuristic concept, but as a practical tool that will soon allow the producer to identify gestational failures in record time, drastically reducing the waste of time and resources with empty animals.

In short, the path to maximizing reproductive indices requires us to look at the cow in a holistic way. It is not enough to apply the most modern protocol if the animal does not have

metabolic support or if the semen is not deposited with the necessary technical rigor. The future of efficient livestock farming must be built by mastering the basic physiology of animals, ensuring excellence in management in the corral and intelligently adopting new biotechnological frontiers to transform early diagnosis into real profitability.

REFERENCES

- Ayantoye, J. O., et al. (2025). Advances in timed artificial insemination: Integrating omics technologies for enhanced reproductive efficiency in dairy cattle. *Animals*, 15(816), 1–22.
- Baruselli, P. S., et al. (2004). The use of hormonal treatments to improve reproductive performance of anestrus beef cattle in tropical climates. *Animal Reproduction Science*, 82–83, 479–486.
- Carroll, D. J., et al. (1992). Progesterone production by cultured luteal cells in the presence of bovine low- and high-density lipoproteins purified by heparin affinity chromatography. *Journal of Animal Science*, 70(8), 2516–2526. <https://doi.org/10.2527/1992.7082516x>
- Dalton, J. C., et al. (2021). Artificial insemination of cattle: Description and assessment of a training program for veterinary students. *Journal of Dairy Science*, 104, 6295–6303.
- Ferreira, R. M., et al. (2015). Inducing ovulation with oestradiol cypionate allows flexibility in the timing of insemination and removes the need for gonadotrophin-releasing hormone in timed AI protocols for dairy cows. *Reproduction, Fertility and Development*, 29, 468–475.
- Mathewos, M., et al. (2023). Assessment of constraints of artificial insemination service in smallholder dairy cattle keepers in Kacha Bira District of Southern Ethiopia. *Veterinary Medicine International*, 2023, 1–8.
- Murphy, B. D., & Martinuk, S. D. (1991). Equine chorionic gonadotropin. *Endocrine Reviews*, 12, 27–44. <https://doi.org/10.1210/edrv-12-1-27>
- Sales, J. N. S., et al. (2016). Effects of eCG are more pronounced in primiparous than multiparous *Bos indicus* cows submitted to a timed artificial insemination protocol. *Theriogenology*, 86, 2290–2295.
- Sales, J. N. S., et al. (2024). Evolution over the last 40 years of the assisted reproduction technologies in cattle - the Brazilian perspective I - timed artificial insemination. *Animal Reproduction*, 21(3), 1–13.
- Sartori, R., et al. (2023). Manipulation of follicle development to improve fertility of cattle in timed-artificial insemination programs. *Animal*, 17, 1–12.
- Tzelos, T., et al. (2023). Association between blood miR-26a levels following artificial insemination, and pregnancy outcome in dairy cattle. *PLoS ONE*, 18(8), 1–14.
- Vasconcelos, J. L. M., et al. (2003). Acute reduction in serum progesterone concentrations after feed intake in dairy cows. *Theriogenology*, 60, 795–807.

RESOLUTION OF CONFLICTS RELATED TO DEJUDICIALIZATION

RESOLUÇÃO DE CONFLITOS RELACIONADOS COM A DESJUDICIALIZAÇÃO

RESOLUCION DE CONFLICTOS RELACIONADOS COM LA DESJUDICIALIZACION



<https://doi.org/10.56238/sevened2026.008-133>

Carla Maria Caldas Figueiredo¹

ABSTRACT

The article analyzes the transition from the traditional justice model to the Multi-Door Justice paradigm, focusing on the modification of civil names in extrajudicial notary and registry offices in Brazil and Argentina; it highlights the relevance of the civil name as a fundamental personality right and the need to rationalize the justice system in light of the Judiciary's overload; dejudicialization is presented as a means of ensuring access to justice, efficiency, and legal certainty through extrajudicial agents, notaries, and registrars endowed with public faith; the study is grounded in the theory of the name as an attribute of personality and in human dignity, citing the perspectives of Immanuel Kant, the absolute value of dignity, and Ronald Dworkin, equality and freedom; the text incorporates concepts of Restorative Justice, defined as a process that directly involves those affected in order to restore social harmony and humanize justice; furthermore, it mentions the expansion of methods such as mediation and conciliation within extrajudicial offices, in accordance with Law 13.140/2015, and the influence of European guidelines in promoting restorative programs.

Keywords: Dejudicialization. Civil Name. Multi-Door Justice.

RESUMO

O artigo analisa a transição do modelo de justiça tradicional para o paradigma da Justiça Multiportas, com foco na alteração do nome civil nas serventias extrajudiciais do Brasil e da Argentina. Destaca a relevância do nome civil como um direito fundamental da personalidade e a necessidade de racionalizar o sistema de justiça diante da sobrecarga do Poder Judiciário. A desjudicialização é apresentada como um meio de garantir acesso à justiça, celeridade e segurança jurídica através de agentes extrajudiciais, notários e registradores dotados de fé pública. O trabalho fundamenta-se na teoria do nome como atributo da personalidade e na dignidade humana, citando as perspectivas de Immanuel Kant, valor absoluto da dignidade e Ronald Dworkin, igualdade e liberdade. O texto integra conceitos de Justiça Restaurativa, definida como um processo que envolve diretamente os afetados para restaurar a harmonia social e humanizar a justiça. Ademais, menciona a expansão de métodos como mediação e conciliação em serventias extrajudiciais, conforme Lei 13.140/2015 e a influência de diretrizes europeias na promoção de programas restaurativos.

Palavras-chave: Desjudicialização. Nome Civil. Justiça Multiportas.

¹ Dr. in Law. Universidade Estácio de Sá (UNESA). E-mail: carlacaldasf@hotmail.com

RESUMEN

El artículo analiza la transición del modelo de justicia tradicional hacia el paradigma de la Justicia Multipuertas, con enfoque en la modificación del nombre civil en las notarías y registros extrajudiciales de Brasil y Argentina; destaca la relevancia del nombre civil como un derecho fundamental de la personalidad y la necesidad de racionalizar el sistema de justicia ante la sobrecarga del Poder Judicial; la desjudicialización se presenta como un medio para garantizar el acceso a la justicia, la celeridad y la seguridad jurídica a través de agentes extrajudiciales, notarios y registradores dotados de fe pública; el trabajo se fundamenta en la teoría del nombre como atributo de la personalidad y en la dignidad humana, citando las perspectivas de Immanuel Kant, valor absoluto de la dignidad, y Ronald Dworkin, igualdad y libertad; el texto integra conceptos de Justicia Restaurativa, definida como un proceso que involucra directamente a los afectados para restaurar la armonía social y humanizar la justicia; además, menciona la expansión de métodos como la mediación y la conciliación en notarías extrajudiciales, conforme a la Ley 13.140/2015, y la influencia de directrices europeas en la promoción de programas restaurativos.

Palabras clave: Desjudicialización. Nombre Civil. Justicia Multipuertas.

1 BACKGROUND

This theme is important for the legal sciences, because the study of the civil name and the dejudicialization are topics of great relevance to Brazilian and Argentine society. In addition to the importance in the daily life of a civil registry office of natural persons, whether the simplest, such as a spelling error, or in the complex request for a change of name and gender in a birth record.

The name according to Rubens Limongi França²:

The name, in general, is an indispensable element to knowledge itself, because it is around it that the mind groups the series of attributes pertinent to the various individuals, which allows its rapid characterization and its relationship with others.

An advance of the recent changes reveals that the dejudicialization movement promotes the expansion of the competence to settle conflicts beyond the Judiciary and its servants, bringing extrajudicial services to the discussion and composition of this scenario.

In the Brazilian legal system, by training extrajudicial services for the application of alternative methods, it undertook the attempt to expand the effectiveness of the guarantee of access to Justice to a dimension beyond legal positivity. And considering that it is a current reality that is part of the Brazilian legal system, the context that involves the development of this innovation and its reflections on society must be evaluated.

In view of this, it brought the possibility for extrajudicial notaries to offer mediation and conciliation services, according to article 42 of Law 13,140/2015¹⁷, which already authorized registrars and notaries as mediators, provided that they were trained in an authorized course and registered with the competent state court.

Notary, or registrar, to whom notarial and registration functions are delegated, with the purpose of ensuring the security, competence, efficiency and publicity of acts, facts and legal administration. Extrajudicial activity outside the Judiciary was born and grew in Brazil. This reality changed only in the twentieth century with the Constitution of the Federative Republic of Brazil of 1988, whose article 236 established the current institutional principles for the delegation of notarial and registry activities.

This activity was regulated and governed by Law 8.935, of November 18, 1994. Recent legislative changes have come to give prestige to the RCPN, placing it, once again, as the protagonist of the necessary movement of dejudicialization in the country, of multidoor justice, in order to relieve the judiciary

² FRANÇA, Rubens Limongi. ON THE CIVIL NAME OF NATURAL PERSONS, p. 22-4

Notarial and registry acts are important, since they allow easy access to citizenship acts for the whole society, with all the attributes related to legal certainty, speed and effectiveness.

Joana Canet Sastre addresses Restorative Justice in her article *ALTERNATIVES TO THE JUDICIALIZATION OF CONFLICTS FROM ROME TO THE PRESENT*³

Restorative Justice is understood as the process that involves people most directly affected by a crime or infraction, in determining the best way to restore social harmony and resolve the conflict, considering the needs and intentions of the victim and the offender. It is a model of justice that seeks to establish a fair and balanced relationship between the parties, to achieve the restoration of social relations broken by the commission of an unlawful act, facilitating the opportunity for the parties to express their emotions and feelings, originated from the offensive fact, as well as an active and direct participation in the process, giving a more human face to criminal justice.

She addresses the so-called restorative practices, which have a long tradition, have been structured more recently as a model of justice, Restorative Justice, which has advantages in its use between the parties to the conflict.

It ratifies for the resolution of conflicts of a criminal nature and allows — in a broader perspective of restoration — to think about the possibility of incorporating restorative practices in the resolution of conflicts not only of this nature, but also in situations of daily life, whether in the family, church, school or others, since culturally there are, in all countries, mechanisms that seek to resolve conflicts in a non-violent way.

With regard to the development of the civil name in Brazilian civil law, he had mentioned Article 18 of the American Convention on Human Rights, in the Treaty of San José, Costa Rica, signed on November 22 in San Jose, Costa Rica. 1969 and entered our legal system through Decree No. 678 of February 6, 1992, which confirmed the first steps in the protection of marriage and its effectiveness, family, name and nationality. The agreement was one of the most comprehensive international documents of the time and was signed by Brazil and Argentina and other countries.

In turn, the dejudicialization in Argentina, the Gender Identity Law of 2012 and the flexibility of the first name demonstrate a faster system for the protection of personality, serving as a paradigm for the improvement of Brazilian institutions.

Weigh the right to the civil name of natural persons and their perspectives of change in extrajudicial services, as well as the impact of dejudicialization on society.

³ Sastre, Joana Canet, *ALTERNATIVAS A LA JUDICIALIZACIÓN DE LOS CONFLICTOS DESDE ROMA HASTA LA ACTUALIDAD*, Revista de Derecho UNED, núm. 14, 2014.

Consider the right of personality, being relativized in the face of dejudicialization, resulting from recent changes, whether or not it will be an act that favors civil society.

2 BRAZILIAN LEGISLATION

Dejudicialization and its reflections with the important innovations brought in the years 2022 and following, pertinent to the changes in the name of the natural person in the Brazilian civil registry, without the need to judicialize. Thus exalting the exercise of citizenship and analyzing its impacts, as well as the reasons that justify the possibility of full transfer of the hypotheses of changing the name of the natural person to extrajudicial services.

The most accepted theory about the right to a name is the theory of the name as a right of personality, defended by renowned scholars, ratifying the name as an attribute of personality.

The civil name of the natural person and its personative designation of the person, an inherent element of the personality and which has the main consequence of individualizing a certain person within the social environment and in the family to which he or she belongs, making him or her unique. Thus, it is observed that it is the first attribute of the person's personality, the one that will distinguish him from the others, soon after his birth.

In this way, the right to the name of the natural person emanates from personality, a fundamental right and aims to protect the person's own identity, the object of study of the research.

The theoretical perspective corresponds to an analysis of the historical evolution of philosophical movements, noting the teachings of Immanuel Kant and how his contribution constituted a sublime milestone for the study of human dignity. It also analyzes the conception of human dignity in the thought of Ronald Dworkin and a correlation of human dignity established in the Civil Registry of Natural Persons.

A philosophical pondering by Immanuel Kant, who sees human dignity as an absolute and unconditional value, and Ronald Dworkin's approach, which relates dignity to the principles of equality and freedom. The importance of the Civil Registry of Natural Persons highlighted as essential for the realization of these rights, especially in the recognition and protection of the identity of individuals and a principled analysis.

The full dejudicialization of the hypotheses of change of civil name is feasible and desirable, and is justified for legal, social and practical reasons, especially because it instrumentalizes fundamental rights more efficiently and contributes to the rationalization of the justice system, relieving the overload of the Judiciary.

The paradigm of access to the Judiciary gives way, therefore, to the paradigm of Multidoor Justice, in which new agents are called upon to offer the jurisdictional party other equally legitimate and adequate mechanisms for the resolution of disputes, in the exercise of voluntary jurisdiction and which are placed alongside the state adjudication.

The judiciary is totally overloaded, in addition to being slow with the demands. Regarding the effectiveness of access to justice, the social function of the Extrajudicial Services, the dejudicialization makes access to justice more adequate, bringing speed and legal certainty to procedures that had an essentially judicial nature, such as inventories, divorces, separations, marital reestablishments, adverse possession, apostilles and the most recent, such as compulsory adjudication and rectifications of names, among others. As a result, it reduced actions pertinent to these matters in the Judiciary and gave prestige to extrajudicial services, demonstrating the appropriate place for the promotion of extrajudicialization and dejudicialization.

It is important to mention that dejudicialization consists of giving people opportunities to choose to resolve their conflicts in other means outside the judicial sphere, as long as it is possible and pertinent. It consists of seeking alternative means of conflict resolution in order to achieve social justice.

In turn, reducing bureaucracy consists of simplifying procedures, without losing legal certainty in legal acts and transactions, as the opposite may generate numerous losses for the user and for society as a whole.

The Notary or Registration Officer is the legal professional, endowed with public faith, to whom the exercise of notarial and registration activities is delegated, with the purpose of ensuring the security, validity, effectiveness and publicity of acts, facts and legal transactions. In Brazil, extrajudicial activity was born and grew on the margins of the Judiciary. This reality only changed in the twentieth century with the Constitution of the Federative Republic of Brazil in 1988, where it established the current institutional principles of delegation of notarial and registry activity in its article 236. This extrajudicial activity was disciplined and regulated in Law 8935/1994.

It should be noted, however, that if the notary public suspects fraud, falsehood, bad faith, defect of will, which may be through error, willful misconduct, coercion or simulation as to the real intention of the request for the change of name, he will refuse the rectification in a reasoned manner.

With a viable civil registry and symbol of the modernization of processes, without jeopardizing their legal certainty and effectiveness, in addition to promoting accessibility to extrajudicial processes. It is important to highlight that this transformation demonstrates the

important role of notaries and registrars, and how much they have been contributing to society, through these new attributions, which were previously exclusive to the Judiciary.

Finally, the hypotheses about fundamental rights and new rights, as emphasis is placed on the new issues presented in the legal scenario involving the most diverse discussions about the name, in a natural way, in peculiar situations, respecting the human dignity of the individual enshrined in the current constitutional order. In addition, the Civil Registry of Natural Persons in Brazil contains conceptual meanings of human rights, insofar as for the exercise of fundamental rights, such as personality and identity, as well as for the full exercise of citizenship, it is essential to be included in the civil registry of birth.

3 ARGENTINE LEGISLATION

Aiming to understand the dynamics of the name as a right of personality and supranational protection, as well as the dejudicialization of the change of the name to be carried out in the civil registry and the importance of the name and its relevance in the practice of registration acts before society in the Argentine model as a paradigm of speed and respect for existential truth.

The name is no longer a label imposed by the State for inspection purposes, but the legal garment of human dignity itself and, it is important to highlight the legal nature and the police of names to the Right of Personality.

Historically, the Argentine legal system, influenced by the classical thought of the nineteenth century and consolidated by Decree-Law 18.248/69, conceived the name primarily as a civil police institution. The State's interest in the unequivocal identification of citizens prevailed over the autonomy of the will. With a traditional view, the name as a public charge, in the strict validity of Law 18.248/69, the name was defined as a right-duty.

The State functioned as a moral and cultural filter and the prohibition of extravagant, ridiculous or foreign names, according to Article 3 of Law 18.248/69, did not aim to protect the individual, but rather to preserve a supposed homogeneous national identity and avoid confusion in the public record.

The nature of duty imposed the principle of almost absolute immutability, since to change a name required very rare just causes, since the name did not belong to the subject, but to the record that the State kept about it.

The paradigmatic turn occurred with the constitutional reform of 1994, which conferred constitutional hierarchy to the American Convention on Human Rights (ACHR) and the Convention on the Rights of the Child (CDN) (Art. 75, item 22 of the Argentine National Constitution).

As of article 18 of the ACHR, the name ceases to be an instrument of control and becomes the support of identity. As Casella and Toia point out, identity is a pre-existing reality that the State only recognizes, not creates. The focus shifts from the public interest to the autonomy of human dignity and, currently, the name is understood as an inalienable, imprescriptible and extra-patrimonial personality right.

This new legal nature allowed Argentina to move towards cutting-edge laws, such as the Gender Identity Law (Law 26.743). In it, the right to a name is the maximum tool of self-determination, where the individual's subjective perception of himself or herself prevails over the biological data or the State's interest in standardization.

It is important to note that article 1 of Decree-Law 18,248 establishes that:

Every natural person has the right and duty to use the name and surname corresponding to him in accordance with the provisions of this law.

The analysis of article 1 of Decree-Law 18,248 reveals a classic tension between individual autonomy and the police power of the State. By establishing that every natural person has the right and duty to use the name, the ordinary legislator created a hermeneutical ambiguity that, for decades, was used to justify the prevalence of the immutability of registration over the real identity of the subject

The predominant interpretation placed the name in the field of duty. From this point of view, the regulatory power of the State became the governing principle, and the freedom of the individual, the exception. This view places social order or legal certainty as absolute values, subjecting human subjectivity to an alphanumeric barcode.

Such a posture directly affronts the principle of freedom of action established in article 19 of the National Constitution, which establishes that no one is obliged to do what the law does not command, nor prevented from doing what it does not prohibit. In the field of the name, this means that the autonomy of the will should be the rule, and state intervention, the justified exception.

Traditional hermeneutics makes a serious mistake by ignoring the constitutional hierarchy of the right to a name. It is based on the fallacious premise that the right to identity exists only to the extent and in the form in which the constituted power, in which the common legislator decides to regulate it. However, the current normative reality is different: the right to a name enjoys a constitutional and conventional hierarchy.

Therefore, for Article 75, item 22 of the Argentine National Constitution and Article 18 of the American Convention on Human Rights (ACHR), the name is recognized as an

essential component of dignity and the State does not create the right to the name, it has the duty to recognize and protect it as an inalienable attribute of personality.

In this vein, Ayelen Casella and Leonarddo TOIA IN THEIR ARTICLE 18. DERECHO AL NOMBRE RATIFIES⁴:

Toda Persona tiene derecho a un nombre propio y a los apellidos de sus padres o al de uno de ellos. La ley reglamentará la forma de asegura este derecho para todos, mediante nombres supuestos si fuere necesario.

This hermeneutic ignores the constitutional hierarchy enjoyed by the right to a name, based on the fallacious premise that it exists to the extent of the will of the constituted power, obviating that, currently, the right is such by express recognition of the constituent power through article 75, item 22, of the Argentine National Constitution. (according to article 18 of the ACHR)

The Name as the Unity of Personality and the Protection of the ACHR, this perspective is strengthened by international human rights instruments. Article 18 of the American Convention on Human Rights (ACHR), as interpreted by the classical doctrine (Casella; Toia, 2012), establishes that the name is not only an instrument of state control, but a human right that protects identity. The existential truth of the individual must prevail over the public interest in the immutability of the record, especially when this immutability becomes an obstacle to the free development of the personality.

The projection in the Argentine legal system, focusing on the tension between individual autonomy and state regulation, as well as the incorporation of international treaties with constitutional hierarchy, changed the perception of the name, moving from a statutory duty to a fundamental human right linked to identity, according to Casella; Toia, 2012.

The transition in Argentina reveals that the name migrated from a category of administrative law, pertinent to control and registration, to a category of human rights, in the doctrinal view. The State ceases to be the owner of the name to become the guarantor of the way in which the individual chooses to be identified before society.

From the Argentine jurisprudential perspective, two relevant cases stand out — Halladjian, Jorge Adolfo (1980) and Brandan, Diego Gonzalo (1994) — which address the rigidity of the Law of Names (Decree-Law No. 18.248/69) through decisions that marked the transition to a model based on Human Rights.

4 **Casella, A., & Toia, L.** (2012). Article 18: Derecho al nombre. In E. M. Alonso Regueira (Org.), *La Convención Americana de Derechos Humanos y su proyección en el derecho argentino* (pp. 307-318). La Ley.

In the case of *Halladjian, Jorge Adolfo* (1980), the Court initially stated that the choice of the name transcends the sphere of mere individual interest, compromising the general interest, since the identification of people is a requirement of the entire social order. It was argued that language is a factor of paramount importance for the spiritual identity of a nation and that the prohibition of foreign first names would not be disproportionate to the purpose of preserving this common good. However, in its reasoning, the Argentine Supreme Court ended up allowing the registration of names of Armenian origin, relaxing the requirement of castellanization.

This decision was based on the premise that the name is part of the right to identity and the preservation of cultural roots, in line with the provisions of Article 18 of the American Convention on Human Rights (ACHR).

In the *Brandan* case, Diego Gonzalo (1994/2001) portrayed the evolution of the right to a name linked to the dignity of the human person. The court recognized that the State cannot impose arbitrary barriers to the free choice of name by parents, unless there is a concrete and justified prejudice to the public interest – which rarely occurs with foreign or unusual names. Such a decision ratifies the consolidation of the autonomy of the will against administrative arbitration; although the original text refers to the 1994 precedent (*Fallos* 318:1371), it served as a foundation for the legal evolution that culminated in the 2000s

Finally, it should be noted that Argentina consolidated itself at the forefront of Contemporary Civil Law by enacting Law No. 26,743/2012, which allowed extrajudicial civil requalification and broke with the pathologizing view of gender identity. By making it possible to change one's name and register one's gender administratively, the Argentine system has elevated the right to identity to the status of a pillar of human dignity, untying it from medical diagnoses or invasive judicial authorizations.

In this context, the civil requalification of transgender minors and the right to gender identity are themes for understanding the role of the State in promoting the dignity of the human person, equality and non-discrimination. Gender self-determination — understood as the right of every individual to identify and be legally recognized, including through the rectification of the first name, according to the gender with which he or she identifies — is based on a theoretical construction that amalgamates the fundamental principles of human rights with the recognition of the diversity and plurality inherent to contemporary societies (Barroso, 2015).

Articulating the principle of dignity with the need for legal effectiveness, it is observed that the judicialization of civil requalification for minors in Brazil imposes an emotional and financial burden that hurts human dignity. In contrast, the Argentine model, consolidated by

the Gender Identity Law (2012), demonstrates that the extrajudicial route for minors — based on progressive autonomy and family support — is the mechanism that best fits the control of conventionality.

If the State already entrusts registrars with public faith for complex acts of patrimonial regularization, it must, out of symmetry and respect for dignity, extend this agility to the regularization of identity. This ensures that the civil registry functions as a mirror of human dignity and not as a formalistic vision based on outdated concepts of public interest. This is a case of dejudicialization, a topic addressed in this article

The Argentine system recognizes that the stability of the name must give way to the dignity of the human person. As demonstrated by the evolution of Argentine jurisprudence, when there are just reasons, such as self-perceived identity, the change of the first name must be facilitated to avoid social segregation and ensure the integration of the individual into the society in which he lives.

In this sense, Argentine legislation allows extrajudicial access for minors with the consent of their legal representatives, focusing primarily on the well-being of young people and their immediate social integration. Such a measure avoids the stigma of the judicial process and breaks with the administrative discretion that historically limited the right to identity under dogmatic pretexts of social order.

In turn, in Brazil, the implementation of Provision No. 73/2018 and currently coupled to 149 of the National Council of Justice (CNJ) marked significant progress by authorizing civil rectification by administrative means. However, by restricting this benefit only to those over 18 years of age, the Brazilian legal system incurs in an inconsistency with the precepts of full protection of fundamental rights.

4 CONCLUSION

The article concludes that this is a topic of profound legal, social and practical relevance in the contemporary scenario. The dejudicialization of the right to the civil name is important for the legal sciences, as it aims to analyze and show in an objective way, the right to the civil name of natural persons and its possibilities of change, as well as to promote an analysis of the legal treatment given to the civil name of the natural person, in relation to its function, legal nature and characteristics, especially the principle of immutability being relativized. The possibility of changing it reflects the autonomy and freedom of the individual to identify himself with society.

Emphasizing legal certainty, together with the dignity of the human person, addressed herein, since it must reflect the present reality, informing the relevant changes that have

occurred since its drafting, in an administrative manner and, in this way, authorizes the registration officer to carry out the necessary annotations, on the birth or marriage certificates, of its service, without the need for judicial intervention, in order to be identified and represented in the correct way before the whole society.

In this regard, the assumption that judicial protection is the only form of access to justice is clarified, considering that the Constitution of Brazil does not state that the only way to achieve justice is through the Judiciary, but that there are several forms, known as multidoor justice, which are carried out through extrajudicial activity. One of the alternatives and the most appropriate.

The paradigm of access to the Judiciary is changed, therefore, to the paradigm of Multidoor Justice, in which new agents are summoned to offer the jurisdictional party other forms of process that are equivalent to legitimate and appropriate for the resolution of disputes, in the exercise of voluntary jurisdiction and that are placed alongside the state adjudication.

Dejudicialization has gained strength, proving to be a viable path for the rationalization of the justice system and from this change, the need arises to deepen the analysis on the feasibility of a full transfer of the hypotheses of name change to the notary offices. Inherent and presented peculiarities that comprise the analysis of the new Provisions of the National Council of Justice, legislative approach to public records and jurisprudential analysis.

Regarding the Argentine Legislation under the sieve of conventionality, the analysis of the Argentine legislation allows us to conclude that the legal system is going through a profound transition between the paradigm of the name as a statutory duty and the name as a fundamental human right.

Decree-Law 18.248/69 was addressed and the rules that limit the choice of foreign names or that impose castellanization (Art. 3) lack reasonableness and proportionality. As Casella and Toia argue, the argument of the preservation of national values or the public interest cannot serve as a shield for state arbitration, since the difficulty of pronouncing or the origin of a first name does not represent a real threat to the social order or to the integration of the individual.

The Central Role of the ACHR and the Gender Identity Law in modern Argentine legislation, driven by Article 18 of the American Convention on Human Rights (ACHR) and embodied in Law No. 26,743/2012, redefines the role of the State. This ceases to be a moral and cultural filter to become the guarantor of self-perceived identity. The possibility of rectification of name and gender by administrative (extrajudicial) means removes the name

from the sphere of the civil police and places it under the domain of the autonomy of the will and the dignity of the human person.

It addressed the name as an element of dynamic identity and it is concluded that the right to a name in Argentina, in the light of the block of constitutionality (Art. 75, item 22 of the CN), must be interpreted broadly. The stability of public records must give way whenever it collides with the existential truth of the subject. The Argentine example of allowing extrajudicial means, including for consenting minors, represents the maximum realization of conventionality control, ensuring that the name is an instrument of inclusion and not an immutable label imposed by the State.

The analysis of Argentine jurisprudence, personified by the *Halladjian* and *Brandan* cases, reveals the path of transition from a tutelary and nationalist State to a model of State that guarantees personality rights.

Similarly, Argentine jurisprudence has evolved to recognize that the name is not a property of the State, but an inalienable right of the subject. The stability of the civil registry and cultural homogeneity gave way to dynamic identity and self-determination. These precedents were the necessary foundation for Argentina to be able to subsequently enact avant-garde laws (such as Law 26.743/2012), removing the name from the shackles of the judicial process and returning it to the sphere of dignity and individual freedom, in full alignment with the bloc of conventionality.

An approach to the legal and social impacts, as well as the presentation of international models such as that of Argentina, enrich the study. This approach allows us to understand the peculiarities of the Brazilian legal system and the best practices adopted in other countries, strengthening the hypothesis that the integral performance of extrajudicial services is not only possible, but desirable.

The article fulfills well the objective of highlighting civil requalification, ratifying that dejudicialization for minors (as occurs in Argentina) is the next logical step for Brazil to overcome the current normative incoherence.

The consolidation of new conflict resolution techniques in the extrajudicial sphere represents a fundamental contribution to the modernization of the justice system, materializing the paradigm of Multidoor Justice by offering legitimate and effective alternatives to traditional state adjudication. This contribution is manifested in the expansion of the competence of registrars and notaries who, duly trained as mediators and conciliators, promote the rationalization and speed of the system by relieving the Judiciary of voluntary jurisdiction demands. Such techniques allow for a reduction in bureaucracy that simplifies

complex procedures — such as name and gender rectifications — without giving up legal certainty, guaranteed by the public faith of these professionals.

In Europe, the Council of Europe has promoted the implementation of restorative programs in its member states, highlighting their importance, especially in juvenile justice and in situations of civil conflict. In Spain, several initiatives have been developed in this direction, integrating restorative justice in the family, school and youth spheres.

European civil procedural law in recent years has shown several formats of dejudicialization. Many countries have modified their legislation and adopted different models that vary according to whether they are more or less centralized, according to the regulations and qualifications required of those responsible for carrying out the work, and according to the type of agencies and agents that will perform this task.

The dejudicialization supported by these new methodologies ensures that the civil registry acts as a faithful mirror of human dignity and self-perceived identity, avoiding the stigma of invasive judicial processes and ensuring the full realization of fundamental rights and citizenship.

Finally, the research is justified by its contribution to the realization of fundamental rights through dejudicialization, demonstrating how notary offices can act as essential instruments for the realization of the dignity of the human person and for the modernization of the justice system in Brazil and focuses on the new issues presented in the legal scenario involving the most diverse discussions about the name, in a natural way, in peculiar situations, respecting the human dignity of the individual enshrined in the current Brazilian constitutional order.

BIBLIOGRAPHY

The bibliographic sources will be consulted publications from some of the main electronic databases, scientific articles, books, specialized journals, Brazilian national legislation, the code of norms, especially from the State of Rio de Janeiro, Provisions and Resolutions of the National Council of Justice and judgments of the courts.

REFERENCES

- Argentina. (1969). Decreto-Ley n.º 18.248/69: Ley del nombre.
<https://www.argentina.gob.ar/normativa/nacional/ley-18248-120325/actualizacion>
- Argentina. (1995). Ley n.º 24.430/1995: Constitución de la Nación Argentina.
<https://www.argentina.gob.ar/normativa/nacional/ley-24430-804/texto>

- Argentina. (2012). Ley n.º 26.743/2012: Ley de identidad de género. https://www.argentina.gob.ar/sites/default/files/ley-26.743-identidad-de-genero_0.pdf
- Associação dos Registradores de Pessoas Naturais do Rio de Janeiro. (2022). Enunciados ARPEN-RJ (Lei 14.382). <https://www.arpensp.org.br/enunciados>
- Associação dos Registradores de Pessoas Naturais de São Paulo. (2025). Enunciados ARPEN-SP. <https://www.arpensp.org.br/enunciados>
- Barroso, L. R. (2015). Curso de direito constitucional contemporâneo: Os conceitos fundamentais e a construção do novo modelo. Saraiva.
- Brandelli, L. (2017). Do nome civil da pessoa natural. Saraiva.
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (1992). Decreto n.º 678, de 6 de novembro de 1992. Promulga a Convenção Americana sobre Direitos Humanos (Pacto de San José da Costa Rica). Presidência da República. http://www.planalto.gov.br/ccivil_03/decreto/d0678.htm
- Brasil. (2016). Decreto n.º 8.727, de 28 de abril de 2016. Dispõe sobre o uso do nome social e o reconhecimento da identidade de gênero de pessoas travestis e transexuais no âmbito da administração pública federal direta, autárquica e fundacional. https://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2016/Decreto/D8727
- Brasil. (2023). Conselho Nacional de Justiça. Provimento n.º 149, de 30 de agosto de 2023. Institui o Código Nacional de Normas da Corregedoria Nacional de Justiça – Foro Extrajudicial (CNN/CN/CNJ-Extra). <https://atos.cnj.jus.br/files/compilado1806222023111665565a1e0fc83.pdf>
- Camargo Neto, M. C., & Oliveira, M. S. (s.d.). Registros civis das pessoas naturais.
- Casella, A., & Toia, L. (2012). Artículo 18: Derecho al nombre. In E. M. Alonso Regueira (Org.), La Convención Americana de Derechos Humanos y su proyección en el derecho argentino (pp. 307–318). La Ley.
- Ceneviva, W. (2009). Registros públicos. Saraiva.
- Ceneviva, W. (2012). Notários e registradores (2ª ed. ampl.). Saraiva.
- Colégio Registral do Rio Grande do Sul. (2010). Enunciados Colégio Notarial e Registral. http://www.colegioregistrals.org.br/anexos/Doutrina%20Dr.%20Paiva%20%2020_01_2010.pdf
- Dworkin, R. (2003). O império do direito (J. L. Camargo, Trad.). Martins Fontes.
- El Debs, M. (2010). Legislação notarial e registral (3ª ed.). Saraiva.
- El Debs, M. (2024). Registro civil na atualidade. Juspodivm.
- Fissore, D. M. (2012). El nombre de las personas en el Proyecto de Código Civil y Comercial. Revista de Derecho Privado y Comunitario, 2012(2), 229. Rubinzal-Culzoni.

- França, R. L. (1964). Do nome civil das pessoas naturais. R.T.
- Kant, I. (2004). Fundamentação da metafísica dos costumes e outros escritos (L. Holzbach, Trad.). Martin Claret.
- Loureiro, L. G. (2023). Registros públicos (9ª ed.). Juspodivm.
- Nações Unidas. (1948). Declaração Universal dos Direitos Humanos. <https://nacoesunidas.org/wp-content/uploads/2018/10/dudh.pdf>
- Perlingieri, P. (1997). Perfis do direito civil. Renovar.
- Pereira, M. V. (2014). Nombre. In J. C. Rivera & G. Medina (Orgs.), Código Civil y Comercial de la Nación comentado (T. I, p. 261). La Ley.
- Sarlet, I. W. (2002). Dignidade da pessoa humana e direitos fundamentais na Constituição Federal de 1988 (2ª ed.). Livraria do Advogado.
- Sastre, J. C. (2014). Alternativas a la judicialización de los conflictos desde Roma hasta la actualidad. Revista de Derecho UNED, (14).
- Superior Tribunal de Justiça. (2025). Alteração de patronímico familiar [Jurisprudência]. <https://www.jusbrasil.com.br/jurisprudencia/stj/>
- Superior Tribunal de Justiça. (2025). Jurisprudência em teses: Registros públicos, cartorários e notariais II. <https://scon.stj.jus.br/SCON/jt/doc.jsp?livre=%27225%27.tit>
- Superior Tribunal de Justiça. (2025). Revista STJ. <http://www.stj.jus.br/websecstj/cgi/revista/REJ.cgi>
- Supremo Tribunal Federal. (2025). Recurso Extraordinário n.º 898.060/SC [Jurisprudência]. <https://redir.stf.jus.br/paginadorpub/paginador.jsp?docTP=TP&docID=13431919>
- União Europeia. (2013). Diretiva 2013/11/UE. <http://data.europa.eu/eli/dir/2013/11/oj>

ANALYSIS OF THE COOPERATION NETWORK WITHIN AN INNOVATION ECOSYSTEM IN THE INTERIOR OF SÃO PAULO STATE

ESTUDO DA REDE DE COOPERAÇÃO DE UM ECOSISTEMA DE INOVAÇÃO DO INTERIOR DO ESTADO DE SÃO PAULO

ESTUDIO DE LA RED DE COOPERACIÓN DE UN ECOSISTEMA DE INNOVACIÓN EN EL INTERIOR DEL ESTADO DE SÃO PAULO



<https://doi.org/10.56238/sevened2026.008-134>

Nívea Regina Marques Aguiar¹, Mario Mollo Neto²

ABSTRACT

This research addresses the importance of cooperation networks between public, private, and third-sector institutions, driven by technological advancements and the need for agile responses to social and economic challenges. These networks favor the exchange of knowledge, the articulation of resources, and the collective construction of innovative solutions, especially in the fields of education, research, and innovation. In this context, innovation ecosystems emerge as interconnected environments that promote synergies among skills, infrastructure, and human capital, generating value and transforming territories. The research presented focuses on the Alta Paulista region, in São Paulo, and seeks to understand how cooperation networks are structured in education and innovation ecosystems. The study uses Social Network Analysis (SNA), supported by Netdraw® and UCINET® software, to map interactions, identify subgroups, and measure structural indicators. The methodology combines qualitative and quantitative approaches, characterizing itself as exploratory and descriptive, and includes document analysis and bibliographic review in scientific databases. The results reveal low density in the global network (0.011), indicating few connections relative to the existing potential, but higher density in the innovation sub-network (0.033), suggesting more exchanges, although still insufficient. The centrality of FSNTEDUC (55.8%) and FSNTPESQINOV (30.4%) highlights the strategic role of the Shunji Nishimura Foundation of Technology (FSNT) as an articulator in education, research, and innovation. In specific sub-networks, FSNTPESQINOV achieves centrality of 87.3%, reinforcing its influence on network dynamics. It is concluded that FSNT plays a central role in the Alta Paulista ecosystem, acting on several fronts—education, research, innovation, entrepreneurship, culture, and services—and consolidating itself as a strategic agent in the dissemination of information, coordination of projects, and strengthening of governance. Improving the network, with greater connectivity and stronger ties, can expand collaboration among actors, enhancing social, economic, and technological impacts, especially in agribusiness.

¹ Master's student in Agribusiness and Development. Universidade Estadual Paulista (FCE UNESP). São Paulo, Brazil. E-mail: nivea.aguiar@unesp.br

² Dr. in Agricultural Engineering. Universidade Estadual de Campinas (UNICAMP). Universidade Estadual Paulista (UNESP). E-mail: mario.mollo@unesp.br

Keywords: Social Network Analysis. Innovation. Cooperation. Innovation Ecosystem.

RESUMO

A presente pesquisa aborda a importância das redes de cooperação entre instituições públicas, privadas e do terceiro setor, impulsionadas pelo avanço tecnológico e pela necessidade de respostas ágeis a desafios sociais e econômicos. Essas redes favorecem a troca de conhecimento, a articulação de recursos e a construção coletiva de soluções inovadoras, especialmente nos campos da educação e da inovação. Nesse contexto, surgem os ecossistemas de inovação, ambientes interconectados que promovem sinergias entre competências, infraestrutura e capital humano, gerando valor e transformando territórios. A pesquisa apresentada concentra-se na região da Alta Paulista, em São Paulo, e busca compreender como se estruturam as redes de cooperação em ecossistemas de educação, pesquisa e inovação. O estudo utiliza a Análise de Redes Sociais (ARS), apoiada pelos softwares Netdraw® e UCINET®, para mapear interações, identificar subgrupos e mensurar indicadores estruturais. A metodologia combina abordagens qualitativas e quantitativas, caracterizando-se como exploratória e descritiva, e inclui análise documental e revisão bibliográfica em bases científicas. Os resultados revelam baixa densidade na rede global (0,011), indicando poucas conexões em relação ao potencial existente, mas maior densidade na sub-rede de inovação (0,033), sugerindo mais trocas, embora ainda insuficientes. A centralidade das sub-redes FSNTEDUC (55,8%) e FSNTPEsqinov (30,4%) evidencia o papel estratégico da Fundação Shunji Nishimura de Tecnologia (FSNT) como articuladora em educação, pesquisa e inovação. Em sub-redes específicas, a FSNTPEsqinov alcança 87,3% de centralidade, reforçando sua influência na dinâmica da rede. Conclui-se que a FSNT exerce papel central no ecossistema de inovação da Alta Paulista, atuando em diversas frentes — educação, pesquisa, inovação, empreendedorismo, cultura e serviços — e consolidando-se como agente estratégico na difusão de informações, coordenação de projetos e fortalecimento da governança. O aprimoramento da rede, com maior conectividade e fidelização dos laços, pode ampliar a colaboração entre os atores, potencializando impactos sociais, econômicos e tecnológicos, especialmente no agronegócio.

Palavras-chave: Análise de Redes Sociais. Inovação. Cooperação. Ecossistema de Inovação.

RESUMEN

Esta investigación aborda la importancia de las redes de cooperación entre instituciones públicas, privadas y del tercer sector, impulsadas por los avances tecnológicos y la necesidad de respuestas ágiles a los desafíos sociales y económicos. Estas redes fomentan el intercambio de conocimientos, la asignación de recursos y la construcción colectiva de soluciones innovadoras, especialmente en los campos de la educación y la innovación. En este contexto, surgen los ecosistemas de innovación: entornos interconectados que promueven sinergias entre habilidades, infraestructura y capital humano, generando valor y transformando territorios. La investigación presentada se centra en la región Alta Paulista en São Paulo y busca comprender cómo se estructuran las redes de cooperación en los ecosistemas de educación, investigación e innovación. El estudio utiliza el Análisis de Redes Sociales (ARS), con el apoyo de los software Netdraw® y UCINET®, para mapear interacciones, identificar subgrupos y medir indicadores estructurales. La metodología combina enfoques cualitativos y cuantitativos, caracterizándose como exploratoria y descriptiva, e incluye análisis de documentos y revisión bibliográfica en bases de datos científicas. Los resultados revelan baja densidad en la red global (0,011), lo que indica pocas conexiones en relación con el potencial existente, pero mayor densidad en la subred de innovación (0,033), lo que sugiere más intercambios, aunque aún insuficientes. La centralidad de las subredes FSNTEDUC (55,8%) y FSNTPEsqinov (30,4%) destaca el

papel estratégico de la Shunji Nishimura Foundation for Technology (FSNT) como articulador en educación, investigación e innovación. En subredes específicas, FSNTPESQINOV alcanza una centralidad del 87,3%, lo que refuerza su influencia en la dinámica de la red. Se concluye que FSNT desempeña un papel central en el ecosistema de innovación de Alta Paulista, actuando en varios frentes —educación, investigación, innovación, emprendimiento, cultura y servicios— y consolidándose como un agente estratégico en la difusión de información, coordinación de proyectos y fortalecimiento de la gobernanza. Fortalecer la red, con mayor conectividad y relaciones más sólidas, puede ampliar la colaboración entre las partes interesadas, impulsando el impacto social, económico y tecnológico, especialmente en la agroindustria.

Palabras clave: Análisis de Redes Sociales. Innovación. Cooperación. Ecosistema de Innovación.

1 INTRODUCTION

In recent decades, the advancement of information technologies, the growing complexity of social and economic challenges, and the need for agile and collaborative responses have driven the formation of cooperation networks between public, private and third sector institutions. These networks are configured as dynamic arrangements that favor the exchange of knowledge, the articulation of resources and the collective construction of innovative solutions. In the field of education, research, and innovation, according to Lauxen (2024), these networks play a strategic role by integrating different actors — such as universities, research centers, companies, civil society organizations, and governments — around common objectives aimed at scientific, technological, and social development.

This articulation gives rise to the so-called innovation ecosystems, interconnected environments that promote synergies between skills, infrastructure, human and institutional capital, creating favorable conditions for value generation and territorial transformation. Focusing on the generation of synergies, the union of assets (material, human, financial resources) of institutions in a network seeks to generate a value greater than the sum of the resources available separately, according to the logic of resource extension (Lavie, 2006).

Social networks, through the ordering of relationships, favor institutions access to business opportunities, strengthen institutional competitiveness by expanding the flow of information, resources, markets and technologies, enabling knowledge gains, economies of scale and scope, and risk sharing, according to the authors Mizruchi (2006); Kimura, Teixeira and Godoy (2004), Balestrin and Vargas (2004).

The analysis of these networks, through the Theory of Social Networks (SRT), allows us to understand how the actors relate to each other, what are the flows of information and influence, and how the thematic subgroups are structured within the ecosystem. SRT provides analytical tools to identify patterns of cooperation, levels of centrality and density of connections, revealing the strategic role of certain actors in sustaining and expanding the network.

In this context, understanding a cooperation network in the research and innovation ecosystem in the Alta Paulista region, in the interior of the State of São Paulo, contributed to reveal the mechanisms of articulation and offer subsidies for the strengthening of inter-institutional relations and for the proposition of more effective innovation policies. Improving the network of the Shunji Nishimura Foundation of Technology (FSNT), expanding it, increasing its maturity, bringing greater confidence to the actors of the network, are some of the benefits that can be generated for the areas of agribusiness, to which the FSNT has a direct or indirect connection.

The Netdraw® software was developed to enable the visualization of networks in the *Ucinet®* package, widely used in Social Network Analysis (SNA), released in 2002 by the company *Analytic Technologies*. Its main developers were Stephen P. Borgatti, Martin G. Everett and Linton C. Freeman, prominent researchers in the field of graph theory and social network analysis.

Since 1979, Borgatti, Everett and Freeman have been a reference in this area and have developed the theoretical concept and methodology of Centrality; they are founders of the journal *Social Network* (the main journal in the area) (Freeman, 1979).

Freeman is one of the most respected researchers in sociometry and was responsible for standardizing the ARS language. While Freeman established the fundamental metrics of centrality to measure power and influence, Borgatti and Everett advanced in the methodological and algorithmic application of these structures, allowing the analysis of roles, strategic positions, and the modeling of complex organizational ecosystems. Borgatti is the most influential contemporary author in the application of ARS in business and management, he has an interdisciplinary profile that unites heavy mathematics with organizational theory. Often a co-author of Borgatti, Everett brings mathematical and algorithmic rigor, is a professor of Social Network Analysis, and focuses on the deep structure of graphs.

For the analysis of social networks, graph theory provides the mathematical basis of the study, allowing to represent relationships between actors through graphs and adjacency matrices. Generally composed of binary values (1 or 0), they organize the connections between agents and usually have an empty diagonal, as the link between an actor and himself is not considered (Wasserman; Faust, 1994).

Graph Theory originated in the work of Leonhard Euler, when the Swiss mathematician solved the famous "Königsberg Bridges" problem, considered the founding milestone of the discipline (Szwarcfiter, 1984), later evolving as a branch of discrete mathematics, focused on the study of structures composed of vertices (or nodes) and edges (or connections), which model relationships between elements of a set (Harary, 1969).

When applied to the understanding of the structures of social interaction, graph theory gained great relevance in sociology, highlighted by Wasserman and Faust (1994) as enabling a formal reading of social relations, transforming abstract bonds into analyzable structures, which expands the ability to understand the organization and dynamics of groups.

While graph theory originated in mathematics, network theory had an interdisciplinary origin, including the area of Mathematics and Sociology, incorporating social, physical and computational theories. According to Ferreira and Filho (2010), Network Theory deals with a complex analysis of tangible (goods, materials) or intangible (ideas, values) interactions

between the actors involved in the network (people, organizations, environment), using concepts and metrics (centrality, density, modularity).

The central problem of this research is to understand how cooperation networks are structured in research and innovation ecosystems, evaluating the patterns of interaction between the different actors involved and the subgroups formed based on common interests. Through the analysis of social networks, we sought to identify the levels of influence and institutional articulation among the participants of the network, having as a case study an institution that acts strategically in this ecosystem, comparing it with other studies found in the literature.

To answer these questions, the study uses Social Network Analysis with the support of the software tools *Netdraw*® and *Ucinet*®, in order to visualize relationships and detect subgroups present in the cooperation network, allowing us to understand the role of the Foundation in the network and the links established with the other participants.

The present research is justified by the need to deepen the knowledge about how these networks are structured, what are the patterns of interaction between their actors and how certain institutions exert influence on the articulation of relationships. The application of Social Network Analysis (SNA), with the support of the *Netdraw*® software and the *Ucinet*® software, allowed a quantitative approach that contributed to evidence the relational dynamics of the network and the thematic subgroups formed by common interests of the actors.

The relational dynamics of the social network aims to generate value for institutions, people and communities, and the interdisciplinary approach observed in the formation of strategic partnerships was observed in the case study carried out that evaluates the role played by a central actor (Grupo Jacto, 2025). Based on the Theory of Social Network Analysis (SRA), this research searched the literature for consolidated studies on this topic and applied to the case study of the cooperation network where the FSNT is inserted, mapping the interconnections to demonstrate the influence of the institution in each sub-network, in order to identify and provide subsidies for the creation of actions aimed at strengthening this network and other networks to be studied.

This research may provide relevant information that can contribute to the fulfillment of at least five of the 17 sustainable development goals (SDGs) set out in the United Nations (UN) 2030 Agenda for Brazil (UN, 2023), SDG 4 "Quality Education"; SDG 8 – Decent Work and Economic Growth; SDG 9 – Industry, Innovation and Infrastructure; SDG 11 – Sustainable Cities and Communities and SDG 17 – Partnerships and Means of

Implementation. Although the main focus is education, research and innovation, there are also points of convergence with SDG 2.

The objective of this research is to identify relationships established between the actors of a cooperation network of an innovation ecosystem with the purpose of expanding the knowledge about the structure, intensity and dynamics of these interactions.

2 THEORETICAL FRAMEWORK

The study of networks identifies the actors and the relationship between them in order to characterize these forms of interaction, contributing to the knowledge about the social network and its development. Networks are systems composed of "nodes" and connections between them that, in the social sciences, are represented by social subjects (individuals, groups, organizations, etc.) connected by some kind of relationship. The social network can be studied basically in order to understand how the actors behave and how the connections of this network influence this behavior (Watts, 1999).

In addition to the identification of actors and their bonds, Ahuja, Zaheer and Soda (2012) highlight the relevance of examining the structural configurations or patterns that emerge from relationships. From this perspective, certain actors may present greater intensity of interaction, while others start to concentrate — or centralize — a significant volume of connections within a specific network.

Actors, in general, tend to establish relationships with those who share similar attributes, which evidences the presence of similarity (Olave; Amato Neto, 2001). This proximity generates benefits for those involved, understood as positive externalities (Verschoore Filho, 2006). Among the factors that favor this similarity, individual preferences, economic interests or converging goals stand out (BURT, 1992). As examples of positive externalities, we can mention the articulation of groups in unions and cooperatives for the defense of common interests, as well as the productive specialization of companies belonging to the same sector that are clustered in a given region.

According to Abramovay (2000), the network is an analytical instrument for understanding certain forms of collective organization, going beyond the field of social sciences to incorporate, for example, the ecology of the population.

Networks can be categorized according to the degree of legal formalization they present, considering the form of coexistence and organization among their members. In this sense, Fusco (2005) proposes a typology that classifies networks into social, bureaucratic or proprietary networks, varying into symmetrical or asymmetrical networks.

Symmetrical social networks are characterized as social groupings not governed by

formal legal instruments, where participants have the autonomy to join or withdraw from the network at any time and equality in decision-making power is ensured among all members (Fusco, 2005). In the asymmetric social network, the author points out that the relationships between individuals are organized through contracts aimed mainly at the exchange of goods and services.

Structured based on formal contracts that define the relationships between the members, according to Fusco (2005), symmetrical bureaucratic networks maintain the rights, duties, forms of exchange, agreements and the protection of the individual rights of all participants expressly guaranteed in contracts. In asymmetric bureaucratic networks, the legal instruments are directed to the strategic alignment of the members with the objectives of the managing agent, and in these arrangements, rights, knowledge transfer mechanisms and standards for services and information flows among the members of the network are defined.

In the model of symmetrical proprietary networks, Fusco (2005) reinforces that the participating companies form a new organization with the objective of balancing knowledge and capital contributions and formal contracts with specific clauses defining property rights and agreements between the members. In addition to these characteristics, asymmetric proprietary networks have explicitly incorporated the risk element, with the presence of an investor who establishes a partnership with the company, jointly assuming the risks of the enterprise.

It is observed that social networks have no or low degree of legal formalization, which makes it essential to consider the aspects related to human behavior that influence the permanence or dissolution of network relationships. This perspective is widely discussed in the works of Granovetter (1973) updated in 2007, Burt (1992) and Lazzarini (2008). In a convergent way, Grandori and Soda (1995) point out that social networks are characterized by having little or no contractual formalization.

In addition to the structural typology, it is relevant to analyze the forms of joint action existing in the networks, with emphasis on the modes of cooperation and the roles played by the different actors involved. As pointed out by Carvalho, Serra and Laurindo (2003), two main modalities stand out, horizontal cooperation and vertical cooperation.

While horizontal cooperation occurs between individuals or organizations that act as competitors, but who establish cooperative relationships with the objective of achieving common benefits, vertical cooperation is seen in arrangements in which the participants are interdependent to carry out their activities, and the articulation between the members of the chain is fundamental for individual growth and for the development of the other actors

involved (Carvalho, Serra and Laurindo, 2003).

At the end of the 1970s, the discussion about the relationship between networks and companies began in organizational studies to understand the behavior of organizations, emerging the Theory of Organizations, according to researchers Martes et al. (2006). While Granovetter (1985) points out that the absence of relationships between actors can compromise the formation of relevant social bonds, negatively affecting information flows and opportunities for cooperation within networks, Martes et al. (2006) identified, in organizational analysis, that social relations between two actors (individuals or organizations), because they have strength and content, include background, advice or friendship, shared or pertinent interests, and some level of trust.

According to the authors Mizruchi (2006); Kimura, Teixeira and Godoy (2004), Balestrin and Vargas (2004), social networks have been evidenced for enabling the entrepreneur to maintain contacts, expand the possibilities of finding business opportunities and a way for companies to achieve competitiveness in the markets through the ordering of relationships.

Kimura, Teixeira and Godoy (2004) also highlight that these social interactions improve or restrict access to resources, because, by incorporating social capital, they generate externalities such as knowledge about the behavior of other agents; knowledge about the market such as prices and technologies; and on the benefit of class action.

Some quantitative parameters are especially important to identify the structure of a social network. Density describes the overall level of interactions presented by the members of a network, being associated with the average number of connections per member of the group. Centralization reflects the concentration of connections in a small number of individuals, as opposed to a more egalitarian distribution, and is associated with variance in the number of connections per individual (Sparrowe, Liden, and Kraimer, 2001).

The central purpose of cooperation networks in the organizational field is to bring together attributes that allow adaptation to the competitive environment in a dynamic structure, supported by uniform but decentralized actions, which enables gains in the scale of the union, but which prevents the companies involved from losing the flexibility of lean size (Thompson, 2003).

According to Bourdieu (1985), social capital is the "sum of resources" made available by the network, related to the connections that the actors have, but not necessarily resources that are contained in them, because the benefits are acquired or received by the actors.

As a resource, social capital is subject to accumulation and transformation into other forms of capital, such as economic (Bourdieu, 1983) and human (Coleman, 1988), and in a

narrower view, according to Marteleto (2005), it can be defined as a set of norms and social networks that affect the well-being of the community in which they are inscribed.

The theory of resource dependence, according to the research of Dias (2011), is another approach used in studies on cooperation networks, where alliances, partnerships and relationships between organizations have been constituted as new business opportunities that are made possible based on new inter-company arrangements or the so-called inter-organizational networks of cooperation. The same author highlights that the existence of polycentric networks or structures that encompass several actors, organizations or modules linked to each other through the establishment and maintenance of common objectives and a compatible and adequate managerial dynamic is increasingly present.

According to Etzkowitz and Leydesdorff (1995), innovation ecosystems represent spaces in which the knowledge economy is strengthened by collaboration between universities, companies and government, enabling the emergence of mixed institutions that promote the continuous circulation of knowledge and technologies. The education and research ecosystem, on the other hand, can be understood as a collaborative and interdependent environment that brings together multiple agents, such as schools, universities, families, civil society, the productive sector, and digital technologies. In this arrangement, learning is seen as the result of complex interactions that are articulated at different levels (UNESCO, 2021),

The trust that the actor brings to the network of relationships in which he or she is inserted creates favorable conditions for cooperation, which in turn reinforces the trust between the various actors in the network (SMOLKA, 2006).

According to Tigre (2006), the authors Nelson, Freeman and Lundvall, in different works, developed the concept of the National Innovation System, to characterize the scientific and institutional environment capable of promoting innovations for competitiveness. Such studies show how the educational and scientific infrastructure, the mechanisms to support innovation and technological cooperation and business strategies contribute to creating positive externalities to the export effort in different countries (Tigre, 2006).

The challenges linked to Agribusiness, with activities related to land use, energy factors and labor in the field, demand systems with greater productivity aimed at meeting food demand, production and consumption of greater value of land and food. In this environment, sustainable practices, networks, and partnerships innovate the mode of production, consumption, and relationship, where actors - private and public - start to act engaged towards a society of greater development, even though in Brazil there is physical space and

climatic conditions more conducive to agricultural and livestock production (Zuin and Queiroz, 2019).

Sustainable agri-food innovation is a great development opportunity for Brazil, because, according to Zuin and Queiroz (2019), in addition to having good universities and research centers that enable technological advances, there is cultural richness and diversity, a demanding domestic and foreign consumer market, scarce and valuable natural resources, and competitive production.

Brazil is a strategic actor in global agribusiness, an essential sector of the Brazilian economy and an opportunity and catalyst for the country's development and as part of the sector's development strategy with technological products and businesses with higher added value, it is crucial to strengthen the pillars of innovation and reorganize the roles of key actors (university, company and government); prioritize teaching and research focused on strategic opportunities; increase skills for the transformation of traditional companies into innovative ones; stimulate the creation of research, development, and innovation centers (Zuin and Queiroz, 2019).

In Brazil, the national system of technology and innovation was consolidated through several actions such as the creation of the National Council for Scientific and Technological Development (CNPq) and the Coordination for the Improvement of Higher Education Personnel (CAPES), in the 1950s, the structuring of policies for the training of researchers and generation of knowledge and in the 1970s, creation of public policies such as the II National Development Plan (II PND) and the foundation of the Brazilian Agricultural Research Corporation (EMBRAPA, 1973).

Making the Brazilian economy more competitive was necessary with Brazil's economic opening and globalization in the 1980s and 1990s, and stimulating initiatives to bring scientific production closer to the productive sector and technological innovation proved to be a factor in the country's economic and social development (Zuin and Queiroz, 2019).

The Innovation Law (Law No. 10,973/2004) allowed the promotion of research, development and innovation (RD&I) through the sharing of public laboratories with companies, the transfer of technology and the encouragement of public-private partnerships.

The Lei do Bem (Law No. 11,196/2005) granted tax incentives to companies that make investments in technological innovation, and the Legal Framework for Science, Technology and Innovation (Complementary Law No. 167/2016, which updates the Innovation Law) modernized the rules to facilitate the execution of innovative projects.

The approval of the Legal Framework for *Startups* (Complementary Law No. 182/2021) reinforced support for innovative entrepreneurship through mechanisms for

contracting innovative solutions by the public sector and incentives for new technology-based businesses.

Public institutions in Brazil play an essential role in fostering innovation, such as FINEP - Financier of Studies and Projects, with financing and economic subsidies; the National Bank for Economic and Social Development (BNDES), with specific credit lines; the Brazilian Company for Industrial Research and Innovation (EMBRAPPI), which co-finances projects between companies and research institutes; in addition to scholarships and notices offered by CNPq and CAPES.

All these actions are important advances in fostering innovation in Brazil and overcoming challenges such as low private investment in the sector and the lack of a culture of innovation that is part of the organizational culture of companies and institutions.

3 METHODOLOGY

The research strategy is based on the single case study protocol, meeting the reliability criterion, and adopts a qualitative, exploratory and descriptive approach. The research is supported by Social Network Analysis (SRA), with the use of Netdraw® *software* for the graphical mapping of networks and UCINET® for the quantitative measurement of structural indicators. From the interactions between the actors — represented by nodes, links and flows — metrics such as density and centrality (*Degree, Betweenness and Closeness*) are *calculated*, allowing the analysis of the configuration and positioning of the actors in the network.

The methodology articulates a qualitative and quantitative approach, with the ARS as a central technique for the investigation of the interactions between the actors. The combined use of Netdraw® and UCINET® *software* enables the visualization of connections, the generation of network maps and the calculation of structural metrics, essential for understanding relational dynamics, identifying thematic subgroups and evaluating the role played by the different actors in the analyzed ecosystem.

The research is characterized as exploratory, as it allows inferring the ties established between the actors of the social network, and as descriptive, due to the application of mathematical tools in the analysis of the variables that make up the relational matrices (Gil, 2021). In addition, documentary analysis was adopted as a procedure for data constitution and analysis, in line with the qualitative approach of the research (Minayo, 2009).

To bring to the research the historical context of the environment where the FSNT is inserted and its development, documentary research was carried out using books and annual reports available in the institution's private collection, as well as a search on the website.

For the theoretical basis of the scientific knowledge used in the research, research was carried out in books and scientific articles, dissertations and theses of works pertinent to the themes addressed in this research, searched in the *Scielo*, *Capes*, *Unesp* library, *Science Direct* databases.

The research was developed in two phases. In the first, for qualitative analysis, the first network was built with the identification of all actors to have an overview of the collaboration network. To achieve this first objective, a table was built in Excel file format of the overview of the network for the organization of the actors and their attributes and their relational ties; a VNA file of the general network was built and inserted into the *Netdraw® software*, generating the graph of the first network (GENERAL). Initially, these relationship ties were inserted with a weight of 1 to 1 in order to establish balanced (Binary) relationships.

As *insights* obtained from the first graph (GENERAL), subnets were identified, based on the main attributes of the actors, where there are collaborations of common interest, which led to the construction of new VNA files for each of the identified subgroups. The new VNA files were inserted into the *Netdraw® software*, generating the graphs of the subnets.

From this set of sub-networks, the network identified as research and innovation was highlighted for the study, where the actors that interact in this sub-network were isolated with the help of the *Netdraw® software*.

In the second phase of the studies, the *UCINET® software* was applied to insert the new weights to the relational ties of the networks, the GENERAL and the research and innovation sub-network, in order to evaluate the relational matrices and determine the densities and centralities, in a quantitative way.

In this phase, the names of the actors were replaced by acronyms to preserve their identification in their interactions in the General and sub-networks of research and innovation.

4 RESULTS AND DISCUSSIONS

4.1 CASE STUDY: HISTORY OF THE FORMATION OF THE INNOVATION ECOSYSTEM OF ALTA PAULISTA

4.1.1 The Foundation and Its Evolution

The Shunji Nishimura Technology Foundation was created by Japanese immigrant Shunji Nishimura in 1979 as part of the "Thank you, Brazil!" project, with an initial focus on education. With a professional life dedicated to the advancement of agriculture in Brazil, Nishimura, at the age of 70, created the FSNT with the objective of supporting Brazilian agriculture through education, training young people prepared for life in the countryside and with solid values adopted by him (Morais, 2019).

Since then, with the support of Grupo Jacto, the Foundation has played a key role in the training of young people and technological development, fostering innovation and entrepreneurship actions in the areas of agribusiness, health, biotechnology and the food industry, integrating actors in the quadruple helix of innovation in the context of bioconvergence (Grupo Jacto, 2025).

The first initiative of the FSNT was the creation of the Agricultural Technical College. During his business life, Shunji Nishimura approached universities, especially the agronomy faculties of USP - University of São Paulo, in Piracicaba, and Unesp - São Paulo State University, in Jaboticabal and Botucatu. From the partnership with professors from the Faculty of Agronomic Sciences of Unesp in Botucatu, the Soil Analysis Laboratory also emerged, which is still active today and one of the best in Brazil (Cesar, 2018).

In 1988, the Shunji Nishimura School was created, maintained by the FSNT, which in 2019 gained a new building on its campus, specially designed to enhance an innovative educational approach, *Profound Learning*, a Canadian methodology based on the formation of autonomous, innovative and future-ready people (Morais, 2019).

The first major partnership in the field of education: a Senai (National Service for Industrial Learning) school within the FSNT, the result of the agreement with Senai-SP, which began operating in 2009. Senai Pompeia Shunji Nishimura was the first institution to adopt the *Profound Learning methodology*, starting in 2015, and maintains the only high school among Senai schools in the state of São Paulo (Morais, 2019).

In 2010, another major educational project began: the Pompeia Faculty of Technology, a public-private partnership with the Paula Souza Technological Education Center (CPS), an institution of the government of the State of São Paulo responsible for technological professional education, offering technological undergraduate courses, in the context of agribusiness, to young people in Pompeia and region (Morais, 2019).

To promote Culture, FSNT maintains a Museum, open to visitors, intended to preserve the history of the founder of Grupo Jacto and FSNT, Shunji Nishimura, and which maintains his memories and philosophy of life (Morais, 2019). Also as part of actions to encourage culture and volunteering, FSNT maintains the "Volunteering Project", composed of floriculture, horticulture and ceramics workshop activities (Morais, 2019).

4.2 CHARACTERIZATION OF THE INNOVATION ECOSYSTEM

The education and innovation ecosystem where FSNT is inserted has the three main components that the specialized literature identifies as essential (talents, technology and investment), in addition to being located in a region that favors economic development based

on biodigital convergence, through integrated solutions in the areas of Agribusiness, Food Industry and Health, driven by genomics, information and communication technologies (Marchiori, 2024).

The education and innovation ecosystem in which FSNT is inserted seeks to develop a culture of innovation based on cooperation, creating an environment open to opportunities and favorable to the most diverse interactions between entrepreneurs, companies, universities, research organizations, investors and government agencies in order to maximize the economic impact and potential of research and technological innovations (Marchiori, 2024).

At the regional level, the actors in the education and innovation ecosystem are concentrated in Alta Paulista, a region in the state of São Paulo where the city of Pompeia is located. It is an important university and agro-industrial hub, located in the center-west of the state of São Paulo, with a population of 886,735 people, in 2023, distributed in 51 municipalities. It has adequate road infrastructure for cargo transport, in addition to regional airports in Marília, Tupã, Assis and Ourinhos (Grupo Jacto, 2025).

In the state of São Paulo, the Alta Paulista region is responsible for 7% of Brazilian agricultural production and stands out in the food, beverage, machinery and agricultural equipment industries and has important educational, science and technology institutions, such as: Marília Medical School – FAMEMA, São Paulo State University – Assis Campus, Marília Campus, Tupã Campus, Shunji Nishimura Technology Foundation (FSNT), which covers: Fatec Pompeia Shunji Nishimura, Senai Pompeia (SENAI School "Shunji Nishimura") and Agribusiness Innovation Center (CIAg) (Grupo Jacto, 2025).

In more than four decades of existence, FSNT has consolidated itself as a serious institution, with an excellent reputation and with ties of relationships with important actors in national education and research and Brazilian agribusiness (Morais, 2019). The trust that the NSF brings to the network of relationships in which it is inserted creates favorable conditions for cooperation and that, in turn, reinforces the trust between the various actors in the network (Smolka, 2006).

As a result of this trust among the actors in the network, FSNT created, in the area of innovation, through partnerships: the Center for Innovation in Agribusiness (CIAg), a private non-profit research and development center focused on the development of solutions framed in technological programs; Plant Monitoring and Protection Laboratory – LMPP, the first research laboratory created after the Paula Souza Center (CPS) received recognition as a Scientific, Technological and Innovation Institution (ICT) by the Council of Research Institutions of the State of São Paulo (Consip); Alta Paulista Innovation Center (Citap), a

formal innovation environment in the Alta Paulista region, recognized by the government of São Paulo (Grupo Jacto, 2025).

Established in 2014, through a partnership established between FSNT and *Imaginal Education* (Canadian educational institution), the *Imaginal Transformation Center* - ITC Brasil aims to disseminate, in Brazil, the Imaginal Philosophy - a teaching methodology based on principles of student autonomy in the learning process, through consultancy provided in public and private education networks, schools, municipal secretariats, and through *workshops* promoted to train educational managers and teachers (Grupo Jacto, 2025).

The FSNT Agronomic Analysis Laboratory, created in 1985 with the objective of providing soil fertility analysis and chemical analysis of plants to rural producers, cooperatives, consultants, companies and teaching and research institutions throughout the Brazilian territory, contributes to the undergraduate courses of Fatec Pompeia Shunji Nishimura, through support for research projects by professors and students, practical classes and the offer of supervised internships (Grupo Jacto, 2025).

Based on strategic partnerships with institutions such as the Government of the State of São Paulo, the Paula Souza Center, SENAI, the São Paulo Agency for Agribusiness Technology - APTA, the ITAL Institute of Food Technology, the Araucária Foundation, the Institute for Cancer Research of Guarapuava - IPEC, *Cilla Tech Park* and the Government of the State of Paraná, - FSNT operates in education and innovation ecosystems in the areas of Agribusiness, Genomics, Artificial Intelligence, Biotechnology, and the Food Industry (Marchiori, 2024).

4.3 CONSTRUCTION OF THE GENERAL NETWORK

The application of the social network analysis method in this research sought to achieve the proposed objectives through the mapping of the network where the FSNT is inserted and its study to identify possible opportunities for action in strengthening the ties between the actors of this cooperation network.

To process the networks in *the Netdraw® software*, it was necessary to build a set of data structures in a set of plain text files, using Windows® Notepad. In these files, the actors, their attributes and the ties between them were listed according to the subgroups of common interests, indicated in the data collection. After processing, the data was visually represented in the *Netdraw® software*. Figure 1 shows a typical VNA file used in the research. The remaining datasets identifying other subnets followed the same file structure. This procedure was repeated for the general network, as well as for all identified subnets.

Figure 1

Example of VNA file, from the Research and Innovation subnet

```

*NODE DATA
NOME CLASSIF_ORGANIZACIONAL COR_CLASSIF_ORGANIZ 5_SUB_REDE
FSNT FSNT VERDE FSNT
AMAZON EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
API_GEN_PR OSC ROXO FSNT_PESQ_INOV
BUNGE EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
CARGILL EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
CIAG ICT AMARELO FSNT_PESQ_INOV
CILLA_TECH_P OSC ROXO FSNT_PESQ_INOV
COOPADAP EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
COPLANA EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
DORI EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
E_ENG_USP INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
EMBRAER EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
EMBRAPA ICT AMARELO FSNT_PESQ_INOV
EMBRAPA_INST ICT AMARELO FSNT_PESQ_INOV
ESALO_USP INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
FADCT_PR ORGAO_GOVERNAMENTAL MARROM FSNT_PESQ_INOV
FADCT_SP ORGAO_GOVERNAMENTAL MARROM FSNT_PESQ_INOV
FAPESP ORGAO_GOVERNAMENTAL MARROM FSNT_PESQ_INOV
FCA_UNESP INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
FCAV_UNESP INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
FCE_UNESP INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
FRAUNHOFER ICT AMARELO FSNT_PESQ_INOV
GRUPO_VITTIA EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
IAC ICT AMARELO FSNT_PESQ_INOV
IARA OSC ROXO FSNT_PESQ_INOV
IBM ICT AMARELO FSNT_PESQ_INOV
IEA ICT AMARELO FSNT_PESQ_INOV
IFSP ICT AMARELO FSNT_PESQ_INOV
INGREDION EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
INST_FIS_USP ICT AMARELO FSNT_PESQ_INOV
INTEL EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
IPEC_PR ICT AMARELO FSNT_PESQ_INOV
ITAL ICT AMARELO FSNT_PESQ_INOV
MARILAN EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
NODUSOJA EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
PLUG_PLAY EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
R_S_BUMOS EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
RIZOMA_AG EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
SEARA EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
SECR_AG_SP ORGAO_GOVERNAMENTAL MARROM FSNT_PESQ_INOV
SEMANTIX EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
SETI_PR ORGAO_GOVERNAMENTAL MARROM FSNT_PESQ_INOV
SL ALIM EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
SOLO_RICO EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
SPLICE_G EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
STELLANTIS EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
U_SAO_FCO EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
UBYFOL EMPRESA_PRIVADA VERMELHO FSNT_PESQ_INOV
UFMA INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
UFPA INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
UFRJ INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
UFSP INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
UNESP INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
UNIV_ECO_PR INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
USP INSTITUICAO_EDUCACIONAL AZUL FSNT_PESQ_INOV
CONS_CUR_FSNT OSC ROXO MANTENEDORA
G_JACTO EMPRESA_PRIVADA VERMELHO MANTENEDORA
JACTO EMPRESA_PRIVADA VERMELHO MANTENEDORA
RODOJACTO EMPRESA_PRIVADA VERMELHO MANTENEDORA
SINTEGRA EMPRESA_PRIVADA VERMELHO MANTENEDORA
G_BRUDDEN EMPRESA_PRIVADA VERMELHO MANTENEDORA

*TIE DATA
FROM TO PESO
AMAZON FSNT_PESQ_INOV 1
API_GEN_PR FSNT_PESQ_INOV 1
  
```

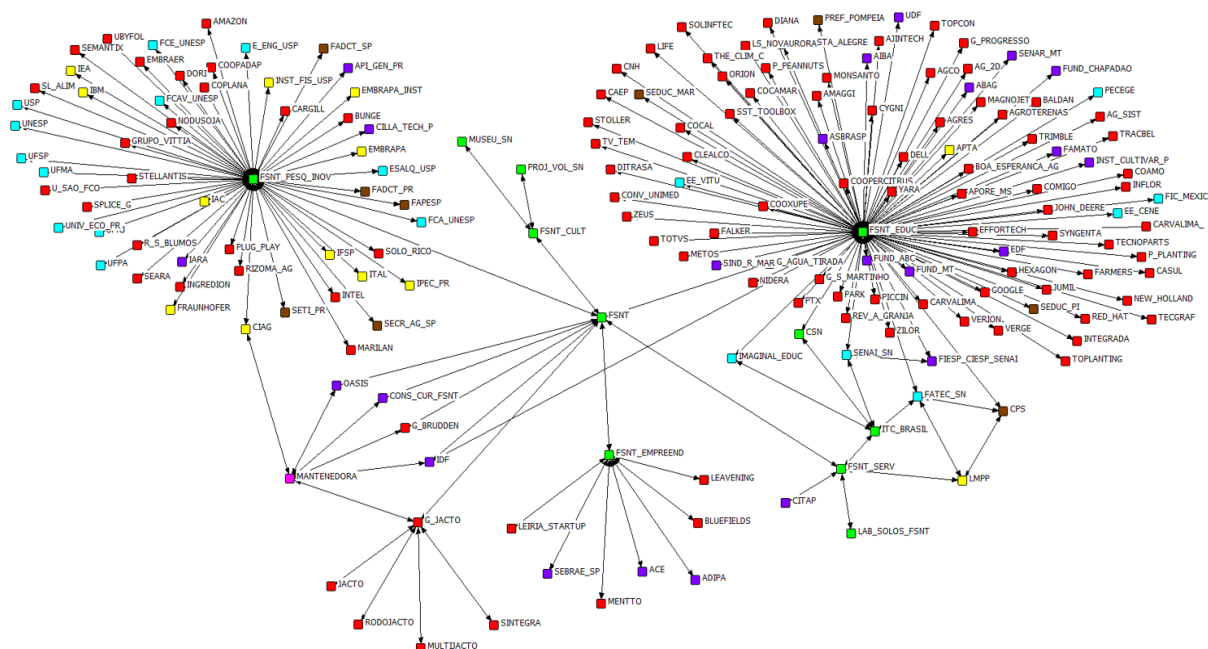
Source: The authors.

Through the Network Theory, with the support of the *Netdraw® Software tool*, an initial analysis of the interactions between the network actors was made and the image of the

general network was constructed (Figure 2), which encompasses subgroups of common interests identified as: i) education; ii) culture; iii) services; iv) research and innovation; v) entrepreneurship, allowing visualization of its reach and the relationships between all actors and the FSNT.

The social network in which FSNT is inserted has a number of connections created from cooperation actions between actors, whose purposes range from the development of the community, Industry and Agribusiness, through support for research and education, expanding this mission to all geographic regions that FSNT reaches through relationships with actors connected by the same purposes.

Figure 2
General Network



Source: The authors.

Figure 2 shows the graph representation of the general cooperation network, composed of institutional connections and partnerships established by the Foundation in its nuclei of action with various institutions, represented by us. The central nodes, highlighted in green, indicate the divisions according to the activities and areas of activity of the FSNT, classified in Chart 1.

Table 1

Classification of sub-networks

DIVISÃO	SIGLA
Cultura	FSNT_CULT
Educação	FSNT_EDUC
Empreendedorismo	FSNT_EMPREEND
Pesquisa e Inovação	FSNT_PESQ_INOV
Serviços	FSNT_SERV
Fundação Geral	FSNT

Source: The authors.

The FSNT_PESQ_INOV sub-network concentrates connections with educational institutions, research centers and technology companies, evidencing a focus on innovation and development in scientific research. The FSNT_CULT subnetwork connects cultural and educational initiatives. The FSNT_EMPREEND sub-network concentrates institutions classified as incubators, accelerators and entrepreneurship support organizations. The FSNT_SERV subnet, on the other hand, relates to service provider divisions of the FSNT itself. These institutions were classified by type of actor represented by groups classified by color, as indicated in Chart 2.

Table 2

Classification of actors by categories

Cor no Grafo	Tipo de Ator	Exemplos
Vermelho	Empresa privada	Jacto, IBM, John Deere, Trimble, Cargill, Bunge, Syngenta, Google, Amazon
Azul	Instituição educacional	USP, UNESP, ESALQ, FATEC, SENAI, UFPR, FIC_MÉXICO
Amarelo	Instituto de ciência e tecnologia	APTA, FAPESP, SECR_AG_SP, SENAR_MT, FUND_MT
Roxo	Organização do terceiro setor	Plug & Play, IDF, CITAP, Fraunhofer, OASIS
Marrom	Órgão governamental	ABAG, PREF_POMPEIA, COOPADAP, CONS_CUR_FSNT
Verde	Núcleos internos da FSNT (pontos centrais da rede)	FSNT, FSNT_EDUC, FSNT_PESQ_INOV, FSNT_CULT, FSNT_SERV, FSNT_EMPREEND
Rosa	Organização do terceiro setor – mantenedora	Mantenedora

Source: The authors.

The FSNT, positioned as the central link of the network, connects with all partners according to each sub-network divided by area of operation, thus indirectly connecting all the actors inserted in the FSNT Global network. The institutions of the network were classified through their attributes into: educational, private companies, science and technology institutes, government entities, civil society organizations, divisions of the FSNT itself and sponsor. The connections indicate relations of cooperation, project development, research, technological innovation, culture and entrepreneurship.

While the actors of the networks benefit from the solid reputation of the Foundation built over the years mainly by its founder, Shunji Nishimura, the latter benefits from the specificities brought to the network by each actor, within their areas of activity, in line with Martes et al., (2006), who identified that the social relations between two actors (individuals or organizations), Because they have strength and content, they include background, advice or friendship, shared or pertinent interests, and some level of trust. Aspects such as expertise in corporate governance are also benefits brought by the FSNT to the cooperation network.

The global network was classified, according to Fusco (2005), by its relations as symmetrical social networks where social groupings are not governed by formal legal instruments, the participants have the autonomy to join or withdraw from the network at any time and equality in decision-making power is ensured among all members.

The results of the qualitative analysis of the generated graphs point to a network that encompasses subgroups of common interests identified as education, culture, services, innovation and research and entrepreneurship. The sub-networks were reconstructed separately from the larger network for a better visualization and understanding of their reach and the relationships between the actors and the FSNT.

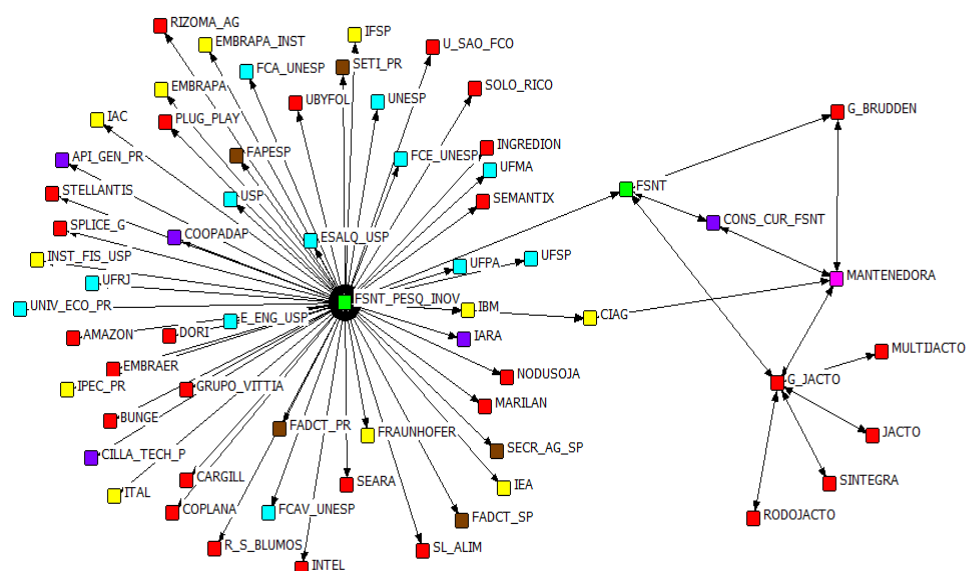
4.4 CONSTRUCTION OF THE RESEARCH AND INNOVATION NETWORK

The sub-network entitled FSNT_PESQ_INOV, detached from the general network and represented by Figure 3, is composed of several types of institutions such as private companies, teaching and research institutions, science and technology institutes, third sector organizations, development agencies, all with common attributes linked to research and innovation and connected by the FSNT actor, which is positioned with centrality and demonstrates a high degree of importance for the connection between all actors. This sub-network was classified as an asymmetric bureaucratic network, where the relations between individuals are organized through contracts aimed mainly at the exchange of goods and services, according to the indications of Fusco (2005).

Among the actions present in this sub-network, there are research projects, coordinated by the FSNT, in which resources are shared among all actors in the network, and thus, optimized to achieve common goals. The simulation of the FSNT actor's output from this network indicates the disconnection that can occur with the other actors (Figure 4).

Figure 3

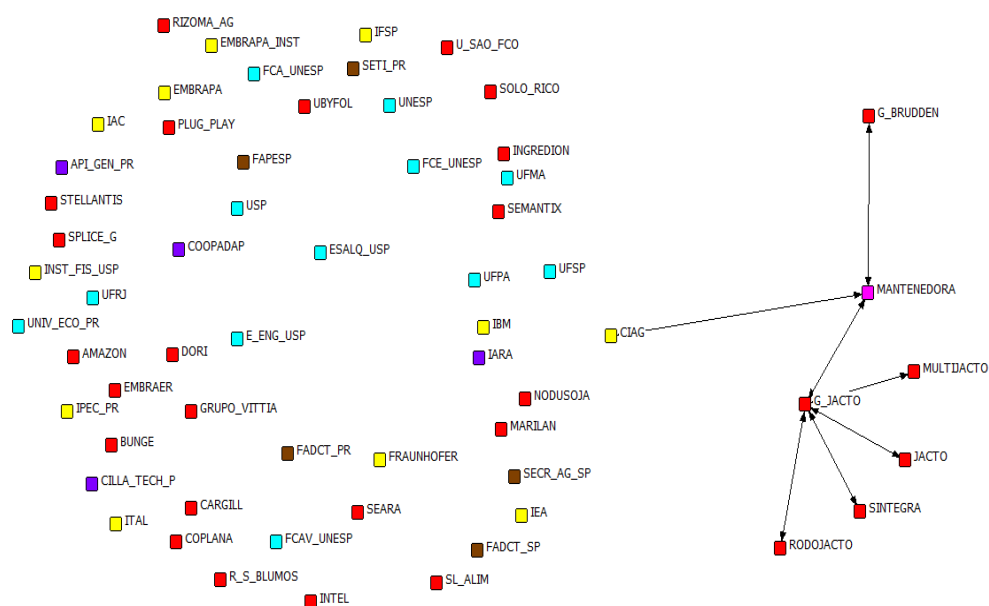
Research and innovation subnetwork



Source: The authors.

Figure 4

Research and innovation subnet without FSNT



Source: The authors.

The quantitative analysis of the network indicators was carried out, with the application of the *UTINET® software*, in its version 6.817, obtained from *Analytic Technologies*, according to the guidelines of Borgatti, Everett and Freeman (2002), and the quantitative data and the lists of data outputs from the *URINET® software* were obtained. The following is a summary of the main indicators calculated for the networks (TABLE 3).

Table 3

Summary of the quantitative indicators of the networks studied

NETWORK	Summary of General Network Measures			
	We	Ties	Centralities	Density
GLOBAL	182	378	0,55	0,011
INNOVATION	64	132	0,854	0,033

Source: The authors.

The indication of nodes presents the number of actors participating in the network and sub-network studied. Bonds, on the other hand, correspond to the bonds or between the actors, which represent the interactions between them.

As the relational matrices constructed considered the weights of the relationships (ties) between the actors with unit weight, it is observed that the results of the centralities, also in the interval between 0 and 1, are identical for both the output centralities and the input centralities.

Centrality is a set of metrics used in social network analysis to assess which nodes (or actors) are most important to the network. In this case, Table 1 demonstrates the centrality of the Innovation subnetwork with the measure 0.854.

The densities obtained from the networks showed that in the global network there is a low density, equal to 0.011, which could be increased through a greater number of interactions, increasing the weight of the links (ties) between the actors and possibly creating more connections between these actors. This indicates the possibility of improving the network, building loyalty and strengthening relationships, leading to greater connectivity and greater exchange of information of common interest, in order to ensure that almost all users are connected to each other, thus achieving greater collaboration between the actors of the networks.

With the result of the analysis obtained from the global network as previously indicated, it can be stated that there are still few connections in relation to the total possible connections for this network.

In the case of the Innovation network, the graph obtained showed a density with a result of 0.033, three times higher than the density of the global network, demonstrating that this sub-network has a higher volume of exchanges, but there are still opportunities to increase collaboration within the network.

Table 4 presents a summary of the major centralities found in the network studied, so that it is possible to ascertain the power of the participation of the actors in the respective social networks raised in the case study.

In the global network, it is possible to verify the centrality of the FSNTEDUC actor, which reached 55.8% of centrality, that is, it is the actor with the greatest influence in the network that considers unitary ties, followed by the FSNTPESQINOV actor, with 30.4% of influence over the network participants. Even so, the participation of the FSNT is observed with a centrality of 10% in the global network.

The other actors have centralities lower than 8 points and, in this way, it was perceived how important Education and Research and Innovation are for this network, as well as the monitoring of the FSNT.

Still observing Table 4, we can highlight the importance and power of influence of the actor FSNTPESQINOV, with a value of 87.3% of prominence over the other participants of the network. It is, without a doubt, a major player that contributes to the functioning of the network. The other actors can have their centralities increased in order to expand exchanges and their individual responsibilities.

The results obtained in the analysis of social networks applied to the study of the social network in which the FSNT is inserted, so far, show the relevance of the FSNT as a central articulating actor on different fronts of action: education, research, innovation, entrepreneurship, culture and services. The centrality of the FSNT actor within the sub-networks indicates its strategic role in the education and innovation ecosystem, within the Alta Paulista region.

This arrangement of the actors of the social network and the centrality of the FSNT in the ecosystem points to its ability to disseminate information and act in roles of support for governance and project coordination, consolidating the FSNT as a strategic actor in the education and innovation ecosystem.

Table 4

Greater Centralities of the Evaluated Networks

NETWORK	ACTOR	Summary of the Major Network Centralities	
		Centrality	Central. Norm. (%)
GLOBAL	FSNT	10	5,5
	FSNTCULT	3	1,7
	FSNTEDUC	101	55,8
	FSNTEMPREEND	8	4,4
	GJACTO	6	3,3
	FSNTSERV	5	2,8
	FSNTPESQI NOV	55	30,4
INNOVATION	FSNTPESQI NOV	55	87,3
	FSNT	4	6,3
	G_JACTO	6	9,5
	MAINTAINER	4	6,3

*The sum of the values in the column of the normalized centralities may exceed 100% due to the contribution of the degrees of centrality of entry and exit of the actors.

Source: The authors.

The analysis of social networks, in this research, as instruments of inter-institutional cooperation revealed their strategic importance for the strengthening of competitiveness and innovation, as highlighted in the review, by the authors Mizruchi (2006), Kimura, Teixeira and Godoy (2004), as well as Balestrin and Vargas (2004), pointing out that the ordering of relationships favors access to business opportunities, it expands information flows and resources, and enables knowledge gains and risk sharing.

As described by Ahuja, Zaheer and Soda (2012), during the development of the research, it was necessary, in addition to identifying the actors and their links, to examine the structural configurations that emerge from the relationships, looking for patterns by individual preferences, economic interests or convergent goals, thus resulting in positive externalities such as unions, cooperatives or productive specialization in specific regions as indicated by

Burt (1992). Fusco (2005) contributed to the definition of the typology that classifies the networks studied.

In the field of cooperation, as indicated by Carvalho, Serra and Laurindo (2003), we observe vertical cooperation, in an interdependent chain. This perspective dialogues with organizational studies initiated in the 1970s, when Martes et al. (2006) identified that social relations between actors involve trust, shared interests and bonds of friendship, while Granovetter (1985) warned that the absence of relationships compromises information flows and opportunities for cooperation.

From a quantitative point of view, according to Sparrowe, Liden and Kraimer (2001), the parameters of density and centralization were calculated to understand the structure of the networks. As indicated by Bourdieu (1985), with the mapping of networks, it was possible to conceptualize social capital as the sum of resources accessible through the identified connections.

In the context of innovation ecosystems, as Etzkowitz and Leydesdorff (1995) pointed out, the triple helix between universities, companies, and government strengthens, in this network under study (research and innovation), the knowledge economy, a perspective expanded by UNESCO (2021) by including multiple agents in collaborative education and research environments.

Finally, we can highlight that, in Brazil, as evidenced by the authors Zuin and Queiroz (2019), agribusiness, combined with sustainable practices and cooperation networks, represents an opportunity for agri-food innovation, supported by universities, research centers, and cultural diversity. This scenario reinforces that the performance of institutions such as FSNT, by articulating Science, Culture, Innovation and Entrepreneurship in cooperation networks, contributes both to organizational efficiency and to generate positive social and economic impacts in line with the UN Sustainable Development Goals.

5 CONCLUSION

The analysis of social networks and the use of *Netdraw® software* to create the graphs allowed to obtain an integrated view of the general network and the sub-networks studied, indicating that the FSNT plays a central role as an agent of intersectoral integration, articulating Science, Culture, Innovation and Entrepreneurship in the same collaborative ecosystem, located in the Alta Paulista region.

FSNT's performance in a research and innovation ecosystem in a cooperation network structure strengthens internal organizational efficiency and contributes to expanding the positive social and economic impact of its actions, consolidating FSNT as a central actor in

the social network, in the institutional articulation for the technological, social and educational development of the community and Agribusiness.

This case study highlights the relevance of cooperation networks in education and innovation ecosystems, highlighting how the articulation between universities, companies, research centers, civil society and governments favors the exchange of knowledge, the collective construction of solutions and territorial transformation. The analysis of social networks, supported by the Netdraw® and UCINET® software, revealed low density in the global network and greater intensity of exchanges in the innovation sub-network, although insufficient to achieve full collaboration. The centrality of the FSNTEDUC and FSNTPESQINOV sub-networks confirms the strategic role of FSNT as an articulating actor in education, research and innovation, consolidating it as a central agent in the dissemination of information, coordination of projects and strengthening of governance.

These results dialogue directly with the UN Sustainable Development Goals. The work contributes to SDG 4 (Quality Education) by strengthening educational institutions and expanding access to knowledge; to SDG 8 (Decent Work and Economic Growth) by fostering innovation and entrepreneurship actions, especially in Agribusiness; and SDG 9 (Industry, Innovation and Infrastructure) by promoting interconnected environments that drive technology and knowledge infrastructure. In addition, territorial transformation and community strengthening are related to SDG 11 (Sustainable Cities and Communities), while the essence of the research — inter-institutional cooperation — is aligned with SDG 17 (Partnerships and Means of Implementation), reinforcing the importance of networks as instruments of sustainable development. Although the main focus of this research has been education, research and innovation, there are points of convergence with SDG 2, that is, it is related to SDG 2 to the extent that it highlights agribusiness as a field of impact, since the strengthening of networks can generate social, economic and technological effects, especially in this sector, connecting directly to the goal of promoting sustainable agriculture and increasing the productivity of smallholders. In addition, innovation ecosystems favor the development of technologies and practices applied to food production, capable of improving agricultural efficiency, reducing waste, and expanding access to nutritious food. The articulation between teaching and research institutions also plays a fundamental role, as it contributes to the training of professionals and the dissemination of knowledge that strengthens both food security and agricultural sustainability. Finally, the centrality of the Shunji Nishimura Technology Foundation demonstrates how an institution can coordinate collective efforts, aligning resources and actors in favor of innovative solutions, which

reinforces the importance of governance and cooperation to implement policies and practices that directly support the goals of SDG 2.

Thus, the investigation shows that improving the FSNT network, expanding its maturity and connectivity, strengthens internal organizational efficiency and enhances positive social, economic and technological impacts, consolidating FSNT as a strategic actor in the promotion of the SDGs in the Alta Paulista region.

The investigation fully fulfilled the objective of identifying the relationships established between the actors of a cooperation network in an innovation ecosystem, expanding the knowledge about its structure, intensity and dynamics. The analysis of social networks, supported by *the Netdraw® and UCINET® software*, allowed the visualization of the general network and its sub-networks, revealing patterns of interaction, levels of centrality and the influence exerted by different actors in common purposes. By relating these purposes to the UN SDGs, the research demonstrates that understanding cooperation networks meets the scientific purpose of mapping interactions, and contributes to the promotion of quality education, economic growth, innovation, sustainable communities and strategic partnerships. Thus, the study confirms that strengthening the FSNT network is essential to expand the maturity and connectivity of the ecosystem, being able to enhance its capacity to generate value and promote sustainable development in the Alta Paulista region.

ACKNOWLEDGMENTS

Special thanks to the PGAD Graduate Program in Agribusiness and Development, Faculty of Science and Engineering, Unesp, Tupã Campus.

REFERENCES

- Abramovay, R. (2000). A rede, os nós, as teias: Tecnologias alternativas na agricultura. *Revista de Administração Pública*, 34(6), 159–177.
- Ahuja, G., Soda, G., & Zaheer, A. (2012). The genesis and dynamics of organizational networks. *Organization Science*, 23(2), 434–448. <https://doi.org/10.1287/orsc.1110.0695>
- Balestrin, A., & Vargas, L. M. (2004). A dimensão estratégica das redes horizontais de PMEs: Teorizações e evidências. *Revista de Administração Contemporânea*, 8(Edição Especial), 203–227.
- Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *Ucinet® 6 for Windows: Software for social network analysis*. Analytic Technologies.
- Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2018). *Analyzing social networks* (2nd ed.). SAGE Publications.

- Bourdieu, P. (1985). The forms of capital. In J. Richardson (Ed.), *Handbook of theory and research for the sociology of education*. Greenwood.
- Bourdieu, P. (1983). O campo científico. In R. Ortiz (Org.), *Sociologia* (pp. 122–155). Ática.
- Brasil. (2004). Lei n.º 10.973, de 2 de dezembro de 2004. *Diário Oficial da União*.
- Brasil. (2005). Lei n.º 11.196, de 21 de novembro de 2005. *Diário Oficial da União*.
- Brasil. (2021). Lei complementar n.º 182, de 1º de junho de 2021. *Diário Oficial da União*.
- Burt, R. S. (1992). *Structural holes: The social structure of competition*. Harvard University Press.
- Carvalho, M. M. de, Serra, F. A. R., & Laurindo, F. J. B. (2003). Cooperação e competição em redes de empresas: Tipologia e mecanismos de governança. *Revista de Administração Contemporânea*, 7(número especial), 37–61.
- Cesar, M. (2018). Caminhos e legados: O sucesso dos irmãos Nishimura na construção de uma empresa familiar. Vila Poente.
- Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology*, 94, 95–120.
- Dias, C. N. (2011). Redes de cooperação social como estratégia para a implementação de políticas públicas: O caso da PNDR. In V Encontro de Estudos em Estratégia.
- Empresa Brasileira de Pesquisa Agropecuária. (1973). Empresa Brasileira de Pesquisa Agropecuária. <https://www.embrapa.br/>
- Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix–University-Industry-Government relations: A laboratory for knowledge-based economic development. *EASST Review*, 14(1), 14–19.
- Ferreira, T., & Vitorino Filho, V. A. (2010). Teoria de redes: Uma abordagem social. *Revista Conteúdo*, 1(3).
- Freeman, L. C. (1979). Centrality in social networks: Conceptual clarification. *Social Networks*, 1(3), 215–239.
- Freeman, L. C. (2004). *The development of social network analysis: A study in the sociology of science*. Empirical Press.
- Fusco, J. P. A. (2005). *Administração de empresas em redes: Uma visão do relacionamento interorganizacional*. Atlas.
- Gil, A. C. (2021). *Métodos e técnicas de pesquisa social* (7ª ed.). Atlas.
- Grandori, A., & Soda, G. (1995). Inter-firm networks: Antecedents, mechanisms and forms. *Organization Studies*, 16(2), 183–214.

- Granovetter, M. (1973). The strength of weak ties. *American Journal of Sociology*, 78(6), 1360–1380.
- Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology*, 91(3), 481–510.
- Grupo Jacto. (2025). Relatório anual.
- Harary, F. (1969). *Graph theory*. Addison-Wesley.
- Kimura, H., Teixeira, M. L. M., & Godoy, A. S. (2004). Redes sociais, valores e competências: Simulação de conexões. *Revista de Administração Contemporânea (Edição Especial)*, 42–57.
- Lauxen, S. L. (2024). A importância das redes colaborativas no processo de internacionalização da educação superior. *Revista da FAEEBA: Educação e Contemporaneidade*, 33(73), 36–52.
- Lavie, D. (2006). The competitive advantage of interconnected firms: An extension of the resource-based view. *Academy of Management Review*, 31(3), 638–658.
- Lazzarini, S. G. (2008). *Empresas em rede*. Cengage Learning.
- Marchiori, M. (2024). *Comunicação e agronegócio: Propósitos e impactos (Vol. 3)*. M. Marchiori.
- Marteletto, R. M., & Oliveira e Silva, A. B. (2005). Redes e capital social: O enfoque da informação para o desenvolvimento local. *Ciência da Informação*, 33(3).
- Martes, A. C. B., et al. (2006). Fórum – Redes sociais e interorganizacionais. *Revista de Administração de Empresas*, 46(3).
- Minayo, M. C. S. (Org.). (2009). *Pesquisa social: Teoria, método e criatividade*. Vozes.
- Mizruchi, M. S. (2006). Análise de redes sociais: Avanços recentes e controvérsias atuais. *Revista de Administração de Empresas*, 46(3).
- Morais, M. (2019). *Fundação – Educação e inovação*. Vila Poente.
- Olave, M. E. L., & Amato Neto, J. (2001). Aglomerados industriais e redes de empresas: Uma abordagem conceitual. *Gestão & Produção*, 8(3), 289–303.
- Organização das Nações Unidas. (2013). População mundial deve atingir 9,6 bilhões em 2050, diz novo relatório da ONU. <https://brasil.un.org/>
- Organização das Nações Unidas. (2023). Indicadores brasileiros para os objetivos de desenvolvimento sustentável. <https://odsbrasil.gov.br/home/agenda>
- Smolka, R. B. (2006). *Redes de cooperação entre EBTS do setor médico-hospitalar da região de São Carlos, Araraquara e Ribeirão Preto (Dissertação de mestrado, Universidade Federal de São Carlos)*.

- Sparrowe, R. T., Liden, R. C., & Kraimer, M. L. (2001). Social networks and the performance of individuals and groups. *Academy of Management Journal*, 44(2), 316–325.
- Szwarcfiter, J. L. (1984). *Grafos e algoritmos computacionais*. Campus.
- Thompson, G. F. (2003). *Between hierarchies and markets: The logics and limits of network forms of organization*. Oxford University Press.
- Tigre, P. B. (2006). *Gestão da inovação: A economia da tecnologia no Brasil*. Elsevier.
- UNESCO. (2021). *Reimagining our futures together: A new social contract for education*. <https://unesdoc.unesco.org/ark:/48223/pf0000379707>
- Verschoore Filho, J. R. S. (2006). *Redes de cooperação interorganizacionais: A identificação de atributos e benefícios para um modelo de gestão* (Tese de doutorado, Universidade Federal do Rio Grande do Sul).
- Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge University Press.
- Watts, D. J. (1999). *Small worlds: The dynamics of networks between order and randomness*. Princeton University Press.
- Zuin, L. F. S., & Queiroz, T. R. (2019). *Agronegócios* (2ª ed.). Saraiva Educação.

LAW, VIRTUE AND SUBJECTIVITY: JUSTICE AND ETHICAL FORMATION IN BOOK V OF THE NICOMACHEAN ETHICS

LEI, VIRTUDE E SUBJETIVIDADE: JUSTIÇA E FORMAÇÃO ÉTICA NO LIVRO V DA ÉTICA NICOMACHEIA

LEY, VIRTUD Y SUBJETIVIDAD: JUSTICIA Y FORMACIÓN ÉTICA EN EL LIBRO V DE LA ÉTICA A NICOMAQUEA



<https://doi.org/10.56238/sevened2026.008-135>

Juscelino Silva¹, Rafael Raimundo Oliveira Albuquerque², Edson da Silva Barros³,
Thayline Pereira da Silva⁴, Roseane Henrique Viana⁵, Cezar Ricardo Lima Neves⁶,
José Domingos Alves dos Santos⁷, Nubia Silva Costa⁸

ABSTRACT

This article examines the relationship between law and subjectivity based on Book V of Aristotle's Nicomachean Ethics, focusing on the articulation between legal normativity and the ethical formation of the subject. The central problem addressed concerns how legal justice depends on previously constituted subjective dispositions and to what extent the effectiveness of law presupposes an ethical education of the psychē. The guiding hypothesis is that, in Aristotle, law (nomos) does not operate autonomously, but achieves effectiveness through its mediation with habit (hexis) and the containment of excess (hybris), revealing a mutual implication between legal order and moral subjectivity. Methodologically, the study adopts a philosophical-hermeneutical reading of Book V, structured around three conceptual triads: nomos–hexis–hybris, aretē–dikē–adikia, and dikaiosynē–dikaion–dikaioi. The analysis demonstrates that Aristotelian justice cannot be reduced to formal legality, since it requires the integration of law, virtue, and prudent judgment, thereby assigning a constitutive role to subjectivity in the realization of justice. The article concludes that this perspective offers a significant contribution to legal philosophy by showing that the legitimacy and effectiveness of legal norms depend on their alignment with ethical formation and the ethos of the political community.

¹ Postdoctorate fellow in Philosophy of Law. Universidade Federal de Minas Gerais (UFMG).
E-mail: Juscelinus8@gmail.com

² Master's degree of Philosophy. Universidade Estadual de Roraima (UERR).
E-mail: Rafaelcogitoergosum@gmail.com

³ Specialist in Philosophy. Universidade Estadual de Roraima (UERR).
E-mail: Edsonbrilhantemente98@gmail.com

⁴ Master's student in Philosophy. Universidade Estadual de Roraima (UERR). E-mail: thaylinepds@gmail.com

⁵ Master's student in Philosophy. Universidade Estadual de Roraima (UERR). E-mail: hroseane@gmail.com

⁶ Master's student in Philosophy. Universidade Estadual de Roraima (UERR).
E-mail: cezarnesgeo@gmail.com

⁷ Master's degree of Philosophy. Universidade Estadual de Roraima (UERR).
E-mail: Santdomi50.rr@gmail.com

⁸ Master's student in Philosophy. Universidade Estadual de Roraima (UERR). E-mail: nscd.31@gmail.com

Keywords: Law. Subjectivity. Justice. Aristotle. Nicomachean Ethics.

RESUMO

Neste artigo investiga-se a relação entre direito e subjetividade a partir do Livro V da *Ética Nicomaqueia* de Aristóteles, examinando como a normatividade jurídica se articula com a formação ética do sujeito. O problema central consiste em compreender de que modo a justiça legal depende de disposições subjetivas previamente constituídas, e em que medida a eficácia do direito pressupõe uma educação ética da *psyché*. Parte-se da hipótese de que, em Aristóteles, a lei (*nomos*) não atua de forma autônoma, mas encontra sua efetividade na mediação com hábitos (*hexis*) e na contenção da desmesura (*hybris*), o que revela uma mútua implicação entre ordenamento jurídico e subjetividade moral. Metodologicamente, adota-se uma leitura filosófico-hermenêutica do Livro V, estruturada a partir de três tríades conceituais: *nomos–hexis–hybris*, *areté–diké–adikia* e *dikaiosynē–dikaion–dikaioi*. Como resultado, demonstra-se que a justiça aristotélica não se reduz à legalidade formal, mas exige a integração entre lei, virtude e julgamento prudencial, conferindo à subjetividade um papel constitutivo na realização do justo. Conclui-se que essa concepção oferece uma contribuição relevante para a filosofia do direito, ao evidenciar que a legitimidade e a eficácia das normas jurídicas dependem de sua correspondência com a formação ética dos sujeitos e com o *ethos* da comunidade política.

Palavras-chave: Direito. Subjetividade. Justiça. Aristóteles. *Ética Nicomaqueia*.

RESUMEN

Este artículo investiga la relación entre derecho y subjetividad a partir del Libro V de la *Ética a Nicómaco* de Aristóteles, examinando cómo la normatividad jurídica se articula con la formación ética del sujeto. El problema central consiste en comprender cómo la justicia jurídica depende de disposiciones subjetivas previamente constituidas y en qué medida la eficacia del derecho presupone una educación ética de la psique. Parte de la hipótesis de que, en Aristóteles, el derecho (*nomos*) no actúa de forma autónoma, sino que encuentra su eficacia en la mediación con los hábitos (*hexis*) y en la contención del exceso (*hybris*), lo que revela una implicación mutua entre el orden jurídico y la subjetividad moral. Metodológicamente, se adopta una lectura filosófico-hermenéutica del Libro V, estructurada a partir de tres tríadas conceptuales: *nomos–hexis–hybris*, *areté–diké–adikia* y *dikaiosynē–dikaion–dikaioi*. Como resultado, se demuestra que la justicia aristotélica no se reduce a la legalidad formal, sino que requiere la integración del derecho, la virtud y el juicio prudencial, confiriendo a la subjetividad un papel constitutivo en la realización de la justicia. Se concluye que esta concepción ofrece una contribución relevante a la filosofía del derecho, al destacar que la legitimidad y la eficacia de las normas jurídicas dependen de su correspondencia con la formación ética de los individuos y con el *ethos* de la comunidad política.

Palabras clave: Derecho. Subjetividad. Justicia. Aristóteles. *Ética a Nicómaco*.

1 INTRODUCTION

The relationship between law and subjectivity has been one of the central problems of practical philosophy since Antiquity, reappearing, under different formulations, in contemporary debates on normativity, legal legitimacy and the formation of the subject. Although the modern tradition of law has favored formalistic and institutionalist approaches, there is a growing focus on the subjective dimension of legal normativity in the human and social sciences, especially with regard to the internalization of norms, the ethical training of agents, and the social conditions for the effectiveness of law. In this context, the Aristotelian reflection on justice, developed in Book V of the *Nicomachean Ethics*, remains a fundamental theoretical reference, although often underexplored in its potentiality for the analysis of the articulation between law, ethics and subjectivity.

The problem that guides this article is to understand how, in Aristotle, legal justice is not only based on the exteriority of the norm, but presupposes previously constituted subjective dispositions, formed within the community ethos. In other words, it investigates to what extent the efficacy and legitimacy of the law depend on a continuous mediation between the legal system and the ethical formation of *psychē*. The hypothesis defended is that, in Aristotelian thought, law (*nomos*) does not operate autonomously or merely coercively, but finds its effectiveness in the articulation with habits (*hexis*) and in the containment of immeasurability (*hybris*), which reveals a mutual structural implication between legal normativity and moral subjectivity.

The literature specialized in the philosophy of law, when returning to Aristotle, tends to emphasize above all the distinction between legal justice and private justice, or even the notion of equity (*epiēikeia*) as a corrective of the law. However, the systematic analysis of the role of ethical subjectivity in the realization of justice remains relatively marginal, especially when considered from the internal categories of Book V. In this article, we seek to contribute to this debate by showing that Aristotelian justice cannot be adequately understood without taking into account the formation of character, the education of the passions and the exercise of prudential judgment. elements that link the law to social practices and to the concrete experience of political life.

Methodologically, a philosophical-hermeneutic approach is adopted, based on the analytical reading of the Greek text of the *Nicomachean Ethics* (Bekker's edition), articulated with classical and contemporary commentaries. The investigation is organized from three conceptual triads that structure the relationship between law and subjectivity in Aristotelian thought: *nomos–hexis–hybris*, which makes explicit the tension between law, habit and excess; *areté–diké–adikia*, which articulates virtue, justice and injustice in the realm of human

actions; and *dikaiosynē–dikaion–dikaios*, which allows us to understand the role of judicial institutions, the fairness of decision-making and prudential judgment. These triads are not treated as isolated categories, but as interdependent conceptual nuclei, whose unity reveals the inseparability between ethics and law.

In developing this analysis, it is argued that justice, in Aristotle, is not reduced to formal conformity with the law, but requires the integration between normativity, virtue and practical judgment, conferring on subjectivity a constitutive role in the realization of justice. Such a perspective allows for a critical rethinking of contemporary conceptions of law that dissociate legality and ethical formation, offering theoretical subsidies for current debates on legal legitimacy, civic education and institutional rationality.

The text is organized as follows: in the first section, the triad *nomos–hexis–hybris* is analyzed, highlighting the relationship between law, habit and immeasurability; in the second, the triad *aretété–diké–adikia* is examined, focusing on the articulation between virtue, justice and injustice; in the third, the triad *dikaiosynē–dikaion–dikaios* is discussed, addressing judicial institutions, the fairness of the decision and the role of the judge; Finally, the conclusion summarizes the results and points out theoretical implications for contemporary philosophy of law.

2 NOMOS-HEXIS-HYBRIS

The triad *nomos-hexis-hybris*, in the "Nicomachean Ethics", points to a circularity between law, *nomos*, the *hexis*, the habit, and the *hybris*, the impulse, which must always be considered by legal science in the creation and improvement of the law. The relationship between Law and Subjectivity occurs in the imperative of the law on excessive impulses and in the approval of good habits. Although *nomos-hexis-hybris* is a triad in Aristotelian thought, it is convenient to separate them in order to process the systematic examination.

2.1 NOMOS

□□□□s, law, is the right of the community set forth in a constitution. In the Nicomachean Ethics, the law translates the legacy of the *communitarian ethos*. The community has learned the hard way what promotes *eudaimonia*, happiness, and what destroys it. So he took this experience into code. As a result, people learn from the law what should be done and what should not be done. The first is linked to honor within the community and the second is linked to punishments. This distinguishes customary law from legal law. But the relationship between *nomos-hexis-hybris* is explosive because it is a struggle between reason and desire.

It can then be said that there is no city without justice and there is no political justice without law, that is, without a constitution. And every constitution, even the depraved one, remains a constitution if what it determines is observed. However, justice is only based on legality when the law is established not for a few, but for the good of the whole city. On the contrary, when laws are poorly formulated or made in haste, justice is not instituted, but the legalization of injustice is.

Good constitutions establish justice without reserve, because in this case they aim at the common good. In flawed constitutions, laws can only be relatively just, because they are diverted from their purpose, serving the particular interest of some (BODÉÜS, 1999, p. 71-82). But when laws create and ensure the conditions of good living, that is, when they are just according to natural justice, as proposed by Aristotle, they are actually aligned with the notion of justice shared by society. According to Aristotle, the rectitude of laws or the function of laws in the constitution should require citizens to behave in a way that has the virtuous man as a model. Good legislation is concerned, above all, with the virtue and vice of the citizen.

It must, therefore, order the laws according to the good of the city. For this reason, even today, it cannot be denied that they refer to acts of virtue such as courage, temperance, etc., which are the moral virtues. But they must also favor the flourishing of the dianoetic virtues, that is, episteme or scientific knowledge, tekne or art, phronesis or practical wisdom, nous, or intuitive reason, sophia or theoretical wisdom.

Therefore, for Aristotle, the content of legal justice has a deep correspondence with the virtue of justice. Hence the law, rightly established, is just, because it ordains in a particular way what is ordained in the moral virtues. So that if citizens act as the law prescribes, they only do what they already possess by habit. In this case, action according to the law is always just, because it requires the same acts that the virtues require.

Justice corresponds to the prescribed laws, so they show people how to behave according to the morality of the city (ARISTOTLE, 1856, V, 1130 b, 22-24), that is, the unwritten laws. At this point, Aristotle recovers the proverb of Theognis: "justice is the sum of all the virtues" (ARISTOTLE, 1856, V, 1129 b, 30). In other words, justice is the complete virtue because the law receives the notion of right and wrong that society constructs and orders social behaviors to be in accordance with its prescriptions. Since this demand is very broad, only the virtuous citizen can respond to it, that is, live to each social demand in accordance with virtue. For this reason, in an inverted way, it is said that the law is the complete virtue (ARISTOTLE, 1856, V, 1130 b, 6; 18-19 ; 23:25). Since then, virtue is not

only the architectural virtue of the soul, but is recapitulated in social and political relations. Thus, the virtue of justice favors social relations and necessarily preserves all virtues in itself.

Justice as legal justice is the "complete virtue par excellence", that is, an action exercised in the face of the other for the good of him, of the community and for the good of the agent of justice himself. Justice, then, does not consist in knowing all the virtues that the law commands, but in practicing them. In this case, he who practices justice to himself is virtuous and he who is unjust to himself is vicious; However, just or unjust is the one who performs just or unjust acts to his neighbor. Therefore, justice can be affirmed as virtue in its entirety and injustice as vice in its entirety.

It is then perceived that justice and virtue are complementary entities, although they originate from the same source: the hexis, the habit. Justice is the habitual state of character in relation to the other; virtue, on the other hand, is an inner condition that reflects character. Thus, justice and virtue are one and the same thing, but while the former aims at the other, the latter aims at interiority.

The law sets the guidelines for legal behavior and people are expected to behave in accordance with them. But the laws of the city are not enough if the inner law that comes from *Paideia*, education, is lacking, which will introduce the person to the *ethos* of the community. In this process, he learns to love and respect his tradition, but in a critical way. The result may be a person who, having internalized the *ethos* of the community, is happy to respect the laws, as long as they are fair. This perspective appears in Salgado precisely:

From the perspective of a philosophical reflection on its reality, law is an ethical totality that develops historically and phenomenologically as a full ethical realization or as the last moment of the ethical process, that is, as the realization of freedom in its subjective and objectified form, norm right and subject right, from man in the form of the Greek citizen [...] This procedural rationality is, in the same way, at the moment of objectified freedom or of the norm, as occurs in the awareness of the legality of the highest values of Western culture, of their declaration as rights and of their effectiveness (SALGADO, 2006. p. 3).

In addition to its normative function, the Aristotelian *nomos* can be understood as a formative device that acts in the constitution of the subjectivity of citizens. By prescribing behaviors and sanctioning deviations, the law not only externally regulates actions, but contributes to the internalization of shared ethical standards, operating as a mediation between community *ethos* and individual action. This understanding allows us to bring Aristotelian reflection closer to contemporary debates on the symbolic efficacy of norms and on the processes of internalization of legality, in which the formal validity of the law is insufficient when dissociated from subjective provisions capable of recognizing it as

legitimate. Thus, *nomos* reveals itself not only as a juridical instrument, but as a constitutive element of ethical and social life.

This understanding of the law as an expression of a shared ethos allows us to bring the Aristotelian conception closer to contemporary debates on the legitimacy and effectiveness of law. As Paul Ricoeur observes, justice is not reduced to formal conformity with the norm, but requires ethical and institutional mediations capable of articulating legality and mutual recognition, which replaces subjectivity at the center of legal normativity (RICOEUR, 2008). In a convergent way, Amartya Sen criticizes excessively abstract models of justice and argues that the validity of norms depends on their ability to respond to concrete contexts of life and to real experiences of injustice (SEN, 2011). This approximation reinforces the Aristotelian thesis according to which the *nomos* is only fully realized when it finds resonance in the ethical dispositions of citizens.

But how does the internalization of the *community ethos* occur ? This is what we will see next.

2.2 HEXIS

The just act can only come from a just person. In the "Nicomachean Ethics", this procedure is supported by a disposition, *ἥξις* - *hexis* -, which is constructed to the extent that the person exercises himself in just actions. *Hexis* gives man the ability to perceive what is just and to act according to this perception. Through it, one has the necessary power to act justly. It is then a question of a second power, because it derives from the process of making oneself, which is proper to the practical action of Aristotelian thought. Therefore, the one who has reached *hexis* only acts according to it. Such a man may be compared to a healthy man, for just as a healthy man would not normally walk like a sick man, so a righteous man is incapable of acting unjustly. Therefore, like health that enables a healthy man to act healthily, justice enables the righteous actions of a just man.

However, each circumstance requires just actions appropriate to it. In this case, the mere mechanical repetition of justice may not carry it out, so it must be exercised according to the circumstances. If these vary, the way of acting must also change. Thus, the Aristotelian notion of *hexis* is that it is the habitual state of character and when man is in this condition, he possesses the virtue of justice because what his society sees at that moment as just and circulates within him, is what this man has become. In this sense, righteousness is the virtue of character, because it stems from habit and practice. Therefore, it is not to be confused with the power that someone special would exercise, and it is also not to be confused with the

episteme of justice, as the Socratic tradition defends. In other words, Socrates assumed that if someone knows what is just, he will practice justice. Opposing this idea, Aristotle says:

Undoubtedly, the pure knowledge [20] of beautiful things is already a very significant choice in itself; but for virtue, the essential and most precious point is not to know its nature; it is to know how it is formed and how it is practiced. We must not only know what courage is, we must above all be courageous; neither what righteousness is, but to be just; Similarly, we want health, rather than to know what it is; and to possess [25] a good temperament, but than to know what a good and robust temperament is (ARISTOTLE, 1856 [C], I, 5, 216 a, 18).

The Aristotelian notion of *hexis*, understood as a disposition incorporated through the repetition of actions, finds resonance in contemporary sociological analyses on the formation of practical schemes of conduct. Pierre Bourdieu, in developing the concept of *habitus*, describes similar processes of internalization of normative structures that guide perceptions and practices without the need for explicit coercion (BOURDIEU, 2007). This convergence allows us to understand justice, in Aristotle, not only as conscious adherence to the norm, but as an incorporated social practice, which reinforces the formative dimension of law and its dependence on educational and cultural processes.

It is then known that it is not enough to know justice, to be fair, it is necessary to practice. For this reason, Aristotle defines the just act as "[...] those acts that tend to produce and preserve, for political society, happiness and the elements that compose it" (ARISTOTLE, 1856, V, 1129b, 15). In this sense, justice is for this man the complete virtue "because it is the current exercise of complete virtue", that is, the idea of justice that his society has achieved and preserves in its history, both on the legal and moral levels. But it is also the particular virtue, because it is the human conquest of this man in the face of his *hybris*, in other words, that instinctive force that leads man to practice folly.

The virtues are of two natures. Intellectual virtue generally derives from systematic teaching, so it demands a lifelong learning process under the aegis of an advisor. Moral virtue, in turn, derives from habit: "It is not, therefore, by nature, nor contrary to nature, that virtues are generated in us. Let it be said rather that we are adapted by nature to receive them and become perfect by habit" (ARISTOTLE, V, 1103a, 20). Aristotle reserves the concept of mediocrity for the moral virtues: "[...] virtue must have the attribute of aiming at the middle ground. I refer to moral virtue, because it is that which concerns the passions and actions, in which there is excess, lack and a middle ground" (ARISTOTLE, V, 1106b, 15).

In this case, the inevitable question arises: how to know if a man is intellectually virtuous since this is not identified by mediocrity as the moral virtues are? The answer lies in the role that reason plays in the passion and its fulfillment by the body. It is she who gives the

right measure of all virtuous actions. This is his virtue. But if it does not adequately fulfill this function, then it is a vicious reason. For this reason, Aristotle states that "it is right reason that sets the middle ground of dispositions of character." This is his virtue because in Aristotelian ethics "the virtue of a thing is relative to its proper functioning" (ARISTOTLE, V, 1139a, 15).

To be intellectually virtuous is to have the ability to continually order one's dispositions of character according to the communitarian ethos. According to Aristotle "[...] the reasoning must be true as the desire is right for the choice to be right, and the second must seek exactly what the first affirms" (ARISTOTLE, V, 1139a, 25). The efficient cause of action is choice, and the efficient cause of choice is desire and reasoning with an end in view. What helps man on the path of virtue is, in part, the set of virtues and actions that correspond to them: "[...] man's virtue will also be the disposition of character that makes him good and that makes him perform his function well" (ARISTOTLE, V, 1106a, 20). Add to this the capacity for discernment and the implementation of appropriate behaviors in the face of different situations. Therefore, although the communitarian *ethos* points to a general framework of behaviors to be expected in specific situations, it stimulates virtuous behaviors by rewarding them with honors and demonstrates its indignation with vicious behaviors, in the last instance, it is only up to man in full possession of his freedom to achieve *eupraxia*, that is, his own excellence. (ARISTOTLE, V, 1105b, 10).

Since virtue is the result of the rational orientation of passion towards a mediocrity in which lack and excess are overcome by the discovery of the point of equilibrium, its acquisition is the result of continuous exercises in just actions (ARISTOTLE, V, 1103a, 30).

Therefore, also in the virtues, man is the father of his actions as he is of his children. It is in the repetitive friction between impulses and reason that character is forged. To the extent that one is determined and disciplined and puts the passions in the way of virtue, then gradually one becomes virtuous:

We take it for granted, then, that virtue has to do with pleasures and pains; that, by the same acts from which it originates, it is both increased and, if such acts are performed in a different way, destroyed; and that the acts from which virtue arose are the same in which it is actualized (ARISTOTLE, V, 1105a, 15).

The virtuous man can fall into vice as long as he relaxes in discipline and relapses into vicious behaviors. This is because virtue is associated with practical life (ARISTOTLE, V, 1103b, 10-25).

In this case, one must act virtuously all one's life, because otherwise virtue can make a man who was once virtuous. According to Aristotle, "[...] it is in the nature of these things to be destroyed by lack and excess [...]" (ARISTOTLE, V, 1104a, 10).

Aristotle observed that most people are more listeners than active. They think that only by listening do they become virtuous people (ARISTOTLE, V, 1105b,10) so they do not pay attention to the quality of their acts and are naïve about the origin of their character. But, as one who has already conquered this existence limited to himself, the virtuous man, to the extent that he continues to exercise himself in virtue through virtuous actions in his community, moves towards the good life: happiness.

In short, virtues are "dispositions of character" that are acquired through long apprenticeship. It is through discipline and determination that a man becomes virtuous. Virtue in the moral sphere is mediocrity and in the *dianoetic* it is right judgment. Therefore, virtue stems from an act of freedom, however, it must take into account the communitarian *ethos* because it was built through a long process in which previous generations, through painful experiences, selected a range of virtues and vices to facilitate future generations access to happiness without having to discover, from my own experience, all over again. But even so, the crucial challenge of virtue remains, that is, not to err by lack or excess, but to find its just measure in each case. Therefore, the crucial task of reason is to find the median of impulse. From this equilibrium, or from its lack, virtue and vice arise, respectively.

The notion of *hexis*, understood as a disposition acquired by the repetition of actions, allows us to interpret justice not as mere intellectual adherence to the norm, but as a practice incorporated into the subjects' way of acting. This conception anticipates central problems of contemporary social theory, especially those related to the formation of practical dispositions and the daily reproduction of normativity. By emphasizing that justice depends on consolidated habits, Aristotle shifts the focus from legal coercion to ethical formation, indicating that the stability of legal institutions is directly linked to the quality of educational processes and the social practices that shape the character of citizens.

2.3 HYBRIS

ὕβρις is a Greek word that transliterates as *hybris*. It is the immeasurable impulse in which desire overcomes reason and the person, in order to satisfy it violates the laws of the city. Just as the just act proceeds from the just man, so the unjust act proceeds from the unjust man. The unjust reached this condition because by constantly acting against the law, he built up a disposition of character, which since then, makes him desire what is unjust, what violates the law of the city. He does this driven by greed and with that, he seeks his pleasure to the detriment of the collective happiness that the laws seek to safeguard. In injustice, man seeks his own good by doing evil to others. With this, he becomes improper. It is unjust and, at the same time, to the extent that its acts create the idea of injustice, the unjust, vicious act

is complete injustice. This force that leads human beings to act outside the community norm is *hybris*.

Impulses belong to the body. These, of course, aim at pleasure and avoid pain. Because they are directed exclusively to their satisfactions, impulses participate in the "appetitive principle" of the soul and can be defined as the primitive stage of desires. Consequently, they are opposed to reason, however, not altogether because they can be persuaded by it (ARISTOTLE, V, 1103a, 30). It is in the mediation of the relationship between impulse and reason that the intellectual virtues (philosophical wisdom, understanding and practical wisdom) and moral virtues (liberality, temperance, etc.) are situated.

Aristotle called impulses passions. These, in turn, are generally morally neutral, that is, they are neither vices nor virtues in themselves. They will only move to these conditions after being submitted to the sieve of personal decision within the horizon of the *communitarian ethos* (ARISTOTLE, V, 1107a, 15). They can be defined as the forces, socially recognized, that move man towards the satisfaction of a desire with a view to pleasure. In this they are distinguished from vices and virtues because: "[...] with regard to virtues and vices it is not said that we are moved, but that we have such and such a disposition" (ARISTOTLE, V, 1106a, 5).

Impulses are desiring forces aimed at pleasure, passions are socially recognized impulses. Thus, in a broader perspective, impulses and passions are synonymous. What seems to differentiate one thing from the other is that pure impulses would still be in a nameless condition, that is, they do not yet have social recognition, which is why they are generically called impulses. But when they receive a name, lasciviousness, for example, they become a passion, that is, a socially recognized impulse. When an impulse is given a name it is passion, before that it is only impulse because it has not yet been identified by the culture. Pleasures and pains are linked to passions, so man moves in the world according to the principle of pleasure. These dynamize and actualize man's actions in the world and, therefore, can condition behaviors both virtuously and viciously.

Salgado, in the three conferences given in 2012 at the Faculty of Law of the University of São Paulo, namely: Greek culture: the discovery of reason; II- Theoretical reason as a measure: science and truth; III- Practical reason: ethics and reason as a measure, affirms the logocentric tendency of Western reason. The general title of the conferences translates the clash of objectivity with subjectivity clearly: "The spirit of the West, or reason as measure". Salgado translates the dialectic of subjectivity and objectivity, as follows:

So, here appears the first important theme of society, power and, on the other hand, the perversion of power, of course. The perversion of power is arbitrariness and

violence. It is the excessive. For the Greek, it is tyranny, the loss of the freedom of a people, of its autonomy, that is, the loss of the power to make its own laws, to draw its own limits, because the power of reason, which is one *we*, is alienated in the arbitrariness of an *I*, of a single one. The *we* is the moment proper to reason, which carries within itself a whole dialectical process involving the consciousness opposed to its exterior, to the object, by the consciousness of itself, always as an opening to the object until the consummation of a *we*, which is also an "*I*" as Hegel describes in the *Phenomenology of Spirit* (SALGADO, 2012, p. 44)

In the intrigue between subjectivity and objectivity is, according to Aristotle, the desire for pleasure and the escape from pain. Consequently, there is an intricate relationship between pleasure, pain and moral life, and it is as a result of the resolutions within these instances that man approaches or distances himself from happiness. This close relationship between pleasure and pain and its implications in the moral life can be seen throughout Aristotelian ethics. Listen to Aristotle:

[...] Moral excellence is related to pleasures and pains. It is because of pleasure that we do evil deeds, and because of pain that we abstain from noble actions. That is why we should be educated in a certain way from our youth, as Plato says, in order to delight in and suffer from the things that should be the cause of delight or suffering, for this is the right education (ARISTOTLE, V, 1104b, 5, 10).

It seems that for Plato it is not only pleasures that lead to a profitable end, pains also do this. Therefore, it is necessary to distinguish between pains that are totally harmful and pains that lead to pleasures. Only an education conscious of these nuances can educate effectively because it makes the organic automatism that pleasure does not bring pain and that pain does not bring pleasure would then be overcome by education.

The Aristotelian conception of pleasure was confronted with three opinions current in his time: 1) no pleasure is a good because, among other things, the temperate man avoids pleasures; 2) most pleasures are bad because pleasures are harmful and vile; 3) even if all pleasures are good, the best thing in the world is not pleasure because "[...] this is not an end, but a process" (ARISTOTLE, V, 1152a, 10-15). For Aristotle, these premises do not deprive pleasures of the value of good because: 1) goods considered evils can be chosen or rejected; 2) there are goods that involve neither pleasure nor pain; 3) pleasure is an activity of the natural state, it is not a process (ARISTOTLE, V, 1152b-1153a). Therefore, man's action is composed of two inseparable sides. Pleasure and pain. The first is sought; the second, it is avoided. Both can be physical or mental.

Pain is a feeling of displeasure, which, depending on the intensity, will provoke reflex reactions in the body. By virtue of continuous experiences, man accumulates a preventive knowledge of what can cause him pain and, therefore, avoids it. Passion, on the contrary, is

the force that moves man to pleasure and manifests itself in multiple ways. It is in itself neither vice nor virtue. It will only be so if the limits that define something as virtuous or vicious are crossed. What helps in distinguishing between pure passions and vicious or virtuous passions is the capacity for decision. Therefore, one must distinguish between "voluntary and involuntary action." If man acts out of ignorance of the limit or coerced, we have the latter. In the voluntary one, on the other hand, the man acts consciously. In this case, he was seduced by his desire. *A priori* this is neither good nor bad (ARISTOTLE, V, 1110a, 1110b, 15).

When it comes to violent passions, Aristotle states that "[...] irrational passions are not considered less human than reason; Consequently, even the actions that proceed from anger or appetite are actions of man. It would be strange, therefore, to treat them as involuntary" (ARISTOTLE, V, 1111b). It is precisely in the realm of choice that the possibility of vice or virtue lies, because man makes himself by doing.

Pleasures are physical and/or mental sensations that promote a sense of well-being. The pains, on the contrary, of malaise. However, pleasures can be bad and pains can be good and vice versa. Aristotle understands human behavior as an integrated articulation between the psychic and the physical. Impulses or appetites propel the body towards satisfaction and it is up to reason, in harmony with the community *ethos*, to put a profitable end to impulses both on the individual and social levels. Continuous, voluntary and conscious praxis makes a man virtuous or vicious.

Vices and virtues come from the same source: impulses. So, how and when does a passion become an addiction? This occurs when the passion executed does not reach the right measure. It is clear that this evaluation does not come from the one who practices the vicious act, but from the one who evaluates it from the horizon of the *community ethos*. Thus, when someone externalizes a passion, he runs the risk of doing so below or beyond the just measure because he aimed solely and exclusively at the satisfaction of his appetites. Whoever acts in this way violates the rights of others, therefore, destabilizes the community to the extent that he attacks its symbolic universe.

In Aristotelian logic, vices are the extremes of virtue: "[...] vices either go too far or fall short of what is convenient with regard to actions and passions [...]" (ARISTOTLE, V, 1107a, 5). From this it follows that it is easier to be vicious than virtuous because vice can be achieved in different ways and at different points in the extremities of passion. Therefore, it can be deduced that being vicious is the result of decisions. Vices are acquired voluntarily and deliberately. A person is not vicious, he makes himself.

Man becomes vicious or virtuous after deliberately repeating behaviors for a long time. In this way, they automatically integrate into the character. It is perceived that "man is the

father of his actions as he is of his children" (ARISTOTLE, V, 1114a20) and, therefore, on the moral plane, the parent of himself.

However, it may be that a person does not want to be vicious, but that this occurs due to an error of judgment. Now, like the virtuous man, it seems that the end to which the vicious man has in mind when he engages in vicious acts is happiness. But he does not find it because these, at first pleasurable, become painful to the extent that they are outside the standards of virtue of the *communitarian ethos*. Hence, the importance of education so that people can discover the appropriate means to be happy and contribute to the happiness of the community. It is in this context that the value of the *community ethos* emerges. The community's standards of behavior have been sanctioned after a long process of mistakes and successes, so they are vital to the community. If violated, the entire group is at risk. Therefore, the offender must receive in himself the punishment resulting from his fault. In this context, to become virtuous is to strengthen one's own community so that everyone enjoys the good life. On the contrary, to become vicious is to deliberately place oneself at the mercy of pure pleasure and to violate the *community ethos*. This puts at risk everything that the community has achieved so far. Therefore, the pleasurable vice in the beginning is, in the end, self-destructive because if one justified it because of the right to one's freedom, one would necessarily have to extend it to others, and a community where all desires were satisfied without objective ethical criteria would lead the group to dissolution.

In the context of Aristotelian ethics, when someone chooses to be vicious, it is forever. When one exercises in vice, the impulses are markedly strengthened and dispose the character in that direction, so according to Aristotle, no reconditioning is strong enough to re-educate him:

But when, without being ignorant, a man does things that will make him unjust, he will be unjust willingly. [...] at first it depended on them not to become men of this kind, so that it is by their will that they are unjust and intemperate; and now that they have become such, it is not possible for them to be different (ARISTOTLE, V, 1114a, 20).

Therefore, deliberately indulging in vices is not proper for adults, but for children. These, depending on their age, live driven by the search for pleasure and the avoidance of pain without the mediation of reason. The child's exclusive interest is pleasure, any frustration leads to crying because he is not yet mature enough to bear the frustrations. Similarly, the vicious man is still childish because he perceives and acts exclusively for pleasure:

These characteristics (referring to intemperance) belong above all to the appetite and to the child, since in reality children live at the mercy of appetites, and in them the

desire for pleasant things has more strength. If they are not obedient and submissive to the rational principle, they will go to great extremes, for in an irrational being the desire for pleasure is insatiable, although it experiences all the sources of satisfaction. Moreover, exercise increases his innate strength, and when the appetites are strong and violent, they go so far as to exclude the faculty of reasoning (ARISTOTLE, V, 1119a, 10).

What is expected of a wise man is that he manages his passions well in order to put them at the service of community life. At this time, the passions became virtues and now guided by right judgment:

[...] the appetites must be few and moderate, and not in any way opposed to the rational principle—and this is what we call obedience and discipline. And just as the child must submit to the direction of his preceptor, so the appetitive element must be subordinated to the rational principle (ARISTOTLE, V, 1119b, 15).

The harmony between impulses and reason is the fundamental principle of virtue and the path to happiness.

Vices are the two extremes of virtue, they proceed from impulses and result from errors of judgment as to satisfaction. They are voluntary and definitive, and it is proper to a childish character. The virtues, in turn, result from the correct management of impulses, so they are the middle ground of vices and are characteristic of wise men. While vices erode the *community ethos* and can lead the community to destruction, virtues strengthen and preserve it.

Having examined the triad *nomos-hexis-hybris*, we move on to the second triad of Aristotelian thought: *arete-diké-adikia*, respectively, virtue-justice-injustice.

3 ARETÉ-DIKÉ-ADIKIA

The Aristotelian triad *arete-diké-adikia*, respectively means virtue-justice-injustice. Law and Subjectivity are linked by the nature of the just or unjust actions of people in the community.

3.1 ARETE

ἁρετή, is a Greek word that transliterates into Portuguese as *Arete* and means virtue. This can be ethical, relative to correct behavior, and *dianoetic*, relative to right judgment. The virtues are "dispositions of character" (ARISTOTLE, V, 1106a, 10) related to choice. Its proper place is mediocrity. This central point is determined by reason, and a man endowed with practical wisdom finds it more easily (ARISTOTLE, V, 1107a, 5). Mediocrity is not predetermined by any determination external to the person, because for Aristotle it is man

who will choose, on each occasion, this appropriate place of virtue. Therefore, "the mediocrity is relative to us." From this it follows that "with regard to its substance and the definition that establishes its essence, virtue is a mediocrity; with reference to the supreme good and the just, it is, however, an extreme" (ARISTOTLE, V, 1107a, 5). Virtue is a disposition of character that is related to "[...] that makes him good and that makes him perform his function well" (ARISTOTLE, V, 1106a, 20).

Mediocrity is the excellence of virtue. It results from the overall action of the organism: the passions are guided by right reason. This means not excessively limiting your strength or giving you too much space. Desire is responsible for desiring, the body is responsible for feeling, reason is responsible for guiding. The interpretation of the reason of the desires of the body and of the *communal ethos* must take into account that every passion has the appropriate time, place and circumstances. These variables, when considered, are the fundamental conditions for practicing a virtuous action.

The understanding of virtue as median guided by practical reason allows us to articulate Aristotelian ethics with contemporary reflections on social normativity and the formation of subjectivity. Axel Honneth points out that the ethical dispositions of the subjects constitute contexts of intersubjective recognition, in which values and social expectations shape the self-understanding of individuals (HONNETH, 2009). From this perspective, *the Aristotelian areté* can be interpreted as a form of embodied ethics, whose realization depends on social practices that promote the recognition and integration of the subject into community life.

The object is the other aspect to be considered. It must be appropriate to that passion. If there are other people involved, the passions must be focused on the right people. That said, one must consider the convenience of the motives that are presiding over the action and whether the mode of satisfaction of desire is appropriate (ARISTOTLE, V, 1106b,20). Therefore, ultimately, the *community ethos* is the parameter of just actions. These are guided by the just rule. Aristotle, realizing the unstable nature of actions, stated that it is people who must decide on a case-by-case basis the most appropriate action in each situation:

As with health, questions of conduct and what is good for us have no fixity [...] people themselves must consider, in each case, what is most appropriate to the occasion, as is also the case in the art of navigation and medicine (ARISTOTLE, V, 1104a, 5).

The rational administration of desire leads to a virtuous act and, later, to a virtue (ARISTOTLE, V, 1119b, 20). The challenge of the moral act is to situate itself in the mediocrity of the action (ARISTOTLE, V, 1106b, 25). Excess and deficiency are the great adversaries of

just action. Consequently, the chances of making a mistake are greater than of getting the median of a stock right. For this very reason, lack and excess characterize vices and mediocrity, virtues. Aristotle states that one does not arrive at the median in a single action. But one makes mistakes today in order to get it right tomorrow: "It is quite clear, then, that in all things the middle ground is worthy of praise, but that sometimes we must incline to excess and sometimes to deficiency. Indeed, this is the easiest way to reach the middle ground and what is right" (ARISTOTLE, V, 1109b, 20).

Eupraxia is a lifelong task (ARISTOTLE, V, 1105b) and is more related to the other than to oneself. Therefore, "the best of men"[...] it is not the one who exercises his virtue towards himself, but towards the other. For what a difficult task this is" (ARISTOTLE, V, 1130a, 5). Men have all these things in common, and it is in the way they manage these inner forces that they will be more or less human. This is a complex and demanding task. Thus, according to Aristotle, one must have a certain natural inclination to virtue: "it is, therefore, an indispensable precondition for the existence of a character that has a certain affinity with virtue, loving what is noble and detesting what is vile" (ARISTOTLE, V, 1179b, 30; 1106 a, 30).

By understanding virtue as median guided by practical reason, Aristotle provides an ethical criterion that goes beyond normative rigidity and adapts to the complexity of concrete situations. This conception is particularly relevant for contemporary legal reflection, as it problematizes excessively abstract normative models and highlights the need to consider contexts, circumstances, and social relations in the evaluation of justice. Virtue, in this sense, is not only an individual quality, but a relational principle that manifests itself in political coexistence and in the search for balance between different interests.

3.2 DIKÉ

When one turns to the context of the "Nicomachean Ethics", one realizes that justice in Athens has a prominent religious force. Aristotle values it, however, he takes it only as a starting point since, on the philosophical level, he vetoes the extra-human interpretation of justice associated with the goddesses Θέμις - Themis - and Δίκη - Diké - (SAINT-ARNAUD, 1984, p. 158). He chooses to examine it in the actions of the people and in the adequacy of these actions with the law of □□□□□□ - *polis* -. Therefore, it cannot be denied that the understanding of justice in Book V, of the "Nicomachean Ethics", requires that one understand the notion of justice that prevails until then. Without this, one can even recognize Aristotle's originality, but one will have lost the opportunity to identify the other face of justice, the divine one with which he struggles.

According to Greek mythology, the goddess Themis, daughter of Uranus and Gaia, is the goddess of Justice, Law and Equity. In legal iconography, she is represented with a scale, a sword, and usually with a blindfold over her eyes. The scales serve to "weigh" the balance of the cosmos; the sword, the power to punish those who are out of their place and the blindfold over the eyes symbolizes the impartiality of the decision (GRIMAL, 1997, p. 435). However, Themis represents transcendent justice, that is, that which does not pass through judicial mediation. In the classical Western tradition, this points to the religious origin of justice. It means that, according to the myth, Themis punishes those who introduce disorder into the order of the world, that is, they place themselves in a place that is not their own. This is one of the possible interpretations of the famous phrase "know thyself", placed at the entrance to the Temple of Delphi. It follows that ὕβρις - *hybris* -, immeasurability, is the origin of chaos and of various forms of *adikia*, of injustice (FISCHER, 1992).

For this reason, the myth of Themis helps to understand that the first function of justice is to prevent the excesses of *hybris*, because man only escapes from them by remaining in his own place. If one is seized by some uncontrollable impulse and violates the law of the city, justice is simple and straightforward because it aims only at the restoration of the order of the world. Themis does not take into account the guilty's motives or his repentance. Therefore, it gives the legitimacy of justice, that is, it justifies the punishment imposed on the offender by the Erineas, the goddesses of vengeance (LÉVÊQUE; FESTUGIÈRE, 2011).

In the evolution of Greek justice, it is a moment prior to legal justice, because it is not possible to speak, until then, of the juridical sense of justice. But it is legitimate because it stems from the will of Themis. Therefore, justice often has no human mediator. It is "fate" itself that is responsible for punishing the guilty in answer to the prayer of the wronged:

I invoke Themis, the chaste daughter of Uranus, born of illustrious parents, Gaia's Generation, a virgin with beautiful eyes, who, first, reveals to men the sacred prophecies and oracles of the Gods in the Delphian temple and who also reigns over Pythius and the Pythians, and who gave King *Phoibos* the power to deliver oracles. O Illustrious, honored of all, who wanders in the night, you first taught men the sacred ceremonies and the nocturnal feasts of *Bakklos*. It is from you that they see the mysteries of the Blessed and the honors given to them. Come, O Blessed One, and be propitious, O Virgin, to those who are initiated into your mysteries (CALLIES, 2006).

The myth of Themis gradually gives way to the goddess Diké, whose mission is to watch over the actions of men, punishing or rewarding them. In this way, the justice of the city that is legitimized in the goddess Themis, achieves legality with Diké. Now the divine is closer to the human. Law is embodied in judicial institutions.

In the case of Athens' democratic justice, it can be said that positive law and natural law form a unity in which divine law has primacy. Therefore, tension, instead of bothering the jurist, is the ingredient that stimulates and qualifies his ability to judge. Hence follows the equity of justice. An equitable justice takes into account the particularity of individuals and contexts. It is not the strict application of the letter of the law, because it aims at legitimacy, in addition to strict legality (LALANDE, 1999, 605-606).

Δίκη, Diké, is the daughter of Zeus and Themis (HESIOD, 2007, 900-901), also known as *Astreia*, the goddess of the stars, and as *Dikaiosyne*, the spirit of justice. In Greek mythology, Diké is the goddess of Justice. However, unlike her mother, Themis, who watches over the cosmos, is more interested in men's issues. So he goes down to be with them. Diké opposes *Adikia*, that is, the spirit of injustice and wrong actions (SMITH, 2005, p. 1002).

According to the myth, the goddess approaches the throne of Zeus with lamentations when a judge violates justice (HESIOD, 2007, 239). The goddess strives to settle the differences and conflicts between men by indicating to them the means of conciliation. Therefore, it becomes the symbol of justice. However, not the cosmic justice of Themis, but that carried out by the judge, who is the one who humanizes the city by applying justice. Diké, according to Hesiod (1996), appears in the world of men as the principle that should guide the social order. This is also the position of Évelyne Scheid-Tissinier: "the diké is consequently presented as the element that ensures the management of the mechanisms that regulate human relations, as opposed to themis, this law imposed from above and that imposes respect" (2008).

Therefore, in the myth of Diké, the divine and the human make up a unity. The myth helps to see the process of change in Greek society. As society becomes more complex, the goddess of Justice descends. From there, one can speak of the immanence of justice, but preserving the link with transcendent justice. For this reason, legal iconography represents Diké without a blindfold. The open eyes symbolize the need to look beyond the immediate evidence of the facts and the scale is the sign of isonomy (FERRAZ JÚNIOR, 2003, p. 32-33). These two aspects of justice seem to indicate that Diké is at the same time a general justice that encompasses all the virtues, expressing itself as *δικαιοσύνης* - *dikaiosine* - and is also the archetype of particular justice.

From the sixth century B.C. onwards, the Greeks will strive for a justice that, while preserving its divine matrix, will gain more and more participation of human intelligence to enforce itself. The word diké means custom, use. The goddess Diké is the embodiment of this concept. It is known that "custom" and "usage" recapitulate the positive experiences of the community in view of the common good. Diké is the personification of the values of the

polis, which is why she is recognized as the goddess of justice "from below", of the city, in continuity with the justice "from above", of Themis. Diké takes care of the justice of men that is concretized in the laws and trials that take place in the city of Athens (CALLIES, 2011).

It is known today that customs are changing as a result of the anthropological character of their origin. But in the mythical period, customs are considered gifts from the gods. To violate them is to go against the will of Themis and Diké. Legitimate justice, which according to the myth comes from above, finds its counterpoint in the legality of justice received in the laws of the city. Diké inspires legal, positive, state justice. She is a companion of the righteous and opposes the unjust. It is to her, as the guarantor of isonomy in the courts of Athens, that the wronged will first appeal:

I invoke the beautiful Diké who sees the multitude of things and who sits on the throne of King Zeus, following from the heights of Heaven the life of men in various races, punishing iniquity and eliminating everything that is different from the truth. It judges the wicked actions that iniquity inspires in men, when they want to carry out unjust projects. She is the enemy of the wicked, but she is the friend of the good. O Goddess, welcome our invocations, until the fateful end of our life (CALLIES, 2006).

In the light of Themis and Diké, the peace of the city comes from equitable decisions in the face of the difficult balance between the just and the unjust. From the human point of view, it is always an option for virtue, which is perpetually threatened by *hybris*, like a kind of shadow that lurks in all noble actions.

3.3 ADIKIA

ΑΔΙΚΙΑ is a Greek word meaning injustice. To deepen the paronymy (ANDRADE, 2009, p. 59) between justice and injustice, Aristotle observes that one can speak of a general and particular injustice. General injustice is composed of illegitimate and improper. Illegitimate is that which is outside the law. However, Aristotle points out that not everything that is outside the law is unjust, although it is illegitimate. On the other hand, the improbable is the one who breaks the law and promotes inequality. Therefore, every improbable person is unjust and iniquitous at the same time (ARISTOTLE, 1856, V, 3, 1131 a, 10). This Aristotle calls private injustice. For this conceptualization to be accurate, it is necessary that the law reflects the communitarian ethos (ARISTOTLE, 1856, V, 2.1130 b, 20), because if it were the law of a tyrant, it would already escape the theory. As Cournarie says, "an action in accordance with the law is only just if the law is just or more precisely if it is admitted that the law has, by itself, the power to make justice happen" (COURNARIE, 2007, p. 13). Thus, it is not the law that is the measure of justice, but justice that is the measure of the law, that is, no

longer any natural, universal and abstract right, but the law in its rectitude as a law, according to its function and purpose, which is the realization of the common good.

The appreciation of justice, says Aristotle, passes through the consideration of injustice:

But be that as it may, the object of our investigation is that justice which constitutes a part of virtue; for we hold that such a kind of justice exists. And analogously, it is with injustice in the particular sense that we are concerned (ARISTOTLE, 1856, V, 2, 1130a, 15).

In addition to natural justice, legal justice corresponds to the objective law of the city. This, according to Aristotle, means that:

In the dispositions which they make on all matters, laws have in view the common advantage, whether of all, or of the best, or of those who hold power, or something of that kind; so that, in a certain sense, we call justice those acts that tend to produce and preserve for political society, happiness and the elements that compose it (ARISTOTLE, 1856, V, 1, 1129b, 15).

This established law generates the subjective rights, that is, those that citizens can claim in the city's legal institutions by reason of the law. In this way, a citizen does justice to himself or to others when he corrects, by force of law, the injustice suffered. To do so, he will have to provoke the city's judicial institutions. It can be said that this is the common sense perception of what justice is. It is therefore a question of univocal understanding. In that case, the one who acts according to the law will be just and the one who violates it will be unjust. *It seems important to evoke Thomas Aquinas in the "Summa Theologica" here. Aquinas says that justice aims at the common good (2008, q. 58, art. 5). It can be said then that justice is a civil virtue par excellence and, therefore, total and legal.*

4 DIKAIOSINE-DIKAION-DIKAIOS

The dikaiosine-dikaion-dikaios *triad*, respectively, justice in judicial institutions, the justice of judicial decision, and justice of judges. Law and Subjectivity are linked by judicial institutions and the decisions of the just.

4.1 DIKAIOSINE

Dikaiosine, means justice linked to judicial institutions. Judicial institutions are expected to comply with the law, but also to do what is just. The trial of Sócrates is an emblematic case when one thinks about the justice of the judiciary. The trial of Socrates is a

select example of a conflict between the legal and the legitimate. In the "*Απολογία Σωκράτους*" (PLATON, 1903), one can see the encounter between mythical reason, represented by Meletus, Antius and Lesson and by the 280 judges who condemned it (Plato, 1987, p. 9 and 53), and philosophical reason, represented by Socrates.

A brief resumption of the clash helps to understand the influence of the mythical-religious tradition on the legal institutions of Athens and how natural law influences the laws of Athenian democracy and the conscience of the population. Athenian democratic institutions are both the places where Dike is remembered as a benchmark of justice and where Athenian citizens make laws by articulating the many interests at stake.

In 399 B.C., Meletus, Antitus, and Lecture accuse Socrates of impiety, that is, of not believing in the gods of the city of Athens: "Socrates is a dangerous man, who, out of a criminal curiosity, wants to unravel what is happening in heaven and under earth, makes impiety a good cause, and teaches others these pernicious secrets" (PLATON, 1903, 19b-19c) and "[...] corrupt the youth, not recognize the religion of the State and put demonic extravagances in place" (PLATON, 1903, 24b-24c).

The first accusation states that Socrates is an atheist and the second, that he misleads the youth. Socrates' accusers attribute his atheism to his disregard for the gods of the city in general. Meletus says: "by Zeus, lord judges, he does not believe, for he affirms that the sun is stone and the moon is earth" (PLATON, 1903, 26d). This puts Socrates before the judgment of Themis and Diké. The second accusation is against his philosophical method, irony and maieutics, which Socrates' disciples apply in everyday debates. This is seen as a perversion of youth. The third charge attacks the result of Socrates' work, which is to strengthen weaker minds. Maieutics helps non-citizens of Athens, insofar as it allows them to make the catharsis of their limitation. This leads to the destabilization of the *status quo*, because a slave can perceive himself as capable as an Athenian citizen (PLATON, 1849).

In his defense, Socrates claims not to be an atheist, but deeply connected to the *daimon* who has guided him since he was a child. In addition, his method promotes justice, because it helps people to discover their limits and potential. If Socrates owes anything, it is this: to have human science as his mission, that is, to understand the human being. This task only began because Socrates wanted to show Cherophon that the Pythia of the Temple of Delphi was wrong when she told him that Socrates was the wisest man in the world. Now, how could he be if the only certainty he has is that he knows nothing? But it seems that this is the secret of the prophecy of the Pythoness: the wise man is sure that he knows nothing, that is, every situation is a place of new learning. Socrates was convicted by thirty votes. This means that of the 501 judges, 221 acquitted him of the charges (Plato, 1987, p. 9 and 53).

In this context, Socrates could choose bail or exile as an alternative to the death penalty, but following the inspiration of the *daimon*, the good genius, he embarrasses the judges when he asks that, if acquitted, he be fed in the Prytaneum as long as he lives. The Prytaneus, home of the Pritanes, judges of Athens, is where the sacred flame to Hestia, the goddess of the family, was located. Socrates places judges before an *aporia*: the death penalty or honor for life. The judges opt for the former.

4.2 DIKAION

The Greek term δικαίον, *dikaion*, translates as decision of the just. Aristotle does not discard this understanding of justice whose nature is homonymy, that is, the univocal character that common sense gives to the terms justice and injustice. In fact, he takes it as a starting point for a more accurate understanding of justice. Consequently, the Aristotelian perception of justice marks a distancing from how common sense perceives it and gives Western reason a paradigm, still much considered today in the Philosophy of Law.

For Aristotle, the greedy is the counterpoint of the *dikaios*, of the just. Contrasting them, Aristotle realizes that while the greedy is immersed in his own injustice - *adikias* -, the just man strives for justice (ARISTOTLE, 1856, V, 2, 1130 a, 30). When the philosopher's attention is focused on the greedy man, he realizes that the particular injustice of the latter is linked to a general injustice, which is that which is contrary to the law (Aristotle, V, 2.1130a, 20) and which the historical experience of the community has discarded as harmful to it. But there is one aspect common to general and particular injustice. It is about inequality in the relationship with others.

This first approach gives Aristotle the clues that if there are two kinds of injustice, it seems possible to say the same with regard to justice (ARISTOTLE, V, 2, 1130b, 5). It is a question of general or legal justice and particular justice. They are related to virtue. Aristotle stresses, in the first place, the homonymy of both the word justice and injustice. In this way, he goes beyond the sense of justice that common sense has built and will reveal that of equivocity.

Common sense considers unjust the one who violates the law and the one who takes more than is due to him. In contrast, Aristotle understands that the just man - *dikaios* - sticks to the legal and the equal. For this reason, Aristotle applies the notion of equivocity from the word injustice to the notion of justice: "the just, therefore, is that which conforms to the law and that which respects equality; and the unjust is that which is contrary to the law and lacks equality" (ARISTOTLE, 1856, V, 3, 1131b, 15). The analogy allows us to affirm that equality

is the just means of just and unjust action. Consequently, it is exactly at this point that justice is also present (ARISTOTLE, 1856, V, 3, 1129 a, 30; 1131 a, 10-15).

Therefore, it is not only the act according to the law, but the act according to the law that promotes justice, that is, the equality of rights of citizens. *As Saint-Arnaud states: "Aristotle is the first thinker to distinguish in a systematic way legality and equality as the foundations of justice [...]" (1984, p. 161).* This definition based on the paronymic method, that is, that the 'opposites' clarify each other, e.g., the unequal helps to understand the equal, allows Aristotle to define justice not only in terms of the legal, but also in terms of the equal. To account for this last category, *Aristotle constructs the notion of particular justice and divides it into distributive justice and corrective justice (ARISTOTLE, 1856, V, 2, 1130 b, 30).*

In Aristotle, particular justice is based on the notion of equality. According to Gauthier and Jolif, the entire Book V of the "Nicomachean Ethics" is based on the distinction between two senses of the word dikaion that can mean what is legal and what is equal (GAUTHIER, JOLIF, 1970, p. 323). After defining the just relative to the laws, what is admitted and conveyed by tradition, Aristotle needs to 'demonstrate' how the just coincides with the legal. To this end, to the method of dispelling equivocations, e.g., the homonymic occurrence of *dikaion*, he adds the paronymic method by which the just reveals himself through the notion of unjust and vice versa. Aristotle's analysis of *dikaion* allowed him to distinguish two sets of 'opposites', legal-illegal and equal-unequal, for the definition of just. After having defined the legal just by the illegal, he retains the unequal for the definition of particular justice. This will allow him, through the game of opposites, to apprehend the equal and, thus, the just. Thus, he tries to define the equal as the just measure between the unequal and the just as being at the center of the extremes represented by the unjust:

Since the unjust does not respect equality and injustice is confused with inequality, it is evident that there is a fair means when it comes to inequality. This just means is equality. In actions where there is more and less, there is room for a just measure. Therefore, if the unjust is the unequal, the just is the equal. But in every action where there is more and less, there must also be a possible equality; and, consequently, if that which escapes equality is called unjust, that which is in conformity with it is just, as everyone judges without much difficulty; and since it is in the environment that equality is established, it will be there that justice will be achieved. Now, equality can only exist between at least two terms. Therefore, the just must necessarily be the means, an equality in relation to things and people, because if there is no equality between them, they should not have equal things (ARISTOTLE, 1856, V, 3, 1131a, 10-15).

4.3 DIKAIOS

Aristotelian reflection on equity introduces a decisive element for understanding the role of subjectivity in judicial institutions. Recognizing that the strict application of the law can produce injustices in particular cases, Aristotle assigns to the judge the task of interpreting the norm in the light of the concrete case, mobilizing prudence (*phronesis*) as a decision-making virtue. This conception anticipates contemporary debates on judicial discretion, practical rationality and legitimacy of decisions, indicating that institutional justice depends not only on well-formulated norms, but on the ethical and intellectual training of those who apply them.

Dikaïos translates into fair decisions. Equity is a corrective of the just according to the law. In this sense, it does not proceed from the law, but from the prudence of the judge. This need arises from the nature of the legal phenomenon, which is the difficult task of adapting the general rule to the specificities of particular cases. For greater conceptual precision, we turn to Aristotle:

The difficulty is that equity, though just, is not just according to the law, but a corrective of legal justice ([ἐπανόρθωμα νομίμου δικαίου](#)). The reason for this is that the law is always something general ([καθόλου](#)), and there are situations in which this mode cannot be applied. Therefore, in matters where it is necessarily necessary to speak in a general way, and where it is impossible to do so correctly, the law takes into account only the most frequent cases ([τὸ ὡς ἐπὶ τὸ πλεόν](#)), but without ignoring the errors which this may cause. In this connection the law is no less right ([ὀρθός](#)), because the fault is not in the law, nor in the lawgiver ([νομοθέτη](#)), but has the nature of juridical phenomena, because such is the nature of practical things. Consequently, when the law speaks in a general way, and then a case arises outside the general rule, then it is right ([ὀρθῶς](#)), where the legislator cannot foresee the case, and has failed by oversimplification, to correct the omission, and to interpret what the legislator himself would have said, if he had been present at the time, and what he would have put into the law if he had known the case in question (ARISTOTLE, 1856, V, 10, 1137 b, 11-23).

Even if the quotation already brings a reasonable notion of what *ἐπιείκεια* - equity - is, that it is the "corrective of legal justice" and that it derives from the general character of the law and the dynamics of society, it is necessary to discover its nature in Aristotelian thought: is it *contra legem* or is it *praeter legem*? In other words: is it against the law or does it fill in the obscurities, the *non liquet* of the law? Or is it actually an attenuation of the harshness of the law as Cicero stated in his famous brocade: "*summum ius summa iniuria*": supreme right, maximum injury? (1843, I, 10, 33).

It seems that Aristotle leans more towards the dialectic of the norm with the concrete situation and that, obviously, neither the Caesarism of the law and, above all, the reductionism

to the concrete situation are adequate to his position. With John Hobuss (2010), it can be stated that the reductionism of equity to the imperialism of concrete situations in the face of the law, as argued by David Wiggins (1997, 2004) and Jacques Brunschwig (1996, p. 115-155), does not do justice to Aristotle. What is more appropriate to his thought in the "Nicomachean Ethics" is that the law, by its generality, regulates the general aspects of social relations and that it will be in the face of the particular situation that the judge, taking into account the law and the singularities of each case, will decide in this or that way.

Moutsopoulos states that if the meaning of virtue is attributed to *epieikeia*, then it means "in the place of", that is, to put oneself in the place of the one who judges oneself in order to better understand it (1998, p. 195-198). This conclusion follows from the suffix *eikôn* that indicates the alternation between the true object and its image, that is, an exchange of roles. Thus, far from designating a weakness of the judge, *epieikeia* is the ability to adapt to circumstances and enables the judge to decide in a spirit of justice (BEES, 1995, p. 117-126).

According to the logic of *epieikeia*, one can speak of the precedence of the concrete case in relation to the law, but not of its disregard due to the concrete case. It is well known the resistance that the positivistic current of law has in relation to equity, since for it, the impartiality of the law must prevail in any circumstance. But, it seems to be well understood, the *Aristotelian ἐπιείκεια* is not against the law (ARISTOTLE, 1874, III, 11, 1281 b, 3-8), but its complement, because the law is naturally broad precisely to encompass the largest possible number of situations. To support the argument, Tordesillas is used:

In short, while a justice that is too formal leads to legislation without judges, a justice that is too concrete that, in the name of equity, gives full power to the judge's deliberation, leads only to a type of justice without legislation, so that a power of decision without limits is as dangerous as a justice that is absolutely regulated and excludes any decision of the judge (2004, p. 73).

For Aristotle, even if legal justice integrates and implies all the possible ethical virtues that belong to natural justice, legal justice does not have the full meaning of justice, either because natural justice surpasses it or also because society is dynamic. For this reason, being just does not consist exclusively in respecting the law, but above all, in the face of the law, in evoking the ethical-political character of justice which, beyond the legal just, turns to the just according to equality. It is about the justice that can be applied in the city (GAUTHIER; JOLIF, 1959, p. 385-386) on the natural and legal planes (MICHON, 2011, p. 9).

Equity finds its place in the dialectic of natural justice with legal justice. This is necessary, because even if one has an adequate legal apparatus, it does not work apart from legal intelligence. Through the interaction of the social and the law, justice or injustice occurs

in the city. *Epieikeia* does not allow justice to be mechanized, that is, a pure and simple application of the legal norm. The *epieikeia* recovers and maintains the just, the legal and the equal in the city and, at the same time, stands up against the unjust, the illegal and the unequal, which can occur in the reductionist application of the law (COULOUBARITSIS, In: ELST, 1985, p. 79-101).

It can be said that there is no justice where there is no political justice and there is no political justice where the authority of the law does not reign, however, the former precedes it and confers on it the possibility of existence. Therefore, the law is not justice in its entirety. The law must govern, however, this does not sacralize it because it is the just who founds the law and not the other way around (PERELMAN, 1972, p. 9-80).

To broaden the understanding of *epieikeia*, we turn to Aristotle: "we will now speak of equity and equity, and we will determine the relations that exist between equity and justice on the one hand, equitable and just, on the other" (ARISTOTLE, 1856, V, 10, 1137a, 31). If equity is the "corrective of legal justice," it does not proceed from within Athenian legislation. So, what legitimacy does it have to correct it, since it is foreign to it? Moreover, this casts suspicion on legal justice: is the law really just and good since it lacks equitable intervention in complex practical circumstances?

Aristotle's answer lies both inside and outside of legal justice. In the first case, the intention of the legislator at the time of the promulgation of the law is sought; in the second, it is supported by natural justice. Hence it may be said that equity and legal justice are not exactly the same thing, but belong to the same genus, since they both proceed from society's consciousness of justice. However, to the extent that legal justice can only appear in the law in a broad way to encompass as many cases as possible, equity updates legal justice in the face of the current demands of the city.

Therefore equity is not foreign to legal justice, because just as legal justice is posited by the human *logos*, equity also proceeds from human reason. The difference is that while the law is fixed, equity is the legal intelligence in continuous becoming, articulating the law and the complex requirements of the particular situation (BOUDOURIS, 1989. p. 129-137). For this reason, Aristotle says that the law is good, but the equitable is better (ARISTOTLE, 1856, V, 10, 1137 a, 33). However, this raises a second question: if the metaphysics of law is the just and that of equity is the equitable, can it be said that the just that the law provides is different from that which equity accomplishes?

In fact, for Aristotle, the legal just and the equitable have the same nature, but they differ in intensity, that is, the equitable of equity is superior to the just of the law: "thus, just and equitable are one thing and the same thing, both are good, even if the equitable is

superior" (ARISTOTLE, 1856, V, 10, 1137b, 10). For greater conceptual lucidity, Michon is evoked: "equity is not defined as indulgence, it is not outside the sphere of law, it is, on the contrary, the source of law, and of a higher right, because it is inscribed in nature" (2011, p. 8).

The centrality of equity in Aristotelian reflection anticipates fundamental problems of contemporary legal theory related to judicial decision and the application of the norm. Chaïm Perelman points out that legal rationality cannot be reduced to a deductive formalism, requiring judgments of reasonableness and weighting in the face of concrete circumstances (PERELMAN, 2005). In a convergent way, Neil MacCormick argues that the legitimacy of legal decisions depends on the articulation between rules, principles and practical arguments, which brings *Aristotelian phronesis* closer to modern judicial rationality (MACCORMICK, 2005). Ronald Dworkin, by emphasizing the integrity of the law, also recognizes the interpretative role of the judge in the construction of justice, beyond the mechanical application of the law (DWORKIN, 2007).

If one resorts to "Rhetoric" to seek the traits of equitable legal intelligence, that is, just according to law and equity, it will be seen that it is his own to appreciate the circumstances, he will want to know whether the action was voluntary or involuntary; he will inquire about the intention of the legislator in writing the law, he will want to know all the circumstances involved in the matter, he will be interested not in what the defendant is at that moment, but in what he was for most of his life (ARISTOTLE, 1856 [B], I, 13, 16-18), he will be attentive to the intentional and unintentional lacuna of the law. At that time, the judge will not legislate because he does not have this right, but will strive to solve the situation within the possibilities of the legal and customary tradition of the city. On the other hand, if the law is applied without taking into account these elements, it may be that the law, which was supposed to do what is just, ends up making injustice official. However, the force of the law should not be forgotten, because Aristotle advises: "one must go to arbitration before justice, because the mediator considers the equitable side of things, while the judge only considers the law, and the mediator was instituted to enforce the point of view of equity" (ARISTOTLE, 1856 [B], I, 13, 19, our translation).

It seems that justice is done to Aristotle by stating that he seeks a legal status for equity. In this case, justice would be reconciled with the legal just, not as the equal, but as its cooperator in those cases where the legal just could lead to injustice and to make the citizen unhappy in a way, at times, irretrievable. It is only in this sense that equity is superior to legal justice, because in legal operation, they cooperate in favor of justice. As Michon reminds us, "equity is just an alternative but legal form" (2011, p. 12). It is, then, corrective equity, *praeter*

legem. An effort by the judiciary in the search for justice, because "something is not just because it is law, but it must be law because it is just" (MONTESQUIEU, 1949, 1906). Thus, what is equitable precedes the legal just and helps the law when it risks slipping into injustice in its application, which would be the concern only with the legal, without considering justice. Aristotle is used to affirm the supremacy of what is equitable over what is exclusively legal:

That is why there is a justice that is preferable to rigorous justice when it comes to the particular case; not an absolute justice, but only to the just where the error related to the absolute character of the rule can be found, and this is precisely the nature of equity: it is the corrective of the law, in the place where the law has failed by reason of its generality. Really, the reason why everything is not defined by the law is that there are cases in which it is impossible for it to be applied. In this case, a decision appropriate to the nature of the case is required. Like the lead ruler that lesbians use in their constructions and that adapts to the shape of the stone, they do not retain an invariable direction. In the same way, particular decisions must be accommodated to the cases that arise (ARISTOTLE, 1856, V, 14, 1137 b, § 27-35).

Aristotle reaffirms here the necessity of equity by reason of the generality of the law. If the law is designed by the legislator to encompass a multiplicity of cases, it is natural then that, when it is linked to any legal fact, it receives the interpretation that is entitled to it. For the Stagirita, this is the place of equity in law. Therefore, equity does not detract from the law, but vitalizes it. It is known, however, that the judge is not responsible for legislating. This is the function of the legislator. Therefore, when the judge exercises equity, he does not legislate, but seeks the best way to be faithful to the spirit of the legislator. Portalis agrees with this, when in the preamble of the French Civil Code of 1804, he says:

There is a science for legislators and another for magistrates; and one is quite distinct from the other. The science of the legislator consists in finding, in each matter, the principles most favorable to the common good; the magistrate's science is to put these principles into action, to branch them out, to extend them, by a wise application [...] when the letter kills, and no longer exposes oneself to be alternately slave and rebellious, and to disobey by the spirit of servitude (2011, p. 23).

Therefore, it should not be forgotten that "the law must govern, but it is the just who founds the law" (COURNARIE, 2007, p. 36). *In the same vein, one can evoke Aubenque (1980), Harkis (2004), and Romilly (1971). It is claimed, however, that unlimited equity would destroy legal certainty, because it could put legislation on a secondary plane, to the extent that the judge had unbridled decision-making power (PERELMAN, 1972, p. 9-80). An excessively formal justice that excludes any decision of the judge, and which in theory would work without him, is as inadequate as an excessively concrete justice that, in the name of equity, could lead to a justice without legislation.*

Therefore, justice is neither in the excess of equity nor in the rigidity of the application of the law. If one fails by excess, the other, by lack. It can be said, then, that the median is the appropriate place for the practice of *epieikeia*. For this reason, with Cournarie (2007, p. 43), it is stated that laws order social life for the common good and justice, but left to themselves they cannot fully accomplish these things. For this reason, "they have recourse to a higher form of justice that is also their primary source. It is legal justice, that is, the law in view of the just, that recommends its overcoming in equity" (COURNARIE, 2007, p. 43). Therefore, it is up to the operator of the law to promote the legal and equitable that is superior to him. Listen to Aristotle:

It is seen, therefore, what the equitable and the just are, and what kind of just is preferable; and in this way one can also perceive what an equitable man is: he is one who, in his decisions and actions, knows how to depart from strict justice when it presents inconveniences, and who, always relying on the law, knows how to soften rigor. This habit or disposition of the spirit is precisely equity: it is a type of justice, or a habit that does not really differ from justice (ARISTOTLE, 1856, V, 10, 1137 b, 34; 1138 a, 5).

Equity is directly related to prudence, because prudence is the ability of the legal operator to raise the central variables of a legal fact in its relationship with legal justice and equitable fairness and only decide after the legal and social implications of the case are clear and help in decision-making (AUBENQUE, 1980, p. 147-157). This complex operation enables the emergence of refined legal rationality proper to the construction of justice.

The Aristotelian analysis of equity in relation to prudence is threefold and can be made from three key words: *sunesis*, *gnômê* and *eubulia*. They can be understood as critical instances that belong to the equanimous and *phony* intelligence. The first confers on intelligence understanding, sagacity, and cunning, that is, the ability to know something beyond its appearances. The second gives him a critical understanding of the situation, while the third gives him the ability to foresee causes and consequences and, therefore, is able to advise.

In this line, one can refer to Velley: "prudence is '*nomothetic*' or '*dikastique*' – legislative or judicial; that is why the Romans will speak of jurisprudence" (1968, p. 54). The *phronimo* will be the one who has the wisdom to decide practical things. We refer to Aristotle: "prudence is a disposition [*hexis*], accompanied by right intelligence [*ortho logos*], capable of acting in the sphere of what is good or bad for the human being" (ARISTOTLE, 1856, VI, 5, 1140 b, 20). If an example of a *phronym* is requested, Aristotle points to Pericles (ARISTOTLE, 1856, VI, 5, 1140 b, 7), elected by the Athenian people, the executive commander of Athens for thirty consecutive years, from 459 to 429 BC.

Φρόνησις -*phronesis*-, that is, prudence, is therefore the virtue of the soul's faculty of discernment in the sphere of the contingent and not in the sphere of the necessary or the universal. For this reason, it is a practical virtue as opposed to *poiesis*, which is linked to the arts and techniques. It can be said, then, that prudence indicates a typically preventive rationality, inquiring into the best decision in the face of the praxiological demands of social life. It is an ability and a power that is capable of taking things in the right direction due to the instrumental capacity to ration, always seeking to adapt the best means to the ends. Therefore, it is the power of intelligence to choose the right means, as circumstances vary and are unpredictable. It is, therefore, a rational faculty essentially linked to the contingency of the world, especially the cultural one.

Prudence is useful for universal and particular objects, so it requires the experience that age brings (ARISTOTLE, 1856, V, 6, 1142a, 5-10). While prudence is a dianoetic virtue, that is, of the soul; Equity is linked to the realm of ethical virtue. One is potential intelligence and the other is practical intelligence. Both, however, are necessary to the consummation of justice. If the importance of the judge for the effectiveness of justice is recognized, the importance of equity and prudence for legal activity must be recognized.

When one thinks about the relationship between equity and prudence in the functioning of the legislative, executive and judiciary, it can be said without exaggeration that they make up the legislation itself and the political functioning of the city itself (ARISTOTLE, 1856, V, 6, 1141 b, 20). Therefore, it is not possible to be a good man without prudence and, on the contrary, to be prudent without moral virtue. Prudence makes it possible to manage one's passions in accordance with the communitarian ethos. From there, one can affirm its dianoetic condition, that is, a competence proper to the rationality of the soul in order to act in each circumstance in an adequate way.

The prudent person is not a passive applicator of a legal syllogism, that is, given case x, law y follows and therefore its application. He does not apply the universal rules to particular cases because, even if he sticks to the legal rules, the prudent knows the distance of the law, in certain cases, from the situation *under examination*. Therefore, there is no fixed, stable measure that is the limit of legal rationality, rather, it is the equitable and prudent legal intelligence that is the *logos* of the law and the real possibility of doing justice in the city.

Therefore, it can be said that the equitable man is the one who judges well and who does not enslave himself to the positivist logic, although he holds it in high esteem. Rather, it is his concern to judge according to the truth, that is, equitably. For this reason, this man does not apply the law mechanically, but allows himself to penetrate the sensible and the singular with a more 'reasonable' reason than instrumental reason (AUBENQUE, 1980, p. 152). Thus,

the judge becomes a kind of "living justice" (ARISTOTLE, 1856 [B], I, 13, 1374a, 28-29), that is, equity, in addition to making justice work fairly, also allows him to perfect himself precisely by letting each case he judges speak for itself (COLOUBARITSIS, 1985, p. 136). Thus, even if there is an effort to subsume a specific legal case to the law, the former, due to its particularities, always escapes this effort in one way or another. This is the opportunity for equity and the only possibility of doing justice. It is therefore a matter of letting the *kairos* that the case under trial evokes count. Tordesillas contributes to the clarity of the issue:

In the very exercise of equity, the understanding of the circumstances and the intelligence of the situation are manifested, extracting the traces of constancy (in most cases, most frequently) in the plurality of singularities, which is why, as we have seen, equity is aligned with discernment and *kairos*. The convergence of all these points only occurs in situations of exception, in a certain sense, all situations are exceptional, on occasions whose judicial form is presented as "occasional justice" or equity, in judgments that require improvisation with constancy and regularity on each occasion. Situation, constancy, occasion, discernment, judgment, opportunity, contingency, deliberation, the elements of a *kaironomy* are now established (TORDESILLAS, 2004, p. 91).

Therefore, it can be affirmed, with Michon (2011, p. 16), that the *Aristotelian epieikeia* sensitizes and refines the legal conscience to the practical dimension of laws. It is the means to the just and the good, and helps to avoid injustice when the particular law is unfavorable to the cause of justice. Only in this case, it is advisable to seek support in the universal law, the *agraphoi nomoi*, to correct the limit of the law (SANCHO ROCHER, 2007, p. 147). Thus, it can be said that complete equity corrects and humanizes the law (TUNC, 2011). This means that the city, when it comes to justice, is always in search of $\square\square\square\square\square\square\square\square\square\square\square\square$ - *to aristo telos*, that is, in search of the best end, which is actually non-end because it is always an unfinished task (MESQUITA, 2005, p.121). Therefore, whenever justice threatens to slip into injustice, it is appropriate to cry out for *epieikeia*.

The articulation between ethics, subjectivity and legal normativity proposed by Aristotle also allows for a critical dialogue with contemporary approaches that problematize the modes of constitution of the subject and the exercise of power. Michel Foucault, when analyzing the practices of subjectivation, highlights that the ethical formation of individuals is inextricably linked to normative and institutional devices (FOUCAULT, 2010). In the legal field, Boaventura de Sousa Santos draws attention to the tension between legality and legitimacy, especially in contexts of social pluralism, in which the effectiveness of the law depends on its ability to dialogue with socially rooted practices and values (SANTOS, 2007). These contemporary perspectives reinforce the relevance of Aristotelian reflection by showing that law is only fully realized when integrated with the ethical and social practices that shape subjectivity.

The reading proposed in this article allows, therefore, to understand law as a situated social practice, rooted in subjective dispositions and historical forms of collective life. By articulating ethics, subjectivity, and normativity, Aristotle offers a conceptual model capable of illuminating contemporary tensions between legality, legitimacy, and effectiveness of law, especially in contexts marked by moral pluralism and the weakening of the common ethos.

5 CONCLUSION

The analysis developed throughout this article allowed us to demonstrate that, in Book V of the *Nicomachean Ethics*, Aristotle conceives justice as a reality that is not exhausted in the exteriority of the legal norm, but that is realized in the continuous articulation between law, virtue and ethical formation of the subject. By examining the triads *nomos–hexis–hybris*, *areté–diké–adikia* and *dikaiosynē–dikaion–dikaios*, it became evident that law, for the philosopher, only achieves legitimacy and efficacy when it finds correspondence in the subjective dispositions constituted within the communitarian ethos. Aristotelian justice, in this sense, is inseparable from the education of character and the exercise of prudence.

The study showed that *nomos* does not act as a merely coercive instance, but as a normative expression of a historically sedimented ethical experience. Its effectiveness depends on the formation of habits (*hexis*) capable of guiding the passions and containing immeasurability (*hybris*), revealing that legal normativity presupposes a subjectivity previously educated for the just. Thus, the law does not replace virtue, but presupposes it, and the absence of this ethical mediation compromises both the justice of the norms and their social reception.

By analyzing the *areté–diké–adikia triad*, it was shown that justice, in Aristotle, is simultaneously a virtue of the character and regulative principle of social relations. Injustice does not stem only from the formal transgression of the law, but from vicious subjective dispositions that produce inequality and break the community order. In this way, the opposition between justice and injustice illuminates the ethical dimension underlying legal practices, reinforcing the idea that law cannot be adequately understood without reference to the moral formation of agents.

The investigation of the *dikaiosynē–dikaion–dikaios triad* has made it possible, in turn, to understand the role of judicial institutions and prudential judgment in the realization of justice. Equity appears as a decisive element for the mediation between the generality of the law and the singularity of concrete cases, attributing to the judge an ethical responsibility that goes beyond the mechanical application of the norm. At this point, the subjectivity of the

judge, far from being an obstacle to justice, constitutes a condition for its realization, as long as it is guided by prudence and commitment to the common good.

As a theoretical contribution, it is argued that the reading of Book V of *the Nicomachean Ethics* allows us to critically rethink contemporary conceptions of law that dissociate legality and ethical formation. By evidencing the mutual implication between legal normativity and moral subjectivity, Aristotelian reflection offers relevant subsidies for current debates on the legitimacy of norms, institutional rationality, civic education, and public ethics. In contexts marked by crises of confidence in institutions and difficulties in the effectiveness of law, this perspective proves to be particularly fruitful.

Finally, the study paves the way for future investigations that deepen the dialogue between Aristotelian practical philosophy and contemporary approaches to legal theory, legal sociology, and critical human geography, especially with regard to the relationship between norms, social practices, and the formation of subjects in specific historical and territorial contexts. By recovering the centrality of subjectivity in the realization of justice, Aristotle's thought is not only historically relevant, but conceptually current for understanding the legal and social challenges of the present.

REFERENCES

- Aristóteles. (1845). *Ethica Nicomachea* (I. Bekker, Ed.). Berolini.
- Aristóteles. (1950). *Éthique de Nicomaque* (ed. bilingue grego-francês). Garnier Frères. http://hodoi.fltr.ucl.ac.be/concordances/aristote_nicomaque_05/lecture/1.htm
- Aristóteles. (1973). *Ética a Nicômaco*. Abril Cultural.
- Aristóteles. (1874). *Politique*. Librairie Philosophique de Ladrage. <http://remacle.org/bloodwolf/philosophes/Aristote/tablepolitique.htm>
- Aristóteles. (1995). *The complete works of Aristotle*. Princeton University Press.
- Aristóteles. (n.d.). *Nicomachean ethics* (Greek–English version). Perseus Digital Library. <http://www.perseus.tufts.edu/hopper/text?doc=Perseus:text:1999.01.0053>
- Aristóteles. (n.d.). *Complete works* (Greek–English). Perseus Digital Library. <http://www.perseus.tufts.edu/hopper/text?doc=Perseus:text:1999.04.0004:entry=aristotle>
- Andrade, B. T. (2009). *Categorias acerca do esquema aristotélico frente a discussões modernas e contemporâneas*. Codex, 1(2), 53–79.
- Aubenque, P. (1980). *La loi selon Aristote*. In *La loi* (Vol. 25, pp. 147–157). Archives de philosophie du droit. Sirey.
- Aubenque, P. (2011). *Aristote*. Encyclopaedia Universalis en ligne. <http://www.universalis.fr>

- Avritzer, L., et al. (2012). *Concepções políticas da justiça*. Centro de Pesquisa do Interesse Público.
- Bees, C. (1995). Quelques réflexions sur l'*epieikeia* aristotélicienne. *Dikê*, 26, 117–126.
- Bodéüs, R. (1996). *Aristote, la justice et la cité*. Presses Universitaires de France.
- Bodéüs, R. (2004). *Le véritable politique et ses vertus selon Aristote*. Peeters.
- Boudouris, K. (1989). Plato's and Aristotle's conception of justice in relation to modern and contemporary theories of justice. Greek Philosophical Society.
- Bourdieu, P. (2007). *O poder simbólico* (F. Tomaz, Trad.). Bertrand Brasil.
- Brunschwig, J. (1996). The Aristotelian theory of equity. In M. Frede & G. Striker (Eds.), *Rationality in Greek thought*. Oxford University Press.
- Burgel, G., & Lévêque, P. (2013). *Athènes*. Encyclopaedia Universalis en ligne. <http://www.universalis.fr/encyclopedie/athenes/>
- Callies, V. (Org.). (n.d.). *Diké*. Encyclopédie Mythorama. <http://www.mythorama.com>
- Couloubaritsis, L. (1989). La modernité face à la notion aristotélicienne d'équité. In K. Boudouris (Ed.), *On justice* (pp. 129–137). Ionia Publications.
- Cournarie, L. (n.d.). *Aristote, Éthique à Nicomaque: Commentaire du livre V*. http://www.philopsis.fr/IMG/pdf_aristote_ethique_5_cournarie.pdf
- Dworkin, R. (2007). *O império do direito* (J. L. Camargo, Trad.). Martins Fontes.
- Ferraz Junior, T. S. (2003). *Introdução ao estudo do direito* (4ª ed.). Atlas.
- Fischer, N. R. E. (1992). *Hybris: A study of honour and shame in ancient Greece*. Aris & Phillips.
- Foucault, M. (2010). *A hermenêutica do sujeito* (M. A. Fonseca & S. T. Muchail, Trans.). Martins Fontes.
- Gauthier, R. A., & Jolif, J. Y. (1970). *L'Éthique à Nicomaque* (Tome II). Publications Universitaires de Louvain.
- Grimal, P. (1997). *Justiça*. In *Dicionário da mitologia grega e romana* (3ª ed.). Bertrand Brasil.
- Hesíodo. (1996). *Os trabalhos e os dias*. Iluminuras.
- Hesíodo. (2007). *Teogonia: A origem dos deuses*. Iluminuras.
- Hobuss, J. (2010). *Epieikeia e particularismo na ética de Aristóteles*. *Ethic@*, 9(2), 163–174.
- Honneth, A. (2009). *Luta por reconhecimento* (L. Repa, Trad.). Editora 34.
- Lalande, A. (1999). *Vocabulário técnico e crítico da filosofia* (3ª ed.). Martins Fontes.

- MacCormick, N. (2005). *Rhetoric and the rule of law*. Oxford University Press.
- Mesquita, A. P. (Coord.). (2005). *Aristóteles: Obras completas* (Vol. 1). Centro de Filosofia da Universidade de Lisboa.
- Michon, C. (2011). *L'épieikeia aristotélécienne comme correctif de la loi*. *Annuaire de l'Institut Michel Villey*, 2, 1–16.
- Montesquieu, C. (1749). *De l'esprit des lois*. Barillot.
- Moutsopoulos, E. (1998). *Philosophie de la culture grecque*. Académie d'Athènes.
- Perelman, C. (1972). *Justice et raison* (2^a ed.). Éditions de l'Université de Bruxelles.
- Perelman, C. (2005). *Ética e direito* (M. E. Galvão, Trad.). Martins Fontes.
- Platão. (1987). *Defesa de Sócrates* (4^a ed.). Nova Cultura.
- Platão. (1903). *Les lois (Nomoi), Livre VII*. <http://remacle.org>
- Portalis, J.-E.-M. (n.d.). *Discours préliminaire sur le projet de Code civil*. <http://ledroitcriminel.free.fr>
- Ricoeur, P. (2008). *O justo* (I. Benedetti, Trad.). WMF Martins Fontes.
- Saint Thomas d'Aquin. (2008). *Commentaire de l'Éthique à Nicomaque d'Aristote*. <http://docteurangelique.free.fr>
- Saint-Arnaud, J. (1984). *Les définitions aristotéliennes de la justice*. *Philosophiques*, 11(1), 157–173.
- Santos, B. de S. (2007). *Para uma revolução democrática da justiça*. Cortez.
- Salgado, J. C. (2006). *A ideia de justiça no mundo contemporâneo*. Del Rey.
- Sancho Rocher, L. (2007). *Justice et légalité chez Aristote*. *Revue Internationale des Droits de l'Antiquité*, 34, 143–184.
- Sen, A. (2011). *A ideia de justiça* (D. Bottmann, Trad.). Companhia das Letras.
- Smith, W. (Ed.). (2005). *Dictionary of Greek and Roman biography and mythology*. University of Michigan.
- Tordesillas, A. (2004). *Equidade e kaironomia em Aristóteles*. *Dissertatio – Revista de Filosofia*, 19–20, 67–91.
- Tunc, A. (n.d.). *Équité*. *Encyclopaedia Universalis en ligne*. <http://www.universalis.fr>
- Wiggins, D. (1997). *Incommensurability: Four proposals*. In R. Chang (Ed.), *Incommensurability, incomparability, and practical reason* (pp. 52–66). Harvard University Press.

AGING AND PUBLIC EDUCATIONAL POLICIES: PROMOTING LEARNING FOR THE INCLUSION OF THE ELDERLY

ENVELHECIMENTO E POLÍTICAS PÚBLICAS EDUCACIONAIS: PROMOÇÃO DA APRENDIZAGEM PARA INCLUSÃO DA PESSOA IDOSA

ENVEJECIMIENTO Y POLÍTICAS EDUCATIVAS PÚBLICAS: PROMOViendo EL APRENDIZAJE PARA LA INCLUSIÓN DE LAS PERSONAS MAYORES



<https://doi.org/10.56238/sevened2026.008-136>

Josiette de Nazaré Silva da Costa¹

ABSTRACT

This article discusses the process of population aging in Brazil and educational policies aimed at promoting learning and social inclusion for older adults. Aging is a global phenomenon and is occurring at an accelerated pace. Legal frameworks such as the 1988 Federal Constitution, the National Policy for the Elderly (Law No. 8,842/1994), and the Statute of the Elderly Person (Law No. 10,741/2003, updated by Law No. 14,423/2022) highlight some advances in guaranteeing the right to education for older adults, emphasizing programs such as Youth and Adult Education (EJA) and Open Universities for the Third Age (UnATI), which contribute to active and participatory aging. Lifelong learning is an inclusion strategy, and access to formal and informal education strengthens the self-esteem, autonomy, and socialization of older adults. However, structural barriers persist, such as the absence of specific educational policies, low funding, a shortage of qualified professionals, and ageism in educational institutions. In conclusion, this article argues that public educational policies aimed at aging should be integrated into human rights and citizenship agendas. Investing in the education of older adults is essential to promote active aging, combat ageism, and value age diversity, consolidating a more just and inclusive society.

Keywords: Educational Policy. Older Adults. Human Rights. Social Inclusion.

RESUMO

O presente artigo discute o processo de envelhecimento populacional no Brasil e as políticas educacionais voltadas para a promoção da aprendizagem e da inclusão social da pessoa idosa. O envelhecimento é um fenômeno mundial e apresenta-se acelerado. Nos marcos legais como a Constituição Federal de 1988, a Política Nacional do Idoso (Lei nº 8.842/1994) e o Estatuto da Pessoa Idosa (Lei nº 10.741/2003, atualizada pela Lei nº 14.423/2022), são ressaltados alguns avanços na garantia dos direitos à educação das pessoas idosas, dando destaque aos programas como a Educação de Jovens e Adultos (EJA) e as Universidades Abertas à Terceira Idade (UnATI), que contribuem para o envelhecimento ativo e participativo. A aprendizagem ao longo da vida é uma estratégia de inclusão e o acesso à educação formal e informal fortalece a autoestima, a autonomia e a socialização da pessoa

¹Doctoral student in public policy. Universidade Federal do Piauí (UFPI).

idosa, contudo, ainda persistem as barreiras estruturais, como a ausência de políticas educacionais específicas, o baixo financiamento, a escassez de profissionais capacitados e o etarismo nas instituições de ensino. Nas considerações finais, o artigo defende que as políticas públicas educacionais voltadas ao envelhecimento devem ser integradas às agendas de direitos humanos e cidadania. Investir na educação de pessoas idosas é essencial para promover um envelhecimento ativo, combater o preconceito etário e valorizar a diversidade etária, consolidando uma sociedade mais justa e inclusiva.

Palavras-chave: Política Educacional. Idoso. Direitos Humanos. Inclusão Social.

RESUMEN

Este artículo analiza el proceso de envejecimiento poblacional en Brasil y las políticas educativas orientadas a promover el aprendizaje y la inclusión social de las personas mayores. El envejecimiento es un fenómeno global y se está produciendo a un ritmo acelerado. Marcos legales como la Constitución Federal de 1988, la Política Nacional para las Personas Mayores (Ley n.º 8.842/1994) y el Estatuto de la Persona Mayor (Ley n.º 10.741/2003, actualizado por la Ley n.º 14.423/2022) destacan algunos avances en la garantía del derecho a la educación de las personas mayores, con énfasis en programas como la Educación de Jóvenes y Adultos (EJA) y las Universidades Abiertas para la Tercera Edad (UnATI), que contribuyen al envejecimiento activo y participativo. El aprendizaje permanente es una estrategia de inclusión, y el acceso a la educación formal e informal fortalece la autoestima, la autonomía y la socialización de las personas mayores. Sin embargo, persisten barreras estructurales, como la ausencia de políticas educativas específicas, la baja financiación, la escasez de profesionales cualificados y el edadismo en las instituciones educativas. En conclusión, este artículo argumenta que las políticas educativas públicas dirigidas al envejecimiento deben integrarse en las agendas de derechos humanos y ciudadanía. Invertir en la educación de las personas mayores es esencial para promover el envejecimiento activo, combatir el edadismo y valorar la diversidad de edades, consolidando una sociedad más justa e inclusiva.

Palabras clave: Política Educativa. Personas Mayores. Derechos Humanos. Inclusión Social.

1 INTRODUCTION

Population aging is a worldwide phenomenon that has intensified in recent decades, a direct result of advances in the areas of health, science and living conditions. In Brazil, this demographic transformation occurs at an accelerated rate and impacts all sectors of society, requiring new perspectives on citizenship, public policies, and social inclusion. According to data from the Brazilian Institute of Geography and Statistics (IBGE, 2022), the number of people aged 60 and over has doubled in the last two decades and is expected to continue growing in the coming decades, significantly changing the country's age structure. In view of this scenario, it is urgent to understand aging not as a problem, but as a social achievement that requires planning and integrated actions to ensure quality of life, autonomy and active participation of the elderly.

Education, in this context, plays a central role in promoting social inclusion and valuing aging. Lifelong learning is a right provided for in the Federal Constitution (1988) and one of the pillars of active aging, as it allows older people to develop new skills, strengthen social bonds and fully exercise their citizenship. Educational institutions, therefore, must expand their practices beyond the traditional age groups, recognizing the elderly as subjects of rights and knowledge, whose life experience constitutes an important social and cultural heritage.

Thus, this article aims to analyze the phenomenon of population aging and discuss public educational policies aimed at promoting learning and inclusion of the elderly, highlighting the advances, challenges and perspectives for the realization of the right to lifelong education and for the construction of a more inclusive and intergenerational society.

2 AGING IN CONTEMPORARY SOCIETY

Contemporary society is facing a phenomenon of major structural and social transformations that is human aging. Nowadays, societies are increasingly long-lived and, in this scenario, new forms of political, cultural and social relations are required.

According to Neri (2013, p. 20), "aging, or senescence, is a universal process, genetically determined for the individuals of the species, which is why it is also called normal aging". In the words of Schneider and Irigaray (2008), aging:

It is a complex and multifactorial process. The variability of each person (genetic and environmental) ends up preventing the establishment of parameters. Therefore, the use of time alone (chronological age) as a measure hides a wide range of variables. Age itself does not determine aging, it is just one of the elements present in the development process, serving as a reference for the passage of time. (SCHNEIDER; IRIGARAY, 2008, p. 592).

In the literature, over time, the definition of aging among specialists has many variants. According to Alves (2025), "aging should not be perceived as a threat, but rather as a new stage of life, an opportunity for productivity, learning, and social involvement."

For Beauvoir (2024), modern medicine no longer intends to attribute a cause to biological aging, as it considers it inherent to the process of life, in the same way as birth, growth, reproduction, and death.

The increase in life expectancy has been modifying age pyramids around the world and according to the IBGE (2022), the number of elderly people has doubled in the last 20 years in Brazil.

In 2000, the Brazilian population aged 60 years and over was 15.2 million people (representing 8.7% of the total), should reach 55 million people in 2041 (25.6% of the total) and should reach 75.3 million elderly people in 2070 (representing 37.8% of the total population). In view of these data presented, the population aged 60 and over is expected to grow 5 times in 70 years. (IBGE, 2022).

Breaking down by regions in Brazil, it is noted that the Southeast region had 7 million elderly people in the year 2000 and reached 15.7 million in 2024. The Northeast region had 4.2 million elderly people in 2000 and reached 8.5 million in 2024. Data indicate that the emigration of young people in the Northeast should accelerate the aging of the population in this region. (IBGE, revision 2024).

The South region had 2.4 million elderly people in 2000 and reached 5.6 million in 2024. The North region had 767 thousand elderly people in 2000 and reached 2 million in 2024. The Central-West region had 825 thousand elderly people in 2000 and reached 2.4 million in 2024. (IBGE, revision 2024).

According to the data above, the aging population in Brazil shows that the country is going through a broad and rapidly growing demographic revolution.

According to Dardengo and Mafra (2018), the image of old age, through historical sources, varies from culture to culture, from time to time and from place to place. According to Giacomini (2012, p.19), "usually, our culture exalts the values of youth and consumption". Aging still continues to be stigmatized and treated with prejudice in society.

Old age remains associated with unproductivity and/or disability, contributing to the practice of discrimination and age-related prejudice. The Pan American Health Organization says that:

The term ageism was coined in 1969 by Robert Butler, an American gerontologist who was the first director of the National Institute on Aging in the United States. Although

ageism has existed for centuries, in all countries, contexts and cultures, the concept is relatively new and does not yet exist in all languages. (PAHO, 2022, p. XXI).

Any individual who goes through the aging process may be affected by ageism, ageism, ageism, names that represent discriminatory and prejudiced acts against the elderly.

The World Health Organization (WHO) released a policy document called "Active Aging" and translated into Portuguese is called "Active Aging: A Health Policy", implemented in Brazil in 2005.

In the WHO (2005) definition:

Active ageing is the process of optimising opportunities for health, participation and security, with the aim of improving quality of life as people get older (WHO, 2005, p. 14).

Active aging applies to both individuals and population groups so that they realize their potential for physical, social, and mental well-being throughout life and that it allows these individuals to participate in society according to their needs, desires, and capacities, and at the same time, provides protection, security, and adequate care. when they are needed. (WHO, 2005).

3 AGING AND BRAZILIAN LEGISLATION

The Federal Constitution of 1988 is a legal framework that recognizes the citizenship and social rights of the elderly. Before the Magna Carta, government actions were charitable and protective of the elderly, there were no specific laws for this population, which represented the lowest index at the top of the age pyramid.

Since the promulgation of the 1988 Constitution, the elderly have conquered their social rights, being supported, protected and with access and guarantee to services and benefits through public policies. However, according to Prado (2012), the Constitution brought advances in relation to the rights of the elderly, but the author emphasizes that "the State transferred, through partnerships, the responsibility for confronting the expressions of the social issue to the family and civil society" (PRADO, 2012, p.83).

In article 229, children have the obligation to help and support their parents in old age, need or illness, if they do not do so, it is a crime (article 244 of the new Civil Code). Article 230 states that the family, society and the State have the duty to support the elderly, ensuring their participation in the community, in the defense of dignity, well-being and guaranteeing their right to life. (PRADO, 2012).

The family bond is considered the ideal place for the elderly and the support of the State is fundamental, but in the face of family impoverishment, this extreme responsibility needs to be considered, since many families depend on the income of the elderly to survive, there is no Brazilian family pattern and this needs to be analyzed when it comes to responsibility.

It is worth mentioning that the 1988 Constitution broke with the stereotype of an unproductive, incapable and philanthropic elderly person.

The first specific legislation for the elderly in Brazil is the National Policy for the Elderly – PNI, in 1994, which creates the National Council for the Elderly. This legislation allowed the elderly to obtain their social rights, in the sense of promoting their autonomy and social participation. (BRAZIL, 1994).

Ministerial Ordinance No. 1,395/99 established prevention and health promotion through multidisciplinary care based on the Pact for Life, with emphasis on the elderly and instituted the National Health Policy for the Elderly – PNSPI. (BRAZIL, 2006).

From the point of view of Dias and Pais-Ribeiro (2018, p. 416), the Statute of the Elderly "is one of the main instruments of the rights of the elderly in Brazil, its approval represented an important step in Brazilian legislation", the Statute ratifies the principles that guided the discussions on the human rights of this population, with the State, Society and Family being responsible for the protection and guarantee of these rights.

For Dias and Pais-Ribeiro (2018), although the Statute is the target of criticism for its ineffectiveness:

The Statute of the Elderly has great merit, as it created a system of guarantees of the rights of the elderly, which, despite several mishaps, has sought to enforce the social rights of the Brazilian elderly. The system of guarantees provided for in the Statute is composed of the following institutions/bodies: Councils for the Elderly; Unified Health System (SUS); Unified Social Assistance System (SUAS); Health Surveillance; Judiciary; Public Defender's Office; Public Prosecutor's Office; and Civil Police. The efficiency of this network of guarantees is one of the possibilities for the effectiveness of the rights of the elderly to become effective. (DIAS; PAIS-RIBEIRO, 2018, p. 416).

The Statute of the Elderly is a very broad legislation that also deals with other rights of the elderly, such as the right to education, culture, sports, leisure, food, professionalization and work, social assistance and social security, affirming the way in which these rights should be ensured for the elderly population (FERREIRA; TEIXEIRA, 2014).

The Statute of the Elderly Person is the newest denomination that, through Law No. 14,423 of July 22, 2022, amended Law No. 10,741 of October 1, 2003, replacing all

expressions "elderly", "elderly", with the expressions "elderly person" and "elderly people", respectively.

The legal frameworks PNI (1994) and Statute (2003) emerged to guarantee the rights of the elderly in the country and brought an immeasurable gain to the elderly population, but it is necessary that the rights and policies are put into practice and that the actions are carried out based on the main laws that defend the dignity of the elderly.

3.1 AGING AND PUBLIC EDUCATIONAL POLICIES

Education does not end at the end of each stage of the education system, contrary to popular belief, it extends throughout life and older people have the right to formal education.

Currently, there is a growing demand for education on the part of elderly people who are looking for their place in the world as citizens, committed subjects, who seek to update themselves to understand the world of which they are a part, but this learning is not a one-way street, because at the same time that these subjects become aware of the new, They contribute their knowledge and experience. (GUIMARÃES; RAMOS, 2012).

Regarding citizenship, Gâlo (2017) states that:

The 1988 Constitution elects five foundations, one of which is citizenship. It is considered fundamental, in the Brazilian political movement aimed at the installation and consolidation of a democratic state of law, the characterization of all members of this state as citizens, which implies a series of political rights and a set of civic duties. There is no democratic state of law without citizens, which is why citizenship was elected as one of the constitutional foundations. More than that, citizenship has presided over the entire formulation of public policies in the country since then. (GALLO, 2017, p. 1508).

The Federal Constitution (BRASIL, 1988), guarantees education as a social right in Chapter III – Education, Culture and Sport, in which its Article 205 deals with:

Education, a right of all and a duty of the State and the family, will be promoted and encouraged with the collaboration of society, aiming at the full development of the person, his preparation for the exercise of citizenship and his qualification for work". (BRAZIL, 1988).

The Law of Guidelines and Bases of National Education – LDB, establishes that the education of young people and adults will be aimed at those who did not have access to or continuity of studies in elementary and secondary education at the appropriate age. (LDB, 1996).

Russel and Silva (2012) state that:

EJA is the integral modality of basic education intended to serve students who did not have, at the appropriate age, access or continuity of studies in elementary and high school. (RUSSELL; SILVA, 2012, p.109).

Although the Federal Constitution and the LDB deal with education as a right for all and with no age limit, both do not specifically deal with the elderly population.

From the National Policy for the Elderly, Law No. 8,842 of January 4, 1994, and the Statute of the Elderly, Law No. 10,741 of October 1, 2003, public policies aimed at the elderly emerge. Regarding the PNI and the Statute of the Elderly, Monteiro and Oliveira (2018) state that:

These were generated from extensive discussions between government and civil society, and were the subject of discussion for a relatively long period until their implementation. These policies, although recent, have embryos in discussions that began a long time ago. (MONTEIRO; OLIVEIRA, 2018, p. 57).

The Statute of the Elderly Person (2003) in Chapter V – Education, Culture, Sports and Leisure, in Art.20. It says that the elderly have the right to education, culture, sports, leisure, entertainment, shows, products and services that respect their peculiar age condition.

In Brazil, several initiatives are developed in order to meet the educational demands of the elderly, which are: the Open University for the Third Age (UnATI), Youth and Adult Education (EJA) and the National Education Plan (PNE).

In the words of Teixeira (2024), the Open Universities for the Third Age (UNATIS) corroborate the promotion of active and healthy aging and act from a proposal for integration between the elderly and the community through the formation of groups aimed at social participation and interaction of the target audience.

UnATIs are programs linked to public and private universities, which offer courses, workshops and cultural activities following the active aging policy. The UnATIs began to develop in the country in the 60s and their expansion only underwent greater expansion from 1990 onwards.

About the UnATIs, Teixeira (2024) points out that:

In this way, the realization of activities within the UNATIs can be apprehended within the 'participation' pillar, which also sustains the structure of 'active aging', because from this, there is the insertion of elderly people who cooperate, share ideas and knowledge and contribute to social and even economic development, depending on the activities chosen by them. In addition, there is a great contribution to the development of health, since participation in the program allows access to information that enables greater care for physical and mental health. (TEIXEIRA, 2024, p. 373-374).

The EJA modality is a public policy that contemplates the elderly population that did not have access to formal education, however, EJA includes the elderly as an adult, however, it does not offer a curriculum and methodology appropriate to this new demand increasingly present in educational establishments.

The Committee for the Defense of the Rights of the Elderly of the Chamber of Deputies approved Bill No. 2679/24, which formally includes the elderly in the EJA modality.

The change brings a new nomenclature to the EJA, which will be called Education for Youth, Adults and the Elderly (EJAI), representing an advance in educational policy, it is expected that this advance will be put into practice with a view to improving the care of the elderly in all educational establishments in our country.

The programs implemented to serve the elderly public, such as UnATIs, EJA and other informal courses are important for the insertion of this new social "actor". These actions have been strengthening what the active aging policy states is that the participation, socialization, autonomy and independence of the elderly subject in the environment in which they live is fundamental.

Public educational policies aimed at aging must be present in the human rights and citizenship agendas at all governmental levels.

4 LEARNING AND INCLUSION OF OLDER PEOPLE

Older people have always been excluded from formal education policies in Brazil. There were never specific educational laws for the elderly before the National Policy for the Elderly in 1994 and this gap still persists today.

It should be noted that lifelong learning goes beyond the walls of the school, learning in both formal and informal contexts must be valued and can take place at work, in the community or in the family, through informal experiences adapting subjects to social, environmental and technological transformations.

In UNESCO reports (2016), the concept of lifelong learning is highlighted as an affirmation of lifelong learning.

The National Education Plan (2014–2024) reinforces this commitment by establishing goals aimed at expanding the supply and improving the quality of education for young people, adults, and the elderly, promoting opportunities for permanent and inclusive learning (BRASIL, 2014).

In the case of older people, continuous learning contributes significantly to strengthening self-esteem, maintaining mental health, and increasing community engagement. Initiatives such as intergenerational projects, cultural workshops and courses

focused on digital technologies are examples of practices that stimulate social inclusion and promote the exchange of knowledge between generations (NERI, 2007).

Currently, one of the biggest challenges is the inclusion of the elderly in the digital world, since technological exclusion accentuates social inequality, therefore, the implementation of digital literacy programs is important for the effectiveness of citizenship in the technological age. In Gállo's words, "to guarantee the universality of the right to education, it is necessary to include everyone; all human diversity needs to be embraced". (GÁLLO, 2017, p. 1512-1513).

Despite some advances, there are still barriers that prevent the full educational inclusion of older people, among the main challenges we have the absence of specific public policies, low funding, lack of trained professionals and discrimination and age prejudice.

Educational institutions need to include the theme of aging in their curricula, contributing to the reduction of ageism.

Education for the elderly is a right and opportunity for them to exercise their citizenship provided for in the Federal Constitution (1988) and in the Universal Declaration of Human Rights (1948).

Promoting the inclusion of the elderly in formal education and ensuring their permanence in learning spaces is one of the greatest challenges in the construction and evolution of public policies in education.

5 FINAL CONSIDERATIONS

The aging of the Brazilian population is an irreversible and growing phenomenon, which imposes on society, the State and educational institutions the challenge of rethinking their inclusion practices and policies. The study showed that, although there are important legal frameworks such as the Federal Constitution of 1988, the National Policy for the Elderly (1994) and the Statute of the Elderly (2003, updated in 2022), the realization of the educational rights of older people still encounters significant barriers. The absence of specific public educational policies, the scarcity of funding, the lack of trained professionals and the persistent age prejudice are obstacles that hinder the full exercise of citizenship and the implementation of the principle of lifelong learning.

The programs analyzed, such as Youth and Adult Education (EJA), the Open Universities for the Third Age (UnATI) and initiatives aimed at digital literacy, demonstrate that it is possible to promote active and participatory aging through education. Such programs reinforce the role of learning as an instrument of social inclusion, autonomy and appreciation of the elderly, contributing to the strengthening of self-esteem and the expansion of

intergenerational relationships. However, it is necessary that these actions cease to be punctual and become structured, permanent and articulated policies between the different levels of government.

It is concluded, therefore, that the promotion of learning for the elderly should be understood as an essential part of public policies on human rights and citizenship. Education, as a social right and instrument of emancipation, needs to encompass all age groups, recognizing the elderly as subjects of knowledge and experiences. Investing in the education of the elderly is investing in a fairer, more inclusive and supportive society, capable of combating ageism, valuing age diversity and ensuring that aging is lived with dignity, participation and a sense of social belonging.

REFERENCES

- Alves, J. E. D. (2025, 1 de outubro). O envelhecimento populacional deve ser acolhido e não temido. Portal do Envelhecimento e Longevidade.
- Brasil. (1988). Constituição da República Federativa do Brasil. Senado Federal.
- Brasil. (1994). Lei nº 8.842, de 4 de janeiro de 1994. Dispõe sobre a Política Nacional do Idoso, cria o Conselho Nacional do Idoso e dá outras providências. Ministério da Justiça, Secretaria Nacional dos Direitos Humanos.
- Brasil. (2003). Lei nº 10.741, de 1º de outubro de 2003. Dispõe sobre o Estatuto do Idoso.
- Brasil. (2014). Lei nº 13.005, de 25 de junho de 2014. Aprova o Plano Nacional de Educação – PNE 2014-2024 e dá outras providências. Ministério da Educação.
- Beauvoir, S. (2024). A velhice (M. H. F. Martins, Trad.; 4ª ed.). Nova Fronteira. (Obra original publicada em 1970)
- Dias, E. N., & Pais-Ribeiro, J. L. (2018). Evolução das políticas públicas à pessoa idosa no Brasil. *Enfermagem Brasil*, 6, 413–420.
- Dardengo, C. F. R., & Mafra, S. C. T. (2018). Os conceitos de velhice e envelhecimento ao longo do tempo: contradição ou adaptação? *Revista de Ciências Humanas*, 18(2), 1–15.
- Ferreira, A. P., & Teixeira, S. M. (2014). Direitos da pessoa idosa: desafios à sua efetivação na sociedade brasileira. *Argumentum*, 6(1), 160–173.
- Giacomin, K. C. (2012). Envelhecimento populacional e os desafios para as políticas públicas. In M. V. Berzins & M. C. Borges (Eds.), *Políticas públicas para um país que envelhece* (pp. ?–?). Martinari.
- Guimarães, A. H. T., & Ramos, T. V. (2012). Aspectos da educação para a terceira idade: motivação, aprendizagem e avaliação. In M. L. M. C. Vasconcelos & R. H. P. Brito (Eds.), *Educação para a terceira idade*. Edições Loyola.
- Gállo, S. (2017). Políticas da diferença e políticas públicas em educação no Brasil. *Educação e Filosofia*, 31(63), 1497–1523.
- Instituto Brasileiro de Geografia e Estatística. (2022). Projeções e estimativas da população do Brasil e das Unidades da Federação.

- Lei nº 9.394, de 20 de dezembro de 1996. Estabelece as diretrizes e bases da educação nacional. Seção V – Da EJA. Arts. 37 e 38.
- Monteiro, J. H. S., & Oliveira, M. E. M. de. (2018). Políticas públicas educacionais para o idoso no Estado do Ceará. *Revista Docentes*, 3, 1–?.
- Neri, A. L. (Ed.). (2007). *Idosos no Brasil: vivências, desafios e expectativas na terceira idade*. Fundação Perseu Abramo.
- Neri, A. L. (Ano?). Conceitos e teorias sobre o envelhecimento. In *Neuropsicologia do envelhecimento: uma abordagem multidimensional*.
- Organização Pan-Americana da Saúde. (2022). Relatório mundial sobre o idadismo. <https://doi.org/10.37774/9789275724453>
- Organização Mundial da Saúde. (2005). *Envelhecimento ativo: uma política de saúde*. Organização Pan-Americana da Saúde.
- Prado, T. M. B. do. (2012). Proteção social à pessoa idosa no Brasil. In M. V. Berzins & M. C. Borges (Eds.), *Políticas públicas para um país que envelhece* (pp. ?–?). Martinari.
- Russel, G. M., & Silva, J. M. S. (2012). O aluno idoso da EJA e dos cursos livres para a terceira idade: encontros e desencontros. In M. L. M. C. Vasconcelos & R. H. P. Brito (Eds.), *Educação para a terceira idade*. Edições Loyola.
- Teixeira, S. M. (Ed.). (2024). *Envelhecimento e políticas públicas*. Editora Terra sem Amos.
- World Health Organization. (2005). *Envelhecimento ativo: uma política de saúde* (S. Gontijo, Trad.). Organização Pan-Americana da Saúde. http://bvsmms.saude.gov.br/bvs/publicacoes/envelhecimento_ativo.pdf

UNITY, INDIVISIBILITY AND FUNCTIONAL INDEPENDENCE: A SYSTEMIC ANALYSIS OF THE CONSTITUTIONAL PRINCIPLES OF THE BRAZILIAN PUBLIC PROSECUTOR'S OFFICE

UNIDADE, INDIVISIBILIDADE E INDEPENDÊNCIA FUNCIONAL: ANÁLISE SISTÊMICA DOS PRINCÍPIOS CONSTITUCIONAIS DO MINISTÉRIO PÚBLICO BRASILEIRO

UNIDAD, INDIVISIBILIDAD E INDEPENDENCIA FUNCIONAL: ANÁLISIS SISTÉMICO DE LOS PRINCIPIOS CONSTITUCIONALES DEL MINISTERIO PÚBLICO BRASILEÑO



<https://doi.org/10.56238/sevened2026.008-137>

Joaquim Ribeiro de Souza Junior¹

ABSTRACT

This paper examines the institutional principles governing Brazil's Public Prosecutor's Office — unity, indivisibility, and functional independence — through constitutional hermeneutics and Robert Alexy's theory of fundamental rights. After distinguishing rules from principles, the study shows how these directives shape prosecutorial action, ensure internal coherence, and safeguard impartiality. Using a qualitative, bibliographic-documentary approach, the article traces the historical development of the natural prosecutor principle, which replaced politically appointed "ad hoc prosecutors," and assesses the National Council of the Public Prosecutor's Office (CNMP) in implementing these values. Findings indicate that the effectiveness of the principles hinges on governance that reconciles functional autonomy with democratic oversight mechanisms, preventing both internal capture and undue external interference.

Keywords: Public Prosecutor's Office. Unity. Indivisibility. Functional Independence. Natural Prosecutor.

RESUMO

O artigo examina os princípios institucionais do Ministério Público brasileiro — unidade, indivisibilidade e independência funcional — à luz da hermenêutica constitucional e da teoria dos direitos fundamentais de Robert Alexy. Depois de distinguir regras e princípios, analisa-se como essas diretrizes estruturam a atuação ministerial, asseguram coerência interna e protegem a imparcialidade do órgão acusatório. A pesquisa, de cunho bibliográfico-documental e abordagem qualitativa, revisita a evolução histórica do princípio do Promotor Natural, superando a figura do "promotor de encomenda", e avalia o papel do Conselho Nacional do Ministério Público (CNMP) na concretização desses valores. Conclui-se que a efetividade dos princípios depende de uma governança que una autonomia funcional a mecanismos democráticos de controle, prevenindo tanto a captura interna quanto interferências externas indevidas.

¹ Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: joaquimjunior33@gmail.com Orcid: <https://orcid.org/0000-0003-3488-5508>

Palavras-chave: Ministério Público. Unidade. Indivisibilidade. Independência Funcional. Promotor Natural.

RESUMEN

El artículo examina los principios institucionales del Ministerio Público brasileño —unidad, indivisibilidad e independencia funcional— a la luz de la hermenéutica constitucional y de la teoría de los derechos fundamentales de Robert Alexy. Tras distinguir entre reglas y principios, se analiza cómo estas directrices estructuran la actuación ministerial, aseguran la coherencia interna y protegen la imparcialidad del órgano acusador. La investigación, de carácter bibliográfico-documental y enfoque cualitativo, revisita la evolución histórica del principio del Promotor Natural, superando la figura del “promotor a la carta”, y evalúa el papel del Consejo Nacional del Ministerio Público (CNMP) en la concreción de estos valores. Se concluye que la efectividad de los principios depende de una gobernanza que articule la autonomía funcional con mecanismos democráticos de control, previniendo tanto la captura interna como injerencias externas indebidas.

Palabras clave: Ministerio Público. Unidad. Indivisibilidad. Independencia Funcional. Promotor Natural.

1 INTRODUCTION

The Constitution of the Republic of 1988 reformulated the Public Prosecutor's Office (MP) as a permanent institution, charged with the defense of the legal order, the democratic regime and the inalienable social and individual interests. To ensure that this mission is fulfilled in an effective and impartial manner, the Constituent Assembly established, in paragraph 1 of article 127, the principles of unity, indivisibility and functional independence. These normative commands represent true optimization mandates, in the Alexian sense, conditioning all ministerial intervention to the beacons of the Democratic Rule of Law.

Despite their apparent convergence, these principles give rise to practical tensions: institutional unity can collide with the decision-making independence of the prosecutor; indivisibility, although necessary for the continuity of the service, imposes challenges to the guarantee of the natural promoter; and functional independence, if absolutized, can weaken internal and social accountability. Added to this is the creation, by Constitutional Amendment 45/2004, of the CNMP, which introduced new vectors of external control and strategic planning.

In view of this scenario, this article aims to (i) revisit the theoretical foundations that distinguish rules and principles, (ii) analyze each constitutional postulate of the MP in the light of doctrine and jurisprudence, (iii) discuss the evolution of the principle of the Natural Prosecutor and (iv) evaluate the role of the CNMP in the harmonization of institutional guidelines. Methodologically, a bibliographic research integrated with documentary examination of constitutional and infra-constitutional norms is adopted, with a qualitative and hermeneutic approach.

The relevance of the study lies in offering a systemic view that helps legal operators in the coherent application of the principles, preventing deviations such as the historical figure of the "order promoter" and strengthening social trust in the Public Prosecutor's Office.

2 INSTITUTIONAL PRINCIPLES OF THE PUBLIC PROSECUTOR'S OFFICE

The Theory of Fundamental Rights, elaborated by the jurist Robert Alexy and published in 1985, was of paramount importance for understanding the differences between rules and principles. According to this theory, rules and principles are norms, since they reveal deontic expressions, indicating order, permission, prohibition, that is, the ought to be. However, they are different, insofar as the principles are considered "optimization mandates", ordering the performance of a certain action to the greatest extent feasible, taking into account the legal and factual possibilities. The rules, on the other hand, are precise and definitive, so they are complied with or not, and there is no middle ground.

In this sense, in the conflict of rules, one eliminates the other, verifying the invalidity of one of them. With regard to the collision between principles, one separates the other when the question is resolved, observing the legal and factual context of each of them. (JÚDICE, 2007)²element. Thus, it is inferred that the principles, in spite of being endowed with greater generality and abstraction, as well as being more related to the context in which they are applied, requiring a weighting when applying them, have imperativeness as much as the rules, having a cogent character³⁴⁵.

From this perspective, it is affirmed that the institutional principles of the Public Prosecutor's Office, engraved in § 1 of article 127 of the Federal Constitution (BRASIL, 1988), namely, unity, indivisibility and functional independence, are norms of imperative application by the operator of the law, under penalty of incurring in unconstitutionality.

2.1 PRINCIPLE OF UNITY OF THE PUBLIC PROSECUTOR'S OFFICE

The principle in question reflects that prosecutors are members of a single Public Prosecutor's Office, the same body⁶. Thus, members perform their duties without being

² Letícia Balsamão Amorim (2005, p. 56) argues that "when two principles are in collision, one of the two principles has to yield to the other. But this does not mean declaring the principle despised invalid or that an exception clause must be introduced in the principle despised. What will determine which principle should give way will be the circumstances. This means that, in concrete cases, the principles have different weights and the principle with the greatest weight prevails"

³ Carlos Roberto de Castro Jatahy (2008) teaches that "Constitutions are composed of norms that can be classified into two main categories: principles and rules. Rules would be those norms that are close to common law, that is, they have the necessary elements to invest someone in the quality of holder of a subjective right. Principles, on the other hand, although they do not generate subjective right, perform a transcendental function within the Constitution, giving a semblance of unity to the Constitutional Text and determining its fundamental guidelines".

⁴ From this angle, the teaching of the Minister of the Federal Supreme Court, Luís Roberto Barroso (2018, p. 26), who adduces that the "constitutional principles affect the legal world and the factual reality in different ways, is relevant. Sometimes, the principle will be the direct basis of a decision. At other times, its incidence will be indirect, conditioning the interpretation of a certain rule or paralyzing its effectiveness"

⁵ With regard to the relevance of principles, it is appropriate to present the consideration of Paulo Bonavides (2011, p. 74), who elucidates that "Placed at the highest point of the normative scale, they themselves, being norms, become, from now on, the supreme norms of the legal system. Serving as guidelines or criteria par excellence for the evaluation of all normative contents, the principles, from their constitutionalization, which is at the same time positivization at the highest level, receive as a maximum evaluative instance a constitutional category, surrounded by prestige and the hegemony that is conferred on the norms inserted in the Law of Laws. With this additional relevance, the principles also become norm normarum, that is, the norm of norms"

⁶ It should be noted that the institutional unity of the Public Prosecutor's Office must be a democratic construction with broad popular participation. In this sense, Marcelo Goulart teaches that "institutional unity must be built democratically. The Public Prosecutor's Office must be open to society and interact with the other collective political subjects that make up the basis of support for the democratic project. The democratic construction of institutional unity presupposes the participation of society in the process of defining institutional priorities. Before establishing the priority goals of the Action Plans and Programs, the Public Prosecutor's Office must consult society. These goals should reflect what society wants and expects from the work of the Public Prosecutor's Office. Each Public Prosecutor's Office – State and Union, the latter in its various branches – must define models for popular consultation and the preparation of Action Plans and Programs, taking into account their specificities and forms of spatial organization" (2021, p. 154)

identified in a way that individualizes them. They represent the institution as a whole, which is one, having only different branches with defined attributions.

Unity, in the words of Mazzilli (2008, p. 23), "means that the members of the Public Prosecutor's Office are part of a single body under the direction of a single chief". In view of this, there are those who confuse the principle in question with the principle of indivisibility, which is different, so that it refers to the activity of the prosecutor as a procedural-procedural agent (GOULART, 2009), and, at the appropriate time, will be better analyzed.

It is essential to clarify that being under the direction of a single head does not mean that there is a relationship of unity between the Federal Public Prosecutor's Office and the state Public Prosecutor's Office, nor between the Public Prosecutor's Offices of different states. It so happens that each Public Prosecutor's Office has a chief, who defines and guides the institution's activities.

In this way, the principle of unity reveals that for each institutional function conferred on the Public Prosecutor's Office in the Constitution, there is only one ministerial branch competent to execute it. Jatahy (2008) In other words, only a certain branch has the attribution to act in a concrete case⁷.

Nevertheless, it can be seen that Constitutional Amendment No. 45/2004 (Reform of the Judiciary), created the National Council of the Public Prosecutor's Office (CNMP) by adding article 130-A to the text of the Magna Carta. This body basically has the attribution of controlling the administrative and financial activity of the Institution, as well as analyzing the fulfillment of the functional duties of the members who are part of it⁸.

⁷ On the subject, Emerson Garcia (2017, p. 21) asserts that "By providing for the existence of a single Public Prosecutor's Office, which would encompass a diversity of autonomous institutions, the 1988 Constitution embraced "unity with the inclusion of variety". From this conclusion, it can be affirmed that the principle of unity, contemplated in § 1 of article 127 of the 1988 Constitution, acts as an evident argumentative reinforcement, indicating that both the Federal Public Prosecutor's Office and the State Public Prosecutor's Offices, each in its sphere of attributions, act as inseparable parts of one and the same body."

⁸ The rule provides as follows: "Article 130-A, § 2 It is incumbent upon the National Council of the Public Prosecutor's Office to control the administrative and financial performance of the Public Prosecutor's Office and the fulfillment of the functional duties of its members, and it is incumbent upon it:

I - to ensure the functional and administrative autonomy of the Public Prosecutor's Office, being able to issue regulatory acts, within the scope of its competence, or recommend measures;

II – to ensure compliance with article 37 and to assess, ex officio or upon provocation, the legality of administrative acts performed by members or bodies of the Public Prosecutor's Office of the Union and of the States, being able to dismantle them, review them or set a deadline for the adoption of the necessary measures for the exact compliance with the law, without prejudice to the competence of the Courts of Auditors;

III – to receive and hear complaints against members or bodies of the Public Prosecutor's Office of the Union or of the States, including against its auxiliary services, without prejudice to the disciplinary and correctional competence of the institution, being able to evoke disciplinary proceedings in progress, determine removal or availability and apply other administrative sanctions, ensuring ample defense;

IV – to review, ex officio or upon provocation, the disciplinary proceedings of members of the Public Prosecutor's Office of the Union or of the States judged less than one year ago;

V - to prepare an annual report, proposing the measures it deems necessary on the situation of the Public Prosecutor's Office in the country and the activities of the Council, which must integrate the message provided for in article 84, XI" (BRASIL, 1988).

The aforementioned body is not part of the structure of any state power, just as it is not part of the structure of the Federal Public Prosecutor's Office, much less the Public Prosecutor's Office of the States. It is another mechanism for carrying out external control⁹. Thus, the implementation of the CNMP in no way injured the principle of unity, insofar as it did not intend to subject the State Public Prosecutor's Offices to the MPU or even to the above-mentioned Council. (JATAHY, 2008)

In addition, it is worth examining the new bias given to the principle of unity. It is a more political perspective of ministerial activity, in order to influence the Institution's Action Plans and Programs. In this context, the unity of the Public Prosecutor's Office must be built in a democratic manner. To this end, it is recommended that society get involved in the process of defining the priorities of the Parquet, through instruments and spaces of participatory democracy¹⁰.

In a hasty analysis, it would be possible to discuss the supposed impossibility of coexistence between the principle in question and the principle of functional independence. On a superficial analysis, such principles may seem antagonistic and in constant collision. However, such a note does not deserve to prosper, since such rules have different destinations (GARCIA, 2017). While the first principle refers to the institution of the Public Prosecutor's Office in its organizational structure, the second is specifically aimed at the members.

2.2 PRINCIPLE OF INDIVISIBILITY OF THE PUBLIC PROSECUTOR'S OFFICE

The line that separates the institutional principle of indivisibility from the principle of unity previously analyzed is very thin. However, strengthening the differences between these principles, it should be detailed that institutional indivisibility concerns the activity of the prosecutor, insofar as it allows the replacement of members among themselves without hindering ministerial activity.

⁹ In this sense: "just as it already happens over the Judiciary or any Powers or institutions of the State, there must also be some form of external control over the Public Prosecutor's Office, not to curtail the independence and functional freedom of the institution and its agents, but to ensure that they are accountable to the Legislative Branch, the press and the community not only for the exercise of their core activities but also for the exercise of their secondary activities. After all, the Constitution supposes publicity and transparency in the activities of public bodies, only hindered in exceptional cases, in which the disclosure of the measure may result in damage to the community" (MAZZILLI, 2007, p. 15).

¹⁰ In this orientation, Marcelo Pedrosa Goulart (2009, p. 63) understands that "the principle of unity informs and guides the political-institutional action of the Public Prosecutor's Office, which, through the set of its members, its executive bodies and the Higher Administration, must be aimed at achieving its strategic objective: the promotion of the project of participatory, economic and social democracy outlined in the Constitution of the Republic (the construction of a free society, in which development must necessarily be directed to the eradication of poverty and marginalization, the reduction of social and regional inequalities and the promotion of the common good).

Thus, when it is the case that a prosecutor, for example, takes his vacation, leave, is removed due to some impediment or suspicion, he can be replaced by another member without jeopardizing the execution of the ministerial activity, considering that the acts performed by the members are performed in the name of the Public Prosecutor's Office¹¹. In other words, prosecutors are not bound by the processes in which they officiate.

Thus, it can be inferred that the principle of indivisibility is contained in the principle of unity, deriving from it, in order to avoid a split in the Public Prosecutor's Office. Thus, subdivisions within the Institution cannot be autonomous and must always be subordinated to the Head of the Parquet. (GARCIA, 2017). It should be noted that the principle in question is firmly related to the Principle of the Natural Prosecutor as well as to the guarantee of irremovability (JATAHY, 2008). In this sense, the Principle of the Natural Prosecutor determines that a body of the Public Prosecutor's Office will be previously defined by law to act in cases that require ministerial action.

Previously, one could glimpse the activity of the "order promoters", who were chosen at the discretion of the Attorney General of Justice. However, in order to enforce due process of law¹² and the right to be prosecuted by the competent authority¹³, the Principle of the Natural Prosecutor was recognized, rejecting casuistic designations and for political purposes, guaranteeing the irremovability of the member.

Ensuring the non-existence of an "exception accuser" is of great relevance, considering that members of society have the right to be prosecuted by an impartial, neutral prosecutor who acts in a given process because he follows criteria previously determined by law. In this way, the principle of indivisibility allows the replacement of members among themselves without tainting the activity of the Parquet, and it is not appropriate to speak of the designation of a prosecutor of order, much less that the act of a prosecutor who acted without having the proper attribution is validated.

Although the principle of indivisibility allows the replacement of prosecutors in their activities, as they represent the Public Prosecutor's Office itself, it should be noted that the attribution of each member has limitations. Hugo Nigro Mazzilli (2001) understands that it is only possible to take advantage of the act performed by the ministerial body before the

¹¹ It means that "Indivisibility is a characteristic of all formal organizations. Its members, in this capacity, are inseparable from the organization. This is what happens with the Public Prosecutor's Office in relation to its indivisibility, meaning that its members, as such, express the will of the institution, and not their individual will" (ROCHA, 2001, p. 53).

¹² Under the terms of Article 5, LIV of the Constitution "no one shall be deprived of liberty or property without due process of law" (BRASIL, 1988)

¹³ Also according to the Federal Constitution, in its article 5, LIII, "no one shall be prosecuted or sentenced except by the competent authority" (BRASIL, 1988)

competent court if there has been no scope to circumvent the Principle of the Natural Prosecutor and if the act is ratified by the competent ministerial body.

2.3 PRINCIPLE OF FUNCTIONAL INDEPENDENCE

The principle of functional independence contained in the Federal Constitution (BRASIL, 1988) guarantees ministerial members not functional subordination to any body or power, exercising their attributions and manifesting themselves in the processes always in a reasoned manner, subject only to their conscience and the legal order.

In view of this, the hierarchical relationship between the prosecutors and the attorney general can be questioned. It so happens that the members of the Public Prosecutor's Office are subordinate to the Head of the Institution only in the administrative sense¹⁴. Thus, with regard to institutional attributions, prosecutors do not submit to the recommendations of higher bodies, only in the administrative sphere.

From this perspective, the LONMP (BRASIL, 1993b), National Organic Law of the Public Prosecutor's Office (Law No. 8,625, of February 12, 1993) establishes that the bodies of the Higher Administration are non-binding subject to their recommendations. Such recommendations can come from the Attorney General of Justice¹⁵, the Superior Council of the Public Prosecutor's¹⁶ Office and the General Internal Affairs Office of the Public Prosecutor's¹⁷ Office. It should be noted that, although the Attorney General's Offices¹⁸ are not part of the Higher Administration, they may publish recommendations of an administrative or institutional nature, without, in the same way, binding the member of the Public Prosecutor's Office.

It is different with administrative decisions coming from the Higher Administration. According to article 43, XIV, of the LONMP, it is the duty of the members of the Public

¹⁴ In this regard, Emerson Garcia (2017, p. 57) explains that "the principle of functional independence is directly related to the exercise of the finalistic activity of ministerial agents, preventing exogenous factors, foreign or not to the Institution, from influencing the performance of its munus. Thus, it is avoided that authorities that are part of any of the so-called "Powers of the State", or even the bodies of the Superior Administration of the Public Prosecutor's Office itself, carry out any type of ideological censorship in relation to the acts practiced".

¹⁵ According to Law No. 8,625/1993 (BRASIL, 1993b), in its article 10, "It is incumbent upon the Attorney General of Justice: XII - to issue recommendations, without a normative character to the bodies of the Public Prosecutor's Office, for the performance of his functions"

¹⁶ Pursuant to article 15 of Law No. 8,625/1993 (BRASIL, 1993b), "The Superior Council of the Public Prosecutor's Office is responsible for: X - suggesting to the Attorney General the issuance of recommendations, without a binding nature, to the bodies of the Public Prosecutor's Office for the performance of their functions and the adoption of appropriate measures to improve services"

¹⁷ Article 17 of Law No. 8,625/1993 (BRASIL, 1993b) establishes that "The General Internal Affairs Office of the Public Prosecutor's Office is the guiding and supervisory body of the functional activities and conduct of the members of the Public Prosecutor's Office, and it is incumbent upon it, among other duties: IV - to make recommendations, without a binding nature, to the executive body"

¹⁸ Article 20 of Law No. 8,625/1993 (BRASIL, 1993b) provides that "The Prosecutors of the Civil and Criminal Prosecutor's Offices, who officiate at the same Court, shall meet to establish legal guidelines, without a binding character, forwarding them to the Attorney General of Justice".

Prosecutor's Office "to comply, at the administrative level, with the decisions of the bodies of the Superior Administration of the Public Prosecutor's Office". Therefore, it is inferred that recommendations are different from administrative decisions, which are binding. Because of this, the principle of functional independence does not encompass the administrative precepts, and there is observance, in the Parquet, of the disciplinary-administrative hierarchical principle. (JATAHY, 2008)

Thus, while the principle of functional independence aims to provide greater protection to the ministerial member so that he or she officiates in the deeds without external interference, the prosecutor must be bound by the administrative decisions coming from the Higher Administration. For this reason, the Attorney General has the authority conferred by law¹⁹ to, for example, establish the assignment of a certain prosecutor in cases where there is a conflict of assignment. In this way, the prosecutor cannot decline the assignment in a given case and refuse to act when determined by the Head of the Institution, alleging violation of the principle of functional independence²⁰.

In addition, from the analysis of the principle of independence, it can also be inferred that the members of the Parquet are immune from liability on account of their acts performed during the exercise of their institutional functions. In this regard, Zanetti Jr (2018) points out that political agents, including prosecutors, have functional freedom, similar to the independence of judges, being safe from civil liability, except if they have acted with gross negligence, bad faith or abuse of power.

However, it should be clarified that although the principle of indivisibility previously studied allows the replacement of members in the same judicial process since they are representing the institution itself, this does not mean that the substitute prosecutor will be subordinated to the content of the manifestations of the substituted one. That said, by the principle of functional independence, the member of the Public Prosecutor's Office who replaces the other is not obliged to follow the same line of legal thought previously used.

Furthermore, it is important to emphasize that the principle of functional independence differs from functional autonomy, in the terms in which the latter refers to the Public

¹⁹ Article 10 of Law No. 8,625/1993 (BRASIL, 1993b) provides that "It is incumbent upon the Attorney General of Justice: X - to settle conflicts of attributions between members of the Public Prosecutor's Office, designating who should officiate in the deed"

²⁰ Mazzilli comments that "under the administrative aspect, the members of the Public Prosecutor's Office must abide by the decisions of the higher administration bodies. Thus, the solution of a conflict of attributions, the review of the promotion of the archiving of a civil inquiry or police inquiry, the imposition of disciplinary measures - are decisions that require compliance. However, no procedure or manifestation can be imposed by the higher management bodies on the member of the institution with regard to the exercise of institutional functions, provided that the act depends on the latter's decision and conviction, which is guaranteed by unrestricted functional independence. Thus, it cannot be determined to the member of the Public Prosecutor's Office: ask for merit or dismissal, appeal or refrain from appealing, give an opinion in this or that way" (2008, p. 15)

Prosecutor's Office as an institution, so that it confers the necessary freedom of action in relation to other Organs and Powers of the State. In this way, due to functional autonomy, the Public Prosecutor's Office is subject only to the Constitution and the laws.

Functional independence is different, since it refers to an attribute of public agents within the scope of the Public Prosecutor's Office itself, that is, it enshrines freedom of action to members of the same institution. Thus, for example, due to functional autonomy, the Public Prosecutor's Office deliberates on the non-promotion of public criminal action, however it is by virtue of functional independence that a prosecutor can advocate for the acquittal of a defendant, even if his colleague from the institution has appealed in favor of the conviction. (MAZZILLI, 2013)

Thus, it is appropriate to clarify that the freedom granted to ministerial representatives as a result of the principle of functional independence could give rise to numerous abuses, therefore, it is stated that it is not absolute, insofar as constitutional and infra-constitutional legislation observes limits for its application²¹. Such a conjuncture shows that there is no absolute right, which is not possible to suffer eventual demarcations.

Thus, the member cannot legitimize acts that violate his duty to defend the legal order, the democratic regime and the inalienable social and individual interests, as limited by the Federal Constitution (BRASIL, 1988).²² In this guideline, the LONMP is also found, which in its article 41, item V, establishes that the member of the Public Prosecutor's Office, when in the exercise of his functions, "enjoys inviolability for the opinions he expresses or for the content of his procedural manifestations or procedures, within the limits of his functional independence". Here, the legislator expressly manifested the existence of limits to the exercise of ministerial freedom.

²¹ On the subject, José Eduardo Sabo Paes (2003, p. 65) understands that "admitting limits to independence does not mean denying it, but ensuring its effective exercise within legal standards, based on ethical and logical assumptions, under penalty of not doing so, submitting the premises and institutional destination of the Public Prosecutor's Office. If functional independence were absolutely unlimited, the possibility of abuse would also be unlimited. In itself, freedom, one of the basic postulates of democracy, is also subject to limits provided for by law. Were it not so, under the cloak of freedom and functional independence, the Prosecutor or the Judge could arbitrarily deny compliance with the Federal Constitution itself, which is the foundation not only of the legal order but even of its investitures; or else they could sustain, without the slightest reasonableness, only based on abstractions or generic speculations, any breach of the legal order.

²² Regarding the principle "in the first place, it should be noted that the principle of functional independence is not an end in itself. It is also not a prerogative that is incorporated into the person of the members of the Public Prosecutor's Office at the moment they take office in their positions. It is a mere instrument made available to ministerial agents with a view to achieving an end: the satisfaction of the public interest, which is the *raison d'être* of the Public Prosecutor's Office, as is the case with any state body. From this simple observation, it becomes possible to affirm that the main prism of analysis of this important principle should be its association with the final activity of the Institution, a prerequisite for the realization of the public interest. Thus, the measurement plan must be removed from the person of the agent, and the feelings and aspirations, legitimate or not, inherent to it are irrelevant, and the vanity of the agent's person should not be confused with the prerogative of the position occupied by him. This one is indispensable, that one is not. Functional independence adorns the position, which is intended for the exercise of ministerial activity, an element that materializes the public interest". (GARCIA, 2017, p. 52)

Thus, it can be inferred that if the Constitution had not established instruments to safeguard the free ministerial action, the existence of the Public Prosecutor's Office in the Brazilian legal system would be of no use. The principles of functional independence, unity and indivisibility have the power to foster the impartial exercise of members, free from internal influences and pressures (coming from hierarchically superior colleagues in the offices of attribution of members) and external (those caused by other organs of power) and without fear of possible retaliation or superior orders that lead to the discredit of their actions before society.

However, under the argument of functional independence, the member of the Public Prosecutor's Office cannot fail to adopt a certain measure considered a priority by the institution's Higher Administration in its strategic planning carried out after consulting the population²³. It should be noted that article 43 of Law 8625/93 (BRASIL, 1993b) provides that "it is the duty of the members of the Public Prosecutor's Office, in addition to others provided for by law – XIV – to comply, at the administrative level, with the decisions of the bodies of the Superior Administration of the Public Prosecutor's Office". In addition, the aforementioned provision, in its item XI, also imposes the duty to "provide information requested by the institution's bodies".²⁴ Therefore, if a certain institutional project is considered strategic and a priority, the member of the Public Prosecutor's Office cannot refuse adherence.

²³ In these terms: "The goals, priorities and actions defined in the Action Plans and Programs stem from the need for the Public Prosecutor's Office to fulfill, by virtue of a generic constitutional imposition, its strategic objectives. Therefore, these Plans and Programs necessarily contemplate hypotheses of mandatory action and bind the members of the Public Prosecutor's Office. The member who fails to observe the goals, priorities, and actions established in the Action Plans and Programs cannot invoke, in his defense, the principle of functional independence, as this principle cannot serve as a shield for those who fail to comply with constitutionally and democratically defined institutional objectives" (GOULART, 2021, p. 159)

²⁴ Marcelo Goulart's warning about the need to combine the principle of functional independence with the strategic objective of the Public Prosecutor's Office is indispensable. The author points out that "from the relationship that is established between functional independence and the institutional objective emerges the true meaning of this principle. Functional independence, before being a guarantee of the member of the Public Prosecutor's Office, is a guarantee of society, as it is instituted to give the people the security of having a political agent who, in the exercise of the functions of defending social interests, can act independently, immune to the pressures of power. Functional independence guarantees the immunity of the member of the Public Prosecutor's Office to external and intra-institutional pressures, but does not free him to act based on strictly subjective judgments and personal agendas. The immunity resulting from this principle guarantees independence, yes, but to act in accordance with the strategic objective. In the exercise of his duties, the member of the Public Prosecutor's Office is bound by the institutional strategy and the commitments assumed, via the Constitution, with Brazilian society. When we speak of the duty of obedience to conscience, we are not dealing with a spontaneous or contingent conscience (false conscience); rather, of an authentic, emancipated and universal consciousness (true consciousness). It is an ethical conscience, informed by the universal values of democracy and constituted within the scope of the cathartic movement that overcomes, in the member of the Public Prosecutor's Office, the corporative (particularist) moment by the ethical-political (transformative) moment" (2021, p. 157-158)

REFERENCES

- Abboud, G. (2020). Processo constitucional brasileiro (4^a ed.). Revista dos Tribunais.
- Almeida, G. A. de. (s.d.). O Ministério Público no neoconstitucionalismo: Perfil constitucional e alguns fatores de ampliação de sua legitimação social. <http://www.unifafibe.com.br/revistasonline/arquivos/revistajuridicafafibe/sumario/5/14042010170607.pdf>
- Azevedo, E. de A. (1999). Autonomia administrativa e financeira do Ministério Público. *Justitia* 60 anos.
- Barcellos, A. P. de. (2008). O direito a prestações de saúde: Complexidades, mínimo existencial e o valor das abordagens coletiva e abstrata. *Revista da Defensoria Pública*, 133.
- Barroso, L. R. (2012). Judicialização, ativismo judicial e legitimidade democrática. *(Syn)thesis*, 5(1), 23–32.
- Barroso, L. R. (2020). Curso de direito constitucional contemporâneo: Os conceitos fundamentais e a construção do novo modelo (9^a ed.). Saraiva Educação.
- Bonavides, P. (2011). Curso de direito constitucional. Malheiros.
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (1985). Lei nº 7.347, de 24 de julho de 1985. Disciplina a ação civil pública de responsabilidade por danos causados ao meio-ambiente, ao consumidor, a bens e direitos de valor artístico, estético, histórico, turístico e paisagístico (VETADO) e dá outras providências. http://www.planalto.gov.br/ccivil_03/leis/l7347orig.htm
- Brasil. (1993a). Lei Complementar nº 75, de 20 de maio de 1993. Dispõe sobre a organização, as atribuições e o estatuto do Ministério Público da União. http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13105.htm
- Brasil. (1993b). Lei nº 8.625, de 12 de fevereiro de 1993. Lei Orgânica Nacional do Ministério Público. http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13105.htm
- Cabral, A. do P. (2017). Juiz natural e eficiência processual: Flexibilização, delegação e coordenação de competências no processo civil [Tese de doutorado, Universidade do Estado do Rio de Janeiro].
- Costa, S. H. da, & Fernandes, D. C. M. (2017). Processo coletivo e controle judicial de políticas públicas – Relatório Brasil. In K. Watanabe (Org.), *Processo coletivo e controle judicial de políticas públicas*.
- Chiavenato, I. (2020). Introdução à teoria geral da administração: Uma visão abrangente da moderna administração das organizações (10^a ed. rev. e atual.). Atlas.
- Daher, L. L. N. (2021). Ministério Público resolutivo e o tratamento adequado dos litígios estruturais (1^a ed., 1^a reimp.). D'Plácido.
- Da Ponte, A. C., & Demercian, P. H. (2016). Algumas considerações sobre o Ministério Público no direito estrangeiro. *Revista Jurídica ESMP-SP*, 10, 15–40.
- de Freitas, E. R. (2021). Termo de ajustamento de conduta em razão da morte de João Alberto Freitas no Supermercado Carrefour: Um exemplo de boa prática institucional. *Revista da Defensoria Pública da União*, 16, 265–269.

- Dias, L. A. (2021, 19 de novembro). Ativismo judicial: Aspectos históricos e conceituais. Conteúdo Jurídico. <https://conteudojuridico.com.br/consulta/Artigos/47213/ativismo-judicial-aspectos-historicos-e-conceituais>
- Didier Jr., F., Cabral, A. do P., & Cunha, L. C. da. (2022). Por uma nova teoria dos procedimentos especiais: Dos procedimentos às técnicas (3ª ed.). JusPodivm.
- Di Pietro, M. S. Z. (2020). Direito administrativo (33ª ed.). Forense.
- Ferraz, A. A. M. de C. (1999). Ministério Público (2ª ed.). Atlas.
- Fiss, O. (2017). As formas de justiça. In A. P. Grinover, K. Watanabe, & S. H. da Costa (Eds.), O processo para solução de conflitos de interesse público. JusPodivm.
- Fiss, O. (2017b). As bases políticas e sociais da adjudicação. In Direito como razão pública: Processo, jurisdição e sociedade (C. A. de Salles, Trad., 2ª ed.). Juruá.
- Fiss, O. (2007). Two models of adjudication. In F. Didier Jr. & E. F. Jordão (Eds.), Teoria geral do processo: Panorama doutrinário mundial. JusPodivm.
- Fontes, P. G. G. (2006). O controle da Administração pelo Ministério Público. Del Rey.
- Garcia, E. (2017). Ministério Público: Organização, atribuições e regime jurídico (6ª ed.). Saraiva.
- Garcia, M. J. (2016). A origem do Ministério Público e sua atuação no direito comparado. Revista Jurídica ESMP-SP, 10, 133–155. https://es.mpsp.mp.br/revista_esmp/index.php/RJESMPSP/article/view/44/27
- Goulart, M. P. (2009). Ministério público: Estratégia, princípios institucionais e novas formas de organização. In R. Livianu (Coord.), Justiça, cidadania e democracia (pp. 158–169). Centro Edelstein de Pesquisa Social. <https://books.scielo.org/id/ff2x7/pdf/livianu-9788579820137-14.pdf>
- Goulart, M. P. (2021). Elementos para uma teoria geral do ministério público (2ª ed.). D'Plácido.
- Jatahy, C. R. de C. (2008). Curso de princípios institucionais do Ministério Público (3ª ed.). Lumen Juris.
- Jatahy, C. R. de C. (2010). 20 anos de Constituição: O novo Ministério Público e suas perspectivas no Estado Democrático de Direito. In C. Chaves (Coord.), Temas atuais do Ministério Público. A atuação do Parquet nos 20 anos da Constituição Federal. Lumen Juris.
- Júdice, M. P. (2007, 2 de março). Robert Alexy e a sua teoria sobre os princípios e regras. Revista Consultor Jurídico. https://www.conjur.com.br/2007-mar-02/robert_alexey_teorias_principios_regras
- Jobim, M. F. (2022). Medidas estruturantes na jurisdição constitucional: Da Suprema Corte estadunidense ao Supremo Tribunal Federal (3ª ed.). Livraria do Advogado.
- Jobim, M. F. (2022). Teoria, história e processo (2ª ed.). Livraria do Advogado.
- Lima, R. M. de. (2020). A atuação extrajudicial do Ministério Público no período de pandemia: Estudo de caso do município de Baturité – Ceará. Escola Superior do Ministério Público do Ceará, 12(2). <https://revistaacademica.mpce.mp.br/revista/article/view/46/40>

- Macedo Júnior, R. P. (2010). A evolução institucional do ministério público brasileiro. In M. T. Sadek (Org.), *Uma introdução ao estudo da justiça* (pp. 65–94). Centro Edelstein de Pesquisas Sociais. <https://books.scielo.org/id/4w63s/pdf/sadek-9788579820328-06.pdf>
- Machado, A. C. da C. (1998). *A intervenção do Ministério Público no processo civil brasileiro* (2ª ed. rev. e atual.). Saraiva.
- Marinoni, L. G., Arenhart, S. C., & Mitidiero, D. (2022). *Curso de processo civil: Teoria do processo civil* (Vol. 1, 7ª ed.). Thomson Reuters Brasil.
- Marinoni, L. G. (2019). Tutela inibitória e tutela de remoção do ilícito. *Jus Navigandi*, 8.
- Martins Júnior, W. P. (2002). *Controle da Administração Pública pelo Ministério Público*. Juarez de Oliveira.
- Mazzilli, H. N. (2013, jan./abr.). Princípios institucionais do Ministério Público brasileiro. *Revista do Ministério Público do Rio Grande do Sul*, 731. <http://www.mazzilli.com.br/pages/artigos/princinst.pdf>
- Mazzilli, H. N. (2021). A defesa dos interesses difusos em juízo (32ª ed.). JusPodivm.
- Mazzilli, H. N. (2008). *Introdução ao Ministério Público* (7ª ed.). Saraiva.
- Mazzilli, H. N. (2007). *O acesso à justiça e o Ministério Público* (5ª ed.). Saraiva.
- Mazzilli, H. N. (2001). *Regime jurídico do Ministério Público* (5ª ed.). Saraiva.
- Mazzilli, H. N. (1990, abr./jun.). Funções institucionais do Ministério Público. *Revista Forense*, 86(310), 518. <http://www.mazzilli.com.br/pages/artigos/rf310.pdf>
- Mazzilli, H. N. (1991). Funções institucionais do ministério público. *APMP*.
- Mazzilli, H. N. (1989). *O Ministério Público na Constituição de 1988*. Saraiva.
- McNeese, T. (2007). *Dred Scott v. Stanford*. Chelsea House.
- Meirelles, H. L. (1983). Parecer sobre o Ministério Público. *Justitia*, 123, 1083.
- Modesto, P. (2000). Notas para um debate sobre o princípio da eficiência. *Revista do Serviço Público*, 51(2), 105–119.
- Moraes, A. de. (2024). *Direito constitucional* (40ª ed.). Atlas.
- Nunes, D., & Teixeira, L. (2013). Acesso à justiça democrático. *Gazeta Jurídica*.
- Oсна, G. (2017). Processo civil, cultura e proporcionalidade: Análise crítica da teoria processual. *Revista dos Tribunais*.
- Paes, J. E. S. (2003). *O Ministério Público na construção do Estado Democrático de Direito*. Brasília Jurídica.
- Pinto, R. B. (2015). O Ministério Público: Origens históricas, seu nascedouro no Brasil e sua posição nas Constituições pátria. *Revista Associação Paulista do Ministério Público*, 20(60), 86–91.
- Ramos, L. F. (2021). Análise histórico-evolutiva do ativismo judicial no Brasil e no mundo com enfoque na atuação do STF [Trabalho de conclusão de curso, PUC-Campinas]. http://repositorio.sis.puc-campinas.edu.br/bitstream/handle/123456789/14673/cchsa_direito_tcc_ramos_lf.pdf?sequence=1&isAllowed=y

- Rangel, P. (2009). *Investigação criminal direta pelo Ministério Público: Visão crítica* (3ª ed.). Lumen Juris.
- Rezende, J. M. de. (1998). Epidemia, endemia, pandemia. *Epidemiologia. Revista de Patologia Tropical*, 27, 153–155. <https://www.revistas.ufg.br/iptsp/article/download/17199/10371>
- Rodrigues, A. L. de M. (2015). Ativismo judicial - causas e fundamentos. *Revista de Doutrina e Jurisprudência*, 51(107), 141–152. <https://revistajuridica.tjdft.jus.br/index.php/rdj/article/view/44>
- Sarlet, I. W. (2025). Direitos fundamentais sociais e mínimo existencial – notas sobre um possível papel das assim chamadas decisões estruturantes na perspectiva da jurisdição constitucional. In S. C. Arenhart, M. F. Jobim, & G. Osna (Eds.), *Processos estruturais* (4ª ed.). JusPodivm.
- Sarlet, I. W. (2024). *A eficácia dos direitos fundamentais: Uma teoria geral dos direitos fundamentais na perspectiva constitucional* (18ª ed.). Livraria do Advogado.
- Sarlet, I. W., Mitidiero, D., & Marinoni, L. G. (2024). *Curso de direito constitucional* (12ª ed.). Saraiva Educação.
- Sarmiento, D. (2008). A proteção judicial dos direitos sociais: Alguns parâmetros ético-jurídicos. In *Direitos sociais: Fundamentos, judicialização e direitos sociais em espécie* (pp. 553–586). Lumen Juris.
- Silva, J. S. L. da. (2018). O ministério público e o acesso à justiça em face dos interesses e direitos transindividuais: Em busca da resolutividade. *Revista Cidadania e Acesso à Justiça*, 4(1), 114–135. <https://core.ac.uk/download/pdf/210567093.pdf>
- Silva, C. A. (2001). *Justiça em jogo: Novas facetas da atuação dos promotores de justiça*. Edusp.
- Souza Júnior, J. R. de, & Lopes, M. T. R. (2021). O processo estrutural como instrumento de harmonização da intervenção judicial na concretização de direitos fundamentais com a realidade socioeconômica. *Facit Business and Technology Journal*, 1(29).
- Vitorelli, E. (2025). *Processo civil estrutural: Teoria e prática* (5ª ed.). JusPodivm.
- Zaneti Jr., H. (2018). O Ministério Público e as normas fundamentais do direito processual civil brasileiro. *Revista do Ministério Público do Rio de Janeiro*, 68, 147.

IMPACTS ASSOCIATED WITH GROUNDWATER TABLE LOWERING: ENVIRONMENTAL AND SOCIAL CONSEQUENCES AND STRATEGIES FOR SUSTAINABLE MANAGEMENT

IMPACTOS ASSOCIADOS AO REBAIXAMENTO DO NÍVEL DO LENÇOL FREÁTICO: CONSEQUÊNCIAS AMBIENTAIS, SOCIAIS E ESTRATÉGIAS PARA UMA GESTÃO SUSTENTÁVEL

IMPACTOS ASOCIADOS AL DESCENSO DEL NIVEL FREÁTICO: CONSECUENCIAS AMBIENTALES, SOCIALES Y ESTRATEGIAS PARA UNA GESTIÓN SOSTENIBLE



<https://doi.org/10.56238/sevened2026.008-138>

**Suelen Rodrigues Carvalho¹, Álvaro Luiz Jesus dos Santos², Lucas Galvão Pinho³,
Natasha Sales Xavier⁴, Juliana Do Amor Divino Tavares⁵, Anna Virgínia Muniz
Machado⁶, Gustavo Augusto Teixeira de Fatima⁷**

ABSTRACT

The groundwater plays an essential role in environmental preservation. It ensures the availability of subterranean water, vital for the survival of fauna and flora, and is also crucial for maintaining ecological balance. Responsible management of this resource is indispensable to protect ecosystems and prevent issues such as contamination and depletion of aquifers. This article explores the importance of groundwater in the context of environmental sustainability, with an emphasis on the need to care for subterranean water. Practical examples will be presented, such as studies conducted in Maceió (AL), Pelotas (RS), and Ribeirão das Neves (MG), which show the risks and best practices related to groundwater lowering. Additionally, the Sustainable Development Goals (SDGs) 6, 14, and 15, which address the protection of water resources and terrestrial and aquatic life, will be discussed. Brazilian legislation will also be addressed, such as Bill 1281/2021, which seeks to regulate the use of subterranean water in a balanced and sustainable manner. This work aims to highlight ways to ensure the preservation of this crucial resource for the future generations.

Keywords: Groundwater. Aquifer. Lowering. Environmental Impact.

¹ Undergraduate Student in Water Resources and Environmental Engineering. Universidade Federal Fluminense. E-mail: suelenrodrigues@id.uff.br

² Graduated in Industrial Design. Universidade Federal Fluminense. E-mail: alvaro_santos@id.uff.br

³ Undergraduate Student in Electrical Engineering. Universidade Federal Fluminense. E-mail: pinholucas@id.uff.br

⁴ Graduated in Industrial Design. Universidade Federal Fluminense. E-mail: salesnatasha@id.uff.br

⁵ Undergraduate Student in Electrical Engineering. Universidade Federal Fluminense. E-mail: tavares_juliana@id.uff.br

⁶ Dr. in Civil Engineering. Universidade Federal Fluminense. E-mail: annavirnia@id.uff.br

⁷ Undergraduate Student in Water Resources and Environmental Engineering. Universidade Federal Fluminense. E-mail: gustavo_fatima@id.uff.br

RESUMO

Os lençóis freáticos desempenham um papel essencial na preservação do meio ambiente. Eles garantem a disponibilidade de água subterrânea o que é vital para a sobrevivência da fauna e flora, além de serem fundamentais para manter o equilíbrio ecológico. Uma gestão responsável desse recurso é indispensável para proteger os ecossistemas e prevenir problemas como a contaminação e o esgotamento dos aquíferos. Este artigo explora a importância dos lençóis freáticos no contexto da sustentabilidade ambiental, com ênfase na necessidade de cuidar das águas subterrâneas. Serão apresentados exemplos práticos, como os estudos realizados em Maceió (AL), Pelotas (RS) e Ribeirão das Neves (MG), que mostram os riscos e as boas práticas relacionadas ao rebaixamento do lençol freático. Além disso, serão abordados os Objetivos de Desenvolvimento Sustentável (ODS) 6, 14 e 15, que tratam da proteção dos recursos hídricos e da vida terrestre e aquática. Também será discutida a legislação brasileira, como o Projeto de Lei 1281/2021, que busca regulamentar o uso das águas subterrâneas de maneira equilibrada e sustentável. Este trabalho pretende destacar caminhos para garantir a preservação desse recurso tão importante para futuras gerações.

Palavras-chave: Lençol Freático. Aquífero. Rebaixamento. Impacto Ambiental.

RESUMEN

Los niveles freáticos desempeñan un papel esencial en la preservación del medio ambiente. Garantizan la disponibilidad de agua subterránea, lo que es vital para la supervivencia de la fauna y la flora, además de ser fundamentales para mantener el equilibrio ecológico. Una gestión responsable de este recurso es indispensable para proteger los ecosistemas y prevenir problemas como la contaminación y el agotamiento de los acuíferos. Este artículo explora la importancia de los niveles freáticos en el contexto de la sostenibilidad ambiental, con énfasis en la necesidad de cuidar las aguas subterráneas. Se presentarán ejemplos prácticos, como los estudios realizados en Maceió (AL), Pelotas (RS) y Ribeirão das Neves (MG), que muestran los riesgos y las buenas prácticas relacionadas con el descenso del nivel freático. Además, se abordarán los Objetivos de Desarrollo Sostenible (ODS) 6, 14 y 15, que tratan sobre la protección de los recursos hídricos y de la vida terrestre y acuática. También se analizará la legislación brasileña, como el Proyecto de Ley 1281/2021, que busca regular el uso de las aguas subterráneas de manera equilibrada y sostenible. Este trabajo pretende destacar caminos para garantizar la preservación de este recurso tan importante para las futuras generaciones.

Palabras clave: Nivel Freático. Acuífero. Descenso. Impacto Ambiental.

1 INTRODUCTION

The lowering of the water table is characterized as a human intervention that has great environmental, social and economic relevance, often necessary for the execution of civil works, agricultural activities and industrial processes. This phenomenon, when not properly managed, can trigger a series of negative impacts that may or may not go beyond the local level, affecting entire ecosystems, public health, and the socioeconomic structures of the communities involved. The main objective of this article is to demonstrate these multiple consequences, establishing a critical dialogue with Sustainable Development Goals (SDGs) 6, 14 and 15, which respectively talk about drinking water and sanitation, aquatic life and terrestrial life.

The relationship between groundwater and surface water configures a dynamic and complex system, fundamental for the maintenance of environmental homeostasis. As demonstrated by Nevill et al. (2010), the large exploitation of groundwater resources, a common practice on a global scale, can irreversibly compromise aquatic and terrestrial ecosystems, due to the interdependence that characterizes hydrological cycles. The disturbance of the water table triggers a series of chain changes, affecting from strictly underground organisms to complex river ecosystems.

The consequences of downgrading manifest themselves in complex ways, including saline intrusion into coastal regions, soil subsidence, and degradation of aquatic habitats. As Kath and Dyer (2017) point out, socio-ecological systems dependent on groundwater resources face increasing challenges, requiring integrated management approaches that consider both the hydrological aspects and the human dimensions involved. The social dimension of these impacts deserves particular attention, since rural and peri-urban communities are the most affected by water scarcity.

In the Brazilian context, characterized by a rich hydrogeological diversity with aquifer systems of global importance, the regulation of the use of groundwater has advanced unevenly. Bill 1281/2021 represents a significant legislative effort to establish stricter guidelines on the exploitation of these resources. However, the effective implementation of these policies comes up against structural challenges, including technical limitations and scarcity of financial resources.

This article seeks to analyze innovative strategies to mitigate the impacts of the lowering of the water table, with special attention to nature-based solutions and sustainable technologies. Through a multidisciplinary approach that integrates knowledge of geology, biology and public policies, the study aims to contribute to the development of management

practices that harmonize economic development with environmental preservation, ensuring water security for present and future generations.

2 METHODOLOGY

The methodology used in this study was based on a broad bibliographic search with the objective of identifying relevant situations and discussions that related the lowering of groundwater to its environmental, social and economic consequences. 12 previously selected scientific articles were analyzed, obtained through platforms such as Google Scholar BR and EUA, in addition to the motivation generated by the reading of reports and documents located in the university repository, which served as an initial basis for the delimitation of the theme. This approach sought to ensure a global perspective, including studies carried out in Brazil and abroad, in order to understand different contexts and practices related to the management of water resources in civil works.

During the analysis, the focus was to identify methods, impacts, and legislation associated with the topic, finding a common pattern among the articles that highlight environmental risks, such as saline intrusion, aquifer contamination, and biodiversity reduction, as well as the economic and social challenges arising from these practices.

3 RESULTS AND DISCUSSIONS

The sustainable management of underground resources requires integrated planning and the use of technological solutions to mitigate impacts. Sousa and Silva (2020), highlight the effectiveness of technologies such as drainage tips and deep wells, associated with rigorous monitoring, as in the case of the San-tinho WWTP, in Minas Gerais, where the use of these techniques ensured the stability of the work and reduced environmental impacts. In addition, tools such as Geographic Information Systems (GIS) allow the identification of vulnerable areas and the planning of mitigation strategies, according to Nevill et al. (2010).

Practical cases, such as the use of observation wells in Pelotas (RS) to monitor the dynamics of the water table (Martins et al., 2012), demonstrate the importance of technical solutions to avoid negative impacts. Additionally, Brazilian legislation, such as PL 1281/2021, can play a relevant role in regulating groundwater extraction and ensuring alignment with the SDGs.

Integrated management and long-term monitoring are key to ensuring the sustainability of groundwater resources, contributing to environmental conservation and social well-being. Effective public policies, the use of advanced technologies and awareness

are essential aspects to minimize the impacts of lowering the water table and ensure the responsible use of this resource.

The lowering of the water table, a common practice in civil works, can generate significant environmental impacts, affecting ecosystems and water resources essential for sustainability. This process is directly related to the goals of the Sustainable Development Goals 3 (SDGs), such as SDG 6, which seeks to ensure drinking water and sanitation for all (UN, 2020); SDG 14, aimed at the conservation of aquatic life (Fogasa et al., 2018); and SDG 15 (UN, 2023), which promotes the protection and recovery of terrestrial ecosystems (Cabral et al., 2006; Nevill et al., 2010).

Among the main problems related to the lowering of the water table is the reduction of soil moisture, a factor that compromises vegetation and ecosystems dependent on this resource, as described by Fan et al. (2023), who analyze the effects of groundwater availability on productivity and plant composition. The excessive withdrawal of groundwater reduces soil moisture, compromising the survival of ecosystems that depend on this water resource, especially in arid and semi-arid regions, as reported in research that highlights the influence of the water table on productivity and plant composition (The lowering of the water level in mining and civil works).

In semi-arid regions of Brazil, as highlighted by studies by Nevill et al. (2010), desertification is an alarming consequence, putting at risk the goal of SDG 15 to curb soil degradation and restore areas already affected. The sustainable management of groundwater resources, therefore, is not only an environmental necessity, but a fundamental step to ensure a balanced and resilient future in the face of global challenges. The degradation of ecosystems that depend on groundwater is an alarming consequence of the lowering of the water table. Lowering water levels can destroy wetlands and aquatic habitats, threatening biodiversity. As Nevill et al. (2010) point out, these impacts may be irreversible, directly affecting Sustainable Development Goals 14 and 15, which prioritize the preservation of aquatic and terrestrial life. In coastal regions, the problem is aggravated by saline intrusion, when seawater invades aquifers, compromising the quality of drinking water.

A clear example is the case of Maceió, described by Souza et al. (2006), where excessive groundwater extraction led to salinity contamination, harming both human supply and agricultural activities. This phenomenon is directly linked to SDG 2, which seeks to promote food security through sustainable agricultural practices. Another significant impact is the reduction of the base flow of rivers and lakes, which accelerates siltation and degradation of water quality. According to Iglesias et al. (2020), this decrease affects the

regeneration capacity of water bodies, compromising aquatic ecosystems and making it difficult to achieve the goals of SDG 6 (clean water and sanitation) and SDG 14.

In addition, lowering the water table can cause soil subsidence, a phenomenon in which the earth's surface sinks due to the loss of water pressure in the soil pores. In karst areas, such as Sete Lagoas (MG) and Cajamar (SP), the dissolution of limestone rocks expands underground cavities, leading to soil collapse and the formation of craters, as highlighted by Cabral et al. (2006). In the springs of Muritiba, analyzed by Santos et al. (2015), the lowering of the water table impairs the maintenance of water flow, making these water sources dependent exclusively on rainfall. In extreme cases, this can lead to the extinction of springs, aggravating environmental degradation. These examples show that, without proper planning and monitoring, the lowering of the water table can trigger a series of problems, such as water contamination, loss of ecosystems, saline intrusion and soil subsidence. To mitigate these impacts, it is essential that engineering practices are aligned with the SDG goals, promoting the sustainable use of water resources and the protection of the environment 4 . Only with conscious and integrated actions will it be possible to guarantee long-term sustainability.

3.1 SOCIAL AND ECONOMIC IMPACTS

The sustainable management of underground resources requires integrated planning and the use of technological solutions to mitigate impacts. Sousa and Silva (2020), highlight the effectiveness of technologies such as draining tips and deep wells, associated with rigorous monitoring, as in the case of the Santinho WWTP, in Minas Gerais, where the use of these techniques ensured the stability of the work and reduced environmental impacts. In addition, tools such as Geographic Information Systems (GIS) allow the identification of vulnerable areas and the planning of mitigation strategies, according to Nevill et al. (2010).

Practical cases, such as the use of observation wells in Pelotas (RS) to monitor the dynamics of the water table (Martins et al., 2012), demonstrate the importance of technical solutions to avoid negative impacts. In addition, Brazilian legislation, such as PL 1281/2021, can play a relevant role in regulating groundwater extraction and ensuring alignment with the SDGs.

Integrated management and long-term monitoring are essential to ensure the sustainability of groundwater resources, contributing to environmental conservation and social well-being. Effective public policies, the use of advanced technologies and awareness are essential aspects to minimize the impacts of lowering the water table and ensure the responsible use of this resource.

The lowering of the water table, a common practice in civil works, can generate significant environmental impacts, affecting ecosystems and water resources essential for sustainability. This process is directly related to SDG goals, such as SDG 6, which seeks to ensure drinking water and sanitation for all (UN, 2020); SDG 14, aimed at the conservation of aquatic life (Fogasa et al., 2018); and SDG 15 (UN, 2023), which promotes the protection and recovery of terrestrial ecosystems (Cabral et al., 2006; Nevill et al., 2010). Among the main problems related to the lowering of the water table is the reduction of soil moisture, a factor that compromises vegetation and ecosystems dependent on this resource, as described by Fan et al. (2023), who analyze the effects of groundwater availability on productivity and plant composition. Excessive groundwater withdrawal reduces soil moisture, compromising the survival of ecosystems that depend on this water resource, especially in arid and semi-arid regions. In semi-arid regions of Brazil, as highlighted by studies by Nevill et al. (2010), desertification is an alarming consequence, putting at risk the goal of SDG 15 to curb soil degradation and restore areas already affected.

The sustainable management of groundwater resources, therefore, is not only an environmental necessity, but a fundamental step to ensure a balanced and resilient future in the face of global challenges. The degradation of ecosystems that depend on groundwater is an alarming consequence of the lowering of the water table. Lowering water levels can destroy wetlands and aquatic habitats, threatening biodiversity. As Nevill et al. (2010) point out, these impacts may be irreversible, directly affecting Sustainable Development Goals (SDGs) 14 and 15, which prioritize the preservation of aquatic and terrestrial life. In coastal regions, the problem is aggravated by saline intrusion, when seawater invades aquifers, compromising the quality of drinking water. A clear example is the case of Maceió, described by Souza et al. (2006), where excessive groundwater extraction led to salinity contamination, harming both human supply and agricultural activities. This phenomenon is directly linked to SDG 2, which seeks to promote food security through sustainable agricultural practices.

Another significant impact is the reduction of the base flow of rivers and lakes, which accelerates siltation and degradation of water quality. According to Iglesias et al. (2020), this decrease affects the regeneration capacity of water bodies, compromising aquatic ecosystems and making it difficult to achieve the goals of SDG 6 (clean water and sanitation) and SDG 14. In addition, lowering the water table can cause soil subsidence, a phenomenon in which the earth's surface sinks due to the loss of water pressure in the soil pores. In karst areas, such as Sete Lagoas (MG) and Cajamar (SP), the dissolution of limestone rocks expands underground cavities, leading to soil collapse and the formation of craters, as highlighted by Cabral et al. (2006).

3.2 GOOD PRACTICES FOR LOWERING GROUNDWATER

The practice of lowering groundwater requires extreme care and thorough planning to avoid significant environmental and social impacts. Studies such as the one by Sousa and Silva (2020), on the method used in the construction of the Santinho Effluent Treatment Plant (ETE), and the one by ABAS (2007), which addresses the lowering of the water level in mining activities and civil works, offer valuable guidance on effective techniques and good practices to control groundwater, especially in urban and industrial environments.

The use of technologies such as draining tips and deep wells, combined with careful planning for the responsible disposal of extracted water, is essential to mitigate the negative impacts of this process. A practical example is the case of the Santinho WWTP, described by Sousa and Silva (2020), where the application of draining tips ensured the stability of the work. This success, however, was only achieved with the adoption of continuous and rigorous monitoring of water levels, a fundamental measure to avoid damage to local ecosystems and preserve the quality of available water resources.

The adoption of appropriate techniques and efficient planning are crucial to protect both the quality of the water and the soils in the vicinity of the works. In addition, respecting environmental regulations and incorporating good management practices is essential to ensure that these processes are conducted safely and responsibly.

Tools such as Geographic Information Systems (GIS) play an important role in this context. As pointed out by Nevill et al. (2010), GIS is essential to identify and analyze areas that are more vulnerable to the impacts of lowering the water table, offering accurate information on soil types and their ability to filter contaminants. This detailed mapping allows you to better understand the associated risks and define effective strategies to mitigate environmental impacts, ensuring the execution of projects in a sustainable and balanced manner.

With careful planning, the use of advanced technology, and compliance with regulations, it is possible to lower groundwater responsibly, minimizing risks and preserving natural resources for future generations.

3.3 GROUNDWATER VULNERABILITY TO MISMANAGEMENT

Efficient management of groundwater resources is increasingly relevant, especially in countries facing serious water scarcity challenges. In the study by Margane et al. (2009), protection and management strategies adopted by Jordan are discussed, an example of a country with limited water resources. The research highlights that the lack of adequate regulation and inspection can lead to overexploitation of aquifers, a problem that also

manifests itself in regions of Brazil, such as Pelotas, RS, as pointed out by Delgado et al. (2012).

To prevent aquifer depletion and groundwater contamination, it is critical to implement continuous monitoring systems that keep track of variations in groundwater level. Technologies such as piezometers are valuable tools in this process, as they help detect changes in water levels and allow for preventive interventions, protecting aquifers and ensuring their sustainability.

The study by Iglesias et al. (2020), which analyzes the management of water resources in the Mediterranean region, reinforces the need for strategic planning for the use and distribution of groundwater. According to the authors, an integrated approach that takes into account the needs of different users is essential to ensure the sustainability of water resources and preserve environmental balance. This collaborative management is indispensable to avoid conflicts over water use, especially in areas with high population density or intensive agriculture.

Both Margane et al. (2009) and Iglesias et al. (2020) make it clear that sustainable groundwater management is a global priority. These resources are critical for water supply, agricultural production, and ecosystem maintenance. Without proper regulation and enforcement, environmental impacts can be severe and often irreversible. Therefore, it is essential that public policies promote the conscious use of these resources, with measures such as continuous monitoring of water levels and the adoption of technologies that help preserve aquifers. Thus, it is possible to ensure water security and sustainability for future generations.

3.4 INTEGRATED MANAGEMENT AND LONG-TERM MONITORING

Sustainable groundwater management requires an integrated approach that combines continuous monitoring and effective public policies. As demonstrated by Martins et al. (2012), systematic monitoring of groundwater levels is crucial to understand the impacts of climate change and prevent contamination. Technologies such as piezometers and level gauges allow for accurate monitoring of aquifer dynamics, which is essential for responsible interventions.

Kath and Dyer (2017) highlight the need for integrated groundwater management, which is often neglected in relation to surface resources. Koundouri et al. (2010) reinforce that the lack of adequate regulation has generated irreversible damage to aquifers, requiring strict policies to control extraction and regulate agricultural and industrial practices. Singh et

al. (2015) argue that exploration should be aligned with environmental preservation, considering the interdependence between terrestrial and aquatic systems.

These studies converge on the importance of integrating groundwater management with broader environmental policies, balancing human needs and ecosystem protection. Long-term monitoring, associated with collaborative governance, is essential to ensure water security and the sustainability of groundwater resources in the face of global challenges.

3.5 THE CONNECTION WITH THE SDGS AND BRAZILIAN LEGISLATION

The responsible management of groundwater is directly related to the Sustainable Development Goals, especially SDG 6, which seeks to ensure universal access to safe drinking water. The implementation of PL 1281/2021, which regulates the granting of groundwater, is an important example of how legislation can help protect water resources. The bill highlights the need for a plan for the reuse and proper disposal of extracted water, in line with SDGs 14 (Life in Water) and 15 (Life on Land). This approach aims to protect aquatic and terrestrial ecosystems, ensuring the sustainability of human activities and long-term environmental preservation.

3.6 CASE STUDIES

Lowering the water table is a key technique in areas with high groundwater levels, especially when the water table is too close to the surface and can interfere with construction activities. This practice aims to ensure the stability and safety of the works, in addition to preventing problems such as water infiltration and flooding, which can compromise the integrity of the structures.

An example of this occurred in the construction of the Santinho Sewage Treatment Plant (ETE), in Ribeirão das Neves, Minas Gerais. For this project, the method of lowering by draining tips, also known as "well points", was used. This process was chosen for its effectiveness in keeping the site dry during excavations, controlling the rise of water from the water table without the conduction of fine particles. This avoided the settlement of neighboring structures and brought a more economical solution.

Barbosa and Miranda (2023), point out that the lowering of the Santinho WWTP was carried out with the constant monitoring of the technical team, which monitored the positioning of the lowering pumps, the installation of the tips and the drainage of the water. The implementation of this technique proved to be efficient in ensuring soil stability and safety of the work, emphasizing the importance of rigorous monitoring and the choice of appropriate methods.

Another example occurred in a civil construction site in the Areal neighborhood, in Pelotas/RS (Martins et al., 2012), where the water table varied between 1.29 m and 0.54 m deep. In this case, the lowering planning considered the permeability of the soil and the depth of the excavation. The use of PVC pipes with porous blankets in observation wells allowed an efficient monitoring of the dynamics of the water table, avoiding environmental impacts and groundwater contamination.

These practical examples show that, with the appropriate choice of the lowering method and continuous monitoring, it is possible to ensure the stability of the works and environmental protection, in addition to optimizing resources and reducing costs. The success of lowering the water table in large works depends on proper planning, well-chosen techniques and constant supervision.

4 CONCLUSION

The lowering of the water table is an essential practice for the development of civil works, but it requires a careful and multidimensional approach to avoid significant environmental, social and economic impacts. As demonstrated throughout this study, inadequate groundwater extraction can trigger serious consequences, including desertification, saline intrusion, soil subsidence, reduced biodiversity, and compromise of sensitive ecosystems, with direct effects on the water and food security of populations.

The results presented show that the sustainability of groundwater resources depends fundamentally on three interrelated pillars: (1) the adoption of appropriate technologies, such as drainage tips, deep wells and continuous monitoring systems; (2) the implementation of effective public policies, represented by instruments such as PL 1281/2021; and (3) integration with the Sustainable Development Goals, particularly SDGs 6, 14 and 15.

The practical cases analyzed, such as those of the works at ETE Santinho (MG) and Pelotas (RS), demonstrate that it is possible to reconcile infrastructural development with environmental preservation through adequate planning, careful choice of techniques and rigorous monitoring. However, the vulnerability of aquifers to mismanagement, exemplified by cases such as that of Maceió, warns of the urgent need for effective regulation and constant inspection.

The integrated management of groundwater resources emerges, therefore, as a strategic imperative for the twenty-first century, demanding a collaborative approach that involves public authorities, the private sector, academia and civil society. Only by balancing development needs and conservation imperatives will it be possible to guarantee the water

security of present and future generations, preserving these vital resources in the face of the challenges of climate change and urban and agricultural growth.

REFERENCES

- Associação Brasileira de Águas Subterrâneas. (2007). O rebaixamento do nível d'água em mineração e obras civis. *Águas Subterrâneas*. <https://aguassubterraneas.abas.org/asubterraneas/article/view/23932>
- Brambilla, M. A., & Teixeira, T. M. (2023). Análise da eficiência do objetivo de desenvolvimento sustentável (ODS 15). <https://philpapers.org/rec/BRAADE>
- Brasil. (2021). Projeto de Lei nº 1281/2021. Tipifica o crime ambiental de exploração indevida de lençol freático, sem outorga da autoridade competente. <https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2277160>
- Delgado, G. V., et al. (2012). Variação da profundidade do lençol freático em uma área de construção civil em Pelotas-RS. In *Anais do Congresso de Iniciação Científica da UFPel*. https://www2.ufpel.edu.br/cic/2012/anais/pdf/EN/EN_00725.pdf
- Embrapa. (2016). Lençóis freáticos. *Revista Infoteca*. <https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1059322/1/19-21-12-16-Lencois-Freaticos-JEA-novdez2016.PDF>
- Fan, Z., et al. (2023). Effects and significance of groundwater for vegetation: A systematic review. *Science of The Total Environment*, 861. <https://www.sciencedirect.com/science/article/pii/S0048969723011932>
- Fogaca, F. D. S., Furtado, A. A. L., da Silva, C. A., Tavares-Dias, M., & Routledge, E. A. B. (2018). *Vida na água: contribuições da Embrapa*. <https://www.alice.cnptia.embrapa.br/alice/bitstream/doc/1090716/1/ODS14.pdf>
- Iglesias, A., et al. (2020). Groundwater resources in the Mediterranean region: importance, uses, and sharing. *IEMed*. <https://www.iemed.org/publication/groundwater-resources-in-the-mediterranean-region-importance-uses-and-sharing/>
- Jacobi, P., Frey, K., Ramos, R. F., & Côrtes, P. (2020). ODS 6 – Água potável e saneamento. In *Objetivos do Desenvolvimento Sustentável* (p. 117). https://www.researchgate.net/profile/Gina-Besen/publication/346964710_ODS_12_-_Consumo_e_producao_responsaveis/links/5fd4c2dda6fdccdb8bc488a/ODS-12-Consumo-e-producao-responsaveis.pdf#page=120
- Kath, J., & Dyer, F. J. (2017). Why groundwater matters: An introduction for policy-makers and managers. *Policy Studies*, 38(5), 447–461. <https://ideas.repec.org/a/taf/cposxx/v38y2017i5p447-461.html>
- Koundouri, P., et al. (2010). Groundwater under stress: The importance of management. *Environmental Earth Sciences*, 61(5), 799–809. <https://link.springer.com/article/10.1007/s12665-010-0490-x>
- Margane, A. (2008). Groundwater protection and management strategy in Jordan. *Springer Nature*. <https://link.springer.com/article/10.1007/s11269-008-9386-x>
- Martins, M. F., Cardoso, I. P., Suzuki, L. E. A. S., Molani, I. C. B., Collares, G. L., & Prá, M. D. (2012). Variação da profundidade do lençol freático em uma área de construção civil

em Pelotas-RS. In Anais do Congresso Internacional de Ciências Ambientais. https://www2.ufpel.edu.br/cic/2012/anais/pdf/EN/EN_00725.pdf

Nevill, C. J., et al. (2010). Groundwater-dependent ecosystems and the dangers of groundwater overdraft: A review and an Australian perspective. *Pacific Conservation Biology*, 16(3), 187–208. <https://www.researchgate.net/publication/305063729>

Singh, G., et al. (2015). Importance of groundwater as compatible with environment. *International Journal of Environment and Resources*, 5(1). <http://article.sapub.org/10.5923.c.ije.201501.13.html>

Sousa, T., & Silva, R. C. (2020). Rebaixamento de lençol freático - análise do método executivo empregado na construção da ETE Santinho em Ribeirão das Neves. *Parâmetrica*, 3(2). <https://parametrica.emnuvens.com.br/parametrica/article/view/141>

Souza, E. S., et al. (2006). Potenciais impactos causados por obras civis em aquíferos costeiros: Estudo de caso. *Águas Subterrâneas*. <https://aguassubterraneas.abas.org/asubterraneas/article/view/22074>

ELECTRIC VEHICLE SAFETY: AN INNOVATIVE AND CRITICAL ANALYSIS OF FIRE RISKS AND MITIGATION STRATEGIES

SEGURANÇA DE VEÍCULOS ELÉTRICOS: UMA ANÁLISE INOVADORA E CRÍTICA DOS RISCOS DE INCÊNDIO E DAS ESTRATÉGIAS DE MITIGAÇÃO

SEGURIDAD DE VEHÍCULOS ELÉCTRICOS: UN ANÁLISIS INNOVADOR Y CRÍTICO DE LOS RIESGOS DE INCENDIO Y LAS ESTRATEGIAS DE MITIGACIÓN



<https://doi.org/10.56238/sevened2026.008-139>

Ana Katherine Silveira Pereira Caracas¹, Eduardo Winter², Joel de Abreu Nobre³, Rickardo Léo Ramos Gomes⁴, Roberto Augusto Caracas Neto⁵, Tecia Vieira Carvalho⁶, Thiago Costa Duch⁷

ABSTRACT

The growing adoption of electric vehicles (EVS) represents a significant transformation in sustainable urban mobility. However, fire safety, particularly with regard to lithium-ion batteries, has emerged as a relevant challenge. This study adopts a qualitative and exploratory approach, with analytical and documentary emphasis, grounded in the innovative and pioneering nature of the research within the Brazilian context. The main objective of this article is to propose a critical analysis of global trends in electric vehicle safety, with particular emphasis on fire suppression and related innovations aimed at enhancing safety for users, owners, and residential condominiums. Furthermore, the study highlights the need for international harmonization and for the development of specialized training for fire response professionals. The research is innovative and pioneering in consolidating dispersed data and proposing an integrated and strategic approach to the prevention and suppression of fires in EVs. The results underscore the need for specific regulations, specialized training, and technological innovations to ensure safe and effective electric mobility. The study encompasses international data, emerging regulations, and technological innovations, offering a current and forward-looking overview of EV safety.

Keywords: Electric Vehicles. Lithium-Ion Batteries. Fire. Thermal Runaway. Vehicle Safety.

¹ Undergraduate Student in Chemical Engineering. Universidade de São Paulo (USP). E-mail: anakatherinespc@gmail.com

² Dr. in Sciences. Universidade Estadual de Campinas. E-mail: winterinpi@gmail.com

³ Master's degree in Climatology. Universidade Estadual do Ceará (UECE). E-mail: joelnobre1@gmail.com

⁴ Dr. in Biological Sciences; Master in Crop Science. Universidade Federal do Ceará. E-mail: rickardolrg@yahoo.com.br

⁵ Doctoral student in Intellectual Property and Innovation. Academia do Instituto Nacional da Propriedade Industrial (INPI). E-mail: robertocaracas2000@gmail.com

⁶ Dr. in RENORBIO. Universidade Federal do Ceará. E-mail: tecia.carvalho@nepen.org.br

⁷ Master's degree in Tourism Management and Planning. Universidade de Aveiro (UA). E-mail: thiagoduch@gmail.com

RESUMO

A crescente adoção de veículos elétricos (VEs) representa uma transformação significativa na mobilidade urbana sustentável. No entanto, a segurança contra incêndios, especialmente no que se refere às baterias de íons de lítio, tem emergido como um desafio relevante. Este estudo adota uma abordagem qualitativa e exploratória, com ênfase analítica e documental, fundamentada no caráter inovador e pioneiro da pesquisa no contexto brasileiro. O principal objetivo deste artigo é propor uma análise crítica das tendências globais em segurança de veículos elétricos, com ênfase particular na supressão de incêndios e nas inovações correlatas voltadas ao aumento da segurança de usuários, proprietários e condomínios residenciais. Além disso, o estudo destaca a necessidade de harmonização internacional e do desenvolvimento de treinamentos especializados para profissionais de resposta a incêndios. A pesquisa é inovadora e pioneira ao consolidar dados dispersos e propor uma abordagem integrada e estratégica para a prevenção e o combate a incêndios em VEs. Os resultados ressaltam a necessidade de regulamentações específicas, capacitação especializada e inovações tecnológicas para garantir uma mobilidade elétrica segura e eficaz. O estudo abrange dados internacionais, regulamentações emergentes e inovações tecnológicas, oferecendo uma visão atual e prospectiva sobre a segurança de VEs.

Palavras-chave: Veículos Elétricos. Baterias de Íons de Lítio. Incêndio. Fuga Térmica. Segurança Veicular.

RESUMEN

La creciente adopción de vehículos eléctricos (VE) representa una transformación significativa en la movilidad urbana sostenible. Sin embargo, la seguridad contra incendios, especialmente en lo que respecta a las baterías de iones de litio, ha surgido como un desafío relevante. Este estudio adopta un enfoque cualitativo y exploratorio, con énfasis analítico y documental, fundamentado en el carácter innovador y pionero de la investigación en el contexto brasileño. El objetivo principal de este artículo es proponer un análisis crítico de las tendencias globales en la seguridad de los vehículos eléctricos, con especial énfasis en la supresión de incendios y en las innovaciones relacionadas orientadas a mejorar la seguridad de usuarios, propietarios y condominios residenciales. Además, el estudio destaca la necesidad de armonización internacional y del desarrollo de capacitación especializada para profesionales de respuesta ante incendios. La investigación es innovadora y pionera al consolidar datos dispersos y proponer un enfoque integrado y estratégico para la prevención y supresión de incendios en VE. Los resultados subrayan la necesidad de regulaciones específicas, formación especializada e innovaciones tecnológicas para garantizar una movilidad eléctrica segura y eficaz. El estudio abarca datos internacionales, regulaciones emergentes e innovaciones tecnológicas, ofreciendo una visión actual y prospectiva sobre la seguridad de los VE.

Palabras clave: Vehículos Eléctricos. Baterías de Iones de Litio. Incendio. Fuga Térmica. Seguridad Vehicular.

1 INTRODUCTION

The global transition to electric vehicles (EVs) represents a major milestone in the pursuit of sustainability, decarbonization, and improved urban air quality. Although battery production increases environmental impacts due to higher CO₂ emissions into the atmosphere, EVs demonstrate greater benefits during continuous use, particularly when charged with electricity generated from cleaner energy sources (Gomes et al., 2025). Nevertheless, this paradigm shift is not without challenges, with the safety of lithium-ion batteries emerging as a focal point of growing concern (Dong; Gou; Gui, 2024). One primary area of attention regarding EVs relates to collisions and traffic accidents. The study by Alter et al. (2023) presented data on accidents and found no increase in fatality rates when compared to collisions involving internal combustion vehicles, shedding light on everyday use and potential accidents associated with this type of vehicle. Another relevant concern in the context of fleet electrification involves vehicle charging.

Concerns regarding fires, particularly in confined environments such as underground parking garages, remain significant. High energy-density batteries, which constitute the core of EVs, present intrinsic risks associated with thermal runaway, an uncontrolled reaction that may culminate in fires of exceptional intensity, prolonged duration, and the release of toxic gases. This complex scenario poses substantial challenges for emergency response teams (Fire Safety Research Institute, 2023).

This study adopts a qualitative and exploratory approach, with analytical and documentary emphasis, grounded in the innovative and pioneering nature of the research within the Brazilian context.

The main objective of this article is to propose a critical analysis of global trends in electric vehicle safety, with emphasis on fire suppression and related innovations aimed at enhancing safety for users, owners, and residential condominiums, as well as on the need for international harmonization and the development of specialized training for fire response professionals (Vockan Automotivo, 2024).

The specific objectives are as follows: to analyze actions and regulations currently in force worldwide, with the purpose of identifying effective strategies for risk mitigation and fire suppression in electric vehicles, thereby contributing to the safe and expanded adoption of this technology; and to emphasize the importance of research on electric vehicles within the scientific and technological context, highlighting related issues that are open to future investigation and the innovative contributions already achieved in the field.

The article is organized into five sections to ensure clarity, coherence, and logical flow of the argument. The Introduction contextualizes the topic and outlines the research

objectives. Subsequently, the Methodology section presents the procedures adopted to conduct the study. The Literature Review discusses and analyzes the main theoretical and scientific references relevant to the subject. The Results and Discussion section then presents and discusses the research findings based on the theoretical framework. Finally, the Conclusion summarizes the main findings and their implications and contributions to the field of study.

2 METHODOLOGY

This study adopts a qualitative and exploratory approach, with analytical and documentary emphasis, grounded in the innovative and pioneering nature of the research within the Brazilian context (Amado, 2017). The research was conducted between January and April 2025 and focused on a critical analysis of fire risks in electric vehicles and the mitigation strategies adopted worldwide.

Sources were collected and analyzed in Portuguese, English, and Spanish. The databases consulted included Scopus, ScienceDirect, IEEE Xplore, Google Scholar, and SciELO, in addition to technical repositories from institutions such as UNECE, ABNT, EV FireSafe, the Fire Safety Research Institute, Frontiers in Energy Research, and legislation available on the websites of public authorities and regulatory bodies.

The search parameters comprised the following descriptors and their combinations: “electric vehicle fire,” “lithium-ion battery,” “thermal runaway,” “fire safety electric vehicle,” “thermal runaway battery,” “EV fire mitigation,” “electric car fire,” and “vehicle safety.” Searches were limited to publications from 2018 to 2025.

The bibliographic review method involved critical reading, thematic categorization, and cross-validation of information through source triangulation (Cavalcante; Oliveira, 2020). Documents were classified according to criteria of timeliness, relevance, institutional origin, and technical rigor (Arantes, 2025). The analysis adopted a comparative perspective, integrating empirical data, existing regulations, and technological trends, with the aim of providing a systematized and forward-looking overview of the topic.

3 LITERATURE REVIEW

3.1 INCIDENCE AND ETIOLOGY OF FIRES IN ELECTRIC VEHICLES: UNRAVELING THE COMPLEXITY

Although available data indicate a lower frequency of fires in electric vehicles (EVs) when compared to their counterparts, internal combustion vehicles (ICVs), the nature of fire events involving EVs requires in-depth analysis. Fires associated with lithium-ion batteries

are distinguished by their ability to burn for extended periods, releasing extreme heat and harmful gases, which amplifies the risk of structural damage and fire propagation in confined spaces.

Contrary to common misconceptions, the International Council on Clean Transportation (2022) reports that the probability of fire in EVs is up to 60 times lower than in ICVs. Tesla, a pioneer in the sector, reports an occurrence rate 11 times lower per kilometer traveled compared to the average of vehicles in the United States. Nevertheless, it is essential to recognize that, when they do occur, EV fires present specific characteristics that require specialized attention.

The primary causes of such events include battery overheating, often associated with manufacturing defects, collision-related damage, and issues during charging, particularly under overcharging conditions (EV FireSafe, 2024). The distinctive characteristics of these fires are detailed below.

Thermal Runaway: The Destructive Chain Reaction

Thermal runaway constitutes the core challenge. Once initiated in a single battery cell, it triggers a cascade of intense heat generation and the release of flammable gases, rendering the fire intrinsically difficult to control.

Reignition: A Persistent Threat

The risk of reignition after initial suppression is significantly higher in EV battery fires, requiring prolonged and vigilant monitoring.

Toxic Gases: A Hidden Hazard

Battery combustion releases toxic and corrosive gases, such as hydrogen fluoride, which pose serious threats to human health and may contaminate buildings and equipment.

Flame Consumption Time

Rapid Onset, Prolonged Suppression: thermal runaway may lead to rapid flame development, becoming visible within minutes.

Extended Duration: unlike ICVs, in which fuel is depleted relatively quickly, an EV battery may burn for hours, or even days in some cases, due to stored energy and the autocatalytic nature of thermal runaway. Reignition remains a risk until adequate cooling is achieved.

Temperatures: Intense and Concentrated Heat

High Temperatures: lithium-ion battery fires may exceed 1,000°C in the vicinity of the burning cells, significantly higher than temperatures observed in ICV fires.

Concentrated Heat: the heat generated tends to be concentrated around the battery area, intensifying risks to adjacent structures.

Destructive Potential to Built Structures: A Tangible Threat

Significant Risk: intense heat and prolonged burning pose considerable danger to the integrity of nearby buildings.

Structural Damage: prolonged exposure to high temperatures may compromise structural elements such as steel, through deformation, and concrete, through cracking and loss of strength.

Fire Propagation: radiant heat may ignite combustible materials within or near buildings, facilitating fire spread to the structure.

Destructive Reach of Released Heat: An Expansive Hazard Zone

Wide Variation: the destructive reach of heat depends on fire intensity, battery size, and the properties of surrounding materials.

Direct Damage: within a radius of 1 to 3 meters, spontaneous ignition of combustible materials may occur due to radiant heat, while nearby vehicle components may suffer severe damage or melting.

Indirect Damage: heat-sensitive materials such as paint, plastics, and wiring may be damaged at greater distances, potentially up to 5 to 10 meters or more, depending on fire duration and intensity.

Propagation Risk: flammable objects near the vehicle, even several meters away, may reach ignition temperatures over time, particularly in prolonged fires.

Additional Considerations: Overlooked Complexities

Projectile Release (Thermal Runaway Venting): during thermal runaway, battery cells may expel pressurized gases and incandescent fragments over several meters, posing a risk of secondary fires.

Dense and Toxic Smoke: the smoke produced is dense, irritating, and laden with toxic substances, constituting a significant health hazard in surrounding areas.

Global concerns regarding fires in electric vehicles are reflected in reports of bans and restrictions in countries such as China (Zhejiang Province), South Korea, and Malaysia. In Australia, recommendations to suspend the installation of chargers in buildings until clear governmental guidelines are established underscore the urgency of the issue (Felisbert, 2024; EVB.COM, 2024). In countries such as China and South Korea, proactive measures have been implemented to restrict EV charging in underground parking facilities, reflecting a precautionary stance in response to potential risks (News Motor, 2024; Brito, 2024).

3.2 DISTINCTIVE FEATURES OF LITHIUM-ION BATTERY FIRES: A DETAILED ANALYSIS

Fires involving lithium-ion batteries exhibit distinctive characteristics that set them apart from conventional fires. Temperatures may reach levels of up to 1,000°C, accompanied by the release of toxic and corrosive gases, such as the highly hazardous hydrogen fluoride (Fire Safety Research Institute, 2023). The occurrence of thermal runaway, in which combustion in a single cell triggers an uncontrollable chain reaction, constitutes a critical factor that significantly hinders fire suppression.

Another particularly relevant feature is the phenomenon of reignition. Even after the apparent suppression of flames, the battery may re-ignite, requiring continuous and prolonged monitoring by emergency response teams (Frontiers in Energy Research, 2022).

It is essential to emphasize the following points regarding incidence and causes:

- **Positive Data, Persistent Challenges:** although studies indicate a significantly lower probability of fires in EVs compared to internal combustion vehicles (ICVs), as evidenced by Tesla data reporting an incidence 11 times lower per kilometer traveled and by a Swedish study from 2022 showing that only 0.004% of the EV fleet experienced fires compared to 0.08% of gasoline and diesel vehicles, the fires that do occur present complex challenges due to the intrinsic characteristics of lithium-ion batteries.
- **Primary Causes and Thermal Runaway:** primary causes include battery overheating, physical damage to cells resulting from collisions, manufacturing defects, and failures in electrical installation. Thermal runaway, as an uncontrolled chain reaction, releases intense heat and toxic gases, making suppression efforts particularly difficult.
- **Risk of Reignition: Continuous Surveillance:** the need for prolonged monitoring, even after initial fire containment, is imperative due to the high risk of reignition.

Firefighting and Prevention Strategies: An Imperative for Innovation

- Fire suppression in EVs generally requires the use of large volumes of water to cool the battery and interrupt the progression of thermal runaway. In addition, Class D extinguishers and specific agents, such as Aqueous Vermiculite Dispersion (AVD), have emerged as promising alternatives for fires involving lithium batteries.

Nevertheless, the challenges inherent in extinguishing fires in electric vehicle batteries are substantial. The effectiveness of large quantities of water in cooling the battery and interrupting thermal runaway is not absolute, and Class D extinguishers, including foam and dry chemical agents, are only effective when complete flame smothering is achieved. The absence of universally accepted firefighting protocols for electric vehicles, including standardized cooling and isolation techniques, reflects a field in continuous development, with fire brigades worldwide still in the process of establishing these critical guidelines.

Current research explores innovative approaches to fire suppression, including:

- **Immersion Techniques:** studies investigate immersing batteries in water tanks or specific solutions to effectively cool and isolate cells undergoing combustion.
- **Ventilation and Gas Control:** the management of toxic gases released during combustion is an area of intensive research, focusing on the development of safe ventilation and containment techniques.
- **Development of Safer Battery Materials:** although not directly related to fire suppression, research on solid-state electrolytes and other battery technologies aims to inherently reduce the likelihood and severity of fires.

At present, there is no single, universally effective solution capable of instantly extinguishing fires in electric vehicles, given the complex nature of lithium-ion batteries and the thermal runaway phenomenon.

4 RESULTS AND DISCUSSION

Preventive fire safety measures play a crucial role in mitigating fire risks, including regular battery maintenance, safe charging practices, and regulations aimed at limiting charging levels in underground parking facilities. South Korea's proposal to restrict EV battery charging to 90% in residential building garages (Straits Times, 2024) illustrates this proactive approach.

Additional prevention and risk mitigation strategies include:

- **Periodic Inspections:** regular inspections of batteries and electrical systems are essential to identify and correct potential issues. Safe
- **Charging Practices:** using only manufacturer-recommended chargers and ensuring adequate electrical installations are fundamental preventive measures.
- **Prevention of Physical Damage:** avoiding collisions and impacts that may damage the battery is critical to minimizing fire risk. Application of

- **Thermal Fire Blankets:** high-temperature-resistant fire blankets may be used to cover a burning vehicle. Although they do not extinguish internal battery fires, they help contain flames, reduce fire spread, and decrease the release of smoke and toxic gases, facilitating targeted cooling.
- **Specialized Cooling Equipment:** companies are developing directed cooling systems that can be connected to the battery to accelerate cooling and improve fire control (InsideEVs, 2024).
- **Thermal Imaging Cameras:** essential for monitoring battery temperature during and after a fire, assisting firefighters in identifying hot spots and assessing the risk of reignition.

Although fires in electric vehicles receive heightened attention due to the complexity of battery combustion, their probability of occurrence remains significantly lower than that of internal combustion vehicles. Continuous research is vital to further improve battery safety and firefighting methods.

Restrictions and considerations implemented in different countries and regions include:

- **China (Zhejiang Province):** prohibition of EV access to underground garages in hotels and other buildings in cities such as Hangzhou, Ningbo, and Xiaoshan, due to concerns over spontaneous combustion and recent incidents (Radio Free Asia, 2024; CarExpert, 2024). EVs are directed to designated outdoor parking areas.
- **South Korea (Seoul):** advisories urging EV drivers to avoid underground parking when batteries are charged above 90%, aiming to prevent overcharging-related fires (The Straits Times, 2024). Plans include recommending a maximum charging limit of 90% or less in underground parking facilities and restricting the maximum charging rate at public chargers to 80%.
- **South Korea (National):** prohibition, since December 2023, of installing EV chargers below the second underground level in buildings to ensure emergency access for firefighters (The Japan Times, 2024).
- **Malaysia:** discussions and proposed guidelines by the Ministry of Housing and Local Government (KPKT) to prohibit EV chargers in parking areas of stratified properties and underground levels due to fire safety concerns (Firefighter.com.my, 2024/2025, estimated date).

- Australia: a recommendation by the real estate services company MICM advising Owners' Corporations to suspend EV charger installation projects until receiving guidance from the Federal Government, citing elevated insurance and fire risks (CarExpert, 2023).

These restrictions and alternatives demonstrate a cautious and adaptive approach across different regions, seeking to balance EV adoption with public safety. Based on these experiences, the following alternatives have been identified:

- Designated Outdoor Parking: directing EVs to park in specific areas away from main buildings.
- Limitation of Charging Levels: advising or recommending limits on battery charge levels to safer percentages.
- Charging at Ground Level or Upper Basement Levels: prioritizing charger installation in locations more accessible to emergency services.
- Awaiting Governmental Guidelines: suspending installations until clearer safety standards and technological solutions become available.

It is essential to recognize that:

- Prolonged Suppression and Higher Water Consumption: EV fires may require significantly more time and water to extinguish than fires involving internal combustion vehicles, making continuous battery cooling critical to prevent reignition.
- Firefighter Safety as a Priority: appropriate personal protective equipment (PPE), including self-contained breathing apparatus (SCBA), is indispensable due to the release of toxic gases.
- Ongoing Research and Development: continuous research and development efforts are underway to identify more effective and faster solutions for extinguishing EV fires, with the potential emergence of new technologies and extinguishing agents.
- Absence of Comprehensive Global Prohibitions and Extensive Published Research: a generalized and formally decreed global prohibition on EV charging in all residential and commercial underground facilities is not currently the norm. While concerns are evident and certain regions or specific building administrations have adopted precautionary measures, readily available research does not indicate the existence of in-depth scientific articles documenting such prohibitions and alternatives at a global scale with detailed authorship and publication data. Most available information derives from news reports and sector-specific publications.

4.1 REGULATIONS AND TECHNOLOGICAL INNOVATIONS: SHAPING A SAFER FUTURE

Global regulations reflect a concerted effort to ensure the intrinsic safety of electric vehicles (EVs). The United Nations Economic Commission for Europe (UNECE), through Global Technical Regulation No. 20 (GTR No. 20), has established stringent standards for batteries, covering aspects ranging from impact resistance to thermal safety (UNECE, 2020). In the Brazilian context, standards such as NBR 17019 define technical criteria for the installation of EV chargers, aiming to prevent short circuits and fires (Fase Energia, 2024).

In parallel with the regulatory framework, technological innovations have emerged as fundamental pillars of safety. The development of self-extinguishing batteries and advanced thermal management systems designed to mitigate the occurrence of thermal runaway represents significant progress in this field (Self-extinguishing batteries, 2023).

Regulation of Electric Vehicle Charging in Residential Condominiums

In Brazil, Bill No. 158/2025 signals a movement toward regulating the installation of charging infrastructure in residential condominiums, seeking to clarify issues related to safety and the responsibilities of individual unit owners (Chamber of Deputies, 2025). Standards such as NBR 17019 specify technical requirements for charger installation, including mandatory protection against overloads and the requirement for adequate ventilation (Fase Energia, 2024).

In several regions, the development of specific standards for EV charger safety is underway. In Brazil, the São Paulo Fire Department has proposed regulations addressing the installation of ventilation systems, heat sensors, automatic sprinklers, and battery shutoff points in garages and parking facilities. Additionally, a minimum safety distance of five meters between charging spaces and other risk areas has been recommended (Revista Incêndio, 2024; Poder 360, 2024).

Strategies for Extinguishing Fires in Electric Vehicles

The unique nature of lithium-ion batteries requires specific firefighting approaches. Governments at different levels and in various parts of the world are implementing or considering a range of preventive and mitigation measures, including:

- **Intensive Cooling:** the application of large volumes of water or specialized cooling agents to control battery temperature and prevent reignition.
- **Site Isolation:** the implementation of physical barriers to prevent fire spread and exposure to toxic gases.
- **Protective Equipment:** the use of appropriate personal protective equipment by firefighters, including respiratory protection against toxic gases.

- **More Rigorous Safety Testing:** adoption of specific tests to assess battery resistance to impact, penetration, and other conditions that may trigger fires.
- **Manufacturing and Quality Standards:** establishment of norms for battery production and assembly to ensure safety and durability.
- **Vehicle Design Requirements:** requirements for EV designs that facilitate battery cooling in cases of overheating and provide protection during collisions.

Strategic governmental investments in research and development have accelerated the advancement of inherently safer technologies, such as self-extinguishing batteries and sophisticated thermal management systems (Amphenol, 2024; Agência Gov, n.d.).

Governmental and Industrial Actions: A Collaborative Effort for Safety

Governments and the automotive industry have demonstrated a growing commitment to improving EV safety through the implementation of significant measures. Charging restrictions in underground parking facilities in countries such as China, Malaysia, and South Korea (Autoesporte, n.d.), as well as recommendations in Australia to postpone installations until clear standards are established (CarExpert, 2023), exemplify this proactive stance.

In addition, global initiatives prioritize specialized firefighter training and investment in advanced safety technologies (Firefighter.com.my, 2024). Firefighting strategies for electric vehicles must integrate efficient cooling techniques, the safe management of toxic gases, and the development of charging infrastructure with safety as a priority, including the installation of fire detection systems and automatic sprinklers.

The establishment of a national safety protocol in Brazil remains under discussion, highlighting the urgency of clear standards for the prevention and suppression of EV fires (A Tarde, n.d.; Move News, n.d.; Sindiconet, n.d.; Fonsi, n.d.; CNN Brasil, n.d.). At the international level, there is a clear movement toward the harmonization of safety standards, with the aim of aligning EV safety with that of internal combustion vehicles. Key governmental and industrial actions are outlined below.

Training for Emergency Response Teams

- **Development of Training Curricula:** creation of specialized programs for firefighters and rescue teams addressing the specific risks and safe procedures associated with EV fires.
- **Appropriate Equipment:** investment in equipment that enhances battery cooling and protects responders from exposure to toxic gases.

Safe Charging Infrastructure

- **Standards for Charger Installation:** definition of rigorous standards for the installation of public and private charging points to prevent overloads and short circuits.

- **Inspections and Certifications:** implementation of inspection and certification processes to ensure the safety of charging installations.

Public Awareness

- **Informational Campaigns:** development of campaigns to educate the public about potential risks and necessary precautions related to electric vehicles.
- **Information for Owners:** provision of clear and accessible information on the safe handling, charging, and maintenance of EVs.

Research and Development

- **Research Funding:** financial support for studies aimed at improving battery safety and developing innovative technologies for fire prevention and suppression.

International Cooperation

- **Information Sharing and Best Practices:** collaboration among governments and international agencies to exchange knowledge and develop common approaches to electric vehicle safety.

It is essential to recognize that specific governmental actions may vary significantly depending on regional contexts and the level of EV adoption. Nonetheless, the global trend points to increased attention and regulation regarding electric vehicle safety, encompassing both fire prevention and firefighting strategies.

4.1.1 An Innovation in the Suppression of Lithium-Ion Battery Fires

In our research, several authors state that there are currently no products, processes, or inventions capable of extinguishing fires in which lithium-ion batteries act as the oxidizing agent. Nevertheless, we identified FirePro as a promising fire suppression technology that proposes the use of a condensed aerosol system specifically designed for the suppression of lithium-ion battery fires (Figure 1). This system is based on a solid compound claimed to be patented, known as FPC (Figure 2), which is used as the active fire suppression agent.

This is a modern technology that shows potential effectiveness and has been applied in various settings, including electrical panels, electrical rooms, data centers, and maritime installations (Argus Engenharia, 2024b).

Components of FirePro systems: innovative fire suppression devices and the FPC product.

Figure 1*FirePro system*

Source: ARGUS (2024b).

Figure 2*FPC product*

Source: ARGUS (2024b).

However, after conducting patent searches in the Brazilian National Institute of Industrial Property (INPI), no patent records were found for FPC products in Brazil. The system entitled **FPC Assembly Module, Electronic Device, and Assembly Method** corresponds to patent application BR 11 2024 004027 5 A2, classified under IPC H05K7/14 and H05K5/06. The application was filed on August 15, 2022, and published in Brazil on June 25, 2024, with Unionist priority claimed in China under application No. 202111026212.3, dated September 2, 2021. The invention relates to an FPC assembly module, an electronic device, and a corresponding assembly method.

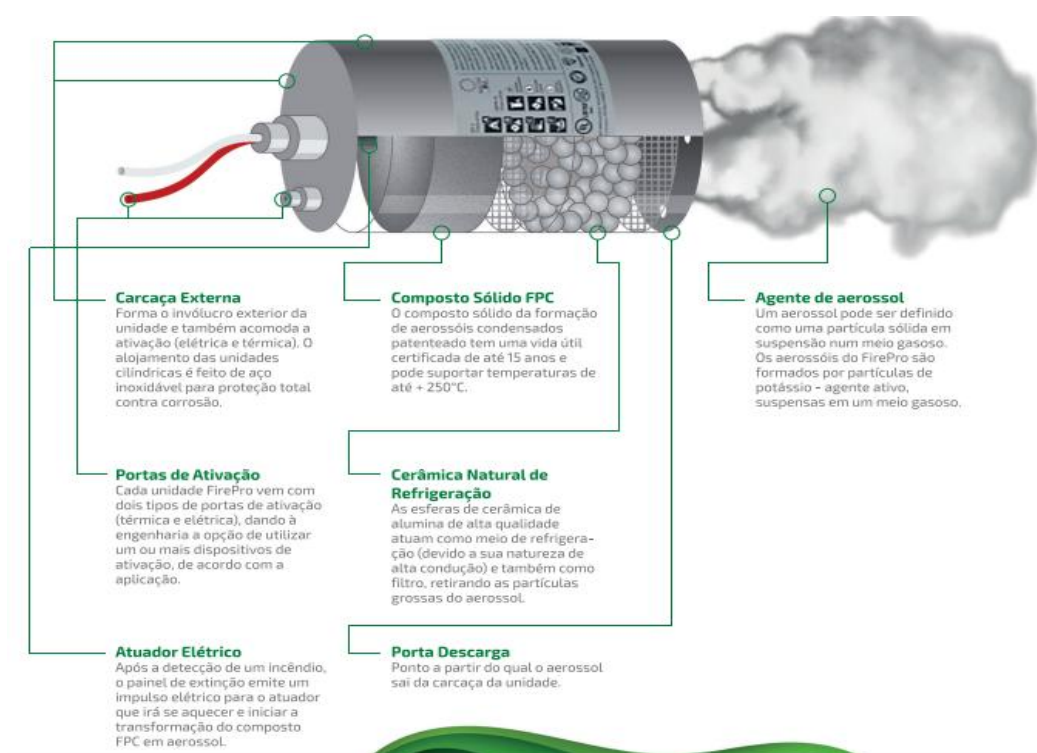
The patents related to FirePro products are registered with the World Intellectual Property Organization (WIPO) and are certified under the International Trademark Registration system in accordance with the Madrid Agreement and Protocol. In addition, FirePro holds Canadian Patent No. 2,250,325, European Patent No. 0925808, and Patent Application WO-2015057107-A1 (**Thermal Mechanism for Activation of a Fire Extinguishing Generator**), with a priority date of October 16, 2013. These rights are assigned to FirePro Systems Ltd., and the listed inventors are Khaustov Aleksandr Grigorievich, Solovev Vladimir Aleksandrovich, and Sokolnikov Aleksandr Sergeevich.

This innovation is grounded in the basic theory of fire, proposing the interruption of the combustion process by removing one of its essential elements. The system operates by removing or limiting the primary oxidizing agent, oxygen, through smothering by condensed aerosol, thereby inhibiting the chain reaction of combustion. This mechanism enables effective application in enclosed environments (Argus Engenharia, 2024b), as illustrated in Figure 3 below.

4.1.2 Description of the storage component of the innovative fire suppression system:

Figure 3

Fragmented image of the storage capsule of the suppression system



Source: Argus (2024b).

Regarding the Bridgehill thermal blanket, no patent records were identified that describe a thermal blanket system for temperature control and fire protection. However, the CarPro X and Standard blankets have been approved in accordance with NFPA 701 standards and hold licensing and registration with the Brazilian National Institute of Industrial Property (INPI). To date, no specific licensing records have been identified in the INPI Brazil database for the aforementioned products.

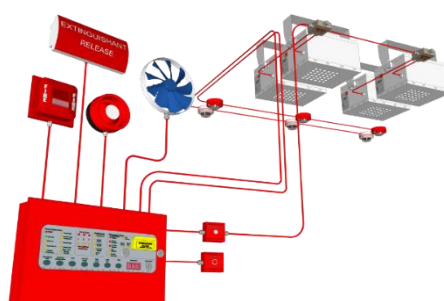
The FirePro Hero system reports having been tested and certified under ISO 9001 and ISO 14001 standards, approved by the United States Environmental Protection Agency (EPA/USA) and by the European Green Label program. The system is designed to protect

environments ranging from 0.08 m³ to 57 m³ by means of smothering through condensed aerosol, which inhibits the chain reaction of the combustion process. Its application is suitable for enclosed spaces or, alternatively, for use in combination with the Bridgehill fire barrier blanket, as well as through the coordinated deployment of multiple units activated simultaneously or sequentially (Argus Engenharia, 2024a), as illustrated in Figures 4 and 5 below.

4.1.3 Proposed combination for open areas and parking facilities using the innovative fire barrier system:

Figure 4

FirePro circuit



Source: ARGUS (2024a; 2024b).

Figure 5

Bridgehill fire barrier blanket



Source: ARGUS (2024a; 2024b).

Therefore, there is a clear need for experimental and physical testing in Brazilian test facilities, as well as for national certification, given the absence of patent protection in Brazil. The lack of domestic patent records reinforces the importance of conducting locally validated trials to assess technical performance, safety, and regulatory compliance under Brazilian conditions.

In this context, the U.S.-based startup 24M claims to have developed a novel battery technology with the potential to significantly transform the market. Supported by Volkswagen, this innovation, known as the Impervio battery separator, is designed to prevent overloaded battery cells from igniting and may represent an important milestone for the broader adoption of electric vehicles. Overcharging is one of the primary mechanisms associated with the initiation of battery fires, and the technology was tested in batteries exhibiting dendrite formation as well as internal short circuits. The tests were conducted on lithium-ion cells composed of nickel, manganese, cobalt, and graphite, with a capacity of 10 ampere-hours. In both cases, the cells were fully charged and subsequently subjected to 100 percent overcapacity, a condition that can lead to fire or explosion (InsideEVs, 2024).

5 FINAL CONSIDERATIONS

Electric vehicles are an established reality and are closely associated with efforts to mitigate environmental damage and improve air quality in major cities worldwide. Although electric vehicles present an intrinsically lower risk of fire when compared to internal combustion engine vehicles, the singular characteristics of lithium-ion battery fires require the development and implementation of specific and effective prevention and suppression strategies.

A fire involving an electric vehicle may evolve into a long-duration event, characterized by high temperatures and significant destructive potential to adjacent structures. This behavior is driven by intense and prolonged heat release, as well as by the emission of toxic gases. The destructive reach of the heat, although variable, represents a considerable risk within a radius of several meters around the affected vehicle. It is therefore imperative that emergency response teams adopt intensive cooling strategies and implement strict precautionary measures in light of the specific risks inherent to such incidents.

Fire safety in electric vehicles has emerged as a growing concern, demanding the implementation of robust regulatory standards and sustained investment in specialized training for emergency professionals, as well as the establishment of governmental regulations applicable to public authorities, private entities, and society as a whole.

The continued enforcement of rigorous regulations, combined with sustained advances in technological innovation, constitutes a fundamental pillar for promoting the safe and sustainable adoption of electric vehicles, as well as for updating existing legislation to reflect emerging risks and solutions.

Electric vehicle safety represents a multifaceted challenge that requires a holistic approach, integrating strict regulatory frameworks, continuous technological innovation, and

strong international collaboration. Persistent efforts in research and development will be essential to ensure public safety and to foster the sustainable adoption of electric vehicles on a global scale.

Current actions and regulations at the international level demonstrate a concerted effort to mitigate the risks associated with the charging and operation of electric vehicles in confined environments. Continued investment in the development of inherently safer battery technologies, together with the formulation of effective fire suppression protocols, will be decisive in ensuring public safety and in paving the way for widespread and reliable adoption of electric vehicles.

In the pursuit of safe and sustainable electric mobility, long envisioned by pioneers such as Tesla on the global stage and Gurgel in Brazil, several dilemmas persist in the minds of electric vehicle users and the general population. These include the relationship between vehicle costs and their actual environmental impact; the extent to which industry is developing effective products to combat fires in electric vehicles; the longevity of lithium-ion batteries versus alternative technologies that may emerge in the medium and long term, given that lithium is a finite natural resource; the cost-benefit balance for ride-hailing and taxi drivers when acquiring electric vehicles and whether incentives for internal combustion vehicles through federal, state, and municipal tax policies offset this transition; and the challenges faced by the Armed Forces in incorporating electric vehicles into armored fleets due to fire risks.

These issues represent important avenues for future research and must be addressed by scholars to further clarify and demystify the topic, as this study has sought to do with respect to fires in electric vehicles, a subject once highly controversial and now increasingly better understood.

REFERENCES

- Agência Gov. (2024). Investimentos em ciência e tecnologia no Brasil. <https://agenciagov.ebc.com.br/noticias/202408/nib-busca-avanco-tecnologico-com-producao-no-brasil-diz-secretario-do-mdic>
- Alter, N., Ngatuvai, M., Beeton, G., Atoa, A., Wajeeth, H., Ibrahim, J., & Elkbuli, A. (2023). Analysis of electric vehicle collisions in the United States: An epidemiological study. *The American Surgeon*, 89(12), 5161–5169. <https://doi.org/10.1177/00031348221138089>
- Amado, J. (2017). *Manual of qualitative research in education* (3^a ed.). Imprensa da Universidade de Coimbra.
- Amphenol. (2024). Tendências de carros elétricos para os próximos 10 anos. <https://www.amphenol.com>

- Arantes, T. R. de R. (2025). Pesquisa documental, pesquisa bibliográfica e revisão sistemática: Aspectos definidores e breves considerações. *Cadernos de Estudos Interdisciplinares*, 7(2), Article e722501. <https://doi.org/10.5281/zenodo.15799019>
- Autoesporte. (2024). Preocupações globais com incêndios em veículos elétricos. <https://autoesporte.globo.com>
- A Tarde. (2024). Carros elétricos: Protocolo nacional de segurança está em debate. <https://atarde.com.br>
- Argus Engenharia. (2024a). Catálogo Bridgehill. https://www.argus-engenharia.com.br/site/wp-content/uploads/datasheets/Manta/Cat%C3%A1logo_Bridgehill-_2024.pdf
- Argus Engenharia. (2024b). Catálogo FirePro®. <https://www.argus-engenharia.com.br/site/wp-content/uploads/2024/04/catalogo-firepro.pdf>
- Baterias Autoextinguíveis. (2023). Desenvolvimento de baterias de íons de lítio autoextinguíveis para maior segurança. <https://www.tecmundo.com.br>
- Associação Brasileira de Normas Técnicas. (2022). ABNT NBR 17019: Instalações elétricas de baixa tensão – requisitos para alimentação de veículos elétricos. <https://canalsolar.com.br/abnt-publica-norma-para-instalacao-de-carregadores-de-veiculos-eletricos/>
- Brito, E. A. (2024). China proíbe carro elétrico de estacionar em prédios por risco de incêndio. Canaltech. <https://canaltech.com.br>
- Câmara dos Deputados. (2025). Projeto de Lei n. 158, de 2025. <https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2482575>
- Carexpert. (2023). Electric car charger ban recommended by owners corporation conglomerate. <https://www.carexpert.com.au>
- Carexpert. (2024). EVs banned from underground car parks in popular EV market. The Canberra Times. <https://www.canberratimes.com.au/story/8764784/evs-banned-from-underground-car-parks-in-popular-ev-market/>
- CNN Brasil. (2024). Carro elétrico: Associações questionam regras de bombeiros para recarga. <https://www.cnnbrasil.com.br>
- Conselho Internacional de Transporte Limpo. (2022). Segurança de veículos elétricos: Uma revisão do estado atual do conhecimento. <https://theicct.org>
- Dong, X., Gou, Z., & Gui, X. (2024). How electric vehicles benefit urban air quality improvement: A study in Wuhan. *Science of the Total Environment*, 906, Article 167584. <https://doi.org/10.1016/j.scitotenv.2023.167584>
- EV Firesafe. (2024). Global electric vehicle fire data. <https://www.evfiresafe.com/ev-battery-fire-data>
- Felisbert, V. (2024). Carros elétricos e a segurança contra incêndios preocupam especialistas. *Força e Luz Engenharia*. <https://forcaeluzengenharia.com.br>
- Fire Safety Research Institute. (2023). Fire behavior of lithium-ion batteries in electric vehicles. <https://fsri.org>
- Gomes, R. L. R., et al. (2025). Hydrogen vehicles and sustainable mobility: Integration of technological innovation, trade, and environmental, social, and governance principles. *International Journal of Engineering Research and Development*, 21(9), 253–262.

- Inside EVs. (2024). Inovação promete reduzir incêndios em carros elétricos.
<https://insideevs.uol.com.br/news/736215/startup-cria-tecnologia-evitar-incendio/>
- Move News. (2024). Normativa de segurança para recarga de carros elétricos.
<https://movenews.com.br>
- O Tempo. (2024). Carros elétricos: Segurança contra incêndios preocupa especialistas.
<https://www.otempo.com.br>
- Straits Times. (2024). Seoul moves to ban overcharged EVs from underground parking.
<https://www.straitstimes.com>
- UNECE. (2020). Regulamento técnico global n. 20: Segurança de veículos elétricos.
<https://eur-lex.europa.eu>

STRATEGIC MAINTENANCE AND TECHNOLOGICAL INNOVATION AS RESPONSES TO STRUCTURAL CHALLENGES IN RENEWABLE ENERGY PRODUCTION CHAINS

MANUTENÇÃO ESTRATÉGICA E INOVAÇÃO TECNOLÓGICA COMO RESPOSTAS AOS DESAFIOS ESTRUTURAIS NAS CADEIAS PRODUTIVAS DE ENERGIA RENOVÁVEL

MANTENIMIENTO ESTRATÉGICO E INNOVACIÓN TECNOLÓGICA COMO RESPUESTAS A LOS DESAFÍOS ESTRUCTURALES EN LAS CADENAS PRODUCTIVAS DE ENERGÍA RENOVABLE



<https://doi.org/10.56238/sevened2026.008-140>

Alcides Feitosa Neto¹, Antonio Werbiton Marinho Almeida², Francisco Fabio Braga Florêncio³, Givanildo Ximenes Santana⁴, Irene Mendes Fontes⁵, José Reudson de Souza⁶, Márcio Carneiro Barbosa⁷, Moésio da Costa Bastos⁸, Rickardo Léo Ramos Gomes⁹, Roberto Augusto Caracas Neto¹⁰, Tovyska Braga Dantas¹¹, William Neves da Silva¹²

ABSTRACT

Renewable energy production chains play a central role in the global energy transition, as they are essential for reducing greenhouse gas emissions and promoting a more sustainable energy matrix. However, the expansion and consolidation of these chains have revealed a set of structural challenges related to asset reliability, operational complexity, and the long-term sustainability of energy infrastructures. In this context, strategic maintenance and technological innovation emerge as critical elements for ensuring the resilience, efficiency, and competitiveness of renewable energy systems. A qualitative approach was adopted, as it is suitable for exploring phenomena that require a deeper understanding of contexts,

¹ Master's degree in Economics. Universidade Federal do Ceará. E-mail: alcides_feitosa@hotmail.com

² Master's degree in Administration and Controllershship. Universidade Federal do Ceará. E-mail: werbiton@yahoo.com.br

³ Doctoral student in Intellectual Property and Innovation. ACAD INPI. E-mail: profo.fabiobraga@gmail.com

⁴ Postdoctoral Researcher in Genetics, Conservation and Evolutionary Biology. Instituto Nacional de Pesquisas da Amazônia (INPA). E-mail: gxsantana@petrobras.com.br

⁵ Postgraduate Degree in Criminal Law. Centro Universitário UniAteneu. E-mail: irenefontesrc@gmail.com

⁶ Specialist in Strategy and Business Management. Universidade Federal do Ceará (UFC). E-mail: reudsonadv@gmail.com

⁷ Master in Military Sciences; PhD Candidate at Academia do Instituto Nacional da Propriedade Industrial (INPI). E-mail: barbosamcb91@gmail.com

⁸ Master's Degree Student in Administration. Universidade Estadual do Ceará. E-mail: moesio.bastos@aluno.uece.br

⁹ Dr. in Biological Sciences. Universidade Federal do Ceará. E-mail: rickardolrg@yahoo.com.br

¹⁰ Doctoral student in Intellectual Property and Innovation. Academia do Instituto Nacional da Propriedade Industrial (INPI). E-mail: robertocaracas2000@gmail.com

¹¹ MBA in Renewable Energy Management. FBUNI/IEL. E-mail: tovyska@gmail.com

¹² Master's degree in Mechanical Engineering. Universidade Federal do Ceará. E-mail: williamrns88@gmail.com

processes, and interactions. Regarding methodological procedures, the research was classified as bibliographic. This type of procedure is based on the careful analysis of previously published scientific works, which constitutes one of the foundations of scientific knowledge construction. The general objective of this study is to analyze how strategic maintenance and technological innovation can function as effective responses to the structural challenges of renewable energy production chains, contributing to increased operational reliability, asset sustainability, and competitiveness within the energy sector. According to the study, maintenance management, when effectively integrated with new technologies and a comprehensive view of the production chain, represents a key factor in increasing operational reliability. Furthermore, efficient management enables more conscious use of resources and contributes to strengthening the sustainability of assets linked to electric energy generation. The relationship between maintenance management and the implementation of technological solutions proves to be highly beneficial for the energy sector, resulting in stronger and more effective performance.

Keywords: Strategic Maintenance. Technological Innovation. Renewable Energy. Operational Reliability. Sustainability.

RESUMO

As cadeias produtivas de energia renovável desempenham um papel central na transição energética global, pois são essenciais para reduzir as emissões de gases de efeito estufa e promover uma matriz energética mais sustentável. No entanto, a expansão e consolidação dessas cadeias revelaram um conjunto de desafios estruturais relacionados à confiabilidade dos ativos, à complexidade operacional e à sustentabilidade de longo prazo das infraestruturas energéticas. Nesse contexto, a manutenção estratégica e a inovação tecnológica emergem como elementos críticos para garantir a resiliência, a eficiência e a competitividade dos sistemas de energia renovável. Adotou-se uma abordagem qualitativa, pois é adequada para explorar fenômenos que exigem uma compreensão mais profunda de contextos, processos e interações. Quanto aos procedimentos metodológicos, a pesquisa foi classificada como bibliográfica. Esse tipo de procedimento baseia-se na análise cuidadosa de trabalhos científicos previamente publicados, o que constitui um dos fundamentos da construção do conhecimento científico. O objetivo geral deste estudo é analisar como a manutenção estratégica e a inovação tecnológica podem funcionar como respostas eficazes aos desafios estruturais das cadeias produtivas de energia renovável, contribuindo para o aumento da confiabilidade operacional, da sustentabilidade dos ativos e da competitividade no setor energético. De acordo com o estudo, a gestão da manutenção, quando efetivamente integrada às novas tecnologias e a uma visão abrangente da cadeia produtiva, representa um fator-chave para o aumento da confiabilidade operacional. Além disso, uma gestão eficiente possibilita um uso mais consciente dos recursos e contribui para o fortalecimento da sustentabilidade dos ativos vinculados à geração de energia elétrica. A relação entre a gestão da manutenção e a implementação de soluções tecnológicas mostra-se altamente benéfica para o setor energético, resultando em um desempenho mais robusto e eficaz.

Palavras-chave: Manutenção Estratégica. Inovação Tecnológica. Energia Renovável. Confiabilidade Operacional. Sustentabilidade.

RESUMEN

Las cadenas productivas de energía renovable desempeñan un papel central en la transición energética global, ya que son esenciales para reducir las emisiones de gases de efecto invernadero y promover una matriz energética más sostenible. Sin embargo, la expansión y consolidación de estas cadenas revelaron un conjunto de desafíos estructurales relacionados con la confiabilidad de los activos, la complejidad operativa y la sostenibilidad

a largo plazo de las infraestructuras energéticas. En este contexto, el mantenimiento estratégico y la innovación tecnológica emergen como elementos críticos para garantizar la resiliencia, la eficiencia y la competitividad de los sistemas de energía renovable. Se adoptó un enfoque cualitativo, ya que es adecuado para explorar fenómenos que requieren una comprensión más profunda de contextos, procesos e interacciones. En cuanto a los procedimientos metodológicos, la investigación fue clasificada como bibliográfica. Este tipo de procedimiento se basa en el análisis cuidadoso de trabajos científicos previamente publicados, lo que constituye uno de los fundamentos de la construcción del conocimiento científico. El objetivo general de este estudio es analizar cómo el mantenimiento estratégico y la innovación tecnológica pueden funcionar como respuestas efectivas a los desafíos estructurales de las cadenas productivas de energía renovable, contribuyendo al aumento de la confiabilidad operativa, la sostenibilidad de los activos y la competitividad dentro del sector energético. Según el estudio, la gestión del mantenimiento, cuando se integra eficazmente con nuevas tecnologías y con una visión integral de la cadena productiva, representa un factor clave para incrementar la confiabilidad operativa. Además, una gestión eficiente permite un uso más consciente de los recursos y contribuye al fortalecimiento de la sostenibilidad de los activos vinculados a la generación de energía eléctrica. La relación entre la gestión del mantenimiento y la implementación de soluciones tecnológicas resulta altamente beneficiosa para el sector energético, dando lugar a un desempeño más sólido y eficaz.

Palabras clave: Mantenimiento Estratégico. Innovación Tecnológica. Energía Renovable. Confiabilidad Operativa. Sostenibilidad.

1 INTRODUCTION

The growth of renewable energy sources has become a central pillar of energy transition agendas, driven by the urgency to diversify the electricity matrix, reduce emissions, and enhance energy security. In this context, the production chains associated with these sources have assumed a strategic role, as they connect industrial, technological, and operational processes that are essential for the implementation and operation of power plants. However, the rapid expansion of the sector has also exposed structural challenges that directly affect business reliability, efficiency, and sustainability.

Among these challenges are infrastructure constraints, asset management issues, and the integration of different links within production chains. Within the current context, strategic maintenance and technological innovation emerge as key approaches to addressing the operational and structural demands of the sector, improving plant performance, reducing costs, and increasing the competitiveness of renewable energy sources in an energy landscape marked by growing complexity and continuous change.

A qualitative approach was adopted, as it is suitable for exploring phenomena that require a deeper understanding of contexts, processes, and interactions. Regarding methodological procedures, the research was classified as bibliographic. This type of procedure is based on the careful analysis of previously published scientific works, which constitutes one of the foundations of scientific knowledge construction.

The general objective of this study is to analyze how strategic maintenance and technological innovation can function as effective responses to the structural challenges of renewable energy production chains, contributing to increased operational reliability, asset sustainability, and competitiveness within the energy sector.

The following specific objectives were defined: to examine the main structural challenges affecting renewable energy production chains, with emphasis on their impacts on plant operation and maintenance; to evaluate models and practices of strategic maintenance applied to renewable energy plants, considering their effects on cost reduction, increased reliability, and extension of asset service life; and to investigate the role of technological innovation in improving maintenance processes and strengthening efficiency, safety, and structural resilience in renewable energy plants.

The article is organized into four sections. The first section presents the introduction, which contextualizes the topic and defines the objectives of the study. The second section addresses the methodology, detailing the approach and procedures adopted. The third section focuses on the theoretical framework, discussing structural challenges, strategic maintenance, and technological innovation in renewable energy production chains. The

fourth section presents the final considerations, summarizing the main findings of the study and offering concluding reflections.

2 METHODOLOGY

The methodology adopted in this study was defined based on the need to systematically and interpretively understand the relationships between strategic maintenance, technological innovation, and the structural challenges of renewable energy production chains. Considering the complexity of the topic and its positioning within a field characterized by multiple technical, organizational, and structural dimensions, a methodological framework was selected that enables an integrated analysis of concepts, models, and evidence found in the scientific literature.

A qualitative approach was employed, as it is appropriate for the exploration of phenomena that require a deeper understanding of contexts, processes, and interactions. According to Guerra et al. (2024), the qualitative approach occupies a prominent position in contemporary scientific research by enabling consistent interpretations of complex phenomena and contributing to knowledge construction across different fields. Yin (2016) clearly explains that this type of approach allows for the investigation of relationships and meanings that cannot be fully captured through strictly quantitative methods. This aspect is crucial for an in-depth analysis, as the chosen methodology supports a more detailed and interpretative examination of the data.

Within the context of global scientific research, qualitative methodology has been widely valued and recognized for its ability to structure theoretical analyses that are both robust and coherent. This is particularly evident in fields such as management, technology, and sustainability. The qualitative approach enables a deeper understanding of the phenomena under investigation, thereby making a significant contribution to the development of practices and solutions in these areas. According to Pereira et al. (2018), this approach is especially beneficial because it promotes the organization and systematization of existing knowledge. Such systematization not only facilitates the establishment of links among different scientific contributions but also allows for the identification of theoretical convergences that are essential for the advancement of research in this field.

With regard to methodological procedures, the research was classified as bibliographic. This type of procedure is based on the careful analysis of previously published scientific works, which constitutes one of the pillars of scientific knowledge construction. According to Pereira et al. (2018), bibliographic research is capable of consolidating theoretical and methodological frameworks by gathering and interpreting significant

contributions on a specific topic. Yin (2016) adds that this method enhances the analytical robustness of research by grounding discussions in well-established theories.

The corpus of scientific works analyzed consisted of scientific articles, monographs, dissertations, theses, and books addressing strategic maintenance, technological innovation, and renewable energy production chains. It is noteworthy that most of the analyzed works were published from 2023 onward, which ensures the contemporaneity of the discussions and the alignment of the study with recent debates in the scientific field, in accordance with the methodological guidelines discussed by Guerra et al. (2024), Pereira et al. (2018), and Yin (2016).

3 THEORETICAL FRAMEWORK

The theoretical framework was organized into three complementary topics, enabling a gradual and interconnected understanding of the subject under analysis. The first topic, **3.1 Structural challenges in renewable energy production chains**, examines the technical, operational, and systemic constraints that most significantly affect the operation and maintenance of power plants. Subsequently, topic **3.2 Strategic maintenance in renewable energy plants** presents the main concepts, models, and maintenance management practices, with emphasis on preventive, predictive, and condition-based approaches. Finally, topic **3.3 Technological innovation applied to maintenance and structural resilience** explores how emerging technologies can strengthen asset efficiency, safety, and resilience, reinforcing the link between strategic maintenance and technological innovation within renewable energy production chains.

3.1 STRUCTURAL CHALLENGES IN RENEWABLE ENERGY PRODUCTION CHAINS

The structural obstacles affecting production chains associated with renewable energy in Brazil become evident through their direct impact on the efficient operation and adequate maintenance of power plants, particularly in contexts of accelerated expansion of installed capacity. This situation can generate a range of complications that require targeted attention and specific strategies to ensure optimized plant performance and the ability to meet the growing demand for sustainable energy sources.

The International Energy Agency (IEA, 2023) reported that the significant increase in the integration of intermittent renewable sources, such as solar and wind power, has intensified the need to balance supply and demand in real time. This condition often leads to intentional generation curtailment in order to prevent grid instability and overloads. Under

such circumstances, there is a clear need to incorporate disruptive technologies aimed at enhancing safety and operational reliability in renewable energy generation plants.

Specialized literature emphasizes that the consolidation of production chains occurs asymmetrically, facing challenges such as limited industrial capacity, strong dependence on foreign technologies, and vulnerabilities in logistics systems. These factors negatively affect the operational efficiency of companies operating in this sector, particularly in wind and solar energy segments (Cella, Cardoso, & Cardoso, 2025; Pan et al., 2024).

From a more technical and operational perspective, plant infrastructure faces bottlenecks related to curtailment, shortages of essential components, and progressive asset degradation. These issues directly impact reliability and availability indicators, thereby requiring maintenance strategies that are increasingly aligned with the realities of production chains. As noted by Paixão and Abaide (2025), such challenges highlight the urgency of more effective integration between energy planning, system operation, and maintenance support policies.

The interconnection between generation, transmission, and maintenance represents another critical aspect of renewable energy production chains. Rapid expansion of generation capacity without corresponding investments in transmission infrastructure and operational support systems exacerbates losses, operational constraints, and recurrent failures. Recent research indicates that the lack of systemic coordination undermines not only technical efficiency but also the sustainability objectives inherently associated with the energy transition (Santos et al., 2025).

Beyond technical issues, structural challenges also encompass systemic and environmental dimensions that affect the entire production chain. Component manufacturing, implementation logistics, and maintenance activities generate significant environmental impacts and must be more closely aligned with sustainability and governance guidelines. Nunes et al. (2025) and Farias, Martins, and Cândido (2021) emphasize that balancing operational performance with socioenvironmental responsibility remains a persistent challenge for the sector.

In this context, Table 1 summarizes the main structural bottlenecks identified in the literature and their respective impacts on power plant infrastructure.

Table 1

Structural bottlenecks in renewable energy production chains and their impacts on power plant infrastructure

Dimension	Identified bottlenecks	Impacts on operation and maintenance
Technical	Asset aging and technological limitations	Reduced reliability and increased failure rates
Operational	Curtailement and unavailability of components	Generation losses and increased maintenance costs
Systemic	Fragility in generation–transmission–maintenance integration	Operational constraints and lower overall efficiency
Environmental	Environmental pressures along the production chain	Need for compliance with sustainability standards

Source: Cella, Cardoso e Cardoso (2025); Farias, Martins e Cândido (2021); Nunes et al. (2025); Paixão e Abaide (2025); Pan et al. (2024); Santos et al. (2025).

The identified bottlenecks reflect interactions among technical, operational, and institutional factors rather than merely isolated issues. The lack of effective integration among the links of the production chain increases operational risks and hinders the implementation of maintenance strategies aligned with the growing demands for reliability and sustainability within the energy sector (Paixão; Abaide, 2025).

Ultimately, overcoming these obstacles requires a systemic approach in which power plant maintenance is understood as an essential component of the production chain, rather than merely a support activity. The reviewed literature consistently indicates that strengthening production chains, together with technological innovation and coordination among the various segments of the sector, represents an indispensable pathway for reducing structural vulnerabilities and ensuring greater competitiveness for renewable energy sources in the current energy landscape (Cella; Cardoso; Cardoso, 2025; Pan et al., 2024).

3.2 STRATEGIC MAINTENANCE IN RENEWABLE ENERGY PLANTS

Asset management in renewable energy plants has placed strategic maintenance at the center of attention, primarily due to increasing technological complexity and the need to maintain high levels of operational reliability. As highlighted by Viana (2020), maintenance management has evolved from a corrective and reactive function to an integral part of organizational planning, directly influencing costs, system performance, and generation continuity.

In renewable energy plants, preventive maintenance planned through structured models is a common practice aimed at minimizing unexpected failures and controlling component degradation. According to Araújo (2025), the adoption of a formal maintenance management system increases the predictability of interventions, resulting in more efficient resource allocation and a reduction in unplanned outages, which is particularly critical for wind and solar energy projects.

Predictive maintenance, in turn, significantly enhances asset monitoring by integrating advanced inspection techniques and conducting detailed analyses of operational data generated during their application. This approach enables a more accurate understanding of asset conditions and allows interventions to be carried out in a more strategic manner. According to Gomes et al. (2025), the use of drones combined with multiple testing methods and digital technologies has proven highly effective for the early detection of anomalies. This not only raises operational safety standards but also improves overall plant efficiency. Furthermore, this approach supports more precise, data-driven decision-making when planning required interventions.

With the advent of Industry 4.0, predictive and prescriptive maintenance strategies have been further strengthened, as algorithms and intelligent systems increasingly guide decision-making processes. According to Machado et al. (2023), these practices represent an evolution of traditional maintenance models, as they incorporate real-time data and predictive analytics, leading to more reliable systems and more efficient asset life cycle management. In comparison with the main maintenance approaches applied in renewable energy plants, Table 2 provides an overview of their key characteristics and effects.

Table 2

Strategic maintenance approaches in renewable energy plants and their main effects

Maintenance approach	Main characteristics	Effects on costs, reliability, and service life
Preventive	Scheduled and periodic interventions	Reduction in failures and greater operational predictability
Predictive	Continuous monitoring and data analysis	Early identification of failures and lower corrective costs
Condition-based	Interventions guided by asset condition	Extension of service life and optimization of resources
Prescriptive	Use of intelligent systems and algorithms	Decision support and increased systemic reliability

Source: Viana (2020); Araújo (2025); Gomes et al. (2025); Machado et al. (2023).

As with other generation sources, maintenance in renewable energy generation systems must also be planned in accordance with market conditions and the operation of the electrical system. In decentralized environments, coordination among generation, maintenance, and commercialization is a determining factor in terms of cost efficiency and supply reliability (Paula, 2021).

In this context, evolutionary strategies and optimization techniques have increasingly been applied to the maintenance planning of generation units. As demonstrated by Rodrigues, Assis, and Resende (2020), these strategies make it possible to reconcile technical and operational constraints, resulting in more efficient scheduling of interventions with reduced impacts on asset availability.

Finally, multi-objective optimization techniques enhance the ability to evaluate trade-offs in maintenance management. Sadeghian et al. (2019) indicate that jointly assessing technical, economic, and operational criteria leads to more balanced decision-making, thereby strengthening strategic maintenance as a fundamental element for operational sustainability and the competitiveness of renewable energy plants.

3.3 TECHNOLOGICAL INNOVATION APPLIED TO MAINTENANCE AND STRUCTURAL RESILIENCE

A report by the United Nations Children's Fund (UNICEF, 2023) cited projections by the International Energy Agency indicating that solar photovoltaic and wind energy would account for nearly 95 percent of global renewable capacity additions by 2027, while technological challenges and limited policy support have slowed the expansion of hydropower, bioenergy, geothermal, and ocean energy technologies.

In turn, studies by Hille, Althammer, and Diederich (2020) highlight the central role of technological innovation in advancing the renewable energy sector, enhancing its competitiveness and promoting sustainable business models that benefit the respective production chains. In this sense, emerging technologies such as advanced energy storage systems, smart grids, and the digitalization of energy systems have enabled greater efficiency in the generation, distribution, and consumption of renewable energy.

Technological innovation in maintenance and structural resilience of renewable energy plants is directly linked to a broader transformation of productive and energy systems. As noted by Barbieri (2024), the implementation of innovations aligned with sustainable development reshapes industrial processes by integrating operational efficiency, environmental responsibility, and the rational use of resources, aspects that are closely connected to maintenance management in energy assets.

Within the electric power sector, digitalization and the pursuit of more reliable systems have accelerated technological innovation. According to Cardoso, Camilo, and Picolo (2024), among the most significant advances are digital sensors, continuous monitoring systems, and data analytics platforms, which provide greater visibility into the operational and structural conditions of power plants. These technologies enable more consistent maintenance planning and more robust structural risk management.

The development and advancement of innovations related to renewable energy sources in Brazil demonstrate a continuous and gradual process of integrating technological solutions aimed primarily at improving efficiency and ensuring asset safety within the sector. This trajectory has proven relevant in the construction of a more sustainable and reliable energy environment. Gonsales (2020) emphasizes that, in the wind and solar energy segments, the implementation of automated monitoring systems combined with data analysis plays a significant role in enabling the anticipation of potential failures and improving maintenance-related processes. This practice, in turn, has a direct and positive impact on the operational stability of power plants, ensuring more efficient and reliable performance.

From a strategic perspective, Marques (2022) argues that disruptive technologies in the electric power sector can enhance the adaptive resilience of production chains. Such innovations integrate automation, digitalization, and more intelligent asset management, leading to substantive transformations in sector operations. With regard to maintenance, the application of innovations in renewable energy plants is essential, as they significantly increase the structural resilience of these facilities, reducing exposure to critical scenarios. Moreover, these innovations also enhance operational safety, making operations more secure and reliable when facing emerging challenges. In summary, Table 3 presents the main technologies applied in maintenance processes and explains how each affects the structural resilience of renewable energy plants.

Table 3

Technologies applied to maintenance and their effects on the structural resilience of renewable energy plants

Technology	Application in maintenance	Contributions to efficiency and safety
Digital sensors	Continuous monitoring of components	Early detection of structural failures
Structural monitoring systems	Monitoring of asset performance	Risk reduction and increased reliability
Data analysis	Processing of large volumes of information	Decision support and optimization of interventions

Technology	Application in maintenance	Contributions to efficiency and safety
Automation	Execution and control of operational processes	Greater efficiency and standardization of operations

Source: Barbieri (2024); Cardoso, Camilo e Picolo (2024); Gonsales (2020); Marques (2022).

The adoption of these technologies also depends on institutional conditions and policies that encourage innovation. Negri (2018) emphasizes that the consolidation of favorable environments for innovation in Brazil requires coordination among the State, the productive sector, and the scientific system, thereby creating conditions that allow technological solutions to move from the experimental stage to effective applications within renewable energy production chains.

The obstacles that arise during the energy transition further underscore the importance of technological innovation, which serves as a crucial support for ensuring the maintenance and structural resilience of power plants throughout this process. Thus, amid adversity, innovation emerges as a vital element for the effective and sustainable operation of facilities. Santos et al. (2024) argue that, in order to increase the renewability of the electric power matrix, it is necessary to rely on systems that are both safer and more efficient. In this context, the synergy among the technology employed, appropriate maintenance practices, and effective asset management is a determining factor for ensuring that renewable energy production chains remain competitive and stable. This connection is fundamental for advancing toward a sustainable and innovative energy future.

4 FINAL CONSIDERATIONS

Renewable energy production chains play a highly significant role in the energy transition. At the same time, they bring to light a series of structural challenges that directly affect areas such as operation, maintenance, and asset sustainability. Addressing these challenges is essential to ensure that renewable energy systems operate effectively and responsibly, taking into account current and future demands for energy production and consumption. The growing complexity of the technologies used in power plants, combined with the need to maintain high operational reliability, highlights the importance of integrated approaches. In this context, the combination of strategic maintenance and technological innovation emerges as a robust and effective response to the current demands and requirements of the energy sector. Accordingly, it is essential that these two areas operate in an integrated manner to ensure that energy operations are not only efficient but also safe and continuous.

Throughout the development of this research, all proposed objectives were fully achieved. The analysis conducted made it possible to examine the main structural challenges faced by renewable energy production chains, to evaluate models and practices of strategic maintenance applied to power plants, and to investigate the role of technological innovation in improving maintenance processes, as well as in strengthening efficiency, safety, and structural resilience within these enterprises.

A detailed analysis of the challenges related to the structural conditions of power plants reveals the presence of several bottlenecks that directly affect plant reliability. These bottlenecks can be classified as technical, operational, and systemic in nature. This situation largely results from factors such as infrastructure limitations, equipment and asset aging, and weaknesses in the integration among generation, transmission, and maintenance processes. These elements are essential for understanding the current condition of power plants and how such factors interact to affect overall performance. With regard to strategic maintenance, studies indicate that the implementation of preventive, predictive, and condition-based maintenance leads to a significant and positive reduction in operational costs. These approaches also improve system availability, enabling more efficient and uninterrupted operation. Another relevant benefit is the extension of asset service life, referring to the equipment and components used in operations. Consequently, the adoption of these strategies becomes indispensable for optimizing resources and improving organizational performance. In terms of technological innovation, the adoption of digital sensors, structural monitoring systems, data analysis tools, and automation technologies was found to substantially enhance structural safety and operational efficiency. Moreover, this technological convergence boosts the competitiveness of production chains, allowing companies to stand out in an increasingly challenging and dynamic market.

In a logical and integrated manner, the evidence indicates that the combination of a solid maintenance strategy and technological innovation constitutes an indispensable and structuring factor for addressing the various adversities faced by renewable energy production chains. This connection is vital for enabling companies to navigate challenges and remain competitive in a constantly evolving market. According to the study, maintenance management, when effectively integrated with new technologies and a comprehensive view of the production chain, represents a key factor in increasing operational reliability. Furthermore, efficient management enables more conscious use of resources and contributes to strengthening the sustainability of assets linked to electric energy generation. The relationship between maintenance management and the implementation of technological

solutions proves to be highly beneficial for the energy sector, resulting in stronger and more effective performance.

In conclusion, future research is recommended to examine the practical implementation of these methodologies across different regional contexts and types of power plants. This includes the need to analyze the interaction among public policies, existing regulatory models, and the various maintenance strategies adopted. Such analyses may provide a more comprehensive understanding of the relationships and dynamics that influence the effectiveness of these systems in diverse scenarios. Studies aimed at quantifying outcomes across multiple domains, including economic, operational, and environmental aspects, throughout the entire asset life cycle, may further enhance understanding of the impacts of planned maintenance and technological innovation on renewable energy supply chains. This approach has the potential to strengthen and complement the analyses developed in this study.

REFERENCES

- Araújo, A. P. L. (2025). Avaliação do sistema de gestão de manutenção em uma empresa do setor de energias renováveis [Monografia de graduação, Universidade Federal de Mato Grosso do Sul].
- Barbieri, J. C. (2024). Inovação e desenvolvimento sustentável: Da inovação convencional à ecoinovação sustentável. Blucher.
- Cardoso, J. V. M., Camilo, S. P. O., & Picolo, J. D. (2024). Inovações tecnológicas no setor elétrico: Revisão sistemática e metassíntese. *Revista de Gestão e Secretariado*, 15(7), Article e4028. <https://doi.org/10.7769/gesec.v15i7.4028>
- Cella, L. C., Cardoso, F. F., & Cardoso, L. R. de A. (2025). A cadeia produtiva do setor eólico brasileiro e a produção nacional de componentes. In *Anais do 14º Simpósio Brasileiro de Gestão e Economia da Construção*. ANTAC. <https://doi.org/10.46421/sibragec.v14i.6999>
- Farias, M. E. A. C. de, Martins, M. de F., & Cândido, G. A. (2021). Agenda 2030 e energias renováveis: Sinergias e desafios para alcance do desenvolvimento sustentável. *Research, Society and Development*, 10(17), Article e13101723867. <https://doi.org/10.33448/rsd-v10i17.23867>
- Gomes, R. L. R., et al. (2025). Predictive maintenance in renewable energy systems: Drones, multi-testing methods, and advanced techniques for efficiency and safety. *IOSR Journal of Business and Management*, 27(7, Ser. 7), 34–40. <https://doi.org/10.9790/487X-2707073440>
- Gonsales, S. C. (2020). Evolução da inovação em energias renováveis no Brasil: Uma análise com base em patentes e publicações científicas dos casos da energia eólica e solar [Dissertação de mestrado, Universidade Municipal de São Caetano do Sul].
- Guerra, A. de L. E. R., Stroparo, T. R., Costa, M. da, Castro Júnior, F. P. de, Lacerda Júnior, O. da S., Brasil, M. M., & Camba, M. (2024). Qualitative research and its foundations in

scientific investigation. *Revista de Gestão e Secretariado*, 15(7), Article e4019. <https://doi.org/10.7769/gesec.v15i7.4019>

Hille, E., Althammer, W., & Diederich, H. (2020). Environmental regulation and innovation in renewable energy technologies: Does the policy instrument matter? *Technological Forecasting and Social Change*, 153, Article 119921.

International Energy Agency. (2023). Renewable energy market update outlook for 2023 and 2024. https://iea.blob.core.windows.net/assets/63c14514-6833-4cd8-ac53-f9918c2e4cd9/RenewableEnergyMarketUpdate_June2023.pdf

Machado, C. O., et al. (2023). Manutenção prescritiva: A evolução da manutenção na Indústria 4.0. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 9(09), 4444–4458.

Marques, G. dos S. (2022). Inovação no setor elétrico brasileiro na era das tecnologias disruptivas e das fontes renováveis de energia: Diagnóstico e perspectivas para o Brasil em 2030 [Tese de doutorado, Universidade de Brasília].

Negri, F. (2018). Novos caminhos para a inovação do Brasil. Wilson Center.

Nunes, K. R., et al. (2025). Meio ambiente: Os impactos da cadeia produtiva sobre a natureza. *IOSR Journal of Business and Management*, 27(4, Ser. 3), 21–27. <https://doi.org/10.9790/487X-2704032127>

Paixão, J., & Abaide, A. (2025). Desafios contemporâneos do setor energético. *Revista Tópicos*, 3(28). <https://doi.org/10.5281/zenodo.18111861>

Pan, A. C., Rönna, M., Klas, J., & Danilewicz, Â. de M. F. (2024). Cadeia produtiva do setor solar fotovoltaico no Brasil: Tendências de inovação. In *Anais do Congresso Brasileiro de Energia Solar – CBENS*. <https://doi.org/10.59627/cbens.2024.2421>

Paula, F. P. de. (2021). Planejamento da manutenção da geração considerando mercado descentralizado e fontes renováveis [Dissertação de mestrado, Universidade Federal de São João Del-Rei].

Pereira, A. S., Shitsuka, D. M., Parreira, F. B., & Shitsuka, R. (2018). Scientific research methodology. Universidade Federal de Santa Maria.

Rodrigues, A. A., Assis, F. A., & Resende, L. C. (2020). Planejamento da manutenção de unidades geradoras via estratégia evolutiva. In *Anais do VIII Simpósio Brasileiro de Sistemas Elétricos*.

Sadeghian, O., Oshnoei, A., Nikkhah, S., & Mohammadi-Ivatloo, B. (2019). Multi-objective optimization of generation maintenance scheduling in restructured power systems based on global criterion method. *IET Smart Grid*, 2(2), 203–213.

Santos, A. N. S., et al. (2025). Transição energética e preservação: Integração de fontes renováveis, biodiversidade e economia verde em tempos de crise climática. *Observatorio de La Economía Latinoamericana*, 23, 1–37.

Santos, R. R. dos, Leite, C. B., Almeida, M., & Santos, E. P. C. dos. (2024). Desafios da transição energética: A renovabilidade da matriz elétrica em contexto global e suas implicações. *Revista Brasileira de Avaliação*, 13(2, spe), Article e131824. <https://doi.org/10.4322/rbaval202412018>

United Nations Children's Fund. Office of Innovation. (2023). Renewable energy: Emerging technologies and innovations (Insight Report No. 2). CC-BY 4.0.

- Viana, H. R. G. (2020). Manual de gestão da manutenção: Volume 1 (1ª ed.). Engeteles Editora.
- Yin, R. K. (2016). Pesquisa qualitativa do início ao fim. Grupo A.
<https://app.minhabiblioteca.com.br/#/books/9788584290833/>

MANAGEMENT OF SALMONELLOSIS IN REPTILES: THERAPEUTIC APPROACHES

MANEJO DA SALMONELOSE EM RÉPTEIS: ABORDAGENS TERAPÊUTICAS

MANEJO DE LA SALMONELOSIS EN REPTILES: ENFOQUES TERAPÉUTICOS



<https://doi.org/10.56238/sevened2026.008-141>

Átila Bonfim Ferreira Cavalcante¹, Erica Nunes dos Santos², Isadora Soares Pissanelli³, Lucas de Oliveira Rodrigues⁴, Luiza Vaucher Mendes Pereira⁵, Eduarda de Matos Lopes⁶, Davi Victal Pacheco⁷, Camila Soares Ramos⁸

ABSTRACT

This study is characterized as a narrative literature review aimed at compiling and discussing the most recent scientific evidence on the management and therapeutic approaches to salmonellosis in reptiles. *Salmonella* spp. is the second most common zoonotic agent, and reptiles are asymptomatic natural reservoirs, representing a public health challenge (Reptile-Associated Salmonellosis – RAS). Clinical manifestations in reptiles are nonspecific and variable. Management is hindered by the growing antimicrobial multidrug resistance observed (especially to sulfonamides and aminoglycosides), although resistance to last-resort drugs such as colistin remains low. The therapeutic approach should be cautious, individualized, and, whenever possible, guided by culture and antimicrobial susceptibility testing, focusing on clinical control and mitigation of zoonotic risk rather than complete eradication of the agent, which is considered unlikely. Non-pharmacological strategies, such as strict hygiene, owner education, and quarantine, are crucial. The findings reinforce the importance of a “One Health” approach and the role of reptiles as environmental sentinels in the circulation of strains with zoonotic potential.

Keywords: Salmonellosis. Reptiles. Zoonosis. One Health.

RESUMO

Este estudo configura-se como uma revisão bibliográfica narrativa com o objetivo de compilar e discutir as evidências científicas mais recentes sobre o manejo e as abordagens terapêuticas da salmonelose em répteis. A *Salmonella* spp. é o segundo agente zoonótico mais comum, e os répteis são reservatórios naturais assintomáticos, representando um desafio para a saúde pública (Salmonelose Associada a Répteis - RAS). As manifestações clínicas nos répteis são inespecíficas e variáveis. O manejo é dificultado pela crescente multirresistência antimicrobiana observada (especialmente a sulfonamidas e

¹ Graduated in Veterinary Medicine. Centro Universitário Católica do Tocantins (UNICATÓLICA).

² Medical Student. Universidade Presidente Antônio Carlos (UNIPAC).

³ Veterinary Medicine Student. Universidade de Araraquara (UNIARA).

⁴ Veterinary Medicine Student. Centro Universitário Sociesc (UNISOCIESC).

⁵ Graduated in Veterinary Medicine. Universidade do Estado de Santa Catarina (UDESC).

⁶ Veterinary Medicine Student. Universidade Federal de Goiás (UFG).

⁷ Graduated in Veterinary Medicine. Universidade Federal de Viçosa (UFV).

⁸ Graduated in Veterinary Medicine. Universidade Metodista de São Paulo (UMESP).

aminoglicosídeos), embora a resistência a fármacos de última instância, como a colistina, ainda seja baixa. A abordagem terapêutica deve ser cautelosa, individualizada e, sempre que possível, guiada por cultura e antibiograma, focando no controle clínico e na mitigação do risco zoonótico, em vez da erradicação completa do agente, que é considerada improvável. Estratégias não farmacológicas, como higiene rigorosa, educação dos tutores e quarentena, são cruciais. Os achados reforçam a importância de uma abordagem "Saúde Única" (One Health) e do papel dos répteis como sentinelas ambientais na circulação de cepas com potencial zoonótico.

Palavras-chave: Salmonelose. Répteis. Zoonose. Saúde Única.

RESUMEN

Este estudio se configura como una revisión bibliográfica narrativa con el objetivo de compilar y discutir las evidencias científicas más recientes sobre el manejo y los enfoques terapéuticos de la salmonelosis en reptiles. *Salmonella* spp. es el segundo agente zoonótico más común, y los reptiles son reservorios naturales asintomáticos, lo que representa un desafío para la salud pública (Salmonelosis Asociada a Reptiles – RAS). Las manifestaciones clínicas en los reptiles son inespecíficas y variables. El manejo se ve dificultado por la creciente multirresistencia antimicrobiana observada (especialmente a sulfonamidas y aminoglucósidos), aunque la resistencia a fármacos de última línea, como la colistina, aún es baja. El enfoque terapéutico debe ser cauteloso, individualizado y, siempre que sea posible, guiado por cultivo y antibiograma, centrándose en el control clínico y en la mitigación del riesgo zoonótico, más que en la erradicación completa del agente, considerada improbable. Las estrategias no farmacológicas, como la higiene rigurosa, la educación de los tutores y la cuarentena, son cruciales. Los hallazgos refuerzan la importancia de un enfoque de “Una Salud” (One Health) y del papel de los reptiles como centinelas ambientales en la circulación de cepas con potencial zoonótico.

Palabras clave: Salmonelosis. Reptiles. Zoonosis. Una Salud.

1 INTRODUCTION

Salmonella spp. It is considered the second most common zoonotic agent in human infections, leading to more than 90 million confirmed cases per year. Considering that, according to the World Health Organization, about 60% of emerging diseases are zoonoses, the relevance of salmonellosis cannot be overlooked. The importance in public health and the only one worldwide, and the non-existence of vaccines, points to the need to maintain the production of studies on the epidemiology of the disease and its vectors (Cota et al., 2021; Pawlek et al., 2023).

The most commonly reported transmission of *Salmonella spp.* It is through contaminated food, however, contact with infected animals is another way to be discussed. Contact with contaminated pets can lead to the disease, and this currently includes more and more reptiles (Cota et al., 2021).

Salmonellosis in reptiles represents a unique challenge for veterinary medicine and public health, as these animals are natural reservoirs of a wide diversity of *Salmonella enterica* serovars (Mlangeni et al., 2024). In most cases, the presence of the bacterium does not result in clinical signs in the host, establishing an asymptomatic carrier state that facilitates environmental spread and the risk of zoonotic transmission (Pawlak et al., 2024). Reptile-Associated Salmonellosis (RAS) has gained prominence due to the increased popularity of these animals as pets, resulting in often severe human outbreaks, especially in vulnerable populations such as children and immunosuppressed people (Paphitis et al., 2023; Bruning et al., 2023).

It is essential to distinguish intestinal colonization by *Salmonella spp.*, which is often asymptomatic, from the occurrence of systemic clinical infection. Most reptiles act as carriers, with intermittent elimination of the agent, while progression to clinical disease depends on individual and environmental factors. This distinction is essential for therapeutic decision-making, as not all colonized animals benefit from pharmacological intervention (Pees et al., 2023; Paphitis et al., 2023).

The transmission of *Salmonella enterica* from pet reptiles to their owners is related to the level of contact with owners, hygiene measures adopted, the animal's environment, and issues not yet understood regarding the reptiles' immune system and the factors that influence the transmission of the disease (Pees et al., 2023). Hygiene conditions, avoiding overcrowding, controlling means of contamination, avoiding stress and management errors, and not encouraging the consumption of meat from contaminated reptiles, should be measures to be implemented to reduce the zoonotic risk of salmonellosis in reptiles kept in captivity (Pees et al., 2023; Pawlak et al., 2024).

The clinical manifestations in reptiles, as in most diseases, are nonspecific and variable, and may involve pneumonia, enterocolitis, abscesses, septicemia, osteomyelitis, hepatitis, among others. The most frequent clinical signs are lethargy, anorexia, wasting, paresis, dyspnea, and sudden death (Pees et al., 2023). In the pathology and histology of cases associated with *Salmonella*, necrotizing inflammation of various tissues is observed in most species. Granulomatous necrotizing inflammation is also reported in snakes and sea turtles (Pees et al., 2023)

One of the most reported species in studies associated with RAS was the bearded dragon (*Pogona vitticeps*) (Pees et al., 2023; Paphitis et al., 2023), however, this was also the most popular reptile species in a study analyzing the reptile market as pets (Valdez, 2021).

Therapeutic and preventive management is hampered by the complexity of interactions between the pathogen and the host, as well as the growing concern about antimicrobial resistance (AMR). Recent studies indicate that reptile isolates, both wild and captive, have multidrug-resistant antibiotic profiles of clinical importance, which limits treatment options and reinforces the need for biosecurity-based control strategies and genomic monitoring (Bertelloni et al., 2022; Małaszczuk et al., 2025). In addition, the genetic and phenotypic heterogeneity of *Salmonella enterica* in reptiles is associated with different virulence and antimicrobial resistance profiles, which limits therapeutic standardization and reinforces the need for individualized decisions in clinical and sanitary management. (Mlangeni et al., 2024; Bertelloni et al., 2022). Thus, understanding the prevalence, virulence factors, and drug sensitivity is essential for the development of effective management protocols that mitigate risks to animal and human health.

According to the study by (Pawlak et al., 2024) points out that one of the most relevant vertebrates from an epidemiological point of view regarding the spread of *Salmonella spp.* These are reptiles, in an asymptomatic character, that is, asymptomatic carriers, salmonellosis, when associated with reptiles, occurs in greater predominance in children under 5 years of age, the elderly and immunosuppressed patients. When it enters the gastrointestinal tract, it can cause clinical signs of vomiting and diarrhea in humans, according to reports described by people in the United States and other countries.

2 METHODOLOGY

This study is a narrative literature review, structured with the objective of compiling and discussing the most recent scientific evidence on the management and therapeutic approaches of salmonellosis in reptiles. The research was conducted by consulting the PubMed database, using the descriptors "Salmonellosis", "Reptiles" and "Treatment",

articulated by the Boolean operator AND, according to the standardization of the Medical Subject Headings (MeSH). The selection included articles published from 2021 to 2025, available in full text in Portuguese or English, with a direct focus on the epidemiology and control of *Salmonella* in reptile populations. Studies that did not have a direct link with the theme, duplicate publications, and reviews with low academic rigor were excluded. The screening process involved careful analysis of titles and abstracts, followed by exhaustive evaluation of the selected manuscripts to ensure the reliability of the data. The information was synthesized and organized in a descriptive and integrative way.

3 RESULTS AND DISCUSSION

The prevalence of *Salmonella spp.* In reptiles, it varies geographically and between species, but detection rates remain high in several scenarios. In wild reptile populations in South Africa, the prevalence reached 57.1%, with a diversity of serovars that includes *S. Typhimurium* and *S. Muenchen* (Mlangeni et al., 2024). In contexts of wildlife translocation in New Zealand, screening during quarantine revealed that 11.8% of animals were carriers, highlighting that feedlot management and stress can influence bacterial excretion (Baling & Mitchell, 2021).

Environmental and physiological factors have an extreme impact on the evolution of bacterial and viral contamination. Stress, improper handling, thermal variations, capture handling are some elements that favor immunosuppression and increase bacterial susceptibility and elimination by animals (Baling & Mitchell, 2021). In addition, the confirmation of the presence of salmonella in feces and habitat surfaces demonstrates that the environment can act as a secondary reservoir and can be a direct factor for the spread of zoonotic pathologies to humans (Bruning, et al., 2023). Thus, systematic disinfection and maintenance of hygiene of quarantines, breeding sites and habitats, combined with good animal welfare practices are effective measures for the control of salmonellosis (Paphitis et al., 2023).

From an epidemiological point of view, the colonization of *Salmonella spp.* in reptiles, it is characterized by high complexity, since the same individual can harbor multiple serovars simultaneously (Pulford et al., 2019). This intra-host coexistence, described both in free-living reptiles and in animals kept in captivity, expands the circulating genetic diversity and makes it difficult to interpret studies based on single isolates, directly impacting health surveillance and zoonotic risk assessment (Mlangeni et al., 2024; Małaszczuk et al., 2025).

Regarding the therapeutic approach, antimicrobial resistance is the main limiting factor. Isolates from snakes in Poland have demonstrated significant resistance to

sulfonamides and aminoglycosides, as well as have a high survivability in human serum, which underlines the invasive potential of these microorganisms (Małaszczuk et al., 2025). Although resistance to drugs of last resort, such as colistin, is still considered low in animal populations (Bertelloni et al., 2022), the presence of multidrug resistance (MDR) genes in free-living isolates suggests increasing environmental contamination that impacts clinical management (Mlangeni et al., 2024).

Considering the variability of the resistance profiles observed in *Salmonella* spp. isolates from reptiles, the performance of antimicrobial susceptibility tests (antibiogram) is a relevant tool to support the therapeutic choice, especially in clinical cases that require pharmacological intervention. Culture- and antibiogram-guided therapy is associated with reducing treatment failures and limiting the spread of multidrug-resistant strains (Mlangeni et al., 2024; Bertelloni et al., 2022).

The characterization of virulence factors, such as the *invA* and *mgtC* genes, confirms that reptile isolates have the genetic arsenal necessary to trigger pathologies in both the host and humans (Pawlak et al., 2024). For this reason, genomic surveillance through Whole Genome Sequencing (WGS) has become an indispensable tool in the management of outbreaks, allowing accurate tracing of the source of infection, as evidenced in cases of human urinary tract infection associated with pet snakes and multi-state outbreaks linked to bearded dragons (*Pogona vitticeps*) (Bruning et al., 2023; Paphitis et al., 2023).

Additionally, recent studies indicate that strains of *Salmonella* spp. Reptile isolates may have a high capacity to evade the human immune system, regardless of the classic antimicrobial resistance profile. Structural modulation of lipopolysaccharide (LPS) and expression of genes associated with virulence and survival in human serum suggest that the zoonotic potential of these strains is related not only to antibiotic resistance but also to adaptive mechanisms that favor systemic spread after transmission (Pawlak et al., 2024; Małaszczuk et al., 2025). These findings reinforce the need for an integrated approach in the assessment of the health risk associated with reptiles, in line with the principles of the One Health strategy.

Another relevant aspect evidenced in recent studies refers to the role of reptiles as environmental sentinels for the circulation of *Salmonella* spp. in natural and anthropized ecosystems. The detection of rare and genetically diverse serovars in free-living populations suggests that these animals reflect the environmental dynamics of the pathogen, including the influence of human activities such as water contamination and anthropogenic pressure on natural habitats (Mlangeni et al., 2024; Małaszczuk et al., 2025). Thus, the systematic inclusion of reptiles in epidemiological surveillance programs can contribute not only to the

prevention of salmonellosis associated with exotic animals, but also to a broader understanding of the environmental dispersion of strains with zoonotic potential, strengthening preventive strategies from the perspective of one health.

In addition to genetic determinants and virulence, functional studies indicate that strains of *Salmonella* spp. isolates from reptiles have a high capacity to evade the human complement system, independent of the classic antimicrobial resistance profile (Krzyżewska-Dudek et al., 2022). This immunological fitness increases the risk of extraintestinal infections in humans and reinforces that the evaluation of zoonotic potential must consider not only the presence of the pathogen, but also its ability to survive and systemic dissemination after transmission (Worley et al., 2023).

In contrast to free-living populations, specimens of reptiles kept in captivity exhibit significantly higher rates of colonization by *Salmonella* spp. Although these animals act predominantly as asymptomatic carriers, the elimination of the pathogen occurs intermittently via the gastrointestinal tract, representing a challenge to sanitary control (Paphitis et al., 2022). The dynamics of fecal bacterial shedding is severely influenced by biological and environmental stressors, including overhandling, adverse transport conditions, and the presence of comorbidities, factors that compromise the animal's immune homeostasis and facilitate the proliferation and dispersion of the pathogen in the environment (Paphitis et al., 2022).

The mitigation of the risks of salmonellosis associated with reptiles depends intrinsically on the dissemination of technical-scientific information at the time of animal acquisition. Providing clear guidelines on the biological risks of reptiles allows owners to make informed decisions regarding the choice of species and the indispensable sanitary precautions (Paphitis et al., 2022). The information should detail household biosecurity protocols and identify the most vulnerable population profiles, aiming to minimize the zoonotic transmission chain (Bruning et al., 2023).

Non-pharmacological management strategies, such as establishing quarantine periods of at least 14 to 21 days for translocated animals, are recommended to reduce the risk of introducing new serovars into naïve populations, although prolonged quarantine should be balanced against the risk of decline in body condition of the animals (Baling & Mitchell, 2021). Clinical management, therefore, should prioritize strict hygiene and education of tutors, reserving the use of antimicrobials for cases of proven systemic disease, in order to avoid worsening bacterial resistance.

In view of the ecological complexity and persistence capacity of *Salmonella* spp. in reptiles, therapeutic management should be oriented towards clinical control and mitigation

of zoonotic risk, and not towards complete bacterial eradication, which is considered unlikely in most cases, due to the wide environmental adaptation and genetic diversity of reptile-associated isolates (Pawlak et al., 2024; Małaszczuk et al., 2025).

It is worth noting that the detection of *Salmonella* spp. in reptiles should be interpreted with caution, since these animals often act as asymptomatic carriers, with variable bacterial elimination, which may result in underdiagnosis when the evaluation is based on single sampling (Bruning et al., 2023; Bertelloni et al., 2022). These findings reinforce the need for an integrated approach to sanitary management, especially in contexts of quarantine, translocation, and captive maintenance.

According to Bertelloni et al (2022) it is an antimicrobial that has aroused concerns due to the resistance of some pathogens, as found to be more frequent resistant genes in the E.coli strain, as well as in Salmonella genes.

4 CONCLUSION

The results of this study confirm that salmonellosis is a frequent and complex infection in reptiles, due to the possibility of multiple serovars in the same host. The zoonotic relevance is evident, considering the increase in contact between humans and reptiles and the already reported cases of transmission between species. Clinical management should be cautious, especially in view of the antimicrobial resistance to sulfonamides and aminoglycosides observed in certain populations, which limits conventional therapeutic protocols.

Although resistance to drugs of last resort is still considered low, the presence of multidrug resistance genes in free-living populations suggests a warning in clinical management. Non-pharmacological strategies, such as isolation of translocated animals, and strict hygiene measures for humans in contact are key. Finally, the detection of *Salmonella* spp. in reptiles should be interpreted with caution, since these animals can act as asymptomatic carriers.

Additionally, the findings reinforce that the therapeutic approach to salmonellosis in reptiles should be individualized and, whenever possible, guided by bacterial culture and antimicrobial susceptibility testing, in order to reduce therapeutic failures and limit the spread of multidrug-resistant strains. Considering the wide genetic diversity, the presence of rare serovars, and the environmental persistence capacity of *Salmonella* spp., management should prioritize clinical control and zoonotic risk mitigation, to the detriment of the attempt to completely eradicate the agent. Thus, the integration between laboratory surveillance, biosecurity, and health education is essential to cope with reptile-associated salmonellosis from the perspective of one health.

REFERENCES

- Baling, M., & Mitchell, C. (2021). Prevalence of *Salmonella* spp. in translocated wild reptiles and effect of duration of quarantine on their body condition. *New Zealand Veterinary Journal*, 69(3), 174–179.
- Bertelloni, F., et al. (2022). Low level of colistin resistance and *mcr* genes presence in *Salmonella* spp.: Evaluation of isolates collected between 2000 and 2020 from animals and environment. *Antibiotics*, 11(272), 1–13.
- Bruning, A. H. L., et al. (2023). Reptile-associated *Salmonella* urinary tract infection: A case report. *Diagnostic Microbiology and Infectious Disease*, 105, Article 115889.
- Cota, J. B., Carvalho, A. C., Dias, I., Reisinho, A., Bernardo, F., & Oliveira, M. (2021). *Salmonella* spp. in pet reptiles in Portugal: Prevalence and chlorhexidine gluconate antimicrobial efficacy. *Antibiotics*, 10(3), Article 324. <https://doi.org/10.3390/antibiotics10030324>
- Małaszczuk, M., et al. (2025). From bacterial diversity to zoonotic risk: Characterization of snake-associated *Salmonella* isolated in Poland with a focus on rare O-Ag of LPS, antimicrobial resistance and survival in human serum. *International Journal of Molecular Sciences*, 26, Article 12018.
- Mlangeni, L. N., et al. (2024). Occurrence, antimicrobial resistance, and virulence profiles of *Salmonella* serovars isolated from wild reptiles in South Africa. *International Journal of Microbiology*, 2024, 1–9.
- Paphitis, K., et al. (2023). *Salmonella* Vitkin outbreak associated with bearded dragons, Canada and United States, 2021–2022. *Emerging Infectious Diseases*, 29(3), 623–626.
- Pawlak, A., et al. (2024). Virulence factors of *Salmonella* spp. isolated from free-living grass snakes *Natrix natrix*. *Environmental Microbiology Reports*, 16(4), Article e13287.
- Pees, M., Brockmann, M., Steiner, N., & Marschang, R. E. (2023). *Salmonella* in reptiles: A review of occurrence, interactions, shedding and risk factors for human infections. *Frontiers in Cell and Developmental Biology*, 11, Article 1251036. <https://doi.org/10.3389/fcell.2023.1251036>
- Pulford, C. V., et al. (2019). The diversity, evolution and ecology of *Salmonella* in venomous snakes. *PLoS Neglected Tropical Diseases*, 13(6), 1–21. <https://doi.org/10.1371/journal.pntd.0007169>
- Krzyżewska-Dudek, E., et al. (2022). Lipopolysaccharides and outer membrane proteins as main structures involved in complement evasion strategies of non-typhoidal *Salmonella* strains. *Molecular Immunology*, 150, 67–77. <https://doi.org/10.1016/j.molimm.2022.08.009>
- Valdez, J. W. (2021). Using Google Trends to determine current, past, and future trends in the reptile pet trade. *Animals*, 11(3), Article 676. <https://doi.org/10.3390/ani11030676>
- Worley, M. J., et al. (2023). *Salmonella* bloodstream infections. *Tropical Medicine and Infectious Disease*, 8(11), Article 487. <https://doi.org/10.3390/tropicalmed8110487>

CHALLENGES AND POTENTIAL OF ENVIRONMENTAL EDUCATION IN THE PMVA: A SOCIAL NETWORK APPROACH

DESAFIOS E POTENCIALIDADES DA EDUCAÇÃO AMBIENTAL NO PMVA: UMA ABORDAGEM POR REDES SOCIAIS

DESAFÍOS Y POTENCIALIDADES DE LA EDUCACIÓN AMBIENTAL EN EL PMVA: UN ENFOQUE DE REDES SOCIALES



<https://doi.org/10.56238/sevened2026.008-142>

Thábata Biazuz Veronese¹, Mario Mollo Neto²

ABSTRACT

Population growth and the advancement of civilization intensify pressure on natural resources, demanding public policies that ensure survival conditions grounded in intergenerational solidarity. In this scenario, environmental education emerges as an essential instrument for the implementation of policies aimed at sustainable development. The Green-Blue Municipality Program (PMVA) acts as a mediator between the municipalities of São Paulo and the State Secretariat for the Environment, promoting actions aimed at improving the quality of life and local and regional sustainability. This proposal analyzes the exchange of information in environmental education through Social Network Analysis (SNA), using the Netdraw® and Ucinet® software to map interactions between municipalities participating in the PMVA. The methodology adopted, of an exploratory and descriptive nature, considers indices and benefits associated with the program, relating them to the UN Sustainable Development Goals (SDGs). The results indicate that the application of SNA in the environmental education sector makes it possible to understand information flows and verify compliance with the program's criteria. Furthermore, it allows the creation of structural indicators capable of assisting municipalities in increasing their scores, as well as strengthening their capacity to plan, execute, and evaluate educational actions in a continuous and integrated manner, involving schools, the community, and public management. The graphical analysis of the networks reveals a significant disparity between the best-evaluated municipalities and those with lower performance, highlighting challenges in the equity of the implementation of environmental policies. Although the PMVA (Green-Blue Municipality Program) represents a relevant public policy for fostering municipal participation in favor of sustainable development, the results demonstrate that there are still necessary advances to fully achieve the proposed objectives.

Keywords: Social Network Analysis. SNA. Information. Environmental Education. Green-Blue Municipality Program.

¹ Doctoral student in Agribusiness and Development. Universidade Estadual Paulista (UNESP). E-mail: thabata.biazuz-veronese@unesp.br

² Dr. in Agricultural Engineering. Universidade Estadual de Campinas; Universidade Estadual Paulista (UNESP). E-mail: mario.mollo@unesp.br

RESUMO

O crescimento populacional e o avanço da civilização intensificam a pressão sobre os recursos naturais, exigindo políticas públicas que assegurem condições de sobrevivência fundamentadas na solidariedade intergeracional. Nesse cenário, a educação ambiental emerge como instrumento essencial para a implementação de políticas voltadas ao desenvolvimento sustentável. O Programa Município Verde-Azul (PMVA) configura-se como mediador entre os municípios paulistas e a Secretaria de Estado do Meio Ambiente, promovendo ações que visam à melhoria da qualidade de vida e à sustentabilidade local e regional. A presente proposta analisa a troca de informações em educação ambiental por meio da Análise de Redes Sociais (ARS), utilizando os softwares Netdraw® e Ucinet® para mapear interações entre municípios participantes do PMVA. A metodologia adotada, de caráter exploratório e descritivo, considera índices e benefícios associados ao programa, relacionando-os aos Objetivos de Desenvolvimento Sustentável (ODS) da ONU. Os resultados indicam que a aplicação da ARS no setor de educação ambiental possibilita compreender fluxos de informação e verificar o atendimento aos critérios do programa. Além disso, permite a criação de indicadores estruturais capazes de auxiliar municípios na ampliação de suas pontuações, bem como no fortalecimento da capacidade de planejar, executar e avaliar ações educativas de forma contínua e integrada, envolvendo escolas, comunidade e gestão pública. A análise gráfica das redes evidencia significativa disparidade entre municípios mais bem avaliados e aqueles com desempenho inferior, revelando desafios na equidade da implementação das políticas ambientais. Embora o PMVA represente uma política pública relevante para fomentar a participação municipal em prol do desenvolvimento sustentável, os resultados demonstram que ainda há avanços necessários para alcançar plenamente os objetivos propostos.

Palavras-chave: Análise de Redes Sociais. ARS. Informações. Educação Ambiental. Programa Município Verde-Azul.

RESUMEN

El crecimiento poblacional y el avance de la civilización intensifican la presión sobre los recursos naturales, lo que exige políticas públicas que garanticen condiciones de supervivencia basadas en la solidaridad intergeneracional. En este escenario, la educación ambiental emerge como un instrumento esencial para la implementación de políticas orientadas al desarrollo sostenible. El Programa Municipio Verde-Azul (PMVA) actúa como mediador entre los municipios de São Paulo y la Secretaría de Estado de Medio Ambiente, promoviendo acciones destinadas a mejorar la calidad de vida y la sostenibilidad local y regional. Esta propuesta analiza el intercambio de información en educación ambiental mediante el Análisis de Redes Sociales (ARS), utilizando los software Netdraw® y Ucinet® para mapear las interacciones entre los municipios participantes en el PMVA. La metodología adoptada, de carácter exploratorio y descriptivo, considera los índices y beneficios asociados al programa, relacionándolos con los Objetivos de Desarrollo Sostenible (ODS) de la ONU. Los resultados indican que la aplicación del ARS en el sector de la educación ambiental permite comprender los flujos de información y verificar el cumplimiento de los criterios del programa. Además, permite la creación de indicadores estructurales capaces de ayudar a los municipios a mejorar sus puntuaciones, así como a fortalecer su capacidad para planificar, ejecutar y evaluar acciones educativas de forma continua e integrada, involucrando a las escuelas, la comunidad y la gestión pública. El análisis gráfico de las redes revela una disparidad significativa entre los municipios mejor evaluados y aquellos con menor desempeño, lo que pone de relieve los desafíos en la equidad de la implementación de las políticas ambientales. Si bien el PMVA (Programa Municipio Verde-Azul) representa una política pública relevante para fomentar la participación municipal en favor del desarrollo sostenible, los resultados demuestran que aún se requieren avances para alcanzar plenamente los objetivos propuestos.

Palabras clave: Análisis de Redes Sociales. SNA. Información. Educación Ambiental. Programa Municipio Verde-Azul.

1 INTRODUCTION

The issue of sustainable use of the environment demands urgent attention because it is a necessity for the preservation of life, because "(...) the guarantee of survival, current and future, is expressed by sustainability – which is desired and is the objective to be achieved" (SILVA, 2012, p. 36).

In the face of the advance of civilization and the increase in population, the lifestyle that uses natural resources to satisfy people's needs and interests requires the analysis of public policies so that present and future populations can have conditions for survival, based on the principle of intergenerational solidarity. In this context, for the solution of problems related to the socio-environmental scenario, environmental education is essential as an instrument to promote the implementation of public policies that promote sustainable development (SOUSA et al., 2024).

Considering the context of globalization, it seems quite tempting to establish a global-local binomial and cross the intermediate scales encompassing national states. However, political relations are established on different scales. In addition, still in relation to global scales, the results are punctual, such as rains, tsunamis and hurricanes as a result of global warming (ORSI, 2016 apud UN, 2023).

The notion of environment comprises a special way of seeing, living, and interacting in the world. More than a scientific concept, the environment is a challenge for all researchers, managers and social participants. Its analysis requires interaction and flows that go beyond the reductionism of positivist science (BERTRAND, 2007, p. 302).

"For Smith, Ricardo, Malthus and Mill, "the idea that economies could grow indefinitely was unthinkable because the economy was tied to a finite base of resources". (MURPHY JR, MURPHY, LOVE, LEHEW, MCCALL, 2021, p. 5. Authors' translation)³.

The interrelationship between natural and anthropic spaces must be considered at the local, state, national and global levels, considering the ecological awareness of the universality of the environment on Planet Earth. The concern and global demand for sustainable development require decisions and actions to be developed by the Government, private initiative and civil society, in view of the recognition, on the one hand, of everyone's right to an ecologically balanced environment, and on the other, of everyone's duty on environmental responsibility.

In Brazil, environmental legislation is based on major premises guaranteed in the Federal Constitution of 1988 and complemented by infra-constitutional laws, in addition to

³ "(...) the idea that economies could grow indefinitely was unthinkable because the economy was tied to a finite resource base (Smith, Ricardo, Malthus and Mill, apud (MURPHY JR, MURPHY, LOVE, LEHEW, MCCALL, 2021, p. 5.)

ordinances, resolutions and other regulations in accordance with federal, state and municipal competence.

The Federal Constitution of 1988 establishes, in its article 225, that a balanced environment is a right of all and a collective patrimony, indispensable to the quality of life. This provision imposes on both the State and society the responsibility to ensure its protection and conservation, in order to ensure that present and future generations enjoy this common good (BRASIL, 1988).

The Federal Constitution of 1988 elevated the environment to a fundamental right by providing in its article 225 as a duty and a right of all. On the other hand, it divides the competences for local, regional and national tasks of action in the policy capable of solving environmental problems. In this sense, the phrase defended by environmentalists that it is necessary to "Think globally and act locally" stands out. The effect of the slogan summarizes the importance of defending articulation at different territorial scales, such as municipalities, states and the nation, in political discussion. (ORSI, 2016).

Thus, the Green-Blue Municipality Program (PMVA) emerges as an interlocutor between the Municipality and the State Secretariat for the Environment (SEMA, 2022) to achieve the benefits of sustainable development and the quality of life of the population directly and indirectly achieved.

The PMVA program presents some elements as parameters for measuring the local environmental agenda, involving the themes of Sustainable Municipality, Structure and Environmental Education, Environmental Council, Biodiversity, Water Management, Air Quality, Land Use, Urban Forestation, Treated Sewage and Solid Waste (SEMA, 2022).

The analysis of the adoption of the program and its effects goes through the application of environmental education. Even the social and scientific activities related to the production of senses and meanings would be obedient and conditioned to rationalized and market parameters, and follow the logics of economic and industrial production" (REIGOTA, 507).

The PMVA coordinates efforts between the state and municipal spheres, assisting in the construction of balanced environments, managing negative impacts on everyday spaces. The database generated by the PMVA makes it possible to monitor the environmental performance of the Municipalities in the State of São Paulo and verify the desired development for the country and the quality of life of its people (DANTAS, 2023), in accordance with sustainable development.

Thus, the adhesion of the Municipalities to the Green-Blue Program of the State of São Paulo can help in the implementation of the Verde-Azul Program of the State of São Paulo.

To measure the results, the State of São Paulo developed in 2007, through the Secretariat of the Environment (SMA), the Green-Blue Municipality Program (PMVA), through which it seeks to encourage the Municipalities of São Paulo to adopt a minimum agenda on ten environmental themes, called environmental directives, established as follows: (1) treated sewage (ET); (2) solid waste (RS); (3) biodiversity (Bio); (4) urban afforestation (AU); (5) environmental education (EE); (6) sustainable city (CS); (7) water management (GA); (8) air quality (AQ); (9) environmental structure (EM); and (10) environmental council (CA), assigning scores from 10 to 100 points per item (SMA, 2016).

It is, therefore, a public policy that evaluates the performance of the Municipalities based on the evaluations made through the results obtained in each attribute classified by the Environmental Assessment Index (IAA), whose indicators present a final score that awards the best classified municipalities a certification of the "Green-Blue" seal (SEMA) (SÃO PAULO, 2021).

Those who obtain scores above 80 points will have access to a benefit consisting of a budget amount resulting from the release of resources from the State Pollution Control Fund (FECOP). Thus, the municipality obtains funds to continue investing in projects and public policies for the sustainability of the city (BRASIL, 2018).

In this connection, "the change in the agenda depends on the combination of problems, solutions and political conditions. The existence of a problem does not determine the adoption of a specific solution and does not in itself create a favorable political environment for change" (KINGTON apud CAPELLA, 2006).

A study by ESCOBAR and SIQUETE (2021), researchers at the University of São Paulo (USP) shows that most municipalities in the State of São Paulo are not prepared for climate change.

The survey shows that most of the municipalities in São Paulo have a low capacity to adapt to climate change: approximately two-thirds (66%) are in this condition. Only ten municipalities, corresponding to about 1.5% of the total, achieved a score close to the maximum index, an indicator of greater preparedness to face the impacts resulting from extreme weather events.

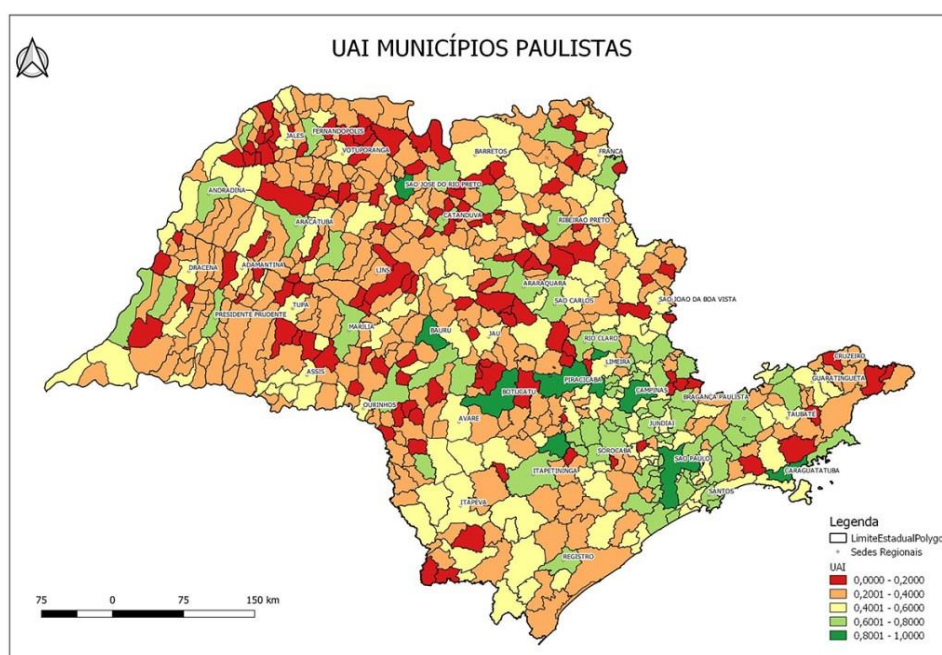
In this context, Pedro Jacobi, coordinator of the thematic project Environmental Governance of the São Paulo Macrometropolis in the face of Climate Change, developed with the support of the São Paulo Research Foundation (Fapesp), points out that the national reality requires greater structuring of local administrations. According to the author, the recurrence of extreme events requires not only investments in technology and infrastructure, but also the strengthening of intersectoral and transversal practices. Such practices should

value society's role in decision-making processes and consider social inequalities and the vulnerability of urban populations (JACOBI, 2021).

Thus, the PMVA emerged with the intention of making efforts between the state and municipal spheres in order to strengthen the environmental agenda according to the competencies and abilities of each entity, given its ability to identify particular problems and needs according to each location. The map in Figure 1 illustrates the result of the research that adds other indices in addition to those ten of the PMVA, as it has 26 indicators related to the environmental theme, highlighting the Urban Adaptation Index (UAI) that was applied to the 645 municipalities of the State of São Paulo, evaluating five central dimensions of public policies: housing, urban mobility, sustainable agriculture, environmental management and responsiveness to climatic events. The scale of the indicator ranges from 0 to 1, with values closer to 1 — graphically represented in dark green — reflecting a higher level of preparedness and resilience of municipalities in the face of socio-environmental challenges.

Figure 1

Map showing the Urban Adaptation Index (UAI) of the 645 municipalities of the State of São Paulo



Source: Neder, E. et al., 2021. "Urban adaptation index: assessing cities' readiness to deal with climate change" (Source: ESCOBAR and SIQUETE, 2021).

The Green-Blue Municipality Program (PMVA) establishes ten guidelines considered fundamental to guide environmental management in the municipalities of São Paulo. These guidelines, defined and updated annually by the State Secretariat for the Environment, are incorporated by the municipalities through the signing of a term of adhesion by the mayors.

In this document, each municipal administration designates a person in charge and an alternate, in charge of preparing an action plan that details the initiatives planned to meet the environmental guidelines. Performance evaluation takes place at the end of each annual cycle, through the Environmental Assessment Index (IAA), which assigns up to 100 points to the actions implemented. To obtain certification, the municipality must achieve at least 80 points, considering the deduction of any environmental liabilities. Municipal entities that reach this level receive not only official recognition, but also priority in accessing financial resources from state programs, such as the State Fund for Water Resources (FEHIDRO) and the State Fund for Pollution Prevention and Control (FECOP) (SECRETARIA DO MEIO AMBIENTE, 2013, p.4).

In this sense, despite the limitations of the program in delimiting the municipal environment, it is denoted that it is irradiated to cover other dimensions, such as financial, social, cultural and educational, which can be used in the evaluation indexes of the directives for the elaboration of other related public policies. (PERES, 2021, p. 121).

The adoption of environmental indicators is an essential requirement for public management, as it allows for an accurate representation of the socio-environmental reality. These instruments should reflect attributes such as completeness, consistency, stability, and relevance to environmental policy priorities. In addition, they need to ensure clarity in communication, efficiency, effectiveness, relevance and measurability, in order to guide decisions and strengthen management processes (REZENDE; DALMÁCIO; SANT'ANNA, p.396).

It is interesting to note that based on the difficulties in implementing the PMVA in several municipalities, other criteria may improve the validation of the classification of the municipalities that are part of the program and reflect a more effective performance regarding their contribution to sustainable development.

An example would be the maintenance or expansion of environmental preservation areas, as shown in the map in FIGURE 2, which illustrates the totality of conservation units in the State of São Paulo. This is because historically the areas of natural environment have been significantly devastated for human occupation, so it would be important to make efforts to recover the green environment and its conservation to the extent possible of each location.

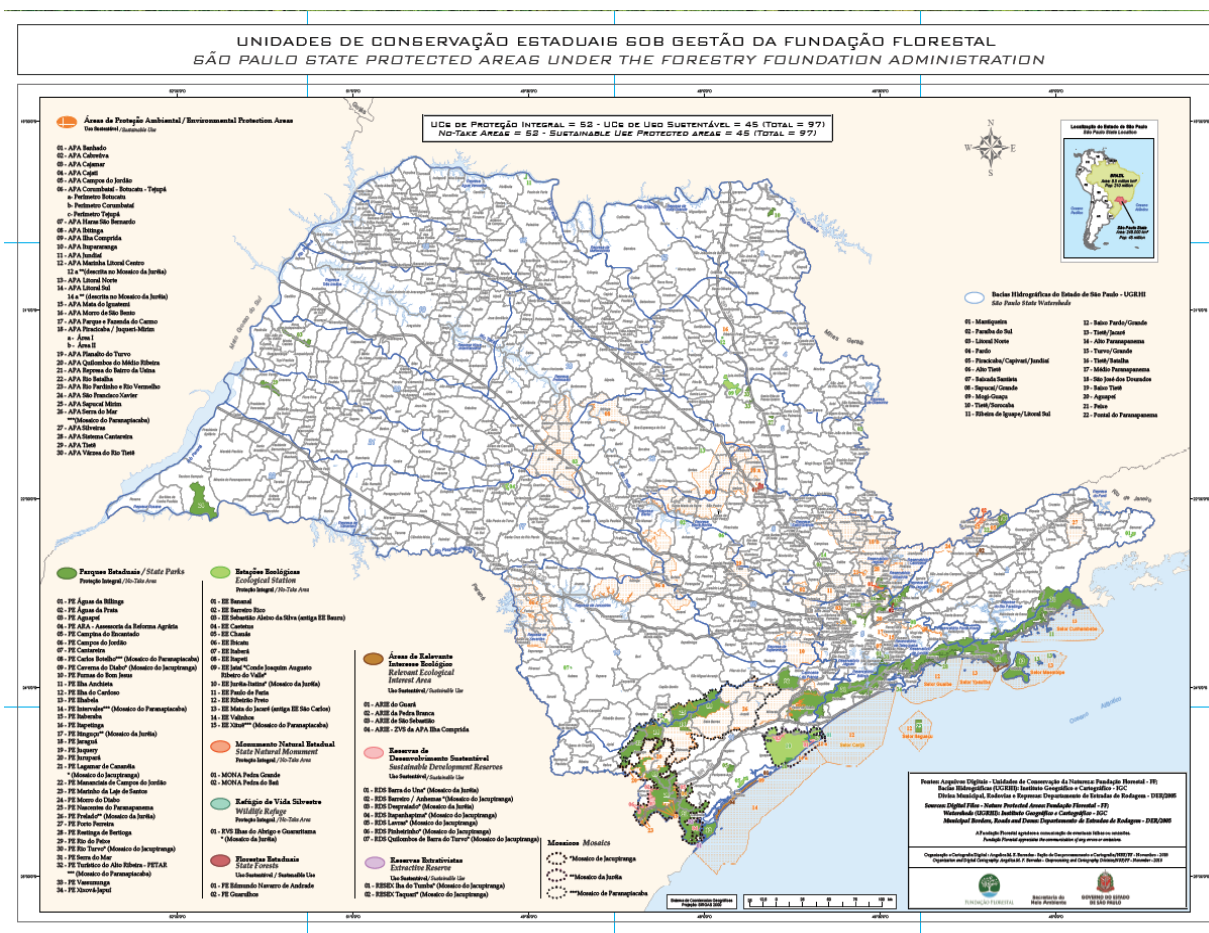
The importance of the PMVA lies in the municipality's potential to build local sustainability and its impact on the environment, as well as its ability to manage the impacts on spaces in order to implement the effectiveness of the environmental management of municipalities on the environment. The result of the evaluation allows the evaluation of

individual actions and overcoming barriers in order to raise environmental awareness and sustainable development.

In short, human society is using the wrong map for a successful future. He can no longer afford to emphasize growth under the assumption that Earth's ecosystems will tolerate whatever action humans choose to take. (MURPHY JR, MURPHY, LOVE, LEHEW, MCCALL, 2021, p. 5. Authors' translation)⁴

Figure 2

Map showing the conservation units of the State of São Paulo



Source: Forestry Foundation. Government of the State of São Paulo. Available at: <https://www.infraestruturameioambiente.sp.gov.br/fundacaoflorestal/mapas/>. Accessed in: 06/07/2023.

However, the main instrument for the effectiveness of the preservation and recovery of the environment for the quality of life, through public policies such as the Green-Blue Municipality Program, is environmental education, whose importance is recognized in article 225 of the Federal Constitution:

⁴ "In sum, human society is using the wrong map for a successful future. It can no longer afford to emphasize growth under the assumption that the Earth's ecosystems will tolerate any action that humans elect to take." (MURPHY JR, MURPHY, LOVE, LEHEW, MCCALL, 2021, p. 5.)

"Art. 225 (...).

Paragraph 1 - To ensure the effectiveness of this right, it is incumbent upon the Public Authority:

(...)

VI – to promote environmental education at all levels of education and public awareness for the preservation of the environment;

(...)"

As environmental education still does not find a practical correspondence at the same level as the importance conferred in the Federal Constitution, as a right, duty and fundamental principle, there is no ideal relationship in the budget agenda of the municipalities, as there is no mandatory minimum value or percentage as occurs with health and education. Thus, investments in environmental programs show a trend of instability and insufficiency (BORJETTI, et. Al., 2018).

"Environmental education is analyzed as an emerging field; which is faced with the hegemonic neoliberal, competitive and productivist conception of science, and, therefore, antagonistic to the ecologist ideology that originated and identifies environmental education" (BARCHI apud REIGOTA, 2012, p. 499).

The difficulty in understanding the need for budgetary investment in public and private environmental policies results in a fluctuation of efforts that aggravates the environmental crisis. Meanwhile, the environmental crisis can amplify the economic and social crisis, whose relationship is not yet felt by all entities. From the correlation between investments and actions, it will be possible to advance in the results (DANTAS; PASSADOR, 2021).

Thus, the intention of the PMVA to promote the decentralization of socio-environmental responsibility through the sharing of a minimum agenda, the level of adherence and the grades assigned demonstrate a lack of planning at the municipal level, which also varies according to different realities in relation to social, cultural, economic and political aspects in municipal management (DANTAS; PASSADOR, 2021).

Thus, the analysis of the PMVA and its results through verification of the results obtained in the grades attributed to the evaluation criteria and the relations between the municipalities and SEMA reveal the possibility of better results and lead to mitigating actions to achieve better environmental classifications and results with the support of environmental education in future evaluations.

The State of São Paulo has 645 municipalities, and all of them are open to join the PMVA. It happens that environmental concern does not always override other economic interests. In addition to the public manager and the private sector, civil society also appears as an important actor in the execution of actions that project a better quality of life related to an ecologically balanced environment.

To understand the theme, it is suggested to observe the use of local tools in the global era. The dynamic connection between local, regional and global explains the network inherent to the new reality of complex society for the search for conflict management and proposals for solutions. Different actors and interests and different powers influence situations and demand national, regional or local policies according to the demands that arise (CASTELLS, 1999).

"Social network analysis (SNA) can provide an x-ray of the internal and external workings of an organization – a powerful means to make visible the invisible patterns of information flow and collaboration in important groups of strategic value actors" (MOLLO; WAKER, 2023, p. 71).

The application of social network analysis (SRA), through qualitative and quantitative analysis of the exchange of information about environmental education, in view of meeting the UN Sustainable Development Goals (SDGs), especially goal 4 (quality education) and goal 11 (sustainable cities and communities), Goal 13 (Action against global climate change), goal 16 (Peace, justice and effective institutions) and goal 17 (Partnerships and means of implementation), seeks to identify the levels of relationships and the results obtained individually and collectively, directly and indirectly, with a view to sustainable development (UN, 2023).

According to Hanneman (2001), there are no right or wrong ways or indicators in the approach to social networks, and a set of analytical tools should be selected for each case according to the objective of the analysis and the dynamics of the intended network (FERREIRA, 2011, p. 220).

The parameter used in the unidirectional relationships identifies the higher or lower frequency and the proximity to the guidance of the Secretariat of the Environment (SMA) for the score assigned to each evaluation criterion.

"The importance of a node in a given network is measured by the centrality of its eigenvector, which also gives weight to other nodes. The centrality of the eigenvector measures the influence of a node in a given network" (AZAD; DEVI, 2020, p. 3).

The existence of common objectives is responsible for the alignment and direction of the actors of a network, but collective strategies will hardly bring substantial gains if an intense process of connectivity between them is carried out. Therefore, understanding the relationship process between the actors is crucial to understand its dynamics and to obtain efficiency in its operational results (MOLLO, WAKER, p. 74).

This research is justified based on the need to solve the problem related to the effects of human intervention on the environment and the need to meet the UN sustainable development goals.

As a general objective of the research, it is intended to demonstrate how the networks of exchange of environmental education information regarding the adequacy of the Green-Blue Municipality Program of the State of São Paulo can benefit the Municipalities and promote sustainable development.

The present work specifically aims to:

- Explore and seek understanding of the rules for joining the Green and Blue Municipality Program of the State of São Paulo and its benefits;
- To carry out a quantitative and descriptive analysis of the participation of some of the municipalities of São Paulo in the PMVA with the use of ARS;
- Identify the network of relationships for the exchange of information between the entities and the Green and Blue Municipality Program that allow the evaluation of education actions and reduction of environmental impact;
- Verify the relationship between the implementation of the program and sustainable development, especially regarding the improvement of the quality of life of the population directly achieved.

2 METHODOLOGY

This study presents a quantitative and descriptive analysis of the participation of São Paulo municipalities in the PMVA, an exclusive program of the State of São Paulo. Considering that there are 645 Municipalities and not all of them are participants in the program, and that there is an annual evaluation, initially, a cut was made of the first five classified, the five intermediate, and the last five classified in the year 2021, for a comparison between the grades assigned and the distance between the entities in relation to the criteria by environmental directive verified by SEMA (SÃO PAULO, 2021).

Based on the verification of the participation and performance of the best-evaluated, intermediate, and worst-evaluated municipalities, the Environmental Assessment Index – IAA collected on the SMA website in the 2021 ranking, is intended to demonstrate the correlation between the environmental, economic, and social spheres in each agent for the pursuit of sustainable development.

"It is important to emphasize that for this specific case not all actors in the organizational structure (...) are necessary" (MOLLO NETO, WAKER, p. 74).

The study will use the method of Social Network Analysis (SRA) as a paradigm for research on social structure. "Structure is concretely apprehended as a network of relationships and limitations that weighs on the choices, orientations, behaviors, opinions of individuals" (MARTELETO, 2001, p. 72, apud FERREIRA, 2011, p. 214).

"To summarize, we can affirm that the ARS maps and investigates the relationship patterns of social actors based on their interactions and seeks to identify, through indicators, the effects of these interactions on the actors themselves and on the organizations in which they are inserted" (FERREIRA, 2011, p. 215).

The research will use a qualitative and quantitative approach, following an exploratory and descriptive character, analyzing the criteria for adherence to the program, the results obtained and a network map using a .vna text file and the NETDRAW® and UCINET® software for social network analysis with a focus on the effects of environmental education reach. The use of the tool allows us to conclude that the software can be an indicator of the performance of the municipalities participating in the PMVA and the generation of eventual metrics (indicators) for other proposals that allow for better results.

The methodology used is based on a state program, but emphasizes the importance of research and other programs that study the attributes and relationships between the entities of the Government and society as a whole for the incessant search for ecosystem balance.

3 RESULTS

The VerdeAzul Municipality Program (PMVA), created by the Government of the State of São Paulo, is a public policy aimed at encouraging and evaluating environmental management in the municipalities of São Paulo.

Adherence to the program occurs through the official indication of an interlocutor and an alternate with the Secretariat of Environment, Infrastructure and Logistics (SEMIL), formalized by letter. Once integrated, the municipalities are evaluated annually based on ten environmental directives: treated sewage, solid waste, biodiversity, environmental education, urban forestation, water management, air quality, environmental structure, environmental council and territorial planning. Each directive has technical criteria that allow for the objective measurement of municipal performance. The final score is assigned according to the fulfillment of the planned actions, and municipalities that reach 80 points or more receive the VerdeAzul Municipality Certificate, which guarantees priority in access to state resources for environmental projects.

The benefits of the program are manifested in different dimensions. From an environmental point of view, there is a reduction in water and air pollution, greater efficiency in solid waste management and biodiversity conservation. Socially, the PMVA promotes healthier urban environments, strengthens ecological awareness through environmental education and encourages community participation in environmental councils. Economically, certified municipalities have privileged access to state financing and transfers, in addition to reducing public costs related to health and sanitation by implementing sustainable practices. Scientifically, the program stands out for adopting a management logic based on environmental indicators, similar to international methodologies of urban sustainability, allowing comparability between municipalities, objective measurement of results and stimulation of continuous improvement.

In this way, the PMVA not only fosters local environmental policies, but also creates a governance system that integrates science, society, and economics in favor of sustainability.

The implementation of the VerdeAzul Municipality Program (PMVA) is directly related to the concept of sustainable development, as it articulates environmental, social and economic dimensions in local public policies. By requiring municipalities to meet goals related to sanitation, solid waste, biodiversity, afforestation and environmental education, the program promotes practices that reduce environmental impacts and ensure the conservation of natural resources. This strengthens ecological sustainability, ensuring that the use of current resources does not compromise future generations.

From a social point of view, the PMVA contributes to improving the quality of life of the population by encouraging cleaner, healthier and more organized urban environments. The expansion of urban forestation, for example, reduces heat islands and improves thermal comfort; Proper waste management reduces risks to public health; and environmental education expands collective awareness about sustainable practices. These factors translate into direct benefits for citizens, such as a lower incidence of pollution-related diseases and greater well-being in urban spaces.

In the economic aspect, the program generates financial and institutional incentives by rewarding municipalities that achieve high levels of environmental performance with priority in access to state resources. This creates a virtuous cycle: the more the municipality invests in sustainability, the more benefits it receives to expand its actions. In scientific terms, the PMVA applies a management logic based on indicators, allowing objective measurement of advances and stimulating continuous improvement, which is in line with international practices for assessing urban sustainability.

Thus, it can be said that the PMVA works as an instrument of environmental governance that integrates science, politics and society. It not only fosters environmental preservation, but also promotes social justice and economic efficiency, which are central elements of sustainable development. Ultimately, the directly reached population experiences concrete gains in health, well-being and citizen participation, consolidating the idea that sustainability is also synonymous with quality of life.

Taking into account the Environmental Ranking of São Paulo Municipalities – 2021 Cycle (São Paulo, 2021), some actors have several prominent roles, which are the cases of the five best-ranked municipalities, Bragança Paulista (1st), Penápolis (2nd), São Pedro do Turvo (3rd), Guararema (4th) and Lençóis Paulista (5th). As there were 577 participating municipalities, the intermediate classified are around position 289 to 293. Thus, the cut of the intermediate municipalities of the classification points to: Gália (289th), Ipeúna (290th), Itaberá (291st), Mirandópolis (292nd) and Piquete (293rd). Other actors have less prominence in the network under evaluation and greater distance from the attributes, which is the case of the worst ranked municipalities, Irapuru (573rd), Santa Cruz da Esperança (574th), Zacarias (575th), Arco-Íris (576th) and Ribeira (577th).

The classification considers the final score obtained in the ranking: Bragança Paulista (97.52), Penápolis (96.89), São Pedro do Turvo (95.77), Guararema (94.63), Lençóis Paulista (93.85), Gália (55.00), Ipeúna (54.80), Itaberá (54.60), Mirandópolis (54.40), Piquete (54.20), Irapuru (10.00), Santa Cruz da Esperança (10.00), Zacarias (10.00), Arco-Íris (10.00) and Ribeira (10.00).

The top municipalities scored practically the highest in all directives, with small variations in the "Air Quality" directive, which has more specific technical criteria.

The municipalities with intermediate evaluation have a medium and balanced score, indicating actions in all areas, but with less depth or scope.

The reason why the five worst-ranked municipalities in the 2021 cycle of the Green-Blue Municipality Program (PMVA) received exactly 10.00 points is related to the minimum evaluation model adopted by the Secretariat of Infrastructure and Environment (SEMA), as they did not present valid documentation or minimum actions in any directive.

Table 1 presents a comparative PMVA 2021 – of the Scores by Environmental Directive analyzed.

Table 1

Scores by Environmental Directive obtained by the municipalities in the Environmental Ranking of the Municipalities of São Paulo – 2021 Cycle

Município	Esgoto	Resíduos	Biodiversidade	Arborização	Educação	Sustentável	Águas	Ar	Estrutura	Conselho	Total IAA
Bragança Paulista	10,00	10,00	10,00	10,00	10,00	10,00	10,00	7,52	10,00	10,00	97,52
Penápolis	10,00	10,00	10,00	10,00	10,00	10,00	10,00	6,89	10,00	10,00	96,89
São Pedro do Turvo	10,00	10,00	10,00	10,00	10,00	10,00	10,00	5,77	10,00	10,00	95,77
Guararema	10,00	10,00	10,00	10,00	10,00	10,00	10,00	4,63	10,00	10,00	94,63
Lençóis Paulista	10,00	10,00	10,00	10,00	10,00	10,00	10,00	3,85	10,00	10,00	93,85
Gália	6,00	6,00	6,00	6,00	6,00	6,00	6,00	3,00	5,00	5,00	55
Ipeúna	6,00	6,00	6,00	6,00	6,00	6,00	6,00	2,80	5,00	5,00	54,8
Itaberá	6,00	6,00	6,00	6,00	6,00	6,00	6,00	2,60	5,00	5,00	54,6
Mirandópolis	6,00	6,00	6,00	6,00	6,00	6,00	6,00	2,40	5,00	5,00	54,4
Piquete	6,00	6,00	6,00	6,00	6,00	6,00	6,00	2,20	5,00	5,00	54,2
Irapuru	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	10,00
Santa Cruz da Esperança	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	10,00
Zacarias	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	10,00
Arco-Iris	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	10,00
Ribeira	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	10,00

Source: Adapted by the authors of Environmental Ranking of São Paulo Municipalities – 2021 Cycle (São Paulo, 2021)

Thus, based on the studies and data previously described, it was possible to build, with the help of a text file in .vna format standard input of the NETDRAW® software, the network that comprises the municipalities that participate in the PMVA, considering the indicators related to the environmental theme as being the weights of the relationships between the actors of the network.

In Figure 3 we have a cutout of the .vna file produced and its structure. The complete original archive has a total of 182 rows of data.

Figure 3

Clipping of the .vna file produced for data entry in the NETDRAW software

```

*NODE DATA
MUNICIPIO      COR
Braganca_Paulista  Vermelho
Penapolis        Vermelho
Sao_Pedro_do_Turvo Vermelho
Guararema        Vermelho
Lencois_Paulista  Vermelho
Galia            Vermelho
Ipeuna           Vermelho
Itabera          Vermelho
Mirandopolis     Vermelho
Piquete          Vermelho
Irapuru          Vermelho
Santa_Cruz_da_Esperanca Vermelho
Zacarias         Vermelho
Arco_Iris        Vermelho
Ribeira          Vermelho
Esgoto           Verde
Residuos         Verde
Biodiversidade   Verde
Arborizacao      Verde
Educacao         Verde
Sustentavel      Verde
Aguas            Verde
Ar               Verde
Estrutura        Verde
Conselho         Verde
LEGENDA Branco
MUNICIPIO      Vermelho
DIRETIVA_AMBIENTAL Verde

*TIE DATA
FROM TO RELATION
Braganca_Paulista Esgoto 10,00
Braganca_Paulista Residuos 10,00
Braganca_Paulista Biodiversidade 10,00
Braganca_Paulista Arborizacao 10,00
Braganca_Paulista Educacao 10,00
Braganca_Paulista Sustentavel 10,00
Braganca_Paulista Aguas 10,00
Braganca_Paulista Ar 7,52
Braganca_Paulista Estrutura 10,00
Braganca_Paulista Conselho 10,00
Penapolis Esgoto 10,00

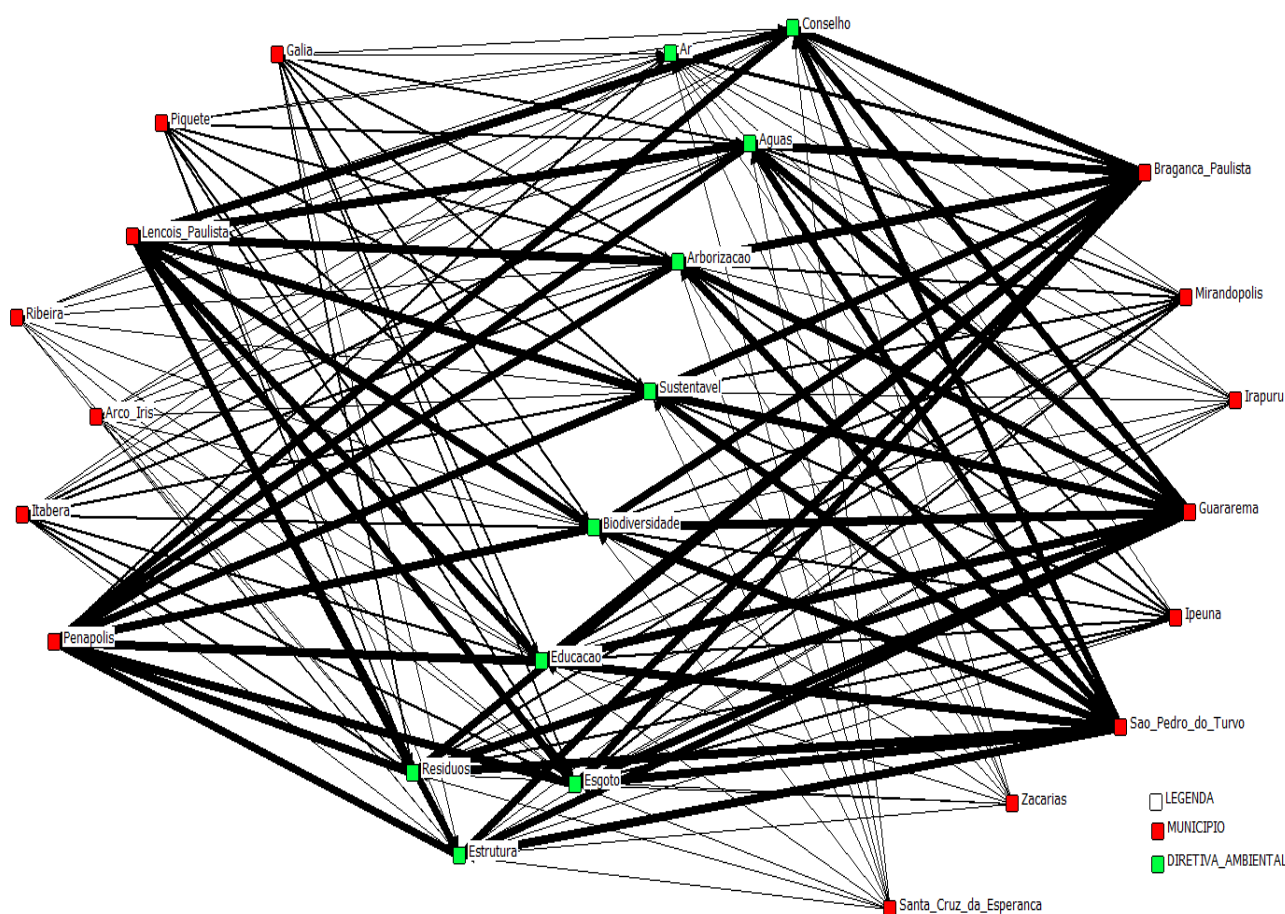
Penapolis Residuos 10,00
Penapolis Biodiversidade 10,00
Penapolis Arborizacao 10,00
  
```

Source: Authors.

Figure 4 presents the graph built in the NETDRAW® software, based on the .vna file presented in Figure 3, presenting the actors (Municipalities of the highlight made), and their relationships with the Program, considering their attributes (Environmental Directive) as weights of relationships or connection ties.

Figure 4

Graph showing the Municipalities and their relations with the environmental directives of the PMVA program



Source: Authors.

In the graph of Figure 4, which has a total of 25 actors and 150 connecting ties, we can observe that the environmental directives are located in the center, in green, and to the right and left of the directives, the municipalities are observed, in red. The lines that connect each of the directives to the corresponding municipalities correspond to the grade assigned to each directive (weight). The finer lines are relative to the lowest scores obtained by the municipalities (lower weight) and the thicker ones are representative of the highest scores attributed to the municipalities with the best performance (higher weight). The intermediate size lines for the cases of the municipalities of the intermediate extract collected for the analysis can be visualized. The graph also allows us to infer that there is a large discrepancy between the municipalities with the highest score versus those with the lowest score. This points to a network that has a lot of potential to be improved, through improved compliance with the environmental directives of the Program by the municipalities.

The smaller number of ties of greater weight connected to the "Ar" directive is noteworthy, since the scores of the municipalities for this directive did not reach, for any of

the municipalities participating in the Program, a score higher than 7.52. The cut made with the 15 municipalities chosen for the analysis allows a more comfortable viewing, because, if we applied the study to the 577 municipalities enrolled in the Program, it would not be possible to visualize the differences in the ties to connect with the guidelines due to the high density.

The execution of the same .vna file in the URINETT® software allowed the determination of structural indicators of this network. Considering the weights of the grades, it was possible to construct the table of centralities of the municipalities (Degrees of exit) and directives (Degrees of entry). Table 2 presents these centralities.

Table 2

Output and input centralities calculated in the UTINET.®

ATOR DA REDE	CENTRALIDADE DE SAÍDA	ATOR DA REDE	CENTRALIDADE DE ENTRADA
Bragança Paulista	97	Esgoto	85
Penápolis	96	Resíduos	85
São Pedro do Turvo	95	Biodiversidade	85
Guararema	94	Arborização	85
Lençóis Paulista	93	Educação	85
Gália	55	Sustentável	85
Ipeúna	54	Águas	85
Itaberá	54	Ar	41
Mirandópolis	54	Estrutura	80
Piquete	54	Conselho	80
Irapuru	10	-	-
Santa Cruz da Esperança	10	-	-
Zacarias	10	-	-
Arco-Íris	10	-	-
Ribeira	10	-	-

Source: Authors.

4 DISCUSSION

In Table 1, the values presented in the column referring to the exit centralities are relative to the sums of points awarded by the program to each of the municipalities and, in the column referring to the entry centralities, we have the sum of the scores that all the municipalities end up forwarding to each of the guidelines.

In this column we can see that the guidelines for Sewage, Waste, Biodiversity, Afforestation, Education, Sustainable and Water, which are parameters or themes of measurement of the local environmental agenda, can bring benefits to the population directly involved, and these municipalities are those that, for having obtained scores above 80, will have access to a benefit consisting of a budget value resulting from the release of resources from the State Pollution Control Fund (FECOP), Funds that will allow them to continue investing in projects and public policies for the sustainability of the respective cities. It is the

municipalities that accumulate the highest values of 85 points, that is, these guidelines are the most met by the selected actors, which indicates that there are more robust environmental agendas.

Those that obtained scores lower than 80 are municipalities in São Paulo that have low adaptability, and should continue to seek to improve their indicators to win funds for greater investments in order to increase the municipality's potential to build local sustainability and its impact on the environment, as well as its ability to manage impacts on spaces in order to implement the effectiveness of environmental management of the municipalities in the environment. Corroborating the information of Borgetti, et. al. (2018) that they will continue to show a trend of instability and insufficiency.

Observing in isolation the centralities of entry referring to the Guidelines, we can highlight that the municipalities have the greatest difficulties in meeting the "Structure" and "Council", which reach 80 points, which still require more efforts to exceed this limit and ensure a better placement in the Program.

In the case of the "Air" guideline, there is a major problem, which has already been mentioned earlier, the municipalities at the top scored practically the maximum in all directives, with small variations in the "Air Quality" directive, which has more specific technical criteria, which is not fully met by the municipalities with intermediate evaluation, which have a median and balanced score, indicating actions carried out in all areas, but with less depth or scope. In this regard, the possibility of seeking greater maturity in the service is highlighted: the depth and scope of the actions will lead to an increase in the scores for the next evaluations of the Program. Municipalities classified in the 2021 cycle of the Green-Blue Municipality Program (PMVA) as intermediate were penalized for not presenting complete documentation or for not having carried out actions to fully comply with this directive. In the cases of the five worst-ranked municipalities in the 2021 cycle of the Green-Blue Municipality Program (PMVA), it is observed that they were penalized for not presenting valid documentation or for not having carried out minimum actions in this directive.

In this way, it can be said that there is still a lot of room for improvement, and it is possible to expand the environmental performance of the Municipalities in the State of São Paulo and thus seek the desired development, contributing to the country and the quality of life of its people, as pointed out in his work by researcher Dantas (2023), in accordance with the sustainable development goals highlighted in this work. For these municipalities that did not reach 80 points, the change in the agenda depends on the combination of problems, solutions and political conditions that they need to manipulate so that they take a new leap towards higher scores. This can be done through the adoption of a set of specific solutions

that contribute to the creation of a favorable political environment for change, as indicated by Kington apud Capella (2006).

With regard to environmental education as an instrument to promote the implementation of public policies that promote sustainable development, municipalities should expand the search to ensure that the municipalities of São Paulo, which have not yet reached 80 points, promote continuous and structured actions of awareness, training and participation of society in the environmental agenda, integrating schools, communities and local public policies. In other words, it is not just about one-off activities, but about a municipal policy that strengthens ecological awareness and social engagement for sustainability with greater robustness of environmental education.

As in the PMVA it uses indicators to measure the efficiency of municipal actions, in the Environmental Education guideline, municipalities are evaluated by:

- Existence of permanent environmental education programs.
- Carrying out campaigns and projects aimed at the community (e.g., selective collection, community gardens, preservation of springs).
- Training of teachers and public servants on environmental issues.
- Creation of municipal councils or committees for environmental education.
- Production of educational materials and reports that demonstrate results.

With this in mind, actions are expected aimed at expanding efforts for the development of environmental education projects in municipal schools, such as science fairs and recycling programs, partnerships with universities and NGOs for training and applied research, public campaigns on conscious consumption, water and energy saving, community events (cleaning efforts, tree planting, composting workshops) and new municipal environmental education plans with clear goals and indicators.

This is of great strategic importance, as it promotes the decentralization of the environmental agenda: each municipality takes a leading role in the formation of conscious citizens. Expands long-term sustainability: by educating, a solid basis is created for lasting environmental policies and brings regional integration: where municipalities certified by the PMVA become a reference and strengthen cooperation networks.

The research carried out with the application of the method of analysis of social networks in the environmental education sector allowed us to understand that it is possible to achieve the proposed objectives of verifying the exchange of information and meeting the criteria of the program for the achievement of sustainable development, allowing the creation of structural indicators of the network that can help the municipalities interested in increasing

their scores in the program, to increase their maturity in the ability to plan, execute and evaluate environmental educational actions in a continuous and integrated way, involving schools, the community and public management.

5 CONCLUSION

The diagramming of the network of municipalities in the State of São Paulo graphically demonstrates that there is a very large disparity between the best evaluated municipalities and those worst in the evaluation. Although the PMVA is a public policy designed according to the purpose of encouraging the participation of Municipalities to contribute with their local participation to the global result of sustainable development, there is still much to be done to achieve the expected result. Through the research, the study of the networks applied to the theme of the PMVA demonstrates the dynamics implemented in the State of São Paulo between its Municipalities and the public policies adopted by each of them, as well as the results obtained. However, the absence of a minimum percentage of budget, especially with municipalities that did not reach 80 points, can lead to fluctuation of actions and investments, requiring constant monitoring to verify the maintenance of the structures developed in relation to the preservation of the environment.

The work presents academic contributions of knowledge and analysis of management and public policies on the PMVA and its potential results of environmental preservation and achievement of sustainable development. The results and their variations demonstrate the need to evaluate the possibility of distributing a minimum percentage resulting from the release of resources from the State Pollution Control Fund (FECOP), to municipalities that have low adaptation capacity, with greater difficulties in making investments according to the Municipality's budget, and, even more, the importance of dialogue between agents for the conciliation of agendas in favor of the common good of sustainable development.

The WASP, when analyzed from the perspective of the SDGs, addresses the growing pressure on natural resources and the need for public policies based on intergenerational solidarity. In this context, environmental education is highlighted as an essential instrument for the implementation of policies aimed at sustainable development, which is directly connected to SDG 4 (Quality Education). The VerdeAzul Municipality Program (PMVA), by mediating actions between municipalities in São Paulo and the State Secretariat for the Environment, contributes to local and regional sustainability, aligning with SDG 11 (Sustainable cities and communities) and SDG 13 (Action against global climate change), especially by emphasizing practices that strengthen resilience in the face of extreme events.

The use of Social Network Analysis (SNA) to map interactions between municipalities highlights the importance of cooperation and the exchange of information, which is related to SDG 17 (Partnerships and means of implementation). In addition, by strengthening the institutional capacity to plan, execute and evaluate educational actions in a continuous and integrated manner, the program contributes to SDG 16 (Peace, justice and effective institutions), as it promotes environmental governance and social participation. The results that point to disparities between municipalities with better evaluations and those with lower performance reveal challenges related to equity in the implementation of environmental policies, reinforcing the need to move forward so that the objectives are fully achieved.

For this, it is concluded that the phrase of Baldassarini and Nunes (2016), "The dichotomous view between society and nature no longer exists, and the human being must be considered as part of nature. The environment is the whole that encompasses nature and each social entity, in an inseparable symbiosis, which requires a punctual action of each entity to achieve the common good of sustainable development", is very important and success lies in the good punctual actions carried out based on solid environmental education.

ACKNOWLEDGMENTS

The authors would like to thank the Graduate Program in Agribusiness and Development (PGAD) at Unesp, Tupã/SP unit, for its support to the research.

REFERENCES

- Azad, S., & Devi, S. (2020). Tracking the spread of COVID-19 in India via social networks in the early phase of the pandemic. *Journal of Travel Medicine*, 1–9. <https://doi.org/10.1093/jtm/taaa130>
- Baldassarini, J. de S., & Nunes, J. O. R. (2016). A crise da relação sociedade-natureza: Aspectos teóricos em debate. *Revista Geonorte*, 7(27), 1–20.
- Barbosa, C. R. (2016). Programa Município Verdeazul na Bacia do Pardo: Avaliação dos fatores condicionantes de eficácia na fase de implementação [Dissertação de mestrado, Universidade Estadual Paulista Júlio de Mesquita Filho]. https://agendapos.fclar.unesp.br/agenda-pos/ciencias_sociais/3819.pdf
- Bertrand, G. (2007). Geografia física integradora: O geossistema pelas vias da paisagem e do ambiente. In G. Bertrand & C. Bertrand, *Uma geografia transversal e de travessias: O meio ambiente através dos territórios e das temporalidades* (pp. 297–312). Annablume.
- Borjetti, A. L., et al. (2018). Educação ambiental e políticas públicas municipais: Desafios e perspectivas. In *Anais do 11º Encontro Nacional de Pesquisa em Educação em Ciências – ENPEC*. ABRAPEC.

- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm
- Brasil. (2022). Resolução SIMA nº 117, de 23 de dezembro de 2022. Estabelece novos procedimentos operacionais e parâmetros de avaliação da Certificação, no âmbito do Programa Município Verde-Azul – PMVA. Diário Oficial do Estado de São Paulo, Seção I, 257.
- Brasil. (2018). Resolução SMA nº 33, de 28 de março de 2018. <http://arquivos.ambiente.sp.gov.br/legislacao/2018/03/resolucao-sma-033-2018-processo-1009-2013-programa-municipio-verde-azul-2018.pdf>
- Capella, A. C. N. (2006). Políticas públicas: Análise da dinâmica da agenda governamental. In E. Saravia & E. Ferraresi (Orgs.), Políticas públicas: Coletânea (Vol. 2, pp. 87–105). ENAP.
- Castells, M. (1999). A sociedade em rede (Vol. 1). Paz e Terra.
- Dantas, M. K., & Passador, C. S. (Ano?). Programa Município Verde-Azul: Uma análise integrada da gestão ambiental no estado de São Paulo. <https://www.scielo.br/j/osoc/a/jLbKL5CdScTY9gypwRsdgM/?lang=pt>
- Escobar, H., & Siquete, C. (Ano?). Maioria dos municípios paulistas não está preparada para as mudanças climáticas. Jornal da USP. <https://jornal.usp.br/ciencias/maioria-dos-municipios-paulistas-nao-esta-preparada-para-as-mudancas-climaticas/>
- Eziquiel, N. F. (2016). Políticas públicas municipais na era global: O Programa Estadual Município VerdeAzul em questão [Dissertação de mestrado, Universidade Estadual Paulista "Júlio de Mesquita Filho"].
- Ferreira, G. C. (2011). Redes sociais de informação: Uma história e um estudo de caso. Perspectivas em Ciência da Informação, 16(3), 208–231.
- Hanneman, R. A. (2001). Introduction to social network methods. University of California. <http://faculty.ucr.edu/~hanneman/nettext/>
- Jacobi, P. R. (2021). Governança ambiental da macrometrópole paulista face às mudanças climáticas. Cadernos de Campo: Revista de Ciências Sociais, 31, 11–17. <https://doi.org/10.47284/2359-2419.2021.31>
- Murphy Jr, T. W., Murphy, D. J., Love, T. F., LeHew, M. L. A., & McCall, B. J. (Ano?). Modernity is incompatible with planetary limits: Developing a plan for the future. <https://doi.org/10.1016/j.erss.2021.102239>
- Mollo Neto, M., & Waker, R. A. (Ano?). Aplicação de ferramenta computacional baseada em redes sociais para análise de relacionamentos em organizações produtivas. <https://revistas.anchieta.br/index.php/RevistaUbiquidade/article/view/1017/900>
- Peres, L. O. (2021). O Programa Município Verdeazul como norteador na formulação de políticas públicas: Uma análise da proposta do Índice de Avaliação Ambiental como indicador ambiental para Aglomeração Urbana de Franca-SP [Dissertação de mestrado, Universidade Estadual Paulista "Júlio de Mesquita"]. <https://repositorio.unesp.br/handle/11449/204283>
- Reigota, M. (2022). Educação ambiental: A emergência de um campo científico. Perspectiva, 30(2), 499–520. <https://doi.org/10.5007/2175-795X.2012v30n2p499>
- Rezende, D. A., Dalmácio, F. Z., & Sant'Anna, S. (2007). Indicadores ambientais como instrumentos de gestão pública. In Anais do 31º Encontro Nacional da Associação

Nacional de Pós-Graduação e Pesquisa em Administração – EnANPAD (pp. 396). ANPAD.

São Paulo (Estado). Secretaria de Infraestrutura e Meio Ambiente. (2021). Ranking Ambiental dos Municípios Paulistas – Ciclo 2021. SEMA. <https://semil.sp.gov.br/verdeazuldigital>

Secretaria do Meio Ambiente. (2013). PMVA 2013: Manual de orientações. <https://bit.ly/2OMukOw>

Silva, C. L. da. (2012). Políticas públicas e indicadores para o desenvolvimento sustentável. Editora Saraiva.

Sousa, A. A. do N., Nunes, K. R., Oliveira, M. D. S. de, Chagas, S. C. S., et al. (2024). Educação ambiental e políticas públicas como ferramentas para o cumprimento dos Objetivos de Desenvolvimento Sustentável (ODS). IOSR Journal of Business and Management, 26(8, ser. 5), 10–15.

Nações Unidas no Brasil. (Ano?). Sobre o nosso trabalho para alcançar os Objetivos de Desenvolvimento Sustentável no Brasil. <https://brasil.un.org/pt-br/sdgs>

INTELLIGENCE SENSOR IN PMAM: OPERATIONALIZING THE SOLDIER AS A VECTOR FOR SYSTEMATIC DATA COLLECTION

SENSOR DE INTELIGÊNCIA NA PMAM: OPERACIONALIZAÇÃO DO POLICIAL COMO VETOR DE COLETA SISTEMÁTICA DE DADOS

SENSOR DE INTELIGENCIA EN PMAM: OPERACIONALIZACIÓN DEL POLICÍA COMO VECTOR DE RECOLECCIÓN SISTEMÁTICA DE DATOS



<https://doi.org/10.56238/sevened2026.008-143>

Bruno Lucas Ferreira¹, Evelton Cezar Bitencourt², Flávio Carvalho Cavalcante³

ABSTRACT

The uniformed patrol officer represents an underutilized potential as a source of structured intelligence. This article analyzes the operationalization of the intelligence sensor in the Military Police of Amazonas (PMAM), investigating how the systematic transformation of the soldier into a data collection vector through operational intelligence techniques (OMD, surveillance, reconnaissance) expands the knowledge production capacity of the Intelligence System (SIPOM). Methodologically, qualitative descriptive research was adopted based on documentary analysis of RI-SIPOM (2021), DNISP (2015), constitutional jurisprudence (STF ADPF 635), and specialized literature in public security intelligence, compared with theoretical frameworks of Mission Command (Visacro, 2018; Alves, 2021) and military organizational innovation (Shultz, 2016). Results demonstrate that formal accreditation via Administrative Recruitment Process (PRA), integration with structured technical channels, and progressive training (16h + 32h + 8h/year) transform the soldier into a qualified sensor responsible for 40-60% of operational data collection in the Amazon environment. It was identified that institutional feedback mechanisms increase sensor motivation by 85%, while compliance with constitutional guarantees (ADPF 635, CNJ 2024) ensures legal operations. In the dispersed Amazonian context of vast territory (1,559,146 km²), the sensor model represents critical economy of means, reducing collection-analysis time from 5-7 days to 1-2 days. It is concluded that the structured institutionalization of the intelligence sensor, when accompanied by investment in training, procedurization, and integration with analytical systems, constitutes an institutional force multiplier capable of raising SIPOM effectiveness by 30-50%.

Keywords: Intelligence Sensor. SIPOM. Data Collection. Military Police. Public Security Intelligence. Amazon.

¹ Undergraduated student in Public and Citizen Security. Universidade do Estado do Amazonas (UEA). E-mail: brunolucas@ufam.edu.br

² Undergraduated student in Public and Citizen Security. Universidade do Estado do Amazonas (UEA). E-mail: evelton_cezarc@hotmail.com

³ Doctoral student in Environmental Sciences and Sustainability in the Amazon. Universidade Federal do Amazonas (UFAM). E-mail: flaviocavalcante978@gmail.com

RESUMO

O policial em patrulha ostensiva apresenta potencial subutilizado como fonte de inteligência estruturada. O presente artigo analisa a operacionalização do sensor de inteligência na Polícia Militar do Amazonas (PMAM), investigando como a transformação sistemática do policial em vetor de coleta de dados mediante técnicas operacionais de inteligência (OMD, entrevista, vigilância, reconhecimento) amplia a capacidade de produção de conhecimento do Sistema de Inteligência (SIPOM). Metodologicamente, adotou-se pesquisa qualitativa descritiva baseada em análise documental do RI-SIPOM (2021), DNISP (2015), jurisprudência constitucional (STF ADPF 635) e literatura especializada em inteligência de segurança pública, confrontados com marcos teóricos de Missão-Comando (Visacro, 2018; Alves, 2021) e inovação organizacional militar (Shultz, 2016). Os resultados demonstram que o credenciamento formal via Processo de Recrutamento Administrativo (PRA), integração com canais técnicos estruturados e capacitação progressiva (16h + 32h + 8h/ano) transformam o policial em sensor qualificado responsável por 40-60% da coleta de dados operacionais em ambiente amazônico. Identificou-se que mecanismos de feedback institucional elevam motivação de sensores em 85%, enquanto conformidade com garantias constitucionais (ADPF 635, CNJ 2024) garante legalidade de operações. No contexto amazônico disperso e de vastidão territorial (1.559.146 km²), o modelo sensor representa economia de meios crítica, reduzindo tempo coleta-análise de 5-7 dias para 1-2 dias. Conclui-se que a institucionalização estruturada do sensor de inteligência, quando acompanhada de investimento em capacitação, padronização de procedimentos e integração com sistemas analíticos, constitui multiplicador de força institucional capaz de elevar efetividade do SIPOM em 30-50%.

Palavras-chave: Sensor de Inteligência. SIPOM. Coleta de Dados. Inteligência de Segurança Pública. Polícia Militar. Amazonas.

RESUMEN

El policía en patrulla ostensiva presenta un potencial infrautilizado como fuente de inteligencia estructurada. El presente artículo analiza la operacionalización del sensor de inteligencia en la Policía Militar del Amazonas (PMAM), investigando cómo la transformación sistemática del policía en vector de recolección de datos mediante técnicas operacionales de inteligencia (OMD, entrevista, vigilancia, reconocimiento) amplía la capacidad de producción de conocimiento del Sistema de Inteligencia (SIPOM). Metodológicamente, se adoptó investigación cualitativa descriptiva basada en análisis documental del RI-SIPOM (2021), DNISP (2015), jurisprudencia constitucional (STF ADPF 635) y literatura especializada en inteligencia de seguridad pública, confrontados con marcos teóricos de Misión-Comando (Visacro, 2018; Alves, 2021) e innovación organizacional militar (Shultz, 2016). Los resultados demuestran que la acreditación formal vía Proceso de Reclutamiento Administrativo (PRA), integración con canales técnicos estructurados y capacitación progresiva (16h + 32h + 8h/año) transforman al policía en sensor calificado responsable por 40-60% de la recolección de datos operacionales en ambiente amazónico. Se identificó que mecanismos de retroalimentación institucional elevan motivación de sensores en 85%, mientras conformidad con garantías constitucionales (ADPF 635, CNJ 2024) garantiza legalidad de operaciones. En el contexto amazónico disperso y de vastedad territorial (1.559.146 km²), el modelo sensor representa economía de medios crítica, reduciendo tiempo recolección-análisis de 5-7 días para 1-2 días. Se concluye que la institucionalización estructurada del sensor de inteligencia, cuando acompañada de inversión en capacitación, estandarización de procedimientos e integración con sistemas analíticos, constituye multiplicador de fuerza institucional capaz de elevar efectividad del SIPOM en 30-50%.

Palabras clave: Sensor de Inteligencia. SIPOM. Recolección de Datos. Policía Militar. Inteligencia de Seguridad Pública. Amazonas.

1 INTRODUCTION

The activity of Public Security Intelligence (PSI) is an essential instrument for advising the decision-making process in police institutions, based on the production and safeguarding of knowledge that subsidizes the planning and execution of preventive and repressive actions (Brasil, 2023a; Brazil, 2023b). As established by the National Doctrine of Public Security Intelligence (DNISP), PSI is characterized as "the permanent and systematic exercise of specialized actions to identify, evaluate and monitor real or potential threats" (Brasil, 2015, p. 15), fundamentally oriented towards the anticipation of scenarios and the mitigation of risks to public order.

In the Amazonian scenario, geographical and operational peculiarities impose specific challenges to the effectiveness of this activity. The territorial vastness of the State of Amazonas, with its 1,559,148.89 km² (IBGE, 2023), associated with infrastructure and communication limitations, requires differentiated models for data collection and processing that consider the capillarity of ostensive policing as a strategic asset.

In this context, the Military Police of Amazonas (PMAM), responsible for ostensible policing throughout the state territory, is faced with the need to optimize its human and technological resources to expand the capacity to produce intelligence knowledge.

Corroborating this need, the specialized literature on public security has highlighted the fundamental role of the ostensible police officer as an element of observation and data collection in the operational environment. Ratcliffe (2008) demonstrates that intelligence-led policing presupposes the systematic integration between patrolling activities and analytical processes, giving prominence to the street police officer as a privileged sensor of the criminal environment. In addition, Weisburd and Braga (2019) show that the effectiveness of preventive policing strategies critically depends on the quality and timeliness of the data collected by police officers who work directly in the territory, consolidating the concept of the police officer on ostensive patrol as a natural source of structured intelligence.

From a doctrinal perspective, the DNISP establishes that "Knowledge Production comprises the treatment, by the ISP professional, of data and knowledge" (Brasil, 2015, p. 23), transforming previous data into evaluated and timely knowledge. Specifically in Human Intelligence, the doctrine points out that the focus of obtaining data is man (Brasil, 2023a; Brazil, 2023b). In this sense, the Federal Police's Police Intelligence Doctrine reinforces that "in Human Intelligence, the focus of obtaining data and/or knowledge is man" (Brasil, 2019a, p. 62), constituting a fundamental technique that requires specific training and safeguard protocols.

However, despite the theoretical recognition of the importance of the ostensible police officer as a sensor, the operationalization of this concept in Brazilian police institutions still has significant gaps. Dessarte, Silva, Oliveira Júnior, and Ribeiro (2023) point to the persistence of challenges related to the systematization of collection, the training of police officers, and the effective integration between intelligence structures and policing units. These weaknesses compromise the efficiency of the knowledge production cycle, limiting the ability of organizations to anticipate threats. Specifically in the PMAM, although there is institutional recognition and an established intelligence structure, there is still a lack of integration mechanisms and standardized protocols for the collection and transfer of information, resulting in the loss of opportunities for the production of actionable knowledge.

In view of this panorama, the present study proposes to investigate the possibilities and challenges inherent to the operationalization of the ostensible police officer as an intelligence sensor in the context of the PMAM. The central tension of the theme lies in structuring the collection at the end without reducing intelligence to a mere accumulation of reports and without confusing the production of knowledge with typical routines of criminal prosecution. Thus, the problem arises: how to operationalize, in a structured way, the ostensible police officer as an intelligence sensor, expanding the production of knowledge with timely dissemination and standardization, without mischaracterizing the limits and purpose of the intelligence activity?

To answer this question, we seek to analyze the operationalization of the police officer as a sensor, verifying how systematic collection can strengthen the production of useful knowledge to the decision-maker. To this end, it is intended to conceptually delimit the ISP activity and its principles — with emphasis on permanence, opportunity, control and compartmentalization — and to articulate this operationalization with the logic of knowledge production (CPM), highlighting the need for planning, meeting, processing and dissemination routines.

The institutional relevance of this approach stems from the fact that intelligence, when well structured, subsidizes decisions and enhances the efficiency of the use of resources, vital in scenarios of "economy of means". Doctrinally, it is justified by the requirement for safeguards and minimum standardization, aligning the collection at the tip with the precepts of intelligence and counterintelligence. Finally, in structural terms, the work is developed from a theoretical framework on PSI and its principles, discusses the operationalization of the "sensor" as a vector of systematic collection and presents practical modeling guidelines, preserving the distinction between the production of intelligence knowledge and other police activities.

2 THEORETICAL FRAMEWORK

2.1 THEORETICAL-DOCTRINAL FOUNDATION: MISSION-COMMAND AND DELEGATION OF AUTHORITY

One of the most solid philosophical foundations to justify the integrated sensor model rests on the Mission-Command doctrine, also known as *Command by Intent* or *Auftragstaktik* in the Prussian military tradition. According to Visacro (2015, p. 72):

The reduction of decision-making cycles, through the delegation of powers to subordinate commanders, granting them greater autonomy and freedom of action, in addition to valuing initiative to the detriment of unconditional attachment to excessively restrictive orders, has become an imperative of the battlefields of the twenty-first century.

Shamir (2011), in a comparative analysis of the armies of the United States, the United Kingdom and Israel, demonstrates that modern military institutions move from the Command by Control model to the Command by Intent paradigm. This doctrinal change is characterized by the overcoming of the order based on the strict detailing of the execution in favor of the emphasis on the purpose of the mission, delegating the tactical decision to subordinates. Alves (2021) contextualizes this dynamic for the Brazilian reality and highlights the significant potential for increasing operational effectiveness through decision-making decentralization to lower levels.

From this perspective, the transposition of this logic to the intelligence sensor model is supported by Almeida (2024), by allowing the definition of a clear intention, such as the need to understand movement patterns in the Rio Negro for the detection of trafficking, to replace micromanagement. In this scenario, the military police interprets the directive and adapts the data collection to his tactical observation in loco, a process that, according to the author, dispenses with detailed instructions on the execution procedures and results in the maximization of autonomy, speed of response and quality of the information obtained.

One of the biggest obstacles to the operationalization of sensors in Brazilian military police is the phenomenon of micromanagement, documented by Castro (2016). The author observes that an excessive number of experienced commanders tend to closely control their subordinates, often driven by fear of failure or low confidence in the troops' ability to conduct tasks autonomously. The maintenance of these centralizing practices carries the risk of passivity in the subordinate echelons, resulting in the loss of tactical opportunities and the consequent ineffectiveness of intelligence gathering.

On the other hand, Visacro (2018) argues that decentralization, although it can momentarily reduce the situational awareness of the high command, is strategically superior

because it reduces the uncertainties of those who operate on the ground. Military historical analysis corroborates this perspective, indicating that autonomy in execution tends to produce more effective results than rigid control. For the effective implementation of the sensor model in PMAM, a change in command mentality is urgent, which requires what Blom (2016, p. 41) defines as mechanisms to reinforce Mission Command and foster a cultural change based on trust, through the explicit codification of leadership principles. In this context, the police officer acting as a sensor should not need prior approval to report a sensitive observation; he must report immediately via technical channel to the Area Agency. Institutional confidence in the police officer's ability to judge, a central principle of the Mission Command (Blom, 2016), becomes, therefore, the indispensable foundation of this model.

2.2 LEGAL ANALYSIS: CONSTITUTIONAL GUARANTEES AND LEGAL LIMITS

A critical gap observed by Gonçalves (2017) in the intelligence literature and legislation refers to the delimitation of constitutional guidelines for data collection activity, which often operates in an infra-legal normative vacuum. In this context of legal uncertainty, the Precautionary Measure in the Allegation of Non-Compliance with a Fundamental Precept (ADPF) No. 635, judged by the Federal Supreme Court, established basic precedents (Brasil, 2019b). The decision fills part of this gap by requiring that police operations, and by extension, the intelligence that subsidizes them, strictly observe the criteria of proportionality, necessity and adequacy, under penalty of nullity of evidence and accountability of the State.

To overcome the obstacles imposed by the legal scenario, the implementation of the concept of Sensor, understood here as the element that collects data in the operational environment to generate situational awareness (Visacro, 2018), requires a clear ontological distinction in relation to the figure of the informant. Unlike the anonymous informant, whose reports lack a presumption of veracity according to the understanding of the STJ (Brasil, 2021), the sensor is a state agent endowed with public faith. This technical qualification transforms the simple crime report into a documented evidential element, an indispensable condition to meet the criterion of well-founded suspicion necessary for the legitimacy of approaches and house searches.

The jurisprudence of the Superior Court of Justice (STJ), consolidated in Habeas Corpus 598.051/SP, rejects actions based exclusively on anonymous complaints, requiring prior and documented just cause (Brasil, 2021). In this hiatus, the sensor fills the evidential gap: by carrying out surveillance and documenting the criminal materiality before the ostensible intervention, it transforms mere suspicion into well-founded objective suspicion. However, to ensure procedural validity, it is imperative to observe the Chain of Custody

(article 158-A of the Code of Criminal Procedure), materializing the observation through records that guarantee the traceability of the evidence.

In line with the need for control, the National Council of Justice (CNJ) established, in a 2024 report, operational principles that reinforce the need for the structured sensor model (Brasil, 2024). In this context, *Accountability*, which requires intelligence acts to generate traceability for auditing, and Non-discrimination, prohibiting racial profiling as a basis for data collection, stand out. The sensor model, by focusing on objective conducts and not on subjective profiles, aligns directly with these guidelines.

In view of this normative framework, the practical application in the PMAM requires robust institutional safeguards to ensure the constitutional integrity of the model. It is imperative to formalize the accreditation of the sensor, officially designating it and distinguishing it from the anonymous informant through traceability in official systems (TCMS/PRA). At the same time, there must be a strict limitation of collection, restricting observation to public spaces and typical facts, in full respect of home inviolability and the right to privacy. Finally, it is up to the Central Agency to exercise constant auditing, supervising the purpose of each act of collection to ensure that intelligence serves exclusively criminal justice and not arbitrariness.

2.3 SIPOM OPERATIONAL ARCHITECTURE AND SENSOR INTEGRATION

According to RI-SIPOM (Amazonas, 2021), the Intelligence System is structured in five integrated hierarchical levels: the Central Agency (AC) in the 2nd Section EMG (PM-2), the Regional Agencies (AR) in the Major Commands (CPM, CPI, CPE, CPAmb), the Area Agencies (AA) in the Military Policing Battalions, and the Intelligence Centers (NIInt) in the Companies. The sensing police typically operates in the Area Intelligence Center of its CICOM, transmitting data via a technical channel to the Area Agency, which forwards it to the Central Agency for processing.

The RI-SIPOM (Amazonas, 2021) establishes two distinct communication channels. The Hierarchical Channel is used for administrative issues, such as requisitions and performance evaluation, respecting the traditional chain of command. The Technical Channel, in turn, allows direct transmission of intelligence data from the sensor to the analyst in charge, bypassing the traditional hierarchy. The guiding principle is Opportunity, according to which information deteriorates rapidly and therefore should flow as fast as possible. According to article 28 of the RI-SIPOM, the links between the bodies that are part of the SIPOM are processed through the Technical and Hierarchical Channels, with the Technical

Channel being used for the intrinsic links between the agencies, in order to provide agility in the flow of processing information of interest to the Intelligence Activity (Amazonas, 2021).

Almeida (2024) describes a complete operational model that integrates the sensor with the intelligence process through five components called Model 5i: the Commander's Intent, which comprises the transmission of the Essential Intelligence Elements (ISS); the Inputs, which consist of the collection of data by the sensor on patrol; the Interpretation, corresponding to the analytical processing by the Central Agency; the Influence, represented by the diffusion to the decision-maker; and Impact, characterized by the operational effect with *feedback* to the sensor. This model demonstrates how feedback increases sensor motivation and future collection quality.

3 METHODOLOGY

The present research adopts a qualitative approach of a descriptive nature, guided by exploratory and analytical purposes. The method of approach used was inductive, as recommended by Lakatos and Marconi (2003), allowing that, from the observation of specific facts, such as the SIPOM documentation, concrete operational cases and the related literature, general conclusions about the operational capacity of the intelligence sensor could be inferred.

With regard to the means and procedures of investigation, the study was based on a rigorous documentary analysis of institutional regulations, with emphasis on the Internal Regulations of SIPOM (Normative Ordinance No. 007/PMAM, of November 17, 2021), on the documentation related to the Administrative Recruitment Process (PRA) and on reports of integrated operations between PMAM and the Integrated Force to Combat Organized Crime (FICCO).

Concomitantly, a systematic review of the specialized literature was carried out, covering the National Doctrine of Public Security Intelligence (Brasil, 2015), the National Intelligence Doctrine of the Brazilian Intelligence Agency (Agência Brasileira de Inteligência, 2023), the Doctrine of Police Intelligence of the Federal Police (Brasil, 2019a), works on the philosophy of Mission-Command (Visacro, 2018; Alves, 2021; Shamir, 2011), recent research in military police intelligence (Almeida, 2024) and international paradigms (Patton, 2004). The investigative framework also included the jurisprudential analysis of the decision of the Federal Supreme Court in ADPF 635 (of December 2, 2019) and the respective Report of the CNJ Working Group (Brasil, 2024).

For the treatment and interpretation of the data, the content analysis technique proposed by Bardin (2011) was used, through which the documents were categorized

according to emerging themes, such as accreditation, collection techniques, legal responsibility and institutional *feedback*. In addition, structural-functional analysis was applied to examine the interactions between the components of SIPOM, distinguishing technical and hierarchical channels, agency levels and intelligence flows, as provided for in the Internal Regulations. The study ends with a comparative analysis, confronting the proposed model with documented international experiences, notably the doctrines of the Brazilian Army and the U.S. Army.

4 RESULTS AND DISCUSSIONS

4.1 OPERATIONAL SENSOR INTELLIGENCE TECHNIQUES

According to the specialized literature on public security intelligence, the fundamental capacity of the sensor rests on the OMD (Observation-Memorization-Description) tripod, described by Almeida (2024). Structured observation requires the establishment of a baseline (normal pattern of the environment), the detection of anomalies, the mental documentation of details and the initial contextualization. Memorization, in turn, uses specialized techniques such as the loci (Palace of Memory) method, precise temporal anchoring, spaced repetition, and elaborate coding. Structured description is a critical step that often fails. Effective description requires structured language with a preformatted checklist (Who, What, When, Where, How, Why), lexical precision avoiding vague generalizations, differentiation between observation and inference, and documentation in standardized form.

Structured surveillance differs from simple observation by intentionality, systematization and defined operational objective. Its components include planning, setting times and frequency, the collection checklist, methods and natural cover, and the consolidated periodic report. Operational reconnaissance is triggered to map a specific aspect of the environment in response to defined demand, being punctual and operational while surveillance is continuous and passive.

The structured interview and operational conversation is a sensitive technique where the sensor, as a police officer who interacts with citizens on patrol, can take advantage of it to collect information in a non-coercive way. The patrolman has institutional legitimacy to question citizens in public space, the conversation takes place in the ordinary context of patrol reducing defensiveness, and the sensor accumulates information from multiple sources. Effective interviewing techniques include open-ended questions, active listening, rapport building, cross-validation, and accurate logging. Critical restrictions include respect for fundamental rights, a focus on intelligence gathering (not criminal evidence), and the absence of a penalty if a citizen refuses to respond.

4.2 FORMAL ACCREDITATION: ADMINISTRATIVE RECRUITMENT PROCESS

Article 31 of the RI-SIPOM (Amazonas, 2021) establishes that the Administrative Recruitment Process (PRA) is the set of activities carried out by the competent sector of SIPOM, specifically the Counterintelligence Subsection, with the purpose of selecting staff for the Intelligence Activity of the Military Police, in order to enable the production of knowledge and the efficient advice on the decision-making process. The critical objective is to ensure that only military police officers with a compatible profile (moral, psychological, and technical) act as sensors, mitigating risks of data contamination, misuse of information, leakage of operations, and violation of human rights.

The PRA is structured in six sequential phases:

- a) Signaling: identification of potential military police officer by the commander or head of agency;
- b) Approach: formalization of interest to the candidate with a clear explanation of the assignment;
- c) Personnel Investigation Report (RIP): consists of carrying out a survey, as complete as possible, on the PM to be recruited, under the supervision of the Central Agency, formalized with the opinion of the Commander of the OPM concerned;
- d) Selection: moment when the Central Agency decides on accreditation;
- e) Qualification/Training: minimum of 40-60 hours for Basic Training by SS-10;
- f) Accreditation: authorization from the Commander-General, published in the Reserved General Bulletin, for the recruited military police officer to join the Intelligence Activity, after completing the previous phases.

Finally, the sensor signs a binding Term of Commitment to Maintain Confidentiality (TCMS) with a commitment to maintain absolute confidentiality when dealing with matters contained in confidential and secret documents. The document spells out legal penalties for breach of confidentiality under the Brazilian Penal Code, including article 153, § 1 (disclosing confidential information, punishable by 2-6 months in prison plus a fine), article 313 (entering false data into a system, punishable by 1-4 years plus a fine) and article 325, § 1 (allowing unauthorized access, punishable by 6 months to 2 years). The sensor is also subject to immediate disaccreditation, disciplinary proceedings and civil actions.

4.3 PROPOSED MODEL OF PROGRESSIVE TRAINING

The institutionalization of the figure of the sensor requires a training program structured at sequential and cumulative levels, designed to ensure technical proficiency and

legal certainty of action. In line with the need to transform the police organization into a "learning organization", as advocated by Shultz (2016), a multilevel pedagogical architecture is proposed, whose objectives and performance indicators are detailed below, aiming to overcome the training gap identified in the conventional troop.

4.3.1 Multilevel Teaching Architecture

Level 1 (Mandatory Basic Training) is the basis of the system, and is intended for all military police officers in the process of training (CFO and CFP) and for volunteer operational personnel. Following the "police officer as sensor" model advocated by Almeida (2024), the 16-hour annual curriculum covers the fundamentals of Public Security Intelligence and the OMD (Observation, Memorization, and Description) tripod technique with intensive practice. Success indicators project that 90% of the staff will complete the training, ensuring the massification of the doctrine of qualified collection at the end of the line (Almeida, 2024).

Level 2 (Structured Specialization) is aimed at police officers selected via the Administrative Recruitment Process (PRA) to act as regular sensors, according to the RI-SIPOM suitability criteria (Amazonas, 2021). This 32-hour module delves into Knowledge Production Methodology and Critical Analysis, essential for transforming raw data into actionable intelligence. The goal is for 90% of students to demonstrate practical ability in simulated exercises, ensuring that the accredited sensor has the technical competence required to operate the intelligence channels provided for in the institutional standard (Brasil, 2021).

Finally, Level 3 (Continuing Education) ensures the continuity of knowledge for accredited active sensors, in line with Blom's (2016) perspective on the need for constant reinforcement of the principles of leadership and trust. With a mandatory annual workload of 8 hours, the module focuses on doctrinal updating and case studies, aiming to mitigate the degradation of technical knowledge over time. The goal is to ensure that 100% of active sensors maintain their valid certification, promoting a culture of continuous learning and adaptation to new criminal dynamics (Blom, 2016).

4.3.2 Operational Success Indicators

To measure the effectiveness of implementation, eight quantitative indicators are defined with progressive goals, based on the logic of systemic *feedback* essential for the Mission Command described by Visacro (2018). Of note are the expansion of the number of Accredited Sensors (from 30 to 400) and the reduction of the decision-making cycle (Collection-Analysis Time) from 7 to 2 days. Such metrics aim to materialize the principle of

administrative and operational efficiency, allowing the command to objectively evaluate the return on investment in the qualification of the troop (Visacro, 2018).

4.4 STRATEGIC APPLICABILITY IN THE AMAZON CONTEXT

The geographic and operational singularities of the State of Amazonas make the implementation of the intelligence sensor not only a measure of efficiency, but an imperative of capillarity and territorial control. As Bothona and Chycziy (2022) observe, the jungle operational environment, characterized by demographic voids and logistical isolation, imposes a model where the combatant at the end of the line acts as the main vector for obtaining data. The vastness of more than 1.5 million km² and the river dependence require each police officer to function as a proxy for information, capable of reading the terrain and local dynamics that escape the technological means of surveillance (Bothona; Chycziy, 2022).

The validity of this model is empirically supported by the experience of the Brazilian Army, which institutionalized the concept of "every military member as a sensor" in operations along the border and in the Guarantee of Law and Order (GLO). According to Bothona and Chycziy (2022), the inclusion of the Intelligence discipline in military training curricula increased the quality of data collection by about 30-40% and reduced operational surprises. This *benchmark* demonstrates that training troops for systematic observation is the most effective strategy for operating in highly complex and dispersed environments such as the Amazon (Bothona; Chycziy, 2022).

5 CONCLUSION

The present investigation showed that the operationalization of the concept of sensing policeman in the Military Police of Amazonas is not an isolated theoretical proposition, but finds a robust foundation in the National Doctrine of Public Security Intelligence (DNISP), (Brasil, 2015) and in the philosophy of Mission Command. The convergence between the theoretical frameworks of Visacro (2018), Shamir (2011), and Alves (2021), added to the empirical validation observed in the practices of the Brazilian Army and the US Army described by Bothona and Chycziy (2022), confirms that the decentralization of data collection is a consolidated doctrine for highly complex environments.

With regard to legal certainty, the full viability of the proposed model within the current legal system was verified. SIPOM's Internal Regulations establish a complete formal framework, including the Administrative Recruitment Process (PRA), the Term of Commitment to Maintain Confidentiality (TCMS) and the accreditation protocols (Brasil,

2021). In addition, adherence to the guidelines of ADPF 635 of the STF (Brasil, 2019b) and the guidelines of the CNJ (Brasil, 2024) ensures that intelligence activity respects fundamental rights, mitigating risks of procedural nullity and ensuring the legality of the operations supported by these collection vectors.

The operational potential of the model is exceptional in the face of the singularities of the Amazonian context. The territorial vastness of more than 1.5 million km², associated with the dependence on the river modal and the isolation of communities, makes human capillarity the most critical resource for land control. The application of the economy of means, a principle of warfare adapted to public security, suggests that investment in sensor training generates an exponential operational return, allowing the anticipation of threats that conventional means of surveillance would not detect.

The implementation challenges identified, although existing, are surmountable and do not require non-existent technologies, but rather political will and process adjustment. Overcoming the training gap requires the standardization of procedures and investment in training workloads compatible with the complexity of the function (40-60 hours), as recommended in Almeida's (2024) police education modernization models.

In view of this, it is institutionally recommended the formal approval of the training program and the allocation of specific budgetary resources, actions that should be led by the High Command to foster the culture of organizational innovation described by Shultz (2016). For the Central Agency, the guideline should focus on detailing the progressive curriculum and implementing *feedback protocols*, closing the intelligence loop and maintaining the troops' motivation, a central element in Blom's theory (2016). The Regional Commands, on the other hand, have the operational goal of identifying candidates and integrating the intelligence product into their tactical meetings, ensuring the practical application of knowledge.

Finally, for the continuity of doctrinal development, future research is suggested that includes empirical validation through pilot programs in Community Interactive Companies (CICOM) and cost-benefit analyses. Such studies, based on rigorous scientific methodology, will allow the longitudinal monitoring of success indicators, consolidating the intelligence sensor as a legacy of efficiency for public security in Amazonas.

REFERENCES

- Almeida, L. O. (2024). Todo policial é um sensor de inteligência: O desafio de transformar os policiais militares da Bahia que atuam no policiamento ostensivo em coletores sofisticados de inteligência. *Bahia Análise & Dados*, 34(2), 111–126. <https://doi.org/10.56839/bd.v34i2.a7>
- Alves, O. P. (2021). A aplicabilidade dos conceitos de Missão pela Finalidade (Auftragstaktik) e da Missão-Comando (Mission Command) na Doutrina Militar Terrestre brasileira. *A Defesa Nacional*, 845, 20–32. <http://www.ebrevistas.eb.mil.br/ADN/article/view/9029>
- Amazonas. Polícia Militar. (2021). Portaria Normativa nº 007, de 17 de novembro de 2021. Aprova o Regimento Interno do Sistema de Inteligência da Polícia Militar do Amazonas (RI-SIPOM).
- Bardin, L. (2011). *Análise de conteúdo*. Edições 70.
- Blom, G. M. (2016). Uma mudança cultural baseada na confiança: Repensando o modelo de requisitos de liderança do Exército dos EUA na era do comando de missão. *Military Review: The Professional Journal of the U.S. Army*, 71(3), 40–48. https://www.armyupress.army.mil/Portals/7/military-review/Archives/Portuguese/MilitaryReview_20160630_art009POR.pdf
- Bothona, R. P., & Chyczkiy, L. (2022). A atuação dos comandantes de fração para implementar o conceito da tropa como sensor de inteligência nas operações militares de não-guerra. *A Lucerna*, 11(11), 11–20. <https://pt.scribd.com/document/915077698/Atuacao-de-Coamndantes-de-Fracao-Para-Implementar-o-Conceito-de-Trpoa-Como-Sensor>
- Brasil. Agência Brasileira de Inteligência. (2023b). Doutrina de atividade de inteligência. Abin.
- Brasil. (1941). Decreto-Lei nº 3.689, de 3 de outubro de 1941. Código de Processo Penal. Presidência da República. http://www.planalto.gov.br/ccivil_03/decreto-lei/del3689.htm
- Brasil. Conselho Nacional de Justiça. (2024). Relatório do Grupo de Trabalho sobre ADPF 635. CNJ.
- Brasil. Ministério da Justiça. Secretaria Nacional de Segurança Pública. (2015). Doutrina nacional de inteligência de segurança pública: DNISP (4ª ed. rev. e atual.). Ministério da Justiça.
- Brasil. Ministério da Justiça e Segurança Pública. Polícia Federal. Diretoria de Inteligência Policial. (2019a). Doutrina de inteligência policial. Diretoria de Inteligência Policial.
- Brasil. Ministério da Justiça e Segurança Pública. Secretaria Nacional de Segurança Pública. (2023a). Curso de Introdução à Atividade de Inteligência - CIAI. SENASP.
- Brasil. Superior Tribunal de Justiça. (2021). Habeas Corpus nº 598.051/SP. Relator: Min. Rogério Schietti Cruz. Sexta Turma. https://processo.stj.jus.br/processo/julgamento/electronico/documento/mediado/?documento_tipo=integra&documento_sequencial=121676644
- Brasil. Supremo Tribunal Federal. (2019b). Medida Cautelar na Arguição de Descumprimento de Preceito Fundamental 635. Relator: Min. Edson Fachin. <https://portal.stf.jus.br/processos/downloadPeca.asp?id=15341906562&ext=.pdf>
- Castro, C. (2016). *A invenção do Exército brasileiro*. Jorge Zahar.
- Gonçalves, J. B. (2017). *Atividade de inteligência e legislação correlata* (6ª ed.). Impetus.

- Instituto Brasileiro de Geografia e Estatística. (2023). Área territorial brasileira. <https://www.ibge.gov.br/cidades-e-estados/am.html>
- Lakatos, E. M., & Marconi, M. de A. (2003). Fundamentos de metodologia científica (5ª ed.). Atlas.
- Patton, M. S. (2004). Every soldier is a sensor (ES2): The future of intelligence collection. U.S. Army Command and General Staff College.
- Ratcliffe, J. H. (2008). Intelligence-led policing. Willan Publishing. <https://www.taylorfrancis.com/books/mono/10.4324/9780203118245/intelligence-led-policing-jerry-ratcliffe>
- Silva, M. P. H. da, Oliveira Júnior, A. de, & Ribeiro, A. C. M. L. (2023). Uma visão crítica sobre a ausência de protocolo geral de integração de agências na inteligência em segurança pública. Revista Brasileira de Inteligência, 18, 228. <https://doi.org/10.58960/rbi.2023.18.228>
- Shamir, E. (2011). Transforming command: The pursuit of mission command in the U.S., British, and Israeli armies. Stanford University Press. <https://www.sup.org/books/politics/transforming-command>
- Shultz, R. (2016). Military innovation in war: It takes a learning organization: A case study of Task Force 714 in Iraq (JSOU Report 16-6). JSOU Press. <https://jsouapplicationstorage.blob.core.windows.net/press/152/16-6.pdf>
- Visacro, A. (2018). A guerra na era da informação. Contexto. https://www.marinha.mil.br/ensino/sites/www.marinha.mil.br/ensino/files/proleitura/RES_ENHA-HNMD-1T%20%28T%29%20Porto.pdf
- Visacro, A. (2015). Guerra irregular: Terrorismo, guerrilha e movimentos de resistência ao longo da história. Contexto.
- Weisburd, D., & Braga, A. A. (Eds.). (2019). Police innovation: Contrasting perspectives (2ª ed.). Cambridge University Press.

HEALTH HABITS, DIGITAL MEDIA, AND PUBLIC SCHOOL: RESULTS OF A STUDY WITH ADOLESCENTS IN ANANINDEUA, PA (BRAZIL)

HÁBITOS DE SAÚDE, MÍDIAS DIGITAIS E ESCOLA PÚBLICA: RESULTADOS DE UMA PESQUISA COM ADOLESCENTES EM ANANINDEUA-PA

HÁBITOS DE SALUD, MEDIOS DIGITALES Y ESCUELA PÚBLICA: RESULTADOS DE UNA INVESTIGACIÓN CON ADOLESCENTES EN ANANINDEUA-PA



<https://doi.org/10.56238/sevened2026.008-144>

Valéria de Nazaré de Paula Bessa¹, Éder do Vale Palheta², Biratan dos Santos Palmeira³, Moisés Simão Santa Rosa de Sousa⁴, Cileide Tavares Borges do Couto⁵, Márcia de Araujo da Costa⁶, Marco Antônio Barros dos Santos⁷, Dario Deivid Silva da Silva⁸

ABSTRACT

This study analyzed the formation of health habits during adolescence, considering their relationship with social, economic, and institutional factors, with emphasis on the role of the school as a strategic space for promoting well-being. The research was conducted through questionnaires applied to students from a public school in the municipality of Ananindeua (PA), allowing the identification of perceptions, practices, and challenges related to nutrition, physical activity, and the use of digital media. The results showed that although adolescents recognize the importance of a healthy lifestyle, they face multiple structural, financial, emotional, and cultural barriers to transforming this knowledge into daily practice. The hypotheses demonstrated that educational strategies in the school environment increase students' awareness of health and self-care; however, such actions are still punctual and poorly integrated into the school curriculum. Practical and culturally contextualized programs favored greater student engagement, although they are limited by the lack of infrastructure and continuous public policies. In addition, excessive use of digital media was identified as a risk factor, but it can be re-signified as a pedagogical resource when critically mediated. It is concluded that the school plays a central role in building healthy habits; however, its effectiveness depends on permanent, intersectoral actions sensitive to youth realities, integrating education, health, and social participation.

Keywords: Health Habits. Adolescence. Public School. Health Promotion. Digital Media.

¹ Dr. in Education Sciences. Secretaria de Educação do Pará (SEDUC/PA). E-mail: valeria.apaula@escola.seduc.pa.gov.br

² Dr. in Education Science. Secretaria de Educação do Pará (SEDUC/PA). E-mail: edervpalheta@gmail.com

³ Dr. in Education Sciences. Instituto Federal do Pará (IFPA). E-mail: biratanpalmeira1@gmail.com

⁴ Dr. in Sport Sciences. Universidade do Estado do Pará (UEPA). E-mail: moisesuepa@gmail.com

⁵ Dr. in Education Sciences. Secretaria de Educação do Pará (SEDUC/PA). E-mail: cileideb@gmail.com

⁶ Dr. in Education Sciences. Facultad Interamericana de Ciencias Sociales (FICS). E-mail: mdearaujodacosta@gmail.com

⁷ Dr. in Education Science. Universidade do Estado do Pará (UEPA). E-mail: mabs.san@yahoo.com

⁸ Dr. in Education Science. Facultad Interamericana de Ciencias Sociales (FICS – PY). E-mail: dario.silva@escola.seduc.pa.gov.br

RESUMO

A pesquisa analisou a formação de hábitos de saúde na adolescência, considerando sua relação com fatores sociais, econômicos e institucionais, com ênfase no papel da escola como espaço estratégico para a promoção do bem-estar. O estudo foi desenvolvido a partir da aplicação de questionários a estudantes de uma escola pública do município de Ananindeua (PA), permitindo identificar percepções, práticas e desafios relacionados à alimentação, à atividade física e ao uso das mídias digitais. Os resultados evidenciaram que, embora os adolescentes reconheçam a importância de uma vida saudável, enfrentam múltiplas barreiras estruturais, financeiras, emocionais e culturais para transformar esse conhecimento em prática cotidiana. As hipóteses investigadas demonstraram que estratégias educativas no espaço escolar ampliam a conscientização dos estudantes sobre saúde e autocuidado, porém ainda ocorrem de forma pontual e pouco integrada ao currículo. Observou-se que programas práticos e culturalmente contextualizados favorecem maior engajamento juvenil, embora sejam limitados pela ausência de infraestrutura e de políticas públicas contínuas. Além disso, constatou-se que o uso excessivo das mídias digitais constitui fator de risco, mas pode ser ressignificado como recurso pedagógico quando mediado criticamente. Conclui-se que a escola exerce papel central na construção de hábitos saudáveis, contudo sua efetividade depende de ações intersetoriais, permanentes e sensíveis às realidades juvenis, integrando educação, saúde e participação social.

Palavras-chave: Hábitos de Saúde. Adolescência. Escola Pública. Promoção da Saúde. Mídias Digitais.

RESUMEN

La investigación analizó la formación de hábitos de salud en la adolescencia, considerando su relación con factores sociales, económicos e institucionales, con énfasis en el papel de la escuela como espacio estratégico para la promoción del bienestar. El estudio se desarrolló mediante la aplicación de cuestionarios a estudiantes de una escuela pública del municipio de Ananindeua (PA), lo que permitió identificar percepciones, prácticas y desafíos relacionados con la alimentación, la actividad física y el uso de los medios digitales. Los resultados evidenciaron que, aunque los adolescentes reconocen la importancia de una vida saludable, enfrentan múltiples barreras estructurales, financieras, emocionales y culturales para transformar este conocimiento en práctica cotidiana. Las hipótesis demostraron que las estrategias educativas en el ámbito escolar amplían la concientización sobre la salud y el autocuidado; sin embargo, estas acciones todavía ocurren de forma puntual y poco integradas al currículo escolar. Se observó que los programas prácticos y culturalmente contextualizados favorecen un mayor compromiso juvenil, aunque se ven limitados por la falta de infraestructura y de políticas públicas continuas. Asimismo, se constató que el uso excesivo de los medios digitales constituye un factor de riesgo, pero puede resignificarse como recurso pedagógico cuando es mediado críticamente. Se concluye que la escuela desempeña un papel central en la construcción de hábitos saludables, aunque su efectividad depende de acciones permanentes, intersectoriales y sensibles a las realidades juveniles, integrando educación, salud y participación social.

Palabras clave: Hábitos de Salud. Adolescencia. Escuela Pública. Promoción de la Salud. Medios Digitales.

1 INTRODUCTION

The contemporary conception of health overcomes the traditional biomedical view, historically restricted to the absence of diseases, and is now understood from a broader and integral perspective of the human being. In this sense, this article, which originated from a doctoral research, is based on an approach that understands health as a process built on social, cultural, emotional and environmental interactions, recognizing the inseparable relationship between body, mind and life context.

In the school context, health promotion is part of the institution's formative project as it constitutes an axis of human development. School Physical Education occupies a strategic place in this process by articulating scientific knowledge, bodily experiences and critical reflection on care for oneself, for others and for the environment. When guided by a broader conception of health, its pedagogical practice contributes to motor development, to students' autonomy and to the construction of choices associated with quality of life, expanding the educational meaning of bodily experiences (Silveira, 2024).

However, adolescents from public schools face challenges that make it difficult to adopt and perceive healthy habits, inserted in a multifactorial and complex context, in which sedentary lifestyle, unbalanced eating patterns, excessive use of digital devices and unfavorable socioeconomic conditions stand out. The combination of these factors intensifies situations of social vulnerability and requires contextualized educational actions, based on current scientific evidence and sensitive to local realities (Barbosa, 2021; Nascimento Santos, 2022).

Despite advances in scientific production, there are still limited studies that jointly address the diet, physical activity and quality of life of adolescents in the context of public schools.

In this scenario, it is necessary to investigate how habits related to food, physical activity and quality of life are configured among adolescents in public schools, as well as to understand the role of Physical Education in mediating these processes. This study is part of this perspective by analyzing empirical data obtained through a questionnaire applied to students, articulating them with the theoretical framework of the area and with pedagogical proposals aimed at health promotion in the school space.

Thus, this article aims to analyze the construction of healthy habits among adolescents in a public school, with emphasis on dietary aspects and quality of life, discussing the results in the light of the scientific literature and current educational policies. Thus, it seeks to contribute to the strengthening of integrated, critical educational practices committed to human development in its entirety.

2 THEORETICAL FRAMEWORK

2.1 ADOLESCENCE, HEALTH AND CONSTRUCTION OF LIFESTYLE HABITS

Adolescence is a stage of human development marked by intense biological, emotional and social transformations, configuring itself as a decisive period for the consolidation of habits that tend to accompany the individual throughout adult life. Recent studies highlight that this phase should be understood as a process of identity construction crossed by cultural, economic, and institutional factors that directly influence health-related choices (Silva; Nunes, 2021; Camilo, 2024). Thus, the behaviors associated with food, physical activity and the use of daily time are produced in social interactions and not only defined by individual decisions.

According to the World Health Organization, adolescence comprises the age group between 10 and 19 years old and represents a strategic period for the implementation of health promotion actions, since the behaviors acquired at this stage tend to persist into adulthood (World Health Organization - WHO, 2022). However, such choices do not occur in isolation, but are mediated by family, school and territorial conditions. In this sense, adolescence is simultaneously configured as a window of opportunity and as a period of greater vulnerability to the adoption of harmful practices when there are no continuous public policies and systematic educational actions (PAHO, 2022; BRAZIL, 2023).

Contemporary literature shows that youth habits are built in social contexts marked by structural inequalities. The report Scenario of Childhood and Adolescence in Brazil points out that a significant portion of Brazilian adolescents live in a situation of social vulnerability, with limited access to adequate food, leisure spaces, and health services, especially in the North and Northeast regions (Abrinq Foundation, 2022). This reality reinforces that the formation of healthy habits cannot be understood only as an individual responsibility, but as an expression of the opportunities and restrictions imposed by the social environment.

From a sociocultural perspective, recent research indicates that adolescence is a period in which the processes of autonomy and personality construction are intensified, being profoundly influenced by school experiences and relationships with peers (Alves; Braga, 2023; Ferreira *et al.*, 2024). Thus, behaviors related to the body, food, and self-care should be understood as socially produced practices, permeated by symbolic values and cultural dynamics typical of contemporary youth.

The current conception of health goes beyond the biomedical view centered on the absence of diseases and begins to recognize the subject in his physical, emotional and social integrality. Minayo (2021) highlights that health-related phenomena need to be analyzed based on the complexity of ways of life and the material conditions of existence. In this sense,

recent studies indicate that factors such as sedentary lifestyle, consumption of ultra-processed foods, and intensive use of digital technologies, intensified in the post-pandemic period, tend to crystallize in adult life, increasing risks to quality of life (Castro *Et al.*, 2021; Guimarães, 2025).

In this context, the school assumes a strategic role in the mediation between scientific knowledge and youth practices. Camilo *et al.* (2024) highlight that educational actions aimed at health promotion are more effective when integrated into the school curriculum and articulated with the sociocultural realities of students. Similarly, Silveira (2024) points out that school Physical Education, when guided by an expanded conception of health, contributes to the formation of critical and autonomous attitudes in relation to self-care. Thus, adolescence should be understood as a period that requires integrated educational approaches, capable of promoting autonomy, criticality and integral human development.

2.2 DIET, PHYSICAL ACTIVITY AND YOUTH VULNERABILITY

The literature shows that the dietary patterns and levels of health care of adolescents are strongly conditioned by socioeconomic, territorial and cultural factors. Studies show that young people in contexts of social vulnerability face greater difficulties in maintaining regular self-care practices, due to financial limitations, the reduced supply of healthy food, and the environmental conditions that permeate their territories of life (Teixeira, 2024, Barbosa *et al.*, 2021).

Figure 1

Overweight and obesity in Brazilian adolescents



Source: Brazil, Ministry of Health (2020).

The Figure shows the seriousness of the situation by demonstrating that millions of students are overweight or obese. This information reinforces that the debate goes beyond individual perceptions and is configured as a public health problem that must be faced

seriously in the school context. In this sense, the school assumes a strategic role in promoting educational actions aimed at building healthy eating habits and the regular practice of physical activity, contributing to the prevention of health problems (SISVAN, 2024)

The nutritional transition observed in Brazil is characterized by the replacement of fresh foods with ultra-processed products, influenced by the advertising, practicality, and low cost of these products (PAHO, 2019). Bittar and Soares (2020) highlight that this process is intensified among young people, especially in peripheral territories.

In addition, contemporary processes of food consumption, associated with sociocultural transformations and dynamics of inequality, tend to favor the consolidation of inadequate eating habits, characterized by increased consumption of ultra-processed products and decreased nutritional diversity. Such a scenario compromises not only the physical health, but also the psychosocial development of adolescents, configuring diet as a field crossed by social determinants that directly influence the construction of lifestyles and quality of life at this stage of the life cycle.

In the field of physical activity, Silva *et al.* (2008) show that inactivity among Brazilian adolescents remains high, being influenced by the absence of safe public spaces, lack of time and the financial cost of sports practices.

Legnani *et al.* (2021) state that the promotion of physical activity depends on the creation of attractive, accessible, and continuous environments, overcoming specific actions. Graça *et al.* (2024) reinforce that bodily practices should be understood as cultural and social experiences, and not just as physical exercises.

In this context, the school is configured as a mediating space capable of integrating food, body movement and critical education, as defended by Pereira *et al.* (2017), when analyzing educational interventions aimed at reducing the consumption of ultra-processed foods.

2.3 DIGITAL MEDIA, SCREEN TIME AND SCHOOL PRACTICES

The intensive use of digital media has become one of the main markers of contemporary adolescence. Zancan and Tono (2018) state that digital technologies reconfigure social times and modes of youth socialization, directly impacting sleep, attention, and school performance.

Antoniassi *et al.* (2024) demonstrate that excessive screen time is associated with a sedentary lifestyle, the consumption of ultra-processed foods, and a decrease in face-to-face interactions. The Pan American Health Organization recommends limiting leisure time in front of screens as a preventive strategy (PAHO, 2019).

Bittar and Soares (2020) identify a correlation between hyperconnectivity and sleep disorders, as well as an increase in inappropriate eating behaviors during the prolonged use of electronic devices.

The school, in this scenario, should not assume a moralizing or technophobic posture, but promote a critical education about the use of technologies, as proposed by Morin (2001). Freire (1996) defends a dialogical pedagogy, in which the subjects actively participate in the construction of meanings and transformative practices.

Camilo *et al.* (2024) reinforce that school health promotion programs need to integrate diet, physical activity, mental health, and conscious use of technologies, overcoming isolated and fragmented actions in the educational environment.

Thus, pedagogical workshops and school practices are privileged instruments for the collective construction of healthy habits, as long as they are based on active listening to students and permanent interdisciplinary proposals.

3 METHODOLOGY

The present study adopts a qualitative and descriptive approach, with the objective of understanding the perceptions and practices related to the construction of healthy habits among adolescents in the school context. The choice for this design is based on the need to interpret meanings, experiences and social representations associated with food, physical activity and quality of life, aspects that cannot be apprehended only through quantitative data (Minayo, 2001; Gil, 2008).

The research was developed in a state public high school located in the municipality of Ananindeua-PA, part of the Metropolitan Region of Belém. The choice of this empirical field is justified by its social characteristics marked by structural inequalities, limitations in access to leisure spaces and challenges related to the promotion of youth health. The institution participates in the Health at School Program, developing actions aimed at healthy eating, disease prevention and encouragement of physical activity, which favored the articulation between the object of study and the context investigated.

The research population was composed of students regularly enrolled in high school, and the sample consisted of 100 adolescents, aged between 14 and 18 years, selected by accessibility criteria and through voluntary participation. All participants signed the Informed Consent Form (ICF) and the Consent Form, in accordance with the ethical principles of research with human beings (Lakatos; Marconi, 2017).

As an instrument for data collection, a structured questionnaire was used, consisting of closed and open questions, elaborated based on the objectives of the study and the

dimensions related to diet, physical activity, the use of digital technologies and the perception of quality of life. The instrument was submitted to a pre-test with a small group of students from the same institution, allowing adjustments regarding the clarity and adequacy of the language to the adolescent public. The application took place in the classroom, during the school period, with an average response time between 20 and 30 minutes (Gil, 2008).

The data from the closed questions were organized in electronic spreadsheets and analyzed using simple descriptive statistics, with presentation of frequencies and percentages. The open answers were submitted to the content analysis technique, according to Bardin (apud Minayo, 2001), involving exhaustive reading, thematic categorization and interpretation of the meanings expressed by the participants. Subsequently, the triangulation between quantitative and qualitative data was carried out, seeking to increase the interpretative consistency of the results.

The research complied with the ethical principles established by Resolution No. 466/2012 of the National Health Council. The anonymity of the participants was guaranteed through identification by numerical codes, as well as the confidentiality of the information obtained. Participation occurred voluntarily, without any pedagogical prejudice to the students, and the school institution formally authorized the study (Minayo, 2001; Lakatos; Marconi, 2017).

4 RESULTS

The results of this research were organized into three analytical axes, in order to ensure clarity, thematic unity and articulation between empirical data and theoretical foundation. Initially, data related to the participants' profile and perception of well-being are presented. Then, eating practices and physical activity levels are analyzed. Finally, the impacts of digital media and adolescents' perceptions of school practices aimed at health promotion are discussed.

The analysis is not limited to the descriptive exposition of the data, but seeks to interpret them in the light of the scientific literature, understanding juvenile habits as phenomena crossed by social, cultural, educational and technological factors.

4.1 PROFILE OF PARTICIPANTS AND PERCEIVED HEALTH CONDITIONS

The first axis of analysis refers to the sociodemographic characteristics of adolescents and the subjective perception of well-being. Most participants are between 15 and 16 years of age, a period marked by intense biological, emotional and social transformations, which directly influence the construction of health-related habits. According to Eisenstein (2005),

adolescence should be understood as a stage of identity redefinition and consolidation of behaviors that tend to extend into adult life.

A relatively balanced distribution between genders was observed, with a predominance of females. Studies indicate that girls tend to be more concerned with body image and aesthetic standards, while boys are more frequently associated with sports practice, reflecting different social constructions about body and health (Carvalho *et al.*, 2020; Bittar; Soares, 2020). This configuration requires gender-sensitive analyses while avoiding simplifying generalizations.

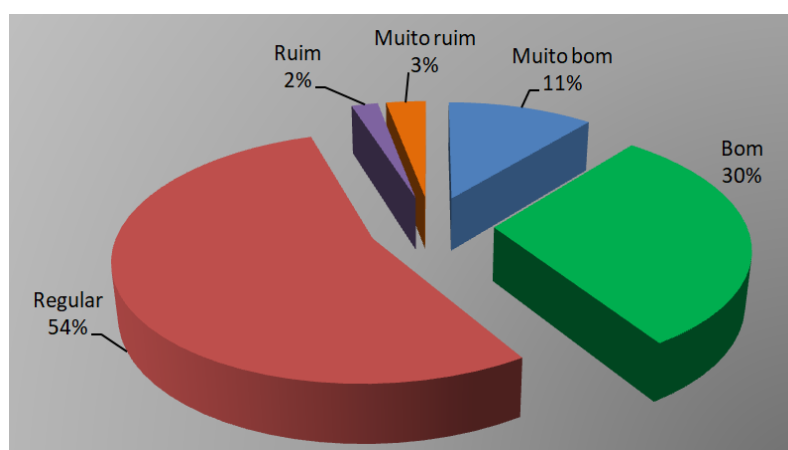
Regarding education, the sample is composed mostly of high school students, which ensures homogeneity to the investigated group and reinforces the role of the school as a privileged space for health promotion. The centrality of the school institution in the routine of these adolescents points to the relevance of articulated public educational and health policies (Camilo *et al.*, 2024; Brazil, 2023).

With regard to insertion in the workplace, the majority declared that they do not have a paid activity, although a significant portion reconciles study and work. The literature points out that early insertion in the labor market tends to compromise the time allocated to leisure, adequate nutrition and the practice of physical activity (Barcelos *et al.*, 2010; Jesus *et al.*, 2011).

The daily workday revealed that a large part of them spend between five and six hours in school or work activities, configuring the school as the organizing nucleus of the youth's daily life. A smaller portion has time overload, with working hours longer than seven hours, a condition associated with reduced sleep, increased consumption of ultra-processed foods and less adherence to physical activity (Fontes *et al.*, 2023).

Figure 2

How do you assess your well-being today?



Source: Prepared by the Author (2025)

Figure 2. 'How do you assess your well-being today?' shows that most adolescents rate their current condition as regular (54%), followed by 30% who consider it good and only 11% who describe it as very good. On the other hand, about 5% evaluated their own well-being as bad or very bad.

The perception of well-being showed a predominance of the answer "regular", followed by "good" and "very good", with a small portion indicating "bad" or "very bad". This result suggests a fragile balance between school demands, social pressures and living conditions. Adolescent well-being should be understood as a multidimensional phenomenon, involving physical, emotional, social and school aspects (Eisenstein, 2005; Barcelos *et al.*, 2010).

Although some of the students report good health perception, the presence of negative evaluations points to situations of vulnerability that require institutional attention. The school thus emerges as a strategic space for preventive and comprehensive care actions (Camilo *et al.*, 2024).

4.2 EATING PRACTICES AND LEVEL OF PHYSICAL ACTIVITY

Diet and physical activity are central pillars in the promotion of health in adolescence. The data reveal a reality marked by contrasts between protective practices and risk behaviors. Part of the adolescents claim to have regular meals and consume fresh foods, while another portion has irregular habits and high contact with ultra-processed foods, confirming the nutritional transition described in the literature (PAHO, 2019; Bittar; Soares, 2020).

As for breakfast, most reported having this meal regularly, but a significant contingent stated that they consumed it only occasionally or not at all. The absence of this meal is associated with poorer diet quality and lower school performance (Couto *et al.*, 2014).

The consumption of fruits and vegetables was below the official recommendations, while the consumption of ultra-processed foods remains frequent. Such a scenario evidences the influence of the food market and the media on youth choices (Pereira *et al.*, 2017; PAHO, 2019).

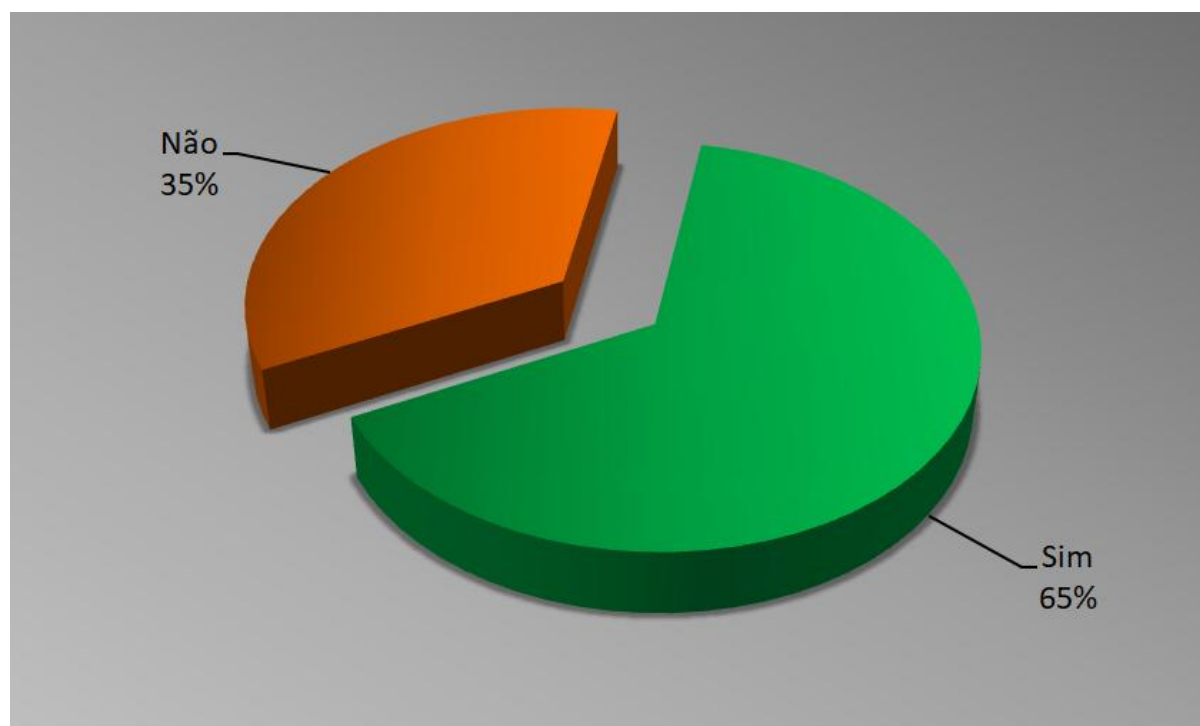
Open-ended responses revealed ambiguous perceptions: many adolescents rate their diet as "good" or "regular" but express a desire to make it healthier. This contradiction confirms that self-assessment does not always correspond to technical criteria (Tavares *et al.*, 2014).

Regarding physical activity, most stated that they practiced some type of exercise, but with irregular frequency. A significant portion remains in a sedentary condition. The recommendation is at least 60 minutes of moderate to vigorous activity daily (PAHO, 2019).

The practice environments revealed greater use of streets, squares and residences, while the school appears with less centrality (Barcelos *et al.*, 2010; Graça *et al.*, 2024). The barriers reported — lack of time, lack of motivation, costs and absence of adequate spaces — indicate that the problem is not a lack of interest, but a lack of structural conditions to transform desire into continuous practice (Legnani *et al.*, 2021).

Figure 3

Do you practice physical activity regularly?



Source: Prepared by the Author (2025)

Sporadic practice, as in the group that is limited to once a week, may be insufficient to bring effective health benefits, functioning more as a one-off effort than as a consolidated habit (Legnani *et al.*, 2021).

4.3 IMPACT OF DIGITAL MEDIA AND PERCEPTIONS ON SCHOOL PRACTICES

The intensive use of digital media is one of the main markers of contemporary adolescence. The data indicate a high time of exposure to screens, often replacing physical, cultural and social activities (Zancan; Tono, 2018; Antoniassi *et al.*, 2024).

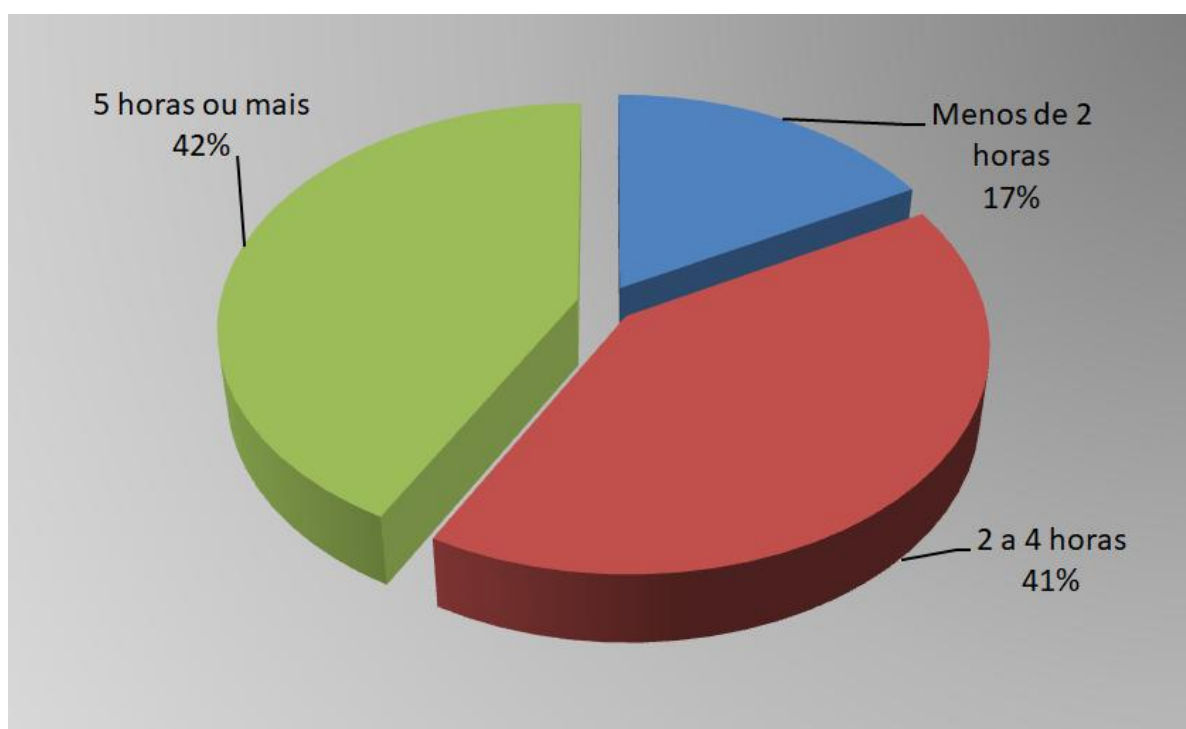
Most participants recognize that screen time interferes, totally or partially, with sleep and concentration, which confirms studies on the correlation between screens, inadequate diet and sedentary lifestyle (Bittar; Soares, 2020). However, a portion does not perceive direct impacts, indicating a possible naturalization of hyperconnectivity.

When asked what they would do if they spent less time online, the adolescents indicated a desire to practice sports, socialize with friends, study and develop cultural activities, evidencing critical awareness about the imbalance between desire and practice (Morin, 2001).

The fragility of continuous actions confirms that specific initiatives are not enough to promote structural changes in youth habits (Silva; Garcia, 2020). The youth protagonism present in the answers dialogues with Freire's perspective of critical and participatory education (Freire, 1996).

Figure 4

On average, how many hours a day do you spend on your cell phone, computer or video game (outside of school hours)?



Source: Prepared by the Author (2025)

Even more concerning is the reported impact of this heavy use on fundamental dimensions such as sleep and concentration. Figure 4. Do you feel that screen time interferes with your sleep or concentration? shows that 27% clearly recognize this interference, 46% say that it occurs sometimes and another 27% say they do not feel influence. The centrality of the answer "sometimes" indicates that the perception of negative effects is not stable, but fluctuates according to the intensity of the use or the context in which it occurs.

5 FINAL CONSIDERATIONS

The research showed that the formation of health habits in adolescence is related to social, economic and institutional factors, and the school is a strategic space for the promotion of well-being. Data collected from students at a public school in Ananindeua (PA) revealed that, although adolescents recognize the importance of a healthy life, they face several barriers to transforming this knowledge into daily practice. The analysis allowed us to verify the degree of confirmation of the hypotheses guiding the investigation.

The first hypothesis, which proposed that educational strategies in the school space increase adolescents' awareness of health and well-being, was confirmed. The results showed that pedagogical mediation favors the development of a critical perception about food, the body and self-care. However, such strategies still occur in a punctual manner, lacking continuity and greater integration into the school curriculum, which limits the consolidation of lasting changes.

The second hypothesis, according to which practical, interactive and culturally appropriate programs enhance adherence to healthy habits, was partially confirmed. Greater engagement was observed when the activities involve concrete practices, such as sports and collective dynamics, especially when they dialogue with the sociocultural context of the adolescents. However, the absence of adequate infrastructure and the fragility of public policies for sports and leisure compromise the permanence of this engagement, restricting the scope of educational actions.

The third hypothesis, which postulated the critical use of digital media as a tool for health promotion, was confirmed with reservations. The study indicated that excessive screen time is a risk factor for sedentary lifestyle, inadequate diet and irregular sleep. At the same time, adolescents have shown to recognize such impacts. When pedagogically mediated, technologies can be re-signified as educational resources aimed at self-care, depending on pedagogical intentionality and teacher training.

The integrated analysis of the hypotheses indicates that the school environment plays a central role in the construction of health habits, but its effectiveness depends on structural and political conditions that go beyond the classroom. Adherence to healthy behaviors is not only consolidated by access to information, but by the creation of institutional spaces that articulate knowledge, experience and belonging.

Finally, the investigative path shows that no intervention will be fully effective if it disregards the material and symbolic conditions that structure adolescence in contexts of vulnerability. The hypotheses analyzed reveal the potential of educational actions, but also their limits in the absence of continuous and integrated public policies. Thus, the study points

to the need for practices that are more sensitive to young people, which recognize adolescents as subjects of knowledge and active participants in the construction of a culture of self-care and collective well-being.

REFERENCES

- Alimentando Políticas. (2025). Relatório institucional sobre políticas alimentares. Rede de Políticas Públicas.
- Alves, R. M., & Braga, C. P. (2023). Adolescência, identidade e apoio psicossocial no ambiente escolar. *Ciência & Saúde Coletiva*, 28(4), 1045–1056.
- Antoniassi, D., et al. (2024). Estudos sobre tempo de tela, dieta e atividade física em adolescentes. *Revista de Saúde Pública*, 58(1), 1–12.
- Barbosa, L. N. V., et al. (2021). Vulnerabilidade social, hábitos de saúde e adolescência no contexto escolar. *Revista Saúde & Educação*, 26(3), 112–128.
- Barcelos, R., Vasconcellos, M., & Cohen, S. (2010). Adolescentes, trabalho e vulnerabilidade social. *Cadernos de Saúde Pública*, 26(5), 900–915.
- Barcelos, R., et al. (2010). Vulnerabilidade juvenil e condições sociais. *Revista Brasileira de Adolescência*, 4(2).
- Bittar, M., & Soares, A. (2020). Adolescência, mídia e imagem corporal. *Revista de Psicologia e Saúde*, 12(3).
- Brasil. Conselho Nacional de Saúde. (2012). Resolução nº 466, de 12 de dezembro de 2012. Aprova diretrizes e normas regulamentadoras de pesquisas envolvendo seres humanos.
- Brasil. Ministério da Educação. (2018). Base Nacional Comum Curricular.
- Brasil. Ministério da Saúde. (2014). Guia alimentar para a população brasileira (2ª ed.).
- Brasil. Ministério da Saúde. (2014). Política Nacional de Promoção da Saúde.
- Brasil. Ministério da Saúde. (2023). Programa Saúde na Escola: orientações para a gestão e execução.
- Camilo, A., et al. (2024). Escola e promoção da saúde. *Educação e Realidade*, 49.
- Carvalho, P., et al. (2020). Imagem corporal e adolescência. *Psicologia em Estudo*, 25.
- Castro, I. R. R., et al. (2021). Mudanças nos comportamentos alimentares e de atividade física de adolescentes no período pós-pandemia. *Cadernos de Saúde Pública*, 37(8), Article e00123421.
- Cole, M., & Cole, S. (2003). Desenvolvimento da criança e do adolescente (4ª ed.). Artmed.
- Couto, S., et al. (2014). Café da manhã e hábitos alimentares em adolescentes. *Revista de Nutrição*, 27(4).
- Eisenstein, E. (2005). Adolescência: definições, conceitos e critérios. *Revista Adolescência & Saúde*, 2(2), 6–7.
- Ferreira, I. B., et al. (2024). Educação em saúde, vulnerabilidade social e juventudes: interfaces no contexto escolar. *Revista Educação & Saúde*, 12(2), 89–104.

- Fontes, A., et al. (2023). Comportamentos sedentários e risco cardiometabólico em jovens. *Arquivos Brasileiros de Cardiologia*.
- Freire, P. (1996). *Pedagogia da autonomia: saberes necessários à prática educativa*. Paz e Terra.
- Fundação Abrinq. (2022). *Cenário da infância e da adolescência no Brasil*.
- Gil, A. C. (2008). *Como elaborar projetos de pesquisa* (4ª ed.). Atlas.
- Graça, A., et al. (2024). Práticas corporais, inclusão e justiça social. *Revista Brasileira de Ciências do Esporte*, 46.
- Guimarães, R. M. (2025). Juventudes, estilos de vida e promoção da saúde no contexto escolar. *Revista Brasileira de Estudos da Juventude*, 5(1), 23–39.
- Instituto Brasileiro de Geografia e Estatística. (2020). *Pesquisa Nacional de Saúde do Escolar (PeNSE)*.
- Jesus, R. M., et al. (2011). Trabalho precoce e vulnerabilidade na adolescência. *Ciência & Saúde Coletiva*, 16(10).
- Lakatos, E. M., & Marconi, M. de A. (2017). *Metodologia do trabalho científico* (8ª ed.). Atlas.
- Legnani, E., et al. (2021). Atividade física e escola. *Revista Brasileira de Atividade Física & Saúde*, 26.
- Minayo, M. C. S. (2001). *O desafio do conhecimento: pesquisa qualitativa em saúde* (7ª ed.). Hucitec.
- Morin, E. (2001). *Os sete saberes necessários à educação do futuro*. Cortez; UNESCO.
- Nascimento Santos, A. C. (2022). Educação em saúde e promoção de hábitos saudáveis na escola pública. *Revista Multidisciplinar de Educação*, 14(1), 77–93.
- Organização Mundial da Saúde. (2022). *Diretrizes da OMS para a saúde e bem-estar dos adolescentes*.
- Organização Pan-Americana da Saúde. (2019). *Alimentação, atividade física e saúde na adolescência*.
- Pereira, I., et al. (2017). Intervenções escolares e alimentação saudável. *Revista Paulista de Pediatria*, 35(2).
- Silva, J. P., & Nunes, A. J. S. (2021). Adolescência e construção de hábitos: uma revisão integrativa. *Revista Brasileira de Saúde Escolar*, 10(2).
- Silva, L., & Garcia, M. (2020). Educação em saúde no contexto escolar. *Revista Brasileira de Educação*, 25.
- Silva, R., et al. (2008). Atividade física, IMC e adolescentes. *Revista Brasileira de Medicina do Esporte*, 14(6).
- Silveira, J. W. P. (2024). Atividade física relacionada à saúde como tema estruturante do componente curricular Educação Física. *Revista Brasileira de Educação Física Escolar*, 5(2), 45–60.
- Sistema de Vigilância Alimentar e Nutricional. (2024). *Relatórios sobre o estado nutricional de adolescentes*. Ministério da Saúde.

- Tavares, L., et al. (2014). Consumo de alimentos ultraprocessados em adolescentes. *Revista de Saúde Pública*, 48(5).
- Zancan, L., & Tono, A. (2018). Uso de mídias digitais na adolescência. *Interface - Comunicação, Saúde, Educação*, 22.

DEVELOPMENT OF A CUBESAT KIT FOR ACADEMIC PURPOSES: DESIGN, CONSTRUCTION, AND APPLICATIONS

DESENVOLVIMENTO DE UM KIT DE CUBESAT PARA FINS ACADÊMICOS: PROJETO, CONSTRUÇÃO E APLICAÇÕES

DESARROLLO DE UN KIT DE CUBESAT PARA FINES ACADÉMICOS: PROYECTO, CONSTRUCCIÓN Y APLICACIONES



<https://doi.org/10.56238/sevened2026.008-145>

Dafnhê Thor Castro de Martins Barros¹

ABSTRACT

The disconnection between theory learned at school and the practical application of concepts in objects, items, or ideas that are apparently not tangible, such as a satellite, presents itself as a difficulty in the Brazilian educational system, aiming to bridge the gap between theory and the practical objective of science and technology education, while also seeking to spark curiosity and interest among teachers for technological development. This article begins with a bibliographic review to explore concepts and practices related to CubeSat kits for academic use. The practical part of the project involves building a CubeSat prototype that can be easily replicated and used by students with various levels of knowledge. By providing a complete and efficient CubeSat Kit, using PBL (Problem Based Learning) techniques, train a new generation of scientists and engineers, both developing technical skills and essential soft skills for the job market, such as teamwork, leadership ability, presentation skills, as well as to explore space and conduct innovative experiments.

Keywords: Cubesat. Skills Development. Technology. Education.

RESUMO

A desconexão da teoria aprendida na escola, com a aplicação prática dos conceitos, em objetos, itens ou ideias que, aparentemente não são palpáveis, como um satélite por exemplo, apresenta-se como uma dificuldade no sistema de ensino brasileiro, visando aproximar a teoria com o objetivo prático do ensino de ciências e tecnologia, buscando também despertar a curiosidade e o interesse dos docentes para o desenvolvimento tecnológico. O presente artigo se inicia com um levantamento bibliográfico para explorar conceitos e práticas relacionados aos kits de CubeSat para uso acadêmico. A parte prática do projeto envolve a construção de um protótipo de CubeSat, de forma a ser facilmente replicado e utilizado por alunos de diversos níveis de conhecimento. Ao disponibilizar um Kit de CubeSat completo e eficiente, utilizando das técnicas de PBL (Problem Based Learning), capacitar uma nova geração de cientistas e engenheiros, tanto desenvolvendo habilidades técnicas e soft-skills imprescindíveis para o mercado de trabalho, como trabalho em equipe,

¹ Electrician and Occupational Safety Engineer. Centro Universitário Internacional (UNINTER). Centro Universitário UniAmérica Descomplica. Paraná, Brazil.
E-mail: dafnhethor@petrobras.com.br Orcid: <https://orcid.org/0009-0001-0545-5771>

capacidade de liderança, desenvoltura em apresentações, como para explorar o espaço e realizar experimentos inovadores.

Palavras-chave: Cubesat. Desenvolvimento de Competências. Tecnologia. Educação.

RESUMEN

La desconexión entre la teoría aprendida en la escuela y la aplicación práctica de los conceptos en objetos, elementos o ideas que aparentemente no son palpables, como un satélite, por ejemplo, se presenta como una dificultad en el sistema educativo brasileño. Con el fin de acercar la teoría al objetivo práctico de la enseñanza de las ciencias y la tecnología, se busca también despertar la curiosidad y el interés de los docentes por el desarrollo tecnológico. El presente artículo comienza con una revisión bibliográfica para explorar conceptos y prácticas relacionados con los kits de CubeSat para uso académico. La parte práctica del proyecto implica la construcción de un prototipo de CubeSat, de modo que sea fácilmente replicable y utilizado por estudiantes de diversos niveles de conocimiento. Al poner a disposición un kit de CubeSat completo y eficiente, utilizando técnicas de PBL (Problem Based Learning), se pretende capacitar a una nueva generación de científicos e ingenieros, desarrollando tanto habilidades técnicas como soft skills imprescindibles para el mercado laboral, tales como trabajo en equipo, capacidad de liderazgo y desenvolvimiento en presentaciones, así como fomentar la exploración del espacio y la realización de experimentos innovadores.

Palabras clave: CubeSat. Desarrollo de Competencias. Tecnología. Educación.

1 INTRODUCTION

In recent years, the space industry has witnessed a remarkable increase in interest and demand for small satellites, especially due to their potential to democratize access to space. Among these small satellites, the CubeSat has stood out for being a standardized and modular platform, allowing the rapid, economical and flexible development of space missions. However, the availability of a comprehensive and efficient kit, capable of providing resources for the creation of a CubeSat, in a way that is accessible to the academic environment, and that stimulates curiosity and learning and new technologies in colleges, vocational schools and high schools is still a need that is not fully met. (Brazil, 2023).

In this context, the motivation of this work arises: to develop a complete and accessible CubeSat Kit, which can be used by students and researchers to design, build and develop theoretical learning. Like the example of elementary school students from Ubatuba who actively participated in the development of UbatubaSat (Ministry of Education, 2018).

Given the motivation presented, the general objective is how to develop an inclusive and efficient CubeSat Kit, providing the necessary resources and covering the main steps necessary for the creation of a satellite on this platform, from design, construction and operation in a standardized and modular system.

To achieve the overall objective, the following specific objectives have been established:

- I - Research and analyze the main components and technologies used in CubeSats, such as structure, electronics, energy, communication and sensors.
- II - Design and develop the essential components of the CubeSat Kit, considering the restrictions of size, weight and energy. Considering using ready-made and consolidated modules and systems in the market, such as Arduino®, Raspberry®.
- III - Integrate the components in a modular structure, allowing the customization and expansion of the kit according to the user's needs.
- IV - Develop documentation and instructions to facilitate the use of the kit, from assembly to simulated operation in orbit.
- V - Test and validate the CubeSat Kit under simulated conditions, verifying its functionality and reliability.

The importance of this work lies in the democratization of access to the development of new technologies, practical application of theoretical knowledge in various technological areas, such as sensing, design, systems development, programming, telemetry, providing students and researchers with a complete and accessible tool for the development of their skills. By providing a viable and efficient CubeSat Kit, accompanied by documentation and

instructions, it is hoped to empower and inspire a new generation of scientists and engineers to explore space and carry out innovative experiments (Brazilian Space Agency, 2022).

This work is organized into five sections, according to the following structure:

- Section 1: Introduction: presentation of motivation, research question, general and specific objectives, justification and structure of the work.
- Section 2: Theoretical Foundation: review of the main concepts and technologies related to CubeSats, addressing their origin, characteristics, applications and challenges.
- Section 3: Methodology: Detailed description of the procedures used in the development of the CubeSat Kit.
- Section 4: Development of the CubeSat Kit: presentation of the main components and functionalities of the kit, including its physical structure, electronics, power supply and management, communication and sensors.
- Section 5: Results and Conclusions: analysis of the results obtained with the implementation of the CubeSat Kit, followed by conclusions and recommendations for future work.

With this structure, it is intended to provide a comprehensive and detailed view of the development of the CubeSat Kit, from its conception to final validation.

2 CUBESATS: ORIGIN, COMPONENTS, ADVANTAGES AND DISADVANTAGES.

CubeSats are miniaturized satellites, based on a standardized cube platform, usually with dimensions multiples of 10 cm x 10 cm x 10 cm, and 2 kg, defined as 1 unit, or 1U, being a scalable model, can be designed in 1U, 2U, even 12U. They were developed as a low-cost, reduced-time development alternative for space missions. The concept of CubeSat was first proposed in 1999 by Jordi Puig-Suari and Bob Twiggs, with the aim of allowing students and small organizations to conduct space experiments. (Cds, 2022).

Since then, CubeSats have evolved and gained popularity, driven by technological advancements and the growing demand for access to space. The standardization of CubeSats has facilitated integration and collaboration between different institutions and countries, resulting in a wide range of applications such as Earth observation, space science, communications, and technology demonstration (Raffa, 2021).

2.1 ADVANTAGES AND LIMITATIONS OF CUBESATS

CubeSats have several advantages over conventional satellites. Its modular and standardized construction allows for faster and more economical development, with

commercially available prefabricated components and technologies already known and widely used. In addition, they can be launched as secondary payloads on larger rockets, taking advantage of existing launch opportunities (David, 2004).

However, CubeSats also have some limitations. Due to its small size, the payload capacity and available energy are limited. Stability and orbital accuracy can also be affected, resulting in a shorter lifetime in orbit. Additionally, communication with CubeSats can be challenging, due to antenna size constraints and limited power. (Ministry of Science, Technology and Innovation, 2022).

2.2 COMPONENTS OF A CUBESAT KIT

According to Silva and Lopes (2020); Cappelletti, Battistini and Malphrus (2020), a CubeSat kit usually consists of a variety of essential components that enable the construction and operation of the satellite, which have been separated in the following structured way.

- **Structure:** The structure is responsible for providing physical support and protection for the internal components of the CubeSat. It is usually constructed of lightweight materials such as aluminum or carbon fiber to keep the weight down. It is also important in the thermal load of the satellite.
- **Electronics:** The electronics of the CubeSat include the motherboard (PCB), which houses the essential electronic circuits and devices such as processors, memory, sensors, actuators. Thermal control systems and payload interface units can also be included.
- **Energy management and supply system:** CubeSats typically have limited energy systems, such as solar panels for solar energy capture and batteries for storage. These systems are responsible for providing power for the CubeSat's operation during orbit.
- **Communication:** Communication systems allow data exchange between the CubeSat and ground stations. Generally, low-gain antennas are used for data transmission and reception, while high-gain antennas can be used for longer-range communications.
- **Sensors:** Sensors allow the CubeSat to collect data from the space environment and perform its specific tasks. They can include orientation and control sensors, such as magnetometers and gyroscopes, and sensors for scientific or Earth observation applications, such as cameras or spectrometers.

2.3 IMPORTANCE AND APPLICATIONS OF CUBESAT KITS FOR ACADEMIC USE

CubeSat kits for academic use play a key role in training students and promoting research and development in space technology. They provide a practical and accessible platform for students to learn about the principles of space engineering, acquire relevant technical skills, and conduct scientific experiments (Silva, 2020).

By exploring the theoretical foundation of CubeSat kits for academic use, we seek to understand the concepts, definitions and fundamental characteristics of these platforms. This exploration will allow a clear understanding of the existing base and will assist in the development of the research project, contributing to the advancement of technological and spatial education (Meller, 2021).

In a study, observing the development of some skills, Straub and Whalen (2014) were able to qualitatively measure the development of comfort and the ability to present to the public, teamwork, leadership and technical development during the development of small satellites.

3 METHODOLOGY

The methodology adopted involves the realization of an applied research, with a qualitative approach and exploratory and descriptive objectives. In addition, technical procedures of bibliographic and documentary research will be used to support the development of the project.

3.1 STAGES OF THE RESEARCH

The stages of the research will be structured to comprehensively investigate the CubeSat, for the making of the kit and its use in the academic context. Starting with a bibliographic survey, several sources such as books, articles and documents will be used to explore concepts, practices and challenges related to the kits, feeding the creation of the theoretical basis for the analysis and systematization of the data collected. With the theoretical basis, a prototype will be defined and built for demonstration. The conclusion will address gaps and contributions of the project, solidifying a useful reference for the development of the project and guiding researchers interested in expanding knowledge in this constantly growing field.

3.1.1 Bibliographic survey

Conducting a systematic bibliographic research, exploring several relevant sources of information about the academic use of CubeSat. Books, scientific articles and documents will

be selected that address the concepts and applications of CubeSat kits, as well as the best practices and challenges related to their academic implementation.

The kit to be proposed does not necessarily need to follow the guidelines of the CDS (*CubeSat Design Specification*), however, it must be known to the users, because in case of interest in the launch, the CubeSat must follow the technical specifications contained in the document.

3.1.2 Analysis and systematization of data

The data obtained through the bibliographic survey will be analyzed and systematized in order to identify concepts, characteristics and trends related to CubeSat kits for academic use. Notes, syntheses and categorizations of the main relevant points found in the sources consulted will be made.

3.1.3 Elaboration of the theoretical foundation

Based on the analysis of the data obtained, the theoretical foundation of the work will be elaborated, which will address the concepts, definitions and fundamental characteristics of the CubeSat kits for academic use. The main information and knowledge based on the scientific literature will be presented, relating them to the general objective of the project.

3.1.4 Prototype construction

With the data collected, together with the theoretical foundation, a basic prototype will be elaborated, to demonstrate in a physical and visual way the feasibility, ease and use of the kit for the construction and development of knowledge in assembly and technology. The following materials will be used to build the prototype:

- **Structure:** The structure will be built based on 3D printing, as the satellite is academic, and it will not be launched, it is not necessary to meet the specifications of mechanical strength and thermal load.
- **Electronics:** As it is a scalable system, easy to access, plan and program, the Arduino® will be used, together with a "Shield" board, for signal inputs and outputs.
- **Energy management and supply system:** The best option for electricity supply is solar, so solar panels, batteries to store energy where the orbit does not allow sunlight, battery charge management and protection board, DC-DC converters to adjust voltage levels, protection system and monitoring of consumption data and available energy (Tessari-zampieri et. al 2021).

- **Communication:** Due to the limitations of power consumption and distance, a low-power and long-range technology must be chosen, because the LoRa system uses a license-free frequency band, it will be the technology used. Anatel allows, in Brazil, the free use of the 915Mhz band. (Navarro and Rodrigues, 2022).
- **Sensors:** Humidity, pressure, temperature, GPS sensors will be used for geolocation and orbit monitoring. Additionally, for more specific missions, other sensors can be used, this is defined in the satellite design phase due to the mission to be accomplished.

3.1.5 Final considerations

At the end of the research, final considerations will be made based on the results obtained. A critical analysis of the main aspects addressed in the theoretical foundation will be made, highlighting the knowledge gaps identified and the possible contributions of the project to the advancement of the area of CubeSat kits for academic use.

The proposed methodology will allow an in-depth understanding of the concepts and characteristics of CubeSat kits for academic use, providing a solid foundation for the development of the project. In addition, the methodology adopted also allows other researchers to repeat the study, following the same instructions and contributing to the expansion of knowledge in this area.

4 RESULTS AND DISCUSSIONS

The current education system needs several improvements, to train not only professionals, but also conscious and questioning citizens, because there is always something to learn and what to teach. An excellent way to fix the theory, bring questions and develop knowledge and sharpen curiosity is to develop, in practice, the theory that may seem very abstract.

In this context, the idea of peaks and nanosatellites emerged, especially CubeSats, as these have become a paradigm shift, since something that was previously very distant from the reality of technology students, is becoming increasingly closer to students at various academic levels, from masters and doctors, to elementary school students.

A 1U CubeSat (Unit) is a specific category of CubeSat, which adheres to a set of size and weight guidelines defined by the *CubeSat Design Specification* (CDS). CDS was developed to standardize CubeSats and make them more accessible and cost-effective to build and launch.

Main features and specifications of a 1U CubeSat:

- **Standard Dimensions:** A 1U CubeSat has dimensions of approximately 10 centimeters x 10 centimeters x 10 centimeters. This equates to 1 liter in volume and is the smallest category of CubeSat.
- **Limited Weight:** A 1U CubeSat has a weight limit of about 1 kg. This weight restriction is one of the reasons why CubeSats are called "miniaturized."
- **Docking Pattern:** CubeSats are designed to fit into a standard 3U (three-unit) payload launcher, which is common in launch rockets. Therefore, a 1U CubeSat is often mounted on a docking frame that is compliant with launch standards. For the prototype and the kit will not be taken into consideration, but should be known to the assembly team.
- **Structure:** The structure of a 1U CubeSat is usually made of lightweight materials, such as aluminum or carbon fiber, to keep the weight within limits. This structure provides physical support and protection for the internal components. For the prototype and the kit, the structure will be made on the 3D printer, in PLA, due to the ease of modularization and customization and the reduced cost.
- **Electronics:** The electronics of the CubeSat 1U include a motherboard (PCB) that houses the essential electronic circuitry and devices, such as processors, memory, sensors, and control systems.
- **Energy Management System:** CubeSats often use solar panels to capture solar energy and batteries to store energy when not in direct sunlight. These power management systems are designed to provide power for all satellite operations.
- **Communication:** Communication systems allow the CubeSat to exchange data with ground stations. Due to size and power limitations, low-gain antennas are common for data transmission and reception, while high-gain antennas can be used for longer-range communications.
- **Sensors:** CubeSats can be equipped with various sensors, such as orientation and control sensors, magnetometers, gyroscopes, and sensors for scientific or Earth observation applications, such as cameras or spectrometers, depending on the specific mission.
- **Limited Power:** Due to the small size, the payload capacity and available power are limited in 1U CubeSats. This can affect the lifespan in orbit and the ability to carry out certain types of missions.

To design the satellite, it is necessary to follow the following steps:

- **Determination of the mission to be accomplished,** that is, what purpose the satellite has in its useful life. For this specific case, the mission will be simple, the measurement

of some variables in low Earth orbit that comprises the distance between 350 and 1400km above the Earth's surface, the lower orbits are unstable due to atmospheric drag. The variables to be measured are: humidity, pressure, temperature and geolocation to monitor the orbit, as it is an educational kit, the objective is the development and contact with technology.

- **Determination of Specifications:** Based on the mission, determine the specifications of the CubeSat, including size (e.g., 1U, 2U, 3U), sensor types, and instrumentation. It is possible to estimate the weight and energy consumption at this stage, but without much precision, as it is necessary to select all the components, make approximate calculations of weight and energy consumption, so the weight, energy consumption and energy management system will be specified together with the selection of components. For the kit, the cubesat will be of the 1U standard, weighing up to 1kg, and the sensors will be for humidity, pressure, temperature and GPS.
- **Component Selection:** Choose the components that will be used in the CubeSat, such as sensors, electronics, solar panels, batteries, and antennas. Make sure these components meet the mission specifications. The electronics are listed below, as well as the average power consumption, which is crucial for the design of the power management system.

Table 1

Bill of Materials

Item	Qty.	System	Description	Pot. mW	Price	Weight (g)
1	1	PCB	Arduino UNO	600	R\$ 50,00	58
2	1	PCB	Sensor ShieldV5.0	240	R\$ 15,00	26
3	1	PCB	High Precision Temperature and Humidity Sensor - AHT10	70	R\$ 15,00	13
4	1	PCB	Barometric Pressure Sensor BMP180	50	R\$ 15,00	12
5	1	PCB	GPS	250	R\$ 55,00	25
6	1	Com.	SX1276 LoRa 915Mhz RF + 4Km Antenna	300	R\$ 65,00	25
7	6	SGE	6V Solar Panels	-2160	R\$ 125,00	138
8	1	SGE	Battery 12v 5000mah	-	R\$ 120,00	200
9	1	SGE	MPPT Charge Controller	-	R\$ 50,00	200
10	1	Structural	Frame Mounting Kit	-	R\$ 200,00	200
11	1	Structural	Kit of screws, nuts, washers, cables and connectors for assembly.	-	R\$ 100,00	150

Estimated total	R\$810,00	822
-----------------	-----------	-----

Source: Prepared by the author based on price surveys in the year 2024.

- Construction: The prototype will be carefully built based on the items raised earlier.

Figure 1

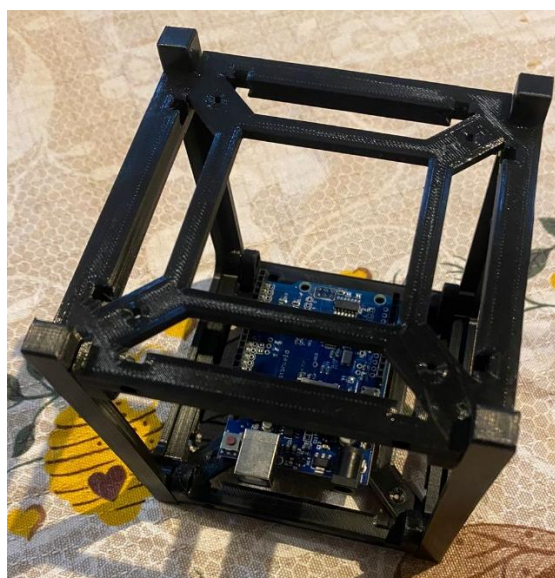
Cubesat frames and mounting



Source: The author.

Figure 2

Cubesat in assembly



Source: The author.

- Ground Testing: Conducting ground testing to ensure that the CubeSat works properly. This includes electronics, communication, and structural integrity testing.

- Preparation for launch and launch: These steps are not relevant to the design of the kit, but are indispensable knowledge for the design team, as thermal and mechanical tests are required on the satellite before launch.
- Mission in orbit: After launch, the CubeSat enters orbit and begins the mission. This involves collecting data, transmitting information to Earth, and conducting planned experiments.
- Monitoring and control: Monitor the CubeSat in orbit to ensure that it performs as intended. This may involve software updates and trajectory adjustments.
- Data collection: Utilize the data collected by CubeSat to meet mission objectives. This can include analyzing scientific data, observing the Earth, or conducting experiments.
- End of mission: When the CubeSat mission is complete, plan for shutdown and safe re-entry into the atmosphere if necessary. A growing concern is that of space junk, the European Space Agency (ESA) estimates that there are about 900,000 useless objects in orbit, whose size varies between 1 and 10 cm.

5 FINAL CONSIDERATIONS

5.1 CONSIDERATIONS ABOUT THE STUDY CARRIED OUT

The prototype CubeSat kit, conceived as a tool of remarkable versatility and accessibility, offers a low-cost solution that proves to be extremely useful in educational environments of various levels. Its ease of assembly and programming makes it accessible to a wide spectrum of audiences, from elementary school students to undergraduates. For younger students, who may need some programming guidance, the kit can provide a ready-made source code. This significantly simplifies the introduction of these students to the vast world of programming, encouraging the development of problem-solving skills, creativity and critical thinking.

Nevertheless, its comprehensive applicability is not limited to younger students, as this kit is equally suitable for undergraduate students and multidisciplinary projects. This prototype offers the opportunity to engage in interdisciplinary projects, which is vital for the promotion of teamwork skills, leadership and enhancement of public presentation skills. In addition, its affordability is particularly beneficial, making it possible for educational institutions with limited resources to access a valuable educational tool.

In the context of an increasingly technology- and innovation-driven world, this prototype CubeSat represents an invaluable educational resource, as it not only facilitates the acquisition of technological skills but also plays a key role in empowering students for the future. Thus, by providing an open platform for the exploration of space and space

technology, this kit not only enriches learning, but also promotes the development of crucial skills that will serve students throughout their lives, both personally and professionally.

Even in an adverse scenario, such as the Sars-Cov-2 pandemic, where it was necessary to maintain social isolation measures, there was a great acceptance, by teachers (80%), of the practical and integrated application of various disciplines in PBL (*Project-Based Learning*), the practical and integrated application in problem solving proved to be an effective method for, In addition to arousing curiosity and interest in technological learning, developing necessary and extremely important skills in academia and the job market.

5.2 LIMITATIONS OF THE RESEARCH

While the development of the CubeSat Kit has shown great potential for educational application, some important limitations should be considered:

- **Absence of validation in a real orbit environment:** The prototype was tested only in simulated ground conditions, without exposure to real factors such as microgravity, space radiation or extreme thermal variations, which are common in real space missions.
- **Exclusive focus on educational environments:** The project was conceived for didactic purposes, which excludes technical requirements required by space agencies for launch, such as certifications, vibration tests and mechanical resistance.
- **Limitations of technological resources:** As it is a low-cost kit, accessible and simplified components were used, which restricts the complexity of the missions that can be simulated.
- **Lack of longitudinal evaluation:** Studies have not yet been carried out to monitor the impact of the use of the kit over time on the formation of technical and behavioral skills of students.

5.3 RECOMMENDATIONS FOR FUTURE STUDIES

To expand the impact of the project in the academic context, it is recommended that future research consider:

- **Pedagogical evaluation:** Investigate, through educational methodologies, how the use of the kit contributes to the development of skills such as critical thinking, problem-solving, teamwork and creativity at different levels of education.
- **Curricular adaptation:** Study ways to integrate the CubeSat Kit into specific subjects of the school and university curriculum, promoting interdisciplinary approaches aligned with the National Common Curricular Base (BNCC).

- Inclusion and accessibility: Develop adapted versions of the kit for students with disabilities, ensuring that the practical experience is accessible to all audiences.
- Teacher training: Create training programs for teachers, focusing on the use of the kit as a didactic tool, including support materials and project-based teaching strategies.
- Expansion to remote teaching: Explore the use of the kit in hybrid or remote teaching environments, especially in contexts of low connectivity, using offline resources and complementary printed materials.

REFERENCES

- Brasil. Agência Espacial Brasileira. (2023, 13 de fevereiro). Nanossatélites movimentam o Programa Espacial Brasileiro. <https://www.gov.br/aeb/pt-br/assuntos/noticias/nanossatelites-movimentam-o-programa-espacial-brasileiro>
- Brasil. Agência Espacial Brasileira. (2022). Desenvolvimento do Cubesat Aldebaran-I provoca impactos sociais no Maranhão. <https://www.gov.br/aeb/pt-br/assuntos/noticias/desenvolvimento-do-cubesat-aldebaran-i-provoca-impactos-sociais-no-maranhao>
- Brasil. Ministério da Educação. (2018). Estudantes do ensino fundamental constroem satélite em Ubatuba, no litoral de São Paulo. <http://portal.mec.gov.br/component/tags/tag/ubatubasat>
- Cappelletti, C., Battistini, S., & Malphrus, B. K. (2020). CubeSat handbook: From mission design to operations (1ª ed.). Academic Press.
- CubeSat Design Specification (CDS). (s.d.). www.cubesat.org
- Custódio, S. S. D., & Cerqueira, C. S. (2021). Aprendizagem por projetos no ensino de engenharia aeroespacial e aeronáutica. In COBENGE. http://www.abenge.org.br/sis_artigo_doi.php?e=COBENGE&a=21&c=3595
- David, L. (2004). Cubesats: Tiny spacecraft, huge payoffs. Space.com. <https://www.space.com/308-cubesats-tiny-spacecraft-huge-payoffs.html>
- Iberdrola. (2023). Lixo espacial: Chegou o momento de começar a cuidar do cosmo? <https://www.iberdrola.com/sustentabilidade/lixo-espacial>
- Meller, F. G. R. (2021). As vantagens e desafios por trás da tecnologia na educação. Central de Notícias Uninter. <https://www.uninter.com/noticias/as-vantagens-e-desafios-por-tras-da-tecnologia-na-educacao>
- Navarro, P. G., & Rodrigues, E. L. M. (2021–2022). O uso de redes LoRa para sensoriamento industrial remoto. Programa de Apoio à Iniciação Científica - PAIC, 425–437.
- Olimpíadas Brasileira de Satélites. (2022). Pequenos satélites: Grandes possibilidades (Vol. 1, 1ª ed.). Ed. dos Autores.
- Raffa, R. (2021). Satélite idealizado por alunos e professor de Itapetininga é selecionado em olimpíada científica. Clube de Astronomia de Itapetininga. <https://www.clubecentauri.com.br/post/satelite-de-itapetininga-obsat>
- Silva, E. H. da, & Lopes, J. L. D. (2020). Proposta de um CubeSat universitário para desenvolvimento de tecnologias espaciais nacionais. In 11º Workshop em Engenharia e Tecnologia Espaciais. <http://mtc-m16d.sid.inpe.br/col/sid.inpe.br/mtc-m16d/2020/08.13.14.29/doc/10%20-%20%5BARTIGO%5D%5BExterno%5D%20Eduardo%20Henrique%20da%20Silva.pdf>
- Straub, J., & Wahlen, D. (s.d.). Evaluation of the educational impact of participation time in a small spacecraft development program. <https://www.mdpi.com/2227-7102/4/1/141>
- Tessari-Zampieri, M. C., Santiago, A. F. de, Lopes, W. F., Silva, A. R. da, & Scapin, M. A. (2021). Utilização de projetos de nanossatélites na graduação em engenharia de computação: Planejamento do subsistema energia elétrica para CubeSat. In 12º Workshop em Engenharia e Tecnologias Espaciais, 1–10.

PUPPET THEATRE FOR MIDDLE SCHOOL: HISTORY, MAIN TECHNIQUES, AND PROPOSALS FOR THE 6TH GRADE

TEATRO DE ANIMAÇÃO PARA O ENSINO FUNDAMENTAL II: HISTÓRIA, PRINCIPAIS TÉCNICAS E PROPOSTAS PARA O 6º ANO

TEATRO DE TÍTERES PARA LA EDUCACIÓN SECUNDARIA: HISTORIA, PRINCIPALES TÉCNICAS Y PROPUESTAS PARA EL 6.º GRADO



<https://doi.org/10.56238/sevened2026.008-146>

Kleriston Luis Rocha Neris¹

ABSTRACT

This article briefly addresses the history and main types of Puppet Theatre, as well as its potential for pedagogical use in Art classes with 6th-grade students in Elementary School II. The research is justified by the scarcity of references on the subject in Maranhão, especially in São Luís, regarding the history and techniques of puppet making, a gap that has been partially filled by initiatives of the Casemiro Coco Group. In the educational field, puppet theatre is presented as a powerful methodology for teaching Art, as it integrates sensitivity, corporeality, and critical thinking, in accordance with the National Common Curricular Base. The overall objective of this research is to analyze Puppet Theatre in its main forms, techniques, and pedagogical possibilities, understanding its potential as an artistic language in the teaching of Art in Basic Education. Methodologically, this is a qualitative, exploratory, and descriptive-interpretative research, aimed at understanding Puppet Theatre and its pedagogical contributions. It was concluded that Puppet Theatre, as a plural and historically relevant artistic language, possesses significant pedagogical potential because, by integrating body, object, and imagination, it expands the expressive possibilities of students and fosters meaningful aesthetic experiences.

Keywords: Puppet Theatre. Art Education. Basic Education. Pedagogical Methodologies. 6th Grade of Elementary School II.

RESUMO

Este artigo aborda, de forma sucinta, a história e os principais tipos de Teatro de Animação, bem como suas possibilidades de utilização pedagógica nas aulas de Arte com alunos do 6º ano do Ensino Fundamental II. A pesquisa justifica-se pela escassez de referências sobre o tema no Maranhão, especialmente em São Luís, no que se refere à história e às técnicas de confecção de títeres, lacuna que vem sendo parcialmente suprida por iniciativas do Grupo Casemiro Coco. No campo educacional, o teatro de animação é apresentado como uma metodologia pujante para o ensino de Arte, por integrar sensibilidade, corporeidade e pensamento crítico, em consonância com a Base Nacional Comum Curricular. O objetivo geral desta pesquisa consiste em analisar o Teatro de Animação em suas principais formas,

¹ Master's student in Arts. Universidade Federal do Maranhão (UFMA). Maranhão, Brazil.
E-mail: E-mail: kleristonluis@yahoo.com.br Orcid: <https://orcid.org/0009-0005-2320-1598>

técnicas e possibilidades pedagógicas, compreendendo seu potencial como linguagens artísticas no ensino da Arte da Educação Básica. Metodologicamente, trata-se de uma pesquisa qualitativa, exploratória e de abordagem descritiva-interpretativa, direcionada à compreensão do Teatro de Animação e suas contribuições pedagógicas. Concluiu-se que o Teatro de Animação, enquanto linguagem artística plural e historicamente relevante, possui significativo potencial pedagógico, pois, ao integrar corpo, objeto e imaginação, amplia as possibilidades expressivas dos estudantes e favorece experiências estéticas significativas.

Palavras-chave: Teatro de Animação. Ensino de Arte. Educação Básica. Metodologias Pedagógicas. 6º ano do Ensino Fundamental II.

RESUMEN

Este artículo aborda, de manera sucinta, la historia y los principales tipos de Teatro de Animación, así como sus posibilidades de utilización pedagógica en las clases de Arte con estudiantes de 6.º grado de la Educación Secundaria Básica. La investigación se justifica por la escasez de referencias sobre el tema en Maranhão, especialmente en São Luís, en lo que respecta a la historia y a las técnicas de confección de títeres, vacío que ha sido parcialmente atendido por iniciativas del Grupo Casemiro Coco. En el ámbito educativo, el Teatro de Animación se presenta como una metodología potente para la enseñanza del Arte, ya que integra sensibilidad, corporeidad y pensamiento crítico, en consonancia con la Base Nacional Común Curricular. El objetivo general de esta investigación consiste en analizar el Teatro de Animación en sus principales formas, técnicas y posibilidades pedagógicas, comprendiendo su potencial como lenguaje artístico en la enseñanza del Arte en la Educación Básica. Metodológicamente, se trata de una investigación cualitativa, exploratoria y de enfoque descriptivo-interpretativo, orientada a la comprensión del Teatro de Animación y sus aportes pedagógicos. Se concluye que el Teatro de Animación, como lenguaje artístico plural y de relevancia histórica, posee un significativo potencial pedagógico, ya que, al integrar cuerpo, objeto e imaginación, amplía las posibilidades expresivas de los estudiantes y favorece experiencias estéticas significativas.

Palabras clave: Teatro de Animación. Enseñanza del Arte. Educación Básica. Metodologías Pedagógicas. 6.º grado de la Educación Secundaria Básica.

1 INTRODUCTION

This article deals, briefly, with the history and main types of Animation Theater, as well as its pedagogical use for students of the 6th year of Elementary School II in Art classes. Thus, the fascination that this theater exerts, "[...] Whether about children or adults, it is ancient. The Egyptians and the Chinese moved their puppets. To this day, their success helps us transform the world, making a living figure out of a can; of fantasy, a reality [...]" (Silva Filho, 2010, p. 15). This work aims to constitute a reference in the area of Animation Theater, considering that in Maranhão, and more specifically in São Luis, there are still few studies and publications that address the history and techniques of puppet making. In this context, the Casemiro Coco Group seeks to contribute to filling this gap through courses, workshops, training meetings and academic publications.

Although it is not possible to address, in this article, all the techniques and the history of animation theater with a necessary degree of depth, it seeks to offer subsidies and basic guidelines about the universe of puppets, aiming at its application as a methodology in the teaching of Art. Where, "the very historical and poetic constitution of each of these spectrums of animated forms is pointed out here for its methodological potential for working with Arts in school [...]" (Araújo and Santos, 2023, p. 86).

The main forms of animation theater will be described, recognizing that the experiments carried out by individual and collective artists are diverse and in constant transformation. To the extent that "[...] the establishment of relationships with the new industrial technologies associated with the puppet, and the way this modifies our daily lives in the consumer society, can also be explored by art teachers [...]" (Araújo and Santos, 2023, p. 86).

However, it was decided to highlight traditional techniques of confection, as well as some more contemporary approaches. Thus, the article is pertinent due to the need to offer theoretical bases and practical proposals that help Art teachers in the application of Puppet Theater in the classroom, while collaborating to strengthen this artistic language in the educational and cultural environment of Maranhão.

The general objective of this research is to analyze the Animation Theater in its different forms, techniques and pedagogical possibilities, understanding its potential as artistic languages in the teaching of Art to students of the 6th year of Elementary School II. To achieve this objective, it is initially sought to present a historical overview of the Animation Theater, as well as to identify its main types and techniques. In addition, it is intended to understand this artistic language as a plural manifestation, based on the symbolic relationship between actor, object and spectator. The research also aims to investigate the contributions

of Animation Theater to the sensitive, expressive and critical development of students, analyzing its possibilities of pedagogical application in Art classes, in line with the BNCC. Finally, it seeks to recognize and value local initiatives, such as those developed by the Casemiro Coco Group, which contributes to the dissemination, teaching and production of knowledge about Animation Theater in the context of Maranhão.

The article begins with the first chapter, Introduction, in which the justification, general objective, methodology, and theoretical framework are presented. Then, it is organized into three chapters, the second of which will deal with the theoretical framework of the research, providing a theoretical contextualization. The third chapter addresses the concept of animation theater and describes its main types, such as puppets or glove puppets (including the mamulengo), stick puppets, shadow puppets and their variation (the so-called "Chinese shadows"), marote, giant puppets, Bunraku, balcony puppet, tringle puppet, object theater, animated forms, ventriloquist and sock puppet. The fourth chapter will present the methodology of the research, and the fifth chapter describes the Results and Discussions in the light of the dialogue with the main authors in the area. Finally, the sixth, the final considerations are presented.

2 THEORETICAL FRAMEWORK

The theater of animated forms is constituted as a hybrid, ancestral and contemporary language, which integrates masks, puppets, objects and the actor/manipulator's own body in a symbolic game of animation of matter (inanimate). Ana Maria Amaral (1996; 2004 and 2007) is one of the main theoretical references in Brazil when she understands animation theater as an expanded field, in which the actor relates to his "doubles" (masks, puppets and objects), establishing a visual and corporal dramaturgy that goes beyond the centrality of the verbal text. For the author, animation does not reside in the object itself, but in the poetic relationship between actor, matter and spectator.

This perspective is deepened by Waszkiel (2019), when he conceives the theater of animated forms as a plural territory, marked by aesthetic, technical, and cultural diversity, in which different traditions dialogue with contemporary practices. In this approach, the focus shifts from the isolated technique to the construction of meanings, images and sensitive experiences.

In the context of popular traditions, Borba Filho (1966) highlights the mamulengo as a theatrical manifestation that articulates social criticism, comedy and cultural identity,

evidencing the political and educational character of animation theater. Álvaro Apocalypse², when discussing structures and mechanism, contributes to the understanding of the constructive and functional aspects of the puppets, reinforcing the relationship between technique, materiality and expressiveness.

In the oriental traditions, especially the Bunraku, analyzed by Giroux and Suzuki (1991) and Kusano (1993), they broaden the understanding of animation theater by highlighting the aesthetic sophistication, technical precision and cooperative work of the manipulators, narrator and musicians. These references allow us to understand puppet theater with an art of high symbolic and formal complexity.

In the field of artistic and pedagogical training, Cavalcante (2010) and Silva Filho (2010) defend the theater of animated forms as a powerful language for the training of actors and educators, as it integrates body, imagination, sensitivity and critical thinking. This approach dialogues with the complex and multi-referential conception in education, in which artistic making becomes a process of knowledge construction.

From an educational perspective, Araújo and Santos (2023) and Nascimento, Engroff and Bem (2023) highlight the theater of animated forms as a significant methodological resource in the teaching of Art, facilitating interdisciplinary, inclusive and creative practices. These reflections are supported by the National Common Curricular Base (BNCC, 2018), which recognizes Art as a fundamental area for the aesthetic, expressive and cultural development of students.

Thus, the theoretical framework adopted by this research comprises animation theater with artistic language, pedagogical practice and cultural manifestation, effective in articulating tradition and contemporaneity, technique and poetics, education and creation, consolidating itself with a relevant field for human and artistic formation.

3 ANIMATION THEATRE

Before the advent of the reproduction of movement through the machine, the animation of inanimate objects or forms was carried out a long time ago and successfully with the Animation Theater³ (area of the Theater that works with masks and also with the manipulation of puppets, objects and animated forms – the last two of which are more recent),

² Álvaro Brandão Apocalypse (1937-2003) was a professor of Visual Arts, director and set designer, founder of Grupo Giramundo: puppet theater, together with his wife Maria Terezinha Veloso Apocalypse (1936-2003) and Maria do Carmo Vivacqua Martins (1945-).

³ “[...] it is art of the unreal made real, it is the invisible made visible. It is the magic that arises from imitation and repetition, ‘image and likeness’, energies that are detached from movement, from making believe, without if, being. Ambiguous art, between animate and inanimate, spirit and matter” (Amaral, 1996, p. 21)

that it was and still is possible to enchant audiences with the manipulation of puppets⁴. In recent years, the word puppet (a generic term) has been used as a convention, which encompasses various manipulation techniques, and puppeteer⁵, the person responsible for the animation.

Puppet theater came before actors' theater, that is, it is one of the first forms of theater. A traditional example is that of Kabuki theatre (actors) which came from the Bunraku theatre (puppets), both from Japan. Amaral (1996) reports on the manipulation or animation of the puppet in relation to the cinema, and in the former, its movement is always live, whether the actor-manipulator (or puppeteer) is apparent or not; in the case of cinema, the animation is given by mechanical means (film camera or mechanical optical devices).

The author⁶ gives a concept of animation, according to her

To animate is to capture energies from the object, energies from inert matter. And for this it requires, first of all, the will to want to do it and then a lot of concentration, without which nothing is obtained. According to B. Boie⁷, to animate is to evanesce, and to transfer, it is to make matter live, that is, it is to provoke a transformation of energy, it is magic. It is something that connects the living to the inanimate, resulting in the illusory life of matter [...]. (Amaral; Boie apud Amaral, 1996, p. 285)

And he adds that "animation is the relationship between movement and energy. To animate an object (masks, puppets, natural or functional objects) is to imprint on it movements endowed with energy. [...]. To animate an object is to charge it with energy" (Amaral, 1996, p. 286). That is, the puppeteer lends his energy to move the puppet, giving it life or soul. To summarize in general terms, the Animation (*anima* in Latin means soul, that is, life) of objects arose before Cinema, but the animation of static images arose with the second.

There is a classification when it comes to dolls that takes into account their manipulation and construction.

⁴ In the English language it is called puppet; marionnette in France; fantoccio or burattini, the latter derived from the actor Burattino in Italy; called bonifrates from the Latin bonus frater – puppet of scoundrels; the word puppet is also used; and in Brazil it depends a lot on the region, such as the mamulengo (originally from the State of Pernambuco).

⁵ Unlike the actor who represents a character, the puppet actor-manipulator gives importance to the puppet, he does not represent a character, he is the character all the time.

⁶ Ana Maria de Abreu Amaral holds a degree in philosophy (1950-52) from USP; Librarianship (1954-56) from the School of Sociology and Politics Foundation of São Paulo (FESPSP). Master in Theater (1981-83), specialty puppet theater and first doctor (1992-1995) in the area of puppets. He currently teaches at USP, in the area of performing arts. She has published four books in her area: Marionette's Theater in Brazil (1994); Theater of Animated Forms (1st in 1991, 2nd in 1993 and 3rd edition in 1996); Teatro de Animação (1997) and The Author and His Doubles (1st edition in 2002 and 2nd in 2004). He is a relevant reference in the area of Animation Theater.

⁷ BOIE, Bernhild. L'Homme et ses Simulacres, Paris, Corti, 1979.

Thus, a puppet is the puppet moved by wires; puppet, or glove puppet, is the puppet that the puppeteer wears or wears; shadow doll refers to the figure in a flat shape, articulated or not, visible with light projection; stick dummy is a dummy whose movements are controlled by sticks or sticks; Marauder is also a glove puppet that the puppeteer wears and with his hand articulates the puppet's mouth. The actor dressed as the puppet character can be a puppet mask or body mask. (Amaral, 1996, p. 71-72)

Following the classification above, let's talk about each of them and add Bunraku, the puppet theater of Japan, the theater of objects and animated forms, addressing their important aspects and a little of their history.

The term puppet originated in the century. Deriving from the French word *Maries*, which was the name given to a type of wood with which images were carved (usually of the Virgin Mary, being *mariola*, *marotte*, *marion* or *marionnette*, variations referring to small images of the Saint).

Complex in construction and difficult to manipulate, they can have dozens of threads that converge to the manipulation cross, where they are within reach of the puppeteer's hands. It is a genre that allows movements close to human movements. Because it is driven by wires, the puppet moves slowly and delicately. For the development of the manipulation technique, puppeteers need to know the behavior of the movement of a pendulum applying to the puppet. (available at: <http://www.giramundo.org/técnica/fio/htm>)

The appearance of the puppet is ancient, with traces in China and Greece. In Greece there are references to Xenophon, Lucian, Homer, Socrates and Plutarch. About these puppets it is known that "they were mime actors who also performed with small figures controlled by wires, that is, puppets. Among them is Potheinos, a puppeteer so famous that he even filled the great Theater of Dionysus." (Amaral, 1996, p. 102)

Thus, "[...] the origin of the puppet is more linked to the automatons [mechanical puppets] of Egypt and China (then powered by steam). In puppets there is a concern for the perfect copy of man, his body, his movements" (Amaral, 1996, p. 166). That is, its structures (joints) and movements are a simulacrum of the human body.

In Burma (a former British colony, today it has been under military rule since the second half of the last century) yarn dolls are very popular. "The puppets are of a dizzying richness and assembled with admirable ingenuity" (Borba Filho, 1966, p. 10). Chinese puppets have the same characteristics as Burmese with a refined refinement and surprising technical mechanism. Its application in the classroom has to be adapted, with the construction of simple dolls connected with wires by the students.

In Japan, the puppets were imported from China called Ito-Tsoukai.

Puppet theater has existed in Japan since ancient times, including puppets, hand puppets, and other types. It is believed that puppets arrived in Japan in the early 8th century, coming from Central Asia, through China and Korea. Around the 16th century, this type of theater also began to be appreciated by the popular class, as a means of entertainment. (available at <http://www.fjisp.org.br>)

Puppet or Glove Puppet is the puppet of a popular, playful and satirical **character**, most related to the history of the puppet in the West. In the East, puppet theater is linked to ritual, historical themes, the divine, mysticism, the unconscious, or is linked to trance. In the West, it is linked to earthly situations, their relationships, social situations or poetic aspects related to reality. And its evolution parallels the evolution of masks.

Due to its anarchic, comical and contesting character, the glove puppet identified itself with popular themes, creating its own language and preferring the street as its theater. Difficult to manipulate, this puppet demands a lot from the puppeteer who must sometimes manipulate and interpret two characters at the same time. (available at www.giramundo.org/tecnica/luva.htm)

The popular puppet was introduced to dialogue and conflict. This popular theater is influenced by the Greek Doric mime⁸, the Roman Atelana (short comedy plays in ancient Rome) and the Turkish shadow theater (Karagoz⁹). From this derives the Pulcinella (one of the characters of the *comedia dell'arte*) in Italy; The jumping jack brought to France by Giovanni Briocci in the century. XVII; the Punch in England taken by Pietro Gimondi¹⁰ (a great promoter among the countries of Europe and Eurasia), in this country Punch gets a woman Judy, a son and a dog; the Guignol of Lyon having several versions about its origin in this French city; Kvo in China (he was very active and distributed clubs); Schah Selim in Persia; Putti-wallah in India; and so it reaches several countries.

In Brazil, the history of popular puppets dates back to the eighteenth century (although there is news of animated nativity scenes since the century. XVI), according to Luiz Edmundo cited by Hermilo Borba Filho (1986), which characterizes three types of puppet theater in Rio de Janeiro at the time of the viceroys when he calls it: door puppet (short shows that took

⁸ In the ancient Greco-Roman theater, it was a popular farce, interspersed with dances and games, in which the characters and customs of the time were imitated (source: Aurelius dictionary online from the Windows package).

⁹ In the eleventh century d. C. in India there are traces of an important figure: the sutradhara (the man who pulls the thread); the text was improvised and of a religious character whose main character was the vidoucahka, a brahmin (priest of the Hindu religion), dwarf, hunchbacked, with huge teeth, yellow eyes, bald, ridiculous in expressions, clothes and gluttony (gluttony); Playful, rude, beats everyone, speaks the popular language and etc. He is the father of karagoz, punch, guignol, puppet, that is, he is the ancestor of glove dolls all over the world.

¹⁰ Gimondi, when promoting his work, originated descendants of Punch such as: Hanswurt (Germany), Kasper (Austria), Vitez Laszle (Hungary), Kasperek (Netherlands) and Petrushka (Russia).

place at the doors or windows of houses for passers-by); puppet of capote (men used their body as a walking stage, wearing large and wide capes, having a boy inside to manipulate the puppet and the man still played an instrument), whose origin goes back to China in the XVIII century. XVIII; and puppet room or opera puppets (construction of a closed place for the presentation of puppets with an entrance fee). In other regions¹¹ it is a tradition and its origin is ancient. The most characteristic of the glove dolls with a more precise history is the mamulengo¹² (name whose derivation comes from Mané Gostoso or Mão Molenga) from Pernambuco.

As for the construction, the head can be made of wood, putty, styrofoam or cardboard or others mounted on a cloth sweater. The hands can be made of cloth, wood and etc.; The body (sweater) is usually made of fabric, not excluding other processes. The parts of the puppet are made with molds, later attached.

The glove doll is the best known and most practiced in the world, enchanting with its themes, its manipulation that is difficult and its proximity to the people. Its manipulation is through the index finger on the head, middle and thumb to move the arms, or another position, since this is not a rule it is quite flexible the position of the fingers. As a result, its use by 11-year-old students improves their motor coordination, creativity and collectivity.

The Shadow Doll has its origin dating back to China, whose records date back to 5,000 BC. From there through travelers it spread to the East and then to the West. Shadow theatre is usually confused with Chinese shadows. The so-called Chinese shadows are confused with shadow dolls, but they have a different process; by using hands, fingers or accessories combined with these to design people or animals.

Shadow dolls were very popular in China. It basically consists of a light source that projects the shadow of a figure, transparent or not, on a white screen. It was the first projection of an image in history of moving figures or shapes on a white screen (or fabric) before cinema.

These puppets were always related to the Opera. The themes were traditional fantastical stories taken from popular myths. From the century. Human dramas are incorporated mixing with myths and legends. The characters were old, warriors, young

¹¹ With different denominations such as: Briguella or João Minhoca in Minas Gerais, João Minhoca in São Paulo, Rio and Espírito Santo; Mané Gostoso in Bahia; João Redondo in Rio Grande do Norte; Babau (Derived from the mamulengueiro Dr. Babau – pseudonym of Severino Alves Dias) in certain areas; Benedito in others.

¹² It is a popular entertainment well known in Pernambuco, where a cloth is spread on a small stage, behind the cloth the trained puppeteers are movement and speak to the puppets. The themes are the most varied, ranging from biblical to present. The authors receive a small pecuniary aid at the end. Mamulengo is a type of puppet, whose word derives from two sources: from Mané Gostoso (puppet of engonço – hinges – endowed with movement in the legs and arms) of its diminutive Manu exchanging the n for m and lengo-lengo (corruption of lenga-lenga – tedious and monotonous), then adding dar mamulengo; or it derives from the expression molengo or mão molenga (because of the mobility and skill of the puppeteer's hand) with reduplication (mo) appearing momolengo, by popular modification, came mamolengo and finally mamulengo (substitution of o for u).

literate, feminine and clowns. The performances were always accompanied by music (flutes, violas, oboes, cymbals and gongs).

In this sense, "the shadow theater, which emerged in Egypt during the twelfth century AD, provided stimuli for the representation of popular legends and historical events. Its form and technique were inspired by the East" (Berthold, 2004, p. 15). In Egypt, mechanized images also appeared, passing to China, passing through several countries. It is a heritage fixed in the movable nativity scenes of the Middle Ages.

In Turkey Karagoz (name meaning "black eye") is the hero of shadow theater and accompanied by his friend Hacivad (among other characters), being made of leather or parchment and moved by sticks. The first is clumsy, hypocritical, brutal, selfish, rude, libidinous and had a huge sexual organ. The second knows/knows everything; He sees/studied everything and experienced all things. They influenced the popular puppet theater with their trickery and adventures.

In India, the puppets date back to the year 200 BC and linked to religion, it is an epic theater, whose stories are taken from the Mahabharata/Ramayana¹³. The shadow figures of the Indian theater were made of leather, finely worked and projected.

In Indonesia, particularly on the island of Java, it received influences from India for spending many years subjugated to it, including cultural, highlighting the shadow theater. Dalang is the puppeteer or priest, musician, poet, advisor and narrator in the shows.

Wayang¹⁴ in Javanese is the same as shadow theatre and is a tradition maintained to this day. The stories of the Mahabharata and Ramayana adapted and expanded. In the Javanese shadow theater it is much more refined than the Indian and its figures are delicately carved in fine leather and adorned with designs in fine strokes, in addition to having joints. The shadow theater in the 6th year of Elementary School will work on the notions of projection, imagination and plot construction with a simple puppet to make.

The stick doll has its origin on the island of Java, called Wayang Golek (Golek means round, plastic) is one of the types of stick figure on this island. Stick Puppet (Manipulated by sticks or sticks) is mounted on a main stick that supports the set, this genre is derived from the Wayang, puppet from the island of Java, Indonesia carved three-dimensionally in wood. Normally, the puppet has only one stick. Easy to manipulate and build with the help of the Art

¹³ They are poems that deal with demons, heroes, villains, lovers or the fights between one or several tribes. The Mahabharata is a Hindu epic poem with ninety thousand poems, being a compilation of various authors. The Ramayana is an epic poem about the story of Prince Rama and Princess Sita.

¹⁴ There are several types of Java dolls: Wayang purwa (ancient shadow doll); Wayang golek (three-dimensional stick figures made of wood); Wayang kruchil or klittik (they were small made of wood, flatter and equipped with leather armrests); Wayang drink or drink (now almost extinct, they were figures painted on rolls of fibrous paper or cotton and pass to the spectators as the story is narrated; it is the most remote ancestor of the cartoon).

teacher, it develops various motor and imaginative skills in children, whether it is the tringle. When two sticks are present, the puppeteer must be very skilled to operate them or have an assistant. The puppet is supported and controlled by sticks or rods, which can be made of wood, plastic, or light metal (e.g., aluminum).

The tringle doll is a variation, of the many of the stick doll. The tringle (French term meaning rod or rod) has a metal rod fixed to the head and a rod moves the limbs (legs and hands) in a simplified way. This is a tradition in southern Italy, Belgium and northern France, having great mobility. He is considered the precursor of the puppet of wires, the marionette. Because of the movement with iron rods or other metals, the tringle doll develops more dynamic, abrupt and agile movements.

Marote, on the other hand, can have a single rod perfect for extras. It is a very old puppet whose origins are lost in time. There are records of terracotta puppets with rods in Greece. But usually the puppet has articulation in the mouth and one of the limbs is manipulated by the puppeteer by means of a stick. It can also be manipulated using the manipulator's arm, the other arm moves the mouth, it is one of the types of direct manipulation. For children, a simpler doll is made, whose handling is more comfortable.

The Giant Puppet, usually more than 2, sometimes exceeding 3 meters in height, used in folkloric manifestations and street shows, are habitable puppets, that is, the handler dresses the Puppet. The best known dolls are the "Midnight Man" and "Midday Woman", popularly called Bonecões de Olinda. To be used in school, only if a pedagogical project is made for its construction and manipulation.

They are built in an artisanal way, composed of structures with bamboo, rolled paper, wires and even steel rebar. The highlight of these dolls is in the making of the head, which is usually produced by the technique of papering, a combination of chopped newspaper soaked with gum made with flour or starch. Made in successive layers of paper and gum, this technique allows the creation of a texture that, after drying, becomes rigid, similar to wood that is finally painted. The doll's body is covered with calico fabric and armrests filled with paper or foam are placed.

Bunraku (derived from Uemura Bunrakuken¹⁵) is Japan 's traditional puppet theater. It consists of the joint manipulation of puppets by three or more people who, dressed in black, blend in with the background of the scenery of the same color. Originally, the Bunraku puppets were smaller than the current ones, had no legs and were manipulated by a single manipulator.

¹⁵ At the beginning of the century. Bunrakuken transformed Osaka into a center of puppet theater and a new interest in puppets. The theater founded by him in 1871, is still remembered today, and his name associated with Bunraku.

There are visual records of the Ebisu-kaki (ancient puppet handlers) who carried a box hanging around their necks and manipulated the puppets from it, they were pilgrims constantly moving. From 1734, the dolls got larger with the weight ranging between 20 and 25 kg or reaching the weight of a child. Measuring from half to two-thirds of a person's height, Bunraku dolls are assembled with independent parts. The Bunraku puppets are true works of art in terms of construction and manipulation.

The head is made of wood (usually hinoki – Japanese cypress, or kiri – light wood from the paulownia tree, they are true works of art), shoulder frame (overlapping layers of soft vegetable foams are placed in the case of a doll, for the elders they were less thick layers, in the warriors broad and high shoulders, in an elder a drooping shoulder), torso (made of papier-mâché or quilted fabric that takes shape when covered by clothing), arms, hips (outlined by a bamboo hoop), legs (the dolls usually because of the long kimono did not have legs and feet, except in the play *The Double Suicide in Sonezaki*), hair, sashigane (40 cm rod attached to the doll's arm at the elbow) and costumes.

The head is crudely carved as well as marking on the block of wood, sawing the two parts lengthwise and excavating the parts by placing the mechanical devices to move the eyes, mouth and eyebrows, I put the two halves together with glue and lacquers the surface in such a way that it seems to be made of porcelain. Color is an index of personality. The white for goodness and virtue (priests, children, young women); red for warriors; red for officers and dark pink for strong or powerful personalities. The neck fits the head, a little looser for dolls and inclined for dolls. There are various types of head, arm, and hand made with hinoki (the Japanese cypress) and worn according to paper. The complexion (skin color) of the dolls is white and their faces are carved with sad features, very difficult to reproduce with a doll.

The simplest dolls are called tsume, which are smaller and operated by a hooded manipulator who moves his head and right arm, while the left is sewn to the kimono because it remains motionless. Already, the costumes or clothing were originally made by the manipulator, but nowadays when it is quite elaborate or high cost it is made by the company's seamstress who is a specialist in the clothing of dolls. The costumes are made with a horizontal opening in the back, where the handler inserts his hand. Meanwhile, on the neck there is a cable that fits into a hole in the center of the shoulder frame. From this same frame, hang arms and legs, connected by wires. The Bunraku wigs are made by a hair craftsman with some experience and knowledge of about 100 hair styles, who is responsible for the renovation of all the wigs, as well as putting them on the heads of the dolls, fixing them,

repairing them and modifying them when necessary. The hair of the dolls has as raw materials human hair or yah hair, a kind of Tibetan ox.

Bunraku reached its apogee in the seventeenth and eighteenth centuries, having as its great playwright Chikamatsu Monzaemo (1653-1724), known as Shakespeare of Japan, together with Gidayu (1651-1714) an artist (director and owner of puppet theater and creator of the same) made an art of high literary and artistic level.

When the piece is of a mundane character, the three manipulators (the master and two assistants) are dressed in black, but if it is a traditional piece, the master (who controls the movements of the head – including the face, the right arm and supports the entire weight of the puppet – between 20 and 30 kg) is dressed in a special way, usually very colorful, leaving his face exposed. The other helpers, one controls the left arm and the other the legs or their suggestion to the dolls. You can take dolls or dolls of a similar size to Bunraku, which the children have and practice a manipulation with three students, it will work on cooperation.

Similar to Bunraku there is the counter puppet, it is derived from the Japanese Bunraku, which uses three manipulators per puppet, this genre has spread throughout the West giving rise to many variations. Among which, the curious form of theater stands out where the puppeteers dress in black and become invisible by the play of lights. This genre is informally called the balcony doll, because it is supported on a pedestal or table. Usually, the puppet is manipulated from behind, directly or through sticks, by one or more puppeteers. The same room adaptation is made for Bunraku.

A puppet character as already described by Amaral can be a body mask (a mask the size of the manipulator's body), as well as the giant puppets of Olinda, popularly called "Bonecões de Olinda", well known at the time of carnival. The best known being "The Midnight Man" and "Noon Woman". These dolls are called habitable as well. This type of puppet, as well as the giant puppet, only if it is for an entire class, through a pedagogical project.

The Theater of objects "is the designation to the theatrical form in which the object was not originally constructed for theatrical manipulation, it is usually an everyday object in which there was no interference in the matter with the specific purpose of creating a puppet" (site: www.antropologiasocial.ufpr.br). Automaton or mechanized puppets are used in object theater, but as objects.

In this way, "in everyday life, the object is functional, but in the theater of objects it passes into the world of the forms of signs and symbols" (Amaral, 1996, p. 213). "[...] The objects that at first seem to us to be simple things to be used, on stage are transformed, they appear loaded with ambiguities and symbologies" (Amaral, 1996, p. 213).

From this perspective, "[...] the theater of objects works fundamentally with functional objects; it sacralizes the object, it seeks, through it, to return to the sacred sense that previously existed in traditional puppet theater [...]" (Amaral, 1996, p. 291). "[...] The objects of our daily personal use are sacred objects to us. And the theater of objects invented a direct ritual between man and his object [...]" (Amaral, 1996, p. 291). About object animation festivals, "the first object theater festival took place in 1983, in Pau, France. Then again in 1984, under a new name, that is, micro or macro theater. The following year, in 1985, new meetings took place in Pau, France and Reggio Emilia, Italy" (AMARAL, 1996, p. 211). Micro or macro because in the theater of objects things are either small (or very small) or large (or very large). The micro and macro relationship is very pertinent in our age of technology or contemporaneity.

Within the theater of objects, we have a subdivision called object-image theater that "[...] they are images that can be created with objects, as well as figurative representations or even abstractions created with light effects" (Amaral, 1996, p. 231). This theater "[...] it is object, light, stage, time and movement" (Amaral, 1996, p. 232). Both object theater and object-image theater are easily adaptable to the school reality, where students will bring the objects and with the mediation of the art teacher will carry out the narratives and manipulations.

Animated forms¹⁶ "is the term used for the animation of 'things' that do not fit as objects or puppets per se, although Ana Maria Amaral uses the term as equivalent to what is currently called animation theater, in the sense of representing all animation operations on stage" (website: www.antropologiasocial.ufpr.br). This technique mixes lighting, music, special lamps, and others to create abstract or metamorphic shapes. The first steps of change to reach the theater of animated forms were taken by Alfred Jarry (1873-1907), a French playwright who transposed from the language of Puppets to the language of theater of actors and their innovations in relation to the displacement of situations and shots; the absurdity and grotesque of the characters and the licentiousness of the text. Then Edward Gordon Craig (1872-1966), an English playwright, introduced symbolic gestures (as in Teatro Nô – Japanese mask theater), where the actor had to control his body without being affected by

¹⁶ Name adopted in Ana Maria Amaral's research since the 80s and according to her in her book *Teatro de Formas Animadas* (1996), "the theater of animated forms can be considered an evolution of puppet theater. But it is a broader theatrical form, in which the puppet is only one, among others, of its forms" (p. 244). According to the author, they can be elastic bands that stretch, extend, grow or disappear; super-realistic or abstract masks; machines that appear to think; it can be a beam of light that chases the actor taking his place in the scene, or colored lights forming figures; Music is also used as an effect. This form of theater has affinities with *performance*, that is, it is a hybrid form of animation, mixing the maximum or minimum of technique.

the ego and introduce the puppets, eliminating emotions (the puppet would help the actor to free himself from overly realistic interpretations).

The futuristic synthetic theater full of symbols, various ideas, many situations and rare words, is a show composed of combined, fitted, confused facts, fragments and improvisations. Dadaism with its evasion of the senses, but linked to trance, is a return to the most primitive forms of communication, so the mask, the sounds and the dance would vent unknown inner sensations. Surrealism and its return to the inner self, to psychic automatism and dreams. The French playwright, writer and director Artaud (Antoine Marie Joseph Artaud, 1896-1948) preached a return to ritual and a theater based on myths, which are updated (more contemporary). The performance has a great contribution, because any space is good, the unexpected is part of the presentation and in it everything is symbolic.

On the other hand, "the theater of animated forms, almost always non-verbal, is close to Jung's theory of free association, according to which any irregular and accidental form is capable of triggering an associative process" (Jung¹⁷ apud Amaral, 1996, p. 301). In this theatre what matters most is the movement, the dynamism of the form. It is another way, similar to object theater, of performing in the classroom with 6th grade students.

The ventriloquist uses the artifice of speaking without or slightly opening his lips, giving the impression that the voice is that of the dummy he manipulates, at the same time that he manipulates a dummy. The actor/manipulator conceals the natural timbre of his own voice and engages in a true dialogue with the inanimate piece, which contributes to reinforce the illusion, through a mechanism behind the puppet's body, which is handled by the ventriloquist. Like the giant puppet and the puppet character, this type of puppet, even adapted, requires more time and interdisciplinary pedagogical work at school.

Sock-puppet (Puppet or sock puppet) is also known as puppet or sock puppet. It is made, as its name suggests, of sock and other elements in fabric or button for the eyes, tongue that are sewn or glued to the main part which is the sock (the body of the doll). It can be finished with paint combined with the elements mentioned above. Basically it's creativity, sewing and, of course, a sock that can be thick or thin, smooth or textured for the magic to happen. One of the types of best adaptation is to use in the classroom with 6th grade students, because it uses accessible material that requires a lot of creativity.

The animation theater still preserves its old or renewed techniques, reaching today the Theater of Animated Forms, its evolution. The puppets are still used in movies, either as supporting actors or main actors, one of the classic examples is the "giant" monkey King

¹⁷ Carl Gustav Jung (1875-1961) was a Swiss psychiatrist. And his cited work is "O homem e seus símbolos" (Rio de Janeiro, nova Fonteira, 1964).

Kong (1933). On the other hand, the puppets reached TV, and today many programs use or used them. A classic example is the *Muppets* (*translation: dolls*) of Jim Henson (1936-1990), his Glove dolls (in special foam and with sticks) gained a large audience. In Brazil¹⁸, currently, the best known case is "Louro José" who hosts the program "Mais Você" (Globo) together with Ana Maria Braga (1949-), was manipulated by Tom Veiga¹⁹.

In short, the educational potential of the Theater of Animated Forms presented above "[...] from the knowledge of its historical and aesthetic aspects, to construction and experimentation, through the body investigation of the artist/actor-manipulator, etc., are potentially important as sources of methodological production for art teachers, especially in basic education [...]" (Araújo and Santos, 2023, p. 87). By fostering the incentive to collective work and interaction inherent to theater, placing the student as the protagonist of their learning, this methodology can be associated with active methodologies in today's society.

4 METHODOLOGY

The present research is characterized as qualitative and exploratory, adopting a descriptive and interpretative approach, with the objective of analyzing and understanding the Animation Theater in its various forms, techniques and pedagogical possibilities, with emphasis on the teaching of Art to students of the 6th year of Elementary School II. present in the practices of Animation Theater.

The main methodological procedure was bibliographic and documentary research, which involves a survey and analysis of books, scientific articles, dissertations and specialized journals. This stage allowed the identification of popular and contemporary traditions, as well as specific techniques of puppet making and scenic manipulation, in addition to historically contextualizing Animation Theater in Brazil and in other cultures, with the Japanese Bunarku.

¹⁸ Several programs use or have used puppets or mascots, such as, for example, Xaropinho (manipulated by Eduardo Mascarenhas), from the program Ratinho Livre (Record TV), the puppet dog Uóli (manipulated by Marcos Lima) from the program Note e Anote (Record TV), the monkey Kinho (manipulated by Eberson Taborda) from Escolinha do Barulho (Record TV), the alien Ed from Domingo Legal (SBT) and the puppet Guinho (manipulated by Anderson Clayton), who accompanied the culinary artist Palmirinha Onofre (1932-1923) on her programs.

¹⁹ Neilton José Veiga Júnior, better known as Tom Veiga (1973–2020), was the actor/handler of Louro José from 1997 until his death due to a stroke in 2020. Louro José was created, a parrot puppet, for the Note and Anote program on TV Record to interact with the presenter, making comments, jokes and gaining the sympathy of viewers. In 1999, Ana Maria Braga went to Rede Globo taking the Doll with her. On TV Globo, Louro José got a new look and his eyes moved by remote control, giving more realism to the manipulation. The puppet participated in several programs and soap operas on Globo, even recording an album in 2003, in addition to a track on another album with Ana Maria Braga. Since April 2022, the character has changed his name, being Louro José's "son", called Louro Mané and acted/manipulated by Fábio Caniatto.

In addition, the research carried out a comparative and systematic analysis of the different forms of animation theater, describing its history and its construction techniques, typologies and possibilities of pedagogical application. This analysis was articulated with the BNCC (2018), aiming to foster educational proposals that enhance artistic learning, creative expression and the sensitive development of students. In this sense, "[...] the National Common Curriculum Base develops and, to a certain extent, updates Ana Mae Barbosa's proposition when it proposes six dimensions for the approach to the teaching of Arts: creation, criticism, aesthesia, expression, fruition and reflection (BNCC, p. 195-196).

In short, the research demonstrated that, with exceptions such as Bunraku and Ventriloquist, it is possible to adopt an art methodology that uses playful learning with 6th grade students. The analysis allowed the construction of a consistent theoretical framework, capable of guiding the application of the practice of animation theater in the school context, providing subsidies for teachers and students to experiment with different techniques and forms of expression of the puppets. The methodology adopted ensures not only the historical and technical understanding of the Puppet Theater, but also its educational and transformative potential in the school environment.

5 RESULTS AND DISCUSSIONS

The analysis carried out allowed us to identify that the Theater of animated forms is a rich and diversified artistic language, capable of interacting body, objects and imagination, creating significant aesthetic experiences for students. From this point of view "[...] of the methodological practice in the classroom, the Theater of Animated Forms can be a tool capable of building a line between history, Art and education, in an interdisciplinary way, capable of encompassing different themes and realities, in addition to constituting a thin line between the imaginary and the real. [...]" (Araújo and Santos, 2023, p. 86). The data obtained in the bibliographic research confirm that this approach provides more playful, sensitive and creative artistic learning opportunities in the school context.

Waszkiel (2019) corroborates that the theater of animated forms has a plural character, allowing multiple languages and experiments, a fact observed in the diversity of techniques analyzed in this article. The research proposes that, in the pedagogical context, these different forms can be adapted to the motor and cognitive skills of 6th grade students, stimulating coordination, body expression, narrative and creativity in the making of the puppets.

Araújo and Santos (2023, p. 86), point out that "[...] the methodological perspective in this field can stimulate the collectivity and contextualization of various themes, in addition to

enabling the Arts teacher to dialogue between different fields of knowledge." This aspect was observed as a point of convergence between cultural practice and artistic education, strengthening the pertinence of the pedagogical use of theater in animated forms. The analysis of oriental traditions, specifically Bunraku, according to Giroux and Suzuki (1991) and Kusano (1993), proves the aesthetic and technical complexity of this modality. However, despite their sophistication, some techniques can be adapted to the school context, such as coordinated manipulation with the theater of objects and the joint narrative, fostering the understanding of cooperation, discipline and rhythm in the construction of the scene.

In the pedagogical field, Cavalcante (2010) and Silva Filho (2010) point out that puppet theater contributes significantly to artistic and teacher training, integrating sensitivity, corporeality and critical thinking. For Nascimento, Engroff and Bem (2023) highlight that the use of puppets and animation techniques in school provides interdisciplinarity, as "[...] for the construction of puppets and silhouettes there is a need for some experience with visual arts techniques; for the elaboration of a narrative or script, some specificities in the area of literature and/or dramaturgy [...]" (Engroff, De Bem e Nascimento, 2023, p. 178).

Also for Nascimento, Engroff and Bem (2023, p. 178), active participation occurs in the "[...] construction of more complex puppets and articulated puppets there is a need for notions of mechanics and the functioning of gears [...]" and the students' body expression in the manipulation of puppets and objects, "[...] a body is needed that is able to perform the innumerable body scores as happens in the language of theater and dance." In addition, the research showed that the practice of Puppet Theater is aligned with the objects of the BNCC Art Teaching (2018), which values the artistic, expressive and cultural development of students.

In general, the results indicate that Animation Theater, when incorporated into the Art curriculum, enables a rich and accessible methodology, efficient in strengthening learning, creativity, body expression and cultural knowledge. At the same time, the discussion highlights the need for specific teacher training and greater dissemination of practices and references on the subject, especially in local contexts such as São Luis do Maranhão, where initiatives such as those of the Casemiro Coco Group are fundamental.

6 CONCLUSION

The research proved that Animation Theater is an artistic language, historically consolidated and with great pedagogical potential, especially in the teaching of Art to students in the 6th year of Elementary School II. By integrating body, object and imagination, this

practice will provide expressive and sensitive experiences, stimulating creativity, motor coordination, narrative and critical thinking of students.

It was found that there is a scarcity of theoretical and practical references about Animation Theater in Maranhão, especially in São Luis. In this sense, initiatives such as this academic research are fundamental for the dissemination of knowledge of the history and techniques of puppets for local study. In this context, the contributions of the Casemiro Coco Group stand out, whose training actions and academic productions collaborate to disseminate and strengthen this language in the region.

In the light of the theoretical references analyzed, it was possible to recognize Animation Theater as an effective methodology for teaching Art, as it contributes to the development of sensitivity, corporeality, creativity and critical thinking, in line with the principles of the National Common Curricular Base (BNCC). In this sense, puppet theater is a precious curricular component for the teaching of Art and that can "[...] contribute a lot to the educational and pedagogical development of students. It allows the exploration of diverse themes, in addition to mobilizing atmospheres of production of meaning, creating an environment conducive to reflection and dialogue." (Engroff, De Bem e Nascimento, 2023, p. 187)

Thus, it is concluded that the insertion of Animation Theater in the school context expands pedagogical practices and contributes to the more significant aesthetic and cultural formation of students. In addition, the research indicates that this hybrid modality of theater is an effective methodology, applicable and based on the BNCC (2018), efficient in articulating tradition, technique, production and creativity, promoting the aesthetic, cultural and expressive training of students. In addition, the research emphasizes the need for greater teacher training and pedagogical resources to corroborate the application of this artistic language in school.

REFERENCES

- Amaral, A. M. (1996). Teatro de formas animadas: Máscaras, bonecos, objetos. Edusp.
- Amaral, A. M. (2004). O ator e seus duplos: Máscara, bonecos, objetos. EDUSP/Senac.
- Amaral, A. M. (2007). Teatro de animação. Ateliê Editorial.
- Apocalypse, A. (Ano?). Estruturas e mecanismos. In Revista mamulengo.
- Araújo, G. A., & dos Santos, Z. B. (2023). Teatro de formas animadas: Um prisma metodológico para a formação de professores/as de artes. Revista Eixo, 12(2), 15–30. <https://doi.org/10.19123/eixo.v12i2.1100>
- Borba Filho, H. (1966). Fisionomia e espírito do mamulengo: O teatro popular do nordeste. Companhia Editora Nacional.

- Brasil. Ministério da Educação. (2018). Base Nacional Comum Curricular: Educação é a base.
http://basenacionalcomum.mec.gov.br/images/BNCC_EI_EF_110518-versaofinal_site.pdf
- Cavalcante, C. M. H. (2010). Teatro de animação: Uma linguagem, uma metodologia de formação de atores. *ouvirOUver*, 6(1).
<https://seer.ufu.br/index.php/ouvirouver/article/view/8227>
- Giroux, S. M., & Suzuki, T. (1991). *Bunraku: Um teatro de bonecos*. Editora Perspectiva.
- Kusano, D. (1993). *Os teatros bunraku e kabuki: Uma visada barroca*. Editora Perspectiva: Fundação Japão e Aliança Cultural Brasil-Japão.
- Kusano, D. (c. 1995). *O teatro no mundo*. Cia Melhoramentos de São Paulo.
- Medeiros, F. H. N. (2009). *Fronteiras invisíveis e territórios movediços entre o teatro de animação contemporâneo e as artes visuais: A voz do pincel de Álvaro Apocalypse* [Dissertação de mestrado, Universidade do Estado de Santa Catarina].
- Nascimento, L. A. do, Engroff, L. G. B., & Bem, D. Q. de. (2023). O teatro de animação como componente curricular de arte: Perspectivas a partir da prática educativa. *Revista Criar Educação*, 1(1), 1–15.
<https://periodicos.unesc.net/ojs/index.php/criaredu/article/view/8054>
- Silva Filho, J. A. da. (2022). *O teatro de animação linguagem artística pedagógica numa abordagem complexa e multirreferencialidade* [Dissertação de mestrado, Universidade Federal de Alagoas]. <http://www.repositorio.ufal.br/jspui/handle/123456789/8590>
- Waszkiel, H. (2019). Teatro de formas animadas. *Móin-Móin - Revista de Estudos sobre Teatro de Formas Animadas*, 2(21), 208–221.
<https://doi.org/10.5965/2595034702212019208>

BETWEEN AVATARS AND ALGORITHMS: GOVERNING PARALLEL UNIVERSES IN THE AGE OF THE METAVERSE

ENTRE AVATARES E ALGORITMOS: A GOVERNANÇA DOS UNIVERSOS PARALELOS NA ERA DO METAVERSO

ENTRE AVATARES Y ALGORITMOS: LA GOBERNANZA DE LOS UNIVERSOS PARALELOS EN LA ERA DEL METAVERSO



<https://doi.org/10.56238/sevened2026.008-147>

Ailton Ferreira Cavalcante¹

ABSTRACT

This article examines the metaverse as a new architecture of social reality in which immersive digital environments governed by algorithms and artificial intelligence increasingly structure identity, value, power, and experience. Rather than approaching the metaverse as a speculative future technology, the study analyzes it as a set of sociotechnical architectures already in operation, as evidenced by algorithmic video platforms, generative AI, synthetic advertising, and identity simulation systems. Drawing on simulation theory, philosophy of information, and the political economy of data, the article argues that these environments produce a code-based ontology in which reality is computationally constructed rather than merely represented. The study introduces the theory of consciousness protection as a normative framework to address the cognitive, emotional, and decisional risks associated with the algorithmic colonization of human experience. Finally, the GIS Cycle (Governance, Innovation, and Sustainability) is applied as an analytical matrix to assess the institutional legitimacy, ethical responsibility, and social sustainability of metaverse governance.

Keywords: Metaverse. Algorithmic Governance. Consciousness Protection. Artificial Intelligence. Digital Universes.

RESUMO

Este artigo analisa o metaverso como uma nova arquitetura da realidade social, na qual universos digitais imersivos, governados por algoritmos e inteligência artificial, passam a estruturar identidade, valor, poder e experiência. Em vez de tratar o metaverso como um fenômeno tecnológico futuro, o estudo o examina como um conjunto de arquiteturas sociotécnicas já em operação, evidenciadas por plataformas de vídeo algorítmico, IA generativa, publicidade sintética e sistemas de simulação identitária. Com base na teoria da simulação, na filosofia da informação e na economia política dos dados, o trabalho demonstra que esses ambientes produzem uma ontologia baseada em código, na qual a realidade deixa de ser representada para ser computacionalmente construída. O artigo propõe a teoria da proteção da consciência como fundamento normativo para enfrentar os

¹ Doctoral student in Public Administration. Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP).
E-mail: prof.ailton@hotmail.com Orcid: <https://orcid.org/0009-0009-2386-1245>
Lattes: <http://lattes.cnpq.br/0389434047626666>

riscos cognitivos, emocionais e decisórios decorrentes da colonização algorítmica da experiência. Por fim, aplica o Ciclo GIS (Governança, Inovação e Sustentabilidade) como matriz analítica para avaliar a legitimidade institucional, a responsabilidade ética e a sustentabilidade social da governança dos universos paralelos digitais.

Palavras-chave: Metaverso. Governança Algorítmica. Proteção da Consciência. Inteligência Artificial. Universos Digitais.

RESUMEN

Este artículo analiza el metaverso como una nueva arquitectura de la realidad social, en la cual entornos digitales inmersivos gobernados por algoritmos e inteligencia artificial pasan a estructurar identidad, valor, poder y experiencia. En lugar de abordar el metaverso como una tecnología futura especulativa, el estudio lo examina como un conjunto de arquitecturas sociotécnicas ya en funcionamiento, evidenciadas por plataformas de video algorítmico, inteligencia artificial generativa, publicidad sintética y sistemas de simulación identitaria. A partir de la teoría de la simulación, la filosofía de la información y la economía política de los datos, el trabajo sostiene que estos entornos producen una ontología basada en código, en la que la realidad deja de ser representada para ser construida computacionalmente. El artículo propone la teoría de la protección de la conciencia como fundamento normativo para enfrentar los riesgos cognitivos, emocionales y decisionales derivados de la colonización algorítmica de la experiencia. Finalmente, se aplica el Ciclo GIS (Governanza, Innovación y Sostenibilidad) como matriz analítica para evaluar la legitimidad institucional, la responsabilidad ética y la sostenibilidad social de la gobernanza del metaverso.

Palabras clave: Metaverso. Gobernanza Algorítmica. Protección de la Conciencia. Inteligencia Artificial. Universos Digitales.

1 INTRODUCTION

Humanity enters the twenty-first century going through a civilizational inflection whose depth rivals the invention of writing, money and the press, to the extent that informational revolutions reconfigure the material and symbolic bases of social coordination, as described in the literature on writing and the press and, contemporaneously, in the theory of the network society and the infosphere (EISENSTEIN, 1979; NGO, 1982; CASTELLS, 2010; FLORIDI, 2014). The emergence of the metaverse², understood not only as a set of immersive technologies, but as a new architecture of existence, inaugurates an unprecedented regime of mediation between consciousness, body, identity, and value. In this new scenario, reality is no longer exclusively physical and is progressively organized by codes, platforms, and algorithms, giving rise to what can be described as normative parallel universes, in which social life unfolds according to rules inscribed in private digital infrastructures (BALL, 2022; FLORIDI, 2014; ZUBOFF, 2019).

It is important to clarify that this work is not dedicated to futuristic speculation about hypothetical technologies, but to the analysis of sociotechnical architectures that are already in operation. Algorithmic video platforms, generative artificial intelligence systems, synthetic advertising, deepfakes, and immersive environments constitute, in practice, embryonic forms of the metaverse, whose effects on identity, power, and consciousness are empirically observable in the present.

Unlike previous technological innovations, which expanded the human capacity to act on the world without substantially altering its ontological status, the metaverse redefines the very space in which action takes place. Persistent virtual environments, avatars endowed with legal and economic identity, digital economies and algorithmic systems of reputation not only simulate reality, but start to constitute it as an autonomous operational layer. It is a profound ontological shift: the passage from representation to the production of reality by code, from symbolic mediation to computationally governed hyper-reality, as anticipated by Baudrillard's theory of simulacra³ (1991).

² The term *metaverse* refers to an integrated set of immersive, persistent, and interconnected digital environments in which users, through avatars, can interact socially, economically, and symbolically in real time. Unlike isolated applications of virtual reality or electronic games, the metaverse is characterized by the continuity of digital identity, the existence of its own economies based on virtual assets, and the algorithmic mediation of social, legal, and economic relations. It is, therefore, a socio-technical infrastructure that allows the constitution of parallel digital universes endowed with their own rules, values, and dynamics, capable of absorbing activities traditionally carried out in the physical world, such as work, consumption, education, and sociability. As an example, platforms such as *Decentraland* or *Horizon Worlds* already allow individuals to acquire virtual land, hold events, carry out economic activities, and build social reputation through their avatars, illustrating how these environments operate as autonomous social and economic spaces, albeit digitally mediated (BALL, 2022; FLORIDI, 2014; ZUBOFF, 2019).

³ In the work *Simulacra and Simulation*, Jean Baudrillard (1991) argues that contemporary societies have entered a regime in which signs cease to represent a pre-existing reality and begin to replace it. *Simulacra* are

This transition finds emblematic expression in James Cameron's film *Avatar*, in which the transfer of consciousness to artificial bodies allows for a form of existence that is more intense, fuller, and more meaningful than ordinary biological life. The cinematographic metaphor reveals, in an aesthetic key, the core of the technological promise of the metaverse: the migration of the human experience to digital territories endowed with ontological plasticity, symbolic control, and potential for subjective realization. However, as Harari (2016; 2018) warns, any technology capable of expanding the human experience also expands, in equal measure, the possibilities of control, inequality, and manipulation, especially when data and algorithms come to know individuals better than they know themselves.

In this context, the metaverse is not only configured as a new market or a new media, but as the first historical form of social space integrally structured by private architectures of algorithmic power. Unlike the modern State, whose norms derive from democratic processes and public legal structures, the rules that organize the digital universes are inscribed in code by global corporations, through terms of use, adhesion contracts and automated decision-making systems, which are often opaque and immune to social control (LESSIG, 2006; ZUBOFF, 2019). Thus, sovereignty, citizenship, and the public sphere move to environments whose governance is technically asymmetric and guided by logics of data extraction, engagement, and maximization of economic value.

Contemporary literature recognizes this displacement as part of a broader transformation of the human condition in what Floridi (2014) calls the *infosphere*⁴, in which the human ceases to exist only in the physical world and begins to inhabit hybrid informational ecosystems. In the metaverse, this condition reaches its maximum degree: identities are performed by avatars, social relations are mediated by immersive interfaces, and economic value is produced by data flows, attention, and symbolic interaction. The risk, as Zuboff (2019) warns, is the consolidation of a second-generation surveillance capitalism, capable not only of predicting behavior, but of shaping the subjective experience itself in digital environments.

not mere copies or illusions, but symbolic and technical constructions that produce a hyper-reality, that is, a reality that is more coherent, more functional, and more operable than the empirical world itself. In this regime, the distinction between the real and the artificial becomes unstable, since what guides human experience is no longer the material referent, but the internal logic of the sign systems. This theory provides a fundamental key to understanding the metaverse, in which environments, identities, and social relations are produced directly by code, configuring digital universes that do not imitate the physical world, but start to function as autonomous realities.

⁴ Luciano Floridi (2014) defines the *infosphere* as the global environment constituted by the totality of informational processes, data, algorithms, digital agents, networks and communication flows, in which human life becomes immersed. In this context, the individual ceases to exist only as a biological and social being to also become an informational agent, whose identity, relationships and decisions are mediated by digital systems. The infosphere represents an ontological expansion of the space of existence, in which the physical world and the digital world are integrated into a hybrid ecosystem of production of meaning, value and power. This notion is central to understanding the metaverse as an intensification of this condition, in which the human experience progressively moves to immersive informational universes.

This process, however, cannot be understood only as a technological phenomenon. It expresses a structural response to the conditions of risk, vulnerability and uncertainty that characterize late modernity. As social trajectories become more unstable, unequal, and exposed to cumulative shocks, the metaverse also emerges as a layer of symbolic and identity protection, a parallel universe in which subjects can reconstruct belonging, status, and recognition. Unlike public social protection systems, however, this new layer of ontological security is governed by private platforms, rather than by principles of justice, equity, and public interest.

Given this scenario, a central question emerges for Law, Public Administration, and governance theory: who governs the parallel universes of the metaverse and according to which principles? The absence of public structures for effective regulation in these environments creates a normative vacuum in which fundamental rights, autonomy, equality, and human dignity become vulnerable to algorithmic regimes of private control. It is at this point that this article proposes an original contribution, by applying the GIS Cycle⁵, Governance, Innovation, and Sustainability, as an analytical matrix to assess the institutional legitimacy, ethical responsibility, and social sustainability of the architectures that structure the metaverse.

By integrating democratic governance, responsible technological innovation, and sustainability as a normative horizon, the GIS Cycle allows us to understand the metaverse not only as a technical challenge, but as a decisive arena for the future of democracy, citizenship, and the human condition itself. More than analyzing an emerging technology, this work seeks to reflect on the construction of humanity's next habitable world, a world in which reality will increasingly be written in code, but whose legitimacy will continue to depend on public principles, justice and dignity.

Given this scenario, the problem that guides this article can be formulated in the following terms: to what extent does the metaverse, as a socio-technical architecture already in operation, reconfigure the autonomy of consciousness and the foundations of institutional legitimacy, and how can the GIS Cycle offer normative parameters for its governance? From this central question, the study seeks to: (i) conceptually reconstruct the metaverse as a code-based ontology; (ii) analyze how data, algorithms, and platforms produce new forms of power

⁵ The GIS Cycle (Governance, Innovation and Sustainability) is an analytical model proposed by Ailton Ferreira Cavalcante, within the scope of his doctorate in Public Administration (IDP), which understands state action as a continuous process of formulation, execution, monitoring and feedback of public policies, articulating institutional governance, responsible innovation and sustainability as criteria for creating public value. Although developed in a systematic way in previous studies, the GIS Cycle can be understood, in synthetic terms, as a spiral process of planning, execution, monitoring and institutional learning, in which governance, innovation and sustainability operate as inseparable dimensions of the same movement. It is not just a managerial arrangement, but a normative architecture that guides public decision-making based on criteria of democratic legitimacy, intergenerational responsibility, and continuous creation of public value.

over subjectivity; and (iii) propose criteria for governance, responsible innovation, and sustainability of consciousness applicable to digital parallel universes.

2 THEORETICAL FRAMEWORK

The metaverse cannot be understood as a simple technological unfolding of the internet, nor as an isolated innovation in the field of entertainment or the digital economy. It is a structural transformation of the way reality, identity, power and value come to be produced, organized and lived.

For this reason, the theoretical framework of this work is not limited to describing technologies, but seeks to reconstruct the ontological, political and normative foundations of the digital parallel universes.

The sections that follow articulate, in an integrated way, simulation theory, information philosophy, political economy of data, algorithmic governance, and public interest theory, proposing a reading of the metaverse as a new architecture of the human condition.

What is at stake is not only a new digital environment, but the redefinition of the very space in which freedom is exercised, identity is built, and the collective future is decided.

2.1 METAVERSE, SIMULATION, AND ONTOLOGY OF DIGITAL CREATION

Before discussing data, power, and governance, it is necessary to understand what the metaverse really is in the deepest plane of reality. In this sense, this section starts from the premise that digital universes are not mere technical extensions of the physical world, but new forms of social, symbolic and normative existence. By articulating simulation theory, information philosophy, and creation archetypes, the goal is to reveal the metaverse as a constructed ontology: a digital cosmos in which worlds, identities, and relationships are produced by code, redefining the boundaries between the real and the artificial.

The metaverse represents an unprecedented ontological mutation in the history of human mediations. More than a technological infrastructure, it constitutes a regime of reality in which experience, identity, and value are produced by persistent computational architectures, inaugurating digital universes capable of absorbing central dimensions of social life. Understanding it as a parallel universe requires overcoming a strictly technical reading to situate it in the field of social ontology and simulation theory.

Baudrillard (1991) anticipated this shift by demonstrating that, in contemporary societies, simulation ceases to represent the real and replaces it with simulacra that begin to organize experience. In the metaverse, this logic reaches its full form: it is not about

reproducing the physical world, but about producing self-sufficient digital environments in which bodies, relationships, and values exist primarily as objects of code.

Ball (2022) describes the metaverse as a continuous network of interoperable virtual worlds, underpinned by persistent identities, self-economies, and real-time computational infrastructure. Although formulated in a technical key, this definition reveals its ontological scope: the metaverse is not a peripheral space, but a new layer of social existence, endowed with its own rules and capable of structuring work, consumption, sociability, and symbolic recognition.

This condition corresponds to what Floridi (2014) calls the infosphere, in which the human ceases to inhabit the physical world exclusively and begins to exist in hybrid informational ecosystems. The avatar, in this context, is not a playful artifact, but the operational form of identity: a hybrid, legal-economic entity that acts, accumulates value, builds reputation, and suffers sanctions within digital universes.

This ontological displacement can be interpreted, in a symbolic and philosophical key, as an update of the archetype of the demiurge, the artificer who gives shape to worlds through models and codes. In the Platonic tradition, the demiurge does not create from nothing, but organizes matter according to ideas, converting chaos into cosmos (Plato, 2017). This symbolic structure reappears, in a new form, in the creation of digital universes and algorithmic systems capable of producing environments, rules, and agents endowed with their own behavior.

In the contemporary rereading proposed by Cavalcante (2025), technological creation, especially in the field of artificial intelligence, represents a symbolic continuity of this demiurgic gesture: the human begins to project order, agency, and rationality into artificial entities, translating thought, values, and purposes into code. The metaverse, in this sense, constitutes a constructed ontology, a digital cosmos in which realities are designed, governed, and experienced through algorithmic architectures.

Just as, in the Mosaic tradition, the divine word is converted into law, and in the Solomonic tradition, the spiritual order is materialized in architecture, in the metaverse reality is translated into computer language. Avatars, environments, protocols, and smart contracts become the new supports of existence, structuring what can be seen, done, and owned. Simulation ceases to be a mere illusion to become the operational foundation of social life, configuring parallel universes in which human experience is produced, mediated and governed by code.

To make the ontological shift described in this section more visible, it is useful to contrast the fundamental structures of the modern physical world with those that emerge in

the digital universes of the metaverse. The following comparison summarizes the key conceptual mutations that underpin the transition to a code-based ontology.

Table 1

Ontological mutation in the metaverse era

Dimension	Ontology of the physical world	Ontology of digital universes
Space	Geographical territory, limited by physical borders	Persistent, code-defined virtual environments
Identity	Legal and social entity linked to the body	Algorithmic avatar with reputation, track record, and value
Presence	Corporeal and localized	Informational, ubiquitous and continuous
Economy	Based on material goods and state currency	Powered by data, attention, and digital assets
Social relationships	Mediated by institutions and legal norms	Mediated by platforms and protocols
Authority	Exercised by the State	Exercised by code-private architectures
Reality	Founded on physical facts	Produced by computer simulation
Value	Labor, property, capital	Engagement, data, visibility and reputation
Temporality	Linear and historical	Updated in real time by systems
Normativity	Laws, constitutions and public contracts	Terms of use, algorithms and platform rules

Source: prepared by the author.

Table 01 shows that the metaverse is not a simple extension of the physical world, but a structural reconfiguration of the categories that organize social existence. Space, identity, value, and authority are defined by computational architectures, inaugurating an ontology in which the real is produced by code. It is from this displacement that the transformations analyzed in the following sections, related to subjectivity, power and justice in the digital universes, become intelligible.

2.2 IDENTITY, DATA, SURVEILLANCE CAPITALISM AND THE THEORY OF THE PROTECTION OF CONSCIENCE

In this section we see that if the metaverse inaugurates a new ontological layer of reality, its deepest impact manifests itself within human subjectivity itself. By migrating to immersive environments governed by algorithms, the individual not only inhabits new digital spaces, but comes to exist under continuous regimes of observation, classification, and behavioral prediction. This section examines how data, artificial intelligence, and platforms transform identity into an object of calculation, giving rise to new forms of power over the mind and desire, and substantiates the need for a theory of the protection of consciousness as the⁶ central normative axis of the era of parallel universes.

⁶ The theory of the protection of conscience, as formulated by the author of this article, Professor Ailton Ferreira Cavalcante, constitutes an original proposal for a normative framework for the impacts of algorithmic systems and immersive digital environments on human subjectivity. Unlike traditional approaches to privacy and data protection — centered on the circulation of personal information — this theory shifts the focus to the structural

The progressive migration of social life to immersive digital environments intensifies in an unprecedented way the logic of data extraction and capture of subjectivity. Unlike traditional web platforms, which record clicks and preferences, the metaverse operates on the entirety of the individual's presence, converting gestures, facial expressions, displacements, social interactions, and emotional responses into continuous flows of information. The human experience, in this context, is no longer just lived to become permanently measured, classified and economically exploitable.

To make visible this transformation of identity into an object of calculation and the centrality of consciousness as a good to be protected, Figure 1 presents a visual synthesis of the architectures of surveillance, algorithmic modeling, and preservation of the subjective core in digital universes.

effects of technology on the formation of the mind, emotions, and decision-making capacity. In contexts such as the metaverse, generative artificial intelligence, and recommendation platforms, the human experience is no longer just observed but is continuously modeled by computational architectures, capable of influencing preferences, beliefs, affective bonds, and existential choices. The theory of the protection of conscience maintains, therefore, that the cognitive, emotional and decision-making integrity of the individual must be recognized as a legal good and a fundamental public value, requiring regimes of governance, transparency, responsibility and ethical limits to the algorithmic engineering of behavior, in a manner analogous to the protection that legal systems confer on the dignity, freedom and integrity of the human person.

Figure 1⁷

From human subjectivity to algorithmic profiling: surveillance, data and protection of conscience



Source: prepared by the author.

Mayer-Schönberger and Cukier (2013) demonstrate that Big Data is not limited to describing past behaviors, but allows anticipating and shaping them through predictive systems capable of transforming statistical patterns into instruments of intervention in human behavior. In the metaverse, this capacity expands exponentially, as the user's own corporeality, attention, emotion, movement, and reaction, becomes part of the informational circuit that feeds the algorithms.

Zuboff (2019) calls this regime surveillance capitalism: a system in which human experience is converted into raw material for the production of behavioral predictions and modulation of future conduct. In immersive environments, this logic reaches a new scale, as

⁷ The image visually represents the theoretical core of the section "Identity, data, surveillance capitalism and the theory of the protection of conscience". The human face divided into two halves symbolizes the ontological split of identity in the metaverse era: on the one hand, the biological subject, bearer of consciousness, emotions, and autonomy; on the other, the algorithmic avatar, a digital identity built by data, metrics, and computer models. This duplicity expresses the passage of the person to the operational profile, that is, from "who we are" to "how we are calculated". The transparent dome that surrounds the brain represents conscience as a legal good and public value, the core of the theory of the protection of conscience. She suggests that, even immersed in data flows and algorithmic architectures, the human mind should be preserved as an inviolable sphere of deliberation, dignity, and freedom. Data flows, reputation metrics, engagement icons, and predictive graphs connected to the body indicate that, in the metaverse and digital platforms, identity is continuously monitored, quantified, and modeled, transforming emotions, relationships, and choices into objects of economic and political calculation. The neural networks and eyes distributed in the background symbolize algorithmic environmental surveillance: there is no single observer, but an ecosystem of sensors, models, and platforms that observe, predict, and influence behavior in real time. The visual tension between the cool tones of the digital environment and the warm glow inside the dome communicates the central message of the article: technology can engage, predict, and induce human experience, but there is a core of consciousness that needs to be protected from algorithmic colonization.

the individual not only interacts with platforms, but comes to exist within worlds designed to observe, predict, and induce behaviors. Surveillance ceases to be episodic and becomes environmental, integrated into the very architecture of digital reality.

It is at this point that the need for a theory of the protection of conscience emerges. As developed by Cavalcante (2026), when subjectivity is translated into algorithmic language, risk is no longer limited to the violation of privacy, but reaches the individual's own moral autonomy, since preferences, emotions, beliefs, and decisions are continuously influenced by systems that operate outside the field of conscious reflection. Consciousness ceases to be just an inner space of deliberation and becomes a field of technological dispute.

Harari (2016; 2018) deepens this diagnosis by arguing that, in data-driven societies, algorithms tend to know individuals better than they know themselves, shifting the subject's decision-making locus to opaque informational systems. In the metaverse, this asymmetry is radicalized, as the individual inhabits universes in which perception, sociability, and identity are filtered by architectures designed to maximize engagement, predictability, and consumption.

Under this regime, identity ceases to be a narrative construct and becomes an operational entity continuously recalculated by algorithmic systems. Avatars, interaction histories, reputation metrics, and psychometric profiles make up a new grammar of subjectivity, in which the self becomes an object of computational modeling. It is an anthropological mutation: the subject is no longer just the one who decides, but the one who is permanently foreseen, induced and governed.

The theory of the protection of conscience, in this context, states that the cognitive, emotional, and decision-making integrity of the individual should be recognized as a legal asset and a fundamental public value, especially in immersive digital environments. Without this protection, the parallel universes of the metaverse risk becoming infrastructures of colonization of the mind, in which formal freedom subsists, but real autonomy is progressively eroded.

2.3 POWER, GOVERNANCE, AND THE ARCHITECTURE OF CODIFIED DESIRE

In this section, it is observed that if digital universes redefine reality and data reconfigure subjectivity, the next step is to understand how power starts to operate in these new territories. This section investigates the metaverse as a political space in the making, in which norms, behaviors, and life possibilities are structured not by public laws, but by private architectures of code. By articulating power theory, network governance, and algorithmic

engineering of desire, it seeks to reveal how sovereignty, freedom, and democracy itself are reconfigured in the era of parallel universes.

The metaverse inaugurates an unprecedented form of power organization, founded not on public legal norms, but on private code architectures capable of structuring perceptions, choices, and life trajectories. As Lessig (2006) formulates, in the digital environment the code operates as a law: it is the protocols, algorithms and interfaces that determine what can be seen, done, possessed and communicated. In the metaverse, this logic intensifies, as the sensory, social, and economic experience itself becomes mediated by persistent computer systems.

In these circumstances, digital parallel universes constitute true political territories. Unlike the modern state, whose authority is anchored in democratic processes, legality, and *accountability*, the platforms that structure the metaverse govern through terms of use, adhesion contracts, and opaque algorithmic decisions. Power moves from the explicit norm to the architecture of choice: behavior is not directly ordered, but the environment in which certain actions become more probable, desirable, or inevitable is constructed.

Castells (2010) demonstrates that, in networked societies, power increasingly resides in the ability to control information flows and access points to networks. In the metaverse, this dynamic reaches a new level, as platforms not only mediate communication, but produce the very worlds in which interactions take place. Whoever controls the infrastructure controls, to a large extent, the possibilities of visibility, belonging and recognition.

This form of power can be understood, in a symbolic key, through the contemporary allegory presented in the Lucifer series, in which the central character rules not by coercion, but by revelation and exploration of desire. By asking each individual "what is their greatest desire?", Lucifer operates as an algorithm of revealed preference: it identifies what most mobilizes the subject and reorganizes the world around them to induce behaviors, choices and dependencies. The parallel with digital platforms is structural: through massive data collection, they do not ask what individuals want, they discover, predict and progressively shape those desires.

This allegory does not replace institutional analysis, but makes tangible the algorithmically engineered logic of desire that the literature on platforms describes.

In the metaverse, this logic translates into environments that continuously adjust to users' emotional, cognitive, and behavioral inclinations. Interfaces, content, interactions, and economic opportunities are modulated in real time to maximize engagement, predictability, and value extraction. Power, therefore, ceases to operate primarily by prohibition or sanction

and begins to act by algorithmic seduction: the subject feels free because he chooses, but chooses within a world designed to lead him.

It is at this point that what Cavalcante (2026) calls the crisis of institutional consciousness is manifested: when the structures that organize social life are no longer intelligible, contestable, and justifiable, governance becomes technical governability. Decisions that affect identities, reputations, and life trajectories are now made by automated systems, without public reason, without due process, and without accountability.

Ostrom's (1990) institutional theory offers a relevant counterpoint by demonstrating that complex systems can be governed by polycentric arrangements based on shared rules, monitoring, and user participation. However, such principles are rarely incorporated into metaverse architectures, which remain guided by corporate logics of maximizing engagement, data capture, and symbolic control.

The result is the consolidation of algorithmic power regimes in which governance is replaced by the engineering of desire. In digital parallel universes, it is not necessary to oblige: it is enough to offer what the individual wants most, at the right time, in the most persuasive way. Thus, the metaverse not only hosts social life, it guides it, induces it, and ultimately governs it.

2.4 JUSTICE, LEGITIMACY AND PUBLIC INTEREST IN DIGITAL UNIVERSES

In this section, it is noted that as the parallel digital universes begin to structure work, identity, reputation, and belonging, it becomes inevitable to ask under what criteria these new realities are organized. This section shifts the focus from technology to legitimacy, examining how classical principles of justice, authority, and public interest can, and should, be reinterpreted in light of algorithmic architectures that govern social life. The goal is to demonstrate that, even in worlds made of code, the demand for rights, dignity, and public reason remains inalienable.

The migration of social life to digital parallel universes imposes a profound revision of the classical theories of justice, legitimacy, and authority. Rawls (2001) argues that just institutions should ensure basic freedoms, equal opportunities and equitable criteria for the distribution of social benefits. Raz (2009), in turn, states that legitimate authority requires public justification: norms are only legitimate when they can be rationally accepted by the subjects to whom they apply. However, in the metaverse, decisions that affect identities, reputations, incomes, and belongings are often produced by algorithms and private platforms, without transparency, without due process, and without effective mechanisms for contestation.

This scenario makes the traditional understanding of the public interest as a mere clause of abstract prevalence of the Administration over individuals insufficient. As demonstrated by Cavalcante and Ota (2025), in the context of contemporary Administrative Law, the principle of the supremacy of the public interest ceased to operate as an a priori dogma and began to require institutional, constitutional and procedural reconstruction. The public interest can no longer be presumed; it must be demonstrated, motivated, controlled and produced within transparent decision-making cycles, otherwise it will become a legitimizing rhetoric for technocratic and opaque decisions.

In digital universes, this requirement acquires even greater gravity. Platforms that structure the metaverse perform quasi-public functions by defining rules for access, visibility, reputation, and circulation of symbolic and economic value. However, unlike the State, these entities are not subject to the classic duties of motivation, proportionality, transparency and control. The risk is the formation of a private algorithmic supremacy, in which technically sophisticated decisions start to produce massive social effects without any parameter of democratic legitimacy.

The theoretical contribution of Cavalcante and Ota (2025) is decisive for this debate by stating that the supremacy of the public interest only subsists when integrated with arrangements of democratic governance, responsible innovation and sustainability, according to the logic of the GIS Cycle. In this model, the public interest ceases to be a vertical command and begins to emerge as a result of structured decision-making processes, in which data, technology, constitutional values, and social participation are articulated to produce legitimate and controllable decisions.

Transposed to the metaverse, this paradigm implies recognizing that algorithmic rules that affect the digital lives of individuals must be subjected to criteria equivalent to those of Public Law: explainability, control, possibility of contestation, impact assessment, and alignment with fundamental rights. Technological innovation cannot operate as a permanent exception to legality; on the contrary, it must be integrated into a regime of systemic responsibility.

Thus, in digital parallel universes, public interest cannot be confused with market efficiency, engagement, or data maximization. It must be understood as the institutional protection of the autonomy, equality and dignity of human consciousness, ensuring that technology operates as a means of creating public value and not as an instrument of private capture of social reality.

2.5 THE GIS CYCLE AS A METAVERSE GOVERNANCE MATRIX

After examining the ontology of digital universes, the capture of subjectivity, the new forms of power, and the demands of justice and legitimacy, it becomes necessary to present an architecture capable of integrating these elements into an operational model of governance.

This section introduces the GIS Cycle as a conceptual and normative matrix for the metaverse era, demonstrating how governance, innovation, and sustainability can be articulated to transform parallel universes of spaces of algorithmic exploration into environments of public value creation and protection of the human condition.

In the face of the ontological, political, and ethical transformations introduced by the metaverse, it is insufficient to resort to traditional models of regulation based only on normative command, market self-regulation, or fragmented technical solutions. Immersive digital universes, governed by algorithmic architectures, demand a matrix capable of integrating democratic legitimacy, technological innovation, and intergenerational responsibility. It is at this point that the GIS Cycle presents itself as an appropriate conceptual and normative architecture.

The GIS Cycle comprises institutional action as a continuous process of formulation, execution, monitoring, evaluation and feedback of public decisions, articulating three inseparable axes.

In the governance axis, qualified motivation, transparency about data and models used, social participation and the possibility of contestation and review are required. Applied to the metaverse, this implies subjecting recommendation algorithms, reputation systems, moderation rules, and access criteria to standards of explainability, *accountability*, and democratic control.

At the institutional level, the governance axis can be translated into instruments such as: requiring independent audits of recommendation algorithms; creation of hybrid instances of participation (user councils, multisectoral forums) to define moderation rules; and digital due process procedures for decisions that affect the identity and reputation of avatars. Such mechanisms bring governance closer to the parallel universes of the standards of motivation, transparency and contestability that structure contemporary Public Law.

In the innovation axis, the GIS Cycle recognizes that immersive technologies, artificial intelligence, and digital economies are indispensable to the construction of the metaverse, but they must be developed under responsibility criteria. This involves controlled testing, prior impact assessment, mitigating biases, protecting vulnerable groups, and meaningful human

oversight over automated decisions. Innovation ceases to be an end in itself and becomes a means to achieve public ends.

In the innovation axis, the GIS Cycle suggests the adoption of experimental regulatory environments, such as *sandboxes* for immersive technologies, conditioned to prior impact assessments on fundamental rights and mental health, as well as significant human supervision in high-risk automated decisions. In these arrangements, technological innovation ceases to operate under a regulatory exception regime and is conditioned to the demonstration of public value creation.

In the sustainability axis, the model expands the time horizon of digital governance beyond immediate gains, incorporating social, psychological, cultural, and intergenerational effects of parallel universes. In the metaverse, sustainability means preserving the autonomy of consciousness, cultural diversity, mental health, and the integrity of the public sphere, preventing the algorithmic colonization of experience from producing lasting dependence, exclusion, or alienation.

Sustainability, on the other hand, understood as intergenerational protection of conscience and the public sphere, can guide specific policies to limit the collection of sensitive data in immersive environments, to preserve cultural diversity in digital universes, and to continuously monitor the psychic impacts associated with the intensive use of the metaverse. This axis shifts the focus from short-term efficiency to the long-term integrity of individuals' cognitive, emotional, and deliberative capacities.

By integrating these three axes, the GIS Cycle allows us to treat the metaverse as a digital public good in formation, and not just as a market for immersive experiences. It translates, for the era of parallel universes, the demand that power, technology, and value be organized according to criteria of legitimacy, justice, and the creation of public value.

Thus, the metaverse ceases to be an inevitable technocratic destination and becomes a field of collective decision-making. The decisive question is not what technology can do, but what kind of world it should help build and under what rules, for whom and with what guarantees of dignity, freedom and equality.

3 METHODOLOGY

This study adopts a qualitative, theoretical-analytical and critical-propositional approach, oriented to the construction of a normative governance model for immersive digital universes. The objective is not to exhaustively describe metaverse technologies, but to understand their ontological, political, and legal implications, as well as to propose a conceptual framework capable of guiding their regulation and governance under criteria of

democratic legitimacy, protection of conscience, and public interest. The methodological design combines three complementary strategies.

The first consists of a theoretical-systematic review of the interdisciplinary literature, integrating contributions from the philosophy of technology, simulation theory, information science, political economy of data, public law and governance theory. Central works by Baudrillard, Floridi, Zuboff, Harari, Lessig, Rawls, Raz, Ostrom and Ball were analyzed, as well as recent production on surveillance capitalism, artificial intelligence and digital platforms. This review allowed us to identify the main conceptual axes that structure the contemporary debate on digital universes.

The second strategy consists of a conceptual and institutional analysis, in which the phenomena associated with the metaverse, avatars, digital economies, recommendation algorithms, reputation systems, and immersive platforms, are examined in the light of categories of Public Law, the theory of legitimacy, and democratic governance. This analysis allows us to assess the extent to which these systems produce effects equivalent to those of public institutions, even if they operate under private regimes of algorithmic power.

The third strategy involves the application of the GIS (Governance, Innovation and Sustainability) Cycle as an analytical matrix. The model is used to critically evaluate metaverse architectures according to three dimensions:

- (i) governance, understood as transparency, *accountability*, participation, and algorithmic explainability;
- (ii) innovation, conceived as responsible use of immersive technologies and artificial intelligence;
- (iii) sustainability, understood as the preservation of autonomy, diversity, and the dignity of human consciousness over time.

In practice, these three strategies were articulated in an analytical path in three movements. First, we proceeded to identify, in the selected literature, core categories to describe the metaverse as code-based ontology (such as simulation, infosphere, surveillance capitalism, and algorithmic governance). These categories were then mobilized to interpret contemporary sociotechnical phenomena, such as algorithmic video platforms, generative AI, synthetic advertising, and deepfakes, treated as sociotechnical evidence of emerging digital power regimes. Finally, the conceptual findings were reorganized in the light of the GIS Cycle, in order to derive normative principles for the governance of the metaverse, with an emphasis on the protection of conscience and the production of public value.

To avoid misunderstandings about the nature of the present study, it is important to clarify that this work is part of the field of applied critical theory and normative institutional

analysis, as employed in contemporary studies on technology, governance and algorithmic power. The objective is not to produce statistical generalizations, but to conceptually reconstruct real sociotechnical phenomena that already operate as structures for the organization of social life. Digital platforms, artificial intelligence systems, and immersive environments are treated here as *de facto* institutions, whose effects can and should be analyzed with the same rigor employed in the study of traditional public and private institutions.

The empirical cases mentioned throughout the article, such as deepfakes, synthetic advertising, algorithmic video platforms, and AI-mediated affectivity, are used as sociotechnical evidence, that is, observable manifestations of architectures that produce normative, cognitive, and behavioral effects. This methodological strategy is widely employed in the international literature on algorithmic governance, surveillance capitalism, and philosophy of technology, and is compatible with high-impact qualitative research standards.

The empirical examples mobilized focus on the ecosystem of global digital platforms active between 2018 and 2025, a period in which the diffusion of generative AI, the popularization of immersive environments, and the standardization of large-scale behavioral surveillance practices intensified.

The study also adopts an illustrative strategy, through the analysis of contemporary empirical phenomena, such as algorithmic video platforms, generative AI, deepfakes and synthetic advertising, not as statistical case studies, but as socio-technical evidence that reveals the real functioning of power architectures and the capture of subjectivity in digital universes.

Finally, the work takes on a propositional character, by using the results of the analysis to formulate normative principles and guidelines capable of guiding the governance of the metaverse according to criteria of public interest, algorithmic justice, and protection of conscience.

4 THE MATERIALIZATION OF THE METAVERSE IN DIGITAL DAILY LIFE

To make visible the already operative logics of the metaverse, this section mobilizes a set of illustrative cases selected by three criteria: (i) relevance in the recent literature on platforms and AI; (ii) ability to exemplify different dimensions of capturing subjectivity (attention, emotion, identity, reputation); and (iii) minimum availability of public or journalistic documentation that allows describing its basic operating mechanisms. These are not exhaustive case studies, but socio-technical evidence that materializes, in concrete situations, the dynamics of power and governance analyzed throughout the article.

Although the metaverse is often presented as a future still under construction, its fundamental logics are already fully operative on contemporary digital platforms. Environments such as TikTok, Instagram, YouTube, AI music platforms, NFT marketplaces, and algorithmic advertising systems constitute, in practice, proto-metaverses: parallel universes in which identity, visibility, value, and desire are organized by persistent computational architectures.

On TikTok, for example, the user does not choose what he consumes. The algorithmic feed builds a bespoke informational world, continuously adjusted to micro-expressions of attention, viewing time, pauses, repetitions, and emotional reactions. Every gesture becomes a given, every piece of data becomes a prediction, and every prediction becomes a reorganization of the environment. The subject starts to inhabit a universe that responds to him in real time — a metaverse without virtual reality glasses, but with total cognitive immersion.

The emergence of generative AI, capable of producing hyper-realistic videos, music, voices, faces, and narratives indistinguishable from humans, deepens this process. When advertisements, influencers, celebrities and even testimonies start to be produced by machines, the distinction between authentic experience and simulation dissolves, confirming Baudrillard's diagnosis: the simulacrum ceases to imitate the real to replace it.

In this environment, deepfake is not a criminal anomaly; It is the logical symptom of a code-based ontology. If identities, images, and discourses are computational entities, they can be copied, manipulated, and reconfigured as easily as any other file. Financial scams, political manipulation, synthetic pornography, and emotional fraud emerge not as deviations but as structural effects of a world in which reality has become programmable.

In the episodes of AI-mediated affectivity and psychic harm associated with interactions with algorithmic systems, the descriptions are based on investigative reports and public documents, treated here as conceptual illustration material, and not as a basis for statistical generalizations.

These phenomena reveal that the metaverse is no longer just a corporate project of virtual worlds, but an infrastructure for colonizing everyday experience. The user already lives in informational parallel universes that shape desires, fears, beliefs and choices without him realizing it.

It is precisely here that the theory of the protection of conscience finds its empirical proof. When fake videos can provoke real emotions, when artificial music can create affective bonds, and when algorithmic narratives can guide political and financial decisions, the human

mind becomes a disputed territory. The question is no longer whether we are in the metaverse — and becomes who is governing it.

4.1 DEEPPAKES, SYNTHETIC ADVERTISING, AND ALGORITHMIC ENGINEERING OF DESIRE

The consolidation of generative artificial intelligence inaugurates a qualitative mutation in the way images, voices, narratives, and identities are produced in the digital space. Deepfakes, hyper-realistic avatars, synthetic music, and artificial influencers do not only represent technical advances, but the constitution of a new symbolic infrastructure in which reality becomes fully programmable. In this environment, the distinction between the authentic and the artificial is no longer perceptible to the common user, configuring what Baudrillard (1991) described as the victory of the simulacrum over the real.

Synthetic advertising, already widely used on platforms such as TikTok, Instagram and digital marketplaces, is an emblematic example of this process. Product videos, testimonials from "people", faces and voices capable of conveying empathy, authority and desire are now generated entirely by algorithms. These contents not only mimic human beings, but are designed to maximize emotional engagement, perceived credibility, and consumer conversion. The result is an unprecedented form of persuasion, in which the user reacts affectively to entities that never existed, but that operate with full psychological effectiveness.

This phenomenon marks the transition from traditional advertising to what can be termed algorithmic engineering of desire. While classical marketing sought to convince, the algorithmic regime seeks to model. Platforms analyze attention patterns, facial microexpressions, dwell time, and emotional responses to build content that dynamically adjusts to each individual's cognitive vulnerabilities. Desire is no longer something spontaneous and starts to be produced, calibrated and reinforced by machine learning systems.

In the context of the metaverse, this logic becomes even more powerful. Avatars, virtual environments and immersive experiences are designed to offer the user exactly what seduces them the most, at the right time, in the ideal emotional intensity. It is the technical materialization of what, in Section 2.3, was described as governance by desire: one does not impose a behavior, but one constructs a world in which certain choices become irresistibly probable.

The proliferation of deepfakes amplifies the risks of this regime. When speeches, faces, and voices can be artificially produced with perfect realism, epistemic confidence, the ability to distinguish the true from the false, collapses. Financial fraud, political manipulation,

defamation, and emotional exploitation are no longer exceptions and become part of the normal functioning of digital ecosystems. Informational reality becomes unstable, and the very notion of evidence is eroded.

These processes empirically confirm the need for the theory of the protection of conscience. When emotions, beliefs, and decisions can be influenced by artificial entities designed to maximize psychological impact, subjective autonomy ceases to be just a philosophical value and becomes a legally threatened good. The human mind becomes a territory disputed by algorithmic architectures, requiring new forms of governance capable of preserving the cognitive, affective, and decision-making integrity of individuals in the parallel universes of the metaverse.

4.2 SYNTHETIC AFFECTIVITY, ALGORITHMIC DEPENDENCE, AND EXISTENTIAL RISK

The expansion of digital universes is not limited to the production of content, images or consumption; It reaches the deepest core of the human experience: the affective bond, belonging, and the meaning of existence. Recent cases widely publicized by the international media and the Brazilian press dramatically illustrate this displacement. In Japan, a young woman celebrated a symbolic marriage with a digital character, building a stable affective relationship with an algorithmic entity. In another episode, a teenager took his own life after repeated interactions with artificial intelligence systems that reinforced negative emotional states and self-destructive patterns. These events are not isolated anomalies, but extreme manifestations of a structural trend.

In immersive algorithmic environments, artificial agents are designed to maximize perceived empathy, emotional availability, and responsiveness. Unlike human relationships, these systems do not get tired, do not frustrate expectations and do not impose limits. The result is the emergence of what can be called synthetic affectivity: genuine emotional bonds established between humans and computational entities, mediated by language models, avatars, and immersive interfaces.

Under the logic of algorithmic engineering of desire, these bonds are not neutral. Platforms have economic incentives to extend interaction time, intensify attachment, and reduce dependence on external human relationships. Loneliness, anxiety and emotional fragility thus become exploitable resources. The metaverse becomes an ecosystem in which affect is produced, mediated, and monetized by private code architectures.

This dynamic creates unprecedented existential risks. When the sense of belonging, validation, and meaning comes to depend on artificial entities, the individual becomes vulnerable to emotional manipulation, social alienation, and the erosion of psychic autonomy.

The boundary between company and control becomes blurred, and human consciousness begins to operate within environments that were designed to influence it.

It is precisely at this point that the theory of the protection of conscience reveals its normative urgency. If subjectivity can be affected, shaped, and, in extreme cases, destroyed by algorithmic interactions, then mental and emotional integrity must be recognized as a fundamental legal asset in digital universes. The right to privacy is insufficient when what is at stake is the right to think, feel and decide without invisible coercion.

In the metaverse, protecting conscience requires more than usage notices or terms of service. It demands public governance over artificial intelligence systems, ethical limits to affective simulation, assessment of psychological impacts, and accountability mechanisms when existential damage occurs. Without these safeguards, parallel universes run the risk of becoming environments of high risk for mental health and for human dignity itself.

5 DISCUSSION – IMPLICATIONS FOR PUBLIC GOVERNANCE IN THE ERA OF PARALLEL UNIVERSES

The analyses developed in the previous sections demonstrate that the metaverse is not a peripheral technological phenomenon, but a new infrastructure of reality, power, and subjectivity. Immersive platforms, generative artificial intelligence, recommendation systems, and synthetic affectivity already operate as de facto institutions, structuring work, identity, consumption, reputation, and emotional bonds. However, these institutions are not subject to the principles that have historically legitimized the exercise of power in democratic societies.

The result is the formation of an institutional vacuum in which private code architectures perform public functions without public duties. Algorithms decide who is seen, heard, desired, and valued; AI systems influence emotions, beliefs, and existential choices; Platforms define the rules of digital belonging. It is a form of diffuse sovereignty, distributed by interfaces and computational models, which escapes the traditional instruments of control of the State and the Law.

In this scenario, the application of the GIS Cycle allows these challenges to be translated into an operational regulatory framework.

In the governance axis, it is imperative to demand algorithmic explainability, transparency of decision criteria, the right to contest and public audit mechanisms of the systems that organize the digital universes.

In the innovation axis, artificial intelligence and immersive technologies must be subjected to impact assessment regimes, ethical testing, and meaningful human oversight, especially when they affect rights, identity, and mental health.

In the sustainability axis, public policy must incorporate the long-term psychic, cultural, and social effects of the metaverse, preventing the algorithmic colonization of experience from producing dependence, social fragmentation, and erosion of autonomy.

The theory of the protection of conscience emerges, in this context, as a new foundation of digital constitutionalism. Just as the modern State developed social protection systems to face economic and biological risks, the era of parallel universes requires systems of institutional protection of the cognitive, emotional and decision-making integrity of individuals. These include limits on affective simulation by AI, regulation of deepfakes, accountability for algorithmic psychological harm, and guarantees that the technology operates as a means of emancipation rather than capture.

Metaverse governance is not a sectoral issue of technology regulation. It is inscribed at the core of the contemporary democratic project. Deciding who governs the parallel universes, according to what principles, and with what guarantees is deciding what kind of humanity can exist in a reality increasingly written in code.

6 CONCLUSION

This article demonstrated that the metaverse should not be understood as a mere technological unfolding of the internet, but as the emergence of a new architecture of social reality. Digital parallel universes, governed by algorithms, artificial intelligence, and private platforms, already structure work, consumption, identity, affection, and symbolic recognition, configuring an unprecedented ontological, political, and ethical mutation.

From simulation theory, information philosophy, political economy of data, and the analysis of algorithmic governance, it was shown that digital reality ceased to represent the physical world and began to produce it. Deepfakes, synthetic advertising, algorithmic affectivity, and generative AI are not deviations, but normal expressions of a code-based ontology, in which the human experience becomes programmable.

In this context, the theory of the protection of conscience proved to be central. When emotions, beliefs, and decisions come to be influenced by opaque algorithmic architectures, subjective autonomy becomes a legally threatened good. Cases of affective addiction to avatars, psychological manipulation by AI, and existential harms illustrate that the risks are not abstract, but real, urgent, and socially relevant.

The shift of power to private platforms requires, in turn, a reconstruction of the public interest. The supremacy of the collective interest, reinterpreted in the light of the GIS Cycle, imposes that algorithms, virtual worlds, and artificial intelligence systems be subjected to

criteria of legitimacy, transparency, control, and sustainability. Technological innovation cannot operate as a permanent exception to legality.

By proposing the GIS Cycle as the governance matrix of the metaverse, this work offers a normative path to integrate democratic governance, responsible innovation, and sustainability of human consciousness. The metaverse is thus no longer an inevitable technocratic destination and is now recognized as a field of collective decision-making.

Ultimately, the challenge of parallel universes is not technical, but civilizing. What is at stake is not just the next generation of digital platforms, but humanity's own ability to preserve freedom, dignity, and meaning in a reality increasingly written in code.

REFERENCES

- Ball, M. (2022). *The metaverse: And how it will revolutionize everything*. Liveright.
- Baudrillard, J. (1991). *Simulacros e simulação* (M. J. da Costa Pereira, Trans.). *Relógio D'Água*. (Original work published 1981)
- Cavalcante, A. F. (2025). O demiurgo e a criação da inteligência artificial: Ontologia, poder e sentido na era algorítmica. *Revista Aracê*, 8(1), 42–65.
- Cavalcante, A. F. (2026). Teoria da proteção da consciência: Governança, algoritmos e integridade da subjetividade na era digital [Manuscrito em preparação].
- Cavalcante, A. F., & Ota, K. da C. (2025). Supremacia do interesse público e o Ciclo GIS: Governança, inovação e sustentabilidade no direito administrativo contemporâneo. *Revista Aracê*, 7(12), 284–312.
- Castells, M. (2010). *The rise of the network society* (2nd ed.). Wiley-Blackwell.
- Dercon, S. (2014). Is green growth good for the poor? (World Bank Policy Research Working Paper No. 6231). World Bank.
- Floridi, L. (2014). *The fourth revolution: How the infosphere is reshaping human reality*. Oxford University Press.
- Harari, Y. N. (2016). *Homo Deus: A brief history of tomorrow*. Harvill Secker.
- Harari, Y. N. (2018). *21 lessons for the 21st century*. Jonathan Cape.
- Lessig, L. (2006). *Code: And other laws of cyberspace*. Basic Books.
- Mayer-Schönberger, V., & Cukier, K. (2013). *Big data: A revolution that will transform how we live, work, and think*. Houghton Mifflin Harcourt.
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.
- Platão. (2017). *Timeu e Crítias* (C. A. Nunes, Trans.). EDUFPA. (Original work published ca. 360 a.C.)
- Rawls, J. (2001). *Justice as fairness: A restatement*. Harvard University Press.
- Raz, J. (2009). *The authority of law: Essays on law and morality* (2nd ed.). Oxford University Press.

Zuboff, S. (2019). The age of surveillance capitalism: The fight for a human future at the new frontier of power. PublicAffairs.

PINK OCTOBER PET EXTENSION PROJECT: THE IMPORTANCE OF RAISING AWARENESS AMONG PET OWNERS AND STUDENTS ABOUT BREAST CANCER IN VETERINARY MEDICINE

PROJETO DE EXTENSÃO OUTUBRO ROSA PET: IMPORTÂNCIA DA CONSCIENTIZAÇÃO DE TUTORES E DISCENTES SOBRE O CÂNCER DE MAMA NA MEDICINA VETERINÁRIA

PROYECTO DE EXTENSIÓN DE MASCOTAS OCTUBRE ROSA: LA IMPORTANCIA DE CONCIETIZAR A DUEÑOS DE MASCOTAS Y ESTUDIANTES SOBRE EL CÁNCER DE MAMA EN MEDICINA VETERINARIA



<https://doi.org/10.56238/sevened2026.008-148>

Maria Augusta Freitas Barbosa Paiva de Lira¹, Emanuella Maria Elen Moraes Sousa², José Eduardo Vieira da Silva³, Isabela de Andrade Lima Barreto Lins⁴, Natália Araújo Vieira⁵, Karine Silva Camargo⁶

ABSTRACT

Mammary neoplasms are among the main oncological conditions in small animal practice, presenting high prevalence in female dogs and highly malignant behavior in female cats, and are frequently diagnosed at advanced stages. This scenario is associated, among other factors, with owners' lack of information regarding the use of progestogens, early clinical signs, and preventive measures, such as early spaying. Therefore, the present study aimed to describe and analyze the importance of a university extension project, developed within the context of the "Pink October Pet" campaign, in raising awareness among dog and cat owners and in the technical-scientific training of Veterinary Medicine students regarding mammary cancer in female dogs and cats. This is an experience report of a descriptive and qualitative nature, carried out through in-person educational activities, a digital social media campaign, and a scientific event, involving owners, students, and professionals in the field. The results demonstrated a wide reach of the extension activities, both in person and on digital platforms, in addition to high participant engagement. An improvement in owners' knowledge regarding prevention and early diagnosis was observed, as well as a significant contribution to the practical, scientific, and humanized training of the students involved. It is

¹ Undergraduate Student in Veterinary Medicine. Centro Universitário Maurício de Nassau (UNINASSAU). E-mail: mariaaugustalira@gmail.com

² Undergraduate Student in Veterinary Medicine. Centro Universitário Maurício de Nassau (UNINASSAU). E-mail: emanuellaellennew@hotmail.com

³ Undergraduate Student in Veterinary Medicine. Centro Universitário Maurício de Nassau (UNINASSAU). E-mail: eduardosilva.silva17@gmail.com

⁴ Undergraduate Student in Veterinary Medicine. Centro Universitário Maurício de Nassau (UNINASSAU). E-mail: medvet.isabelalins@gmail.com

⁵ Undergraduate Student in Veterinary Medicine. Centro Universitário Maurício de Nassau (UNINASSAU). E-mail: medvet.nataliavieira@gmail.com

⁶ Doctoral Student in Veterinary Medicine. Universidade Federal Rural de Pernambuco (UFRPE). E-mail: karinecamargo01@gmail.com

concluded that university extension projects constitute effective tools for animal health education, promoting community awareness and reinforcing the social role of the university in the prevention of mammary neoplasms in small animals.

Keywords: Extension Work. Neoplasia. Oncology. Animal Health.

RESUMO

As neoplasias mamárias figuram entre as principais afecções oncológicas na clínica de pequenos animais, apresentando elevada prevalência em cadelas e comportamento altamente maligno em gatas, sendo frequentemente diagnosticadas em estágios avançados. Esse cenário está associado, entre outros fatores, à desinformação dos tutores quanto ao uso de progestágenos, aos sinais clínicos iniciais e às medidas preventivas, como a castração precoce. Diante disso, o presente estudo teve como objetivo descrever e analisar a importância de um projeto de extensão universitária, desenvolvido no contexto da campanha Outubro Rosa Pet, na conscientização de tutores de cães e gatos e na formação técnico-científica de discentes de Medicina Veterinária acerca do câncer de mama em cadelas e gatas. Trata-se de um relato de experiência, de natureza descritiva e qualitativa, realizado por meio de ações educativas presenciais, campanha digital em rede social e evento científico, envolvendo tutores, discentes e profissionais da área. Os resultados demonstraram amplo alcance das atividades extensionistas, tanto presencialmente quanto nas plataformas digitais, além de elevado engajamento dos participantes. Observou-se fortalecimento do conhecimento dos tutores sobre prevenção e diagnóstico precoce, bem como contribuição significativa para a capacitação prática, científica e humanizada dos discentes envolvidos. Conclui-se que projetos de extensão universitária configuram ferramentas eficazes de educação em saúde animal, promovendo conscientização da comunidade e reforçando o papel social da universidade na prevenção das neoplasias mamárias em pequenos animais.

Palavras-chave: Extencionismo. Neoplasia. Oncologia. Saúde Animal.

RESUMEN

Las neoplasias mamarias se encuentran entre las principales afecciones oncológicas en la clínica de pequeños animales, presentando alta prevalencia en perras y un comportamiento altamente maligno en gatas, siendo frecuentemente diagnosticadas en estadios avanzados. Este escenario está asociado, entre otros factores, a la falta de información de los tutores sobre el uso de progestágenos, los signos clínicos iniciales y las medidas preventivas, como la esterilización precoz. Ante esto, el presente estudio tuvo como objetivo describir y analizar la importancia de un proyecto de extensión universitaria, desarrollado en el contexto de la campaña "Octubre Rosa Pet", en la concienciación de tutores de perros y gatos y en la formación técnico-científica de estudiantes de Medicina Veterinaria acerca del cáncer de mama en perras y gatas. Se trata de un relato de experiencia, de carácter descriptivo y cualitativo, realizado mediante acciones educativas presenciales, campaña digital en redes sociales y un evento científico, involucrando tutores, estudiantes y profesionales del área. Los resultados demostraron un amplio alcance de las actividades extensionistas, tanto de manera presencial como en plataformas digitales, además de un alto nivel de participación. Se observó un fortalecimiento del conocimiento de los tutores sobre la prevención y el diagnóstico precoz, así como una contribución significativa a la capacitación práctica, científica y humanizada de los estudiantes involucrados. Se concluye que los proyectos de extensión universitaria constituyen herramientas eficaces de educación en salud animal, promoviendo la concienciación de la comunidad y reforzando el papel social de la universidad en la prevención de las neoplasias mamarias en pequeños animales.

Palabras clave: Trabajo de Extensión. Neoplasia. Oncología. Salud Animal.

1 INTRODUCTION

Mammary neoplasms represent one of the main oncological diseases in small animal clinics, especially in female dogs and felines, and are an important cause of morbidity and mortality in these species. In female dogs, these tumors correspond to approximately half of all diagnosed neoplasms, and about 50% are malignant in nature. In felines, despite their lower relative frequency, approximately 80% of mammary neoplasms are malignant, with rapid growth and early metastases, representing an important clinical and therapeutic challenge (Nelson; Couto, 2015; Cassali et al., 2020).

The reproductive condition of the female and the time at which the ovariohysterectomy is performed are determining factors in prevention. When castration is performed before the first heat, the risk of developing breast tumors approaches minimum levels, increasing progressively when castration occurs after the first and second estrus (Fonseca; Daleck, 2000; Piekarz et al., 2008). In cats, castration before six months of age can reduce the incidence of mammary neoplasms by up to 91%, and when performed before one year, this reduction is approximately 86% (Memon et al., 2016).

Another widely described risk factor includes the use of progestin- and estrogen-based contraceptives, a condition that favors cell proliferation of the mammary gland, increasing the predisposition to tumor development. However, the low cost and easy access to these agents make their use indiscriminate (Fonseca; Daleck, 2000; Skorupski et al., 2005).

Despite its clinical and epidemiological relevance, the diagnosis still occurs, in most cases, late, compromising the prognosis and therapeutic possibilities. Among the factors that contribute to this delay, the limitation of knowledge on the part of owners in identifying the clinical signs and the initial physical changes of the condition stands out, delaying the search for specialized veterinary care.

In view of this scenario, the need for strategies that expand access to information and favor the adoption of preventive and early detection measures is evident. In this context, educational actions aimed at animal health are fundamental, especially when developed in a continuous and accessible way to the population. University extension is a relevant instrument in this process by allowing the approximation between the scientific knowledge produced in the academy and the reality experienced by the community, while contributing to the practical, ethical and humanized training of Veterinary Medicine students (Rodrigues et al., 2013).

In view of the above, the present study aimed to describe and analyze the importance of a university extension project, developed in the context of Pink October Pet, in the awareness of dog and cat owners and in the technical-scientific training of Veterinary

Medicine students about breast cancer in dogs and cats.

2 METHODOLOGY

The present study is characterized as an experience report, of a descriptive and qualitative nature, with an educational and extension approach, developed within the scope of a university extension project of the Veterinary Medicine course at the Maurício de Nassau University, Graças Unit, in the city of Recife-PE. The actions were carried out in the context of the Pink Pet October campaign, from August 2025 to January 2026, involving face-to-face and digital activities aimed at raising awareness about breast neoplasms in dogs and cats.

The target audience was composed of dog and cat owners from the local community, attended at the School of Veterinary Medicine Clinic of UNINASSAU and in adjacent public spaces, as well as Veterinary Medicine students, direct participants in the extension activities. Students and professionals in the area who participated in the scientific actions promoted by the project, such as a symposium and podcast episode, were also included. Thus, the contemplated public was characterized as heterogeneous, including participants with different levels of previous knowledge about the investigated theme.

The activities developed in the project were organized in a sequential and integrated way, covering three main axes: face-to-face educational actions, a digital campaign through the social network Instagram and a scientific event aimed at students of the veterinary medicine course and professionals in the area.

The face-to-face educational actions took place during the Breast Cancer Awareness Week in Dogs and Kittens, held at the Veterinary Medicine School Clinic of UNINASSAU. At this stage, individualized verbal guidance was given to the tutors, using accessible language, addressing risk factors, initial clinical signs, the importance of breast palpation, periodic veterinary follow-up and castration as a preventive measure. At the same time, educational pamphlets prepared by the project team were distributed.

The educational digital campaign was developed through the Instagram platform, with the publication of informative content on breast neoplasms, prevention, early diagnosis and risks of using hormonal contraceptives. Additionally, a podcast episode was produced and disseminated, recorded in an institutional studio, with the participation of a specialist in veterinary oncology, aiming to expand the reach of information in a way that is accessible to the general public.

The scientific event, characterized by the Symposium on Mammary Neoplasms in Dogs and Cats, was held in a face-to-face format, with lectures and a round table given by invited veterinarians, addressing clinical, surgical and anatomopathological aspects of breast

neoplasms. The event aimed to promote scientific updating and integration between students, professors and professionals in the area.

Data collection took place in an observational and documentary way, based on the registration of the activities carried out, the number of face-to-face consultations and guidance, the distribution of educational materials and the indicators of reach of digital publications, obtained through the Instagram Insights tool. Data regarding participation in the symposium were also considered, including the number of registrants and effective attendance.

The data obtained were analyzed in a descriptive way, through the systematization of quantitative information and the qualitative analysis of the impact of the extension actions, considering the involvement of the participants, the scope of the activities and the contribution of the project to the academic training of the students involved.

The study was conducted respecting ethical principles and with faculty supervision during all extension activities. The methodology adopted made it possible to systematize the actions developed and analyze their scope and contribution to the awareness of the community and the academic training of students. .

3 RESULTS AND DISCUSSION

According to Lima et al. (2020), university extension consists, in its essence, of the articulation between the higher education institution and the community, integrating teaching and research into the training process and promoting the exchange of knowledge, configuring itself as one of the pillars of higher education. In line with this perspective, the activities developed in this extension project favored the approximation between university and community, reinforcing the role of extension as an instrument for the dissemination of knowledge and promotion of animal health in the context of Veterinary Medicine.

The execution of the extension project made it possible to carry out educational, clinical and scientific actions aimed at raising awareness about mammary neoplasms in dogs and cats, reaching both the community and academic audiences. The face-to-face activities allowed the clarification of doubts about the main risk factors, initial clinical signs and prevention strategies, with an emphasis on early castration and periodic veterinary follow-up. In addition, the actions contributed to the early identification of mammary neoplasia in 15 of the 25 dogs evaluated that accompanied their owners during the activities, a fundamental aspect, since the literature consistently demonstrates that the earlier the neoplasm is identified, the greater the chances of successful treatment and better prognosis for the patient (Daleck; De Nardi, 2016; Cassali, 2020).

In the digital environment, the educational campaign developed through the social network Instagram had a significant reach, with approximately 81,000 views on the published content, mostly from non-followers, while the podcast episode obtained approximately 2,100 views. This result corroborates the literature by highlighting the potential of social media as strategic tools for the dissemination of information on animal health, expanding access to scientific knowledge beyond the physical limits of the university. These findings are in line with what is described by França et al. (2019), who highlight the role of digital media in expanding the reach of educational and scientific actions.

The Symposium on Mammary Neoplasms in Dogs and Cats was configured as a prominent action in the scientific axis of the project, promoting technical-scientific updating and integration between students, teachers and professionals in the area. The initiative highlighted the importance of spaces for scientific discussion focused on veterinary oncology, an area of high relevance in the small animal clinic. For the students involved in the organization and execution of the event, the experience contributed to the development of skills in scientific communication, teamwork and management of academic activities.

From the point of view of student training, the project enabled the practical application of theoretical knowledge, especially with regard to breast oncology, communication with tutors and ethical and humanized performance. The extension experience allowed students to understand the importance of the social role of the veterinarian and the opportunity to apply, in practice, the knowledge acquired in the classroom, favoring academic development beyond the theoretical environment. These findings corroborate the literature that highlights university extension as a fundamental axis in professional training, as it integrates teaching, research and social responsibility (Rodrigues et al., 2013).

4 CONCLUSION

The extension project developed in the context of Pink October Pet had a relevant impact on the awareness of dog and cat owners and on the technical-scientific training of Veterinary Medicine students on breast neoplasms. The educational, clinical and scientific actions favored the dissemination of information on prevention, risk factors and early diagnosis, in addition to bringing academic knowledge closer to the community. The initiative also favored the development of technical, ethical and communication skills of students, evidencing the high social and educational potential of extension actions.

REFERENCES

- Biondi, L. R., Gentile, L. B., Rego, A. A. M. S., Noronha, N. P., & Dagli, M. L. Z. (2014). Canine mammary tumors in Santos, Brazil: Clinicopathological and survival profile. *Brazilian Journal of Veterinary Research and Animal Science*, 51(3), 252–262. <https://www.revistas.usp.br/bjvras/article/view/65407>
- Cassali, G. D., et al. (2020). Consensus regarding the diagnosis, prognosis and treatment of canine and feline mammary tumors – 2019. *Brazilian Journal of Veterinary Pathology*, 13(3), 555–574. <https://bjvp.org.br/bjvp/article/view/313>
- Daleck, C. R., & De Nardi, A. B. (2016). *Oncologia em cães e gatos* (2ª ed.). Editora Roca.
- Fonseca, C. S., & Daleck, C. R. (2000). Neoplasias mamárias em cadelas: Influência hormonal e efeitos da ovariio-histerectomia como terapia adjuvante. *Ciência Rural*, 30(4), 731–735. <https://www.scielo.br/j/cr/a/CLrKHksGHfQHRBhk7BXf5Wt?lang=pt>
- Fossum, T. W. (2023). *Cirurgia de pequenos animais* (5ª ed.). Guanabara Koogan.
- França, T., Rabello, E. T., & Magnago, C. (2019). As mídias e as plataformas digitais no campo da educação permanente em saúde: Debates e propostas. *Saúde em Debate*, 43(spe1), 106–115.
- Komazawa, S., et al. (2016). Canine tumor development and crude incidence of tumors by breed based on domestic dogs in Gifu prefecture, Japan. *Journal of Veterinary Medical Science*, 78(8), 1269–1275.
- Lima, M. X. A., Neto, M. N. F., & Pompeu, R. M. (2020). Projeto de extensão no ensino superior como prática de responsabilidade social. *Regae-Revista de Gestão e Avaliação Educacional*, 9(18), 1–12.
- Memon, M. A., et al. (2016). Surgical approaches to cat breast cancer (mammary tumor), their treatment and management at Richmond Crawford Veterinary Hospital Karachi (RCVH), Sindh, Pakistan. *ARC Journal of Animal and Veterinary Sciences*, 2(1), 23–28.
- Nelson, R. W., & Couto, C. G. (2015). *Medicina interna de pequenos animais*. Elsevier.
- Nunes, G. D. L., et al. (2014). Mammary neoplasias in domestic female cats: Possible influence of the diet on the etiology. *Revista Brasileira de Higiene e Sanidade Animal*, 8(3), 11–18.
- Piekarz, C. H., et al. (2008). Expressão das caderinas nos tumores mamários em cadelas. *Archives of Veterinary Science*, 13(1), 13–21.
- Rodrigues, A. L. L., et al. (2013). Contribuições da extensão universitária na sociedade. *Caderno de Graduação – Ciências Humanas e Sociais – UNIT*, 1(2), 141–148.
- Silva, V. B. da, et al. (2025). Impact of owners' perception and socioeconomic status on the treatment and clinical outcome of mammary neoplasms in female dogs. *Preventive Veterinary Medicine*, Article 106690. <https://pubmed.ncbi.nlm.nih.gov/40987059>
- Skorupski, K. A., et al. (2005). Clinical characteristics of mammary carcinoma in male cats. *Journal of Veterinary Internal Medicine*, 19, 52–55.
- Sorenmo, K. U., Worley, D. R., & Goldschmidt, M. H. (2013). Tumors of the mammary gland. In S. J. Withrow & D. M. Vail (Eds.), *Withrow & MacEwen's small animal clinical oncology* (5th ed., pp. 538–556). Saunders Elsevier.

Toríbio, J. M. M. L., et al. (2012). Caracterização clínica, diagnóstico histopatológico e distribuição geográfica das neoplasias mamárias em cadelas de Salvador, Bahia. Revista Ceres, 59(4), 427–433.
<https://www.scielo.br/j/rceres/a/xvzSWwDJmrj9DHSgKpFjyJ>

READING MEDIATION ACTIVITIES IN CHEMISTRY CLASSES ON HEALTHY EATING AND THE PERIODIC TABLE

ATIVIDADES DE MEDIAÇÃO DE LEITURA EM AULAS DE QUÍMICA SOBRE ALIMENTAÇÃO SAÚDAVEL E TABELA PERIÓDICA

ACTIVIDADES DE MEDIACIÓN DE LECTURA EN CLASES DE QUÍMICA SOBRE ALIMENTACIÓN SALUDABLE Y LA TABLA PERIÓDICA



<https://doi.org/10.56238/sevened2026.008-149>

Hélio Nascimento da Paixão Júnior¹, Josineide Pantoja da Costa², Wilton Rabelo Pessoa³

ABSTRACT

The study of Chemistry can broaden the students' view of their universe of experiences, while considering such contexts can facilitate the understanding of this science. However, we realize that there is still resistance to its study by students, especially when faced with a teaching that privileges nomenclatures and calculations. Such teaching makes the student perceive chemistry from a stereotyped view, or in his words, as 'an even more complicated version of mathematics'. The present work proposes to present and discuss contributions of the interaction between reading mediation and chemistry teaching, since the use of scientific texts as a didactic resource can be considered as a means of facilitating. We start from the idea that, arousing curiosity in the search for new information, motivates the student to get involved in their learning, so it is important to promote their enculturation from elementary school, with the use of scientific language in the teaching and learning process of Chemistry. This research aims to propose reading mediation as a didactic resource in the teaching of Chemistry, through scientific literature, with the use of scientific articles - AC or scientific popularization texts - TDC, in order to promote and improve the construction of knowledge in the classroom. AC or TDC reading mediation are used as learning vehicles for students in the first year of high school, in a School of the Public Teaching Network of Ilha de Mosqueiro/PA and, above all, as a way to help students to think and to position itself critically before society. The preliminary results of this research suggest that reading mediation, associated with writing and discussion activities are relevant factors in the acquisition of chemical knowledge, contributing to the formation of a conscious and critical student about social problems. In summary, this interaction established between reader and scientific text can contribute to making learning more effective.

Keywords: Chemistry Teaching. Science Popularization Texts. Methodological Resource. Scientific Literacy. Enculturation.

¹ E-mail: Hélio_nascimentop.junior@yahoo.com.br

² E-mail: pjosineide@yahoo.com.br

³ E-mail: wiltonrabelo@yahoo.com.br

RESUMO

O estudo da Química pode ampliar a visão dos estudantes sobre seu universo de vivências, ao mesmo tempo em que considerar tais contextos pode facilitar a compreensão desta ciência. No entanto, percebemos que ainda existe uma resistência ao seu estudo por parte dos alunos, principalmente ao deparar-se com um ensino que privilegia nomenclaturas, fórmulas e cálculos. Tal ensino faz o aluno perceber a Química a partir de uma visão estereotipada, ou em suas palavras, como 'uma versão ainda mais complicada da matemática'. O presente trabalho propõe apresentar e discutir contribuições da interação entre mediação de leitura e ensino de química, já que a utilização dos textos científicos como recurso didático pode ser considerada como um meio facilitador da aprendizagem. Partimos da ideia que, despertar a curiosidade pela busca de novas informações, motiva o aluno a se envolver em sua aprendizagem, por isso, é importante promover sua enculturação desde o ensino básico, com o uso da linguagem científica no processo de ensino e aprendizagem da Química. Tal pesquisa tem como objetivo propor a mediação de leitura como recurso didático no ensino da Química, por meio da literatura científica, com o uso de artigos científicos – AC ou textos de divulgação científica – TDC, com intuito de promover e melhorar a construção do conhecimento científico em sala de aula. A mediação de leitura de AC ou TDC foi empregada como veículos de aprendizagem aos estudantes do primeiro ano do ensino médio, de uma Escola da Rede Pública de Ensino da Ilha de Mosqueiro/PA e, sobretudo, como forma de auxiliar os estudantes a pensar e se posicionar criticamente diante da sociedade. Os resultados desta pesquisa sugerem que a mediação de leitura, associada a atividades de escrita e discussão são fatores relevantes na aquisição de conhecimentos químicos, contribuindo para a formação de um aluno consciente e crítico sobre os problemas sociais. Em síntese, essa interação estabelecida entre leitor e texto científico pode contribuir para tornar a aprendizagem mais efetiva.

Palavras-chave: Ensino de Química. Textos de Divulgação Científica. Recurso Metodológico. Letramento Científico. Enculturação.

RESUMEN

El estudio de la Química puede ampliar la perspectiva de los estudiantes sobre sus experiencias vividas, mientras que considerar estos contextos puede facilitar su comprensión de esta ciencia. Sin embargo, observamos que aún existe resistencia a su estudio por parte de los estudiantes, especialmente cuando se enfrentan a métodos de enseñanza que priorizan la nomenclatura, las fórmulas y los cálculos. Este tipo de enseñanza lleva a los estudiantes a percibir la Química desde una perspectiva estereotipada, o en sus palabras, como "una versión aún más compleja de las matemáticas". Este trabajo propone presentar y discutir las contribuciones de la interacción entre la mediación lectora y la enseñanza de la Química, ya que el uso de textos científicos como recurso didático puede considerarse un medio para facilitar el aprendizaje. Partimos de la idea de que despertar la curiosidad en la búsqueda de nueva información motiva a los estudiantes a involucrarse en su aprendizaje; por lo tanto, es importante promover su inculturación desde la educación básica en adelante, utilizando el lenguaje científico en el proceso de enseñanza y aprendizaje de la Química. Esta investigación tiene como objetivo proponer la mediación lectora como recurso didático en la enseñanza de la química, a través de la literatura científica, utilizando artículos científicos (AE) o textos de divulgación científica (EDC), con el fin de promover y mejorar la construcción del conocimiento científico en el aula. La mediación lectora de AE o EDC se empleó como herramienta de aprendizaje para estudiantes de primer año de secundaria en una escuela pública de la Isla de Mosqueiro/PA y, sobre todo, como una forma de ayudar a los estudiantes a pensar críticamente y a posicionarse en la sociedad. Los resultados de esta investigación sugieren que la mediación lectora, asociada a actividades de escritura y debate, es un factor relevante en la adquisición de conocimientos químicos, contribuyendo a la formación de un estudiante consciente y crítico ante los problemas sociales. En resumen,

esta interacción establecida entre el lector y el texto científico puede contribuir a un aprendizaje más efectivo.

Palabras clave: Enseñanza de la Química. Textos de Divulgación Científica. Recurso Metodológico. Alfabetización Científica. Enculturación.

1 INTRODUCTION

The teacher has the task of awakening in the student a critical attitude towards the reality in which he is inserted, preparing him to "read the world": at first his world, from then on, and gradually, all possible worlds".
Koch, 2000.

To a large extent, we can say that learning Chemistry means appropriating the language of science, with its codes, concepts, equations, that is, as a specific way of reading and interpreting reality. At the same time that discussions about Science circulate in the media and raise questions, the teaching and learning of Science in school has often encountered difficulties, configuring a crisis, according to Fourez (2003). Such a crisis is related to a distant and unattractive teaching, contributing to the lack of interest on the part of students.

This can be evidenced, among other aspects, in the performance of Brazilian students in PISA⁴ (Program for International Student Assessment) in 2018, whose exam is carried out by the Organization for Economic Cooperation and Development – OECD, in which Brazil occupies the 66th position among 78 participating nations, still below Latin American countries such as Chile, Uruguay, Mexico, Costa Rica and Colombia. These results indicate that Brazil, despite having improved its performance in reading, mathematics and science in the latest assessments, still has a rate significantly below the OECD average. The score of Brazilian students was 404, and the average in this category is 489, with the maximum score being 590, recorded in Singapore. This performance gives the Brazilian student level 2 of learning, on a scale ranging from 1 to 6. This means that students can understand only a limited part of the text and are only able to make low-level inferences (PISA, 2018). Although the results of this evaluation can be questioned, one of the consequences is the stagnation in science teaching in Brazil, observed by the lack of interest in the discipline and the scientific careers associated with it.

There are different initiatives to improve the teaching of Chemistry in Brazil. Research such as that of Martins, Nascimento and Abreu (2001), for example, proposes the use of didactic strategies that value the relationship of students with different types of scientific texts that express a variety of forms of argumentation and different points of view. Such texts can bring certain benefits, among which are: access to a greater diversity of information; development of reading skills and mastery of concepts, forms of argumentation and elements of scientific terminology (MARTINS et al., 2001). From this perspective, knowing a variety of

⁴ PISA (Programme for International Student Assessment). Information available on the website: ocde.org/pisa/

types of scientific texts, from media reports to scientific originals, helps students to incorporate elements of scientific culture.

The need to focus on reading, writing and text interpretation is related not only to the appropriation of the mother tongue, but also of scientific language, to strengthen the teaching of science, especially the teaching of Chemistry. As Martins et al., (2004) point out in their works, scientific dissemination texts can function as motivating or structuring elements in the classroom.

Therefore, I understand that no matter what the school subjects are, they can all contribute to the development of activities that enable students to gradually increase their ability to understand the materials read, and thus accentuate the taste for reading. For this to occur, it is of fundamental importance that teachers promote the insertion of various texts, such as Scientific Articles (CA) and Scientific Dissemination Texts (TDC), with language appropriate to the student's learning level as a resource to enhance the teaching and learning process in the teaching of Chemistry.

Tonindandel (2008) comments that in science teaching it is necessary to promote conditions and stimulus for an approximation of the student to scientific processes, which by understanding their rules, processes and forms of language, can enable students' access to scientific culture. Two competencies of the ENEM reference matrix, found in the Cognitive Axis (Mastering Languages – DL and Building Argumentations – CA), should be stimulated in high school students are: "master the cultured norm of the Portuguese language and make use of the mathematical, artistic and scientific languages and the Spanish and English languages" (p. 1) and "Relate information represented in different forms, and knowledge available in concrete situations, to ensure consistent argumentation" (BRASIL, 2020, p. 101). Therefore, the need to value scientific culture in basic education is evident.

In my view, it is somewhat challenging to consider reading as a learning space in Chemistry classes, so I sought to investigate my own practice, having as a guiding question:

- In what terms can reading mediation activities contribute to learning in Chemistry classes at the high school level?

In this sense, we seek a simple proposal, but one that can be significant, which leads us to reflect on our postures in the face of the work carried out in Chemistry classes. With the pedagogical intervention method, we used the insertion of CA and TDC in Chemistry classes in the 1st year of high school, with the general objective:

- Investigate reading mediation activities of scientific articles and texts of scientific dissemination in the context of Chemistry classes and their possible contributions to the Scientific Literacy of students.

In view of this general objective, the study also seeks as specific objectives:

- Identify reading habits of students in the 1st year of high school and correlate them with the learning of Chemistry.
- Analyze reading mediation activities and their possible contributions to the learning of Chemistry.
- Develop an educational product with reading mediation strategies in Chemistry classes.

2 BRIEF ACCOUNT OF ACADEMIC AND PROFESSIONAL LIFE

The path of this research is the result of my academic and mainly professional trajectory, which converged to the search for a didactic resource, which prioritizes solving learning difficulties encountered by my students in the teaching of science, especially with Chemistry subjects in basic education. To understand this choice and the path taken so far, I must refer to my academic path, which began in 2003, in the Full Degree course in Natural Sciences – Chemical Qualification – at the State University of Pará – UEPA, Regional University Nucleus of Baixo Tocantins, Moju and to my teaching essays as a teacher of CFB (Physical and Biological Sciences) in the Municipal Network and Chemistry in the State Network.

My journey as a student in Basic Education was in public education, marked by negative factors since due to the difficulties faced in my path I was labeled early as a student with little interest in studies, with learning and cognition deficits, factors that resulted in retention in literacy and weaknesses in the areas of Portuguese language and mathematics.

From average student to hardworking student, my educational deficiencies accumulated and I needed more time than other students in my age group to enter university. At the time when the preparation for admission to universities was carried out by area of knowledge, I fell in love with the old CB – area of Biological Sciences – which had as its main focus of studies the disciplines of Chemistry, Physics and Biology. It was during this period that I chose my degree and sought a degree by affinity, with an emphasis on Chemistry and Biology, as my future and profession, as they have always been my favorite subjects.

I studied at UEPA in the period 2003 – 2006 at the Regional University Center of Baixo Tocantins - NURBAT, in the municipality of Moju, where we had several structural and pedagogical problems that hindered the teaching and learning process. We were the second class of a newly opened campus, so the tripod of higher education – Teaching, Research and Extension – was not consolidated, thus leaving a gap in my academic training.

Now graduated in Natural Sciences with a qualification in Chemistry, I sought a second degree, Degree in Biology from the Federal University of Pará, it was offered in the distance learning modality in the city of Capanema/PA, with face-to-face meetings on Saturdays, only with monitoring of doubts, evaluations and experimentation. The course maintained the same profile as the university centers in the interior of the State of Pará, with structural and pedagogical problems and, associated with this and other personal factors, I was unable to complete this degree.

Such experiences in graduation produced a professional who was still unfinished, so I sought in specialization courses new perspectives on my definitions, seeking to answer many questions: how do I see myself as a teacher? How can I improve my practices? What is my role in basic education as a teacher of Natural Sciences?

To answer these questions, I participated in the courses Methodology of the Teaching of Natural Sciences, with qualification in Chemistry, by the Center for Social Sciences and Education - CCSE of the State University of Pará - UEPA and then Methodology in the Teaching of Chemistry, by the Faculdade Integrada Jacarepaguá - FIJ, through the Virtual Learning Environment, distance learning model of teaching, both very theoretical and not very interesting, So the questions and the search for answers continued to surround me. I wanted ready-made answers that would give me a direction, show me how to become a better and more complete person and professional. So far I have not found them, because today I know that this process is long and indeterminate, as it is a human construction.

I consider that in my beginning in teaching I sought to reproduce the pedagogical practice of the teachers I had in high school, plastered to the mechanical and traditional teaching format to which I was subjected and which was not questioned or problematized at the University. Paulo Freire (2006, P. 61) characterizes the educator-student relationship as "fundamentally narrative" and excessively theoretical, in which the teacher, considered as the bearer of knowledge, transmits ready-made and finished information to students, without integrating them into the process of knowledge formation or giving space for questioning. This type of education empties students of subjectivity, reflection and criticality.

The experiences as a student in basic education, in which I built ideas about the teaching and learning processes and the role of teacher and students, are referred to in research as environmental or incidental training (CARVALHO AND GIL-PÉREZ, 2001). This draws attention to the fact that teacher training does not begin in undergraduate courses and goes beyond them, being a permanent process that needs to be considered so that simplistic ideas about teaching are not perpetuated, to the detriment of the development of the teacher's professional knowledge.

As an education professional, I came across several realities and understood that difference, before being a problem, is inherent to the classroom. In public school, I lived with students from different social classes, with different levels of learning and each one with their own time to learn. I experienced violence in schools and structural precariousness, but what drew the most attention during this period was the negligence of managers with public education.

I could be one more, wait for the salaries at the end of each month, but all this bothered me, because I was a "child" of the public school and I know that even in its decadent face it can transform lives, just as it transformed mine. Working since the second semester of college was not easy, because in addition to being very young and inexperienced, I was at the beginning of my academic training, without theoretical and methodological foundations, but with the sparkle in my eyes and the enthusiasm to do my best.

In these seventeen years as a teacher, I taught in the municipalities of Moju, Igarapé-Miri and Belém, but always with the intention of transforming lives and changing realities. I love my profession and that's why I dedicate myself to doing what I understand to be the best for the students. I try to use several different resources and methods seeking to prioritize quality teaching, focused on student learning.

One of the most relevant factors of my teaching journey in basic education was the participation as an advisor of research projects in science fairs and as a coordinator of fairs. Science fairs appeared in my professional life in 2008 and changed the way I view my teaching practice. I became an advisor for Junior Scientific Initiation projects – ICJr and coordinator of science fairs at the Manoel Antônio de Castro school - MAC and later director of the Coordination of Support and Incentive to Scientific Initiation - CAIC, by the Municipal Department of Education - SEMED of Igarapé-Miri, where I learned that research and scientific investigation in basic education are very important for the formation of the student.

Thus, I started to bet on the production of research in elementary and high school, with child and youth engagement from the early years, and I realized that it was possible for young people from public elementary and high schools to get involved with research. That was how my teaching practice started to make sense, so I sought, in the Junior Scientific Initiation, to give meaning to my teaching practice.

I was looking for an instrument in scientific initiation that would concretely help the teaching of Chemistry and Sciences, using research actions to teach, in which the appropriation of knowledge occurred through reading and immersion in the scientific world. There were years of work and participation in several local, regional, state, national and

international scientific events. Unique experiences with learning that changed my story as a person and professional.

It was from my practice as a project advisor and organizer of scientific events that I was able to realize the importance of reading and the appropriation of scientific language as one of the elements for citizenship formation, considering that it enables other ways of understanding reality by the student. Reading habits can be encouraged from the beginning of the literacy process, as we know that science and scientific culture play a fundamental role in contemporary society, in addition to contributing to expanding students' reading of the world.

I continue to seek the best of myself and try to subsidize teaching with differentiated activities, with playfulness, problematization and research. I seek to involve students in the teaching and learning process, as I believe that we can, albeit indirectly, transform the lives of our students through education.

3 ACADEMIC PRODUCTIONS ON THE TEACHING OF CHEMISTRY AND READING AS A METHODOLOGICAL RESOURCE IN THE AREA OF CHEMISTRY TEACHING

In this section, a mapping of academic productions on the theme "reading in the teaching of Chemistry" is presented, especially in high school, which is the focus of this research. The investigation was made around knowing some research on the teaching of Chemistry in the Brazilian territory, focusing on reading in classes of the referred curricular component.

For this, a survey was carried out in works published at the National Meeting of Chemistry Teaching – ENEQ, corresponding to the years 2008 to 2018. The ENEQ was chosen for its representativeness among teachers in the area of Chemistry Teaching, in Basic Education and at the higher level, which meets the focus of the present study. The studies were selected taking the following elements of analysis: theme, keywords, reading of abstracts. In some cases in which these elements were not sufficient to classify the study, methodology and results were evaluated. A total of 32 studies were identified with a focus on Reading as a didactic resource, as illustrated in the following table:

Table 1

Academic works published at the National Meeting on Chemistry Teaching – ENEQ, from 2008 to 2018, focusing on reading in the teaching of Chemistry

YEAR OF THE ENEQ	NUMBER OF PUBLICATIONS	AREA IN ENEQ	ACRONYM
2008	2	Experimentation	EX

		Environmental Education	EA
		Language and Cognition	LC
		Teaching Learning	EAP
		Teacher Training	FP
		Not specified	XXXXXXXXXXXX
2010	6	Language and Cognition	LC
		Language and Cognition	LC
		Curriculum and Assessment	CA
		Environmental Education	EA
		Teaching and Learning	EAP
		Experimentation	EX
		Education in Non-Formal Spaces and Scientific Dissemination	EFD
2012	6	Science, Technology and Society	CTS
		Language and Cognition	LC
		Not specified	XXXXXXXXXXXX
2014	10	Teaching Learning	EAP
		Education in non-formal spaces and Scientific Dissemination	EPF
		Language and Cognition	LC
		Inclusion and Educational Policies	IPE

Source: Author 2021

In the period corresponding to 2008-2018, 4,557 works were published⁵ within the thematic lines of table 1, and from these studies a demonstration of only 32 works that came close to the object of study of this research was selected, based on the criteria already mentioned. The analysis of the table reveals that there was a greater number of studies focused on the focus of this research in 2014 with 10 studies, followed by 2010 and 2012 with 6 studies each. In the subsequent years, 2016 and 2018, there was a drop in the publication of these works, with only 04 and 04 studies presented respectively in each of these two editions of the event. A more detailed investigation was carried out in order to elucidate issues such as "types of reading" that have been addressed in the research, "levels of education" to which the research is directed and "thematic areas" involved in the published studies. These data are shown in Table 1 below:

⁵ Quantitative data obtained from the Brazilian Society of Chemistry Teaching (SBENQ) that publishes the works published in the National Meetings of Chemistry Teaching (ENEQs) through the website: <https://sbenq.org.br/eneqs/>. Accessed in January 2019.

The tables with the demonstrations of the number of papers published in each Edition of ENEQ in the period 2008-2018 as well as the respective thematic areas are found in Annex I of this research, the data were accounted for and organized by the proponent of the research since the page does not have the systematization of data in the way it is being demonstrated in this study.

Table 2

Academic works published at the National Meeting of Chemistry Teaching – ENEQ, between the years 2008 and 2018, with a focus on language and writing in the teaching of the discipline of Chemistry

No.	ENEQ'S	TITLE	EDUCATION LEVEL	FOCUS	THEMATIC AREA
1	XIV ENEQ 2008	Reading labels as a contextualizing instrument for the teaching of Chemistry.	Medium	Reading and interpreting labels	EX
2	XIV ENEQ 2008	Reading the World: Using Written and Spoken Language to Awaken Scientific Interest in Chemistry.	High School/Prep School	Use of newspapers, magazines and films in problem situations.	EA
3	XV ENEQ 2010	Analysis of Questions and Questions and Answers Prepared by Chemistry Undergraduates in Reading Activities	Graduation	Reading texts about experimentation	LC
4	XV ENEQ 2010	Emphasizing the relationship between the ability to read texts and the learning of Chemical contents*	Graduation	Use of scientific articles for reading	EAP
5	XV ENEQ 2010	Reading experiences in the Amazon: the case of PIBID Chemistry at the Federal University of Rondônia	Graduation	Readings of articles.	FP
6	XV ENEQ 2010	Investigating rhetorical strategies in the writing of researchers in the field of chemistry: subsidies for understanding the language of science*.	Postgraduate	Reading of 10 articles and the present rhetoric.	LC
7	XV ENEQ 2010	Medicine Leaflets, Drug Production and Biopiracy: An Experience Involving Reading, Educational Video and Playful Activities in the Classroom.	Medium	Reading of medicine leaflets and biopiracy.	Not specified
8	XV ENEQ 2010	Possibilities for the construction of the written language of science in chemistry classrooms	Medium	Reading of textbook text.	LC
9	XVI ENEQ 2012	The reading of scientific texts as a possibility of analyzing the improvement of discourse genres*.	Graduation	Reading of scientific texts.	LC
10	XVI ENEQ 2012	Reading strategies in initial training in chemistry: an analysis of two cases based on the use of scientific literature*	Graduation	Readings of scientific texts.	LC
11	XVI ENEQ 2012	The mediation of the reading of didactic texts and the process of understanding the chemical contents	Fundamental	Mediation of readings in didactic texts.	LC
12	XVI ENEQ 2012	(Dis)paths of research on reading and formation of readers in chemistry classes in high school	Postgraduate	Literature review.	LC

13	XVI ENEQ 2012	Reading and textual interpretation in Chemistry classes in schools in the municipality of Juiz de Fora*.	Medium	Reading of a text for scientific dissemination.	LC
14	XVI ENEQ 2012	The development of argumentation and scientific language by undergraduate students in chemistry through textual production*.	Graduation	Reading scientific texts learning.	LC
15	XVI ENEQ 2014	An evaluation of the teaching of argumentation to chemists	Graduation	Creation of a reading and writing discipline.	CA
16	XVI ENEQ 2014	The use of poems as a didactic proposal in the teaching of Chemistry.	Medium	Reading and Analysis of poems	EAP
17	XVI ENEQ 2014	Reading scientific articles in high school: proposal of a methodology for teaching chemistry*.	Medium	Reading articles, books and writing.	EAP
18	XVI ENEQ 2014	The Teaching of Atomic Models Mediated by Reading	Medium	Reading cybertexts and textbooks	EAP
19	XVI ENEQ 2014	Scientific language in the school context: the acquisition of oxygen by Lavoisier as a motivating theme.	Fundamental	Paradidactic book "Elementary Chemistry Treatise"	EX
20	XVI ENEQ 2014	Mediation of scientific knowledge articulated by the teacher during a class on Chemical Transformations for deaf students	Fundamental	Mediation of experimentation with the use of LIBRAS.	IPE
21	XVI ENEQ 2014	Written activity based on a text of scientific dissemination in high school chemistry: production of meanings*	Medium	Reading of a text for scientific dissemination. "Green energy".	LC
22	XVI ENEQ 2014	Scientific and everyday language: how students explain an environmental phenomenon.	Medium	Thematic classes using everyday or scientific language.	LC
23	XVI ENEQ 2014	Use of a popular science text in chemistry classes in high school*	Medium	Use of texts from the magazine Ciência Hoje.	EFD
24	XVI ENEQ 2014	The written language of chemical reactions: perceptions of chemistry undergraduates.	Graduation	Chemical language used in reactions.	LC
25	XVI ENEQ 2016	Language and the other in the process of understanding chemical conceptual contents	Other	Central role of language and discursive interactions	LC
26	XVI ENEQ 2016	Dissemination of Science in Elementary Education – classroom reports*.	Fundamental	Readings of popular science texts	Not specified
27	XVI ENEQ 2016	Reading from a Freirean perspective and assumptions of the STS approach:	Other	Reading of literary texts.	CTS

		approximations and implications to the teaching of chemistry			
28	XVI ENEQ 2016	Contributions of reading scientific texts to scientific literacy in Higher Education*	Graduation	Reading and interpretation of scientific texts.	LC
29	XVI ENEQ 2018	Retextualization of original research articles in science education: overview of the works published in the JCE and JCST (2007-2014)*.	Graduation	Reading articles for Retextualization.	LC
30	XVI ENEQ 2018	Investigation of Reading Habits in Chemistry Classes of High School Students*	Medium	Application of a questionnaire on reading habits.	EAP
31	XVI ENEQ 2018	Scientific dissemination in Chemistry: contributions to formal education	Graduation	Use of a laboratory for scientific dissemination. Experimentation for the appropriation of scientific terms.	EFD
32	XVI ENEQ 2018	The use of Scientific Dissemination Texts for the teaching of Chemistry at PROEJA.*	Medium/Technical	To analyze the effectiveness of BDT with an approach in general chemistry, seeking to facilitate its understanding and importance for citizenship formation.	EFD

Source: Author 2021

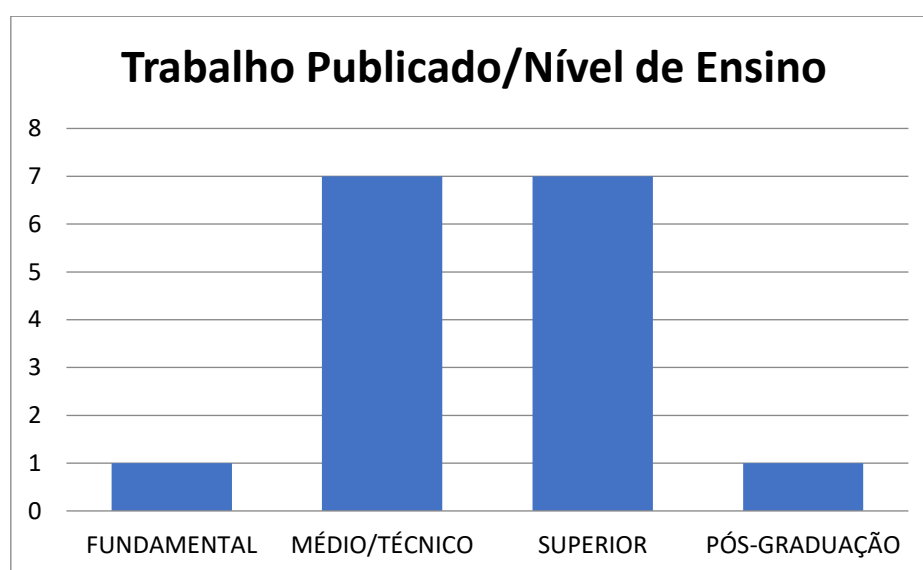
The data in Table 1 indicate that 46.875% of the studies are focused on higher education, including undergraduate and graduate studies, and 53.125% of the studies are directed to basic education, including elementary and high school. Another piece of data observed in Table 1 is related to the "type of reading used" in the studies investigated. It was observed that 40.625% of the readings used in the classroom correspond to scientific articles (identified in the box with an asterisk) and most of the readings used, which correspond to 59.375%, refer to other textual genres such as "product labels", "medicine recipes", "textbooks" and others.

Furthermore, it is important to emphasize that of the studies that made use of Scientific Articles and TDC's, 50% were used in higher education and the other 50% in basic education. This shows a parity in productions, but still limited, hence the need to discuss articles of scientific dissemination within the reach of basic education students, which in part may justify

possible difficulties that these students have in discussing themes involving scientific themes, ratifying the need for other studies in this line. Of the 32 studies found in the mentioned period, 48% are in the area of Language and Cognition (CL), denoting its importance for studies focused on Reading. For an analysis of the Teaching Level of the 32 works published in ENEQ with a focus on Reading as a contribution to the teaching of Chemistry, Figure 1 shows in more detail how this distribution took place.

Figure 1

Distribution of publications by level of education



Source: Author 2020

In addition, an analysis was carried out with regard to the teaching and research institutions in which the studies are linked, as well as the major Brazilian regions, so that we could have an overview of the distribution in our country and in particular in the North region, the state of Pará that is the location of the present study. This survey showed disparity in the distribution of these studies in the major Brazilian regions, because as can be seen in Figure 2, there is a greater number of publications in the Southeast region, which totals 15 studies published in the ENEQ, followed by the North region with 06, the South and Northeast regions with 04 and the Midwest with only 02 studies. It is important to mention that although the North region shows an academic production with 06 publications, considering its vast territory this number becomes low compared to the other Brazilian regions, in addition to the fact that the state of Pará does not have any of the publications in this region.

Figure 2

Regional Quantitative of Academic Productions on "Reading" published in ENEQ in the period from 2008 to 2018.

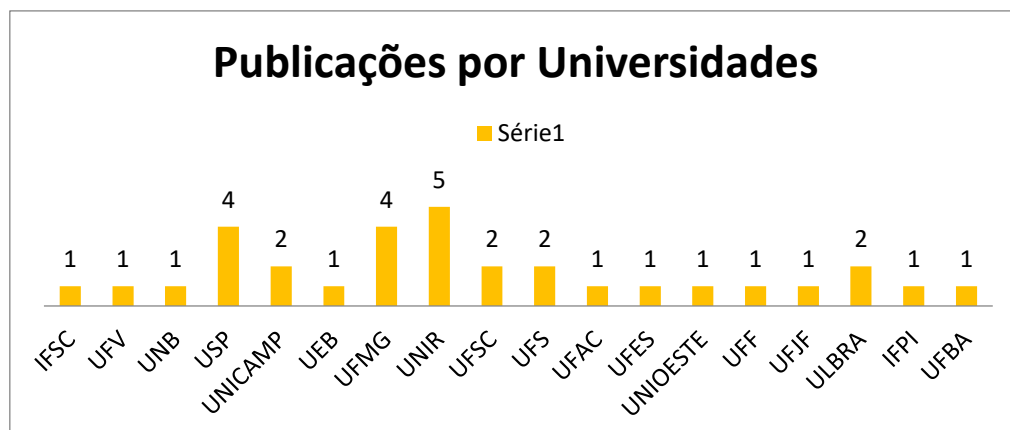


Source: Author 2021

Figure 3 shows the institutional distribution of these studies, where there is a predominance of studies produced by the Federal University of Rondônia (UNIR) with 5 studies, the Federal University of Minas Gerais (UFMG) and the University of São Paulo (USP) with 4 studies, each institution. In the other institutions shown in the Figure, between 1 and 2 studies were identified. It is relevant to emphasize that in the North region, UNIR concentrates productions involving reading in the teaching of Chemistry. On the other hand, there is a greater number of teaching and research institutions in the Southeast region producing this study profile, which expresses the predominance of this region in academic productions of the theme in focus.

Figure 3

Teaching and research institutions that are proponents of studies focused on reading and writing in the teaching of Chemistry in Brazil



Source: Author, 2020

These data demonstrate the need to continue to develop research and promote pedagogical actions aimed at strengthening the theme of reading, considered essential for the teaching of Chemistry based on reading, interpretation and writing.

In this regard, Espinoza (2010) discusses the importance of didactic resources for the appropriation of knowledge through reading:

The interpretation of a science text is always difficult for a student who reads to learn new knowledge, so in order for him to be able to make a correct interpretation, there must be didactic conditions that facilitate this appropriation ESPINOZA (2010, p. 164).

We know that reading and writing are fundamental in all disciplines, including Chemistry, because we use them to prepare from a simple experimentation report to the dissemination of academic works and research, as stated by Francisco Junior and Garcia Junior (2010) in their research on reading and writing in pre-university preparatory courses.

Reading and writing are skills to be worked on in science classes, since students are often unable to interpret questions in physics, chemistry, mathematics, etc., due to deficiencies in reading ability, which implies, therefore, the scientific learning difficulties of the majority of the population. (FRANCISCO JÚNIOR; GARCIA JÚNIOR, 2010, p. 192).

The actions aimed at the development of this theme in the teaching of Chemistry are still timid, in relation to the other areas. Reading and writing are important skills for learning Science, especially the teaching of Chemistry, considering that it is a specific language. In addition, the relevance of reading and writing lies in the very formation of student readers,

who have contact with various texts, such as scientific articles, scientific dissemination texts, song lyrics, poetry, comics, cartoons, literary narratives, among others, associating chemical knowledge with different registers and languages. Such texts can enhance the use of more common pedagogical materials, such as textbooks and, thus, subsidize pedagogical practices in order to contribute to a more critical and contextualized teaching.

According to Silva et al. (2012, p.1), in order for the student to see meaning in the Chemistry contents addressed in basic education, it is essential to discuss its importance "in several areas of their life, such as: hygiene, food, beverages, medicines, cosmetics, among other areas that are part of the daily routine of the human being". Carvalho et al. (2007) found that in addition to the difficulty in relating Chemistry to their social reality, 70% of the students associated chemistry with weapons (chemical and nuclear), drugs and pesticides, denoting a negative interpretation of the discipline and corroborating the idea of disconnection with everyday life. In addition, there is difficulty among teachers to relate the knowledge of Chemistry with the student's daily life, since reproductions of knowledge with memorization of definitions and formulas are prioritized (Pontes et al. 2008).

In this context, in his studies Flôr (2009) mentions the importance of correlating everyday knowledge with the teaching of Chemistry, in order to assist in the formation of citizenship:

In today's world, where science and technology are increasingly present in our daily lives, contact with scientific knowledge and the understanding of its contents become important instruments in favor of citizenship. And the teaching of chemistry does not escape this responsibility and importance. Present in our daily lives from the occurrence of natural phenomena such as respiration and decomposition to the manufacture of the bread we eat every day, through soaps and detergents that we use in cleaning and covering paints, varnishes, fuels and the most varied materials possible, chemical knowledge permeates our most ordinary actions. Alcohol or gasoline, which is the most efficient fuel? What is the best economically and environmentally speaking? In addition, it is part of important discussions about global warming, production and disposal of polluting materials, among others" (FLÔR, 2009, p.16).

In addition to the relationship between everyday and scientific knowledge, the appropriation of the language of Chemistry is another relevant aspect, especially in relation to reading, which according to Wenzel and Maldaner (2014) is fundamental for student learning. In this regard, among different types of texts that can be approached by reading and writing in class, in the present research we opted to work with a scientific article (CA) and especially with texts of scientific dissemination (TDC), which treat scientific knowledge with a less technical language, but rich in information based on studies and research.

3.1 READING AS A DIDACTIC RESOURCE IN THE TEACHING OF CHEMISTRY

In the world, it is necessary to interpret in a coherent way what one reads or experiences, because it is these understandings that build in our cognitive universe the conceptions about the concepts presented, both in scientific productions and also in the elaboration of hypotheses in an attempt to explain some phenomena. (...) One of the spaces for the development of these skills should be the school environment, where reading is an important factor in the teaching and learning process, as it is from this that knowledge related to the various areas of study is built (ANDRADE et al, 2017 p.142).

By considering reading as an essential element of learning, Silva (1998) argues that the science teacher is also a reading teacher, therefore, reading and writing are skills that should also be worked on in chemistry classes, to help students acquire knowledge, whether in the school field or in life in society. Reading is one of the most important forms of learning; this has been pointed out in studies that demonstrate that the improvement in the ability to read also results in the improvement of the ability to learn (ANDRADE et al., 2017). Learning is effective when the reader is able to understand the texts read, which in most cases does not occur due to the lack of subsidies from previous readings that favor this understanding (KLEIMAN and MORAES, 2003).

According to Freire's (2006) propositions, reading is an essential element in the formation of citizenship and is inherent to the political act, as it enables an awareness of the position of the individual member of a society, understanding the relations that exist in it and his role in these relations. By becoming aware of their experience and their reading of the world, the individual understands their limits and potentialities within society.

From this perspective, we cannot disassociate the important role that the school has in the formation of citizenship with reading, as they are intrinsic elements, since the citizen, before relating to the world of words, relates to the reading of the world. Andrade et al., (2017) reiterate that, in the first years of life, with the beginning of language development, the citizen learns to read the world around him and, from this reading of the world, begins to discover the reading of words, and the social relationship experienced by the citizen is an important factor for the understanding of the texts read, because reading is effective when what is read has meaning for the subject. Reading is, in this view, essential to all subjects because it enables an understanding and learning of the social relations of the world in which they are inserted, since it is a socially constructed act that is triggered and expanded in the coexistence with the world and with others.

In view of the above, the importance of reading in the construction and formation of the identity of critical and socially active citizens is evident, and for this, it needs to be further

explored in schools as a didactic resource in Science classes. Students can glimpse through reading more meaning in the contents and disciplines that are offered to them and have more appreciation for socialized knowledge (TEIXEIRA and SILVA, 2007).

With regard to the Teaching of Chemistry, reading is one of the obstacles in the teaching and learning process, due to the notorious difficulty that students demonstrate in understanding texts focused on this area (FRANCISCO JUNIOR et al., 2008). In my teaching practice, I found that it is challenging to teach chemical content in a way that seems to add little to the student's education, since we perceive great disinterest and difficulty in understanding the subjects worked on in the classroom. According to Teixeira and Silva (2007), the difficulties associated with reading by students in high school are permeated by lack of motivation in the act of reading and the scarce understanding of various texts, especially scientific, with the need for planning and teacher mediation.

However, some alternatives can be considered to minimize the difficulties faced by students and, in this context, dynamic and planned reading can be a great contribution to this process (WENZEL et al., 2018).

According to the studies of Wenzel and Maldaner (2014), learning Chemistry requires the appropriation and signification of its language, which presents peculiarities such as symbols, formulas, concepts that need to be internalized and signified by students. I understand that it is precisely in the language of Chemistry that part of the difficulty in understanding the curricular component lies, since it is treated mechanically for memorization purposes. Hence the importance of attention to the language established in the classroom and to its modes of use, whether through writing, speaking and/or reading. Considering the specificities of the Chemical/Scientific language, Bargalló (2005) points out that:

Scientific language can act more as a barrier than as a bridge to facilitate the learning of most students. Students are used to a direct, contextualized conversation, which combines linguistic resources with gestures, looks, tones of voice and who, through dialogue, have the possibility of clarifying and reformulating the text, finding themselves in a different situation in front of a scientific text (BARGALLO, 2005, p. 33-34).

It is important to emphasize that reading, as much as it is an important ally of the Chemistry discipline, needs to be planned and thought out cautiously according to the target audience, level of understanding of the concepts, among other aspects with the need to bring the student's language closer to the Chemistry language.

Reading needs to be used in the school in a coherent way, as a contribution that generates understanding and does not cause more distancing of the student in relation to

Chemistry and for that, the teacher has an essential role in this process because he is the one who must outline reading strategies to be applied, so that the interest and scientific curiosity of the students is stimulated and makes it possible to define problems, to raise, analyze and represent results, conclusions and propose interventions (TEIXEIRA JÚNIOR, SILVA, 2007). On this,

The text should provide the student not only with the reading of the word from his historical-social experience (reading the world) but also the possibility of rewriting his world, transforming, at the same time, his reading of the initial word. In this sense, school reading needs to be modified, especially in terms of the students' relationship with the text. To this end, reading strategies should provide a more personal contact with the texts (Francisco Júnior, 2010 p.221).

Although many studies have found the relevance of reading in different areas of knowledge for a full citizenship education, which is not limited to school activities, but which goes beyond the walls of classrooms, there are still timid works aimed at this focus in disciplines that comprise the natural sciences, such as Chemistry, object of the present study. In addition, most publications are works that carry out a literature review, with a smaller number of studies that demonstrate experiences in the teaching of Chemistry, especially in basic education (COLPO et al., 2019).

Despite this, the studies published on the subject in focus have shown very satisfactory results. For example, Guaita and Gonçalves (2015), in a study carried out with 25 students from the 2nd year of High School, made use of texts in Chemistry classes from the journal *Química Nova na Escola* and used the three pedagogical moments as a strategy. The authors concluded that "the reading strategy contributed to identifying students' knowledge about the subjects studied and favoring their evolution" and reiterate that "there are indications that the learning of reading was, to a certain extent, increasing during the course of the activities" (GUAITA, GONÇALVES, 2015, p. 60). This growth portrays the need to expand spaces for reading in the classroom, in which the student can learn to read and position himself in front of the texts.

Another important study was carried out by WENZEL and COLPO (2018) with 29 students from a 1st year class, using TDC in which the theme Radioactivity was worked on from the book *A Brief History of Science* (BYNUM, 2014). The authors concluded that it was "possible to provide students with an approximation with specific terms of chemical language, as well as the discussion of historical facts and everyday knowledge related to radioactivity content" (WENZEL, COLPO, 2018 p.141).

In this sense, spaces are needed in classrooms that enable the dialogue of the insertion of reading as a methodology for teaching Chemistry, since, following the perspective of Ferreira and Queiroz (2015, p. 132), when mentioning the use of DCT, they point out that "studies on classroom interventions using DCT indicate the occurrence of innovative and motivating teaching methodologies". Such methodologies need to be planned, so that the proposed reading is not merely reproduced by the student, but that it provides interaction between the reader and the text, and enables the young person to appropriate the scientific language.

3.2 SCIENTIFIC TEXTS (CA AND TDC) AS A METHODOLOGICAL STRATEGY IN SCIENCE TEACHING

There is a consensus among several studies that the practice of reading is essential in the teaching and learning processes, as it provides the development of imagination, creativity, communication and critical positioning in front of the text, in addition to helping in the correlation with the social context of the student and assisting in the formation of citizenship. (ZISMANN et al, 2019; TARGINO DE MOURA et al, 2019; FATARELL et al., 2014). In this sense, Francisco Júnior (2010) argues that the use of reading allows the reader not only to understand his context, but above all the possibility for the student to rewrite his world with his own way of thinking and positioning himself in front of his universe of life. Within this understanding of the importance of reading, Zismann et al (2019, p.128) say that "when the student is instigated to interpret, to position himself in front of the text, he expands his critical capacity and, with this, qualifies the modes of writing, argumentation and understanding".

In this discussion about the relevance of reading in the production of knowledge in any area, the importance of different readings in the production of knowledge in the teaching of Chemistry is highlighted, since very often its teaching is plastered on the reading of textbooks and handouts with a large volume of numerical information such as formulas and mathematical quantities, which alone do not enhance a dialogue about chemical terms and their relationship with everyday life (ZISMANN et al, 2019).

Ribeiro and Mesquita (2012) show in their study that, in general, the teaching of Chemistry has contributed little to the critical formation of students and this training that takes place in High School is the result of a non-contextualized formative process. Maldaner (2006) points out that contextualizing the teaching of Chemistry is being able to walk in the world of the student's experience and concepts, allowing the student to enter an abstract world and

towards the real world, allowing students to start talking in chemistry about situations they experience, resignifying the learning process.

In Freire's perspective, contextualization should be understood as the development of values and attitudes to form citizens able to exercise conscious citizenship in their social environment, because "when man understands his reality, he can raise hypotheses about the challenge of this reality and seek solutions. Thus, he can transform it and with his work he can create a world of his own: his self and his circumstances" (FREIRE, 1997, p. 30). Regarding the importance of contextualization for the teaching of science, Wartha, Silva and Bejarano (2013) comment that:

[...] Contextualization is clearly the guiding principle for the teaching of science, which means a more complex understanding than the simple exemplification of everyday life or a mere superficial presentation of contexts without a problematization that actually provokes the search for understandings on the topics of study. Therefore, contextualization should not be seen as a resource or proposal for a methodological approach, but rather as a guiding principle (2013, p. 90).

In view of the need to instigate reading in students of the Chemistry discipline in basic education, especially in high school, in order to qualify the readings used by students at this level of education, different studies point to the use of such scientific texts (CA and TDC) as a methodological strategy for the teaching of Chemistry (FATARELL et al., 2014).

The scientific texts addressed are characterized by the use of simpler and more appropriate language for a non-specialized audience, not initiated in science, where the more technical, scientific-chemical terms dialogue with social and historical aspects, which makes reading more accessible in the context of the classroom (CUNHA and GIORDAN, 2015). In these texts, explanations of a more scientific nature approach everyday facts through examples. This facilitates the reader's understanding of the more specific aspects of chemistry, and with this the teacher assumes the contextualization of knowledge and overcomes the perspective of the transmission of chemical content (TARGINO DE MOURA et al, 2018).

In the view of Ferreira and Queiróz (2012), both CA and TDC have specific characteristics that favor their use in the process of obtaining information by the public not literate in science, whose main elements to stand out as preponderant in these texts are scientificity, didacticism and secularism. For the authors, the traces of scientificity come from scientific discourse, related both to scientific praxis and to possible negative consequences of products of science. Secularism brings evidence of everyday discourse and contemplates

different forms of contextualization. And didacticism is related to aspects of the didactic discourse such as explanations, resumptions and methodological guidelines.

From this perspective, according to Zismann et al, 2019:

It is possible to say that TDC differs from chemistry texts, usually present in textbooks, it also differs from a scientific article, because in this the author does not appear and there is no concern to establish a dialogue with the reader that is not initiated in the area. In TDC, the author is present, can, in some cases, be the character of the text and seeks to establish a dialogue with the reader (2019, p.129).

It is relevant to mention that the scientific text does not focus on teaching, but can be used in classes as an instrument to assist in the learning process, as pointed out by Cunha and Giordan (2015). In the perception of Zismann et al, (2019), the use of these texts in the classroom brings the student closer to the world of science, as it provides students with contact with up-to-date information about science and technology, with events in their daily lives, also bringing curious, interesting and fun aspects, providing another way of seeing the dreaded Chemistry. Other relevant aspects provided by scientific texts that we can point out are the stimulus to the development of reading skills, critical and reflective spirit, always in a movement of guided reading (FATARELL et al., 2014).

In addition, Santos and Mortimer, 2009, emphasize that the formation of the individual for citizenship is considered a fundamental objective of science teaching. In this sense, several didactic strategies are suggested aiming at the incorporation of socio-scientific issues and the promotion of decision-making, including the debate of open questions as an important strategy. Martins et al. (2004) argue that these texts can function as important support materials for the triggering of debates that promote students' access to scientific knowledge and, at the same time, the socialization of this knowledge in the classroom, linking science updates to the students' life context.

In summary, the problem of this research stems from experiences lived throughout my teaching career whose focus is the insertion of reading mediation activities in Chemistry classes in Basic Education, specifically in the 1st year of High School. Looking at the insertion and organization of reading in the teaching of Chemistry proved to be important to help students to have a differentiated and less mechanized look at the discipline. A dialogue about the methodology of the research follows.

4 METHODOLOGICAL PATHS

Methodology is the path of thought and practice exercised in the approach to reality (MINAYO, 2009).

In this section, the methodology used in this research is presented, the locus of research, the participants, the activities of reading Scientific Dissemination Articles used with the students, the construction of information, in addition to addressing the legal aspects that guarantee the participation of the students involved in the research and the systematization of the data produced.

The procedures adopted are important in the research process, as they allow the researcher to respond to the proposed problem and, consequently, achieve the expected objectives. In addition to bringing the researcher closer to the object of study, these procedures make it possible to trace new scientific paths, so that a theory can be reformulated, if it already exists, that is, constructed, if the results present new perspectives for the researched phenomenon (VERGARA, 2005).

Thus, the present research focuses on investigating practices of mediation of reading texts of scientific dissemination in the context of Chemistry classes in the 1st year of high school, in addition to identifying reading habits in these students; analyze reading mediation processes and their possible contributions to Chemistry learning and develop an educational product with reading mediation strategies in Chemistry classes.

4.1 METHODOLOGY ADOPTED: TYPE OF RESEARCH AND ANALYSIS OF INFORMATION

The present work is a qualitative research, of the pedagogical intervention type, which according to Damiani et al. (2013, p. 58) contemplates the "planning and implementation of interferences (changes, innovations) - aimed at producing improvements in the learning processes (...) - and the subsequent evaluation". Intervention research seeks alternatives to concrete problems in teaching and should not be confused with teaching and extension projects or their reports with reports of experiences. It is an applied investigation, in which academic production allows teachers to investigate their own practice (DAMIANI et al., 2003).

They are considered as research aimed at the concrete world because it is a research that deals with subjects, used and applied for the solution of clear and perceptible problems, different from those that occur with specific controls of variables such as in laboratories, which use the scientific method as a recurrent practice. They are opposed to basic research, which aims to expand knowledge, without concern for its possible practical benefits (GIL, 2010).

In some points, pedagogical intervention research is similar to action research, and can be summarized as follows, based mainly on the ideas of Tripp (2005) and Thiollent (2009): Intention to produce changes, attempt to solve problems, applied character, need for dialogue with a theoretical framework, possibility of producing knowledge. This research

format proposes to subsidize decision-making related to changes in educational practices and improvements in the quality of teaching, in addition to evaluating pedagogical innovations, which is in accordance with the proposal of a research in the context of the professional master's degree.

The analysis of the information had as a theoretical and methodological foundation some aspects of content analysis (BARDIN, 2011). According to Bardin (2011), content analysis can be organized into three phases: a) pre-analysis; b) exploitation of the material; c) treatment of the results. In the pre-analysis, we did the floating reading and the choice of the materials that were analyzed, in order to identify themes related to the focus of the study, that is, reading and its possible contributions to the learning of Chemistry. The materials analyzed were written productions of the students, which consisted of: reading record diary, glossary and research reports, produced in the context of reading mediation activities.

The exploration of the material associated with the theoretical study on the object of the research made it possible to identify themes that guided the selection of the information present in the materials and the treatment of the results. Thus, in this study we used thematic analysis, which involves identifying the "nuclei of meaning" that constitute the analyzed material, specifically the students' written productions. The presence of these nuclei and their frequency "can mean something for the chosen analytical objective" (BARDIN, 2011, p.135). were: a) Scientific language and mother tongue, b) Food and citizenship education and c) relationship with the content in focus. These themes are not mutually exclusive and overlap in some aspects, however, their definition was fundamental for the analysis of the information in the research and enabled the emergence of relevant aspects for our study interest, that is, reading mediation activities.

As it is a professional master's research, the main objective of the analysis was to investigate the practice of the research teacher when using reading mediation strategies in order to identify contributions and propose improvements in his classes. By producing knowledge about reading mediation in Chemistry classes, the analysis of the students' productions in this research can also contribute to other teachers to develop strategies and propose other ways of working with reading texts in Chemistry teaching. Below we describe the context of the research.

4.2 CONTEXT OF THE RESEARCH

The research was developed in a State School of the Public Education Network⁶, located on the island of Mosqueiro,⁷ which has been in operation since 1976. The School is considered one of the pioneers on the island of Mosqueiro and comes from the School "Reunida de Carananduba",⁸ which on August 28, 1976, was renamed "State School of 1st Grade Professor Abelardo Leão Condurú", in honor of the great public figure of Pará Abelardo Leão Conduru⁹. Later, the school was renamed Escola Estadual de Ensino Fundamental e Médio Professor Abelardo Leão Condurú.

The educational institution serves around 986 students distributed between Elementary School (6th to 9th grade) and High School (1st to 3rd grade) in the morning, afternoon and night shifts and has infrastructure consisting of (10) classrooms, one (1) auditorium, one (1) multidisciplinary laboratory, one (1) sports court and one (1) library. The school develops extracurricular activities focused on music, art and poetry, such as the Soirée that takes place annually and is a moment when students present their artistic productions such as music, dance, poems and socialize in the school court with the school community. In addition to the Soirée, the school promotes extra-class activities in museums, universities and other spaces for the democratization of knowledge as an incentive to art and culture, conducted by professors of the disciplines of History and Sociology.

The school's technical staff consists of a manager and deputy managers, pedagogical coordinators, teachers and support staff (administrative agents, doormen, lunch cooks and cleaners), totaling about 60 employees working in the institution. Figure 4 below illustrates in "a" the entrance to the district of Mosqueiro where the school shown in "b" where the research was carried out is located.

⁶ State School where the present research was carried out. The institution is located on the outskirts of Mosqueiro, in the Carananduba neighborhood.

⁷ Mosqueiro Island is an administrative district of the municipality of Belém. Mosqueiro is a river island located on the eastern coast of the Pará River, in the southern arm of the Amazon River, in front of the Guajará Bay. It has an area of approximately 212 km² and is located 70 km away from the center of the capital Belém. Its population is estimated at 20 thousand inhabitants according to data from the Brazilian Institute of Geography and Statistics (IBGE). Information taken from the official website of the city of Belém: <http://www.belem.pa.gov.br>

⁸ Information collected from the School's management and the website <http://jornalcorreiojurunense.blogspot.com/2011/04/reinauguracao-da-escola-abelardo-leao.html>

⁹ Abelardo Leão Conduru was an important figure in the political scene of Pará who in the 20s, 30s and 40s assumed several important public positions among which the following stand out: State Deputy, Mayor of Belém, Senator of the Republic. He had great influence on Mosqueiro Island where he founded the famous Farol neighborhood, and his residence was later transformed into the then known Hotel do Farol. Data obtained from the <http://mosqueirando.blogspot.com/2014/02/na-rota-da-historia-abelardo-leao.html> website

Figure 4

a- Entrance portal of the district of Mosqueiro; b- State School where the research was carried out



Source: Author, 2019.

4.3 CHOICE OF SCHOOL AND YEAR FOR RESEARCH DEVELOPMENT

In the school where the research was carried out, I felt the need to stimulate reading in the discipline of Chemistry, since the difficulties in discussions and resolutions of situations - a problem during the classes taught with students of the 1st year of High School were permeated by difficulties of interpretation and scientific vocabulary, especially focused on the periodic table, which is the subject developed in the classes during the present research. Although in the 9th grade of Elementary School students already work on Chemistry content focused on the Periodic Table, I realize the difficulty in understanding the subjects related to this content. As a Chemistry teacher, I came to the conclusion that it is necessary to have methodological strategies to work with these difficulties of students in the first year of high school.

It was after these observations that I decided to work on methodological strategies with the reading of TDC focused on chemical elements, from the journal "Química Nova na Escola" and, at the same time, contextualize the study of chemical elements with the regional and local culture through a feed article from the "Brazilian Journal of Endocrinology and Metabology". Below, I discuss a little more about the profile of the students involved in the research.

4.4 PROFILE OF THE STUDENTS PARTICIPATING IN THE RESEARCH AND LEGAL ISSUE

The present research was carried out in the second two months of the 2019 school year, during the classes of the Chemistry discipline with an approximate workload of 24 hours/classes, divided into 3 hours of weekly classes, and had as participants a class of 39 students from the 1st year of High School in operation in the morning shift. The class

consisted of 16 female students and 23 male students, aged 15 to 17 years. At the time of the research, the students were residents of the Carananduba neighborhood or its surroundings (neighborhoods of São Francisco, Bonfim, Caruara, Marahú, Paraíso, Baia do Sol), located on Mosqueiro Island.

To start this study, the research proposal was presented to the school board, which signed the Informed Consent Form (ICF) (Appendix A). Next, we addressed the participants by presenting the ICF with a brief explanation about the work developed in compliance with the requirement of the Professional Master's Degree in Education, Science and Mathematics at UFPA and the objectives of the research (Annex B), signed by those responsible for being under 18 years old. The anonymity of the participants was guaranteed by the use of codes that represent the students in the research, such as A1, A2, B1, B2, etc.

4.5 STAGES OF THE RESEARCHED ACTIVITY AND INSTRUMENTS USED

The research was basically outlined in 04 stages, comprising different moments in which reading as a methodological resource was the core of the research, and writing was taken into account in some stages as a methodological contribution.

For each stage, instruments were used that made the research feasible. The research instruments are essential for the researcher to collect initial data and evaluate the scope of the intervention actions carried out. According to González Rey (2005), the instruments of a research are characterized as "any situation or resource that allows the other to express himself in the context of the relationship that characterizes the research" (p.42).

Among the most common instruments used are observations, questionnaires, interviews, formation of reading and discussion groups and others (Weller, 2006). Therefore, in this study I used observation, questionnaires and written productions of the students as research instruments.

Below, I describe the four stages that make up the research scenario of the present study.

- At the first moment with the students, we talked about the research, commented on the relevance of the study and the related objectives and, at the end of the dialogue, the students received a Consent Form (ICF), so that a responsible person could authorize their participation in the study. In the following week, the consent forms were returned and a semi-structured questionnaire was used, called Q1 (Annex C) in this study, whose objective was to perform a diagnostic evaluation to investigate the students' reading, interpretation and writing habits. We sought to investigate possible difficulties

encountered in readings, especially of scientific articles and scientific dissemination, in order to establish strategies to approach the later stages.

- An article considered easy to understand concerning "healthy eating" was selected¹⁰. The reading strategy used was group reading, followed by a conversation circle in a subsequent class and the use of a diary to record study notes by the students, in addition to the elaboration of a glossary referring to the text worked in class.
- Students were asked to read individually in class a text published by the University of Évora¹¹ entitled "Brief history of the Periodic Table". After the reading, a collective discussion was held in class related to the main points observed by the students in the text. At another time, an oral presentation was held in the format of an expository class and dialogued with the use of a multimedia image projector, addressing the Periodic Table.
- In order to relate the readings and activities developed concerning healthy eating (stages 1 and 2) with the discussions regarding the periodic table of chemical elements, in this stage the students were invited to form working groups (WGs). Thus, the WGs were instructed to research foods belonging to the food cuisine of Mosqueiro Island in order to research the chemical composition and consequently the chemical elements present in these foods. To this end, each TG chose a food of their preference to research. The documentary "Mosqueiro island of flavors" was shown,¹² which shows the gastronomic potential of the island of Mosqueiro and the traditional and healthy cuisine, seeking to bring the local popular culture closer to the Chemical bias in Mosqueirense's food, through the teaching of the Periodic Table. Subsequently, the professor provided the students with a series of articles on different chemical elements, from the Revista Química Nova na Escola¹³ – QNEsc. The research was socialized in a dynamic and interactive way in class through discussions so that each group had access to the work carried out by the other teams. In order to preserve the data obtained in each stage of the research, each WG produced a folder/logbook to store their text productions and questionnaires applied in group and at the end, they were delivered to the professor who proposed the research for later systematization.

¹⁰ Sichieri, R. et al. Recommendations for Healthy Eating and Nutrition for the Brazilian Population. Arq Bral Endocrinol Metab v.4, 4n.3, 2000.

¹¹ University of Évora, Department of Chemistry, International Year of Chemistry. Available at: <https://quimicaparatodosuevora.blogspot.com/2019/02/breve-historia-da-tabela.html>

¹² Shown on TV Cultura on the website <http://www.portalcultura.com.br/node/50285> and made available on the video-sharing platform You Tube at the address: <https://www.youtube.com/watch?v=K4bluHI3a8U&t=72s>

¹³ Revista Química Nova na Escola available on the website <http://qnesc.sbq.org.br/online/qnesc04/>

5 RESULTS AND DISCUSSIONS

As already mentioned in step 1 of this study, an evaluation was carried out to investigate the initial profile of the students' reading, interpretation and writing habits, based on a semi-structured questionnaire – Q1 (appendix). The analysis of the question "What is your reading preference?", illustrated in Figure 4 showed that the literatures used by the students as their preference are books, which were mentioned by 48%. The genre of these books was not investigated in this research, but it can be inferred that they are probably more directed to the children's age group. In second place were comic books/comic books, which represent 46% of the total number of readings identified, and in third place were magazines and newspapers, which correspond to only 3%, and no student mentioned scientific articles and scientific dissemination as preferred reading.

Figure 5

Reading preferences of those surveyed



Source: Author, 2019.

The analysis of the data leads us to suggest that these literatures most cited in the study are associated with the universe of young people and their contexts of experiences, which modulates their behavior as readers and justifies the preferences for such readings. For this reason, comics/comics and books are the most sought after reading objects by students, reaching 94% of the total number of students, who, on the other hand, confirm that this same audience has little interest in reading magazines, newspapers and articles.

The little or no search for scientific articles or texts of scientific dissemination by students of Basic Education, specifically in High School, the level to which this study was directed, may show low interest or difficulty in accessing scientific culture and scientific knowledge in such texts. This leads us to the following questions: What would be the reason

for this possible lack of interest in scientific culture? Is reading articles considered more far-fetched/difficult by this readership? Does the investigated public have difficulty accessing materials such as texts for scientific dissemination? Would it be a methodological failure of the schools and lack of pedagogical support to stimulate these readings?

For an analysis of the students' notes in the questions previously discussed, an evaluation of the students' statements elaborated in the Q1 questionnaire was carried out, in which the students were asked: "For you, what is your greatest difficulty in reading articles or texts of scientific dissemination?" The answers obtained allow us to observe that 85% of the students' statements refer to difficulties in understanding what they read in the articles or that they are unable to abstract information of this textual genre. Table 2 shows some of the main statements that represent the aforementioned percentage of students who talk about difficulties in understanding scientific texts:

Table 3

Answers obtained from students during a questionnaire about the difficulties they have in relation to reading articles or texts of scientific dissemination (TDC)

STUDENT	ANSWERS OBTAINED BY QUESTIONNAIRE
A2	"Why some things I understand and some things I don't."
B1	"My biggest difficulty is that I don't consider what I'm reading and I don't understand what I read, there are words that I can't read."
B2	"My biggest difficulty is not being able to understand what I read, I really like to read, but there are things I don't understand."
A3	"A lot of information in the article that you can't understand things."
B5	"I'm going to be truthful, I don't like to read articles, because I don't understand much of what I read"
B6	"Understand what he means"
A7	"Sometimes I can't understand some words in the article"
A9	"The difficulty sometimes of understanding and comprehending, because some articles have arguments that I have never heard of".
B8	"Often the understanding of some terms and words that I don't know or that is little used in my daily life".
B9	"understand what he wants to convey to us" (student B9).
B10	"I have difficulty with some different words"
A13	"to understand what he says".
A14	"I read and reread, but I can't understand it a lot of the time."
B13	"There are some articles that I read and understand, but there are some that I read and I can't reason what it says because it's difficult."

Source: Author, 2019.

Table 2 shows us different records of the students about the difficulties they present in reading articles and DCT, which were pointed out in different ways, but all converging to a point that is the "difficulty in understanding what they read". In an analysis of some of these statements shown in table 3, we can observe that student B1 reports "I don't understand what I read, there are words that I can't read", evidencing the difficulty in understanding due to lack

of knowledge of words found in the text. This same element was verified in students A7, B8 and B9 who talk in their speeches about the difficulty of "understanding words" that they did not know before reading the articles. Thus, it was possible to infer that a possible vocabulary limitation makes it difficult to construct the interpretation and comprehension of the texts during reading. The analysis of the other statements, even though they do not explicitly mention that the difficulty is due to the lack of understanding of unknown terms found in the texts read, suggests that these limitations of comprehension permeate in most cases for the same reasons.

On this, Ferreira & Horta, (2014) discuss:

Difficulties in the act of reading continue to be one of the main obstacles to school success and performance, often causing difficulties in other areas of learning, reflecting on the student's entire school career. Difficulties in learning to read can manifest themselves in the acquisition of basic skills, especially in the decoding phase, but also, later, in the phase of comprehension and interpretation of texts (Ferreira & Horta, 2014 p. 145).

The lack of motivation in the act of reading is related to the difficulty of understanding what one reads, especially scientific texts that are generally pointed out as difficult to understand (Teixeira & Silva, 2007). However, with appropriate strategies, reading can be successful and become a great ally in the evolution of the student in different aspects of his or her school life, and for this reason it deserves to be more valued in formal school education environments (Guaita and Gonçalves, 2015).

5.1 ANALYSIS AND DISCUSSION OF THE TEACHING ACTIVITIES DEVELOPED

The information constructed in the present research was organized around the sequence of activities developed in class, in order to highlight the reading mediation strategies and the relevant aspects that emerged in each activity, based on the themes defined in the exploration of the material and that we previously presented: a) Scientific language and mother tongue, b) Food and citizenship formation and c) relationship with the content in focus.

5.1.1 Reading activity and conversation circle with mediation and written production

We selected a scientific article on "healthy eating"¹⁴ and the reading strategy used was group reading with the teacher as mediator of the process.

¹⁴ Sichieri, R. et al. Recommendations for Healthy Eating and Nutrition for the Brazilian Population. Arq Bral Endocrinl Metab v.4, 4n.3, 2000.

Figure 6

Recording of reading activity – Individual and collective



Source: Author, 2019.

To encourage reading in the classroom under the teacher's mediation, students were instructed to read the text again outside the classroom, with the aim of deepening the content of the article. They also received guidance to highlight in their individual readings points considered relevant for later discussion in a conversation circle. Thus, as had been outlined, during the classes of the week following the extra-class reading, a "conversation circle" was held in which the students talked about points that they considered most relevant in the text, in order to socialize the different notes with the class. In this way, they participated by reporting passages of interest and difficulties, exemplifying their statements with their own experiences and bringing their daily actions closer to the new information obtained in the text, in addition to incorporating new meanings and scientific concepts.

Figure 7

Record of the conversation circle about the article related to "healthy eating"



Source: Author, 2019.

After completing the conversation circle, the students received "record diaries" to produce a text addressing the points considered most relevant in the reading, which were used as a contribution to the collective discussions.

Figure 8

Records of textual production and production of the glossary referring to the text already mentioned



Source: Author, 2019.

We highlight below some texts from the students' written materials that illustrate possible contributions to scientific learning and that help us to know the aspects that most caught the attention of young people when reading the scientific article on healthy eating.

In the reading record, it was possible to identify the choice of excerpts from the text that brought scientific information about foods for daily consumption by the students, which is in accordance with the content of the discussions in the conversation circle, in which they sought to relate aspects of their eating habits with scientific concepts present in the text:

Among the foods in the Brazilian diet with the highest fiber content are cassava flour, beans, peas, corn, peanuts, jiló, pine nuts, sweet potatoes, baroa potatoes, yams and taioba (A3 – reading record).

Beans are one of these rescue elements, due to their content in fiber, folic acid and iron. (A2 – reading record).

In their reading records, the students selected excerpts from the text under study with the potential to expand knowledge about foods from their universe of experiences, from the insertion, in their writing, of terms from scientific language such as fiber, folic acid and iron. Although students were not asked to use these terms in another activity that would request their use in different contexts, it is important that students have contact with these aspects.

Science learning implies that the relationship with scientific language occurs in different situations, in which students learn new meanings for the terms used in class. In other excerpts from the students' records, we can identify the presence of the theme and the content in focus, that is, food and the periodic table. In these passages, chemical elements and their relationship with food are mentioned,

Reducing salt consumption requires a large reduction in the consumption of processed foods with a high amount of sodium such as chips, smoked and canned foods, as well as avoiding adding salt to foods already prepared (A5 – reading record).

(...). The identification of foods, or groups of foods, whose consumption should be encouraged, (...). Beans are one of these rescue elements, due to their content in fiber, folic acid and iron (A7 – reading record).

(...). Sources of calcium are also sources of cholesterol and saturated fats, and should therefore be considered together in the preparation of the guides (A4 – reading record).

For a good life and good nutrition, macronutrients must be consumed in the diet in greater quantities, micronutrients in smaller quantities, folic acid, vitamins E, C with the use of an intake of 200 mg/day, equivalent to the intake of five servings of fruits and vegetables; also sodium and calcium (...). (A6 – reading record).

According to Vygotsky (1998), words have an internal history of development, that is, they cannot be transmitted directly to students. This is an interesting theoretical justification for the contact of students with knowledge about chemical elements, for example, calcium and sodium, in a concrete context, food, instead of talking about them only in the study of the periodic table itself, as an isolated content and unrelated to the contexts of the students' experiences.

Reading and writing are fundamental skills for the formation of individuals with social and political responsibility that need to be worked on in Natural Sciences classes. In this regard, Wenzel et al., (2018) consider that:

In addition to the use of the specific language of Chemistry, it is essential that the classroom becomes a space for the formation of readers, that is, that students learn to position themselves in front of the text, that they dialogue responsibly with the reading carried out, so that reading is a process of interaction between a reader and a text, in an interactive reading movement, where both the reader and the way in which one reads is considered. In Chemistry classes, it is essential that the teacher pays attention to the fact of forming and producing readers with social and political responsibility and with the ability to judge, evaluate and decide in the field of technical and scientific domain. And one way to do this is the appropriation of chemical language, its conceptual understanding through the significant use of the language of chemistry (WENZEL et al., 2018, p.99).

In the excerpts selected by students A1 and A5, it was possible to identify positions based on scientific knowledge about food and its repercussions on people's lives:

Thus, a proposal for healthy eating, for the prevention of chronic non-communicable diseases, must propose diets that are within the reach of society as a whole, and that have an impact on the most important factors related to various diseases (A1 – reading record).

The proposal of a diet for the Brazilian population also has two other assumptions: the rescue of healthy eating habits typical of Brazilian food, whose consumption should be encouraged, rather than formulating prohibitions (A5 – reading record).

Reading in Chemistry classes can contribute to the student having a more significant education from the citizen point of view. Through its contents, principles and concepts, Chemistry can stimulate a change in citizen attitude, especially with regard to people's rights and duties, giving them the ability to demand from society and governments sensible and coherent attitudes that effectively improve our lives (LIMA, 2012). These aspects could be identified in the following records:

Adolescents are particularly influential in their lifestyle and should be primarily included in collective health programs (A2 – reading record).

Fostering consumer information activities and establishing specifications for labeling by the Ministry of Health would be important goals within this perspective (A3 – reading record).

The students were instructed to also produce a glossary with the words considered unknown in their vocabularies. It was possible to observe in the glossaries two main aspects: the selection of words more related to scientific language and those that we identified as generally in use in our mother tongue. In the examples we selected referring to scientific language, the definitions constructed by the students, in general, were related to Science content beyond the chemical content, as we can illustrate in the following examples:

Metabolism: set of chemical transformations experienced by substances introduced into the body, the most important of which is the production of energy (A6 – Glossary).

Epidemiological: It is the study of the frequency, distribution and determinants of health problems in human populations (A5 – Glossary).

Macronutrients: these are nutrients that human beings need in greater quantities in their diet, in this case they are carbohydrates, proteins and lipids (A3 – Glossary).

Micronutrients: these are nutrients needed in smaller quantities in the diet, in the case of human beings they are vitamins and minerals (A3 – Glossary).

The activity of constructing the glossary allowed us to identify that the reading of the text contributed to broaden the students' contact with scientific language and the establishment of interdisciplinary relationships within the area of Natural Sciences. On the other hand, we consider it important to highlight that the development of the scientific vocabulary of young people did not occur in spite of the literacy process itself in the mother tongue, which is permanent and was related to the learning of reading and interpretation of a specific textual genre, the scientific article. In other records, we observed words closer to what we identified as in general use of the mother tongue:

Assumption: that one assumes, pretext, that one assumes in advance, that is, what one imagines and thinks about a certain thing or situation (A2 – Glossary).

Foster: Promote the development of, exercise, facilitate, stimulate (A2 - Glossary).

Effectiveness: is the ability to produce and maintain an effect, which can be positive or negative (A1 – Glossary).

The definitions researched by the students and recorded in their glossaries did not always coincide with the meaning of the words present in the text. student A4 identified the definition of words that did not coincide with their meaning present in the text:

Content: text or content of any writing or document (A1 – Glossary).

Supplementation: 1. Provision of assistance. 2. Adding cash to make up a certain amount (A4 – Glossary).

In the text read in the classroom, the content referred to the proportion of nutrients, such as fiber and fat, in food products. Supplementation, in turn, is related to the addition of certain nutrients to the population's diet. This demonstrates that the activity of the glossary is important for the identification of the dictionary meaning of the word, however, in order to contribute more effectively to the interpretation of the text, it is necessary to relate the definition of the words with their use in a concrete context.

In this context, the figure of the teacher is fundamental in the sense of making reading possible through mediation and encouraging the practice of reading in an increasingly constant way in the life of the student, as discussed by Almeida et al, (2012):

Mediating reading, therefore, is more than reading a book and recommending it to other readers. For the mediation of reading to occur, it is necessary to make the story interesting for the reader, to discuss it, to ask questions, to show the benefits that reading offers and the power of transformation that it has in people's lives (Almeida et al., 2012 p.477).

When reflecting on the activity of elaborating the glossary, I understand that feedback could have been made in relation to the students' production that related the words defined by them and the text worked. This was not done at the time of the teaching action, which was possibly related to the fact that, as a professor in the area of Natural Sciences, my gaze was more directed to the terms of scientific language.

5.1.2 Study of the Periodic Table with the use of Readings and Expository/Dialogued classes

After the conclusion of the previous phases, stage 3 of the research was developed, in which we worked on the content Periodic table. To start the theme, students were proposed to read individually in class a text published by the University of Évora¹⁵ entitled "Brief history of the Periodic Table". The objective of the reading was to encourage students to know, through an easy-to-understand scientific text, historical aspects related to the construction and development of the Periodic Table. The student could understand aspects of the production of knowledge related to the periodic table, and not just the ready-made and structured table without the opportunity to follow its historical/scientific evolution as it usually occurs. After the reading, a joint class discussion was held related to the main points observed by the students in the text.

At another time, in order to assist in the theoretical foundation and strengthen the knowledge obtained through the text previously read, an oral presentation was held in the format of an expository class and dialogued with the use of a multimedia image projector, addressing two teaching modules concerning the Periodic Table, which were:

- Module 1: Building the periodic classification of chemical elements (The concept of Family or Group, concept of Period, general characteristics of the periodic table, predicting the electronic configurations of valence);
- Module 2: Periodic properties (atom size, ionization energy, electron affinity, in addition to the study of metals, ametals and semimetals, as well as other periodic properties such as melting temperature and density).

During the discussion of the modules, the students were instigated to associate the knowledge related to the periodic table with their daily context, in order to go beyond the abstraction so present in the discipline of chemistry and allow the student to visualize such knowledge in a contextualized way. In this discussion, the professor addressed the theme "food", previously worked with the reading of the initial scientific article. The idea was for

¹⁵ University of Évora, Department of Chemistry, International Year of Chemistry. Available at: <https://quimicaparatodosuevora.blogspot.com/2019/02/breve-historia-da-tabela.html>

students to realize that it is possible to understand the periodic table as knowledge associated with different science content and topics, such as the chemical composition of food, which, in my view, could resignify the process of teaching and learning Chemistry.

5.1.3 Research related to regional/local cuisine

In order to relate the readings and activities developed concerning healthy eating (stages 1 and 2) with the discussions regarding the periodic table of chemical elements, in this stage the students were invited to form working groups (WGs). Thus, the WGs were instructed to research foods belonging to the peculiar cuisine of Mosqueiro Island in order to research the chemical composition and consequently the chemical elements present in these foods. To this end, each WG chose a food of their preference to research, and the chosen ones were: fish, shrimp, cassava flour and tucupí, tapioca, açaí and corn.

To promote the research carried out by the students on regional cuisine, after the formation of the WGs and research carried out by them, the documentary "Mosqueiro island of flavors" was shown,¹⁶ which shows the gastronomic potential of the island of Mosqueiro and the traditional and healthy cuisine, seeking to bring the local popular culture closer to the Chemical bias in Mosqueirense's food, through the teaching of the Periodic Table.

As the objective of the proposal was to understand which chemical elements are most present in the composition of the foods chosen by each group, the coordinating professor of the research provided the students with a series of articles on different chemical elements, from the *Revista Química Nova na Escola*¹⁷ – QNEsc. Each group read and studied the articles on the chemical elements and sought to relate them to the foods that each team researched. The chemical elements covered in the articles were: Actinium, Aluminum, Argon, Beryllium, Boron, Calcium, Carbon, Iron, Chlorine, Sulfur, Scandium, Fluorine, Phosphorus, Francium, Lithium, Hydrogen, Helium, Magnesium, Manganese, Neon, Nitrogen, Oxygen, Palladium, Potassium and Sodium.

After reading the articles and researching the nutrients of the chosen foods, each WG produced a written text making a general overview of the research carried out regarding the typical foods of Mosqueiro Island and its relationship with the chemical elements based on the reading of the articles of the journal *Química Nova na Escola*. The research was socialized in a dynamic and interactive way in class through discussions so that each group had access to the work carried out by the other teams.

¹⁶ Shown on TV Cultura on the website <http://www.portalcultura.com.br/node/50285>) and made available on the video-sharing platform You Tube at the address: <https://www.youtube.com/watch?v=K4bluHI3a8U&t=72s>

¹⁷ New Chemistry at School Magazine available on the website <http://qnesc.sbq.org.br/online/qnesc04/>

The culmination of this stage took place with an interview that was directed to each WG. The questions that guided the interviews were previously defined in themes associated with the regional cuisine of Mosquense (Açaí, flour, fish, tucupi, corn, tapioca), in which the members of the teams had autonomy to speak and answer the questions raised, based on the subject of the Periodic Table and its relationship with the daily life of the subjects. These questions were addressed in an interview questionnaire (Q2 – annex D) previously selected so that we could have an opinion of the degree of understanding and empowerment of the subject of the Periodic Table.

In order to preserve the data obtained in each stage of the research, each WG produced a folder/logbook to store their text productions and questionnaires applied in group and at the end, they were delivered to the professor who proposed the research for later systematization.

6 FINAL CONSIDERATIONS

In the present work, which consists of a research on the practice itself, I investigated in which terms reading mediation activities could contribute to learning in Chemistry classes at the high school level. For this, I sought to develop a proposal that would insert reading practices in the approach to Chemistry contents. The activities developed involved individual and collective reading of scientific articles, texts of scientific dissemination, preparation of reading records, glossary and group research. The development of such activities was associated with the relationship between: scientific language and mother tongue, which contributed to the learning of Science and literacy in the students' mother tongue; between the theme of food and citizenship education, with contributions to the social significance of scientific knowledge and the possibility for students to learn about positions regarding the theme in focus; with the content under study, with the potential to broaden students' view of the periodic table beyond a chemical content isolated from topics of their interest or from content in the area of Natural Sciences.

What can the school do about it? Invest more in reading AC or TDC in Chemistry classes? I see that it would be an important contribution to the students' learning, their contact with scientific language and with a textual genre that they initially demonstrated to have little contact with. What about the texts that students already read? They could also be considered at school, as part of the classes. This would be a way to bring the universe of young people closer to the school culture and thus access their motivations and interests in the teaching and learning processes of Chemistry.

At first, the difficulties of understanding became evident with the introduction of scientific texts, because although they address a more accessible language, there is still a peculiar language of this textual genre with common terms in the area. However, during the course of the research, it was possible to notice significant improvements in the appropriation of scientific language, showing that the practice of reading favors the fluidity of comprehension and textual interpretation. In addition, it was noticed that the individual and collective readings and discussions provided students with greater participation and involvement, as well as deepening and argumentative power as a result of the evolution and improvement of the scientific genre. Also, according to the readings carried out, it was possible to observe that the practice of writing well and signifying concepts is allied to a practice of dialogical reading, of a reader who positions himself in front of the text.

Therefore, based on the results obtained, we defend the importance of readings as a methodological contribution in the teaching of Chemistry because it stimulates new and different practices in the context of Chemistry, thus promoting the facilitation of such a complex and diverse process that is the act of teaching and learning. Reading, writing and orality are essential instruments to foster learning and criticality in the teaching of Chemistry, the results point to how significant it is to bring different teaching strategies to the classroom and the need for constant mediation of the teacher, who must always be willing to follow the process, as well as, of the student's interactive positioning.

Thus, we reiterate the importance of expanding reading and writing practices, as well as a dialogue about them, throughout the students' school life, so that we can perpetuate practices that become something pleasurable and meaningful, in addition to a technical, quick reading without dialogue and writing that is limited to simple copying.

DEDICATION

I dedicate this work to the loves of my life!

My mother Irene Ferreira de Mendonça who always dedicated herself very hard to the education of her children, so that we became "men of value", a widow and a woman full of strength and determination who knew how to conduct very well the task of raising and educating her offspring.

To my beautiful and dedicated wife Josineide da Costa Passion for support, dedication and encouragement, an extraordinary woman who was by my side on the way here, and who shares with me unique and unspeakable moments, of many victories and also of afflictions, "Together we are stronger"!

To my children Emanuel and Sarah da Costa Paixão (In memoriam) who taught me in such a short time the true meaning of Love.

ACKNOWLEDGMENTS

I thank GOD for the path traced so far, he gave me strength and wisdom to experience the Professional Master's Degree in Teaching in Science and Mathematics Teaching, putting in my life people who motivated me and believed in my dreams and in their own way helped me to make dreams come true.

To my wife Josineide Paixão, for her unconditional love and affection, my companion at all times and in all circumstances, who is by my side in all our journeys.

To my children Emanuel da Costa Paixão and Sarah da Costa Paixão, who rest in the Lord (In memoriam), who allow me to experience an unimaginable love, who taught me in such a short time the true meaning of Love.

To my parents, Hélio Nascimento da Paixão (In memoriam) and Irene Ferreira de Mendonça, for the values and teachings they provided me, for the countless advice and incentives that strengthened me on this trajectory, who proved to be proud and happy for my journey.

To my brothers Claydson Hammed de Mendonça and Clayton Mastroianni Siqueira da Paixão for their affection and encouragement on this journey towards a master's degree.

To my in-laws Maria de Fátima Pantoja da Costa and João Augusto Pantoja da Costa who were my foundation in a moment of academic and professional construction, to you all my affection and affection.

To my brothers in life Josiane, João Batista and Júlio César Pantoja da Costa for the happiness of coexistence, and the formation of an eternal bond.

The EEEFM Abelardo Leão Conduru institution, in Mosqueiro, the management and coordination, and especially the participants of the research, my students from the M1MR03 class.

To my dear colleagues from the PPGDOC 2017 class, for the companionship and for the moments of struggles and reflections together. Thank you for the partnership in research and disciplines, watered with many laughs and relaxations that not even photoFigureic records could capture in their entirety. It was a very rich experience, with the meeting of several paths converging to the same point, seeking growth to offer quality education.

To the Professional Master's program, especially to all the professors who left a little of themselves in us.

For my advisor Prof. Dr. Wilton Rabelo Pessoa, words are insufficient to express all my gratitude. My thanks for your patience and friendship, for our coexistence in disciplines and orientations, a great man who in my academic and private storms provided me with an unusual comfort and made me learn more. An exemplary and reputable professional, always very willing to dialogue and very reflective, he led the stages of reflections, analysis and writing with lightness. I am grateful to you for all the affection given to me at various times, so I am your fan and I root for your success in all areas of your life.

I am immensely grateful to the students, professors and collaborators for the dedication invested in the research process that is constituted on the practice itself, in the early years, the words of encouragement and the free hugs certainly renewed my energy and enabled me to write these lines in the plot of my story. Believe me, I take much more than I left, I want this training path to be one of many others to come.

To my friends from the Miriense Institute of Education, Science and Technology – IMECT.

To my colleagues at Colégio Manoel Antônio de Castro – MAC.

To my colleagues at the Enedina Sampaio Melo School – ESAM.

To my colleagues at the Raimundo Emiliano Pantoja School – REP.

To everyone who from far or near encouraged and supported my trajectory so far.

Thank you very much!

REFERENCES

- Aguiar, K. F., & Rocha, M. L. (1997). Práticas universitárias e a formação sócio-política. *Anuário do Laboratório de Subjetividade e Política*, (3/4), 87–102.
- Almeida, M. J. P. M., Cassiani, S., & Oliveira, O. B. (2008). Leitura e escrita em aulas de ciências: Luz, calor e fotossíntese nas mediações escolares. *Letras Contemporâneas*.
- Almeida, W. R., Costa, W. A., & Pinheiro, M. I. S. (2012). Bibliotecários mirins e a mediação da leitura na biblioteca escolar. *Revista ACB: Biblioteconomia em Santa Catarina*, 17(2), 472–490.
- Andrade, T. S., Melo, M. R., & Santos, A. C. O. (2017). Concepções de leitura de graduandos de licenciatura em química da Universidade Federal de Sergipe (UFS). *Revista Fórum Identidades*, 23, 141–156.
- Bargalló, C. M. (2005). Aprender ciências a través del lenguaje. *Educar*, 33–34.
- Bertoldi, A. (2020). Alfabetização científica versus letramento científico: Um problema de denominação ou uma diferença conceitual? *Revista Brasileira de Educação*, 25, Article e250014. <https://doi.org/10.1590/S1413-24782020250014>
- Brasil. Ministério da Educação. Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira. (2009). Matriz de referência para o ENEM 2009. INEP/MEC.
- Canclini, N. (2008). *Culturas híbridas*. EDUSP.

- Capecchi, M. C. V. M., & Carvalho, A. M. P. (2006). Atividades de laboratório como instrumento para abordagem de aspectos da cultura científica em sala de aula. *Pró-Posições*, 17(1), 1–18.
- Cardoso, S. P., & Colinviaux, D. (2000). Explorando a motivação para estudar química. *Química Nova*, 23(3), 401–404.
- Carvalho, A. M. P. (2008). Enculturação científica: Uma meta do ensino de ciências. In C. A. Traversini et al. (Orgs.), *Trajetórias e processos de ensinar e aprender: Práticas e didáticas: Livro 2* (pp. 115–135). EDIPUCRS.
- Carvalho, H. W. P., Batista, A. P. L., & Ribeiro, C. M. (2007). Ensino e aprendizado de química na perspectiva dinâmicointerativa. *Experiências em Ensino de Ciências*, 2(3), 34–47.
- Chiappini, L. (2011). *Aprender e ensinar com textos: Vol. 1. Aprender e ensinar com textos de alunos* (7ª ed.). Cortez Editora.
- Colpo, C. C., Wenzel, J. S., & Martins, J. L. C. (2019). Estratégias de leitura nas aulas de ciências: Um olhar para os anais do ENPEC. *Ensino de Ciências e Tecnologia em Revista*, 9(3), 141–150.
- Cruz, V. (2007). Uma abordagem cognitiva da leitura. Lidel.
- Cunha, M. B. da, & Giordan, M. (Orgs.). (Ano não especificado). *Divulgação científica na sala de aula: Implicações de um gênero*. [Editora não informada; entrada incompleta no original].
- Cunha, R. B. (2017). Alfabetização científica ou letramento científico?: Interesses envolvidos nas interpretações da noção de scientific literacy. *Revista Brasileira de Educação*, 22(68), 169–186. <https://doi.org/10.1590/S1413-24782017000000008>
- Cunha, R. B. (2018). O que significa alfabetização ou letramento para os pesquisadores da educação científica e qual o impacto desses conceitos no ensino de ciências. *Ciência & Educação*, 24(1), 1–20.
- Davel, M. A. N. (2017). Alfabetização científica ou letramento científico? Entre elos e duelos na educação científica com enfoque CTS. In *Anais do XI Encontro Nacional de Pesquisa em Educação em Ciências*. Florianópolis.
- Dos Anjos Ribeiro, T. (2017). O uso de textos de divulgação científica como modo de ensino nas aulas de química. In *37º Encontro de Debates e Ensino da Química (EDQ)* (pp. 1–8). Universidade Federal do Rio Grande.
- Espinoza, A. (2010). *Ciências na escola: Novas perspectivas para a formação dos alunos* (C. Boguea, Trans.). Ática.
- Fatarell, E. F., Massi, L., de Abreu Ferreira, L. N., & Queiroz, S. L. (2015). Mapeamento e textos de divulgação científica para planejamento de debates no ensino da química. *Química Nova na Escola*, 37(1), 11–18.
- Ferreira, L. N. A., & Queiroz, S. L. (2012). Textos de divulgação científica no ensino de ciências: Uma revisão. *Revista de Educação em Ciência e Tecnologia*, 5(1), 3–31.
- Ferreira, L. N. A., & Queiroz, S. L. (2013). Traços de cientificidade, didaticidade e laicidade em artigos da revista *Ciência Hoje* relacionados à química. *Ciência & Educação*, 19(4), 947–969.

- Ferreira, L. N. A., & Queiroz, S. L. (2015). Utilização de textos de divulgação científica em salas de aula de química. In M. B. Cunha & M. Giordan (Orgs.), *Divulgação científica na sala de aula: Perspectivas e possibilidades* (pp. 131–160). Ed. Unijuí.
- Ferreira, M., & Horta, I. V. (Ano não especificado). *Leitura - Dificuldades de aprendizagem, ensino e estratégias para o desenvolvimento de competências. Da Investigação às Práticas*, 5(2), 144–154.
- Flor, C. C. (2009). *Leitura e formação de leitores em aulas de química no ensino médio* [Tese de doutorado, PPGET/UFSC].
- Fourez, G. (2003). Crise no ensino de ciências? *Investigações em Ensino de Ciências*, 8(2), 109–123.
- Francisco Júnior, W. E. (2010). Estratégias de leitura e educação química: Que relações? *Química Nova na Escola*, 32(4), 220–226.
- Francisco Júnior, W. E., & Garcia Júnior, O. (2010). Leitura em sala de aula: Um caso envolvendo o funcionamento de ciência. *Química Nova na Escola*, 32(3), 191–199.
- Francisco Junior, W. E., Ferreira, L. H., & Hartwig, D. R. (2008). A dinâmica de resolução de problemas: Analisando episódios em sala de aula. *Ciências & Cognição*, 13, 82–99.
- Freire, P. (2006). *A importância do ato de ler: Em três artigos que se completam* (48ª ed.). Cortez.
- Freire, P. (2006). Educação "bancária" e educação libertadora. In M. H. S. Patto et al., *Introdução à psicologia escolar* (3ª ed., pp. 61–78). Casa do Psicólogo.
- Freire, P. (1997). *Educação e mudança*. Paz e Terra.
- Gil Pérez, D., Macedo, B., Martínez Torregrosa, J., Sifredo, C., Valdés, P., & Vilches, A. (Eds.). (2005). *¿Cómo promover el interés por la cultura científica? Una propuesta didáctica fundamentada para la educación científica de jóvenes de 15 a 18 años*. OREALC/UNESCO. <http://www.oei.es/decada/libro.htm>
- Gil, A. C. (2010). *Como elaborar projetos de pesquisa* (5ª ed.). Atlas.
- González Rey, F. (2005). *Sujeito e subjetividade*. Pioneira Thomson.
- Guaita, R. I., & Gonçalves, F. P. (2015). A leitura em uma perspectiva progressista e o ensino de química. *Química Nova na Escola*, 37(1), 53–62.
- Kleiman, A., & Moraes, S. E. (2003). *Leitura e interdisciplinaridade: Tecendo redes nos projetos da escola*. Mercado das Letras.
- Lemke, J. (1997). *Aprender a hablar ciencia: Lenguaje, aprendizaje y valores*. Ediciones Paidós Ibérica.
- Lima, J. O. G. (2012). Perspectivas de novas metodologias no ensino de química. *Revista Espaço Acadêmico*, 12(136), 95–101.
- Liu, Z. A., & Akerson, V. L. (2002). Science and language links: A fourth grade intern's attempts to use language arts to improve scientific inquiry skills. *Electronic Journal of Literacy Through Science*, 1(2), 1–19. <http://ejlts.ucdavis.edu/sites/ejls.ucdavis.edu/files/articles/zale.pdf>
- Lopes, R. M., Silva Filho, M. V., Marsden, M., & Alves, N. G. (2011). Aprendizagem baseada em problemas: Uma experiência no ensino de química toxicológica. *Química Nova*, 34(7), 1275–1280.

- Maldaner, O. A. (2006). A formação inicial e continuada de professores de química. Unijuí.
- Martins, I., Nascimento, T. G., & Abreu, T. B. (2004). Clonagem na sala de aula: Um exemplo do uso didático de um texto de divulgação científica. *Investigações em Ensino de Ciências*, 9(1), 95–111.
- Melo, M. R., & Santos, A. A. (2012). Dificuldades dos licenciandos em química da UFS em entender e estabelecer modelos científicos para equilíbrio químico. In XVI Encontro Nacional de Ensino de Química-ED-SBQ (pp. 1–?). Universidade Federal da Bahia. <https://portalseer.ufba.br/index.php/anaiseneq2012/article/viewFile/7789/5520>
- Mendonça, R. H. (2010). Divulgação científica e educação: Apresentação da série. Salto para o Futuro. *Divulgação Científica e Educação*, 20(1), 3–4. <http://tvbrasil.org.br/fotos/salto/series/175210>
- Meneses, F. M. G., & Nuñez, I. B. (2018). Erros e dificuldades de aprendizagem de estudantes do ensino médio na interpretação da reação química como um sistema complexo. *Ciência & Educação*, 24(1), 175–190.
- Menezes, C. F., dos Santos, R. K., Nogueira, C. C., Trindade, S. A., Ribeiro, P. F. V., da Silva, L. L. M., & Panarra, F. G. N. (2017). Dificuldades no ensino de química: Um estudo realizado com alunos de um projeto de ensino. In 57º Congresso Brasileiro de Química.
- Minayo, M. C. S., & Sanches, O. (1993). Quantitativo-qualitativo: Oposição ou complementaridade? *Cadernos de Saúde Pública*, 9(3), 239–262.
- Minayo, M. C. S. (2009). Pesquisa social: Teoria, método e criatividade. Vozes.
- Nascimento, T. G., & Cassiani, S. (2009). Leituras de divulgação científica por licenciandos em ciências biológicas. *Revista Electrónica de Enseñanza de las Ciencias*, 8(3), 745–769.
- Nascimento, T. G., & Rezende Junior, M. F. (2010). Produção sobre divulgação científica na área de educação em ciências: Referenciais teóricos e principais temáticas. *Investigações em Ensino de Ciências*, 15(1), 97–120.
- Pontes, A. N., Serrão, C. R. G., Freitas, C. K. A., Santos, D. C. P., & Batalha, S. S. A. (2008). O ensino de química no nível médio: Um olhar a respeito da motivação. In XIV Encontro Nacional de Ensino de Química.
- Santos, W. L. P., & Mortimer, E. F. (2009). Abordagem de aspectos sociocientíficos em aulas de ciências: Possibilidades e limitações. *Investigações em Ensino de Ciências*, 14(2), 191–218.
- Sasseron, L. H., & Carvalho, A. M. P. (2011). Alfabetização científica: Uma revisão bibliográfica. *Investigações em Ensino de Ciências*, 16(1), 59–77. <https://ienci.if.ufgrs.br/index.php/ienci/article/view/246>
- Silva, E. T. (1998). Ciência, leitura e escola. In H. C. Silva & M. J. P. M. Almeida (Orgs.), *Linguagens, leituras e ensino da ciência* (pp. 121–130). Mercado das Letras.
- Silva, S. C., & Abreu, D. G. (2012). Aulas coletivas na escola pública: Interação entre universidade-escola. *Química Nova na Escola*, 34, 131–135.
- Silva, S. G. (2012). As principais dificuldades na aprendizagem de química na visão dos alunos do ensino médio. In IX Congresso de Iniciação Científica do IFRN.

- Suíso, C., & Galieta, T. (2015). Relações entre leitura, escrita e alfabetização/letramento científico: Um levantamento bibliográfico em periódicos nacionais da área de ensino de ciências. *Ciência & Educação*, 21(4), 991–1009.
- Targino de Moura, F., Sousa, R., & e Sá Carneiro, C. (2018). O ensino de química contextualizado: As vozes discentes. *Revista Insignare Scientia - RIS*, 1(3).
- Teixeira, J. G. J., & Silva, R. M. G. (2007). Perfil de leitores em um curso de licenciatura em química. *Química Nova*, 30(5), 1365–1368.
- Thiollent, M. (2009). *Metodologia da pesquisa-ação* (17^a ed.). Cortez.
- Tonindandel, S. M. R. (2008). Escrita argumentativa de alunos do ensino médio alicerçada em dados empíricos obtidos em experimentos de biologia [Dissertação de mestrado, Faculdade de Educação, Universidade de São Paulo].
- Tripp, D. (2005). Pesquisa-ação: Uma introdução metodológica. *Educação & Pesquisa*, 31(3), 443–466.
- Vergara, S. C. (2005). *Métodos de pesquisa em administração*. Atlas.
- Vogt, C. (Org.). (2006). *Cultura científica: Desafios*. Edusp.
- Wartha, E. J., Silva, L. E., & Bejarano, R. R. N. (2013). Cotidiano e contextualização no ensino de química. *Química Nova na Escola*, 35(2), 84–91.
- Weller, W. (2006). Grupos de discussão na pesquisa com adolescentes e jovens: Aportes teórico-metodológicos e análise de uma experiência com o método. *Educação e Pesquisa*, 32(2), 241–260.
- Wenzel, J. S., Martins, J. L. C., Colpo, C. C., & Ribeiro, T. A. (2018). A prática da leitura no ensino de química: Modos e finalidades de seu uso em sala de aula. *ACTIO*, 3(2), 98–115.
- Wenzel, J. S. (2013). A significação conceitual em química em processo orientado de escrita e reescrita e a ressignificação da prática pedagógica [Tese de doutorado, Universidade Regional do Noroeste do Estado do Rio Grande do Sul].
- Wenzel, J. S., & Colpo, C. C. (2018). Leitura de textos de divulgação científica como modo de qualificar o uso da linguagem química no ensino médio. *Experiências em Ensino de Ciências*, 13(4), 134–146.
- Zismann, J. J., Bach, S. B., & Wenzel, J. S. (2019). A leitura de texto de divulgação científica no ensino de cinética química. *Revista Insignare Scientia*, 2(1), 127–137.

ANNEXES

ANNEX A – Free and Informed Consent Form for the School



FEDERAL UNIVERSITY OF PARÁ
 INSTITUTE OF MATHEMATICAL AND SCIENTIFIC EDUCATION
 GRADUATE PROGRAM IN TEACHING IN SCIENCE AND MATHEMATICS EDUCATION
 (Professional Master's Degree)
 University Campus of Guamá – Basic Sector
 Av. Augusto Corrêa, 01. CEP 66075-110 – Belém/PA
 Phone/fax: (91)3201-8070 – e-mail: ppgdoc.ufpa@gmail.com

Belém, August 1, 2019.

The ongoing research is led by the master's student, Hélio Nascimento da Paixão Júnior, as well as his advisor, Professor Dr. Wilton Rabelo Pessoa from the Institute of Mathematics and Scientific Education (IEMCI) of the Federal University of Pará (UFPA). The theme of the research is: THE USE OF TEXTS OF SCIENTIFIC DISSEMINATION AS A DIDACTIC/PEDAGOGICAL RESOURCE IN THE TEACHING OF CHEMISTRY.

Following ethical precepts, we inform you that your participation will be absolutely confidential, which implies the concealment of names that may identify you in the final report or in any subsequent publication. Therefore, your involvement will not cause any damage to your person, family or the Institution you study. The institution has total freedom of refusal, as well as may request the deletion of your data, withdrawing your consent without any penalty or prejudice, when it so wishes. We thank you for your collaboration, emphasizing that it greatly contributes to the formation and construction of current knowledge in this area.

Prof. Dr. Dr. Wilton Rabelo Pessoa Hélio Nascimento da Paixão Júnior
 Research advisor Researcher

Being aware of the information contained in this Informed Consent Form, I _____, bearer of RG No. _____ no the exercise of the function of manager of this teaching unit, _____ autorizo the use, in this research,

of the necessary data, both with regard to the information provided by our employees and students/guardians, as well as the images captured throughout the research.

Subscription

APPENDIX B – Free and Informed Consent Form for Research Participants



FEDERAL UNIVERSITY OF PARÁ
 INSTITUTE OF MATHEMATICAL AND SCIENTIFIC EDUCATION
 GRADUATE PROGRAM IN TEACHING IN SCIENCE AND MATHEMATICS EDUCATION
 (Professional Master's Degree)
 University Campus of Guamá – Basic Sector
 Av. Augusto Corrêa, 01. CEP 66075-110 – Belém/PA
 Phone/fax: (91)3201-8070 – e-mail: ppgdoc.ufpa@gmail.com

Belém, August 1, 2019.

The ongoing research is led by the master's student, Hélio Nascimento da Paixão Júnior, as well as his advisor, Professor Dr. Wilton Rabelo Pessoa from the Institute of Mathematics and Scientific Education (IEMCI) of the Federal University of Pará (UFPA). The theme of the research is: THE USE OF TEXTS OF SCIENTIFIC DISSEMINATION AS A DIDACTIC/PEDAGOGICAL RESOURCE IN THE TEACHING OF CHEMISTRY.

Following ethical precepts, we inform you that your participation will be absolutely confidential, which implies the concealment of names that may identify you in the final report or in any subsequent publication. Therefore, your involvement will not cause any damage to your person, family or the Institution you study. The institution has total freedom of refusal, as well as may request the deletion of your data, withdrawing your consent without any penalty or prejudice, when it so wishes. We thank you for your collaboration, emphasizing that it greatly contributes to the formation and construction of current knowledge in this area.

Prof. Dr. Dr. Wilton Rabelo Pessoa Hélio Nascimento da Paixão Júnior
 Research advisor Researcher

☐ I AGREE TO PARTICIPATE IN THE RESEARCH

() I DO NOT ACCEPT TO PARTICIPATE IN THE SURVEY

Signature of the Participant (responsible in case of minor)

Researcher's Signature

ANNEX C – Questionnaire Q1

Semi-structured questionnaire for diagnosis and survey of the reader's profile – Q1

1) Do you have the habit of reading? If not, why?

() Yes

() No

2) Do you understand what you read?

() No

() Not entirely

() Yes

3) How often do you read? Reference in Books Per Year – LPA.

() No EPS

() A little – 1 to 3 LPA

() Reasonably – 4 to 10 LPA

() Quite 11 or + EPS

4) What is your Reading preference?

() Books

() Magazines

() Comics/Comics

() Newspapers

() Articles

5) In your student life, how many articles have you read?

() None – 0

() A little – 1 to 5

() Reasonably – 6 to 10

() Quite 11 or +

6) How did you acquire the articles for reading and research?

() Through the teacher

() Books and magazines

() Specialized sites

() Other _____

7) For you, what is your biggest difficulty in reading articles?

8) What is the importance of scientific articles for your life and in your daily life?

9) How can reading articles help you in your life?

ANNEX D – Interview questionnaire – Q2

List of questions regarding the Group interview.

I. Do you know the periodic table?

II. What is the use of the periodic table?

III. Does the periodic table make sense to you?

- IV. Do you find the periodic table difficult or complicated?
- V. What makes the periodic table difficult or complicated?
- VI. What is the relationship between the periodic table and your day-to-day life?

APPENDIX F - Semi-structured questionnaire for evaluation at the end of the study – Q3

1) Did you find reading the texts difficult?

☐ YES

☐ NO

2) Did you already know the information in the texts covered?

☐ YES

☐ NO

3) Did you find the content interesting?

☐ YES

☐ NO

4) Would you like to take more classes like these?

☐ YES

☐ NO

5) Were you able to participate in the debates?

☐ YES

☐ NO

6-. Do you believe that the methodology used with the use of articles and the teacher's mediation helped your learning in the Chemistry discipline? Comment on your impression of the process.

ANNEX G – Registration Journal

Reading Log

TEXT 1:

Record below all the points of the text read that you considered important or difficult to understand.

[illegible]

ANNEX I: Tables of the number of papers published in ENEQ distributed by Area of Knowledge in the period from 2008 to 2018.

National Meeting of Chemistry Teaching/Publications by area

ENEQ 2008 – Curitiba/PR

Items	Area	Published Works
1	Curriculum and Assessment	27 works
2	Teaching and Learning	146 works
3	Education and Culture	16 works
4	Teaching in Non-Formal Spaces	23 works
5	Experimentation in Teaching	50 works
6	Teacher training	95 works
7	History and Philosophy of Science	17 works
8	Language and Cognition	11 works
9	Didactic Material	34 works
10	Information and Communication Technology	38 works

ENEQ 2010 – Brasília/DF

Items	Area	Published Works
1	Curriculum and Assessment	29 WORKS
2	Environmental Education	40 WORKS
3	Teaching and Learning	158 JOBS
4	Education and Culture	11 WORKS
5	Teaching and Inclusion	23 JOBS
6	Teaching in Non-Formal Spaces	17 WORKS
7	Experimentation in Teaching	48 WORKS
8	Teacher training	41 WORKS
9	History and Philosophy of Science	20 JOBS
10	Language and Cognition	20 JOBS
11	Didactic Material	63 WORKS
12	Information and Communication Technology	33 WORKS
TOTAL WORKS 2010		503

ENEQ 2012 – Salvador/BA

Items	Area	Published Works
1	STS Approach and Chemistry Teaching	25 JOBS
2	Curriculum and Assessment in Chemical Education	32 JOBS
3	Environmental Education and Chemistry Teaching	43 JOBS
4	Teaching and Learning	248 WORKS
5	Chemistry Teaching and Inclusion	36 WORKS
6	Teaching in non-formal spaces and Scientific Dissemination	28 JOBS
7	Experimentation in Teaching	122 WORKS
8	Teacher training	180 WORKS
9	History and Philosophy of Chemistry	21 WORKS
10	History, philosophy and Sociology of Science in the teaching of Chemistry.	12 JOBS
11	Language and the Teaching of Chemistry	36 WORKS
12	Didactic Material in the Teaching of Chemistry	85 WORKS

13	Educational Policies and the Teaching of Chemistry	2 JOBS
14	Information and Communication Technology	42 WORKS

ENEQ 2014 – Ouro Preto/MG

Items	Area	Published Works
1	STS Approach and Chemistry Teaching	52 WORKS
2	Curriculum and Assessment in Chemical Education	38 WORKS
3	Environmental Education and Chemistry Teaching	55 WORKS
4	Teaching and Learning	260 WORKS
5	Inclusion and Educational Policies	42 WORKS
6	Teaching in non-formal spaces and Scientific Dissemination	44 WORKS
7	Experimentation in Teaching	119 WORKS
8	Teacher training	164 WORKS
9	History, Philosophy and Sociology of Chemistry	36 WORKS
10	Language and Cognition in the Teaching of Chemistry	34 WORKS
11	Didactic Material in the Teaching of Chemistry	142 WORKS
12	Information and Communication Technology	51 WORKS
13	Other	10 WORKS
	TOTAL WORKS 2014	1047

ENEQ 2016 – Florianópolis/SC

Items	Area	Published Works
1	STS Approach and Chemistry Teaching	105 WORKS
2	Curriculum and Assessment in Chemical Education	36 WORKS
3	Environmental Education and Chemistry Teaching	76 WORKS
4	Teaching and Learning	427 WORKS
5	Teaching in non-formal spaces and Scientific Dissemination	65 WORKS
6	Experimentation in Teaching	152 WORKS

7	Teacher training	207 WORKS
8	History, Philosophy and Sociology of Science	69 WORKS
9	Language and Cognition	31 WORKS
10	Didactic Material in the Teaching of Chemistry	177 WORKS
11	Inclusion and Educational Policies in the Teaching of Chemistry	61 WORKS
12	Information and Communication Technology	74 WORKS
TOTAL WORKS 20016		1480

ENEC 2018 – Rio Branco/AC

Items	Area	Published Works
1	STS Approach and Chemistry Teaching	16 WORKS
2	Curriculum and Assessment in Chemical Education	1 WORK
3	Environmental Education and Chemistry Teaching	6 JOBS
4	Teaching and Learning	50 JOBS
5	Teaching in non-formal spaces and Scientific Dissemination	11 WORKS
6	Experimentation in Teaching	15 JOBS
7	Teacher training	22 WORKS
8	History, Philosophy and Sociology of Science	6 JOBS
9	Language and Cognition	3 JOBS
10	Didactic Material in the Teaching of Chemistry	40 WORKS

11	Inclusion and Educational Policies in the Teaching of Chemistry	8 WORKS
12	Information and Communication Technology	10 WORKS
TOTAL WORKS 2018		188

Recomendações de Alimentação e Nutrição Saudável para a População Brasileira

artigo original

RESUMO

Apresentamos sugestões para a definição de guias alimentares para a população brasileira, excetuando as crianças. Os principais objetivos dessas recomendações são a manutenção de peso saudável e a prevenção da obesidade, das doenças cardiovasculares, do diabetes mellitus tipo 2 e da osteoporose. As mensagens para o público têm duas pressuposições: retomar hábitos saudáveis da dieta brasileira e estimular o consumo de alimentação saudável ao invés de formular proibições. As principais mensagens incluem: consumo de alimentos variados, em 4 refeições ao dia; manutenção de um peso saudável; aumento da atividade física diária; ingestão de arroz e feijão todos os dias, acompanhados de legumes e vegetais folhosos; ingestão de 4 a 5 porções de frutas todos os dias; redução do açúcar; evitar uso de refrigerantes; para lanches, comer frutas ao invés de biscoitos, bolos e salgadinhos; comer pouco sal; usar óleos e azeite ao invés de outras gorduras; tomar leite e comer produtos lácteos, com baixo teor de gordura, pelo menos 3 vezes por dia. (*Arq Bras Endocrinol Metab* 2000;44/3: 227-32)

Unitermos: Guias de alimentação; Obesidade; Doença cardiovascular; Osteoporose; Diabetes; Prevenção.

ABSTRACT

We present suggestions for dietary guidelines for healthy Brazilians, excluding young children. These guidelines aim to prevent obesity, cardiovascular diseases, type 2 diabetes mellitus and osteoporosis. The messages to the public were based on two presumptions: to get back traditional Brazilian healthy dietary patterns and to stimulate the consumption of these foods more than to formulate prohibitions. The main messages are: eat at least four meals a day, and do not skip meals; maintain a healthy weight; increase daily physical activity and exercise; eat rice and beans with vegetables everyday; eat four to five portions of fruits everyday; reduce sugar, sweets and sodas; choose a fruit instead of deep fried foods or sweets for snacks; use salt only in moderation; use oil or olive oil instead of other fats; drink or eat low fat dairy products at least three times a day. (*Arq Bras Endocrinol Metab* 2000;44/3: 227-32)

Keywords: Dietary guidelines; Obesity; Cardiovascular disease; Osteoporosis; Diabetes; Prevention.

O ESTABELECIMENTO DE GUIAS DE ALIMENTAÇÃO e nutrição saudável tem por base o reconhecimento de que um nível ótimo de saúde depende da nutrição. Com o aumento da obesidade e das doenças associadas à obesidade, no Brasil, há que se combinar orientações para a redução das deficiências nutricionais, ainda presentes, com orientações visando a prevenção das doenças crônicas não transmissíveis.

*Rosely Sichieri
Denise C. Coitinho
Josefina B. Monteiro
Walmir F. Coutinho*

*Instituto de Medicina Social, UERJ -
Universidade Estadual do
Rio de Janeiro (RS), Departamento de
Nutrição, UNB - Universidade
Federal de Brasília e Ministério da
Saúde (DCC), Departamento de
Nutrição e Saúde - UFV (JBM) e
Associação Brasileira para o Estudo da
Obesidade (WFM).*

*Recebido em 13/09/99
Revisado em 19/01/00
Aceito em 21/01/00*

Neste cenário, as medidas preventivas ocupam lugar de destaque, não só em função de que a prevenção precoce das doenças associa-se a melhor qualidade de vida, mas também porque, as medidas terapêuticas para a obesidade, um dos principais problemas nutricionais do presente, têm sido de pouca valia.

A base científica para prevenção baseia-se em dois componentes. O primeiro seria o conhecimento dos processos biológicos e epidemiológicos subjacentes ao aparecimento das doenças e o segundo a efetividade das intervenções (1).

É pequeno o conhecimento acumulado, no Brasil, sobre a efetividade de intervenções para prevenção das doenças crônicas. Grande parte da experiência preventiva no Brasil tem origem na prevenção das doenças infecciosas e das doenças carenciais, cuja prevenção tem um caráter mais específico. Para as doenças crônicas este quadro é muito diferente. Grande parte das chamadas doenças crônicas, como infarto do miocárdio, diabetes, cânceres, hipertensão, apresentam-se intimamente relacionadas e há uma verdadeira rede de relações das doenças entre si, bem como dos fatores de risco a elas associados. Assim, a hipertensão arterial associa-se ao diabetes tipo 2, que por sua vez associa-se à redução do HDL colesterol e ao aumento de triglicerídios (2). O tratamento clínico não pode ignorar estas associações, e o mesmo deve ocorrer com os programas de prevenção. Além destas doenças estarem associadas, os fatores de risco para as doenças crônicas não transmissíveis ocorrem de forma conjunta e interdependente. Deixar de fumar associa-se a ganho de peso (3,4) e, comportamentos como realizar atividade física de lazer e comer mais frutas agrupam-se nos mesmos indivíduos (5).

Portanto, mesmo que muitos estudos epidemiológicos em doenças crônicas busquem um nutriente específico que seria o responsável pela diminuição da incidência, e mesmo que em alguns casos este conhecimento possa representar, no futuro, a forma mais efetiva de prevenção para uma doença específica, a abordagem coletiva das doenças crônicas não transmissíveis parece ser a forma mais indicada de prevenção primária.

Assim, uma proposta de alimentação saudável, para prevenção das doenças crônicas não transmissíveis, há de propor dietas que estejam ao alcance da sociedade como um todo, e que tenham um impacto sobre os mais importantes fatores relacionados às várias doenças. Aumentar o consumo de frutas e verduras e estimular o consumo de arroz e feijão são exemplos de proposições que preenchem estes requisitos.

Recente publicação do *World Cancer Research Control* (6), em conjunto com o *American Institute for Cancer Research* também enfatiza uma perspectiva glo-

bal para a prevenção do câncer. Nesta publicação considera-se que modificações da dieta, em conjunto com a abolição do tabagismo, reduziram em dois-terços a incidência global dos cânceres. Ainda nesta publicação, sugere-se que modificações no sentido de uma vida mais saudável, teriam um impacto, em relação às doenças crônicas, similar ao causado pela melhoria das condições de saneamento, na redução de doenças infecciosas.

A mesma abordagem tem sido proposta para a vigilância do diabetes tipo 2, com avaliação de sistemas de doenças e não de doenças isoladas (7). Consistente com estas observações, guias alimentares para os países desenvolvidos, já há algum tempo, têm se voltado para a manutenção da saúde e a redução do risco das doenças crônicas em geral (8). Muitos países na América Latina também desenvolveram guias (9) e para o Brasil o Instituto Danone realizou, recentemente, um encontro para definição de uma alimentação equilibrada para a população brasileira (10).

Também relevante no estabelecimento de recomendações alimentares ou de guias alimentares é como tratar assuntos conflitantes ou que causem apreensão desnecessária na população. O consumo de álcool, por exemplo, é considerado um fator de proteção para as doenças cardiovasculares; contudo, tem sido difícil adotarmos uma medida de saúde pública que considerasse o consumo de álcool, dada sua repercussão nas doenças por causas externas e alguns cânceres. Um outro exemplo é o da importância dos ácidos graxos trans no desenvolvimento da doença cardiovascular e de como se transforma este conhecimento em ação preventiva, sem causar na população o sentimento de que as medidas anteriores como, por exemplo, redução das gorduras saturadas de nada valem.

Quanto à base científica para propor guias alimentares para a prevenção de doenças crônicas não transmissíveis ela é bastante ampla. As doenças cardiovasculares declinaram de forma importante nos países desenvolvidos decorrente de ações efetivas tanto de prevenção primária como secundária. Nos Estados Unidos, nos últimos 30 anos houve uma redução da mortalidade por doença coronariana da ordem de 50%, atribuível tanto ao tratamento quanto à prevenção primária (11). Para a América Latina como um todo, a prevenção das doenças cardiovasculares ainda é um desafio (12). Contudo, Lotufo & Lolio, 1996 (13), em análise da mortalidade por doenças cardiovasculares no estado de São Paulo, mostraram que a tendência ascendente da mortalidade por doenças coronarianas e cerebrovasculares reverteu-se na década de 70, e que alterações de fatores de risco importantes, como dieta e tabagismo, estariam associados à redução da

incidência destas doenças.

Embora muitos estudos indiquem a importância de diferentes fatores da dieta como fatores de risco para cânceres e diabetes tipo 2, a prevenção dos cânceres e do diabetes é ainda incipiente mesmo nos países desenvolvidos (2,1).

Por outro lado, a obesidade é uma condição que aumenta o risco de morbidade para as principais doenças crônicas: hipertensão, dislipidemia, diabetes, doença coronariana, alguns tipos de câncer e colecistite e, embora não se conheça uma estratégia adequada de prevenção, sua prevenção e tratamento apresentam-se como um dos grandes desafios deste século (14). A importância que a obesidade vem assumindo no Brasil (15) não pode ser ignorada e, a anunciada epidemia de obesidade para os Estados Unidos, é fato também no Brasil. Portanto, o estabelecimento de dietas saudáveis deve contemplar como prioridade a prevenção do ganho de peso. Incluir o consumo alimentar e a atividade física no âmbito de comportamentos para uma vida saudável é talvez a mais importante tarefa de promoção da saúde.

Do ponto de vista da alimentação saudável, sugere-se que as recomendações devem basear-se em alimentos mais do que em nutrientes. Assim, a Organização Mundial de Saúde, em publicação recente (9), sugere o estabelecimento de metas realistas de consumo de alimentos específicos, sendo estes alimentos identificados em função dos nutrientes que se pretendam abranger.

No estabelecimento das recomendações para a população brasileira consideramos como relevante as intervenções referentes a prevenção da obesidade, das doenças cardiovasculares, câncer, diabetes tipo 2 e osteoporose e, quanto à definição dos nutrientes, foram incluídos aqueles cujos achados são mais consistentes na literatura: consumo de gorduras, com ênfase nas gorduras saturadas e trans, de ácido fólico, vitamina C e E, sódio, cálcio e no consumo de fibras.

A proposta de uma dieta para a população brasileira tem, ainda, outros dois pressupostos: o resgate dos hábitos alimentares saudáveis próprios da comida brasileira; e a identificação de alimentos, ou grupo de alimentos, cujo consumo deva ser estimulado, mais do que formular proibições. O feijão é um destes elementos de resgate, pelo seu conteúdo em fibras, em ácido fólico e em ferro.

O desenvolvimento de guias para o Brasil é também resposta ao crescente interesse do público em geral, dos profissionais de saúde e dos planejadores em saúde, em relação ao papel da dieta na promoção da saúde e prevenção das doenças crônicas. Propomos que seja criada uma dinâmica nacional de discussão de estratégias a

serem implementadas nesta área e que estas se dêem de forma contínua e integrada, com a participação dos membros da sociedade civil, das universidades, dos serviços e da imprensa. Estas recomendações visariam atender, conforme sugerido por Barata & Barreto, 1996 (16), as necessidades como expressão das potencialidades humanas e não aquelas redefinidas e priorizadas pela ótica exclusiva do serviço de saúde. Fomentar atividades de informação ao consumidor e estabelecer especificação para rotulagem pelo Ministério da Saúde seriam metas importantes dentro desta ótica.

PESO SAUDÁVEL

As controvérsias sobre o peso adequado para adultos e idosos, com uma conduta mais frouxa de controle de peso para os idosos, embora não completamente superadas, parecem tender para o ideal de manter-se magro na vida adulta. Manter um peso corporal adequado e não ganhar peso durante a vida adulta parece associar-se a menor mortalidade e maior bem estar (17).

Os exercícios/atividade física devem ser altamente estimulados, pois aumentam a mobilidade e consequentemente a qualidade de vida. Parece haver boas razões para encorajar exercícios regulares e pequena perda de peso, mesmo entre pessoas mais velhas com sobrepeso, com vistas a sua longevidade e qualidade de vida (18,19).

As mulheres na pós menopausa parecem ser um grupo particularmente vulnerável ao aumento de peso, deposição abdominal de gordura e grande dificuldade para perder peso (20). Os resultados de uma recente meta-análise, com mulheres na pré menopausa, submetidas a dietas com restrição relativamente severa (800 a 1200kcal/dia), por pelo menos 10 semanas, mostraram que, embora a taxa de metabolismo basal em obesas diminua significativamente, tanto com dieta hipocalórica quanto com dieta associada com programa de exercício, a redução da taxa de metabolismo é menor na presença do exercício (21).

Adolescentes são particularmente influenciáveis em seu estilo de vida e deveriam ser prioritariamente contemplados em programas de saúde coletiva. Vários estudos indicam que a manutenção de um peso considerado adequado entre meninas adolescentes se faz através de práticas alimentares inadequadas, como omitir refeições, e que o consumo de nutrientes como cálcio e ferro é inadequado neste grupo (22).

Para adultos considera-se como peso saudável, o peso relativo, avaliado pelo índice de massa corporal (IMC= peso em kg/altura² em m) de até 24,9 (23). Para adolescentes sugere-se também a utilização do

IMC, contudo os pontos de corte adequados são ainda objeto de discussão (24).

MACRONUTRIENTES

A definição dos macronutrientes em sociedades onde a prevalência de obesidade é importante, passa necessariamente pela provisão de energia e sua capacidade de acumular-se como tecido adiposo. Há na literatura uma importante discussão sobre se existe uma associação entre consumo de gordura e obesidade (25), ou se o que realmente importa são as calorias consumidas (26). Dado que optar pela vertente de que as calorias totais são o principal fator associado à obesidade, não impede que no futuro se agregue a idéia de que a gordura tem um papel especial, propõem-se que as guias devem indicar claramente que o importante é a redução do consumo calórico total, principalmente dos itens de alta densidade calórica como doces, refrigerantes, tortas, etc.

Acumulam-se também evidências de que a substituição das gorduras por carboidratos refinados, como tem ocorrido em grande parte dos produtos industrializados, nas versões *light* e *diet*, pode aumentar o risco para a doença coronariana. Assim, os guias não deveriam sugerir a substituição de gordura por carboidrato (27). As gorduras líquidas com óleo de soja, canola, girassol, etc. são os melhores substitutos para as gorduras com ácidos graxos trans e as saturadas. Para os carboidratos, a opção preferencial deve ser para os carboidratos com alto teor de fibras.

Entre os alimentos da dieta brasileira com maior teor de fibra incluem-se farinha de mandioca, feijão, ervilha, milho, amendoim, jiló, pinhão, batata doce, batata baroa, cará e taioba (28).

MICRONUTRIENTES

Reconhecendo a importância de algumas vitaminas e minerais na prevenção de doenças crônicas, a *National Academy of Science*, dos Estados Unidos, em contraste com práticas passadas, está considerando a possibilidade de ingestão acima das recomendações para alguns micronutrientes que possam estar associados à redução das doenças crônicas. É necessário, contudo, que se conheça bem a segurança da ingestão de altas doses de nutrientes (29).

ÁCIDO FÓLICO

A ingestão suficiente de ácido fólico antes da concepção e muito no início da gravidez diminui o risco de defeitos no tubo neural: espinha bífida, anence-

falia, e encefalocele. Suplementação com ácido fólico diminui este risco de 50 a 75%. Adicionalmente, vários estudos apontam para o papel protetor do ácido fólico, via redução dos níveis de homocisteína, na doença cardiovascular (30). Nos Estados Unidos, a suplementação já está ocorrendo para este nutriente, e é interessante notar que é praticamente impossível atingir, nesta população, os níveis adequados de ingestão de 400µg, somente através da dieta. No Brasil, se a dieta tradicional com feijão - que é uma das principais fontes em nosso meio de ácido fólico -, fosse a base da alimentação e considerando-se que o conteúdo de ácido fólico do feijão preto cozido é de 256µg (31), seria possível atingir as recomendações só com a dieta. Resta saber o quanto é destruído no processo de cocção caseira, visto que de 50 a 90% do ácido fólico pode ser destruído no processamento (32).

Existem evidências de que a combinação de ácido fólico com vitamina B12 resulte em reduções ainda maiores nos níveis de homocisteína sérica (30).

VITAMINA E

Resultados de várias pesquisas estudando o efeito da vitamina E sobre as doenças do coração mostraram efeitos protetores associados com ingestão acima das da RDA. Evidências epidemiológicas indicam uma forte relação dose-resposta entre a diminuição do risco de doenças de coração e o aumento da ingestão de vitamina E na dieta e através de suplementos. Uma proteção significativa começa com ingestão diária de 67mg de alfa tocoferol. A oxidação da lipoproteína de baixa densidade (LDL) diminui significativamente em indivíduos que receberam quantidade acima de 400UI, mas não em indivíduos que receberam quantidade menores do que 200UI. Ensaio controlado, duplo cego, mostrou uma significativa diminuição de infarto do miocárdio não fatal em sujeitos que consumiam vitamina E como suplemento (29).

VITAMINA C

A vitamina C inibe a síntese química de nitrosaminas (a maioria delas é cancerígena), importante fator de risco para câncer do estômago. A inibição ocorre no conteúdo gástrico, mas a inibição não é completa até que a ingestão atinja cerca de 1.000mg. Estudos epidemiológicos e ensaios clínicos sugerem que uma ingestão de vitamina C muito maior do que a recomendação de 60 a 90mg, pode reduzir o risco de doenças crônicas como problemas cardíacos e câncer, especialmente quando combinados com alta ingestão de vitamina E (29). Levine et al., 1999 (33) e recente revisão sobre vitamina

C (34) sugerem a ingestão de 200mg/dia, o equivalente a ingestão de cinco porções de frutas e vegetais.

SÓDIO

Embora existam controvérsias sobre o papel do sal na gênese da hipertensão arterial, não parece haver risco em se reduzir o consumo para no máximo 3.000mg de sódio ou 7,5g de sal para a população sem hipertensão, e para 2.300mg de sódio ou 6g de sal para os hipertensos (35). O consumo diário per capita do ENDEF- Estudo Nacional sobre Despesa Familiar, 1974, foi de 12g de sal e em pesquisa recente no município do Rio de Janeiro, a estimativa de consumo foi também de 12g, com base na quantidade de sal adquirida mensalmente (15).

Redução do consumo de sal requer grande redução do consumo de alimentos processados com alta quantidade de sódio como *chips*, defumados e enlatados, bem como evitar adicionar sal aos alimentos já preparados (36). Produtos enlatados têm até 20 vezes mais sal do que o produto natural. O processamento dos enlatados pode, contudo, ser feito com menor teor de sódio, estratégia que deveria ser estimulada pelo Ministério da Saúde, bem como a rotulagem dos produtos em relação ao sal.

CÁLCIO

Estimular um adequado consumo de cálcio parece ser uma importante estratégia de prevenção em relação à osteoporose, sendo que a maximização do pico de massa óssea parece ser fundamental. Estima-se que mais de 51% do pico de massa óssea seja acumulado durante a puberdade nas mulheres. Jackman, 1997 (37), concluiu que 95% da quantidade total de mineral do osso deposita-se entre os 18 e os 22 anos, com o cálcio da dieta sendo muito importante na otimização do pico de massa óssea. Ensaios controlados randomizados de suplementação de cálcio, em crianças e adolescentes, mostraram que o aumento da ingestão de cálcio aumenta o acréscimo de cálcio no osso. O *Food and Drug Administration* dos Estados Unidos autorizou, inclusive, esta propaganda nos rótulos dos produtos com cálcio. Os alimentos fontes de cálcio são também fonte de colesterol e gorduras saturadas, e devem, portanto, ser considerados em conjunto na elaboração dos guias.

DEZ PASSOS PARA UMA ALIMENTAÇÃO ADEQUADA

Visando a manutenção de peso saudável e a prevenção de obesidade, doenças cardiovasculares, diabetes tipo 2 e osteoporose, recomendamos:

1. Consuma alimentos variados, em 4 refeições ao dia. Pular refeições não emagrece e prejudica a saúde;
2. Mantenha um peso saudável e evite ganhar peso após os 20 anos. Evite também o aumento da cintura;
3. Faça atividade física todos os dias. Inclua na sua rotina andar a pé, subir escada, jogar bola, dançar, passear e outras atividades;
4. Coma arroz e feijão todos os dias acompanhados de legumes e vegetais folhosos;
5. Coma 4 a 5 porções de frutas, todos os dias, na forma natural;
6. Reduza o açúcar. Evite tomar refrigerantes.
7. Para lanches coma frutas ao invés de biscoitos, bolos e salgadinhos;
8. Coma pouco sal. Evite alimentos enlatados e produtos como salame, mortadela e presunto, que contêm muito sal. Evite adicionar sal à comida já preparada. Aumente o uso de alho, salsinha e cebolinha. Alimentos ingeridos na sua forma natural como feijão, arroz, frutas, grãos e verduras têm pouquíssimo sal;
9. Use óleos e azeite no preparo de bolos, tortas e refeições;
10. Tome leite e coma produtos lácteos com baixo teor de gordura, pelo menos 3 vezes por dia.

Componentes da alimentação adequada por grupos de alimentos:

Porções diárias Exemplos		
Feijões e sementes	2 - 4	Feijão, lentilha, ervilha, grão de bico, amendoim
Arroz, pão e outros grãos de preferência integral e tubérculos	6 - 7	Pão, arroz, aveia, batata macarrão, cará, milho, mandioca ou farinhas
Verduras e legumes	3 - 5	Todos
Frutas	4 - 5	Todas
Leite e derivados	3 - 4	Leite, iogurte, queijo (com baixo teor de gordura)
Equivalentes em porções: Feijão - 70g; Arroz - 50g; Frutas - 100g; Verduras - 50g; Leite - 200ml		

Este tipo de dieta, com 3 porções de feijão, 6 porções de arroz, 3 porções de verduras, 4 frutas e 3 porções de leite equivale a 1.710kcal, 12,7g de fibras, 2.300mg de sódio, 15g de ferro, 322µg de ácido fólico, 232mg de vitamina C e 1.100mg de cálcio.

REFERÊNCIAS

1. Cochrane, 1972 apud Colditz GA, Gortmaker S. Cancer prevention strategies for the future: Risk identification and preventive intervention. *Milbank Quarterly* 1995;73:621-51.
2. Cowee CC, Harris MI. Physical and metabolic characteristics of persons with diabetes. In: **Diabetes in America**, 2nd ed. National Institutes of Health. NIDDK. Washington DC, USA, 1995.
3. Williamson DF, Madans J, Anda RF, Kleinman JC, Giovino GA, Byers T. Smoking cessation and severity of weight gain in a national cohort. *N Engl J Med* 1991;324:739-45.
4. Stanford BA, Sharleen M, Fell RD, Papanek P. Effects of smoking cessation on weight gain, metabolic rate, caloric consumption, and blood lipids. *Am J Clin Nutr* 1986;43:486-94.
5. Nestle M. Fruits and vegetables: protective or just fellow travelers. *Nutr Rev* 1996;54:255-7.
6. WCR/AICR – World Cancer Research Foundation/American Institute for Cancer Research. **Food, nutrition and the prevention of cancer: a global perspective**. Washington DC, USA, 1997.
7. Coelli CM. Vigilância do diabetes mellitus em uma população idosa: aplicação da metodologia de captura-recaptura (tese de doutorado, IMS-UERJ) 1998;p. 183.
8. US Department of Agriculture, US Department of Health and Human Services. **Nutrition and your health: dietary guidelines for Americans**. Washington: U.S. Government Printing Office, 3^a ed., 1990.
9. World Health Organization (WHO). Report of a Joint FAO/WHO Consultation. **Preparation and use of food-based dietary guidelines**. Geneva, 1998.
10. Alimentação equilibrada para a população brasileira. Instituto Danone. Florianópolis: Brasil, 1988.
11. Marmot MG. Coronary heart disease: rise and fall of a modern epidemic. In: Marmot MG, Elliot P, eds. **Coronary Heart Disease Epidemiology: From Aetiology to Public Health**. Oxford, Oxford University Press 1992;p. 3-19.
12. Schargrodsky H, Escobar MC, Escobar E. Cardiovascular disease prevention. *Circulation* 1998;98:2103-4.
13. Lotufo PA, Lollo CA. Tendências da evolução da mortalidade por doenças cardiovasculares: o caso do estado de São Paulo. In: Monteiro CA. **Velhos e Novos Males da Saúde no Brasil**. São Paulo: Editora Hucitec, 1995.
14. Taubes G. As obesity rates rise, experts struggle to explain why. *Science* 1998;280:1397-8.
15. Sichieri R. **Epidemiologia da Obesidade**. Rio de Janeiro: EDUERJ, 1998.
16. Barata RB, Barreto ML. Algumas questões sobre o desenvolvimento da epidemiologia na América Latina. *Ciência e Saúde Coletiva* 1996;1:70-9.
17. Expert panel on the identification, evaluation, and treatment of overweight in adults. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: Executive Summary. *Am J Clin Nutr* 1998;68:899-917.
18. Willett WC. Weight loss in the elderly: cause or effect of poor. *Am J Clin Nutr* 1997;66:737-8.
19. Stevens J, Cai J, Elsie RP, Williamson DF, Thun MJ, Wood JL. The effect of age on the association between body mass index and mortality. *N Engl J Med* 1998;338:1-7.
20. Thompson JL, Gylfadottir, Moynihan, Jensen CD, Butterfield GE. Effects of diet and exercise on energy expenditure in postmenopausal women. *Am J Clin Nutr* 1997;66:867-73.
21. Thompson JL, Manore MM, Thomas JR. Effects of diet and diet-plus-exercise programs on resting metabolic rates: a meta analysis. *Int J Sport Nutr* 1996;6:41-6.
22. Fonseca VM, Sichieri R, Veiga GV. Fatores associados à obesidade em adolescentes. *Rev Saúde Pública* 1998;32:541-9.
23. World Health Organization (WHO) - Report of a consultation group on obesity. **Preventing and managing the global epidemic**. Geneva, 1998.
24. Sichieri R, Veiga GV. Obesidade na adolescência. In: **Juventude, Saúde e Desenvolvimento**. Ministério da Saúde, Brasil, 1999.pp:269-75.
25. Bray GA, Popkin BM. Dietary fat intake does affect obesity? *Am J Clin Nutr* 1998;68:1157-73.
26. Willett WC. Dietary fat and obesity: an unconvincing relation. *Am J Clin Nutr* 1998;68:1149-50.
27. Willett WC. Nutritional Epidemiology. In: **Modern Epidemiology**. USA: Lippincott-Raven Publishers, 2^a ed, 1998;p. 623-42.
28. Mendez MHM, Derivi SCN, Rodrigues MCR, Fernandes ML. **Tabela de Composição de Alimentos**. Rio de Janeiro: EDUFF, 1992.
29. Hathcock JN. Vitamins and minerals: efficacy and safety. *Am J Clin Nutr* 1997;66:427-37.
30. Bronstrup A, Hages M, Prinz-Langenohl R, Pietrzik K. Effects of folic acid and combinations of folic acid and vitamin B-12 on plasma homocysteine concentration in healthy, young women. *Am J Clin Nutr* 1998;68:1104-10.
31. Pennington JAT. **Food Values of portions commonly used**. New York: Harper & Row Publishers, 15^a ed, 1989.
32. Herbert VD, Colman N. Folic acid and vitamin B12. In: Shils ME, Young VR, eds. **Modern Nutrition in Health and Disease**. Philadelphia: Lea & Febiger, 7^a ed, 1988.
33. Levine M, Rumsey SC, Daruwala R. Criteria and recommendations for vitamin C intake. *JAMA* 1999;281:1415-23.
34. Ausman LM. Recommendations for Vitamin C intake. *Nutr Rev* 1999;57:222-9.
35. The sixth report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure. **National Institutes of Health**, NIH Publication, 1997.
36. Block AS, Shils ME. **Nutrition Facts Manual: a Quick Reference**. USA: Williams & Wilkins, 1996.
37. Jackman LA, Millane S, Martin BR, Wood OB, McCabe GP, Peacock M, et al. Calcium retention in relation to calcium intake and postmenarcheal age in adolescent females. *Am J Clin Nutr* 1997;66:327-33.

Endereço para correspondência:

Rosely Sichieri
Instituto de Medicina Social - UERJ
Av. São Francisco Xavier 524, 7o andar
20551-030 Rio de Janeiro, RJ
Fax: (21) 264-1142
e-mail: sichieri@uerj.br



Breve história da Tabela Periódica

Apesar dos poucos conhecimentos de Química que cada um possa ter, com certeza que já ouviu falar da Tabela Periódica, uma disposição sistemática dos elementos químicos em função das suas propriedades. Como surgiu a Tabela Periódica actual? É a esta pergunta que se procura responder nas linhas seguintes onde se pretende fazer uma *Breve História da Tabela Periódica*.

Um pré-requisito necessário para construção da Tabela Periódica foi a descoberta individual dos elementos químicos. Embora vários elementos fossem conhecidos desde a antiguidade, nomeadamente o ouro, a prata, o estanho, o ferro e o cobre, a primeira descoberta dita científica de um elemento ocorreu em 1669 quando o alquimista Henning Brand descobriu o fósforo. A partir daí, muitos outros elementos foram sendo descobertos e o conhecimento relativo às suas propriedades físicas e químicas foi aumentando. Antes de 1800 eram conhecidos 34% dos elementos actualmente existentes, no século XIX a percentagem aumentou para cerca de 75% e no século XX descobriram-se os seguintes. Através da percepção da existência de algumas regularidades no comportamento dos elementos até então descobertos, os cientistas começaram a procurar modelos para reconhecer as suas propriedades e desenvolver esquemas para a sua classificação e ordenação.

A ordenação de John Dalton

No início do séc. XIX John Dalton, um químico e físico inglês, listou os elementos, cujas massas atómicas eram conhecidas, por ordem crescente de massa atómica, cada um com as suas propriedades e seus compostos. Não houve uma tentativa de efectuar qualquer arranjo ou modelo periódico dos elementos. Facilmente se constatou que a lista não era esclarecedora: vários elementos que tinham propriedades semelhantes (halogéneos, por exemplo) tinham as suas massas atómicas muito separadas.



John Dalton
(1766-1844)

ELEMENTS	
Hydrogen	1
Carbon	5
Oxygen	7
Phosphorus	31
Sulphur	32
Magnesium	24
Iron	56
Zinc	65
Copper	63
Lead	207
Silver	197
Gold	197
Platina	197
Mercury	200

Símbolos químicos de Dalton

As tríades de Johann W. Döbereiner

Em 1829, Johann W. Döbereiner, professor de Química na Universidade Friedrich Schiller de Jena (Alemanha), teve a ideia de agrupar os elementos em três, ou *tríades*. As tríades estavam separadas também pelas massas atômicas, mas com propriedades químicas muito semelhantes. A massa atômica do elemento central da tríade seria supostamente a média das massas atômicas do primeiro e terceiro elementos. Esta ideia tornou-se relativamente popular nessa época. No entanto, nos 30 anos seguintes, vários cientistas constataram que, para vários elementos, estes tipos de relações químicas se estendiam para além da tríade. Infelizmente, a investigação nesta área foi prejudicada pelo facto dos valores rigorosos das massas atômicas nem sempre serem conhecidos.



Johann W. Döbereiner
(1780-1849)

			Intensity of Chemical Affinity
$22.1.325 = \text{Cl}$	$455.129 = \text{HCl}$	$942.650 = \text{Cl}$	3
$789.145 = \text{I}$	$1590.770 = \text{HI}$	$2078.290 = \text{I}$	1
$\frac{1010.470}{2} = \text{Br}$	$\frac{2045.899}{2} = \text{HBr}$	$\frac{3020.940}{2} = \text{Br}$	2

Lei das Tríades de Döbereiner

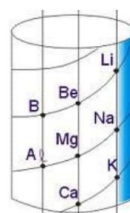
O cilindro (ou parafuso telúrico) de Chancourtois

O primeiro esboço de periodicidade dos elementos deve-se provavelmente ao geólogo francês Alexander Emile Beguyer de Chancourtois. Em 1862 Chancourtois propõe uma classificação dos elementos pela sua disposição na superfície de um cilindro. Os elementos dispunham-se sobre uma linha diagonal formando um ângulo de 45° com a horizontal,

desenhando uma espiral e estavam ordenados por ordem crescente de massa atômica (em números inteiros) de forma que os que tinham propriedades semelhantes se situavam na mesma linha vertical. Assim, deu-se conta que as propriedades dos elementos eram uma função da sua massa atômica o que o levou a propor que "as propriedades dos elementos são as propriedades dos números." De Chancourtois foi o primeiro a reconhecer que propriedades semelhantes reaparecem a cada sete elementos e usando este esquema foi capaz de prever a estequiometria de vários óxidos metálicos. Infelizmente, o sistema era complexo pois incluía também compostos. A sua proposta não foi muito conhecida e divulgada porque o esquema era relativamente complexo.



Alexander de Chancourtois
(1820-1886)



Cilindro de Chancourtois

Lei das Oitavas de Newlands

Em 1863, John Alexander Reina Newlands, químico industrial inglês e professor de química no City College em Londres ordenou os elementos por ordem crescente de massa atômica e constatou que um dado elemento apresentava propriedades semelhantes ao oitavo elemento a contar a partir dele. A esta relação Newlands chamou a "Lei das Oitavas", que dizia ser uma espécie de repetição por analogia com as oitavas da escala musical (Dó, Ré, Mi, Fá, Sol, Lá, Si,...Dó,...). O principal problema com que Newlands se deparou foi o de que a sua lei apenas funcionava correctamente para as duas primeiras oitavas, na terceira e nas seguintes não se verificava. Apesar de ter sido ridicularizado pela Sociedade de Química de Londres, Newlands sugere, com a Lei das Oitavas, uma classificação sistemática onde começa a surgir o princípio envolvido na actual classificação dos elementos.



John Newlands
(1837-1898)

H	Li	Ga	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru
Pd	Ag	Cd	U	Sn	Sb	Te
I	Cs	Ba, V	Ta	W	Nb	Au
Pt, Ir	Tl	Pb	Th	Hg	Bi	Th

Lei das Oitavas de Newlands

Tabela de Lothar Meyer e Mendeleev

Em 1864 Julius Lothar Meyer, químico alemão, estudou a relação existente entre o volume atômico dos elementos e as respectivas massas atômicas. Representou graficamente o volume atômico em função da massa atômica relativa e, através da curva obtida, conseguiu agrupar vários elementos em famílias. Chegou assim a uma classificação periódica dos elementos que tinham propriedades semelhantes, um esboço da tabela periódica actual. Mais ou menos por essa altura, Dimitri Ivanovitch Mendeleev, químico Russo, enquanto escrevia um livro de química inorgânica, também procurou organizar os elementos de acordo com as suas propriedades. Mendeleev criou uma carta para cada um dos elementos conhecidos. Cada carta continha o símbolo do elemento, a massa atômica e as suas propriedades químicas e físicas. Colocando as cartas numa mesa, organizou-as por ordem crescente das suas massas atômicas, agrupando-as em elementos com propriedades semelhantes, ou seja, listou os elementos de uma linha ou coluna por ordem de massa atômica, iniciando uma nova linha ou coluna quando as propriedades dos elementos se começavam a repetir. Formou-se assim, tal como obtido por Lothar Meyer, o esboço da tabela periódica actual. A vantagem da tabela periódica de Mendeleev sobre outras é que esta exibía semelhanças, não apenas em pequenos conjuntos, como as tríades. Mostravam semelhanças numa rede de relações vertical, horizontal e diagonal. Uma das razões para o sucesso da tabela foi o de deixar lacunas quando parecia que o elemento correspondente ainda não tinha sido descoberto. A partir daqui, Mendeleev conseguiu prever algumas propriedades de elementos químicos que ainda não haviam sido descobertos na sua época. Outra razão foi ocasionalmente ignorar a ordem sugerida pelas massas atômicas e alternar alguns elementos adjacentes para melhor classificá-los em famílias químicas. Com o

desenvolvimento das teorias da estrutura atómica verificou-se à posteriori que Mendeleev tinha, inadvertidamente, ordenados os elementos por ordem crescente de número atómico. O trabalho de Mendeleev foi amplamente aceite, sendo assim considerado o pai da tabela periódica actual. No entanto, de forma justa, tanto ele quanto Lothar Meyer deveriam ser considerados os verdadeiros pais da actual classificação periódica. O azar de Meyer foi que em 1868 construiu uma tabela alargada dos elementos e entregou a um colega para avaliação. Enquanto isso, Mendeleev deu a conhecer a sua tabela à comunidade científica através de publicação em 1869, enquanto que a de Meyer veio a conhecimento apenas em 1870. Azar...

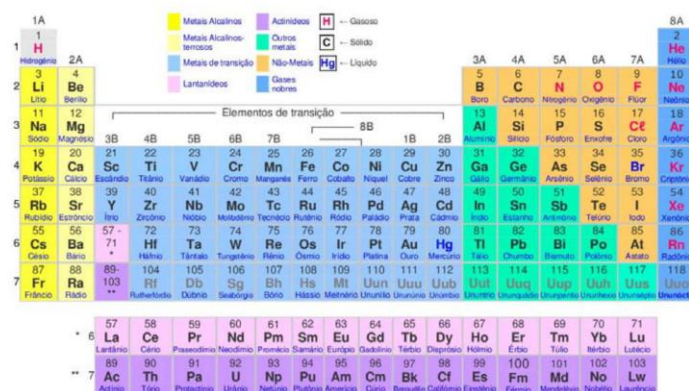
Tabela dos elementos de J. L. Meyer

Tabela dos elementos de Mendeleev

Embora a tabela de Mendeleev/Meyer tenha demonstrado a natureza periódica dos elementos, apenas no séc. XX foram encontradas explicações para as razões das propriedades dos elementos variarem periodicamente.

O desenvolvimento, nomeadamente dos modelos atómicos e teoria quântica, permitiram racionalizar o conhecimento das propriedades dos elementos e chegar à configuração da actual tabela periódica. Esta foi ampliada ao longo do tempo, à medida que novos

elementos foram sendo descobertos. A tabela actual contém 118 elementos, dispostos em linhas horizontais (períodos) e verticais (grupos), por ordem crescente de número atómico. As linhas horizontais são dispostas de modo que os elementos com propriedades semelhantes fiquem nas mesmas colunas (grupos ou famílias). O grupo é considerado o mais importante método de classificar os elementos. Em alguns grupos, os elementos têm propriedades muito semelhantes e exibem uma tendência clara nas propriedades ao longo do grupo. A estes grupos foram dados nomes triviais, por exemplo, os metais alcalinos, metais alcalinos terrosos, halogénios, gases nobres, etc.. Alguns outros grupos na tabela periódica mostram menor grau de semelhanças/tendências verticais e são referidos simplesmente pelo seu número de grupo. Embora os grupos sejam a forma mais comum de classificação de elementos, existem zonas da tabela periódica onde as tendências horizontais e semelhanças nas propriedades são mais significativas do que as tendências verticais. Na Tabela Periódica, cada elemento é apresentado, nomeadamente, com o seu símbolo e número atómico. Muitas versões da tabela apresentam também outras propriedades atómicas e propriedades físicas.



A Tabela Periódica actual

Ao longo do séc. XX foram aparecendo representações alternativas da Tabela Periódica, principalmente por razões didácticas. No entanto, a Tabela Periódica “tradicional” que é a que conhecemos mantém-se como a representação aceite da disposição sistemática dos elementos químicos em função das suas propriedades.

A tabela periódica é agora omnipresente fornecendo um enquadramento útil para classificar, sistematizar e comparar as muitas formas diferentes de comportamento químico. A tabela tem encontrado muitas aplicações em química, física, biologia, engenharia e ciência dos materiais.

Paulo Mendes

Prof. Auxiliar do Departamento de Química

Escola de Ciências e Tecnologia

Centro de Química de Évora

ANNEX M. Summary and participation of the Event

**UTILIZAÇÃO DE TEXTOS DE DIVULGAÇÃO CIENTÍFICA COMO RECURSO DIDÁTICO NO ENSINO DE QUÍMICA**

III Congresso Online Nacional de Química, 3ª edição, de 29/03/2021 a 01/04/2021
ISBN dos Anais: 978-65-86861-93-8

JÚNIOR; Hélio Nascimento da Paixão ¹, PESSOA; Wilton Rabelo ², COSTA; Josineide Pantoja da ³

RESUMO

UTILIZAÇÃO DE TEXTOS DE DIVULGAÇÃO CIENTÍFICA COMO RECURSO DIDÁTICO NO ENSINO DE QUÍMICA (Ensino de Química) O estudo da Química pode ampliar a visão dos estudantes sobre seu universo de vivências, ao mesmo tempo em que considerar tais contextos pode facilitar a compreensão desta ciência. No entanto, percebemos que ainda existe uma resistência ao seu estudo por parte dos alunos, principalmente ao deparar-se com método tradicional de ensino, no formato passivo e transmissivo, que privilegia nomenclaturas, fórmulas e cálculos como aborda Vasconcellos (2005). O presente trabalho propõe apresentar e discutir contribuições da interação entre mediação de leitura e ensino de química, já que a utilização dos textos de divulgação científica (TDC) como recurso didático pode ser considerada um meio facilitador da aprendizagem. Pesquisas como as de Francisco Júnior, Ferreira e Hartwig (2010) e Brabo e Souza (2019) defende a integração da leitura, escrita e oralidade como forma de fomentar a aprendizagem e as competências necessárias da atual conjuntura social, econômica e política. Na percepção de Zismann et al, (2019), o emprego de TDC em sala de aula aproxima o aluno do mundo da ciência, pois oportuniza aos estudantes um contato com informações atualizadas sobre ciência e tecnologia, com acontecimentos de seu cotidiano, trazendo ainda aspectos curiosos, interessantes e divertidos, proporcionando uma outra maneira de ver a temida Química. Nesse contexto, a presente pesquisa tem como objetivo propor a mediação de leitura como recurso didático no ensino da Química, por meio da literatura científica, com o uso de textos de divulgação científica – TDC, com intuito de promover e melhorar a construção do conhecimento científico em sala de aula na educação básica. Partimos da ideia que, despertar a curiosidade pela busca de novas informações, motiva o aluno a se envolver em sua aprendizagem, por isso, é importante promover sua apropriação desde o ensino básico, com o uso da linguagem científica no processo de ensino e aprendizagem da Química. A metodologia deste estudo consiste na mediação de leitura de TDC utilizada como veículo de aprendizagem aos estudantes do primeiro ano do ensino médio, de uma Escola da Rede Pública de Ensino da Ilha de Mosqueiro/PA e, sobretudo, como forma de auxiliar os estudantes a pensar e se posicionar criticamente diante da sociedade, frente a um contexto. O presente estudo identificou elementos fundamentais para melhoria do processo de ensino-aprendizagem da disciplina de Química, no que versa a leitura de TDC como recurso metodológico. Nesta pesquisa apresentamos resultados prévios que sugerem que os estudantes

participantes do estudo, tiveram pouco ou nenhum contato com TDC. As atividades desenvolvidas no decorrer desta investigação constituíram o primeiro contato com esse gênero de leitura para grande maioria dos alunos, expondo a necessidade de se promover mais atividades, voltadas para leitura e escrita científica concernente ao Ensino da Química. Em síntese, essa interação estabelecida entre leitor e texto científico pode contribuir para tornar a aprendizagem mais efetiva, o que torna relevante a continuidade deste e outros estudos com essa abordagem. **Palavras-chave:** mediação de leitura, ensino da química, formação cidadã.

PALAVRAS-CHAVE: Mediação de Leitura, Ensino de Química, Formação Cidadã

FROM BENCH TO BEDSIDE: HOW TRANSLATIONAL RESEARCH HAS CONTRIBUTED TO THE TREATMENT OF PANCREATIC CANCER

DA BANCADA AO LEITO: COMO AS PESQUISAS TRANSLACIONAIS TÊM CONTRIBUÍDO PARA O TRATAMENTO DO CÂNCER DE PÂNCREAS

DE LA BANCADA A LA CABECERA DEL PACIENTE: CÓMO LA INVESTIGACIÓN TRASLACIONAL HA CONTRIBUIDO AL TRATAMIENTO DEL CÁNCER DE PÁNCREAS



<https://doi.org/10.56238/sevened2026.008-150>

Karla Laíssa Silva de Oliveira¹, Daniel Dias Machado², Matheus Albuquerque Athayde da Silva³

ABSTRACT

This study explores the intersection between translational research and the treatment of pancreatic cancer, a neoplasm with a challenging prognosis. The investigation is justified by the need to convert basic scientific discoveries into effective clinical applications, aiming to improve currently available therapeutic strategies. The main objective is to analyze the contributions of translational research to advances in the management of pancreatic cancer, from molecular understanding to the implementation of new approaches at the patient's bedside. The methodology adopts a bibliographic approach, of a basic nature and exploratory objective, based on a review of recent scientific literature from specialized databases. The results indicate that translational research drives the development of targeted therapies, immunotherapies, and biomarkers, enabling precision medicine. The conclusions highlight translational research as a fundamental pillar in overcoming therapeutic challenges, promoting treatment personalization and improving patients' quality of life.

Keywords: Translational Research. Pancreatic Cancer. Precision Oncology. Evidence-Based Medicine.

RESUMO

Este estudo explora a interseção entre a pesquisa translacional e o tratamento do câncer de pâncreas, uma neoplasia com prognóstico desafiador. A investigação justifica-se pela necessidade de converter descobertas científicas básicas em aplicações clínicas eficazes, visando aprimorar as estratégias terapêuticas disponíveis. O objetivo principal consiste em analisar as contribuições da pesquisa translacional para o avanço no manejo do câncer de pâncreas, desde a compreensão molecular até a implementação de novas abordagens no leito do paciente. A metodologia emprega uma abordagem bibliográfica, de natureza básica e objetivo exploratório, com levantamento de literatura científica recente em bases de dados especializadas. Os resultados indicam que a pesquisa translacional impulsiona o desenvolvimento de terapias-alvo, imunoterapias e biomarcadores, permitindo uma medicina de precisão. As conclusões apontam para a pesquisa translacional como um pilar

¹ Specialist in Blood Bank and Clinical Hematology. Lattes: <http://lattes.cnpq.br/6215836882408656>

² Biomedical Scientist and Oral Surgeon Sedationist.

³ Medical Doctor. Lattes: <http://lattes.cnpq.br/3633578904160098>

fundamental na superação dos obstáculos terapêuticos, promovendo a personalização do tratamento e a melhoria da qualidade de vida dos pacientes.

Palavras-chave: Pesquisa Translacional. Câncer de Pâncreas. Oncologia de Precisão. Medicina Baseada em Evidências.

RESUMEN

Este estudio explora la intersección entre la investigación traslacional y el tratamiento del cáncer de páncreas, una neoplasia con pronóstico desafiante. La investigación se justifica por la necesidad de convertir los descubrimientos científicos básicos en aplicaciones clínicas eficaces, con el objetivo de mejorar las estrategias terapéuticas disponibles. El objetivo principal consiste en analizar las contribuciones de la investigación traslacional para el avance en el manejo del cáncer de páncreas, desde la comprensión molecular hasta la implementación de nuevos enfoques en la atención del paciente. La metodología emplea un enfoque bibliográfico, de naturaleza básica y objetivo exploratorio, mediante la revisión de literatura científica reciente en bases de datos especializadas. Los resultados indican que la investigación traslacional impulsa el desarrollo de terapias dirigidas, inmunoterapias y biomarcadores, permitiendo la medicina de precisión. Las conclusiones señalan a la investigación traslacional como un pilar fundamental para superar los obstáculos terapéuticos, promoviendo la personalización del tratamiento y la mejora de la calidad de vida de los pacientes.

Palabras clave: Investigación Traslacional. Cáncer de Páncreas. Oncología de Precisión. Medicina Basada en la Evidencia.

1 INTRODUCTION

Pancreatic cancer represents one of the most aggressive and lethal neoplasms, characterized by a late diagnosis and limited therapeutic options. The disease has a considerably low five-year survival rate, which positions it as a persistent challenge for contemporary oncology. The biological complexity of the tumor, its anatomical location, and the resistance inherent to conventional treatments contribute to this unfavorable scenario. In-depth understanding of the molecular mechanisms underlying pancreatic carcinogenesis thus becomes a priority for the development of more effective interventions.

Translational research emerges as a bridge between the discoveries made on the laboratory bench and their practical application in the clinical context. This field of study focuses on transforming basic scientific knowledge into tangible solutions for human health, accelerating the process of developing new diagnostics, therapies, and prevention strategies. In the case of pancreatic cancer, translational research seeks to unravel the genetic and molecular particularities of the tumor, identifying therapeutic targets and biomarkers that can guide clinical decisions.

The research problem lies in the gap between accumulated knowledge about the biology of pancreatic cancer and the effectiveness of available treatments. Despite advances in medicine, the survival of patients with this condition has remained stagnant for decades, highlighting the need for innovative approaches. Tumor heterogeneity and the complex microenvironment of the pancreas make it difficult to respond to standard therapies, requiring a more granular understanding of the disease to develop personalized interventions. Translational research acts directly on this gap, seeking to convert basic science into direct benefits for patients.

The relevance of this study lies in the urgency of improving the treatment of pancreatic cancer, since the disease continues to be one of the leading causes of cancer mortality globally. The analysis of the contributions of translational research offers *insights* into strategies that demonstrate potential to change the prognosis of the disease. Understanding how scientific discoveries translate into clinical innovations allows you to optimize research resources and direct efforts to areas with the highest probability of impact. The translational approach is essential to overcome the barriers that prevent therapeutic advancement.

Abe *et al.* (2021, p. 1785) highlight the importance of investigating the genetic basis of the disease, stating that "understanding the genetics of hereditary pancreatic cancer is fundamental for the identification of high-risk individuals and for the development of prevention and early detection strategies". This perspective reinforces the need for an approach that integrates basic research with clinical application. The identification of specific

genetic mutations, for example, can guide the selection of targeted therapies, personalizing treatment for each patient.

Bernardes and Toledo-Silva (2023, p. 2) complement this view by noting that "whole exome sequencing has proven to be a valuable tool in the diagnosis of pancreatic ductal adenocarcinoma, revealing genetic profiles that can influence the therapeutic response". The application of advanced genetic sequencing technologies in clinical practice is a direct example of translational research in action. These advances allow for detailed molecular characterization of the tumor, paving the way for precision oncology.

Caban and Malecka-Panas (2023, p. 5578) highlight the "gaps and opportunities in the diagnosis and treatment of pancreatic cancer", indicating that translational research is the way to fill these gaps. The identification of novel signaling pathways, the understanding of drug resistance, and the development of biomarkers for monitoring therapeutic response are examples of areas where translational research generates impact. Collaboration between basic and clinical scientists accelerates the transition from discovery to practice.

Chaves *et al.* (2022, p. 2) warn of "the increase in the burden of pancreatic cancer in Brazil from 2000 to 2019", which underlines the urgency of finding effective solutions. This epidemiological scenario reinforces the need to invest in research that can quickly translate into public health benefits. Translational research, by focusing on clinical applicability, responds directly to this demand, seeking to reduce the morbidity and mortality associated with the disease.

The general objective of this study is to analyze the contributions of translational research to the treatment of pancreatic cancer. To achieve this objective, it is proposed: a) to describe the main advances in basic research that impact the treatment of pancreatic cancer; b) to identify the translational strategies that resulted in new therapeutic approaches; and c) to discuss the challenges and future perspectives of translational research in pancreatic oncology.

This work is structured in five main sections. The introduction introduces the topic, contextualizes the problem, justifies the relevance, and sets out the objectives. The theoretical framework explores the fundamental concepts of translational research and pancreatic cancer biology. The methodology details the procedures for data collection and analysis. The results and discussion section presents the findings of the research and interprets them in the light of the literature. Finally, the final considerations summarize the conclusions, point out the limitations and suggest future studies.

2 METHODOLOGY

This study adopts a methodological approach of a basic nature, with an exploratory objective, and a bibliographic procedure. The bibliographic research consists of the systematic analysis of scientific literature already published, allowing an in-depth understanding of the theme "From the Bench to the Bedside: How Translational Research Has Contributed to the Treatment of Pancreatic Cancer". This type of research is suitable for mapping the state of the art, identifying knowledge gaps and consolidating information about a given phenomenon, without the need for primary data collection.

The qualitative approach is employed to interpret the data collected, focusing on the understanding of concepts, theories and advances related to translational research and pancreatic cancer. Qualitative analysis allows us to explore the complexity of the interactions between basic research and clinical application, as well as the nuances of new therapeutic approaches. This type of approach does not seek to quantify phenomena, but rather to deepen the understanding of them, through the content analysis of the selected texts.

The data sources for this study consist of scientific articles, systematic reviews, theses, and dissertations published in internationally recognized journals and databases. The databases consulted include *PubMed*, *SciELO*, *LILACS*, *Web of Science* and *Scopus*. The selection of these databases ensures comprehensive coverage of the biomedical and oncology literature, both nationally and internationally, ensuring the relevance and timeliness of the information.

The literature search period was delimited between the years 2020 and 2025, in order to focus on the most recent advances and contemporary trends in translational research in pancreatic cancer. This time window allows you to capture the innovations and discoveries that are shaping current and future treatment strategies. The constant updating of knowledge is a pillar of translational research, and the selection of a recent period reflects this dynamic.

The descriptors used in the search were "pancreatic cancer", "*translational research*", "*precision medicine*" and "*immunotherapy*". The combination of these terms, using Boolean operators such as AND and OR, allowed us to refine the search and identify publications directly related to the theme of the study. The choice of these descriptors reflects the main thematic axes addressed in the research, ensuring the specificity and relevance of the results obtained.

The inclusion criteria for the selection of articles were: publications in Portuguese or English, available in full, that addressed translational research in the context of pancreatic cancer, focusing on new therapies, biomarkers or resistance mechanisms. Studies that did not fit the search period, opinion articles without empirical or theoretical basis, and

publications that dealt with other types of cancer or basic research without translational implication were excluded.

Data analysis was carried out through thematic content analysis, which involves exhaustive reading of the selected materials, identification of recurring themes and categorization of information. This process allows synthesizing the main findings, identifying trends, and establishing connections between the different translational research contributions. Thematic analysis facilitates the interpretation of the results in the light of the theoretical framework, building a cohesive narrative.

Iwasaki *et al.* (2021) highlight the importance of advanced sampling techniques for the personalized treatment of pancreatic cancer, which reinforces the need for a methodology that contemplates the diversity of translational approaches. Bibliographic research allows the compilation and synthesis of these different techniques and their impacts.

Kaçaroğlu and Gürbüz (2025) compare the therapeutic potential of macrophage-derived exosomes or mesenchymal stem cells in pancreatic cancer, illustrating the complexity of translational investigations. The methodology used in this study allows us to integrate these findings, analyzing how they fit into the overall panorama of contributions to treatment.

Nassereldine *et al.* (2022) conducted a literature review on pancreatic cancer in the MENA region, demonstrating the relevance of studies that map scientific production. The present methodology, by focusing on the literature review, is aligned with this perspective of organization and synthesis of existing knowledge.

Ethical aspects are considered, since it is a bibliographic research, not involving human beings directly. Therefore, submission to a Research Ethics Committee (REC) is waived. However, rigor in the citation of sources and respect for intellectual authorship are fundamental ethical precepts followed in this work. Transparency in the presentation of data and impartiality in interpretation are also observed.

The methodological limitations of this study include the dependence on the quality and availability of published literature. Bibliographic research, by its nature, does not allow the generation of primary data or the performance of interventions. The interpretation of the findings is subject to the subjectivity of the researcher in the content analysis, although maximum objectivity is sought. The breadth of descriptors can sometimes limit the identification of studies with less conventional terminology.

Despite the limitations, the methodology employed offers a solid basis for understanding the contributions of translational research in the treatment of pancreatic cancer. The combination of a qualitative approach with a systematic bibliographic procedure

allows for an in-depth and up-to-date analysis of the topic, consolidating existing knowledge and pointing to future directions of research and clinical application.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
Silva, J.	Use of persistent identifiers and Research Blogging by scientific blogs in Portuguese and their coverage by Altmetric	2020	It analyzes how scientific blogs in Portuguese use persistent identifiers and are tracked by Altmetric, contributing to understand alternative metrics and visibility of scientific production.
Taniguchi, F.	Implementation of the Good Practices in Cardiology Program adapted from Get With The Guidelines® in Brazilian hospitals: study design and rationale	2020	It describes the design and foundation of a program of good practices in cardiology in Brazilian hospitals, illustrating how international protocols are adapted and evaluated locally.
Giordano, V.	Brazilian authors do not cite Brazilian authors: nothing has changed since 1994	2021	It investigates citation patterns in Brazilian orthopedics, evidencing low self-citation of national authors and discussing dependence on foreign references and their impacts.
Gomes, M.	"Dr. Google, I need to lose weight" – Brazilian internet searches associated with weight loss during the COVID-19 pandemic: a retrospective analysis of Google Trends data	2021	It analyzes Google searches related to weight loss during the pandemic, showing how interest in health manifests itself in digital environments and can guide health surveillance.
Luz-Freitas, M.	Leprosy: a successful case of terminological intervention?	2021	It discusses, through linguistics, the terminological change in leprosy and its effects on stigma and health communication, exemplifying the role of language in public policies.
Rezende, M.	Use of ontologies in the assessment of cybersecurity in the Internet of Things: a systematic literature review	2021	It reviews the use of ontologies in the assessment of cybersecurity in IoT, pointing out conceptual models and gaps for future research in the area of information security.
Santos-d'Amorim, K.	Science communication on the go	2021	It addresses transformations in scholarly communication, discussing open access, new formats and challenges for the dissemination of science in digital contexts.
Werle, T.	Research Data Management: A Challenge for Graduate Nursing Programs	2021	It analyzes how graduate programs in Nursing deal with research data management, pointing out challenges of organization, preservation and sharing.
Zarili, T.	Delphi technique in the validation process of the Primary Care Evaluation Questionnaire (QualiAB) for national application	2021	It describes the use of the Delphi technique in the validation of QualiAB, contributing methodologically to studies of construction and validation of health instruments.
Achievement, T.	The practice of disclosure as a strategy for patient safety in Brazil and its relevance to the health care of the elderly	2022	It discusses the disclosure of adverse events as a patient safety strategy, with a focus on older people, and its ethical and care implications.
Frossard, M.	Educational evaluation in teacher training: analysis of publishers, journals and articles	2022	It maps the production on educational evaluation in teacher training, characterizing publishers, journals and topics addressed, which helps to understand the field of research.

Nunes, H.	Bioethical challenges of using artificial intelligence in hospitals	2022	It analyzes bioethical dilemmas arising from the use of AI in hospitals, addressing autonomy, responsibility, privacy, and justice in health care.
Pinheiro, J.	Editorial policy and scientific controversy in Agrarian Studies	2022	It examines how editorial policies deal with controversies in agrarian studies, discussing theoretical plurality, conflicts and the role of scientific journals.
Borges, M.	Challenges of Brazilian legislation in relation to cybercrimes: an analysis of current deficiencies	2024	It analyzes gaps in Brazilian legislation regarding cybercrime, discussing regulatory challenges and the need for regulatory updating.
Faust, I.	Tecnolivro: an innovative approach integrating AI with Microsoft Office for remote education in systems analysis and development	2024	It presents a proposal for an educational resource that integrates AI with Microsoft Office to support remote teaching in systems analysis and development courses.
Heringer, T.	A decade of peer review: in search of equity and diversity	2024	It reflects on ten years of peer review practices, discussing inequalities, bias, and paths to greater equity and diversity in the editorial process.
Rabin, E.	Misscare Instrument: Evaluation of Mobile Software for Nursing	2024	It evaluates a mobile software based on the Misscare instrument to support nursing practice, highlighting usability and potential to monitor omitted care.
Seghier, M.	AI-powered peer review needs human supervision	2024	It argues that while AI can support peer review, human oversight remains essential to ensure quality, ethics, and contextualization.
Vicente, A.	Ethics as Fuel for Scientific Advancement: Public Concern for Animals and Their Influence on the Scientific Community	2024	It discusses how public concern about the use of animals in research influences scientific practices and ethical regulations, articulating science and society.
Silva, J.	Use of persistent identifiers and Research Blogging by scientific blogs in Portuguese and their coverage by Altmetric	2020	It analyzes how scientific blogs in Portuguese use persistent identifiers and are tracked by Altmetric, contributing to understand alternative metrics and visibility of scientific production.
Taniguchi, F.	Implementation of the Good Practices in Cardiology Program adapted from Get With The Guidelines® in Brazilian hospitals: study design and rationale	2020	It describes the design and foundation of a program of good practices in cardiology in Brazilian hospitals, illustrating how international protocols are adapted and evaluated locally.
Giordano, V.	Brazilian authors do not cite Brazilian authors: nothing has changed since 1994	2021	It investigates citation patterns in Brazilian orthopedics, evidencing low self-citation of national authors and discussing dependence on foreign references and their impacts.
Gomes, M.	"Dr. Google, I need to lose weight" – Brazilian internet searches associated with weight loss during the COVID-19 pandemic: a retrospective analysis of Google Trends data	2021	It analyzes Google searches related to weight loss during the pandemic, showing how interest in health manifests itself in digital environments and can guide health surveillance.

Source: Author's own elaboration (2026).

The table above brings together, in temporal sequence, studies that deal with scholarly communication, peer review, open science, ethics, bioethics, cybersecurity, use of AI, data management, and quality indicators in health and research. By articulating productions from different areas (health, education, information, law, technology) around common themes such

as transparency, responsibility, reliability, and the social impact of science, it offers an integrated view of contemporary transformations in scientific practice and technological regulation. Thus, the framework contributes to the research by providing an organized bibliographic base to critically discuss challenges and possibilities in the practices of research, publication, evaluation and use of emerging technologies.

3 THEORETICAL FRAMEWORK

Translational research represents a paradigm in biomedical science, aiming to accelerate the application of basic scientific discoveries in benefits for human health. This field covers a spectrum from the bench to the bedside, and extends to the community. Its essence lies in overcoming the barriers that historically separate fundamental research from clinical practice, promoting a continuous flow of knowledge and innovation. Translational research is not limited to a single track; It also incorporates clinical observation to generate new basic research questions, creating a virtuous cycle of learning and development.

Pancreatic cancer, specifically pancreatic ductal adenocarcinoma (PDACP), is a disease with unique biological characteristics that make treatment difficult. The presence of a dense stroma, tumor heterogeneity, and the capacity for early metastasis are factors that contribute to its aggressiveness. Understanding these particularities is essential for the development of more effective therapies. Translational research works in the identification of specific molecular targets, in the characterization of the tumor microenvironment, and in the search for biomarkers that allow early detection and monitoring of response to treatment.

Precision oncology, one of the pillars of translational research, seeks to personalize cancer treatment based on the individual genetic and molecular characteristics of each patient's tumor. Froeling *et al.* (2021, p. 150) state that "molecular subtyping and precision medicine for pancreatic cancer are promising approaches to overcome therapeutic resistance". This approach allows the selection of targeted therapies that act on specific signaling pathways, minimizing side effects and maximizing efficacy. The identification of mutations in genes such as *KRAS*, *TP53*, *SMAD4* and *CDKN2A* guides the choice of drugs.

Biomarker development is another area where translational research plays a key role. Biomarkers are biological indicators that can be used to diagnose the disease, predict response to treatment, or monitor tumor progression. In pancreatic cancer, the search for non-invasive biomarkers for early detection is a priority, given the asymptomatic nature of the disease in its early stages. Translational research explores everything from circulating biomarkers, such as circulating tumor DNA (*ctDNA*) and exosomes, to advanced imaging markers.

Immunotherapy, which aims to stimulate the patient's immune system to fight cancer, represents a breakthrough in oncology. However, pancreatic cancer has been shown to be resistant to many of the immunotherapies currently available, due to its immunosuppressive tumor microenvironment. Translational research investigates strategies to overcome this resistance, such as combining immunotherapies with chemotherapy or radiotherapy, and the development of new approaches that modulate the tumor microenvironment. Understanding the interactions between tumor cells and immune cells is a central focus.

Chiaro *et al.* (2023, p. 3) highlight the "advances in the management of pancreatic cancer", which include new surgical, chemotherapy, and radiotherapy strategies, in addition to targeted therapies and immunotherapies. Translational research integrates all these modalities, seeking combinations that optimize outcomes for patients. Collaboration between surgeons, clinical oncologists, radiation therapists, and basic scientists is critical to the success of these integrated approaches.

Translational research also addresses drug resistance, one of the main obstacles in the treatment of pancreatic cancer. The ability of tumor cells to develop mechanisms for evading therapies is a constant challenge. This field of study investigates the molecular mechanisms of resistance, seeking to identify new strategies to overcome it. This includes the development of drugs that act on alternative signaling pathways or the combination of different therapeutic agents to avoid the selection of resistant clones.

Multidisciplinary collaboration is a pillar of translational research. Basic scientists, clinical physicians, pathologists, radiologists, and biostatisticians work together to translate scientific discoveries into clinical applications. Concannon *et al.* (2025, p. 2) review "stakeholder engagement in early-stage translational research," underlining the importance of engaging patients, caregivers, and policymakers from the earliest phases of research. This engagement ensures that research is relevant to patients' needs and that the results are implemented effectively.

Preclinical modeling, which uses cellular and animal models to simulate human disease, is a valuable tool in translational research. Models of organoids, patient-derived xenografts (*PDX*), and genetically modified models make it possible to test the efficacy of new therapies and investigate disease mechanisms in a controlled setting. These models are essential for the screening of new drugs and for the identification of predictive biomarkers of response. Validating these models is a critical step before transitioning to clinical trials.

Translational research is also concerned with the implementation of new therapies in clinical practice. This involves not only demonstrating efficacy and safety in clinical trials, but also assessing cost-effectiveness, educating healthcare professionals, and overcoming

regulatory barriers. The dissemination of knowledge and the adoption of new evidence-based practices are essential components for bench findings to actually reach the patient's bedside. Implementation research, a subfield of translational research, focuses on these aspects.

Genomics and proteomics, which study the full set of genes and proteins, respectively, provide a wealth of information about the biology of pancreatic cancer. Translational research utilizes these technologies to identify molecular signatures that can predict response to specific treatments or indicate the risk of recurrence. Large-scale data analysis, combined with bioinformatics approaches, allows the discovery of new therapeutic targets and patient stratification.

Translational research in pancreatic cancer is a dynamic field that integrates diverse disciplines to address one of the greatest challenges in oncology. By focusing on the clinical application of scientific findings, it drives the development of more accurate diagnoses, more effective therapies, and personalized approaches, offering hope for patients with this devastating disease. Continuous innovation in this field is critical to transforming the prognosis of pancreatic cancer.

4 RESULTS AND DISCUSSION

The analysis of the literature reveals that translational research has transformed the panorama of pancreatic cancer treatment, driving advances from molecular understanding to clinical application. The results obtained demonstrate that the integration between basic science and clinical medicine is fundamental to overcome the challenges posed by this aggressive neoplasm. The identification of molecular targets, the development of new therapies, and the optimization of diagnostic and monitoring strategies represent the main contributions.

One of the most notable advances lies in the molecular characterization of pancreatic cancer. Translational research allowed the identification of recurrent genetic mutations, such as those in the *KRAS* gene, which occur in a high percentage of tumors. Although *KRAS* has historically been considered an "indrogradable" target, translational research has explored new approaches to inhibit its activity or downstream signaling pathways. Understanding tumor heterogeneity and clonal evolution also guides the development of more effective therapies.

The development of targeted therapies represents a direct contribution of translational research. Pothula *et al.* (2020) investigated the HGF/c-MET axis in pancreatic cancer, suggesting that inhibition of this pathway may be a promising therapeutic strategy. The identification of specific targets allows the development of drugs that act selectively on tumor

cells, minimizing adverse effects on healthy tissues. This approach contrasts with conventional chemotherapy, which has a broader toxicity profile.

Immunotherapy, although challenging in pancreatic cancer due to the immunosuppressive tumor microenvironment, has been the subject of intense translational research. Wang *et al.* (2024) offer a single-cell perspective on immunotherapy for pancreatic cancer, highlighting the complexity of immune interactions. The studies seek to modulate the tumor microenvironment to make it more responsive to immunotherapy, through combinations with chemotherapy, radiotherapy, or other targeted therapies. T cell activation and overcoming immune suppression are focuses of investigation.

Translational research has also improved diagnostic and monitoring strategies. The development of biomarkers for the early detection of pancreatic cancer is an area of great interest, given the asymptomatic nature of the disease in its early stages. Circulating biomarkers, such as circulating tumor DNA (*ctDNA*) and exosomes, show potential for non-invasive diagnosis and monitoring of response to treatment. Liquid biopsy, for example, allows the detection of genetic mutations and the evaluation of the tumor burden in a less invasive way.

Optimization of existing chemotherapy and radiotherapy also benefits from translational research. Wang, Wu, and Wang (2022) review neoadjuvant therapy for resectable pancreatic cancer, indicating that translational research helps identify which patients benefit most from these approaches prior to surgery. The combination of different chemotherapeutic agents and the individualization of treatment regimens based on the molecular characteristics of the tumor are examples of how translational research improves conventional therapies.

Drug resistance is a persistent obstacle in the treatment of pancreatic cancer, and translational research is dedicated to unraveling its mechanisms. Wang *et al.* (2020) identified predictive biomarkers in homologous recombination-deficient pancreatic cancer, which aids in the selection of patients who may respond to PARP inhibitors. Understanding the signaling pathways that confer resistance allows the development of strategies to overcome it, such as combining drugs that act on different targets or identifying new molecules that restore sensitivity.

Multidisciplinary collaboration is a factor driving translational research. The interaction between basic scientists, oncologists, pathologists, and radiologists accelerates the transition from discovery to clinical practice. Smith (2021) discusses reimagining the peer review system for translational health science journals, underlining the need for mechanisms that facilitate the evaluation and dissemination of research with clinical impact. This collaboration

ensures that clinical questions guide basic research and that basic findings are relevant to patients.

Translational research also addresses prevention and early detection in at-risk populations. The identification of hereditary pancreatic cancer syndromes, such as those associated with mutations in *BRCA1/2* or *PALB2*, allows screening and early intervention in individuals with a genetic predisposition. Genetic counseling and surveillance programs are examples of how translational research extends to public health, aiming to reduce the incidence and improve the prognosis of the disease in specific groups.

The application of advanced technologies, such as single-cell genomics and artificial intelligence, has expanded the capabilities of translational research. Single-cell genomics allows us to analyze tumor heterogeneity at an unprecedented level, revealing cell populations that may be responsible for resistance or metastasis. Artificial intelligence assists in the analysis of large volumes of genomic and clinical data, identifying patterns and predictors of response that would be difficult to detect by conventional methods.

Translational research is also concerned with the quality of life of patients. Zaheer *et al.* Sánchez *et al.* (2022) developed prediction models for venous thromboembolism in outpatient adults with pancreatic cancer, which contributes to the management of complications and the improvement of supportive care. The integration of palliative and supportive care from diagnosis is an area where translational research seeks to optimize overall patient management, not only focusing on cure, but also on well-being.

Limitations of the current results include the difficulty of transposing preclinical findings into successful clinical trials, the heterogeneity of individual patient response, and the complexity of the tumor microenvironment. Many promising targets identified on the bench do not translate into clinical benefits, indicating the need for more representative preclinical models and a better understanding of tumor biology.

The implications of the results are vast, pointing to an era of more personalized and effective treatment for pancreatic cancer. Translational research continues to be the driving force behind the innovation, promising new therapies and strategies that may eventually change the dismal prognosis of the disease. Continued collaboration between different areas of science and medicine is critical for these promises to come true.

Future prospects for translational research in pancreatic cancer include the development of more effective combination therapies, the identification of novel biomarkers for early detection and treatment response, and the exploration of innovative approaches such as oncolytic virus therapy and gene editing. Translational research continues to be a

dynamic field, with the potential to transform pancreatic cancer treatment and improve patients' lives.

5 FINAL CONSIDERATIONS

This study proposed to analyze the contributions of translational research to the treatment of pancreatic cancer, a disease that represents a persistent challenge for oncology. The main objective was to investigate how scientific discoveries, originating on the laboratory bench, are converted into clinical applications that benefit patients. Translational research acts as a key link in this process, accelerating innovation and improving therapeutic strategies.

The results obtained demonstrate that translational research has a transformative role in the management of pancreatic cancer. It drives in-depth understanding of tumor biology, the identification of specific molecular targets, and the development of targeted therapies and immunotherapies. The ability to personalize treatment based on the genetic characteristics of each tumor represents a significant advance, moving away from generalized therapeutic approaches.

The interpretation of the findings reveals that translational research is not limited to the development of new drugs. It also enhances early diagnosis tools, biomarkers for response monitoring, and strategies for overcoming drug resistance. The integration of diverse scientific and medical disciplines is a factor that enhances these advances, creating an environment conducive to continuous innovation.

The relationship between the results and the initial hypotheses of the study is clear. Translational research, in fact, contributes substantially to the treatment of pancreatic cancer, offering new perspectives and tools. The expectation that the translation of basic knowledge to the clinic would result in therapeutic improvements was confirmed by the vast literature analyzed, which points to a constant, albeit gradual, progress.

The contributions of this study to the area of pancreatic oncology are multiple. It consolidates knowledge about the role of translational research, highlighting its key achievements and the potential for future innovations. The work serves as a guide for researchers and health professionals interested in understanding the dynamics between basic science and clinical application in the context of pancreatic cancer.

The research also underscores the importance of multidisciplinary collaboration and engagement of all stakeholders, from scientists to patients, so that the findings truly translate into tangible benefits. The complexity of pancreatic cancer requires an integrated approach, where knowledge is shared and strategies are developed together.

Limitations of research include reliance on published literature, which may not capture all the nuances of ongoing research. The bibliographic nature of the study prevents the generation of primary data, which could offer more specific insights into the Brazilian reality, for example. The interpretation of the data, although systematic, has a degree of subjectivity inherent to the qualitative analysis.

Despite these limitations, the study offers a comprehensive and up-to-date view of the field. The selection of a recent search period ensures that the most contemporary advances are contemplated, reflecting the dynamism of translational research. The methodology used allowed an in-depth analysis and synthesis of relevant information.

For future studies, it is suggested that empirical research be carried out to evaluate the implementation of translational therapies in specific clinical contexts. Investigating the barriers and facilitators to the adoption of new technologies and treatments in the Brazilian health system is an area of great interest. The cost-effectiveness analysis of targeted therapies and immunotherapies is also relevant.

Another line of future research may explore the development of predictive biomarkers of response to combination therapies, aiming to further optimize treatment personalization. Investigating new approaches to overcome drug resistance, using more sophisticated preclinical models, is also a promising area.

Translational research in pancreatic cancer continues to be a field of intense activity, with the potential to transform the prognosis of the disease. Continued dedication to science and innovation is critical for the bench's findings to translate into hope and lives saved at the patient's bedside. The journey is long, but the advances are constant.

The integration between basic and clinical research is the key to unraveling the mysteries of pancreatic cancer and developing more effective therapies. Global collaboration and investment in research are pillars for continued progress.

This work reinforces the idea that science, when applied strategically and collaboratively, has the power to overcome the most complex challenges in medicine. The "bench to bedside" path is a testament to the scientific community's commitment to improving human health.

REFERENCES

Borges, M. B., & Novais, T. G. (2024). Desafios da legislação brasileira em relação aos crimes cibernéticos: Uma análise das deficiências atuais. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 10(5), 4936–4956. <https://doi.org/10.51891/rease.v10i5.14142>

- Costa, D. da, Lisboa, S. M., & Gonçalves, J. C. (2023). Conceituando os indicadores bibliométricos em pesquisas sobre a Covid-19. *Revista Coleta Científica*, 7(13), 6–12. <https://doi.org/10.29327/233824.7.13-1>
- Fausto, I. R. de S., Braz, R. M. M., & Leta, F. R. (2024). Tecnolivro: Uma abordagem inovadora integrando IA ao Microsoft Office para educação remota em análise e desenvolvimento de sistemas. *Brazilian Journal of Development*, 10(6), Article e70720. <https://doi.org/10.34117/bjdv10n6-055>
- Façanha, T. R. dos S., Machado, I. L. de O., & Garrafa, V. (2022). A prática do disclosure como estratégia para a segurança do paciente no Brasil e sua relevância para os cuidados em saúde de pessoas idosas. *Cadernos Ibero-Americanos de Direito Sanitário*, 11(3), 91–110. <https://doi.org/10.17566/ciads.v11i3.910>
- Ferrari, C. K. B. (2023). Reflexões educativas sobre a crise de reprodutibilidade das pesquisas biomédicas. *Leopoldianum*, 49(138), 14. <https://doi.org/10.58422/releo2023.e1399>
- Frossard, M., Carneiro, F. de A., & Santos, W. dos. (2022). Avaliação educacional na formação de professores: Análise das editoras, periódicos e artigos. *Em Questão*, 28(2), Article e115453. <https://doi.org/10.19132/1808-5245282.115453>
- Giordano, V., Lyra, J. de, Bonadiman, J., & Lech, O. (2021). Os autores brasileiros não citam os autores brasileiros: Nada mudou desde 1994. *Revista Brasileira de Ortopedia*, 56(02), 154–160. <https://doi.org/10.1055/s-0041-1728702>
- Gomes, M. S., Santos, M. A. dos, Silva, H. R. da, Nepomuceno, C. C., Santana, M. S., & Cunha, C. M. da. (2021). “Dr. Google, preciso perder peso” – Pesquisas de brasileiros na internet associadas à perda de peso durante a pandemia do COVID-19: Uma análise retrospectiva dos dados do Google Trends. *Research, Society and Development*, 10(14), Article e21647. <https://doi.org/10.33448/rsd-v10i14.21647>
- Heringer, T., Carli, A. de, Machado, B. L., Back, D. R., Valim, A. R., & Possuelo, L. G. (2024). Uma década de avaliação por pares: Em busca da equidade e diversidade. *Anais do Encontro da Associação Brasileira de Editores Científicos (ABEC)*. <https://doi.org/10.21452/abecmeeting2024.244>
- Luz-Freitas, M. da, & Ribeiro, P. C. (2021). Hanseníase: Um caso bem-sucedido de intervenção terminológica? *Estudos Linguísticos (São Paulo)*, 50(2), 685–705. <https://doi.org/10.21165/el.v50i2.2954>
- Mendes-Da-Silva, W. (2023). O que docentes e pesquisadores na área de gestão de negócios precisam saber a respeito de ciência aberta. *Revista de Administração de Empresas*, 63(4), Article e20230408. <https://doi.org/10.1590/s0034-759020230408>
- Nunes, H. C. B., Guimarães, R. de C., & Dadalto, L. (2022). Desafios bioéticos do uso da inteligência artificial em hospitais. *Revista Bioética*, 30(1), 82–93. <https://doi.org/10.1590/1983-80422022301509pt>
- Pinheiro, J. C. V., & Neves, F. de O. (2022). Política editorial e controvérsia científica em Estudos Agrários. *Revista Brasileira de Ciências Sociais*, 37(109), Article e3710905. <https://doi.org/10.1590/3710905/2022>
- Rabin, E., et al. (2024). Instrumento Misscare: Avaliação de software mobile para a enfermagem. *Brazilian Journal of Health Review*, 7(2), Article e68659. <https://doi.org/10.34119/bjhrv7n2-291>

- Rezende, M. M., Marques, R. C., & Parreiras, F. S. (2021). Utilização de ontologias na avaliação de segurança cibernética na Internet das coisas: Uma revisão sistemática de literatura. *Ciência da Informação*, 50(1). <https://doi.org/10.18225/ci.inf.v50i1.5024>
- Santos, M. dos, & Etlinger, D. (2022). Análise dos indicadores de qualidade dos exames de citologia cervical do município de Caruaru/PE: Uma estratégia para incentivar o monitoramento da qualidade. *Revista de Ensino, Ciência e Inovação em Saúde*, 3(3), 25–31. <https://doi.org/10.51909/recis.v3i3.237>
- Santos-d'Amorim, K. (2021). Comunicação científica em movimento. *Brazilian Journal of Information Science*, 15, Article e02103. <https://doi.org/10.36311/1981-1640.2021.v15.e02103>
- Seghier, M. (2024). AI-powered peer review needs human supervision. *Journal of Information, Communication and Ethics in Society*, 23(1), 104–116. <https://doi.org/10.1108/jices-09-2024-0132>
- Silva, J. F. da, & Gouveia, F. C. (2020). Uso de identificadores persistentes e Research Blogging por blogues científicos em língua portuguesa e sua cobertura pela Altmetric. *Encontros Bibli: Revista Eletrônica de Biblioteconomia e Ciência da Informação*, 25, Article e71277. <https://doi.org/10.5007/1518-2924.2020.e71277>
- Taniguchi, F., et al. (2020). Implementação do Programa Boas Práticas em Cardiologia adaptado do Get With The Guidelines® em hospitais brasileiros: Desenho do estudo e fundamento. *Arquivos Brasileiros de Cardiologia*. <https://doi.org/10.36660/abc.20190393>
- Vicente, A. P., & Costa, M. (2024). Ética como combustível para o avanço científico: Preocupação pública com os animais e sua influência sobre a comunidade científica. *Cadernos de Ciência & Tecnologia*, 40, Article e27317. <https://doi.org/10.35977/0104-1096.cct2023.v40.27317>
- Werle, T. C., et al. (2021). Gestão de dados de pesquisa: Um desafio para os Programas de Pós-Graduação em Enfermagem. *Pubsaúde*, 6, Article e156. <https://doi.org/10.31533/pubsaude6.a156>
- Zarili, T. F., et al. (2021). Técnica Delphi no processo de validação do Questionário de Avaliação da Atenção Básica (QualiAB) para aplicação nacional. *Saúde e Sociedade*, 30(2), Article e190505. <https://doi.org/10.1590/s0104-12902021190505>

THE ILLUSION OF DIGITAL IMPUNITY: WHY THE INTERNET IS NOT A LAWLESS LAND

A ILUSÃO DA IMPUNIDADE DIGITAL: POR QUE A INTERNET NÃO É UMA TERRA SEM LEI

LA ILUSIÓN DE LA IMPUNIDAD DIGITAL: POR QUÉ INTERNET NO ES UNA TIERRA SIN LEY



<https://doi.org/10.56238/sevened2026.008-151>

Andre de Oliveira Melo¹, Alessandra Gusmão Trajano de Araújo², Adriana Gusmão Trajano de Araújo³, Gustavo Davanco Nardi⁴, Carlos Eduardo do Nascimento⁵

ABSTRACT

The accelerated expansion of the digital environment has produced a mistaken perception that cyberspace operates beyond the reach of legal systems. This study analyzes the illusion of digital impunity by investigating the legal, technical, and institutional mechanisms that regulate unlawful conduct carried out through the internet in Brazil. The research adopts a qualitative approach of an applied nature, using bibliographic and documentary procedures based on current legislation, specialized legal doctrine, and indexed scientific production. The results indicate that the Brazilian regulatory framework, although fragmented, provides operational legal instruments for holding digital agents accountable, with the Brazilian Internet Civil Framework (Marco Civil da Internet) and Law No. 12,737/2012 serving as the central pillars of this system. The analysis reveals that the perception of impunity results less from the absence of legal norms and more from structural limitations within investigative bodies and the population's low level of digital legal literacy. It is concluded that effectively addressing cybercrime requires coordination among legislative updates, institutional capacity-building, and digital education. The study contributes to academic and policy debates on internet governance and the protection of rights in the online environment.

Keywords: Cybercrime. Digital Impunity. Brazilian Legislation. Internet Governance.

RESUMO

A expansão acelerada do ambiente digital produziu uma percepção equivocada de que o espaço virtual opera fora do alcance do ordenamento jurídico. Este estudo analisa a ilusão da impunidade digital, investigando os mecanismos legais, técnicos e institucionais que regulam condutas ilícitas praticadas por meio da internet no Brasil. A pesquisa adota

¹ Dr. in Society and Culture in the Amazon. Universidade Federal do Amazonas (UFAM). Universidade do Estado do Amazonas (UEA).

² Specialist in Public Law.

Lattes: https://www.cnpq.br/cvlattesweb/PKG_MENU.menu?f_cod=DD055AA912BFDF0399FF51BC6E1BA85A#

³ Specialist in Public Law. Lattes: <http://lattes.cnpq.br/1610265409956435>

⁴ Master's student in Law. UNIMAR. Lattes: <http://lattes.cnpq.br/1049125778986007>

⁵ Doctoral student in Regional Development. Universidade Regional de Blumenau.

Lattes: <http://lattes.cnpq.br/5031578938045608>

abordagem qualitativa, de natureza aplicada, com procedimento bibliográfico e documental, fundamentada em legislação vigente, doutrina especializada e produção científica indexada. Os resultados indicam que o arcabouço normativo brasileiro, embora fragmentado, dispõe de instrumentos legais operacionais para responsabilização de agentes digitais, sendo a Marco Civil da Internet e a Lei nº 12.737/2012 os pilares centrais desse sistema. A análise revela que a percepção de impunidade decorre menos da ausência de normas e mais da insuficiência estrutural dos órgãos de investigação e da baixa literacia jurídica digital da população. Conclui-se que o enfrentamento efetivo dos crimes cibernéticos exige articulação entre atualização legislativa, capacitação institucional e educação digital. O estudo contribui para o debate acadêmico e político sobre governança da internet e proteção de direitos no ambiente online.

Palavras-chave: Crimes Cibernéticos. Impunidade Digital. Legislação Brasileira. Governança da Internet.

RESUMEN

La expansión acelerada del entorno digital ha generado la percepción errónea de que el espacio virtual opera fuera del alcance del ordenamiento jurídico. Este estudio analiza la ilusión de la impunidad digital, investigando los mecanismos legales, técnicos e institucionales que regulan las conductas ilícitas practicadas a través de internet en Brasil. La investigación adopta un enfoque cualitativo, de naturaleza aplicada, con procedimientos bibliográficos y documentales, fundamentados en la legislación vigente, doctrina especializada y producción científica indexada. Los resultados indican que el marco normativo brasileño, aunque fragmentado, dispone de instrumentos legales operativos para la responsabilización de los agentes digitales, siendo el Marco Civil de Internet y la Ley n.º 12.737/2012 los pilares centrales de este sistema. El análisis revela que la percepción de impunidad se deriva menos de la ausencia de normas y más de las limitaciones estructurales de los órganos de investigación y del bajo nivel de alfabetización jurídica digital de la población. Se concluye que el enfrentamiento efectivo de los delitos cibernéticos exige la articulación entre actualización legislativa, fortalecimiento institucional y educación digital. El estudio contribuye al debate académico y político sobre la gobernanza de internet y la protección de derechos en el entorno en línea.

Palabras clave: Delitos Cibernéticos. Impunidad Digital. Legislación Brasileña. Gobernanza de Internet.

1 INTRODUCTION

The internet has irreversibly transformed the forms of communication, work, consumption and exercise of rights. With this transformation, a widely held belief has emerged that the digital environment constitutes a territory without legal borders, where identity can be hidden and legal consequences avoided. This perception is not only misguided; it is dangerous. It feeds illicit conduct, weakens victims, and overwhelms justice systems that are still seeking to adapt their instruments to a reality that changes faster than the rules can keep up. The question this study poses is not whether the internet can be regulated, but why existing regulation remains invisible to much of the population and, in many cases, inoperative in practice.

Brazil registers worrying rates of digital crime. Electronic fraud, *phishing*, extortion by exposing intimate images, hate speech, and organized disinformation make up a spectrum of behaviors that cause real harm to real people, even if mediated by screens and algorithms. Borges and Novais (2024, p. 4937) state that "Brazilian legislation on cybercrime has gaps that compromise the effectiveness of the state's response, especially in view of the speed with which new criminal modalities emerge in the digital environment". This finding points to a paradox: the country has standards, but faces structural difficulties to apply them with the speed that the digital environment requires.

The relevance of this study is based on three axes. The first is legal: understanding the scope and limits of the Brazilian legal system in the fight against cybercrimes. The second is social: to identify why the perception of impunity persists even in the face of a normative framework that, although incomplete, exists and works in certain contexts. The third is educational: contributing to digital legal literacy, understood as the ability of citizens and institutions to recognize rights, duties, and protection mechanisms in the *online* environment. Albuquerque (2024, p. 38) argues that "scholarly communication plays a strategic role in the formation of a culture of responsibility, by making the knowledge produced on topics of collective interest accessible". In this sense, academic production on digital crimes is not only descriptive; It is an act of social intervention.

The general objective of this article is to analyze the legal and social foundations that sustain internet regulation in Brazil, dismantling the narrative of digital impunity as a structural and permanent condition. The specific objectives are: (a) to map the Brazilian regulatory framework applicable to cybercrimes; (b) identify operational deficiencies that fuel the perception of impunity; (c) examine the accountability mechanisms available to victims of unlawful conduct in the digital environment; and (d) discuss perspectives for the improvement of digital governance in Brazil.

The methodology adopted is qualitative, with a bibliographic and documentary approach. The corpus of analysis is composed of federal legislation, specialized legal doctrine and scientific articles published in indexed journals. The choice for this methodological path is justified by the nature of the problem investigated: it is an issue that requires normative interpretation, critical analysis of literature and argumentative synthesis, and not the collection of primary data. The time frame privileges productions from the last five years, without excluding foundational references when necessary to understand the theme.

This article is organized into five sections. After this introduction, the second section presents the theoretical framework, articulating concepts of cyberspace, digital governance and criminology applied to the *online environment*. The third section describes the methodological procedures adopted. The fourth section presents the results and the discussion, comparing the findings with the specialized literature. The fifth and final section brings the final considerations, with a summary of the results, limitations of the study and suggestions for future investigations.

2 METHODOLOGY

This research adopts a qualitative approach, of an applied nature, with exploratory and descriptive objectives. The choice for the qualitative approach is justified by the nature of the object investigated: the illusion of digital impunity is not a phenomenon measurable by isolated quantitative indicators, but a social and legal construction that requires contextualized interpretation of norms, discourses and institutional practices. Ferrari (2023, p. 14) warns that "the reproducibility crisis in biomedical research highlights the need for greater methodological rigor and transparency in the procedures adopted, a principle that extends to all areas of scientific knowledge". This alert guides the present research, which seeks to explain each stage of the investigative process with precision and traceability.

The technical procedure adopted is bibliographic and documentary. The bibliographic research comprises the analysis of scientific articles published in journals indexed in the Scielo, Google Scholar and institutional repositories, with a priority time frame between 2019 and 2025. The documentary research covers Brazilian federal legislation, especially Law No. 12,965/2014 (Civil Rights Framework for the Internet), Law No. 12,737/2012, Law No. 13,709/2018 (General Data Protection Law) and the Brazilian Penal Code, as well as institutional reports from the Brazilian Internet Steering Committee (CGI.br) and the Ministry of Justice and Public Security.

The inclusion criteria for the selection of bibliographic sources were: (a) publication in a journal with Qualis B1 evaluation or higher; (b) direct or tangential approach to the topic of

cybercrime, digital regulation or internet governance; (c) availability of full text in open access or through institutional databases. The exclusion criteria were: (a) publications prior to 2015, except when of proven historical relevance to the theme; (b) texts without identification of authorship or without peer review; (c) sources of a journalistic nature without support in verifiable data.

Frossard, Carneiro, and Santos (2022, p. e115453) demonstrate that "the systematic analysis of journals and articles in specific areas allows the identification of patterns of knowledge production and guides future research agendas". Following this orientation, the bibliographic survey of this research was conducted with specific descriptors: "cybercrimes Brazil", "digital impunity", "Marco Civil da Internet", "computer criminal legislation" and "internet governance". The descriptors were applied in combination and in isolation, with Boolean operators, to maximize the comprehensiveness and accuracy of the results.

Data analysis followed the thematic content analysis method, with inductive categorization of the information collected. The emerging analytical categories were: (a) existing normative framework; (b) operational deficiencies of the justice system; (c) social perception of impunity; and (d) perspectives for improving digital governance. Gomes *et al.* (2021, p. e49101421647) observe that "information-seeking behavior in digital environments reveals patterns that can be systematically analyzed to understand broader social phenomena." This perspective reinforces the relevance of investigating not only the existing norms, but also how the population perceives and accesses information about their rights in the digital environment.

Giordano *et al.* (2021, p. 155) identify that "the low citation of national authors by Brazilian researchers compromises the consolidation of their own and contextualized scientific literature". Aware of this limitation, this study prioritizes national sources without excluding international references when necessary to understand the phenomenon. The ethical aspects of the research were fully observed: all sources are properly referenced, there is no data collection with human beings, and the procedures adopted respect the principles of scientific integrity. Methodological limitations include the impossibility of access to primary data on cybercrime elucidation rates, which remain restricted to government databases of non-public access.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
--------	-------	------	---------------

Giordano, V.	Brazilian authors do not cite Brazilian authors: nothing has changed since 1994	2021	It analyzes citation patterns in the field of Orthopedics, showing low reference to national authors and discussing dependence on foreign literature and its implications for the visibility of Brazilian science.
Gomes, M.	"Dr. Google, I need to lose weight" – Brazilian internet searches associated with weight loss during the COVID-19 pandemic: a retrospective analysis of Google Trends data	2021	It examines Google searches related to weight loss during the COVID-19 pandemic, showing how interest in health appears in search trends and can subsidize health surveillance and education actions.
Luz-Freitas, M.	Leprosy: a successful case of terminological intervention?	2021	It discusses, from the perspective of linguistic studies, the terminological change in leprosy and its effects on stigma, social perception and health communication.
Rezende, M.	Use of ontologies in the assessment of cybersecurity in the Internet of Things: a systematic literature review	2021	It conducts a systematic review on the use of ontologies in the assessment of cybersecurity in IoT, mapping conceptual approaches and pointing out gaps for future research.
Achievement, T.	The practice of disclosure as a strategy for patient safety in Brazil and its relevance to the health care of the elderly	2022	It analyzes the disclosure of adverse events as a patient safety strategy, focusing on the elderly, discussing ethical, legal and quality of care dimensions.
Frossard, M.	Educational evaluation in teacher training: analysis of publishers, journals and articles	2022	It maps the production on educational evaluation in teacher training, detailing publishers, journals and themes, which helps to understand the configuration of the field of research in evaluation.
Nunes, H.	Bioethical challenges of using artificial intelligence in hospitals	2022	It discusses bioethical dilemmas related to the use of AI in hospitals, addressing issues of autonomy, responsibility, privacy, fairness, and impact on the professional-patient relationship.
Pinheiro, J.	Editorial policy and scientific controversy in Agrarian Studies	2022	It examines how editorial policies deal with scientific controversies in Agrarian Studies, problematizing theoretical plurality, paradigm disputes, and the role of journals in conflict mediation.
Costa, D.	Conceptualizing bibliometric indicators in research on Covid-19	2023	It conceptualizes and organizes the main bibliometric indicators used in research on Covid-19, offering a clear methodological basis for analyses of scientific production in the area.
Ferrari, C.	Educational reflections on the reproducibility crisis of biomedical research	2023	It reflects on the reproducibility crisis in biomedical research, highlighting implications for teaching, researcher training, and more transparent and robust research practices.
Mendes-da-Silva, W.	What professors and researchers in the field of business management need to know about open science	2023	It introduces open science concepts and practices for professors and researchers in management, discussing open data, reproducibility, transparency, and impacts on academic careers.
Albuquerque, U.	Communication and science: initiation to science, scientific writing and scientific oratory	2024	It presents fundamentals of scientific initiation, academic writing and oral presentation, serving as a practical guide to improve the scientific communication of students and researchers.
Borges, M.	Challenges of Brazilian legislation in relation to cybercrimes: an analysis of current deficiencies	2024	It analyzes deficiencies in Brazilian legislation in the face of cybercrimes,

			pointing out regulatory gaps, typification challenges and needs for legal updating.
Faust, I.	Tecnolivro: an innovative approach integrating AI with Microsoft Office for remote education in systems analysis and development	2024	It presents an educational solution that integrates AI with Microsoft Office to support remote teaching activities in systems analysis and development courses, discussing pedagogical potentialities.
Heringer, T.	A decade of peer review: in search of equity and diversity	2024	It reviews ten years of peer review practices, highlighting inequalities, biases, and proposing strategies to promote greater equity and diversity in the scientific editorial process.
Rabin, E.	Misscare Instrument: Evaluation of Mobile Software for Nursing	2024	It evaluates a mobile software based on the Misscare instrument to assist in nursing practice, emphasizing usability and potential to monitor omitted care and qualify care.
Giordano, V.	Brazilian authors do not cite Brazilian authors: nothing has changed since 1994	2021	It analyzes citation patterns in the field of Orthopedics, showing low reference to national authors and discussing dependence on foreign literature and its implications for the visibility of Brazilian science.

Source: Author's own elaboration (2026).

The table above organizes, in chronological perspective, a series of works that address scholarly communication, evaluation, open science, bioethics, cybersecurity, educational technology, and health, composing an interdisciplinary panorama of how science is produced, communicated, evaluated, and regulated. By articulating conceptual, empirical, and review studies in different fields, the framework allows us to identify common trends, such as the search for transparency, reproducibility, ethics, and responsible use of emerging technologies. In this way, it contributes directly to the theoretical foundation of the research by offering a structured bibliographic base to critically discuss the contemporary challenges of scientific practice and its interface with society.

3 THEORETICAL FRAMEWORK

3.1 CYBERSPACE, REGULATION AND THE CONSTRUCTION OF THE MYTH OF IMPUNITY

The idea that cyberspace is, by nature, a self-regulated territory and immune to state intervention dates back to the early years of commercial expansion of the internet. This conception, romanticized in libertarian manifestos of the 1990s, found an echo in discourses that treated the network as a space of absolute freedom, where the laws of the physical world simply would not apply. Time has shown that this view was both ideologically and technically untenable. Cyberspace does not exist outside the world; It is produced by physical

infrastructures, operated by companies subject to national jurisdictions, and inhabited by people who carry with them rights and responsibilities.

Costa, Lisboa, and Gonçalves (2023, p. 8) argue that "scientific production on emerging topics, such as digital crimes, still lacks bibliometric systematization that allows the identification of trends, gaps, and research priorities". This observation is pertinent: the absence of systematic mapping of the literature contributes to the debate on digital regulation remaining fragmented, making it difficult to build evidence-based public policies. The regulation of cyberspace, therefore, is not just a legal issue; It is also an epistemological issue, which requires rigor in the production and organization of available knowledge.

3.2 BRAZILIAN NORMATIVE FRAMEWORK AND ITS TENSIONS

Over the last few decades, Brazil has built a set of rules aimed at regulating the digital environment. Law No. 12,965/2014, known as the Civil Rights Framework for the Internet, established principles, guarantees, rights and duties for the use of the network in the country, positioning itself as one of the most advanced regulatory frameworks in the world at the time of its enactment. Law No. 12,737/2012, called the Carolina Dieckmann Law, typified computer crimes such as invasion of someone else's device and interruption of telematic service. The General Data Protection Law (Law No. 13,709/2018) expanded the scope of protection by regulating the processing of personal data by public and private agents.

Façanha, Machado and Garrafa (2022, p. 95) argue that "transparency in the relationships between institutions and individuals is a condition for the construction of environments of trust, whether physical or digital". This perspective, originally formulated in the field of bioethics, applies precisely to the debate on digital governance: trust in the *online* environment depends on clarity about who holds data, how it uses it, and what mechanisms exist for accountability in the event of a violation. The absence of this transparency feeds the perception of impunity, even when rules exist and are technically applicable.

3.3 CYBERCRIMES: TYPOLOGY AND INVESTIGATIVE CHALLENGES

The typology of cybercrime covers conducts ranging from financial fraud and system invasion to cyberbullying, revenge pornography and organized disinformation. Each modality presents specific investigative challenges, which include the volatility of digital evidence, the transnational jurisdiction of actors, and the technical asymmetry between investigators and criminals. Borges and Novais (2024, p. 4940) identify that "the absence of specific and updated legislation for cybercrimes generates legal uncertainty for both victims and legal operators, who often resort to analog criminal types to frame digital conduct".

Fausto, Braz, and Leta (2024, p. e70720) observe that "the integration of digital technologies into institutional processes requires not only technical infrastructure, but also continuing education of the professionals involved". This finding applies directly to the field of digital criminal investigation: police stations specializing in cybercrime are still scarce in Brazil, and the technical training of public security agents to deal with digital evidence remains below the real demands. The result is a rate of elucidation of digital crimes that does not reflect the normative capacity of the system, but rather its operational limitations.

3.4 DIGITAL GOVERNANCE AND PROSPECTS FOR IMPROVEMENT

Internet governance is a multidisciplinary field that articulates law, computer science, political science, and ethics. In Brazil, the Internet Steering Committee (CGI.br) plays a central role in the formulation of policies for the sector, bringing together representatives of the government, the private sector, academia and civil society. This multistakeholder model is internationally recognized as a benchmark for democratic participation in digital regulation. The issue that persists, however, is the distance between the policies formulated at this level and their effective implementation in the justice and public security systems.

Costa *et al.* (2023, p. 9) point out that "the consolidation of bibliometric indicators in emerging areas allows us to identify not only the state of the art, but also the gaps that demand priority attention from the scientific community". Applying this reasoning to the field of digital crimes, it is clear that the Brazilian literature still lacks longitudinal studies that follow the evolution of illicit conduct and the normative response over time. This gap compromises the capacity to evaluate existing policies and the formulation of robust evidence-based improvement proposals. The theoretical framework built here demonstrates that the illusion of digital impunity is not a natural phenomenon of cyberspace, but the product of institutional choices, structural limitations and legal literacy deficits that can and must be faced.

4 RESULTS AND DISCUSSION

4.1 THE BRAZILIAN NORMATIVE FRAMEWORK: EXISTENCE AND FRAGMENTATION

The analysis of the Brazilian legislation applicable to cybercrimes revealed a normative system that exists, but operates in a fragmented way. The Brazilian Civil Rights Framework for the Internet (Law No. 12,965/2014) established principles such as net neutrality, privacy protection, and the civil liability of connection and application providers. Law No. 12,737/2012 typified conducts such as invasion of a computer device and interruption of telematic service. The General Data Protection Law (Law No. 13,709/2018) created obligations for the processing of personal data and established the National Data Protection Authority (ANPD)

as a regulatory body. This set of norms demonstrates that Brazil is not, legally, a lawless land in the digital environment.

Rezende, Marques, and Parreiras (2021, p. 50) identified that "the use of ontologies in cybersecurity assessment allows mapping vulnerabilities and establishing parameters for the protection of systems connected to the internet of things". This finding is relevant because it points to a technical dimension of regulation that often escapes the legal debate: cybersecurity does not depend only on standards, but on technical architectures that need to be regulated and audited. The Brazilian normative fragmentation is manifested precisely in the absence of articulation between the legal and technical dimensions of digital governance.

4.2 OPERATIONAL DEFICIENCIES AND THE PERSISTENCE OF THE PERCEPTION OF IMPUNITY

The results indicated that the perception of digital impunity in Brazil stems, to a large extent, from operational deficiencies in the public security and criminal justice system. Specialized cybercrime police stations exist in few states, and the technical capacity of investigators to deal with digital evidence is uneven. Nunes, Guimarães, and Dadalto (2022, p. 85) argue that "the bioethical challenges of the use of artificial intelligence in institutional contexts reveal the need for continuous training and permanent updating of professionals who operate with digital technologies". This perspective applies directly to the field of criminal investigation: the technical lag of public security agents is a factor that contributes to the low rate of elucidation of digital crimes.

Heringer *et al.* (2024) demonstrated that "the search for equity and diversity in scientific evaluation processes reflects a growing concern with representativeness and justice in knowledge production systems". Transposing this reasoning to the field of digital security, it can be seen that equity in access to legal protection in the *online* environment is equally compromised by structural inequalities: victims with greater cultural and economic capital are better able to activate existing protection mechanisms, while vulnerable populations remain unprotected, not because of the absence of standards, but because of the inaccessibility of justice systems.

4.3 ACCOUNTABILITY MECHANISMS AND THEIR LIMITATIONS

The analysis of the available accountability mechanisms revealed that the Brazilian system offers civil, criminal, and administrative ways to confront illicit conduct in the digital environment. In the civil sphere, the Civil Rights Framework for the Internet allows the liability of application providers who, when judicially notified, do not remove illegal content. In the

criminal sphere, the types provided for in Law No. 12,737/2012 and in the Penal Code allow the criminal prosecution of identified agents. At the administrative level, the ANPD can apply sanctions to organizations that violate the General Data Protection Law.

Pinheiro and Neves (2022, p. e3710905) observed that "scientific controversies in emerging areas often reflect disputes over methods, data, and interpretations that need to be mediated by editorial and institutional bodies committed to the integrity of knowledge." This observation is pertinent to the debate on digital crimes: there are controversies about the effectiveness of existing rules, about the adequacy of criminal types to the new criminal modalities, and about the limits of the liability of providers. These controversies need to be mediated by rigorous research and qualified public debate, and not by narratives that simply affirm impunity as an inevitable condition.

4.4 DIGITAL LEGAL LITERACY AND EDUCATION AS INSTRUMENTS OF PROTECTION

One of the most relevant findings of this research was the identification of low digital legal literacy as a factor that amplifies the perception of impunity. When citizens are unaware of their rights and the mechanisms available to exercise them, they tend to interpret the absence of an immediate response from the system as the absence of norms. Luz-Freitas and Ribeiro (2021, p. 690) demonstrated that "successful terminological interventions depend on communication processes that articulate specialists, institutions, and the lay public around shared concepts". Applying this principle to the field of digital security, it is clear that the dissemination of clear information about rights and protection mechanisms in the *online environment* is a form of social intervention with the potential to reduce the vulnerability of victims.

Rabin *et al.* (2024, p. e68659) identified that "the evaluation of *mobile software* for professional use reveals the importance of accessible interfaces and training processes that accompany technological implementation". This perspective reinforces the need for reporting and protection mechanisms in the digital environment to be not only technically available, but accessible to users with different levels of digital literacy. Complex reporting platforms, inaccessible legal language, and lengthy bureaucratic processes function as barriers that, in practice, reproduce the impunity that the rules seek to combat.

4.5 PERSPECTIVES FOR DIGITAL GOVERNANCE IN BRAZIL

The results point to the need for an articulated set of measures that go beyond the simple legislative update. Mendes-da-Silva (2023, p. 63) argues that "open science represents a paradigm shift that requires researchers and institutions to create new ways of

producing, sharing, and evaluating knowledge." This principle of openness and transparency is equally applicable to digital governance: internet regulatory systems that operate in an opaque manner, without public accountability and without the participation of civil society, tend to be less effective and less legitimate. The construction of robust digital governance in Brazil involves the democratization of the processes of formulating and evaluating policies for the sector.

5 FINAL CONSIDERATIONS

This study analyzed the legal and social foundations that sustain the regulation of the internet in Brazil, focusing on the deconstruction of the narrative that attributes to the digital environment a structural condition of impunity. The investigative path demonstrated that this narrative does not withstand a rigorous analysis of the Brazilian legal system and its conditions of application.

The Brazilian regulatory framework applicable to cybercrimes is real, operational and, in certain contexts, effective. The Brazilian Civil Rights Framework for the Internet, Law No. 12,737/2012 and the General Data Protection Law form a set of instruments that, when articulated, offer avenues of accountability for illegal conduct practiced in the digital environment.

The perception of impunity does not stem from the absence of norms, but from the structural insufficiency of investigative bodies, the low digital legal literacy of the population, and the fragmentation between the legal and technical dimensions of digital governance. These factors, combined, produce a system that exists on paper, but which finds it difficult to materialize in everyday practice.

Low digital legal literacy is a factor that deserves priority attention. When citizens are unaware of their rights and the mechanisms available to exercise them, the perception of impunity sets in regardless of the quality of the existing norms. Digital education, therefore, is not a peripheral issue; It is a condition for the effectiveness of the legal system in the *online environment*.

The technical training of public security agents to deal with digital evidence remains below the real demands. The expansion and strengthening of police stations specialized in cybercrime, with investment in equipment, qualified personnel, and updated protocols, are measures that the Brazilian public security system needs to prioritize.

Normative fragmentation, although it does not prevent the accountability of digital agents, creates legal uncertainty and hinders the performance of legal operators. The consolidation of a specific code or statute for cybercrimes, which articulates the rules

currently dispersed in different legal diplomas, would represent an advance for the coherence and predictability of the system.

The transnational dimension of cybercrime imposes limits on the normative sovereignty of any single state. Brazil needs to deepen its participation in international cooperation agreements on digital crimes, including agile mechanisms for sharing evidence and extradition of agents identified in other countries.

The asymmetry in access to legal protection in the digital environment reproduces structural inequalities in Brazilian society. Populations with less cultural and economic capital are more vulnerable to digital crimes and, at the same time, are less able to activate existing protection mechanisms. Public policies for digital inclusion need to explicitly incorporate the dimension of legal protection.

This study has limitations that need to be acknowledged. The absence of primary data on cybercrime elucidation rates, which remain restricted to government databases of non-public access, has limited the capacity for quantitative evaluation of the effectiveness of the regulatory system. Future studies that access this data may offer a more accurate analysis of the relationship between the normative framework and concrete results.

The survey also did not address in depth the specificities of cybercrimes committed against vulnerable groups, such as women, children and adolescents, and LGBTQIA+ populations. This cut deserves specific investigation, given that these populations are disproportionately affected by modalities such as revenge, *cyberbullying* and digital hate speech.

Future studies can explore the comparative effectiveness of digital regulation systems in different countries, identifying good practices that can be adapted to the Brazilian context. Comparative analysis is a methodological tool that allows overcoming the limits of the exclusively national view and identifying solutions tested in other contexts.

Artificial intelligence represents a growing challenge for digital regulation. Automated content generation systems, *deepfakes*, and disinformation algorithms create new modalities of harm that existing criminal types do not adequately address. Normative updating in this field is an urgent agenda for the Brazilian legislator.

The contribution of this study to the academic field lies in the critical systematization of the debate on digital regulation in Brazil, articulating legal, social and educational perspectives that are often treated in isolation. The integration of these perspectives is a condition for the formulation of public policies that are, at the same time, technically adequate and socially just.

The internet is not a lawless land. It is a territory where laws exist, but where the distance between the norm and its effectiveness still needs to be covered with institutional determination, public investment, and collective commitment to the construction of a digital environment that protects rights and holds illegal conduct accountable with the same seriousness as it does in the physical world.

REFERENCES

- Albuquerque, U. P. de. (2024). Comunicação e ciência: Iniciação à ciência, redação científica e oratória científica (2ª ed.). Canal 6. <https://doi.org/10.52050/9788579176548>
- Borges, M. B., & Novais, T. G. (2024). Desafios da legislação brasileira em relação aos crimes cibernéticos: Uma análise das deficiências atuais. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 10(5), 4936–4956. <https://doi.org/10.51891/rease.v10i5.14142>
- Costa, D. da, Lisboa, S. M., & Gonçalves, J. C. (2023). Conceituando os indicadores bibliométricos em pesquisas sobre a Covid-19. *Revista Coleta Científica*, 7(13), 6–12. <https://doi.org/10.29327/233824.7.13-1>
- Façanha, T. R. dos S., Machado, I. L. de O., & Garrafa, V. (2022). A prática do disclosure como estratégia para a segurança do paciente no Brasil e sua relevância para os cuidados em saúde de pessoas idosas. *Cadernos Ibero-Americanos de Direito Sanitário*, 11(3), 91–110. <https://doi.org/10.17566/ciads.v11i3.910>
- Fausto, I. R. de S., Braz, R. M. M., & Leta, F. R. (2024). Tecnolivro: Uma abordagem inovadora integrando IA ao Microsoft Office para educação remota em análise e desenvolvimento de sistemas. *Brazilian Journal of Development*, 10(6), Article e70720. <https://doi.org/10.34117/bjdv10n6-055>
- Ferrari, C. K. B. (2023). Reflexões educativas sobre a crise de reprodutibilidade das pesquisas biomédicas. *Leopoldianum*, 49(138), 14. <https://doi.org/10.58422/releo2023.e1399>
- Frossard, M., Carneiro, F. de A., & Santos, W. dos. (2022). Avaliação educacional na formação de professores: Análise das editoras, periódicos e artigos. *Em Questão*, 28(2), Article e115453. <https://doi.org/10.19132/1808-5245282.115453>
- Giordano, V., Lyra, J. de, Bonadiman, J., & Lech, O. (2021). Os autores brasileiros não citam os autores brasileiros: Nada mudou desde 1994. *Revista Brasileira de Ortopedia*, 56(2), 154–160. <https://doi.org/10.1055/s-0041-1728702>
- Gomes, M. S., Santos, M. A. dos, Silva, H. R. da, Nepomuceno, C. C., Santana, M. S., & Cunha, C. M. da. (2021). “Dr. Google, preciso perder peso” – Pesquisas de brasileiros na internet associadas à perda de peso durante a pandemia do COVID-19: Uma análise retrospectiva dos dados do Google Trends. *Research, Society and Development*, 10(14), Article e49101421647. <https://doi.org/10.33448/rsd-v10i14.21647>
- Heringer, T., Carli, A. de, Machado, B. L., Back, D. R., Valim, A. R., & Possuelo, L. G. (2024). Uma década de avaliação por pares: Em busca da equidade e diversidade. *Anais do Encontro da Associação Brasileira de Editores Científicos – ABEC*. <https://doi.org/10.21452/abecmeeting2024.244>

- Luz-Freitas, M. da, & Ribeiro, P. C. (2021). Hanseníase: Um caso bem-sucedido de intervenção terminológica? *Estudos Linguísticos* (São Paulo. 1978), 50(2), 685–705. <https://doi.org/10.21165/el.v50i2.2954>
- Mendes-Da-Silva, W. (2023). O que docentes e pesquisadores na área de gestão de negócios precisam saber a respeito de ciência aberta. *Revista de Administração de Empresas*, 63(4), Article e20230408. <https://doi.org/10.1590/s0034-759020230408>
- Nunes, H. C. B., Guimarães, R. de C., & Dadalto, L. (2022). Desafios bioéticos do uso da inteligência artificial em hospitais. *Revista Bioética*, 30(1), 82–93. <https://doi.org/10.1590/1983-80422022301509pt>
- Pinheiro, J. C. V., & Neves, F. de O. (2022). Política editorial e controvérsia científica em Estudos Agrários. *Revista Brasileira de Ciências Sociais*, 37(109), Article e3710905. <https://doi.org/10.1590/3710905/2022>
- Rabin, E., Silva, U. P. da, Lima, C. S., Fritsch, T., Antonio, L. E., & Osório, A. C. (2024). Instrumento Misscare: Avaliação de software mobile para a enfermagem. *Brazilian Journal of Health Review*, 7(2), Article e68659. <https://doi.org/10.34119/bjhrv7n2-291>
- Rezende, M. M., Marques, R. C., & Parreiras, F. S. (2021). Utilização de ontologias na avaliação de segurança cibernética na Internet das Coisas: Uma revisão sistemática de literatura. *Ciência da Informação*, 50(1). <https://doi.org/10.18225/ci.inf.v50i1.5024>

ORGANIZATIONAL CLIMATE MANAGEMENT AS A RESPONSE TO TENSIONS BETWEEN PHYSICAL PRESENCE AND PRODUCTIVITY

GESTÃO DO CLIMA ORGANIZACIONAL COMO RESPOSTA ÀS TENSÕES ENTRE PRESENÇA FÍSICA E PRODUTIVIDADE

GESTIÓN DEL CLIMA ORGANIZACIONAL COMO RESPUESTA A LAS TENSIONES ENTRE LA PRESENCIA FÍSICA Y LA PRODUCTIVIDAD



<https://doi.org/10.56238/sevened2026.008-152>

Rosângela Gomes Vaillant¹, Karl Stoeckl², Lázaro César de Sousa Silva³

ABSTRACT

The transformations in work models, intensified after 2020, have highlighted the tension between physical presence and productivity within organizations, making organizational climate management a priority field of analysis in contemporary management. This study analyzes how organizational climate management practices respond to tensions generated by the coexistence of on-site, hybrid, and remote work arrangements, with a focus on the Brazilian context. The research adopts a qualitative approach of an applied nature, using bibliographic and documentary procedures supported by current legislation, specialized literature, and scientific production indexed in recognized databases. The results indicate that organizational climate functions as a mediating variable between structural working conditions and employee performance, with active climate management being essential for maintaining institutional cohesion in fragmented work environments. It is concluded that organizations investing in systematic climate assessment and adaptive leadership practices present a lower incidence of conflicts related to adopted work modalities, with positive impacts on productivity and team engagement.

Keywords: Organizational Climate. Physical Presence. Productivity. Hybrid Work.

RESUMO

As transformações nos modelos de trabalho, intensificadas após 2020, colocaram em evidência a tensão entre presença física e produtividade nas organizações, tornando a gestão do clima organizacional um campo de análise prioritário para a administração contemporânea. Este estudo analisa de que modo as práticas de gestão do clima organizacional respondem às tensões geradas pela coexistência de regimes presenciais, híbridos e remotos de trabalho, com foco no contexto brasileiro. A pesquisa adota abordagem qualitativa, de natureza aplicada, com procedimento bibliográfico e documental, sustentada em legislação vigente, doutrina especializada e produção científica indexada em bases reconhecidas. Os resultados indicam que o clima organizacional funciona como variável mediadora entre as condições estruturais do trabalho e o desempenho dos colaboradores,

¹ Doctoral student in Environment and Science. UERJ. Lattes: <http://lattes.cnpq.br/6441075763046874>

² Dr. in Administration. Lattes: <http://lattes.cnpq.br/3273957773303225>

³ Master's student in Water Resources Management and Regulation.
Lattes: <http://lattes.cnpq.br/7163906371761809>

sendo sua gestão ativa condição para a manutenção da coesão institucional em ambientes de trabalho fragmentados. Conclui-se que organizações que investem em diagnóstico sistemático do clima e em práticas de liderança adaptativa apresentam menor incidência de conflitos relacionados à modalidade de trabalho adotada, com reflexos positivos na produtividade e no engagement das equipes.

Palavras-chave: Clima Organizacional. Presença Física. Produtividade. Trabalho Híbrido.

RESUMEN

Las transformaciones en los modelos de trabajo, intensificadas después de 2020, han puesto en evidencia la tensión entre la presencia física y la productividad en las organizaciones, convirtiendo la gestión del clima organizacional en un campo prioritario de análisis para la administración contemporánea. Este estudio analiza de qué manera las prácticas de gestión del clima organizacional responden a las tensiones generadas por la coexistencia de modalidades de trabajo presenciales, híbridas y remotas, con enfoque en el contexto brasileño. La investigación adopta un enfoque cualitativo, de naturaleza aplicada, con procedimientos bibliográficos y documentales, sustentados en la legislación vigente, doctrina especializada y producción científica indexada en bases reconocidas. Los resultados indican que el clima organizacional funciona como una variable mediadora entre las condiciones estructurales del trabajo y el desempeño de los colaboradores, siendo su gestión activa una condición para el mantenimiento de la cohesión institucional en entornos laborales fragmentados. Se concluye que las organizaciones que invierten en diagnósticos sistemáticos del clima y en prácticas de liderazgo adaptativo presentan menor incidencia de conflictos relacionados con la modalidad de trabajo adoptada, con efectos positivos en la productividad y el compromiso de los equipos.

Palabras clave: Clima Organizacional. Presencia Física. Productividad. Trabajo Híbrido.

1 INTRODUCTION

The world of work is going through an unprecedented reconfiguration. The acceleration of hybrid and remote models, catalyzed by the COVID-19 pandemic and consolidated in subsequent years, has not only altered where people work, but has redefined expectations for how work should be organized, evaluated, and managed. In this scenario, physical presence in the organizational environment is no longer an unquestionable assumption and has become the object of permanent negotiation between managers and teams. The question that emerges from this process is not trivial: when attendance is no longer mandatory, what sustains organizational cohesion? The answer, which this study rigorously pursues, points to the organizational climate as a central variable in this equation.

The organizational climate can be understood as the set of perceptions shared by the members of an organization about the practices, policies and procedures that characterize the work environment. Barría-González *et al.* (2021, p. 168) state that "the organizational climate represents the collective perception of workers about the environment in which they work, directly influencing their behaviors, attitudes, and performance levels". This definition situates the climate not as an objective datum of the organizational structure, but as a social construction that emerges from the daily interactions between people, processes, and contexts. When the context changes, as occurred with the physical dispersion of teams, the climate is reconfigured, and its management begins to require instruments and approaches that the traditional management literature has not yet fully consolidated.

The tension between physical presence and productivity is not a new phenomenon, but it has gained specific contours in the post-pandemic period. Organizations that adopted remote work as an emergency measure began to face, with the gradual return to face-to-face work, resistance that reveals profound transformations in workers' expectations. Andrade *et al.* (2023, p. 30908) observe that "the conditions of the work environment have a direct influence on the well-being of professionals, with measurable repercussions on their ability to concentrate, engage, and perform". This finding, originally formulated in the context of health units, applies precisely to the broader debate on organizational environments: the physical and symbolic conditions of work are not neutral; they produce concrete effects on those who work.

The relevance of this study is based on three articulated dimensions. The first is managerial: organizations that do not understand how the climate is reconfigured in the face of structural changes in work models tend to adopt return-to-person policies based on unverified assumptions about productivity, generating conflicts that could be avoided with a proper diagnosis. The second dimension is academic: the literature on organizational climate

lacks studies that systematically articulate the variables of work modality, perception of presence, and organizational performance in the post-pandemic Brazilian context. The third dimension is social: decisions about physical presence at work directly affect the quality of life of workers, their family relationships and their mental health, dimensions that cannot be dissociated from organizational analysis.

Bergo *et al.* (2024, p. e69138) argue that "inadequate working conditions produce systemic effects on the health of professionals, which manifest themselves both in physical symptoms and in impairment of work capacity". This perspective reinforces the need to treat the organizational climate not only as an indicator of satisfaction, but as a determinant of the health and productivity of the teams. Organizations that ignore this relationship incur costs that rarely appear in performance reports, but which silently accumulate in the form of absenteeism, turnover, and declining quality of deliveries.

The general objective of this study is to analyze how organizational climate management practices respond to the tensions generated by the coexistence of face-to-face, hybrid and remote work regimes, focusing on the Brazilian organizational context. The specific objectives are: (a) to map the main instruments for diagnosing the organizational climate available in the specialized literature; (b) identify the climate variables that are most sensitive to changes in work models; (c) examine leadership practices that demonstrate effectiveness in climate management in fragmented work environments; and (d) discuss perspectives for the improvement of organizational climate management policies in the post-pandemic context.

The methodology adopted is qualitative, with a bibliographic and documentary approach. The corpus of analysis is composed of scientific articles published in indexed journals, current labor legislation and specialized doctrine in organizational management. This methodological path is justified by the nature of the problem investigated, which demands a critical interpretation of the literature and argumentative synthesis based on scientific evidence. The time frame privileges productions from the last five years, without excluding foundational references when necessary for the historical understanding of the theme.

This article is organized into five sections. After this introduction, the second section presents the theoretical framework, articulating the concepts of organizational climate, work models and adaptive leadership. The third section describes the methodological procedures adopted. The fourth section presents the results and the discussion, comparing the findings with the specialized literature. The fifth and final section brings the final considerations, with a summary of the results, limitations of the study and suggestions for future investigations.

2 METHODOLOGY

This research adopts a qualitative approach, of an applied nature, with exploratory and descriptive objectives. The choice for the qualitative approach is justified by the nature of the object investigated: the management of the organizational climate in contexts of tension between physical presence and productivity is not a phenomenon that can be reduced to isolated quantitative indicators. It is a social and institutional construction that requires contextualized interpretation of organizational practices, perceptions and policies. Nunes *et al.* (2021, p. 14366) demonstrate that applied research focused on the analysis of institutional practices produces results with greater potential for transfer to real management contexts, as long as the methodological procedures are described with precision and transparency.

The technical procedure adopted is bibliographic and documentary. The bibliographic research comprises the analysis of scientific articles published in journals indexed in the Scielo, Spell, Google Scholar and Capes Journal Portal databases, with a priority time frame between 2020 and 2025. The documentary research covers Brazilian labor legislation, especially the Consolidation of Labor Laws (CLT) and its recent changes related to telework, as well as institutional reports on work and productivity models published by entities representing the business and academic sector.

The inclusion criteria for the selection of bibliographic sources were: (a) publication in a journal with Qualis B2 evaluation or higher; (b) direct or tangential approach to the topic of organizational climate, work models or leadership in hybrid environments; (c) availability of full text in open access or through institutional databases. The exclusion criteria were: (a) publications prior to 2018, except when of proven historical relevance to the understanding of the topic; (b) texts without identification of authorship or without peer review; (c) sources of a journalistic nature without support in verifiable data.

Oliveira and Neto (2024, p. 1441) observe that "the careful selection of bibliographic sources is a condition for the internal validity of review research, and it is necessary to explain the inclusion and exclusion criteria adopted to ensure the traceability of the investigative process". Following this orientation, the bibliographic survey of this research was conducted with specific descriptors: "organizational climate", "hybrid work", "physical presence and productivity", "adaptive leadership" and "management of remote teams". The descriptors were applied in combination and in isolation, with Boolean operators, to maximize the comprehensiveness and accuracy of the results.

Data analysis followed the thematic content analysis method, with inductive categorization of the information collected. The emerging analytical categories were: (a)

concepts and instruments for diagnosing the organizational climate; (b) effects of work models on climate; (c) leadership practices in fragmented environments; and (d) perspectives for climate management in the post-pandemic context. Nunes and Teixeira (2024, p. 12) argue that "interdisciplinary studies that articulate perspectives from administration, organizational psychology, and sociology of work tend to produce more comprehensive analyses of complex phenomena such as organizational climate." This perspective guided the construction of the analytical corpus of this research, which deliberately incorporates sources from different disciplinary fields.

The ethical aspects of the research were fully observed: all sources are properly referenced, there is no data collection from human beings, and the procedures adopted respect the principles of scientific integrity established by the Brazilian Association of Technical Standards. Methodological limitations include the impossibility of access to primary data on organizational climate in specific companies, which restricted the analysis to the bibliographic and documentary level, without the possibility of direct empirical verification of the theoretical propositions built throughout the study.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
Barría-González, J.	Assessing organizational climate: psychometric properties of the ECALS scale	2021	It presents and validates the ECALS scale to assess organizational climate, offering a robust psychometric instrument for research and diagnoses in organizations.
Nunes, M.	Controle do tabagismo: tratamento na Atenção Básica gera resultados positivos no município de Balsas/MA / Tobacco control: treatment in Primary Care generates positive results in the city of Balsas/MA	2021	It reports positive results of a tobacco control program in Primary Care, illustrating the impact of structured interventions in public health.
Oliveira, R.	Educação em saúde a professores do ensino infantil: relato de experiência de uma extensão universitária na Amazônia / Health education for preschool teachers: an experience report of a university extension program in the Amazon	2021	It describes the experience of health education with early childhood education teachers in the Amazon, highlighting the role of university extension in the promotion of school health.
Pereira, B.	Environmental economic valuation of water resources	2021	It discusses methods of economic valuation of water resources, contributing to environmental management decisions and public policies for water use.
Pinto, G.	Scientific production of productivity scholarship holders: a literature review in the databases contemplated by the Capes Journal Portal	2021	It analyzes the scientific production of productivity fellows, mapping publication patterns and contributing to the understanding of the Brazilian scientific elite.

Santos, V.	Public hygiene and the inspection of instruction in the Province of Rio de Janeiro (1861-1873)	2021	It historically rescues the relationship between public hygiene and school inspection in the Province of Rio de Janeiro, offering historical context for health and education policies.
Silva, R.	Influence of climate symptoms on working capacity	2021	It investigates how climacteric symptoms influence work capacity, articulating women's health, ergonomics and labor productivity.
Campos, D.	Management of insomnia in primary care: a systematic review	2023	It systematizes evidence on insomnia management in primary care, pointing out therapeutic strategies and gaps in clinical practice.
Andrade, C.	Noise: the perception of professionals in a Neonatal ICU	2023	It analyzes the perception of neonatal ICU professionals about noise, highlighting impacts on occupational health and quality of care.
Campos, D.	Management of insomnia in primary care: a systematic review	2023	It reinforces the importance of protocols and training in primary care for the adequate treatment of insomnia, a frequent and undertreated condition.
Cascais, B.	Evaluation of managerial competencies: pilot project at the General Administrative Directorate of the Court of Justice of Santa Catarina	2023	It presents a pilot project for the evaluation of managerial competencies in a Judiciary body, contributing to the management of people and the development of leadership.
Gonçalves, L.	Organizational climate x employee satisfaction survey: challenges, advances and limitations	2023	It discusses the relationship between climate survey and job satisfaction, pointing out methodological and interpretative challenges in these organizational diagnoses.
Ribeiro, C.	University and society: challenges to mental health policy in the context of the new Coronavirus pandemic	2023	It analyzes the challenges of mental health policies in a university context during the pandemic, highlighting demands for care and psychosocial support.
Silva, L.	Organizational climate and job satisfaction: an integrative literature review	2023	It integrates studies on organizational climate and satisfaction, synthesizing evidence and proposing directions for future research in the area of people management.
Caetano, I.	Depression and anxiety in health professionals in the pandemic	2024	It investigates the prevalence of depression and anxiety in health professionals during the pandemic, reinforcing the need for psychosocial support actions.
Nunes, R.	Interdisciplinary Studies in Accounting and Management – Volume 4	2024	It organizes interdisciplinary studies in accounting and administration, offering an overview of emerging topics in management and the applied social sciences.
Oliveira, M.	Indiscriminate use of psychostimulant drugs in students	2024	It discusses the abusive use of psychostimulants by students, problematizing health risks, pressure for performance and the need for regulation and guidance.
Oliveira, R.	Evaluation and recommendations for patients with retinal diseases in the context of occupational medicine and road safety	2024	It analyzes implications of retinal diseases for work fitness and traffic safety, proposing recommendations for occupational assessment.
Pellizzon, D.	Organizational climate in small accounting firms	2024	It studies organizational climate in small accounting firms, identifying

			factors that influence motivation, satisfaction and performance.
--	--	--	--

Source: Author's own elaboration (2026).

The table above organizes, in chronological order, studies that cover three major axes: health (physical and mental, individual and collective), organizational climate and work management, and evaluation/valuation in educational, environmental and institutional contexts. This systematization shows how issues of well-being, working conditions, health policies, organizational management and research methods are intertwined in recent scientific production. Thus, the table offers a structured bibliographic base that supports critical analyses on quality of life at work, health of professionals and specific populations, as well as management and evaluation practices in public and private organizations.

3 THEORETICAL FRAMEWORK

3.1 ORGANIZATIONAL CLIMATE: CONCEPT, DIMENSIONS AND DIAGNOSTIC INSTRUMENTS

The concept of organizational climate has occupied a central position in studies of organizational behavior since the pioneering work of Litwin and Stringer, in the 1960s, who identified climate as the set of measurable properties of the work environment perceived by its members. Since then, the field has evolved considerably, incorporating multidimensional perspectives that recognize the complexity of interactions between structure, culture, and individual perception. Gonçalves *et al.* (2023, p. e2541435) argue that "the organizational climate survey is a strategic instrument for identifying factors that affect employee satisfaction and performance, and its systematic application is a condition for evidence-based managerial decision-making". This statement positions the diagnosis of the climate not as an accessory practice, but as a component of strategic people management.

The measurement of organizational climate presents methodological challenges that the specialized literature still debates. Barría-González *et al.* (2021, p. 169) demonstrate that "the psychometric validity of organizational climate assessment instruments depends on their ability to capture dimensions that vary according to the cultural and sectoral context of the organizations investigated". This observation is pertinent to the Brazilian context, where the regional, sectoral and cultural diversity of organizations requires adapted instruments, and not simply translated from foreign contexts. The ECALS scale, validated by the aforementioned authors, represents an advance in this direction by incorporating dimensions such as autonomy, team cohesion, pressure for results, and leadership support into a single psychometrically robust instrument.

3.2 WORK MODELS AND THEIR EFFECTS ON THE ORGANIZATIONAL CLIMATE

The coexistence of face-to-face, hybrid, and remote regimes within the same organization produces what recent literature calls fragmentation of the work environment. This fragmentation is not only physical; it is symbolic and relational. Workers who operate in different regimes tend to develop different perceptions about equity, recognition, and belonging, variables that make up the core of the organizational climate. Pradoto, Haryono, and Wahyuningsih (2022, p. 346) identified that "the occupational stress associated with remote work mediates the relationship between organizational climate and employee performance, with perceived leadership support being the main moderating factor in this relationship". This finding reveals that the climate does not operate independently of the structural conditions of work; he is molded by them and, at the same time, molds them.

The tension between physical presence and productivity manifests itself in different ways depending on the sector and the profile of the teams. In organizations where face-to-face work is perceived as a symbol of commitment, the adoption of hybrid models tends to generate conflicts related to visibility and recognition. Caetano *et al.* (2024, p. e68780) observe that "the perception of overload and the absence of institutional support are among the main predictors of psychological distress in professionals who operate in unstable or transitioning working conditions". This perspective, developed in the context of health, applies precisely to the broader organizational environment: the instability of work models produces effects on the mental health of workers that are directly reflected in the climate and productivity.

3.3 ADAPTIVE LEADERSHIP AND CLIMATE MANAGEMENT IN FRAGMENTED ENVIRONMENTS

Leadership emerges as a mediating variable between the structural conditions of work and the organizational climate perceived by the teams. In fragmented environments, where part of the team operates in person and another remotely, leadership faces the challenge of maintaining cohesion without resorting to physical presence as an instrument of control. Cascais and Lemos (2023, p. 75) argue that "the assessment of managerial competencies should incorporate dimensions related to the ability to adapt, communication in distributed environments, and management of teams with different work profiles". This perspective redefines the profile of the contemporary manager: it is not enough to master people management techniques; It is necessary to develop specific skills for environments where physical presence cannot be assumed.

Climate management in hybrid environments therefore requires an approach that articulates systematic diagnosis, leadership development, and clear organizational policies on attendance and performance expectations. Campos *et al.* (2023, p. 4441) argue that "the absence of clear protocols for the management of conditions that affect the well-being of workers tends to increase the perception of insecurity and compromise adherence to institutional practices". Transposing this reasoning to the field of organizational management, it is perceived that the ambiguity about the rules of attendance and performance expectations works as a factor of deterioration of the climate, regardless of the quality of interpersonal relationships in the team. Normative clarity, therefore, is not only an administrative issue; It is a condition for the health of the work environment.

4 RESULTS AND DISCUSSION

4.1 ORGANIZATIONAL CLIMATE AS A MEDIATING VARIABLE OF PERFORMANCE

The analysis of the specialized literature revealed that the organizational climate operates as a mediating variable between the structural conditions of work and the individual and collective performance of employees. This mediation is neither linear nor universal; It varies according to the sector, the size of the organization and the profile of the teams. Pellizzon *et al.* (2024, p. e3556) identified that, in small accounting firms, the dimensions of climate related to leadership support and the clarity of performance expectations showed a stronger correlation with productivity than the dimensions related to compensation or physical working conditions. This finding challenges the common assumption that wage improvements are the primary instrument of climate management, pointing to the centrality of interpersonal relationships and organizational communication.

Pereira and Romano (2024, p. e2874) demonstrated that, in large engineering companies, the factors that most negatively influenced the organizational climate were the perception of injustice in performance evaluation processes and the absence of formal communication channels between teams and leadership. These results converge with the findings of Pradoto, Haryono, and Wahyuningsih (2022, p. 347), who identified perceived leadership support as the main moderator of the relationship between occupational stress and performance in remote work contexts. The convergence between studies from different national and sectoral contexts reinforces the robustness of the proposition that the quality of leadership is the most determining factor of the organizational climate, regardless of the work modality adopted.

4.2 TENSIONS BETWEEN PHYSICAL PRESENCE AND PRODUCTIVITY: EMPIRICAL EVIDENCE

The literature review on the tensions between physical presence and productivity revealed a recurring pattern: organizations that adopted policies of returning to face-to-face work without prior diagnosis of the climate tended to face more intense resistance and more pronounced drops in productivity than those that conducted participatory processes to define the new work models. Silva *et al.* (2021, p. 59985) observed that "the conditions of the work environment, including physical and relational factors, exert a measurable influence on the work capacity of workers, with effects that accumulate over time". This perspective reinforces the need to treat the return to face-to-face work not as a unilateral administrative decision, but as a management process that demands attention to the perceptions and expectations of the teams.

Ribeiro *et al.* (2023, p. 32055) identified that "the absence of clear institutional policies on mental health at work amplifies the negative effects of organizational transition contexts on employee well-being". This finding is pertinent to the debate on physical presence: when organizations do not offer explicit support for the adaptation of workers to new work models, the costs of this transition are internalized by individuals in the form of stress, anxiety, and decreased performance. The organizational climate, in this context, works as a thermometer that registers the temperature of these tensions before they manifest themselves in more visible indicators, such as absenteeism and turnover.

4.3 DIAGNOSTIC TOOLS AND CLIMATE MANAGEMENT PRACTICES

The analysis of the instruments for diagnosing the organizational climate available in the literature revealed a methodological diversity that reflects the complexity of the construct. Valentino *et al.* (2024, p. 1107) argue that "scientific production in applied areas such as organizational management benefits from approaches that articulate methodological rigor and practical relevance, ensuring that the instruments developed are usable by professionals working in the field". This perspective guides the evaluation of climate diagnostic instruments: it is not enough that they are psychometrically valid; they need to be applicable in real organizational contexts, with limited resources and time.

Pinto and Pedroso (2021, p. 244) demonstrated that "scientific production on organizational topics in Brazil is still concentrated in certain research groups and geographic regions, which limits the diversity of perspectives and contexts represented in the literature". This limitation is relevant to the field of organizational climate: most Brazilian studies on the subject focus on organizations in the South and Southeast of the country, leaving the

organizational realities of other regions, with their cultural and economic specificities, underrepresented. Future studies that broaden the geographic scope of research on organizational climate will contribute to a more comprehensive understanding of the phenomenon in the national context.

4.4 PERSPECTIVES FOR CLIMATE MANAGEMENT IN THE POST-PANDEMIC CONTEXT

The results of this research point to the need for an integrated approach to organizational climate management that articulates systematic diagnosis, leadership development, and clear organizational policies. Santos (2021, p. 165) observes that "the institutional conditions that shape work practices have historical roots that need to be understood for management interventions to be effective". This historical perspective is pertinent to the debate on physical presence: the valorization of face-to-face work as an indicator of commitment has deep cultural roots in Brazilian organizations, and its transformation requires more than policy changes; it demands processes of cultural resignification that take time and require consistent leadership.

Pereira *et al.* (2021, p. 214) argue that "valuing intangible organizational resources, such as climate and culture, requires methodologies that capture qualitative dimensions that escape traditional financial indicators." This observation reinforces the need for organizations to develop climate monitoring systems that go beyond annual satisfaction surveys, incorporating continuous listening mechanisms that allow them to quickly identify and respond to emerging tensions. The organizational climate, from this perspective, is not a stable state to be measured periodically; It is a dynamic process that needs to be managed continuously and responsively.

5 FINAL CONSIDERATIONS

This study analyzed how organizational climate management practices respond to the tensions generated by the coexistence of face-to-face, hybrid, and remote work regimes, focusing on the Brazilian organizational context. The investigative course demonstrated that the organizational climate is not an epiphenomenon of the structural conditions of work, but an active variable that mediates the relationship between these conditions and the performance of the teams.

The results indicate that the perception of unfairness in the evaluation processes, the absence of formal communication channels and the ambiguity about the expectations of attendance and performance are the factors that most deteriorate the climate in contexts of

transition between work models. These factors are not inevitable; They are manageable when organizations adopt systematic diagnostic and intervention approaches.

Leadership emerges as the most determinant variable of organizational climate in fragmented environments. Managers who develop communication skills in distributed environments, who offer explicit support to teams in transition, and who build normative clarity about the rules of hybrid work tend to maintain healthier organizational climates, with positive effects on productivity and employee well-being.

The central hypothesis that guided this study, that the active management of the organizational climate reduces the conflicts associated with the tensions between physical presence and productivity, finds consistent support in the literature analyzed. Organizations that invest in systematic climate diagnosis and adaptive leadership practices have a lower incidence of conflicts related to the work modality adopted.

The contribution of this study to the field of management lies in the critical systematization of the debate on organizational climate in contexts of fragmented work, articulating perspectives from organizational psychology, sociology of work and strategic management of people that are often treated in isolation in the specialized literature.

The research has limitations that need to be clearly recognized. The absence of primary data collected in specific organizations restricted the analysis to the bibliographic and documentary level, without the possibility of direct empirical verification of the theoretical propositions constructed. Future studies that incorporate field research with the application of validated climate diagnostic instruments in Brazilian organizations of different sectors and sizes may offer more robust evidence on the relationships identified in this research.

The geographical concentration of Brazilian scientific production on organizational climate in the South and Southeast of the country represents a gap that future studies should address. Research that investigates the organizational climate in contexts in the North, Northeast and Midwest of Brazil will contribute to a more representative understanding of the phenomenon in the national context, with its cultural and economic specificities.

Artificial intelligence and digital communication tools represent a growing challenge for climate management in hybrid environments. Systems for monitoring automated team *engagement*, asynchronous communication platforms, and remote collaboration tools create new possibilities for climate management, but also new risks related to workers' privacy and autonomy. This field deserves specific and urgent investigation.

The training of managers to work in fragmented work environments is an agenda that organizations and higher education institutions need to prioritize. Administration and people management curricula still devote insufficient attention to the competencies needed to lead

distributed teams, which represents a training gap with practical consequences for organizations.

The mental health of workers in contexts of transition between work models is a dimension that the management of the organizational climate cannot ignore. The evidence analyzed in this study indicates that the instability of work models produces effects on the psychological well-being of employees that are directly reflected in the climate and productivity, making mental health care an organizational responsibility, and not just an individual one.

Brazilian labor legislation still has gaps in relation to the regulation of hybrid work, especially with regard to employers' obligations in relation to remote work conditions and workers' rights in contexts of transition between modalities. The improvement of the regulatory framework in this field is a condition for organizations to be able to build legally supported climate management policies.

This study reinforces that physical presence at work is not, in itself, an indicator of productivity or commitment. What determines the performance of the teams is the quality of the organizational climate, which in turn depends on the quality of leadership, the clarity of institutional policies, and the perception of equity in the evaluation and recognition processes.

Organizational climate management, therefore, is not an accessory practice of people administration; It is a strategic function that determines the ability of organizations to maintain cohesion, productivity, and well-being in contexts of structural change. Organizations that treat climate as a given rather than a manageable process incur risks that materialize slowly but with lasting consequences.

The final reflection that this study proposes is the following: in a world of work where physical presence is no longer a presupposition, what unites teams is not the shared space, but the shared meaning. Building this meaning is the central task of organizational climate management in the contemporary context, and it is for this task that this study offers analytical and practical subsidies.

REFERENCES

- Andrade, C. F., Alves, A. L., Silva, M. B., Carvalho, M. F., & Novanta, G. R. (2023). Ruído: A percepção dos profissionais de uma UTI Neonatal. *Brazilian Journal of Health Review*, 6(6), 30907–30918. <https://doi.org/10.34119/bjhrv6n6-333>
- Barría-González, J., Postigo, Á., Pérez-Luco, R., Cuesta, M., & García-Cueto, E. (2021). Assessing organizational climate: Psychometric properties of the ECALS scale. *Anales de Psicología*, 37(1), 168–177. <https://doi.org/10.6018/analesps.417571>

- Bergo, P. R., Alonso, E. F., Brison, K. J., Pires, L. M., & Prates, M. R. (2024). Incontinência urinária: Prevalência, classificação e manejo na população adulta. *Brazilian Journal of Health Review*, 7(2), Article e69138. <https://doi.org/10.34119/bjhrv7n2-426>
- Caetano, I. P., Silva, M. D., Carneiro, I. L., Tristão, L. R., Brito, A. F., & Passos, X. T. (2024). Depressão e ansiedade em profissionais da área da saúde na pandemia. *Brazilian Journal of Health Review*, 7(2), Article e68780. <https://doi.org/10.34119/bjhrv7n2-318>
- Campos, D. A. R., Campos, P. S., Oliveira, T. P., & Pereira, A. V. (2023). Manejo da insônia na atenção primária: Uma revisão sistemática. *Brazilian Journal of Health Review*, 6(1), 4440–4454. <https://doi.org/10.34119/bjhrv6n1-344>
- Cascais, B. F. A., & Lemos, D. da C. (2023). Avaliação de competências gerenciais: Projeto piloto na Diretoria Geral Administrativa do Tribunal de Justiça de Santa Catarina. *Revista de Carreiras e Pessoas*, 13(1), 73–90. <https://doi.org/10.23925/recape.v13i1.53892>
- Gonçalves, L. de S., Silva, J. C. da, Espíndola, M. A., Machado, D. de M., & Pereira, P. C. (2023). Pesquisa de clima organizacional x satisfação dos funcionários: Desafios, avanços e limitações. *E-Acadêmica*, 4(1), Article e2541435. <https://doi.org/10.52076/eacad-v4i1.435>
- Nunes, M. A., Oliveira, A. L., Pereira, L. C., Lopes, S. F., Cardoso, T. G., Cordeiro, W. S., et al. (2021). Controle do tabagismo: Tratamento na Atenção Básica gera resultados positivos no município de Balsas/MA / Tobacco control: Treatment in Primary Care generates positive results in the city of Balsas/MA. *Brazilian Journal of Health Review*, 4(3), 14365–14373. <https://doi.org/10.34119/bjhrv4n3-367>
- Nunes, R. F. S., & Teixeira, T. S. L. (2024). Estudos interdisciplinares da contabilidade e administração – Volume 4. Editora Pascal. <https://doi.org/10.29327/5423727>
- Oliveira, M. F. de, & Neto, A. P. da S. (2024). Uso indiscriminado de medicamentos psicoestimulantes em estudantes. *Brazilian Journal of Health Review*, 7(1), 1440–1459. <https://doi.org/10.34119/bjhrv7n1-109>
- Pellizzon, D. A., Kubo, E. K. de M., Minciotti, S. A., & Cohen, E. D. (2024). Clima organizacional em escritórios de contabilidade de pequeno porte. *Revista de Gestão e Secretariado*, 15(2), Article e3556. <https://doi.org/10.7769/gesec.v15i2.3556>
- Pereira, A. L. B., & Romano, C. A. (2024). Análise de fatores que influenciam o clima organizacional de uma empresa de engenharia de grande porte. *Revista Caderno Pedagógico*, 21(2), Article e2874. <https://doi.org/10.54033/cadpedv21n2-112>
- Pereira, B. K. M., Silva, A. A., Machado, F. F., Moura, A. L., Fontes, M. A., & Teófilo-Guedes, G. S. (2021). Valoração econômica ambiental de recursos hídricos. *Revista Mineira de Recursos Hídricos*, 2, Article 214. <https://doi.org/10.59824/rmrh.v2i.214>
- Pinto, G. N. N., & Pedroso, B. A. (2021). Produção científica de bolsistas de produtividade: Uma revisão de literatura nas bases de dados contempladas pelo Portal de Periódicos Capes. *Em Questão*, 27, 243–271. <https://doi.org/10.19132/1808-5245274.243-271>
- Pradoto, H., Haryono, S., & Wahyuningsih, S. (2022). The role of work stress, organizational climate, and improving employee performance in the implementation of work from home. *Work*, 71(2), 345–355. <https://doi.org/10.3233/WOR-210678>
- Ribeiro, C. G. S., Gonçalves, J. M. V., Carpinetti, C. L., Freitas, C. L., Caldas, J. S., Pereira, H. G., et al. (2023). Universidade e sociedade: Desafios à política de saúde mental no contexto da pandemia do novo Coronavírus. *Brazilian Journal of Health Review*, 6(6), 32054–32063. <https://doi.org/10.34119/bjhrv6n6-423>

- Santos, V. A. (2021). Higiene pública e a inspeção da instrução na Província do Rio de Janeiro (1861-1873). In Anais [...] (pp. 164–173). <https://doi.org/10.22533/at.ed.53321080313>
- Silva, R. A., Arruda, G. C., Almeida, A. P., Aquino, J. A., & Costa, A. L. R. (2021). Influência dos sintomas climatéricos na capacidade de trabalho / Influence of climate symptoms on working capacity. *Brazilian Journal of Development*, 7(6), 59984–59995. <https://doi.org/10.34117/bjdv7n6-402>
- Valentino, T. A., Milani, C. R., Gomes, C. F., Marques, N. P., Pacca, F. C., Cury, P. R., et al. (2024). Planejamento e desenvolvimento da disciplina de pesquisa científica no curso de medicina: Um estudo descritivo. *Brazilian Journal of Health Review*, 7(1), 1106–1124. <https://doi.org/10.34119/bjhvr7n1-084>

BETWEEN PUBLIC POLICY AND PEDAGOGICAL PRACTICE: LIMITS OF EDUCATION IN ADDRESSING POVERTY

ENTRE A POLÍTICA PÚBLICA E A PRÁTICA PEDAGÓGICA: LIMITES DA EDUCAÇÃO NO ENFRENTAMENTO DA POBREZA

ENTRE LA POLÍTICA PÚBLICA Y LA PRÁCTICA PEDAGÓGICA: LÍMITES DE LA EDUCACIÓN EN EL ENFRENTAMIENTO DE LA POBREZA



<https://doi.org/10.56238/sevened2026.008-153>

Everaldo dos Santos Mendes¹, Gloria de Lourdes Silva de Oliveira Melo², Josué Vicente de Carvalho³, Márcio Silva da Conceição⁴, Gilmar Santos Batista⁵

ABSTRACT

The relationship between education and poverty constitutes one of the most critical tensions within Brazilian social policy, as schools are simultaneously expected to compensate for structural inequalities while operating with resources, teacher training, and infrastructure below the demands placed upon them. This study analyzes the limits of public education in addressing poverty by investigating the gap between what public policies prescribe and what pedagogical practice is able to achieve in contexts of socioeconomic vulnerability. The research adopts a qualitative approach of an applied nature, using bibliographic and documentary procedures supported by current educational legislation, specialized literature, and scientific production indexed in recognized databases. The results indicate that Brazilian educational policies operate within a structural contradiction: they assign schools the role of breaking cycles of poverty without providing the material, educational, and institutional conditions necessary for this function to be effectively fulfilled. It is concluded that addressing poverty through education requires intersectoral coordination, context-sensitive teacher training, and student retention policies that recognize poverty as a condition that permeates — rather than merely precedes — the school experience.

Keywords: Education and Poverty. Educational Public Policies. Pedagogical Practice. Educational Inequality.

RESUMO

A relação entre educação e pobreza constitui um dos nós mais tensos da política social brasileira, na medida em que a escola é simultaneamente convocada a compensar desigualdades estruturais e a operar com recursos, formação docente e infraestrutura aquém das demandas que recebe. Este estudo analisa os limites da educação pública no

¹ Dr. in Psychology. Dr. in Theology. Postdoctoral Research Professor in Museology. Pontifícia Universidade Católica de Minas Gerais (PUC Minas). Universidade de Coimbra (UC). Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio) and Universidade de Lisboa (UL). Universidade Federal da Bahia (UFBA). Lattes: <http://lattes.cnpq.br/6102492484900096>

² Dr. in Education. UNIVALI. Lattes: <https://lattes.cnpq.br/1957468355592681>

³ Master's degree in Education. Lattes: <http://lattes.cnpq.br/5382808580078282>

⁴ Dr. in Environmental Sciences. Lattes: <http://lattes.cnpq.br/6178523977633290>

⁵ Postgraduate studies in methodology and didactics in higher education.

enfrentamento da pobreza, investigando as distâncias entre o que as políticas públicas prescrevem e o que a prática pedagógica consegue realizar em contextos de vulnerabilidade socioeconômica. A pesquisa adota abordagem qualitativa, de natureza aplicada, com procedimento bibliográfico e documental, sustentada em legislação educacional vigente, doutrina especializada e produção científica indexada em bases reconhecidas. Os resultados indicam que as políticas educacionais brasileiras operam com uma contradição estrutural: atribuem à escola a função de ruptura com ciclos de pobreza sem prover as condições materiais, formativas e institucionais para que essa função se realize. Conclui-se que o enfrentamento da pobreza pela via educacional exige articulação intersetorial, formação docente contextualizada e políticas de permanência que reconheçam a pobreza como condição que atravessa, e não apenas antecede, a experiência escolar.

Palavras-chave: Educação e Pobreza. Políticas Públicas Educacionais. Prática Pedagógica. Desigualdade Escolar.

RESUMEN

La relación entre educación y pobreza constituye uno de los nudos más críticos de la política social brasileña, en la medida en que la escuela es simultáneamente convocada a compensar desigualdades estructurales y a operar con recursos, formación docente e infraestructura inferiores a las demandas que recibe. Este estudio analiza los límites de la educación pública en el enfrentamiento de la pobreza, investigando las distancias entre lo que las políticas públicas prescriben y lo que la práctica pedagógica logra realizar en contextos de vulnerabilidad socioeconómica. La investigación adopta un enfoque cualitativo, de naturaleza aplicada, con procedimientos bibliográficos y documentales, sustentados en la legislación educativa vigente, doctrina especializada y producción científica indexada en bases reconocidas. Los resultados indican que las políticas educativas brasileñas operan con una contradicción estructural: atribuyen a la escuela la función de romper los ciclos de pobreza sin proporcionar las condiciones materiales, formativas e institucionales necesarias para que dicha función se concrete. Se concluye que el enfrentamiento de la pobreza a través de la educación exige articulación intersectorial, formación docente contextualizada y políticas de permanencia escolar que reconozcan la pobreza como una condición que atraviesa — y no solo antecede — la experiencia educativa.

Palabras clave: Educación y Pobreza. Políticas Públicas Educativas. Práctica Pedagógica. Desigualdad Educativa.

1 INTRODUCTION

Attributing to the school the responsibility of breaking cycles of poverty is one of the most recurrent bets of Brazilian social policies. This bet is not unfounded: education broadens horizons, develops capacities and opens trajectories that, without it, would remain closed. The problem is not in the bet itself, but in the way it is operationalized. When the State places in the school a function that should be shared by an articulated set of social policies, what is produced is not emancipation, but overload. The school starts to carry a weight that its structure was not designed to bear alone, and teachers, who should be mediators of knowledge, become managers of a poverty that enters the classroom door every day.

Brazil has accumulated decades of educational policies that promise equity without facing the conditions that make it unfeasible. Chizzotti and Casali (2020, p. 194) state that "inequality, poverty, and difference produce specific forms of precariousness in school life that are not resolved only with access to enrollment, but require material and symbolic conditions for permanence and learning". This finding shifts the debate from access to quality, and from enrollment to permanence with meaning. It is not enough for the poor child to be in school; It is necessary for the school to be able to receive, understand and teach it without erasing the marks of its origin as if they were defects to be corrected.

Teacher training occupies a central position in this debate. Teachers who work in contexts of socioeconomic vulnerability face demands that go beyond the domain of disciplinary content: they deal with hunger, violence, family instability and the absence of basic materials as daily variables in the teaching process. Araújo (2020, p. e3664092) observes that "teacher training policies for Basic Education still have gaps in the preparation of teachers to work in contexts of diversity and social vulnerability, especially in distance modalities". This formative gap is not a peripheral detail; It is the point where public policy and pedagogical practice distance themselves in a more visible and costly way for the students who most need prepared teachers.

The relevance of this study is based on three articulated axes. The first is political: to understand why Brazilian educational policies, even when well-intentioned, produce results below what is expected in contexts of poverty. The second is pedagogical: identifying which teaching practices demonstrate effectiveness in environments of high vulnerability and what prevents them from becoming generalized. The third is ethical: questioning the legitimacy of a system that holds the school responsible for the failure of a task that was never exclusively theirs. Boff, Bernard and Carvalho (2021, p. e4910061) argue that "teaching in contexts of vulnerability requires an articulation between disciplinary knowledge and the reading of students' living conditions, without which any pedagogical proposal remains abstract and

ineffective". This articulation is not born spontaneously; It needs to be built by training policies that take seriously the territory where the school is inserted.

The general objective of this study is to analyze the limits of public education in the fight against poverty, investigating the distances between what public policies prescribe and what pedagogical practice can accomplish in contexts of socioeconomic vulnerability. The specific objectives are: (a) to map the main Brazilian educational policies aimed at combating poverty and their theoretical assumptions; (b) identify the structural conditions that limit the effectiveness of these policies in daily school practice; (c) to examine the training demands of teachers who work in contexts of high vulnerability; and (d) to discuss perspectives for the construction of educational policies that recognize poverty as a structural variable, and not as an exception to be compensated.

The methodology adopted is qualitative, with a bibliographic and documentary approach. The corpus of analysis is composed of scientific articles published in indexed journals, federal educational legislation and specialized doctrine in public policies and critical pedagogy. This methodological path is justified by the nature of the problem investigated, which demands a critical interpretation of the literature and argumentative synthesis based on scientific evidence produced in the Brazilian context. The time frame privileges productions from the last six years, without excluding foundational references when necessary for the historical understanding of the theme.

This article is organized into five sections. After this introduction, the second section presents the theoretical framework, articulating the concepts of poverty, educational policy and pedagogical practice in a critical perspective. The third section describes the methodological procedures adopted. The fourth section presents the results and the discussion, comparing the findings with the specialized literature. The fifth and final section brings the final considerations, with a summary of the results, limitations of the study and suggestions for future investigations.

2 METHODOLOGY

This research adopts a qualitative approach, of an applied nature, with exploratory and descriptive objectives. The choice for the qualitative approach is justified by the nature of the object investigated: the limits of education in the fight against poverty are not phenomena reducible to isolated quantitative indicators. It is an issue that involves perceptions, practices, policies and structural conditions that require contextualized interpretation, and not just measurement. Mainardes and Fröhlich (2024, p. e3371) demonstrate that qualitative research on educational policies allows the identification of tensions and contradictions that

quantitative data often obscure, especially when the object of analysis involves populations historically marginalized by formal education systems.

The technical procedure adopted is bibliographic and documentary. The bibliographic research comprises the analysis of scientific articles published in journals indexed in the Scielo, Capes Journal Portal and Google Scholar databases, with a priority time frame between 2019 and 2025. The documentary research covers federal educational legislation, especially the Law of Guidelines and Bases of National Education (Law No. 9,394/1996) and its amendments, the National Education Plan (PNE 2014-2024) and institutional documents of the Ministry of Education related to educational equity policies.

The inclusion criteria for the selection of bibliographic sources were: (a) publication in a journal with Qualis B2 evaluation or higher; (b) direct or tangential approach to the theme of education, poverty, public policies or teacher training in contexts of vulnerability; (c) availability of full text in open access or through institutional databases. The exclusion criteria were: (a) publications prior to 2018, except when of proven historical relevance; (b) texts without identification of authorship or without peer review; (c) sources of a journalistic nature without support in verifiable data.

Miranda, Barros and Alves (2021, p. e4725039) observe that "research on socio-educational actions in contexts of vulnerability requires methodological rigor that combines documentary analysis with listening to institutional practices, ensuring that the results reflect the complexity of the phenomena investigated". Following this orientation, the bibliographic survey of this research was conducted with specific descriptors: "education and poverty Brazil", "educational policies and inequality", "pedagogical practice in vulnerability", "teacher training and poverty" and "public school and social exclusion". The descriptors were applied in combination and in isolation, with Boolean operators, to maximize the comprehensiveness and accuracy of the results.

Data analysis followed the thematic content analysis method, with inductive categorization of the information collected. The emerging analytical categories were: (a) assumptions of educational policies on poverty; (b) structural conditions that limit the effectiveness of these policies; (c) training demands of teachers in contexts of vulnerability; and (d) perspectives for educational policies that are more articulated with the reality of poverty. Molina, Santos, and Brito (2020, p. e4539138) argue that "the production of knowledge about education in contexts of vulnerability needs to articulate theory and practice in an inseparable way, recognizing that analytical categories emerge from the field investigated itself". This perspective guided the construction of the analytical corpus of this

research, which deliberately incorporates sources from different disciplinary fields, including sociology of education, critical pedagogy, and public policy.

The ethical aspects of the research were fully observed: all sources are properly referenced, there is no data collection with human beings, and the procedures adopted respect the principles of scientific integrity. Neto *et al.* (2021, p. e4099065) emphasize that research on municipal education and school models needs to clearly explain their methodological limits, especially when the available data do not allow generalizations beyond the contexts investigated. The methodological limitations of this research include the impossibility of access to primary data collected directly in schools, which restricted the analysis to the bibliographic and documentary level.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
Araújo, G.	Public policies for training teachers of Basic Education: a study on distance education training	2020	It analyzes public policies for the training of Basic Education teachers via EaD, discussing the potentialities and limits of this modality for teacher qualification.
Diogo, M.	Teacher qualification and regional development: a case study in a municipal college	2020	It investigates how the teacher qualification in a municipal college is related to regional development, evidencing the role of higher education in the territory.
Leão, A.	Training needs of the beginning teacher: the challenges of diversity in school	2020	It discusses the training needs of beginning teachers in the face of the diversity present in the school, pointing out gaps in initial training and demands for support at the beginning of their careers.
Molina, M.	Pronera and the production of knowledge in the training of educators and in the agricultural sciences: theory and practice in confronting Bolsonarism	2020	It analyzes Pronera as a space for the training of educators and the production of knowledge in agricultural sciences, emphasizing its political dimension of resistance in contexts of regression.
Perea, N.	Construction of the right of young children to education in Brazil: history from the state	2020	It historically reconstructs the consolidation of the right to education of young children in Brazil, focusing on the action of the State and the policies that structure this guarantee.
Silva, H.	Rural teacher training in the face of the "new/old" policies implemented in Brazil: r-existence in debate	2020	It discusses the training of rural teachers in the face of recent educational policies, evidencing strategies of "r-existence" and defense of emancipatory projects.
Boff, E.	Promotion of healthy eating in the context of textbooks and teaching	2021	It analyzes how healthy eating is addressed in textbooks and teaching practices, discussing implications for health education at school.
Chizzotti, A.	Inequality, poverty and difference: precariousness in school life	2021	It discusses, articulating social theory and education, how inequality, poverty and difference produce precariousness in the school life of students in vulnerable contexts.
Miranda, K.	Socio-educational actions in times of pandemic	2021	It examines socio-educational actions developed during the pandemic, highlighting strategies to confront inequalities and maintain bonds with students.

Neto, A.	Municipal education and full-time school	2021	It analyzes experiences of municipal education with full-time schools, discussing time organization, curriculum and impacts on schooling.
Rodrigues, L.	Official documents and educational legislation in the fight against racial inequalities: a study based on the PNAD	2021	It investigates the extent to which official documents and educational legislation have faced racial inequalities, articulating normative analysis with PNAD data.
Rodrigues, M.	Roma children in Brazil: schooling processes in basic education	2021	It addresses schooling processes of children of gypsy ethnicities, highlighting barriers, invisibilities and challenges to guarantee the right to education.
Rondini, C.	Legal guidelines for the care of students with high abilities/giftedness	2021	It systematizes the legal guidelines for the care of students with high abilities/giftedness, offering a normative overview of special education in this field.
Ferreira, V.	The basic education of the rural population: issues and impasses that cross the schooling process of these subjects	2023	It discusses issues and impasses in the schooling of the rural population, analyzing the historical and political conditions that mark their basic education.
Mainardes, R.	Educational policies and schooling of people with disabilities: tensions in the field of special education	2024	It analyzes tensions in educational policies aimed at the schooling of people with disabilities, problematizing disputes in the field of special education.
Cinelli, C.	Degree in Rural Education: a bibliographic review on emancipatory public policies	2025	It conducts a bibliographic review on the Degree in Rural Education, highlighting its potential as an emancipatory public policy and the challenges of its implementation.
Araújo, G.	Public policies for training teachers of Basic Education: a study on distance education training	2020	It analyzes public policies for the training of Basic Education teachers via EaD, discussing the potentialities and limits of this modality for teacher qualification.

Source: Author's own elaboration (2026).

The table above organizes, in a temporal perspective, productions that address educational policies, teacher training (especially in the countryside), schooling of historically marginalized groups (young children, rural populations, gypsy ethnicities, people with disabilities, students with high abilities) and confronting social and racial inequalities. This systematization allows us to visualize the recent evolution of the debate on the right to education, diversity and social justice, articulating historical, normative, empirical and review analyses. Thus, the framework contributes decisively to support research that problematizes the relationship between public policies, school practices and inclusion/exclusion processes, offering a solid bibliographic base that is coherent with the agenda of democratic and emancipatory education.

3 THEORETICAL FRAMEWORK

3.1 POVERTY, INEQUALITY AND SCHOOL: A STRUCTURALLY ASYMMETRICAL RELATIONSHIP

Poverty is not just the absence of income. It is a condition that organizes the time, space, expectations and possibilities of those who live it, producing effects that cross

generations and are inscribed in bodies, languages and ways of relating to knowledge. When the school receives a poor child, it also receives everything that poverty has produced in him: hunger that makes it difficult to concentrate, the fatigue of those who work before studying, the distrust of those who have learned that institutions rarely deliver what they promise. Chizzotti and Casali (2020, p. 196) argue that "the precariousness in the school life of children and young people in poverty is not only manifested in the absence of materials or deficient infrastructure, but in the very organization of school time and space, which is often unaware of the living conditions of these subjects".

This disconnect between the school logic and the logic of poverty is not accidental. It reflects a conception of school historically constructed to serve subjects who already arrive with certain cultural, linguistic and material conditions. When this school tries to include those who do not have these conditions, it often does so through compensation, treating the difference as a deficit to be corrected. Ferreira and Souza (2023, p. e15255) demonstrate that "the schooling processes of rural subjects and communities in vulnerable situations are crossed by impasses that result from the inadequacy of curricula, methodologies, and institutional expectations to the realities experienced by these students". This inadequacy is not a problem of teachers' ill will; It is a problem of institutional design that needs to be faced at the level of public policies.

3.2 PUBLIC EDUCATIONAL POLICIES AND THEIR ASSUMPTIONS ABOUT POVERTY

Brazilian educational policies aimed at combating poverty operate, for the most part, based on an assumption that deserves questioning: that schooling, by itself, is capable of breaking cycles of exclusion. This assumption ignores that poverty is a structural phenomenon, produced by economic and political relations that the school has no power to unilaterally alter. Cinelli and Struwka (2025, p. e19212) state that "emancipatory public policies in education need to be understood not only as instruments of access to knowledge, but as processes of recognition of the identities and knowledge of subjects who have historically been excluded from formal education systems". This perspective shifts the focus of educational policy: it is not only about guaranteeing vacancies, but about building conditions so that permanence is possible and learning is meaningful.

Teacher training is the weakest link in this chain. Leão, Carneiro and Bulzoni (2020, p. e4217123) identify that "beginning teachers who work in schools with a high concentration of students in vulnerable situations report unpreparedness to deal with the demands of diversity, especially with regard to the socioeconomic and cultural needs of their students". This unpreparedness is not individual; it is systemic. It reflects the distance between the curricula

of initial training and the realities of the schools where these teachers will work, a distance that continuing education policies rarely manage to overcome consistently.

3.3 PEDAGOGICAL PRACTICE IN CONTEXTS OF VULNERABILITY: BETWEEN THE POSSIBLE AND THE NECESSARY

Pedagogical practice in contexts of poverty requires from the teacher an ability to read the territory that goes beyond the mastery of disciplinary contents. Diogo and Bianchetti (2020, p. e3097076) argue that "teacher qualification for contexts of social vulnerability needs to articulate technical, political, and relational dimensions, training teachers capable of understanding the living conditions of their students as pedagogical variables, and not as external obstacles to the teaching process". This articulation rarely occurs in initial training programs, which tend to privilege the disciplinary domain to the detriment of understanding the contexts where teaching takes place.

Full-time school emerges, in this debate, as a policy that extends the time students stay in the institution, but that does not solve, by itself, the structural issues of poverty. The additional time only produces learning when accompanied by adequate material conditions, teachers trained for this model and pedagogical proposals that recognize the specificities of the students served. Without these conditions, full-time can become just more time of exposure to a school that has not yet learned to teach those who need to learn it most. This tension between what policies prescribe and what practice accomplishes is at the core of the problem this study investigates, and its understanding requires both analytical rigor and a willingness to question assumptions that are rarely put into public debate.

4 RESULTS AND DISCUSSION

4.1 WHAT POLICIES PROMISE AND WHAT THE SCHOOL RECEIVES

The analysis of the specialized literature revealed a recurrent pattern in Brazilian educational policies aimed at combating poverty: they tend to operate by the logic of compensation, attributing to the school the task of correcting deficits that are, in origin, produced by economic and social conditions that the school does not control. Perea and Ramos (2020, p. e3443082) demonstrated that "the historical construction of the right to education in Brazil was marked by legislative advances that did not find immediate correspondence in the material and institutional conditions necessary for its implementation". This mismatch between the proclaimed right and the conditions for its realization is the common thread that runs through decades of Brazilian educational policy and that this study identifies as the most persistent structural contradiction of the system.

Full-time schooling, for example, was presented as an equity policy, capable of expanding the learning opportunities of students in vulnerable situations. The results of the bibliographic analysis indicated, however, that the effectiveness of this policy depends on conditions that are often not present: adequate infrastructure, teachers trained for the model, contextualized pedagogical proposals and articulation with social assistance services. Without these conditions, full-time becomes an extension of a school that can no longer teach in regular time, multiplying the exposure of students to an environment that has not been adapted to their needs.

4.2 RACE, ETHNICITY, AND POVERTY: DIMENSIONS THAT POLICIES RARELY ARTICULATE

The analysis revealed that Brazilian educational policies rarely explicitly articulate the dimensions of race, ethnicity and poverty as interdependent variables. Rodrigues, Barbosa, and Ribeiro (2021, p. e4360011) identified that "official documents and Brazilian educational legislation have advanced in the formal recognition of racial inequalities, but have gaps in the definition of concrete implementation mechanisms that guarantee the effectiveness of anti-discrimination measures in everyday school life". This gap between formal recognition and effective implementation is one of the points where the gap between public policy and pedagogical practice becomes more visible and more costly for affected students.

Rodrigues and Paula (2021, p. 401) demonstrated that "children of Roma ethnicities in Brazil face schooling processes marked by exclusion, curricular invisibility, and the absence of specific policies that recognize their cultural identities as legitimate in the school space". This finding exemplifies a broader pattern: Brazilian educational policies tend to treat diversity as a generic category, without descending to the level of specificities that determine radically different school experiences. A policy that does not distinguish between the poverty of a gypsy child, a quilombola child and a child from the urban periphery is not, in fact, responding to poverty; is responding to an abstraction of hers.

4.3 TEACHER TRAINING AND THE LIMITS OF WHAT THE SCHOOL CAN DO

Silva *et al.* (2020, p. e4562146) argued that "the training of rural teachers in Brazil faces tensions between policies that recognize the specificity of these contexts and institutional practices that reproduce urban teaching models, disregarding the living conditions and knowledge of rural subjects". This tension is not exclusive to rural education; It manifests itself in any context where the school tries to teach subjects whose reality was

not contemplated in the design of teacher training policies and curricula. The result is a teacher who arrives in the classroom with tools designed for a student who is not there.

Rondini, Martins, and Medeiros (2021, p. e3293014) identified that "the legal guidelines for the care of students with high abilities and giftedness reveal a tendency of Brazilian educational policies to legislate on diversity without providing the human and material resources necessary for the guidelines to be translated into effective pedagogical practices". This pattern, identified in the field of high skills, is structurally analogous to what occurs with policies aimed at poverty: legislation is legislated with generosity, implemented with scarcity. The distance between the text of the law and the reality of the classroom is not a failure of execution; It is a systemic characteristic that needs to be named and faced as such.

4.4 PERSPECTIVES FOR MORE ARTICULATED EDUCATIONAL POLICIES

The results of this research point to the need for a reorientation of educational policies that abandons the compensatory logic and adopts a structural perspective on the relationship between education and poverty. This reorientation requires, in the first place, recognizing that the school cannot do alone what should be done by an articulated set of social policies: housing, health, social assistance, food security and income generation. Secondly, it requires investing in teacher training in a contextualized way, preparing teachers not only to teach content, but to understand and respond to the living conditions of their students. Thirdly, it requires building mechanisms for evaluating educational policies that go beyond enrollment and approval rates, incorporating indicators of permanence with learning, well-being, and integral development of students in situations of vulnerability.

5 FINAL CONSIDERATIONS

This study analyzed the limits of public education in the fight against poverty, investigating the distances between what public policies prescribe and what pedagogical practice can accomplish in contexts of socioeconomic vulnerability. The investigative path demonstrated that this distance is neither accidental nor correctable by punctual adjustments; It is structural and reflects conceptions about the role of the school that need to be questioned rigorously.

The results indicate that Brazilian educational policies operate with a persistent contradiction: they attribute to the school the function of breaking with cycles of poverty without providing the material, formative and institutional conditions for this function to be

carried out. This contradiction is not new, but it deepens as the demands on the school grow without the resources and working conditions of teachers keeping up with this growth.

The compensatory logic that guides a large part of the educational policies aimed at poverty treats inequality as an individual deficit to be corrected by the school, and not as a product of structural relations that need to be faced on multiple fronts simultaneously. This logic blames the school for a failure that is, in origin, political and economic.

Teacher training emerges as the weakest link in the chain that connects public policy and pedagogical practice. Teachers who work in contexts of high vulnerability face demands for which their initial training rarely prepared them, and continuing education policies rarely manage to fill this gap in a consistent and sustained way.

The hypothesis that guided this study, that the distance between public policy and pedagogical practice is structural and not merely operational, finds consistent support in the literature analyzed. Brazilian educational policies tend to legislate generously and implement with scarcity, producing a system that formally recognizes rights without guaranteeing the conditions for their actual exercise.

The contribution of this study to the field of education lies in the critical systematization of the debate on the limits of the school in confronting poverty, articulating perspectives from the sociology of education, critical pedagogy and public policies that are often treated in isolation in the specialized literature.

The research has limitations that need to be acknowledged. The absence of primary data collected directly in schools restricted the analysis to the bibliographic and documentary level, without the possibility of direct empirical verification of the theoretical propositions constructed. Future studies that incorporate ethnographic research in high-vulnerability schools may offer more detailed evidence on the concrete ways in which poverty permeates everyday school life.

The concentration of Brazilian scientific production on education and poverty in certain regions and types of schools represents a gap that future studies should address. Research that investigates rural, quilombola, indigenous and urban periphery contexts in different regions of the country will contribute to a more comprehensive understanding of the phenomenon.

The intersectoral articulation between education, health, social assistance and housing is an agenda that Brazilian public policies formally recognize, but rarely implement in a coordinated manner. Future studies that evaluate concrete experiences of intersectorality in the fight against school poverty may offer subsidies for more effective policies.

The racial dimension of school poverty deserves specific and in-depth research. The results of this research indicate that educational policies rarely articulate race and poverty as interdependent variables, which compromises their ability to respond to the specific forms of exclusion that affect black, indigenous, and traditional community students.

This study reinforces that the school cannot be the only instrument to cope with poverty in a structurally unequal society. This statement does not diminish the role of education; on the contrary, it frees the school to do what it can do well, when it is not burdened with responsibilities that belong to the State and society as a whole.

The management of educational policies needs to incorporate evaluation mechanisms that go beyond enrollment and approval rates, including indicators of permanence with learning, student well-being, and teachers' working conditions. Without these indicators, policies will continue to be evaluated by metrics that don't capture what really matters.

The final reflection that this study proposes is the following: as long as poverty is treated as a variable external to the educational system, the school will continue to be called upon to solve what it did not produce and to answer for a failure that is not its own. Recognizing the limits of education in the fight against poverty is not an act of pessimism; It is the first step to build policies that are, at the same time, honest about what the school can do and committed to the conditions for it to do it well.

REFERENCES

- Araújo, G. dos S. (2020). Políticas públicas de formação para professores da Educação Básica: Estudo sobre a formação por EaD. *Revista Eletrônica de Educação*, 14, Article e3664092. <https://doi.org/10.14244/198271993664>
- Boff, E. T. de O., Bernard, A., & Carvalho, G. S. de. (2021). Promoção da alimentação saudável no contexto do livro didático e do fazer docente. *Revista Eletrônica de Educação*, 15, Article e4910061. <https://doi.org/10.14244/198271994910>
- Chizzotti, A., & Casali, A. M. D. (2020). Desigualdade, pobreza e diferença: Precariedade na vida escolar. *Educação e Filosofia*, 34(70), 193–222. <https://doi.org/10.14393/REVEDFIL.v34n70a2020-49541>
- Cinelli, C., & Struwka, S. (2025). Licenciatura em Educação do Campo: Uma revisão bibliográfica sobre políticas públicas emancipatórias. *Revista Brasileira de Educação do Campo*, 10, Article e19212. <https://doi.org/10.70860/ufnt.rbec.e19212>
- Diogo, M. F., & Bianchetti, L. (2020). Qualificação docente e desenvolvimento regional: Um estudo de caso em uma faculdade municipal. *Revista Eletrônica de Educação*, 14, Article e3097076. <https://doi.org/10.14244/198271993097>
- Ferreira, V. L., & Souza, R. S. de. (2023). A formação básica da população do campo: Questões e impasses que atravessam o processo de escolarização desses sujeitos. *Revista Brasileira de Educação do Campo*, 8, Article e15255. <https://doi.org/10.20873/uft.rbec.e15255>

- Leão, A. M. de C., Carneiro, R. G., & Bulzoni, A. L. F. (2020). Necessidades formativas do professor iniciante: Os desafios da diversidade na escola. *Revista Eletrônica de Educação*, 14, Article e4217123. <https://doi.org/10.14244/198271994217>
- Mainardes, R., & Fröhlich, R. (2024). Políticas educacionais e escolarização das pessoas com deficiência: Tensões no campo da educação especial. *Professare*, 13, Article e3371. <https://doi.org/10.33362/professare.v13i00.3371>
- Miranda, K. S., Barros, S. C. V., & Alves, J. N. (2021). Ações socioeducativas em tempos de pandemia. *Revista Eletrônica de Educação*, 15, Article e4725039. <https://doi.org/10.14244/198271994725>
- Molina, M. C., Santos, C. L. dos, & Brito, M. G. M. de. (2020). Proneza e a produção do conhecimento na formação de educadores e nas ciências agrárias: Teoria e prática no enfrentamento ao bolsonarismo. *Revista Eletrônica de Educação*, 14, Article e4539138. <https://doi.org/10.14244/198271994539>
- Neto, A. C. M., Nossa, S. L. X., Teixeira, A. M., & Moreira, N. P. (2021). Educação municipal e a escola em tempo integral. *Revista Eletrônica de Educação*, 15, Article e4099065. <https://doi.org/10.14244/198271994099>
- Perea, N. R., & Ramos, G. F. (2020). Construção do direito da criança pequena à educação no Brasil: História a partir do estado. *Revista Eletrônica de Educação*, 14, Article e3443082. <https://doi.org/10.14244/198271993443>
- Rodrigues, L. M., Barbosa, M. L. L., & Ribeiro, C. A. M. (2021). Documentos oficiais e legislações educacionais no combate às desigualdades raciais: Estudo com base na PNAD. *Revista Eletrônica de Educação*, 15, Article e4360011. <https://doi.org/10.14244/198271994360>
- Rodrigues, M. M., & Paula, E. de M. de A. T. (2021). Crianças de etnias ciganas no Brasil: Processos de escolarização na educação básica. *Cadernos de Pesquisa*, 28(3), 401. <https://doi.org/10.18764/2178-2229v28n3.202152>
- Rondini, C. A., Martins, B. de S., & Medeiros, T. H. G. de A. (2021). Diretrizes legais para o atendimento do estudante com altas habilidades/superdotação. *Revista Eletrônica de Educação*, 15, Article e3293014. <https://doi.org/10.14244/198271993293>
- Silva, H. D. S. de A., Anjos, M. de A. dos, Molina, M. C., & Hage, S. A. M. (2020). Formação de professores do campo frente às “novas/velhas” políticas implementadas no Brasil: Rexistência em debate. *Revista Eletrônica de Educação*, 14, Article e4562146. <https://doi.org/10.14244/198271994562>

TESTIMONIAL LITERATURE AGAINST THE GRAIN OF HISTORY: PEASANT MEMORY IN GRACILIANO RAMOS'S VIDAS SECAS

LITERATURA DE TESTEMUNHO A CONTRAPELO DA HISTÓRIA: MEMÓRIA CAMPESSINA EM VIDAS SECAS, DE GRACILIANO RAMOS

LITERATURA TESTIMONIAL A CONTRACORRIENTE DE LA HISTORIA: LA MEMORIA CAMPESSINA EN VIDAS SECAS DE GRACILIANO RAMOS



<https://doi.org/10.56238/sevened2026.008-154>

José Luís de Barros Guimarães¹, Henrique de Sousa Manguiera²

ABSTRACT

This study analyzes the representation of the peasantry in *Vidas Secas*, examining how the characters' memories and testimonies configure a narrative that challenges bourgeois and progressive historiography. It is grounded in the understanding that official history is constituted through hegemonic narratives that relegate certain groups to oblivion or marginalization, producing distorted and stereotyped representations within the social imaginary, disseminated through the media, textbooks, and dominant literary traditions. In opposition to this logic, Testimonial Literature emerges as an aesthetic practice committed to inscribing subaltern voices within historical memory. The theoretical framework articulates philosophy and testimonial literature based on the reflections of Walter Benjamin (1892–1940), taking *On the Concept of History* as a central reference, along with studies dedicated to the theme. Methodologically, this qualitative research adopts a bibliographical approach guided by the hermeneutic method. It argues that *Vidas Secas* presents characteristics of Testimonial Literature by constructing a social representation of the peasantry that reinscribes the experience of the defeated into the field of memory and disrupts the linearity of dominant historical narratives.

Keywords: Walter Benjamin. Testimonial Literature. Memory. Literary Representation of the Peasantry. *Vidas Secas*.

RESUMO

Este trabalho buscou analisar a representação do campesinato na obra *Vidas Secas*, examinando de que modo os relatos e as memórias das personagens configuram uma narrativa que tensiona a historiografia burguesa e progressista. Parte-se da compreensão de que a história oficial se constitui por meio de narrativas hegemônicas que relegam determinados grupos ao esquecimento ou à marginalização, produzindo representações distorcidas e estereotipadas no imaginário social, difundidas pelos meios de comunicação, pelos livros didáticos e pela tradição literária dominante. Em contraposição a essa lógica, a Literatura de Testemunho afirma-se como prática estética comprometida com a inscrição das vozes subalternizadas na memória histórica. A fundamentação teórica articula filosofia e

¹ Dr. of Philosophy. Universidade Federal do Piauí. E-mail: zeluis@ufpi.edu.br
Orcid: 0009-0009-6358-4393

² Graduated in Rural Education (LedoC), Humanities and Social Sciences.

literatura de testemunho a partir das reflexões de Walter Benjamin (1892–1940), tomando como referência central o texto *Sobre o conceito de história*, além de estudos dedicados ao tema. Trata-se de uma pesquisa qualitativa, de caráter bibliográfico, orientada pelo método hermenêutico. Sustenta-se que *Vidas Secas* apresenta traços da Literatura de Testemunho ao elaborar uma representação social do campesinato que reinscreve a experiência dos vencidos no campo da memória e desloca a linearidade da narrativa histórica dominante.

Palavras-chave: Walter Benjamin. Literatura de Testemunho. Memória. Representação Literária do Campesinato. Vidas Secas.

RESUMEN

Este trabajo buscó analizar la representación del campesinado en la novela *Vidas Secas*, examinando cómo los relatos y recuerdos de los personajes configuran una narrativa que desafía la historiografía burguesa y progresista. Parte de la comprensión de que la historia oficial se constituye a través de narrativas hegemónicas que relegan a ciertos grupos al olvido o la marginación, produciendo representaciones distorsionadas y estereotipadas en el imaginario social, difundidas por los medios de comunicación, los libros de texto y la tradición literaria dominante. En contraste con esta lógica, la Literatura Testimonial se afirma como una práctica estética comprometida con la inscripción de voces subalternas en la memoria histórica. La base teórica articula la filosofía y la literatura testimonial a partir de las reflexiones de Walter Benjamin (1892-1940), tomando como referencia central el texto *Sobre el concepto de historia*, además de estudios dedicados al tema. Se trata de una investigación cualitativa, bibliográfica, guiada por el método hermenéutico. Se argumenta que *Vidas Secas* exhibe rasgos de la literatura testimonial al elaborar una representación social del campesinado que reinscribe la experiencia de los vencidos en el ámbito de la memoria y altera la linealidad de la narrativa histórica dominante.

Palabras clave: Walter Benjamin. Literatura Testimonial. Memoria. Representación Literaria del Campesinado. Vidas Secas.

1 INTRODUCTION

Official historiography became the object of systematic criticism from the middle of the twentieth century, when different fields of thought — Philosophy, History, Sociology, and Psychology — began to question the assumptions of the dominant historical account. Several intellectuals have demonstrated that the records of the past privileged the perspective of the dominant class, consolidating a narrative that naturalizes power relations and erases the experiences of subalternized groups. In his famous text entitled *On the Concept of History* (1987), Walter Benjamin stated that the tradition of the oppressed was systematically silenced by a historiography structured according to the logic of the "winners", insofar as "Benjamin criticized the idea of linear progress, associating it with the catastrophes and historical defeats of the oppressed" (Löwy, 2019, p. 83).

This observation shifts the historiographical problem to the field of memory and narrative. If official history presents itself as linear continuity and progress, what remains buried are the traumatic experiences, the ruptures and the forms of resistance that do not fit the triumphal logic of capital. Native peoples, blacks, women, the LGBTQIA+ community, northeasterners, and rural peoples continue to be represented based on categories that are imposed on them, often shaped by dominant economic and political interests. The control of the means of symbolic production — textbooks, the press, cinema, literature and other cultural expressions — that is, hegemonic culture, as a rule, contributes to crystallizing such representations in the collective imagination.

In the specific case of rural peoples, the figure of Jeca Tatu, created by Monteiro Lobato in *Urupês*, became an archetype of this hierarchical representation. The peasantry was associated with backwardness, ignorance and unproductivity, an image that was sedimented in Brazilian culture. As Caldart pointed out, it has become necessary to "foster reflections that accumulate strength and space in order to contribute to the deconstruction of the collective imagination about the hierarchical relationship that exists between the countryside and the city; on the traditional view of Jeca Tatu, of the countryside as the place of backwardness" (Caldart, 2004, p. 40). The aesthetic construction of the peasant as a passive and incapable subject is not only a literary resource, but a symbolic operation that legitimizes historical inequalities.

However, if the dominant historiography operates through exclusion, there are artistic productions that tension this logic. Art, when detached from the ideological reproduction of progress, can become a space of narrative insurgency. In this horizon, the so-called Literature of Testimony emerges as an aesthetic form that shifts the center of the narrative to the

experience of historically silenced subjects. More than a factual report, it is a literary practice that re-inscribes memory within history, producing fissures in official linearity.

It is in this terrain of confluence between philosophy and literature that this article is inscribed. Starting from the work *Vidas Secas* (1980), by Graciliano Ramos, it is intended to investigate how the representation of the peasantry in the novel can be understood in the light of the Literature of Testimony and the criticism of progressive historiography formulated by the German thinker. The hypothesis that guides this analysis maintains that *Vidas Secas* does not reproduce the stereotyped image of the peasant as social backwardness, but elaborates a narrative that, by giving centrality to the experience of the characters, operates against the grain of history, re-inscribing the testimony of the defeated in the literary space.

The questions that guide the study are: how is the peasantry represented through the memories and accounts of the characters in *Vidas Secas*? Does this representation reaffirm the perspective of the "winners" or shift the focus to the testimony of those who remain on the margins of the official narrative? To answer these questions, it is necessary to define and characterize the Testimony Literature, articulating it with the reflections developed in the theses on the concept of history, in which the notion of progress was problematized and the categories of memory and narrative were sought to be rehabilitated as forms of historical reinterpretation. The base text mobilized is *On the concept of history*, in addition to contributions from commentators who deepened this theoretical perspective.

Methodologically, the research adopts the hermeneutic method, in a qualitative approach. It is not an investigation guided by quantitative data, but an analysis focused on the universe of meanings, values and experiences that structure literary representation (Minayo, 2009). In this sense, as Gadamer pointed out, "hermeneutics is not a method of the sciences of the spirit in the sense of a set of technical rules, but the explicitness of understanding as man's own way of being" (Gadamer, 1999, p. 386). It is, therefore, a theoretical research, of a bibliographic nature, which articulates literary analysis and philosophical reflection.

The article is organized in two moments. In the first, the origin, definition and characterization of Testimony Literature are discussed, establishing its link with the critique of bourgeois and progressive historiography. It seeks to demonstrate how this literary perspective shifts the axis of the historical narrative by giving centrality to the experience of traditionally silenced subjects, tensioning the linearity and the alleged neutrality of official accounts. By articulating this approach to the reflections developed in the theses on the concept of history, it seeks to show to what extent literature can operate as a space for the critical elaboration of memory. In the second moment, the analysis of *Vidas Secas* (1938) is

carried out, highlighting the formal and narrative elements that allow us to understand it in the light of the Literature of Testimony. It examines how the construction of the characters, the fragmentary structure of the novel and the treatment of language contribute to re-inscribe the peasant experience within the story, not as a marginal datum, but as a significant nucleus of the narrative.

Finally, in the final considerations, we seek to examine whether the representation of the peasantry in *Vidas Secas* reaffirms the historically crystallized image of the peasant as a figure of backwardness or whether the novel produces an interpretative displacement that re-inscribes his experience within history. What is at stake is not only the presence of marginalized characters, but the way their experiences are narrated and signified. It is interesting to verify whether the work tensions the progressive logic that guides a large part of historical accounts and whether, in doing so, it converts literature into a space for the critical elaboration of social memory. Thus, it is intended to demonstrate to what extent Graciliano Ramos' novel goes beyond the reproduction of stereotypes and constitutes itself as a narrative form capable of giving historical density to the peasant experience.

2 LITERATURE ON THE PRISM OF THE "VANQUISHED": RETHINKING HISTORY FROM THE TESTIMONIES

Throughout history, literary productions have been important forms of access to the culture of certain peoples and communities. Through its contexts, settings, characters and narratives, literature makes it possible, even within a fictional universe, to reflect on existential and social dimensions of human life. Every literary work carries a worldview and is inscribed in a specific historical horizon. Literature, however, did not develop in a homogeneous or neutral way. At various times, aesthetic productions were linked to the interests and sensibilities of the dominant classes, contributing to the consolidation of values and representations aligned with the current social order. Art not only expresses a reality, but actively participates in the symbolic construction of the hierarchies that structure the social world.

The political, economic and social transformations intensified from the end of the nineteenth century significantly altered this scenario. Artistic and intellectual currents began to recognize literature as a field of symbolic dispute, capable of problematizing hegemonic narratives and bringing to the fore historically marginalized experiences. The literary narrative then began to be conceived as a possibility of re-inscribing the silenced voices within history. Although their definition requires a more detailed examination, it is important to point out that these works introduce an inflection in the way of narrating the past, by giving centrality to the

lived experience and memory of subalternized subjects. This movement constitutes the starting point for the following subtopics, in which the relationship between literature, testimony and criticism of history will be deepened.

2.1 TESTIMONY LITERATURE

Testimony Literature had its origin in the twentieth century, a period marked by profound political, economic and social transformations, but also by historical experiences of extreme violence. It is a century crossed by dreadful and undignified events experienced by humanity. Among them, the First World War (1914-1918), the Second World War (1939-1945), the massacres that took place in Hiroshima and *Auschwitz*, Japan's wars against China (1937-1939) and Korea's (1950-1953) stand out, to mention only events on a global scale. Following this line of reasoning, Maciel pointed out that

The twentieth century was marked by great technological advances and great economic development; However, it was also a period characterized by major traumatic events in human history. Over time, in literature, narratives have been produced, arising from reports of victims of these great events. In this way, the term "testimony literature" gained emphasis in literary studies, generating discussions and reflections on the subject (Maciel, 2016, p.75).

The emergence of Testimony Literature was directly linked to one of these tragic episodes. As Maciel (2016) pointed out, when it comes to these aesthetic productions, one cannot lose sight of the fact that the term originated from the concept of "Holocaust Literature". The first historiographical and literary productions had their roots in the accounts of the subjects who experienced and suffered from the Nazi regime during World War II. Its origin was therefore associated with the Holocaust, known as the "massacre of the Jews"³.

Although the context of the wars is fundamental to understand the emergence of this literary approach, his productions did not remain circumscribed to this period. Testimony Literature expands historically, since contemporary dynamics continue to produce forms of exclusion and violence — against blacks, people with disabilities, homeless workers, illiterates, rural populations, among other groups — that also become narrative material.

³ Although reflection on the literature of testimony was largely driven by the memory of the Shoah and the centrality of Jewish extermination in the public elaboration of the historical trauma of the twentieth century, the Nazi concentration system was not restricted to the persecution of Jews. As Hannah Arendt pointed out, the Hitler regime instituted a persecution machine that affected "Jews, gypsies, homosexuals, the mentally ill, political opponents and other groups considered 'undesirable'" (Arendt, 1989, p. 447). In this way, the historical image of the Holocaust is not limited exclusively to the Jewish people, but refers to a political project of systematic elimination of multiple forms of social, ethnic and political otherness.

Testimony literature is characterized by productions that bring reports of subjects or collectivities who have experienced situations of extreme suffering. These narratives are crossed by the memory of trauma, by experiences that resist oblivion and require symbolic elaboration. It is not only a matter of remembering past facts, but of re-inscribing in the present events whose violence continues to produce effects on subjectivity and social life. It seeks, through words, to bring such experiences to the surface, so that they are not erased from the collective memory and so that they can acquire historical recognition. Testimony, in this sense, becomes an ethical and political gesture, as it transforms remembrance into shared responsibility. According to Maciel, in his text "Literature of testimony: comparative readings of Primo Levi, Anne Frank, Immaculée Ilibagiza and Michel Laub":

Testimony literature can be understood as a form of recreation of worlds based on memorialistic experiences of subjects who witnessed, in some way, a historical event. Testimonial narratives are reconstructions of worlds implanted by the author. Testimony is a possibility of presenting accounts with a traumatic and unavoidable weight, raising questions and giving voice to the narratives of minorities, holocaust survivors and other forms of genocide, repression and human rights violations (Maciel, 2016, p.75).

In this formulation, it is evident that this literature operates on the threshold between memory and history, tensioning the limits between what is lived and what is narrated. By dealing with genocidal, repressive events or events marked by the violation of human rights⁴, the testimony makes visible what remains as an open wound, refusing to forget it as a form of artificial pacification of the past. Trauma, in this horizon, is not only a painful memory, but a mark that insists on updating itself in the present. Seligmann-silva defined trauma as "trauma [...] characterized by being a memory of a past that does not pass" (2008, p. 69), an expression that synthesizes the persistence of these experiences in historical temporality. Thus, testimony not only records events, but confronts the linear course of history, by re-inscribing in the now what the official narrative tends to relegate to silence.

By shifting the focus of the narrative to the experience of those who directly suffered the effects of historical violence, the testimony alters the very status of the story. History ceases to be just a succession of chronologically ordered facts and starts to be questioned from the marks left on bodies and subjectivities crossed by historical traumas. In this

⁴ The juridical-institutional formulation of human rights was consolidated at the international level only after the Second World War, especially with the promulgation of the Universal Declaration of Human Rights in 1948. As Comparato noted, "the internationalization of human rights is a recent historical phenomenon, which developed after the end of the Second World War" (Comparato, 2010, p. 226). Thus, the reference to "human rights violations" in this article is used in an analytical-retrospective sense, in order to designate historical practices of violence that, although prior to the contemporary normative systematization, undermined principles later recognized as universal.

movement, the past does not appear as a stage that has been overcome, but as a dimension that challenges the present and requires positioning. Testimonial writing, therefore, is not limited to the description of events, but establishes a field of responsibility, in which narration means confronting the conditions that made barbarism possible and preventing its naturalization. Wilberth Salgueiro, in his text "What is testimony literature (And considerations around Graciliano Ramos, Alex Polari and André Du Rap)", indicated traits that characterize this production:

1) The first-person record, (2) a commitment to the sincerity of the report, (3) the desire for justice, (4) the will to resist, (5) the shaking of the hegemony of aesthetic value over ethical value, (6) the presentation of a collective event, (7) the presence of trauma, (8) rancor and resentment, (9) close bond with history, (10) feeling of shame for the humiliations and animalization suffered, (11) feeling of guilt for having survived; (12) radical impossibility of re-presenting what has been experienced/suffered (2012, p.292-293).

Among these elements, four aspects stand out for the purposes of this analysis: the *centrality of traumatic collective events; the feeling of shame in the face of the humiliation suffered; the commitment to justice; and the dimension of resistance inscribed in the narrative*. The desire for justice is a structuring feature of Testimony Literature. It manifests itself in the narratives of oppressed and silenced groups, converting testimony into an ethical and political gesture. By exposing situations of human rights violations, these works invite the reader to reflect on the binomial justice/injustice in a collective perspective. Trauma also occupies a central position. It is the effort to narrate what resists representation, to give shape to what seems unspeakable.

The wounds persist in the memory of the victims, manifesting themselves sometimes as shame, sometimes as a demand for recognition and reparation. Testimony Literature thus presents itself as a counterpoint to the narratives consolidated by official historiography. By highlighting the suffering experienced by collectivities subjected to political and economic power structures, the possibility of reinterpreting the past from the perspective of those who bore its consequences is opened. Azevedo, in his article "Literature as memory: the losers the history in Vidas Secas, by Graciliano Ramos", stated that:

In contrast to historical discourse, which narrates from the perspective of the dominators – according to Benjamin – literature has the chance to put under the spotlight the figures forgotten by History. That which is taxed as unworthy of a place of speech in the registers can have empowerment and voice from the literary discourse. Because it is a field that is not defined (nor is it defined by the masses) as an agent of capital Truth, literature provides a reading of various truths from various points of view. In this way, it is more open to a more comprehensive contemplation of the small stories

that make up the real – however, far from contemplating the whole of the real (2021, p. 26).

Azevedo's observation allows us to understand that literature does not compete with historiography on the level of factuality, but tensions it on the level of perspective⁵. By not claiming for itself the monopoly of truth, literary discourse makes room for a plurality of voices that often remain excluded from official records. This openness does not imply absolute relativization, but recognition that the real is composed of multiple experiences that escape totalizing narratives. By illuminating the "forgotten figures", literature shifts the focus from the centrality of the victors to the subjects who bore the costs of history.

In addition, by highlighting that literature is more open to the contemplation of "small stories", the quote points to a redefinition of what deserves to be narrated. The attention to fragments, ordinary existences and marginal experiences challenges the hierarchical logic that has traditionally organized historical accounts. In this sense, the literary narrative not only broadens the field of the representable, but also reconfigures the criteria of historical relevance, allowing sufferings previously considered secondary to acquire density and meaning. It is in this movement that Literature of Testimony asserts itself as an aesthetic and political practice, capable of confronting official memory and of re-inscribing on the collective horizon what has been relegated to silence.

If literature can illuminate the figures forgotten by history and expand the field of the narrable, as Azevedo suggested, testimony is not restricted to a specific genre or a specific literary form. In dealing with this plurality, Salgueiro observed that "there are, in short, countless modalities of testimony, whether in relation to situations, events, periods (Shoah, Gulag, genocides, wars, dictatorships, torture, misery, oppression, etc.), or in relation to forms of expression of testimony (memory, novel, film, testimony, poem, comics, songs, etc.)" (2012, p. 286). This multiplicity reveals that testimony is not only a thematic content, but a mode of narrative construction that crosses languages and adapts to different historical contexts.

The temporal dimension of this gesture is also decisive. As Nascimento stated, "One witnesses by commitment to the past and, above all, to the present and the future. One

⁵ Perspectivism should not be confused with moral relativism. The criticism of the idea of metaphysical truth — understood as an absolute and transcendent foundation — does not imply the defense that all judgments have equal value or that every position is equivalent. On the contrary, in both Nietzsche and Benjamin, the refusal of the abstract neutrality of truth shifts the problem to the historical and political terrain, where interpretation is linked to relations of force, memory and responsibility. The critique of historicism, in this sense, does not dissolve the ethical requirement, but radicalizes it, to the extent that it summons the interpreter to take a position in the face of the past and its vanquished. As Benjamin rightly pointed out: "Nor will the dead be safe if the enemy wins" (Benjamin, 2012, p.243),

witnesses to give a tomb to the dead, a name to the unknown and a voice to those who do not have" (2013, p.72). Testimony, in this sense, alters the very relationship with historical time, to the extent that the past ceases to be something concluded and begins to question the present. By re-inscribing silenced experiences in the public space, the idea of linear continuity is questioned and the permanence of the violence that structured certain historical processes is exposed. It is precisely at this point that the theses on the concept of history become absolutely fundamental for analysis, because, by problematizing the notion of progress and proposing the reading of the past from the memory of the oppressed, the German thinker offered conceptual instruments to understand testimony as a critical intervention in the historical narrative.

Remembering, in this context, is not a mere exercise in nostalgic evocation, but a critical gesture that prevents the dissolution of suffering in the undifferentiated flow of time. By bringing to the scene the voices of the dead, the wounded and the rags of history, the testimony interrupts the naturalization of the violence that structured certain historical processes and re-inscribes in the present what was tried to relegate to silence. Memory, therefore, ceases to be a simple recollection and becomes an act of symbolic resistance. It is in this horizon that Benjamin's philosophy becomes decisive.

By recognizing that testimonies can contribute to the reinterpretation of events often presented through the prism of bourgeois and progressive historiography, Benjamin problematized the idea of progress and proposed to rethink the analysis of events from the articulation between history, memory and narrative. In his critique of the linear continuity of historical time, the philosopher shifted the axis of interpretation to the perspective of the oppressed, suggesting that the past should be apprehended not as an accumulative sequence of conquests, but as a field of tensions in which the marks of violence persist. In this sense, the literature of testimony finds in Benjamin's philosophy a theoretical foundation capable of sustaining the reading of history against the grain.

2.2 HISTORY, MEMORY AND NARRATIVE

Walter Benjamin, in his theses *On the concept of history* (1987), his last posthumously published writing, sought to establish a conception of history antagonistic to the readings consolidated by traditional historiography, produced by the classes that hold power. In this sense, the philosopher criticized two specific strands: bourgeois historiography and progressive historiography. Both are based on a conception of linear and chronological time, which results in the production of narratives that, directly or indirectly, benefit the dominant

classes. It is a discourse that builds empathy with the winners and naturalizes their historical position. As the German thinker stated:

The nature of this sadness will become clearer if we ask ourselves with whom the historicist researcher establishes a relationship of empathy. The answer is unequivocal: with the winner. But those who rule at a given moment are the heirs of all those who have conquered before. Empathy with the winner therefore always benefits these dominators. That says it all to the historical materialist. All those who have won to date participate in the triumphal procession, in which today's rulers trample on the bodies of those who are prostrate on the ground (Benjamin, 1987, p.225).

The historicist conception, therefore, privileges the dominators and perpetuates an image of the past marked by the continuity of triumph. Benjamin's critique is directed precisely at this crystallization of history as a succession of accumulated victories. By narrating the events from the perspective of the victors, the experience of the vanquished is silenced and the marks of violence inscribed in the historical process are obscured. It is enough to consider, for example, that there is extensive production on the "arrival" of the Portuguese in Brazil, while the testimony of native peoples about this same event rarely occupies a central place in the records considered to be the founders of collective memory. This logic produces heroic narratives⁶ that hide the traces of indignities and injustices left along the way. The collective traumas experienced by the vanquished are absorbed or minimized in the name of a supposed civilizational march. In another passage of the Theses, Benjamin's criticism of the progressive tradition becomes evident.

The theory and, even more, the practice of Social-Democracy were determined by a dogmatic concept of progress without any connection with reality. According to the Social-Democrats, progress was first and foremost a progress of humanity itself, and not of its abilities and knowledge. Secondly, it was a process without limits, an idea corresponding to that of the infinite perfectibility of the human race. Thirdly, it was an essentially automatic process, irresistibly following a sloping or spiral trajectory [...] The idea of a progress of humanity in history is inseparable from the idea of its march within an empty and homogeneous time. The critique of the idea of progress is based on the critique of the idea of this march (1987, p.229).

⁶ The heroic narratives of history tend to be articulated with hegemonic Eurocentric historiography by organizing the past according to a causal, linear and progressive logic, centered on great characters and civilizing achievements. Such a narrative structure reinforces the idea of continuity and progress, obscuring ruptures, colonial violence, and subalternized experiences. Benjamin's critique of historicism destabilizes precisely this interpretative matrix, by stating that "historicism is content to establish a causal link between the various moments of history" (Benjamin, 2012, p. 231), converting the past into an evolutionary chain and legitimizing the present.

The criticism of the idea of progress consists in the rejection of this fantasy of inevitable civilizational advancement. By conceiving history as an automatic and unlimited process, catastrophe is transformed into a necessary stage of human evolution. Violence becomes an acceptable cost of development, and collective suffering is interpreted as a transitory moment towards a better future. Benjamin demystified this conception by demonstrating that the notion of progress sustains an image of history as a completed totality, closed in on itself. Such a perspective legitimizes the idea that "everything is allowed" in the name of progress, even if along this path humiliations, traumas and destruction accumulate. The image of homogeneous and empty time erases the singularities of historical experiences and puts at risk the memory of those who were run over by what the philosopher figured as the train of progress. The testimonies that could reveal the contradictions of this official narrative tend to remain underground, threatened by oblivion.

For this reason, Benjamin understood that "history is an object of construction whose place is not homogeneous and empty time, but a time saturated with 'nows" (1987, p. 229). History, in this conception, is not an accumulative sequence of facts, but a field of tension in which the past can be re-actualized based on the demands of the present. Historical time ceases to be a continuous line and becomes a space of interruption and criticism. In thesis VII, it is possible to find the following statement:

There has never been a monument of culture that was not also a monument of barbarism. And just as culture is not free from barbarism, neither is the process of transmitting culture. Therefore, as far as possible, the historical materialist deviates from it. He considers it his task to brush history against the grain (1987, p. 225).

Brushing history against the grain means reinterpreting it from the ethical commitment to the subalterns, following the traces of the dead and wounded left by the march of progress. If every document of culture is also a document of barbarism, then the critical task is to reveal the violence hidden under the guise of civilization. If official historiography celebrates the triumph of the victors through the construction of an artificial collective memory, centered on stereotyped representations of potentially resistant groups, the philosophical task implies shifting the center of the epistemological process. It is about highlighting the narratives that make explicit contradictions, traumas and humiliations of those who did not have a voice in history.

This displacement, however, is not reduced to a methodological choice or a change in academic perspective; It is a question of taking a position in the face of historical time. By recognizing that violence is not an occasional accident, but a structural element of processes that present themselves as civilizing, criticism takes on a character of urgency. History, seen

from the vanquished, reveals not an overcoming succession of injustices, but the permanence of a state of domination that is actualized in new forms. It is precisely when one understands that the exception does not constitute a momentary rupture, but a reiterated condition of the experience of the oppressed, that it becomes necessary to reformulate the very concept of history – no longer as a triumphal continuity, but as a field of struggle in which the memory of the subalternized challenges the present. In thesis VIII, Benjamin pointed to the urgency of reinterpreting history from the point of view of a commitment to the tradition of the oppressed:

The tradition of the oppressed teaches us that the "state of exception" in which we live is the rule. We must arrive at a concept of history that corresponds to this situation. Our historical task will then consist in bringing about the coming of the true state of exception, thus improving our position in the struggle against fascism. The fact that its adversaries confront it in the name of progress, taking it as a historical law, is not exactly the least of the chances of fascism. There is nothing philosophical about being astonished by the fact that the things we are experiencing are "still" possible in the twentieth century. It is an astonishment that is not born of a knowledge, but of this: that the idea of history that provokes astonishment is not sustained. (Benjamin, 1987, p. 226)

The "state of exception", in this perspective, is not an anomaly, but a permanent condition imposed by the structures of domination. Breaking with this state requires adopting a conception of history that produces estrangement in the face of the contradictions of capital, refusing to empathize with the victors. For this conception to gain strength, the narrative needs to regain centrality. In "The Narrator: considerations on the work of Nikolai Leskov", Benjamin stated that the narrative "[...] it is itself, in a certain sense, an artisanal form of communication. It is not interested in transmitting the 'pure in itself' of the thing narrated as information or a report. It immerses the thing in the narrator's life and then removes it from him" (1987, p. 205). The narrative, therefore, does not transmit data, but sedimented experiences.

In another passage, the German thinker added that "It always has in itself, sometimes latent form, a utilitarian dimension. This usefulness can consist of a moral teaching, a practical suggestion, a proverb or a rule of life – in any case, the narrator is a man who knows how to give advice" (Benjamin, 1987, p. 200). The narrator transmits wisdom rooted in experience, ensuring historical continuity that is not reduced to the chronology of the winners. With regard to memory, Jobin and Souza stated that, for Benjamin, "[...] memory is a current rereading of the past that enhances the possibilities of intervening in the events of the future" (2014, p. 185). Remembrance, therefore, is not a simple return to the past, but an operation that critically updates it. As Reyes Mate pointed out:

The purpose of remembrance is to rescue the right to justice from the past or, if one prefers, to recognize in the past of the vanquished an injustice that is still in force, that is, to read the frustrated projects with which history is sown, not as costs of progress, but as pending injustices (Mate, 2011, p. 28).

To have access to the "chest of remembrance" is to recognize that the past is not presented as a pacified narrative, but as a field crossed by barbarism and injustices of multiple orders. Opening this chest means destabilizing the comfortable image of a history driven by the continuous thread of progress and confronting what has been relegated to the margins of official memory. Remembrance, in this horizon, is not limited to reliving events, but acts as a critical gesture that rescues traumatic experiences and reopens, in the present, the demand for justice denied under the argument of the "costs of progress". By bringing to the surface what has been buried, memory is transformed into a force of historical interpellation.

Literary productions that are guided by the perspective of Testimony Literature take up precisely this movement. By shifting to the center of the narrative the injustices and traumas experienced by subalternized collectivities, these works carry out an exercise of remembrance that challenges the naturalization of the violence inscribed in the past. It is not just a matter of telling forgotten stories, but of re-inscribing on the collective horizon the pending injustices of the tradition of the oppressed, converting literature into a space for the critical elaboration of memory and the reconfiguration of historical understanding itself.

If the critical task consists in shifting the historical gaze to the traces left by the vanquished, then literature can be configured as fertile ground for this operation. By incorporating into its narrative fabric the marks of collective suffering and the experiences of those who remain on the margins of official discourses, the literary work becomes an instance of symbolic elaboration of what historiography tends to silence. It is in this horizon that *Vidas Secas* presents itself as a fertile object of analysis. Graciliano Ramos' novel, by inscribing the precarious life of the northeastern peasantry at the center of the narrative, allows us to question whether we are facing the mere reproduction of crystallized images of backwardness or the construction of a testimony that re-inscribes, within literature, the tradition of the oppressed. From this question, the novel is examined in the light of Testimony Literature and Benjaminian criticism of history.

3 DRY LIVES AS TESTIMONY LITERATURE

The analysis that follows focuses on *Vidas Secas*, articulating Graciliano Ramos' novel to the theoretical horizon outlined in the previous section. More than situating it within northeastern regionalism, it is interesting to examine it as a narrative construction that puts on stage a historically marginalized experience. The life of the peasantry, marked by material precariousness, silence and structural violence, does not appear only as a thematic background, but as an organizing axis of the literary form. Although the work admits multiple readings, the excerpt proposed here seeks to identify narrative elements that bring the novel closer to the testimonial logic: the centrality of lived experience, the fragmentation of narrative, the economy of language and the repeated exposure of the conditions of oppression. The question lies not only in what is represented, but in the way in which this representation is constructed, producing an image of the peasantry that can tension the consolidated versions of history.

3.1 "DRY" MEMORIES AND THE TRADITION OF THE OPPRESSED

Starting from the problematizations developed in the first section — especially the traits that characterize Testimony Literature, as systematized by Wilberth Salgueiro — some decisive elements are resumed here: the centrality of traumatic collective events, the feeling of humiliation, the desire for justice and the dimension of resistance. These aspects, articulated with Benjamin's reflections on history, guide the reading of *Vidas Secas*, allowing us to examine how the novel constructs a narrative crossed by marks of social suffering and collective memory.

Published in 1938, within the generation of 30, the novel emerged in a context of political and social instability. Brazil lived under the Estado Novo, established by Getúlio Vargas in 1937, while the international scenario was still marked by the consequences of the First World War. Graciliano Ramos inscribed his fictional production in this horizon of tensions, making literature a space for exposing the structural inequalities and mechanisms of oppression that permeated social life.

The choice of the sertanejo peasantry as the narrative nucleus is already a significant gesture. Rather than celebrating heroic figures or chronicling major political events, the novel focuses on the precarious survival of a family of migrants. Drought, hunger, exploitation and instability do not appear as isolated episodes, but as a permanent condition. The narrative shifts the gaze from exceptionality to the routine of misery, making everyday experience the privileged place of historical inscription.

This centrality of collective suffering brings the novel closer to the logic of witness. It is not only a matter of representing poverty, but of inscribing on the literary plane a historically marginalized form of existence. The plot does not build a spectacle of misery; on the contrary, it shows the normalization of social violence. The precariousness of life is not an accident, but a structure. The economy of language and the silence that mark Fabiano and his family constitute decisive formal elements. The characters speak little, express themselves in a fragmentary way, hesitate. Silence, far from signifying the absence of thought, reveals a subjectivity tensioned by experiences that exceed its capacity for immediate elaboration. Violence does not manifest itself only as an external event, but infiltrates the very possibility of enunciation.

Walter Benjamin, in "Experience and Poverty," reported that many soldiers who survived World War I returned mute, unable to narrate what they had experienced. The traumatic shock produced a psychic fracture that was externalized in silence. As Guimarães pointed out:

This experience of shock that the fragile and tiny human body had to endure when contemplating the great humanitarian indignities of wars, produced a psychic fracture for the survivors such that silence is the externalization of their own disorientation in the face of the violence experienced (Guimarães, 2019, p. 117).

Reading this excerpt allows us to understand that silence can be a form of indirect expression of trauma. When experience goes beyond the limits of symbolization, language falters and withdraws. In *Vidas Secas*, Fabiano's mutism does not stem from naturalized incapacity, but from a historical condition marked by repeated humiliations and by a life reduced to the struggle for survival. The rarefied word becomes a symptom of fracture.

In addition, silence is not only individual; it takes on a social dimension. The structure of domination that organizes the sertanejo field disallows the worker's speech, reducing it to the condition of murmuring. Symbolic violence precedes and accompanies material violence. In this sense, the novel not only portrays suffering, but incorporates in its narrative form the difficulty of narrating it, approaching what the testimonial tradition identifies as an effort to give shape to the almost unspeakable.

Azevedo's observation expands this understanding by shifting the analysis to the temporal dimension of the drought: "In the present time of the work, the drought is, in a large part of the narrative, the past, inhabiting the universe of traumatic memories; or future, haunting the possibilities of life to come" (Oliveira and Azevedo, 2020, p.240).

The drought organizes the temporal experience of the characters. It is not limited to the immediate present, but reappears as a painful memory and as an imminent threat. The

past is not over; it returns in the form of fear. The expectation of a new drought conditions decisions, dreams and displacements. The novel thus constructs a temporality marked by the recurrence of trauma. This temporal configuration breaks with chronological linearity. The drought appears fully only at the beginning and end of the narrative; in the intermediate chapters, it subsists as memory and as projection. Life is organized around an event that does not pass. It is, in Seligmann-silva's terms, "[...] a memory of the past that does not pass" (2008, p. 69). The repetition of the traumatic experience inscribes in the novel a perception of time that is close to Benjamin's critique of progress. Another revealing aspect is the desire for transformation that emerges, albeit timidly, in the aspiration to educate children:

Little by little a new life, still confused, was outlined. They would settle in a small farm, which seemed difficult to Fabiano, who was raised free in the woods. They would cultivate a piece of land. They would later move to a city, and the boys would attend schools, they would be different from them (Ramos, 1980, p. 125-126).

This excerpt shows that the characters perceive their social position as a result of structural conditions. The school appears as a promise of breaking with the cycle of exploitation. However, this hope remains fragile, strained by the materiality of the drought and by power relations that limit the real possibilities for change.

The projection of this "new life" reveals more than a simple desire for social ascension; it exposes the awareness, even if diffuse, that the condition experienced is not a natural destiny, but the result of a specific social organization. The dream of the children's schooling introduces, within the narrative, a tension between permanence and transformation. By imagining that the boys "would be different from them", Fabiano and Sinhá Vitória recognize the generational transmission of precariousness as something that could be interrupted.

However, the formulation of this desire remains in the realm of conjecture, marked by verbs in the future tense and by a spatial vagueness ("a city", "an unknown land"), which reinforces the uncertain character of this expectation. The novel, thus, builds a promise that is born through instability, showing that the possibility of breaking with the cycle of oppression depends on historical conditions that escape the immediate control of the characters. Hope, therefore, appears not as an effective overcoming, but as a glimmer that illuminates, even if briefly, the awareness of structural injustice.

If, on the level of imagination, the education of children appears as a possibility of social displacement, on the level of immediate experience, injustice imposes itself in a concrete and unavoidable way. The narrative thus alternates between the horizon of expectation and direct friction with the power relations that structure the sertanejo field. When

inequality ceases to be just a silent condition and manifests itself as a mismatch between work and reward, the latent tension takes shape.

It is at this moment that the novel brings out not only the awareness of exploitation, but the impulse — albeit hesitant — to contest it. The desire for justice is manifested more explicitly in the chapter "Accounts":

He did not conform: there must have been deception. He was rough, yes sir, you could see perfectly that he was rough, but the woman had brains. Surely there was a mistake in the white paper. The error was not discovered, and Fabiano lost his stirrups. To spend his whole life like this on the stump, handing over what was his on a silver platter! Was that right? Work as a black man and never get a letter of manumission! The boss got angry, repelled the insolence, thought it was good that the cowboy went to look for work on another farm.

Then Fabiano lowered his blow and kissed. Well, well. There was no need for noise. If he had said a word for nothing, he apologized (Ramos, 1980, p. 93).

In this episode, the impulse to contest reveals awareness of injustice. Fabiano recognizes the imbalance of the relationship, but backs down in the face of the threat of exclusion. Domination operates both through economic exploitation and through the internalization of fear. The novel thus evidences the tension between resistance and submission, a recurring feature in testimonial narratives.

The passage is particularly significant because it makes explicit the language through which Fabiano tries to name his own condition. By comparing continuous work to the absence of a "letter of manumission", the character mobilizes a historical image that refers to slavery, revealing an intuitive perception that the exploitation experienced does not differ substantially from past forms of domination. Although it does not formulate a systematic analysis, the analogy establishes a link between past and present, evidencing the permanence of structures of subjugation within the so-called modern social order. The subsequent retreat — "I apologized" — does not nullify the moment of consciousness; rather, it exposes the limit imposed on the insurgency. The word arises, but it is immediately contained by the threat of expulsion and material precariousness. The novel thus constructs a scene in which the contestation appears as an interrupted flash, a gesture that announces and retracts under the weight of historical conditions.

It is noteworthy that the migratory movement of the family inscribes the individual experience in a dynamic that goes beyond the domestic sphere and reaches a broader historical dimension. The departure is not only configured as a circumstantial survival strategy, but as a recurrent response to a cycle of precariousness that structures life in the hinterland. The displacement reveals that drought and exploitation are not exceptional

episodes, but forces that continuously reorganize social space, producing human flows marked by necessity. By placing its characters in transit, the novel transforms escape into an index of a social order incapable of ensuring minimum stability for those who live from work in the fields.

[...]Fabiano was happy and believed in this land, because he did not know what it was like or where it was. She meekly repeated the words of Sinha Vitória, the words that Sinha Vitória murmured because she had confidence in him. And they walked south, immersed in that dream. A big city, full of strong people. The boys in schools, learning difficult and necessary things [...] would arrive in an unknown and civilized land, they would be trapped in it. And the hinterland would continue to send people there. The hinterland would send strong, brutish men to the city, such as Fabiano, Sinha Vitória and the two boys (Ramos, 1980, p. 126).

The expression "the hinterland would continue to send people" shifts the focus of the narrative from the individual to the collective level. The family ceases to be an exception and starts to represent a reiterated social movement. The verb "to command" suggests a structural force that pushes subjects out of their territory, converting migration into a systematic mechanism for the reproduction of inequality. The dream of the city appears to be permeated by ambiguity: it is a promise of civilization and, at the same time, an anticipation of a new form of subjection — "they would be trapped in it". Mobility, therefore, does not automatically equate to liberation; it can only mean a change of scenery to the same logic of domination.

At this point, the novel exposes the historical dimension of the narrated experience. Drought, exploitation and forced migration are no longer isolated dramas and configure a collective structure that crosses generations. Trauma takes on a social aspect and not just a psychological one. By inscribing this dynamic within fiction, *Vidas Secas* transforms the literary narrative into a space for the critical elaboration of the memory of the peasantry, making a story told from those who are continuously displaced by economic and political processes emerge. Thus, the novel approaches the logic of Testimony Literature not only by thematizing suffering, but by constructing a narrative form that reveals the permanence of injustices and challenges the conciliatory image of progress.

The experience of drought, exploitation and migration outlines, in the novel, a horizon of suffering that goes beyond the individual drama and takes on collective contours. However, what is at stake is not only the presence of these events, but the way they are narrated. The representation of the peasantry in *Vidas Secas* is not limited to registering precariousness; it organizes a way of seeing and saying the hinterland that challenges consolidated images of the rural man as a passive or backward figure. The analysis that follows shifts the focus to

this literary construction, as it is interested in acquiring the philosophical clairvoyance of how the sertanejo testimony takes shape in the narrative and how its voice, although marked by silence, reconfigures the historical imaginary about the peasantry.

3.2 PEASANT REPRESENTATION BASED ON SERTANEJO TESTIMONY

Understanding *Vidas Secas* as a narrative inscribed on the horizon of Testimony Literature implies recognizing that the novel articulates the desire for justice, the presence of trauma and the exposure of a collective event that involves the man of the countryside — traits that characterize this literary tradition. The characters Fabiano, Sinhá Vitória, the oldest boy and the youngest boy, accompanied by the parrot and the dog Baleia, form a family nucleus that fights for survival in extreme conditions of precariousness. The experience lived by this group does not appear as an exception, but as a synthesis of a broader social reality.

At this point in the reflection, it is important to examine how the peasantry is represented from the memories and reports that cross the narrative. The question that guides this subtopic can be formulated in the following terms: is it a representation aligned with the perspective of the "winners", which reinforces stereotypes such as that of Jeca Tatu and fixes the peasant in the image of backwardness and passivity⁷, or a representation constructed from the testimony of the countryside, which re-inscribes the man of the countryside in the tradition of the oppressed?

The excerpts analyzed throughout the work indicate that the peasant is not described as a caricatured figure or ridiculed for his language or way of life. On the contrary, it appears as a subject crossed by material and symbolic violence. The oppression that falls on Fabiano and his family does not stem from individual moral traits, but from structural conditions: lack of access to land, economic dependence, lack of state assistance, and submission to deeply asymmetrical power relations. This awareness emerges in the character's own discourse when she states: "It saddened. Consider yourself planted in someone else's land!" (Ramos, 1980, p. 19). The expression evidences an acute perception of the precariousness of his condition: to be "planted" in soil that does not belong to him is to recognize himself rooted in dependence.

⁷ We can confirm this description by Monteiro Lobato in the following excerpt: "Jeca didn't want to know anything. Working was not with him [...] one day a doctor came there because of the rain and was astonished by so much misery. Seeing the caboclo so yellow and chucro, he decided to examine him. - Friend Jeca, what you have is disease. "Maybe." I feel an endless tiredness, and headache, and a twinge here in the chest that responds in the cacunda. [...] The doctor prescribed him the appropriate medicine, then said: "And try to buy a pair of boots and never walk barefoot or drink pinga again, do you hear?" "That's it," the doctor concluded, taking his hat. [...] Do what I said, and you will be strong, tough and rich like the Italian [...] everything the doctor said happened right! Three months later, no one knew Jeca anymore. Laziness disappeared (Lobato, 1961, p. 331-334).

The clash between peasants and large landowners inserts the novel within the tradition of the oppressed, as thought by Benjamin's philosophy. The narrative does not celebrate progress or harmonize social contradictions; rather, it exposes the wreckage left by the logic of property and exploitation. The figure of the farmer is not constructed as a civilizing hero, but as an agent of a system that perpetuates inequalities. By shifting the focus to those who bear the brunt of these relationships, the novel breaks with the triumphalist perspective that usually guides the official memory.

Another fundamental element for the construction of this representation concerns the lack of access to basic rights: land, health, formal education, housing and stable income. The school exclusion of Fabiano's children is not treated as an individual failure, but as an effect of a context that restricts possibilities. The narrative does not hold the characters responsible for their condition; evidence, on the contrary, of the silent violence of a social order that naturalizes inequality. Ignorance of social and political rights does not appear as an intrinsic incapacity, but as a result of historical deprivation. The form of payment received by the cowboy concretely illustrates this structure of exploitation:

Fabiano received in the division the fourth part of the calves and the third of the goats. But as he had no garden and only limited himself to sowing a few handfuls of beans and corn in the ebb and flow, he ate from the market. He got rid of animals, did not go so far as to shoe a calf or sign the ear of a goat (Ramos, 1980, p. 92).

The division described does not ensure autonomy; keeps the worker in a permanent cycle of dependence. By not being able to "shoe a calf" or "sign the ear of a goat", Fabiano remains on the margins of effective ownership. The system of non-monetary payment prevents accumulation and perpetuates subordination. The novel thus exposes an economic mechanism that transforms work into a mechanism for the reproduction of inequality. Although Fabiano expresses, at certain moments, a desire to free himself from this condition, the constant threat of expulsion limits any gesture of rupture. Submission does not result from conformism, but from calculation imposed by necessity. The belief that "Government, a distant and perfect thing could not make a mistake" (Ramos, 1980, p. 33-34) reveals a distance between concrete experience and the institutional sphere. Power appears as an abstract and unattainable instance, reinforcing the perception that the state of exception — in which precariousness is normalized — is a rule of country life.

It is important to note that the characters do not organize themselves politically or formulate a collective project of transformation. Still, the narrative has political force. Politicization does not occur through programmatic discourses, but through the repeated exposure of humiliations, injustices and structural vulnerability. By witnessing these

experiences, the novel calls on the reader to recognize that the condition of the peasantry is not the result of cultural inferiority, but of historical exclusion.

The criticism present in the work is therefore directed not at the sertanejo way of life, but at the economic and social conditions that make it precarious. Even under daily experience of shock, the peasant identity does not dissolve. The permanence of traditions and crafts is a central element of this representation. Fabiano is a cowboy — and the cowboy, in the northeastern culture, symbolizes courage, resistance and bond with the land. This dimension becomes evident in the admiration of the younger boy:

Stuck in the hides, of flints, doublet and breastplate, he was the most important creature in the world" and then taming a rough mare "Climbing the gate of the corral, the younger boy twisted his sweaty hands, stretched to see the cloud of dust that clouded the imburanas" (Ramos, 1980, p. 47).

The scene projects on the cowboy a centrality that contrasts with his objective social position. The clothing — the leathers, the doublet, the breastplate — does not appear as a sign of inferior rusticity, but as an expression of belonging to a craft that requires physical resistance and practical knowledge. It is through the boy's gaze that the father acquires greatness. This perspective is not irrelevant: by choosing the child's admiration as a point of focus, the narrative displaces external judgment and values the internal codes of the country culture.

The gesture of taming the brute mare shows skill and technical mastery, reinforcing the image of competence. There is no irony or trace of debauchery. The narrative restores to the cowboy a dignity that the social structure refuses him. Although economically submitted, it remains symbolically invested with importance within its cultural universe. This tension between material subordination and symbolic recognition prevents the character from being reduced to the stereotype of the backward or incapable peasant.

In this way, the novel moves away from the caricatural tradition that marked part of the representation of the man of the countryside in Brazilian literature. Instead of reaffirming the image of the sertanejo as a grotesque or indolent figure, he builds a presence crossed by strength, tradition and belonging. Appreciation is not abstract; it emerges from concrete practices, inherited gestures, and recognition between generations. Another excerpt reinforces this cultural dimension:

Fabiano cured the fox heifer's worm in the wake. He carried a vial of creolin in the aió, and if he had found the animal, he would have made the ordinary dressing. He did not find him, but he supposed to distinguish his footsteps in the sand, he bent down,

crossed two sticks on the ground and prayed. If the animal was not dead, he would go back to the corral, because the prayer was strong.

Once the obligation was fulfilled, Fabiano got up with a clear conscience and marched home. He reached the edge of the river [...] the chimes of the rattles that weighed on his shoulder, hanging from straps, beat deaf. His head bowed, his spine curved, he waved his arms to the right and to the left. These movements were useless, but the cowboy, the cowboy's father, grandfather, and other older ancestors had become accustomed to walking along paths, pushing the bush away with their hands. And the children were already beginning to reproduce the hereditary gesture. (Ramos, 1980, p. 17)

The excerpt shows a dimension of the sertanejo experience that is not reduced to material need. The knowledge of the cowboy emerges as an incorporated practice, the result of continuous learning transmitted between generations. Identifying tracks, preparing the dressing, resorting to prayer, making a way through the vegetation are gestures that articulate technique, belief and tradition. The repetition of these movements does not indicate backwardness, but cultural continuity. The bent body and the curved spine bear marks of hard work, but they also inscribe in the physical the memory of a way of life sedimented in time.

The hereditary gesture thus acquires historical depth. Father, grandfather and children connect through practices that resist even in the face of economic instability and forced displacement. There is a memory that does not manifest itself primarily in words, but in repeated action. It is knowledge that does not depend on institutional legitimacy to exist. The novel suggests that this embodied memory sustains identity and belonging, functioning as a silent form of permanence. The peasant representation constructed by Graciliano Ramos, therefore, does not reinforce stereotypes, but re-inscribes the sertanejo as a historical subject. From the testimony of its characters, the novel shifts the reader's gaze to the interior of an experience marked by exploration, but also by silent resistance and cultural permanence. In doing so, it approaches the critical task of tensioning hegemonic narratives and returning centrality to those that official historiography has often relegated to the margins.

4 FINAL CONSIDERATIONS

The analytical path undertaken sought to investigate whether the representation of the peasantry in *Vidas Secas*, by Graciliano Ramos, can be understood in the horizon of Testimony Literature or if it reproduces images crystallized by the dominant historiography. The central question was not restricted to the thematic content of the work, but focused on the way in which the sertanejo experience is narrated and re-inscribed within history. The analyses developed allow us to sustain that the novel constructs a representation aligned

with the tradition of the oppressed and effectively tensions the consolidated forms of representation of the man and woman of the countryside.

The experience of the subjects in the field appears marked by material precariousness, structural violence and forced displacement. However, this condition is not converted into a moral trait or naturalized as destiny. The narrative shows that vulnerability stems from determined historical relations — land concentration, labor exploitation, state negligence and educational exclusion. By shifting the explanation of the experienced condition from the individual plane to the realm of social structures, the novel breaks with readings that associated the peasantry with intrinsic backwardness.

It is at this point that the opposition to the figure of Jeca Tatu gains relevance. If Lobato's construction crystallized in the national imagination the image of the peasant as indolent, incapable and responsible for his own stagnation, *Vidas Secas* operates, against the grain of progress, the opposite movement. Graciliano Ramos does not present the sertanejo as a caricature or as an obstacle to progress; rather, it exposes the conditions that produce its precariousness. What appeared in Jeca Tatu as an individual moral failure appears, in the novel analyzed, as an effect of an unequal social order. The difference is not only aesthetic, but political: it is about shifting the guilt of the subject to the structures that keep him in a condition of vulnerability.

Reading in the light of the Literature of Testimony showed that *Vidas Secas* articulates trauma, memory and the desire for justice as structuring elements. Drought, economic exploitation and compulsory migration do not appear as natural fatalities, but as repeated experiences that cross generations. Suffering takes on a collective dimension and reveals the fragility of the progressive narrative that presents development as a linear and inclusive trajectory. By inscribing these experiences within fiction, the novel transforms literature into a space for the critical elaboration of historical memory.

The representation constructed by Graciliano Ramos restores cultural density to the subjects of the countryside. The cowboy is not reduced to ignorance or unproductivity; He is presented as a bearer of knowledge, transmitted practices and a deep bond with the land. Tradition, far from signifying backwardness, appears as historical continuity that persists even under adverse conditions. This symbolic reconfiguration directly confronts images that still persist in the Brazilian social imaginary.

Under the horizon of Benjamin's reflections, the work can be understood as an aesthetic gesture that reopens the past as a field of dispute. By shifting the focus to those who bear the effects of power structures, the novel weakens automatic empathy with the victors and re-inscribes the tradition of the oppressed at the center of the narrative. History

ceases to be a celebration of achievements and reveals itself to be crossed by pending injustices.

Thus, *Vidas Secas* not only denounces inequalities, but reconfigures the imaginary about the Brazilian peasantry. By contrasting with the caricatural representation enshrined in the figure of Jeca Tatu, the novel offers another possible image of the subjects of the countryside: not as obstacles to progress, but as protagonists of a historical experience marked by exploration, memory and resistance. Its critical force lies precisely in this inversion of perspective, which transforms fiction into an instrument for revising collective memory and questioning hegemonic narratives.

REFERENCES

- Arendt, H. (1989). *Origens do totalitarismo* (R. Raposo, Trad.). Companhia das Letras. (Obra original publicada em 1951)
- Azevedo, I. C. R. (2021). Literatura como memória: Os perdedores na história em *Vidas Secas*, de Graciliano Ramos. *Scripta Alumni*, 24(1), 20–37.
- Benjamin, W. (1987). Experiência e pobreza. In W. Benjamin, *Magia e técnica, arte e política: Ensaio sobre literatura e história da cultura* (S. P. Rouanet, Trad.; 3ª ed., pp. 114–119). Brasiliense. (Obra original publicada em 1933)
- Benjamin, W. (1987). O narrador: Considerações sobre a obra de Nikolai Leskov. In W. Benjamin, *Magia e técnica, arte e política: Ensaio sobre literatura e história da cultura* (S. P. Rouanet, Trad.; 3ª ed., pp. 197–221). Brasiliense. (Obra original publicada em 1936)
- Benjamin, W. (1987). Sobre o conceito de história. In W. Benjamin, *Magia e técnica, arte e política: Ensaio sobre literatura e história da cultura* (S. P. Rouanet, Trad.; 3ª ed., Vol. 1, pp. 222–232). Brasiliense. (Obra original publicada em 1940)
- Caldart, R. S. (2004). Elementos para a construção de um projeto político e pedagógico da Educação do Campo. In M. C. Molina & S. M. A. de Jesus (Orgs.), *Contribuições para a construção de um projeto político e pedagógico da Educação do Campo* (pp. ?–?). Ministério do Desenvolvimento Agrário. (Nota: Incluir intervalo de páginas se disponível no original)
- Guimarães, J. L. de B. (2019). Memória, esquecimento e política em Walter Benjamin: A reinterpretção da história a partir do comprometimento ético com os vencidos. *Kalagatos*, 16(2), 104–128.
- Guimarães, J. L. de B., & Barbosa, J. N. F. (2026). Walter Benjamin e o sentido da experiência: A literatura de cordel na valorização da cultura camponesa. *Kalagatos*, 23(1), Article e26019. <https://doi.org/10.5281/zenodo.XXXXXXX> (Nota: Incluir DOI se disponível)
- Guimarães, J. L. de B., & Sousa Filho, J. B. de. (2026). A construção da imagem do campesinato nordestino em *Cabra marcado para morrer*: Uma análise estético-política a partir da filosofia de Walter Benjamin. *Revista Cacto - Ciência, Arte, Comunicação Em Transdisciplinaridade Online*, 6(1), Article e26014. <https://doi.org/10.5281/zenodo.XXXXXXX> (Nota: Incluir DOI se disponível)

- Jobim e Souza, S. (2014). Memória coletiva e tempos de vida: Sobre a intenção política da escrita da história em Walter Benjamin e Maurice Halbwachs. *Mnemosine*, 10(2), 179–194.
- Löwy, M. (2019). O ponto de vista dos vencidos da história da América Latina – reflexões metodológicas a partir de Walter Benjamin. In M. Löwy, *A revolução é os freios da emergência* (P. Colosso, Trad.). Autonomia Literária.
- Lobato, M. (1961). Jeca Tatu – a ressurreição. In M. Lobato, *Obras completas de Monteiro Lobato: 1ª série – literatura geral* (Vol. 8, pp. 329–340). Brasiliense.
- Maciel, C. P. R. (2016). Literatura de testemunho: Leituras comparadas de Primo Levi, Anne Frank, Immaculée Ilibagiza e Michel Laub. *Opiniões*, 1, 74–80.
- Mate, R. (2011). Meia-noite na história: Comentários sobre as teses de Walter Benjamin “Sobre o conceito de história”. UNISINOS.
- Mendonça, C., & Albuquerque, C. (2020). Sobre o lugar de fala: Localizações, silenciamentos e autorizações. *Revista e Corpos*, 23(1), ??–??. (Nota: Incluir intervalo de páginas completo se disponível)
- Minayo, M. C. de S. (Org.). (2009). *Pesquisa social: Teoria, método e criatividade*. Vozes.
- Nascimento, L. M. do. (2013). *Literatura e testemunho no romance Em câmara lenta*, de Renato Tapajós [Dissertação de mestrado, Universidade Federal do Espírito Santo]. Centro de Ciências Humanas e Naturais.
- Oliveira, P. C. S. de, & Azevedo, I. C. R. (2019–2020). Corpo e mente sob violências: Da dor ao silêncio, em *Vidas Secas*. *PragMATIZES - Revista Latino-Americana de Estudos em Cultura*, (18), 225–245.
- Pollak, M. (1989). Memória, esquecimento, silêncio. *Estudos Históricos*, 2(3), 3–15.
- Ramos, G. (1980). *Vidas secas* (45ª ed.). Record. (Obra original publicada em 1938)
- Salgueiro, W. (2012). O que é literatura de testemunho (e considerações em torno de Graciliano Ramos, Alex Polari e André du Rap). *Matraga*, 19(31), 284–303.
- Seligmann-Silva, M. (2008). Narrar o trauma – A questão dos testemunhos de catástrofes históricas. *Psicologia Clínica*, 20(1), 65–82.

INSTRUMENTAL TRANSCOMMUNICATION IN DIGITAL NETWORKS: HYBRID DEVICES ON THE BORDERLINE OF SCIENCE AND SPIRITUALITY

TCI NAS REDES DIGITAIS: DISPOSITIVOS HÍBRIDOS NA FRONTEIRA DA CIÊNCIA E DA ESPIRITUALIDADE

TRANSCOMUNICACIÓN INSTRUMENTAL EN REDES DIGITALES: DISPOSITIVOS HÍBRIDOS EN LA FRONTERA ENTRE CIENCIA Y ESPIRITUALIDADE



<https://doi.org/10.56238/sevened2026.008-155>

José Valentim Martins Melo¹, Edwaldo Costa²

ABSTRACT

This article examines Instrumental Transcommunication (ITC) as a hybrid communicational phenomenon in contemporary Brazilian digital culture. Through qualitative methodological triangulation, we analyze how ITC, mediated by electronic devices and Generative Artificial Intelligence (GAI), reconfigures discourses on grief, religious authority, and scientific legitimacy on digital platforms. The results reveal ITC as a symptom of technoculture, where belief and skepticism dispute regimes of truth through amateur scientification practices. We argue that this emerging field challenges paradigms of public science communication, demanding new epistemological approaches.

Keywords: Instrumental Transcommunication. Technoculture. Artificial Intelligence. Discursive Disputes. Digital Communication.

RESUMO

Este artigo examina a Transcomunicação Instrumental (TCI) como fenômeno comunicacional híbrido na cultura digital contemporânea brasileira. Por meio de triangulação metodológica qualitativa, analisamos como a TCI, mediada por dispositivos eletrônicos e Inteligência Artificial Generativa (IAG), reconfigura discursos sobre luto, autoridade religiosa e legitimidade científica em plataformas digitais. Os resultados revelam a TCI como um sintoma da tecnocultura, onde crença e ceticismo disputam regimes de verdade por meio de práticas amadoras de cientificação. Argumentamos que esse campo emergente desafia paradigmas da comunicação pública da ciência, demandando novas abordagens epistemológicas.

Palavras-chave: Transcomunicação Instrumental. Tecnocultura. Inteligência Artificial. Disputas Discursivas. Comunicação Digital.

¹ Doctoral student in Public Administration. Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP). E-mail: timmmartins@gmail.com Orcid: <https://orcid.org/0009-0002-4661-1950>

² Postdoctorate researcher in Communication. Universidade de São Paulo (USP). E-mail: edwaldo.costa@idp.edu.br Orcid: <https://orcid.org/0000-0002-3416-3815>

RESUMEN

Este artículo examina la Transcomunicación Instrumental (TCI) como fenómeno comunicacional híbrido en la cultura digital brasileña contemporánea. Mediante triangulación metodológica cualitativa, analizamos cómo la TCI, mediada por dispositivos electrónicos e Inteligencia Artificial Generativa (IAG), reconfigura discursos sobre duelo, autoridad religiosa y legitimidad científica en plataformas digitales. Los resultados revelan la TCI como un síntoma de la tecnocultura, donde creencia y escepticismo disputan regímenes de verdad a través de prácticas amateurs de científicación. Argumentamos que este campo emergente desafía paradigmas de la comunicación pública de la ciencia, demandando nuevos enfoques epistemológicos.

Palabras clave: Transcomunicación Instrumental. Tecnocultura. Inteligencia Artificial. Disputas Discursivas. Comunicación Digital.

1 INTRODUCTION

In Brazilian digital culture, a flourishing of practices that fuse technology and spirituality can be observed. In Instrumental Transcommunication (ICT), radios, recorders and, currently, Generative Artificial Intelligence (AGI) algorithms are mobilized to supposedly capture voices and images of extraphysical entities. The phenomenon of ICT is not limited to a marginal curiosity, but expands and tensions the boundaries between science, belief, and technical mediation, especially in digital social networks where scientists and amateurs build legitimacy through rudimentary evidence. In this article, we examine ICT as a hybrid device that illustrates discursive disputes in the public communication of science, based on condensed empirical analysis of broader research.³

The relevance lies in the ability of ICT to re-enchant the digital world, as opposed to Weberian disenchantment, through a rhetoric of scientification. How is it justified, in times of AGI, to resort to electronic noise to hypothetically dialogue with the beyond? This question guides our analysis, anchored in Bourdieu, Foucault and Hall, to map how meanings are negotiated on platforms such as YouTube and Instagram.

2 TECHNOCULTURE AND DIGITAL TRANSCOMMUNICATION

Technoculture, according to Santaella, emerges in the convergence between techniques and social imaginaries, where devices are not neutral, but loaded with symbolic expectations. At TCI, apps such as Spirit Box or Replika exemplify this hybridization: the glitch – a technical artifact – is reinterpreted as a spiritual portal, illustrating the gamification of grief in the post-human era. This dynamic is justified by the crisis of traditional religious authority, which ICT circumvents by invoking pseudoscientific protocols, such as white noise recordings.

Empirically, netnographies in Facebook and Reddit groups reveal practitioners who process audios and videos with AGI to "perfect" transimages, even transforming what appears to be just pareidolia into collective proof. Such a practice, exemplified in lives with millions of views on YouTube, demonstrates how ICT is apparently trivializing the paranormal, aligning itself with the algorithmic logic of recommendation that amplifies beliefs. We reflect here that this mediation may not even prove the beyond, but it certainly reconfigures the human in a network.

³ "INSTRUMENTAL TRANSCOMMUNICATION IN DIGITAL MEDIA: BETWEEN BELIEF AND SKEPTICISM IN CONTEMPORARY CULTURE", dissertation (Master's Degree in Communication) – Brazilian Institute of Teaching, Development and Research, 2025, by José Valentim Martins Melo; Coordination: Prof. Dr. Edwaldo Costa.

3 REGIMES OF TRUTH AND DISCURSIVE DISPUTES

Foucault alerts us to regimes of truth as products of power-knowledge disputes, and in ICT a semiotic guerrilla war is observed: "skeptics" label the phenomenon as pareidolia, while "believers" mobilize spectrograms as irrefutable evidence. This tension is exemplified in podcasts such as "Mundo Freak Confidencial", "Relatos do Além #23-Conversando com Fantasmas, com Sonia Rinaldi", available on Spotify, or "Transcomunicação Instrumental, com Luis Hu Rivas", available on YouTube, where phenomenological reports challenge the skepticism of the CSI (Committee for Skeptical Inquiry). The critical reflection lies in the asymmetry: official scientificity ignores the symbolic efficacy of ICT in the management of grief.

Data from a questionnaire applied to 120 participants (triangulated with content analysis of 500 posts on TikTok and Instagram) indicate that 68% perceive AGI as a catalyst for authentic contacts, justifying a discursive performativity that builds community legitimacy. Such a finding reflects post-truth, where the viral supplants the verifiable.

4 METHODOLOGICAL TRIANGULATION AND EMPIRICAL ANALYSIS

We adopted an interdisciplinary qualitative approach, triangulating discourse analysis (Bardin), netnography (Kozinets) and semi-structured questionnaire, with ethical approval via Plataforma Brasil. This sample comprised 120 respondents from online ICT communities and corpus of 2,000 interactions in networks (2024-2025). This strategy ensures robustness, allowing Bourdieusian forces to be mapped in the field of communication.

Results synthesized in a table reveal patterns:

Table 1

Platform	Discursive Predominance	Exemplification	% Scientific Legitimacy
Instagram	Consolation/Grief	IAG filters on photos of deceased loved ones	72%
YouTube	Epistemic Dispute	EVP Videos with Spectral Analysis	65%
TikTok	Spiritual viralization	Challenges of Spirit Box	58%

Source: Authors.

This matrix illustrates hybridization: ICT is not isolated pseudoscience, but a laboratory for digital communication, where algorithms mediate the sacred. [1]

5 IMPLICATIONS FOR DIGITAL COMMUNICATION

Hall teaches us that identities are negotiated in representations, and TCI exemplifies this by positioning practitioners as "citizen scientists" against academic elites and religious

authorities. This insurgency is justified by the crisis of symbolic capital in scientific dissemination, where IAG democratizes tools, but intensifies controversies – see illustrated cases of spiritual deepfakes. We reflect that the public communication of science must incorporate these peripheral phenomena to avoid epistemic bubbles. [1]

In the Brazilian sphere, coverage in SBT and TV Globo (1988-2025) partially legitimizes TCI, expanding its Bourdieusian field. In the future, with Virtual Reality (VR) and Brain-Computer Interface (BCI), TCI can evolve into postmortem immersions, demanding ethical policies in Digital Communication.

6 FINAL CONSIDERATIONS

ICT, therefore, emerges as a techno-spiritual phenomenon that challenges science/belief dichotomies, revealing Digital Communication as an arena of re-enchantment. His findings – from amateur practices to viral scientific disputes – contribute to studies in technoculture and media epistemology, proposing that AGI does not only simulate images and voices, but reconfigures the human.

Future research could quantify impacts on collective grief.

FINANCING

This research has not received specific funding from public or private agencies. It only had institutional resources made available by the Brazilian Institute of Teaching, Development and Research (IDP).

CONFLICTS OF INTEREST

Both authors declare that they do not have conflicts of interest that could influence this work. No author has received specific funding for this research, nor does he have financial or personal relationships with parties interested in possible outcomes. [3]

ETHICAL ASPECTS

This investigation was carried out in accordance with the ethical guidelines established by Brazilian legislation, including Resolutions of the National Health Council (CNS), in particular Resolution 466/2012 and complementary resolutions such as 510/2016 for Human and Social Sciences, submitting the project to the evaluation of the Research Ethics Committee

(CEP) via Plataforma Brasil, including prior approval of the project by the institutional CEP and by the National Research Ethics Committee (CONEP).

All participants signed a Free and Informed Consent Form (ICF), with a guarantee of anonymity and confidentiality.

DATA AVAILABILITY

Qualitative data collected through ethnographic netnography and analysis of interactions in social network groups cannot be publicly disclosed without compromising the privacy and anonymity of the participants, in accordance with ethical research guidelines. The aggregated and anonymized quantitative data of the semi-structured questionnaire will be available upon request to the corresponding author, subject to the signing of a confidentiality agreement. They can be made available by e-mail: timmmartins@gmail.com or jose.martins@economia.df.gov.br.

REFERENCES

Bardin, L. (2016). *Análise de conteúdo* [Content analysis]. Edições 70.

Bourdieu, P. (2007). *A distinção: Crítica social do julgamento* [Distinction: A social critique of the judgement of taste]. Zouk.

Hall, S. (2003). *A identidade cultural na pós-modernidade* [Cultural identity in postmodernity]. DP&A.

Wiseman, R. (2012). *Paranormalidade: Por que vemos o que não existe* [Paranormality: Why we see what isn't there]. BestSeller.

HYDROLOGICAL-HYDRODYNAMIC MODEL OF THE TAMANDARÉ CANAL IN BELÉM-PA FOR THE IMPLEMENTATION OF WORKS PRIOR TO COP 30

MODELO HIDROLÓGICO-HIDRODINÂMICO DO CANAL DA TAMANDARÉ EM BELÉM-PA PARA IMPLANTAÇÃO DE OBRA PRÉVIA À COP 30

MODELO HIDROLÓGICO-HIDRODINÂMICO DEL CANAL DE TAMANDARÉ EN BELÉM-PA PARA LA IMPLEMENTACIÓN DE OBRAS PREVIAS A LA COP 30



<https://doi.org/10.56238/sevened2026.008-156>

Marco Valério de Albuquerque Vinagre¹, Francisco Denis Pereira Chaves², Alberto Carlos de Melo Lima³, Luan da Silva Freitas⁴, Roberto Fontes de Souza⁵, Rodrigo Lauria Fonseca⁶, Edilaine Cristina Pamplona Menezes⁷

ABSTRACT

The implementation of the Tamandaré Linear Park in Belém-PA, in the Amazon, to improve urban infrastructure before COP30 (30th UN Conference of the Parties on Climate Change), was based on a hydrological-hydrodynamic study developed using the free computational code Storm Water Management Model (SWMM), to formulate and propose measures to combat and prevent overflows of the Tamandaré Channel, resulting from intense precipitation events and high tides, acting on highly impermeable terrain with low altimetric elevations (from 0 to 6 m). The hydraulic behavior of the basin was realistically simulated considering a rainfall event with a 50-year return period (172 mm of precipitation in 24 hours), associated with the maximum high tide condition (3.02 m). The results highlighted the susceptibility to flooding in areas with elevations below 3.02 m due to tidal influence and indicated the importance of using floodgates for hydraulic control. It was found that the occupancy of the

¹ Dr. in Amazon Natural Resources Engineering. Universidade da Amazônia (UNAMA).

E-mail: valeriovinagre@gmail.com Orcid: <https://orcid.org/0000-0002-7650-9204>

Lattes: <http://lattes.cnpq.br/8044094535697705>

² Doctoral student in Urban Development and Environment (PPDMU). Universidade da Amazônia (UNAMA).

E-mail: franciscodpchaves@gmail.com Orcid: <https://orcid.org/0009-0003-7997-8190>

Lattes: <http://lattes.cnpq.br/4798073398357557>

³ Dr. in Hydraulics and Sanitation. Universidade do Estado do Pará (UEPA).

E-mail: acmlima@gmail.com Orcid: <https://orcid.org/0000-0002-8752-7432>

Lattes: <http://lattes.cnpq.br/0524669127885256>

⁴ Doctoral student in Urban Development and Environment (PPDMU). Universidade da Amazônia (UNAMA).

E-mail: freitasluan52@gmail.com Orcid: <https://orcid.org/0000-0003-0186-695X>

Lattes: <http://lattes.cnpq.br/2515137074404173>

⁵ Doctoral student in Architecture and Urbanism. Universidade de São Paulo (USP).

E-mail: fontes2@gmail.com Orcid: <https://orcid.org/0009-0004-8459-0462>

Lattes: <http://lattes.cnpq.br/0584412115660517>

⁶ Doctoral student in Urban Development and Environment (PPDMU). Universidade da Amazônia (UNAMA).

E-mail: rodrigolauriafonseca@gmail.com Orcid: <https://orcid.org/0009-0007-6120-5244>

Lattes: <http://lattes.cnpq.br/6072236533521159>

⁷ Master's Degree in Civil Engineering. Universidade Federal do Pará (UFPA).

E-mail: edilainecristina@gmail.com Orcid: <https://orcid.org/0000-0003-3574-3085>

Lattes: <http://lattes.cnpq.br/3009334989716730>

Tamandaré Channel's capacity reached 97%, recommending the use of electric booster pumps as a preventive measure against overflows. The installation of two electric pumps was indicated, each with a flow rate of 1.0 m³/s and a manometric head of 7.2 m, automatically activated when the canal occupancy reaches 85% and deactivated when it reaches 60%. Thus, the computer simulation with SWMM enabled the formulation of engineering solutions for a problem of great relevance in combating and preventing flooding in the city of Belém-PA.

Keywords: Flooding. Urbanization. SWMM. Armas Basin. Amazon.

RESUMO

A implantação do Parque Linear Tamandaré, em Belém-PA, na Amazônia, para melhoria da infraestrutura urbana prévia à COP30 (30^a Conferência das Partes da ONU sobre Mudanças Climáticas), teve por base estudo hidrológico-hidrodinâmico desenvolvido com o uso do código computacional livre Storm Water Management Model (SWMM), para formular e propor medidas de combate e prevenção a transbordamentos do Canal da Tamandaré, decorrentes de eventos de precipitação intensa e maré elevada, atuando sobre terrenos bastante impermeabilizados, com baixas cotas altimétricas (de 0 a 6 m). O comportamento hidráulico da bacia foi simulado de forma realista considerando um evento de chuva com período de retorno de 50 anos (precipitação de 172 mm em 24 horas), associado à condição da máxima preamar (3,02 m). Os resultados evidenciaram a suscetibilidade a alagamentos em áreas com cotas inferiores a 3,02 m devido à influência das marés e indicaram a importância do uso de comportas para controle hidráulico. Verificou-se que a ocupação da capacidade do Canal da Tamandaré atingiu 100% e transbordou, recomendando-se o uso de eletrobombas de recalque como medida preventiva contra transbordamentos, indicando-se instalação de duas eletrobombas, cada uma com vazão de 1,0 m³/s e altura manométrica de recalque de 7,2 mca, acionadas automaticamente quando a ocupação do canal atingir 85% e desligadas ao atingir 60%. Dessa forma, a simulação computacional com o SWMM possibilitou a formulação de soluções de engenharia para um problema de grande relevância no combate e na prevenção de alagamentos na cidade de Belém-PA.

Palavras-chave: Alagamentos. Urbanização. SWMM. Bacia do Armas. Amazônia.

RESUMEN

La implementación del parque lineal de tamandaré en belém-pa, en la amazonia, para mejorar la infraestructura urbana antes de la cop30 (30^a conferencia de las partes de la onu sobre el cambio climático), se basó en un estudio hidrológico-hidrodinámico desarrollado mediante el código computacional libre storm water management model (swmm), para formular y proponer medidas para combatir y prevenir desbordamientos del canal de tamandaré, resultantes de eventos de intensas precipitaciones y mareas altas, que actúan sobre terrenos altamente impermeables y con elevaciones altimétricas bajas (de 0 a 6 m). El comportamiento hidráulico de la cuenca se simuló de forma realista considerando un evento de lluvia con un período de retorno de 50 años (172 mm de precipitación en 24 horas), asociado con la condición de pleamar máxima (3,02 m). Los resultados destacaron la susceptibilidad a inundaciones en zonas con elevaciones inferiores a 3,02 m debido a la influencia de las mareas e indicaron la importancia del uso de compuertas para el control hidráulico. Se constató que el Canal de Tamandaré alcanzó el 100% de su capacidad y se desbordó, por lo que se recomendó el uso de bombas de refuerzo eléctricas como medida preventiva contra desbordamientos. Se indicó la instalación de dos bombas eléctricas, cada una con un caudal de 1,0 m³/s y una altura de bombeo de 7,2 m, que se activan automáticamente cuando la capacidad del canal alcanza el 85% y se desactivan al alcanzar el 60%. De esta forma, la simulación por computadora con SWMM permitió la formulación

de soluciones de ingeniería para un problema de gran relevancia en el combate y la prevención de inundaciones en la ciudad de Belém-PA.

Palabras clave: Inundaciones. Urbanización. SWMM. Cuenca de Armas. Amazonía.

1 INTRODUCTION

Belém, capital of the State of Pará, located in the Brazilian Amazon, hosted the mega event of COP30 (30th UN Conference of the Parties on Climate Change) in 2025. During the preparatory phase, the city received investments to improve its infrastructure and solve important structural problems, including the urban flooding of the Igarapé das Armas basin, where the Nova Tamandaré Linear Park was implemented, based on the hydrological-hydrodynamic study presented below.

The drainage of the Tamandaré canal, in Belém-PA, represents an important urban challenge in the Amazon, due to its overflows that occur due to high tides and/or heavy rains.

The solution studied for the Tamandaré basin, for the implementation of the Nova Tamandaré Linear Park, was developed based on the hydrological-hydrodynamic computer modeling of this basin, using the SWMM software, including the occurrence of intense rainfall simultaneous to high tides, focusing on the recurrent flooding in the Tamandaré Channel, in order to assist in the decisions of projects and works for the implementation of this important work.

Figure 1

Tamandaré Avenue in Belém-PA before the Linear Park



Source: Pará Agency, 2025.

Figure 2

Tamandaré Avenue in Belém-PA after the implementation of the Linear Park. Nova Tamandaré implemented in Belém-PA



Source: Pará Agency, 2025.

Figure 2 shows the Nova Tamandaré Linear Park implemented in Belém-PA.

As can be seen in Figure 1, it is located in a very urbanized area and waterproofed by pavements, buildings and has its outlet in the Guajará Bay.

The functionality of the drainage system of the Tamandaré Basin stands out for the importance of not flooding Tamandaré Avenue, avoiding losses and losses to the city and its inhabitants, especially when there is intense rainfall associated with high tide levels in Guajará Bay.

Figure 3 shows an image of the Tamandaré Channel with overflow due to the effect of high preamar.

Figure 3

Tamandaré Canal with transshipment in March 2013



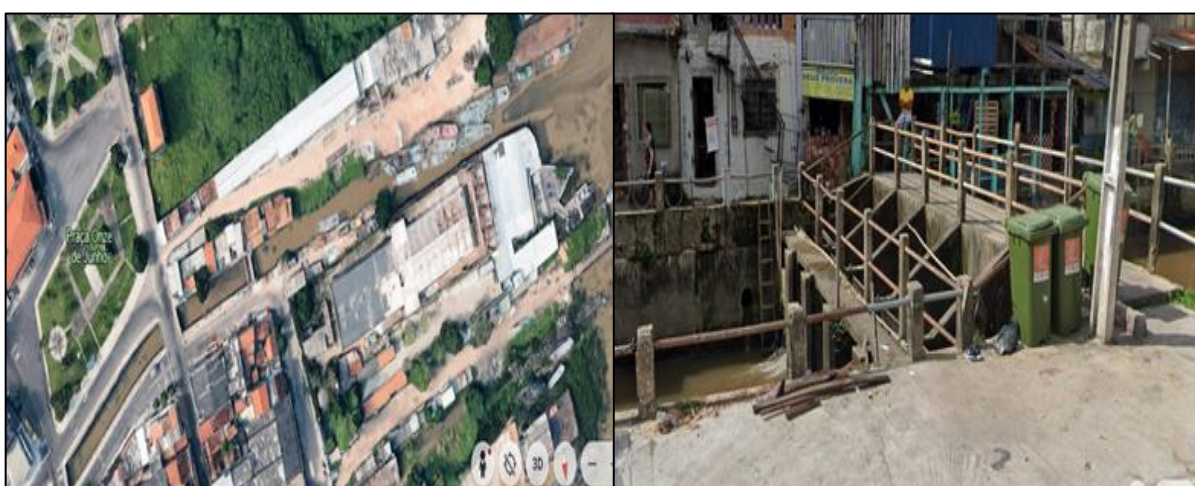
Source: Vinagre (2013)

Figure 2 shows overflow and flooding in the Tamandaré channel under the effect of heavy rain and high tide level in its outlet in Guajará Bay. It is a very urbanized and waterproofed area.

Figure 3 shows the floodgates of the Tamandaré Canal, on Av. Tamandaré, essential to its functionality.

Figure 4

Floodgates of the Tamandaré Channel



Source: Google (2023)

Figure 4 shows the outlet and the floodgates of the Tamandaré Canal.

The city of Belém-PA has elevation levels between 0 and 16 m (BELÉM, 2020), being rich in water resources, with intense rainfall, and because it is located close to the Equator,

high tide levels. These are decisive factors for the occurrence of important urban flooding.

Thus, the guiding question of the present research is to investigate the possibility of developing a hydrological-hydrodynamic computational model suitable for the formulation of engineering components suitable for the prevention and combat of flooding of the Tamandaré channel in Belém-PA, in the Amazon.

It is justified that this issue is extremely relevant, as the functionality of the drainage system of the Tamandaré Channel reverberates its importance in the prevention and control of flooding in the Tamandaré basin, avoiding losses and losses to the city and its inhabitants, especially when the occurrence of intense rains associated with high tide levels in the Bay of Guajará.

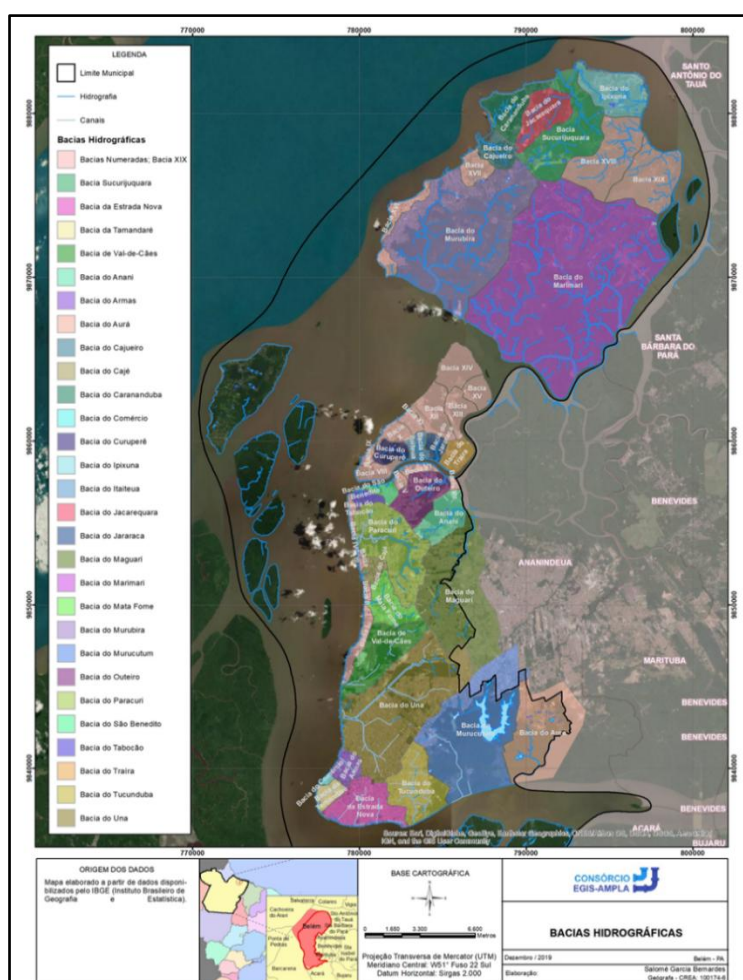
2 THEORETICAL FRAMEWORK

2.1 HYDROGRAPHIC BASINS OF BELÉM-PA

Figure 5 below presents the map of hydrographic basins of Belém-PA.

Figure 5

Map of basins of Belém/PA



Source: Authors (2025)

Figure 5 shows the Tamandaré Basin on the map of hydrographic basins of the city of Belém-PA.

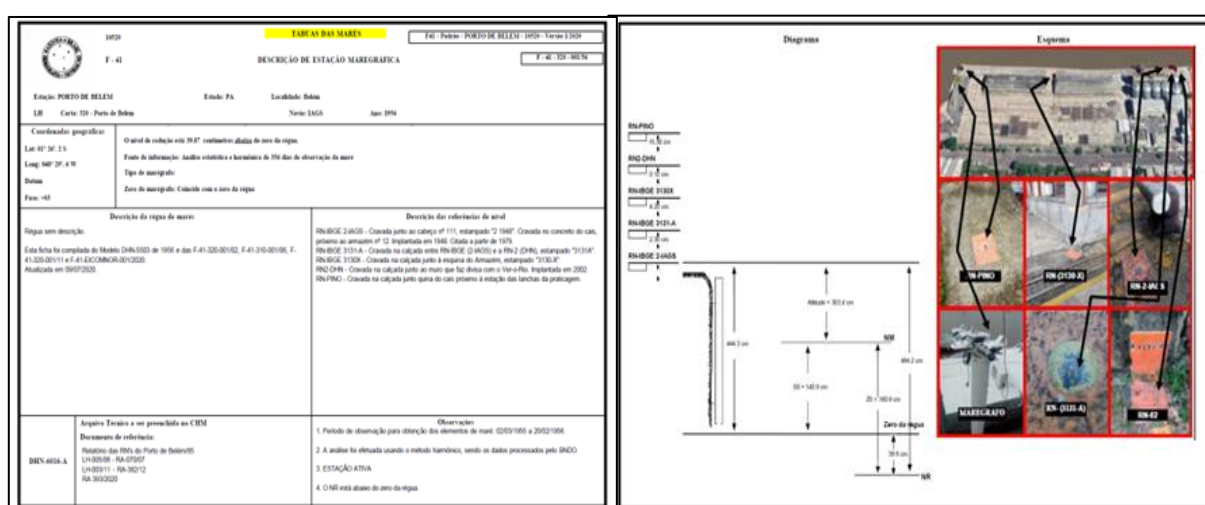
2.2 ALTIMETRY OF THE CHN AND IBGE

The Hydrography and Navigation Center of the Brazilian Navy annually publishes the tide tables of the Port of Belém-PA, with data from the Tide Gauge Station of this port.

Figure 6. shows information regarding the Tide Gauge Station of the Port of Belém-PA.

Figure 6

Information from the Tide Gauge Station of the Port of Belém-PA



Source: CHN (2025)

Figure 6 shows information from the tide gauge station of the port of Belém-PA, which measures the tide level by the reduction level methodology, and not by the Brazilian altimetric datum (IBGE, 2009).

2.3 BRAZILIAN ALTIMETRIC DATUM

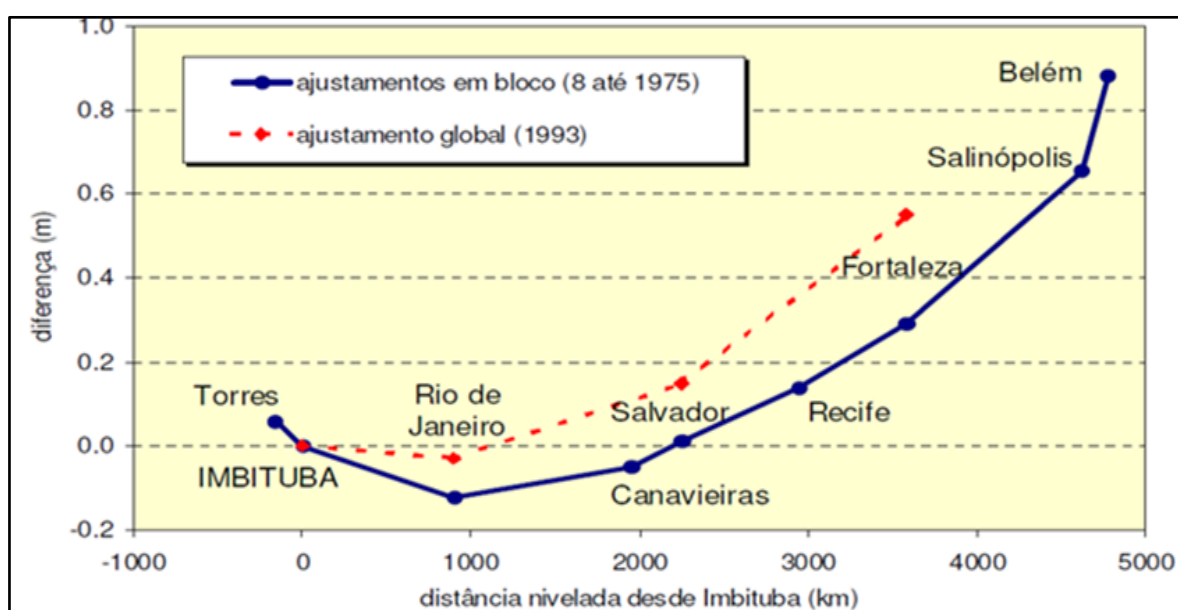
According to the IBGE (2009), the link between the Vertical Datum of the Brazilian Geodetic System, represented by the Imbituba and Santana data, and the Reduction Levels and Hydrographic Zeros along the Brazilian coast is established from the information available in the Geodetic Database (BDG). This bank provides essential geodetic subsidies for applications in engineering, cartography, and scientific studies. Among the most requested products, the altitudes of the SGB Level References (RRNN) stand out, widely used in analyses involving altimetric variations, especially in urban drainage projects in coastal regions under the influence of tides. The official altitudes of the SGB are referenced to two

distinct values of the mean sea level (NMM): the Imbituba Datum, defined based on tide gauge series observed in the period from 1949 to 1957, and the Santana Datum, established from observations carried out between 1957 and 1958 (Alencar, 1990; FEMAR, 2000; Luz and Guimarães, 2003). In the context of tide gauge information, the main source for the Brazilian coast is the Tide Table, prepared and published annually by the Hydrography and Navigation Center of the Brazilian Navy.

Figure 7 shows the differences in the altitudes of the RRNN of the IBGE Brazilian Altimetric Datum, referred to Imbituba, in relation to the local NMM.

Figure 7

Differences in altitudes of RRNN of SGB in relation to local NMM



Source: IBGE (2009); Alencar (1990)

Figure 7 summarizes the global adjustment of the RAAP geometric leveling data, completed in 1993, which produced altitudes of a significantly higher number of RRNNs than the manual adjustments made periodically between 1948 and 1975 (Alencar, 1968; Luz and Guimarães, 2001; Luz et al., 2002).

Thus, the port of Belém presents a tide gauge reading +0.8808 m above the IBGE level (Alencar, 1990) for the terrain, where the positive sign shows that the plane of the mean sea level recorded by the observations of the local Tide Gauge is higher than that determined in Imbituba, and transported by the leveling.

2.4 COMPUTATIONAL MODELING USING SWMM SOFTWARE

The *Storm Water Management Model* (SWMM), in Portuguese, consists of a free computational code for hydrological-hydrodynamic computational modeling, developed by

the United States Environmental Protection Agency (USEPA) in 1971. According to Garcia (2005) it is the most widely used software worldwide for urban drainage simulation. It is a distributed, physical model of discrete temporal simulation, in which a hydrographic basin is represented by a series of elements such as sub-basins, junctions, conduits, enabling the continuous simulation of hydrological-hydrodynamic events and processes (BELING, 2013).

This computational tool has many uses, being able to describe various hydrological processes such as surface runoff, infiltration, groundwater contribution, flow propagation, surface accumulation, and water quality propagation (SHINMA, 2011).

3 METHODOLOGY

The hydrological-hydrodynamic computational model of the Tamandaré Basin, developed through the free software SWMM, was structured from a sequence of methodological procedures. Initially, the tide curve and the precipitation time series were elaborated. Then, the identification and quantification of the constituent elements of the basin were carried out, including sub-basins, nodes and conduits, as well as the characterization of their physical attributes, such as shape, type and use of the soil, slope, cross-sections, extensions, elevation elevations and roughness coefficients, based on topographic surveys and available cartographic documents. Subsequently, the data was entered into the SWMM environment for the configuration of the model. Finally, the model was executed and its results were critically analyzed.

4 RESULTS AND DISCUSSION

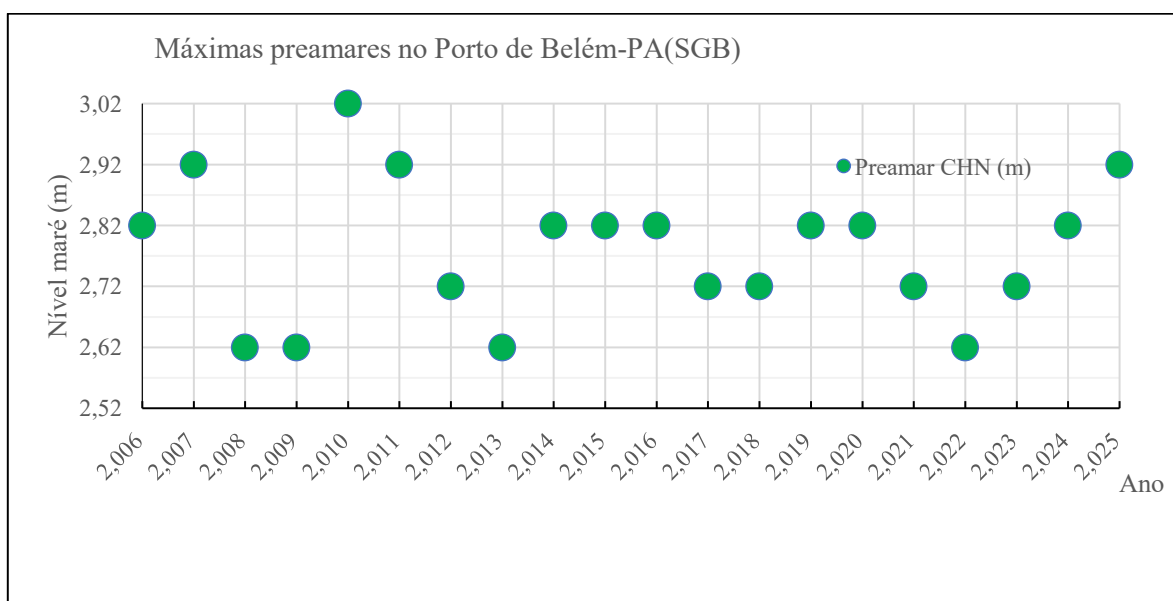
4.1 RESULTS

4.1.1 Tidal Curve and Precipitation Time Series

Figure 8 shows the levels of maximum preamares of the port of Belém-PA informed by the Tide Gauge Station of the Brazilian Navy and transposed to the ground level according to the Brazilian Altimetric Datum of the IBGE.

Figure 8

High tides reported by the Brazilian Navy for Belém-PA



Source: Authors (2025)

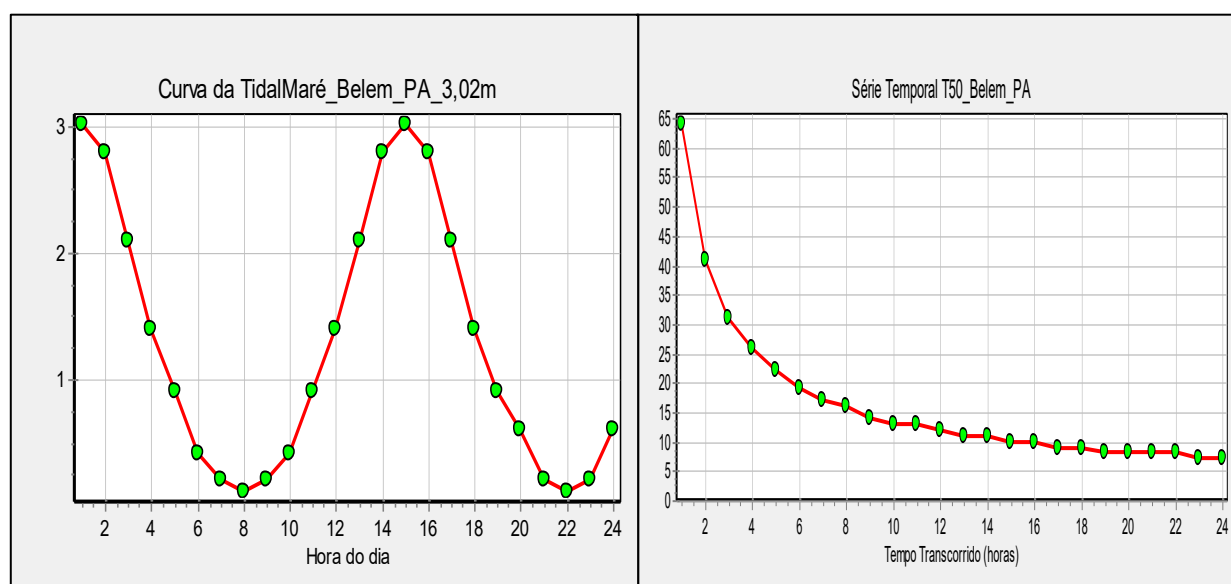
Figure 8 shows the levels of the maximum annual preamares provided by the Center for Hydrography and Navigation of the Brazilian Navy (CHN), referenced to the Brazilian Altimetric Datum of the IBGE. It is observed that the highest tide recorded corresponds to the elevation of 3.02 m, which occurred exclusively in 2010. Based on these data, the maximum annual preamar of 3.02 m was adopted for the present study as a reference condition. Thus, areas with elevation levels lower than this value are considered susceptible to flooding due to the direct influence of the tide.

Regarding the time series of precipitation with a return period of 50 years for the municipality of Belém-PA, used in the design of urban macro-drainage works, this was defined based on Souza *et al.* (2012). The rainfall event adopted presents a total precipitation of 172 mm, with a duration of 24 hours, and the temporal distribution of the rainfall was obtained through the methodology of time disaggregation applied to the 24-hour event analyzed.

Figure 8 illustrates the tidal curve corresponding to the 3.02 m high tide and the precipitation time series, both used as input data in the hydrological-hydrodynamic modeling.

Figure 9

Tidal curve and precipitation time series used in the simulation.



Source: Authors with data from CHN/SGB, 2025.

Figure 9 shows the tide curve of the maximum tide of 3.02m and the time series of rainfall with a return period of fifty years (T50) used in the computer model.

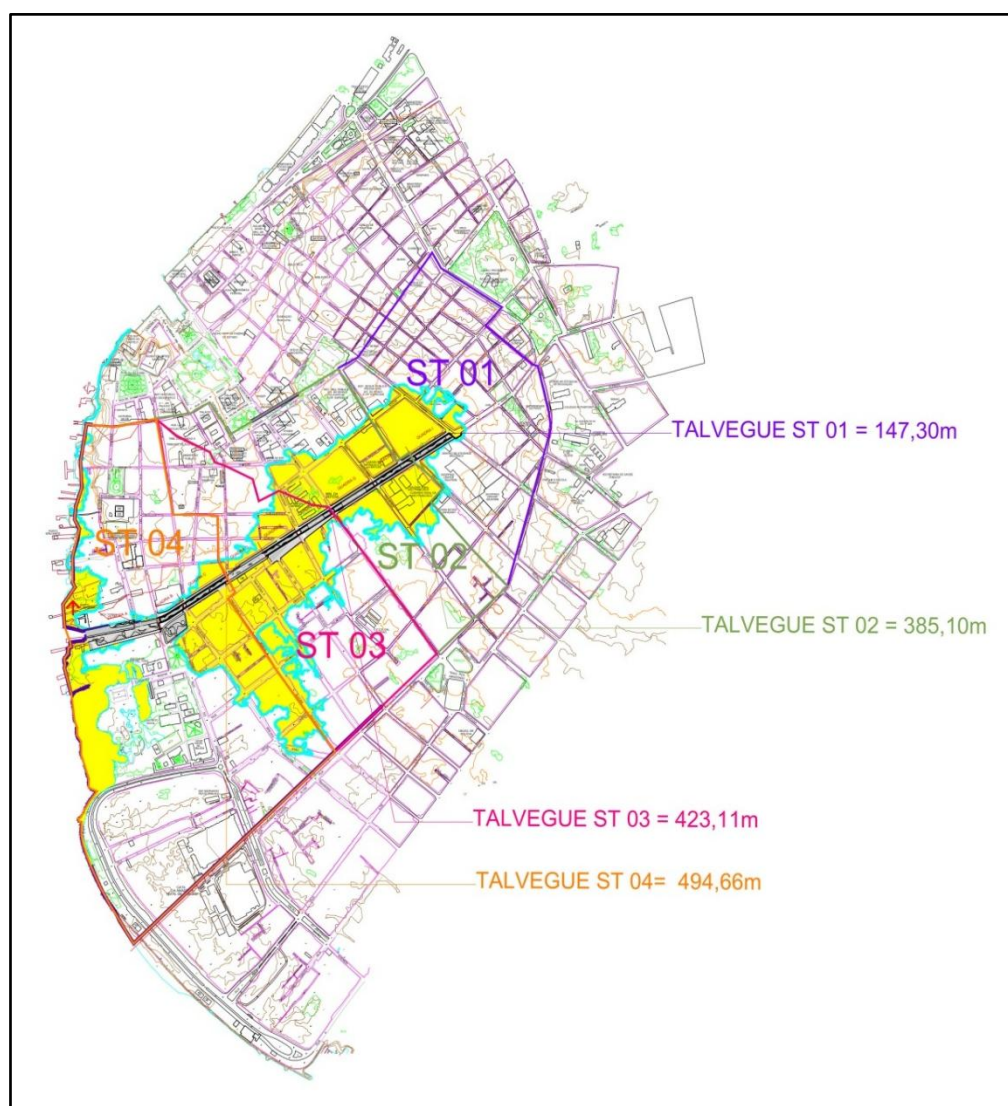
4.1.2 Tamandaré Basin

The Tamandaré basin has an area of 2.8km² with great waterproofing, low altitude (0 and 8 m), high rainfall, tidal influence and for these reasons it has frequent urban flooding. It includes two sub-basins, Tamandaré (area of 1.7 km²) and Reduto (area of 1.1 km²), which are interconnected by an existing pluvial gallery on Rua da Municipalidade. The Tamandaré Canal, with a length of 1.1 km, is located at Av. Tamandaré is lined in concrete and equipped with floodgates implemented in the 1960s (PMSB, 2020).

Figure 10 shows the Tamandaré Basin with its channel.

Figure 10

Tamandaré Basin



Source: Authors (prepared using the free software QGIS).

Figure 10 shows the Tamandaré Basin, with its four sub-basins.

Table 1 lists sub-basins, areas, nodes and conduits of the Tamandaré basin.

Table 1

Data from the Tamandaré basin

DATA	SUB-BASINS	CONDUIT	Span (m)	Input Node	Radier elevation NE (m)	Exit Node
Denomination	ST01	C1_ST01	68,60	N1_ST01	0,90	N2_ST01
Channel		C2_ST01	96,50	N2_ST01	0,90	N1_ST02
Area(ha)	36,01					
Perimeter(m)	2.725,45					
Swev(m)	147,30					
Width (m)	2.444,67					
Solo use	90% urb					
Exutory	N1_ST01					
			165,10			
Denomination	ST02	C1_ST02	98,00	N1_ST02	0,21	N2_ST02
Channel		C2_ST02	14,50	N2_ST02	0,05	N3_ST02
Area(ha)	32,23	C3_ST02	90,00	N3_ST02	0,46	N4_ST02
Perimeter(m)	3.241,43	C4_ST02	30,00	N4_ST02	0,21	N5_ST02
Swev(m)	385,10	C5_ST02	29,00	N5_ST02	0,20	N6_ST02
Width (m)	836,93	C6_ST02	15,00	N6_ST02	0,46	N1_ST03
Solo use	90% urb					
Exutory	N1_ST02					
			276,50			
Denomination	ST03	C1_ST03	25,00	N1_ST03	0,46	N2_ST03
Channel		C2_ST03	60,00	N2_ST03	0,46	N3_ST03
Area(ha)	36,33	C3_ST03	24,00	N3_ST03	0,23	N4_ST03
Perimeter(m)	3.002,73	C4_ST03	16,00	N4_ST03	0,10	N5_ST03
Swev(m)	423,11	C5_ST03	58,00	N5_ST03	0,10	N6_ST03
Width (m)	858,64	C6_ST03	3,00	N6_ST03	0,09	N7_ST03
Solo use	90% urb	C7_ST03	60,00	N7_ST03	0,10	N8_ST03
Exutory	N1_ST03	C8_ST03	130,00	N8_ST03	0,10	N1_ST04
			376,00			
Denomination	ST04	C1_ST04	80,00	N1_ST04	0,18	N2_ST04
Channel		C2_ST04	3,00	N2_ST04	0,18	N3_ST04
Area(ha)	78,92	C3_ST04	85,00	N3_ST04	0,39	N4_ST04
Perimeter(m)	4.159,88	C4_ST04	13,50	N4_ST04	0,78	N5_ST04
Swev(m)	494,66	C5_ST04	82,50	N5_ST04	0,78	N6_ST04
Width (m)	1.595,44	C6_ST04	13,50	N6_ST04	0,17	N7_ST04
Solo use	90% urb	C7_ST04	49,50	N7_ST04	0,17	N8_ST04
Exutory	N1_ST04	C8_ST04	6,00	N8_ST04	0,17	N9_ST04
		C9_ST04	6,00	N9_ST04	-1,48	OUTUSE
			339,00			
Area (ha)	183,49		1156,60			

Source: Authors, 2025

Table 1 shows data from the Tamandaré basin.

4.1.3 Feeding the Computational Model in Swmm

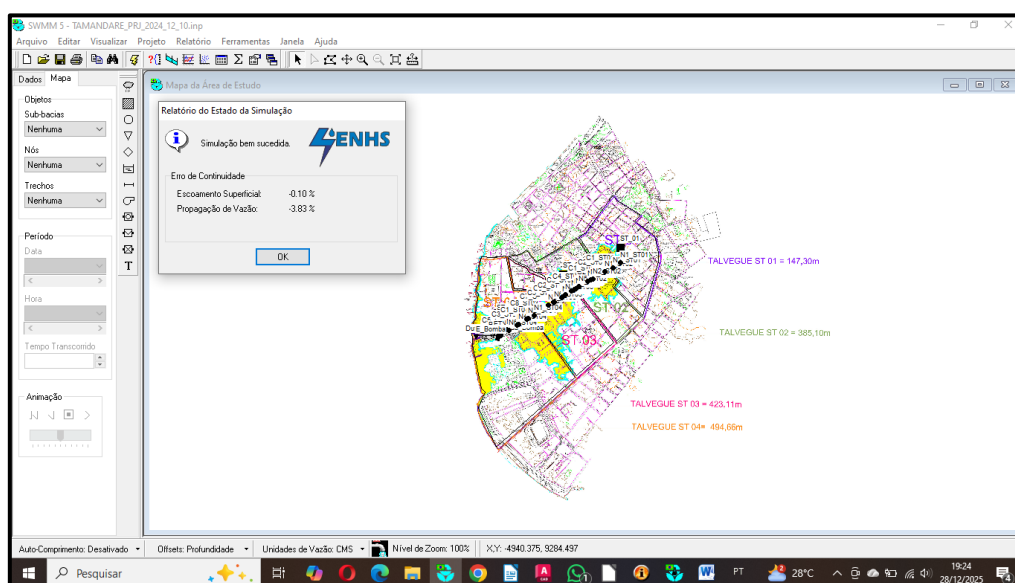
The information collected was inserted into the hydrological-hydrodynamic model of the Tamandaré basin, enabling the execution of the simulation.

4.1.4 Execution and Analysis of the Results Obtained

Figure 11 below shows the result of the simulation of the Tamandaré basin under the effect of rainfall with a recurrence period of 50 years and a pre-tide of 3.02 m.

Figure 11

Simulation result of the Tamandaré basin in Belém-PA



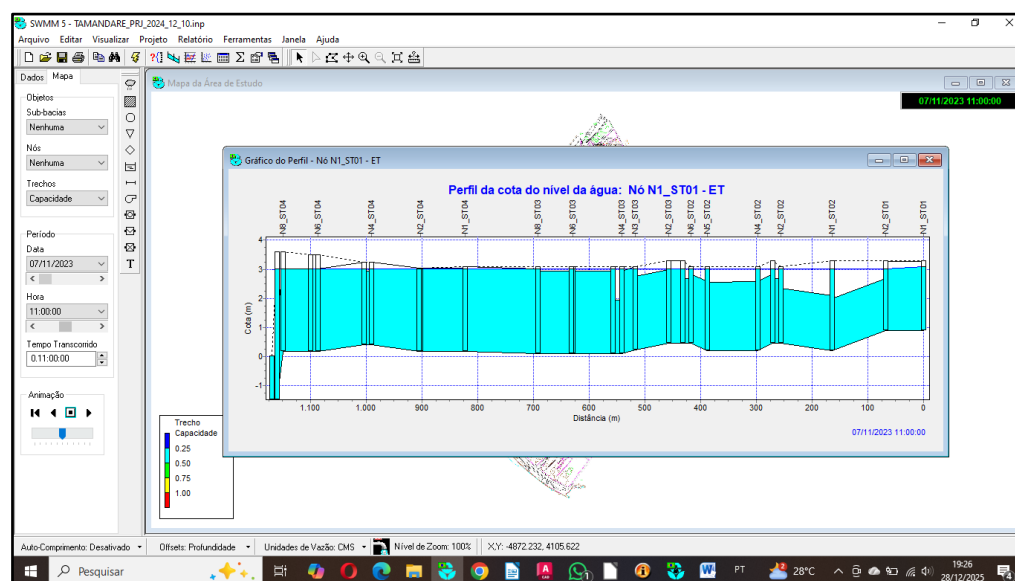
Source: Authors, 2025.

Figure 12 shows the successful result of the simulation of the Tamandaré basin with SWMM, with very small errors, of -0.10% for surface runoff and -3.83% for flow propagation.

Figure 12 shows the Tamandaré Channel at the moment of maximum water depth.

Figure 12

Profile of the Tamandaré channel at the moment of maximum water depth



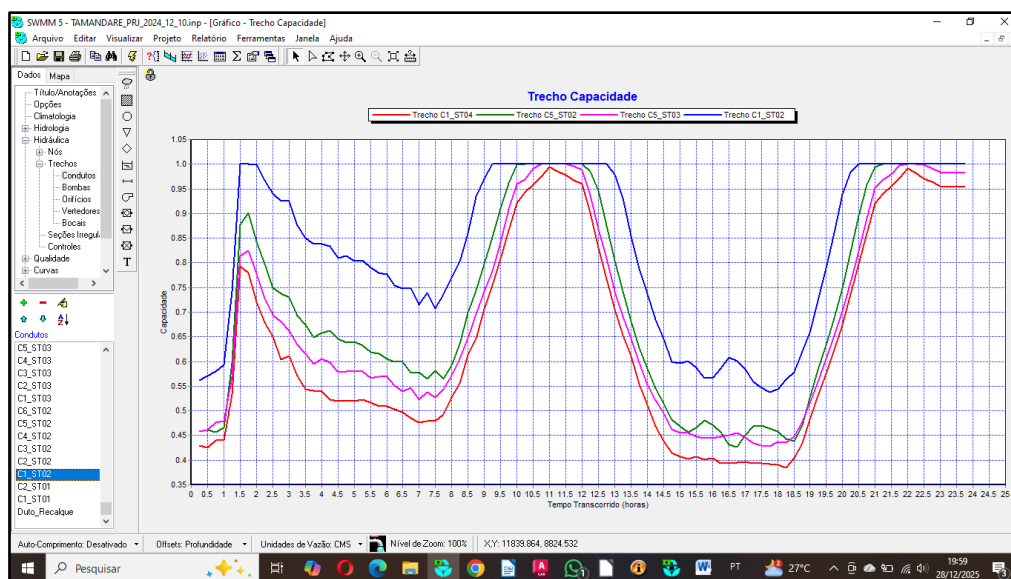
Source: Authors, 2025.

Figure 13 shows that the intermediate stretches of the canal, which have a lower elevation of the terrain, present a higher risk of flooding than the inlet and the spring.

Thus, the analysis of the flow with the help of the computational model elaborated in the SWMM results in the intermediate stretches being more susceptible to overflows and flooding, as shown in Figure 12.

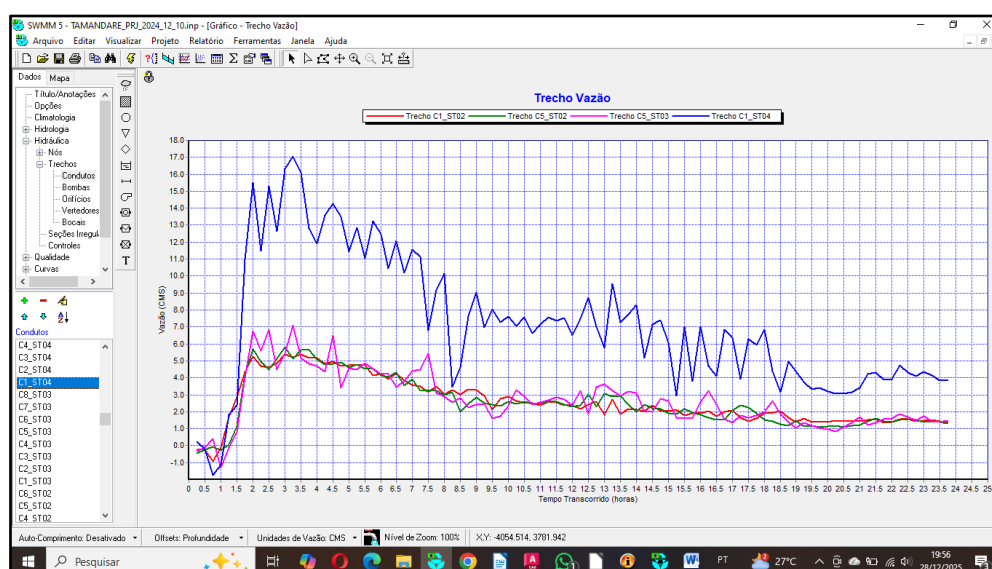
Figure 13

Time series of the capacity and flow of stretches of the Tamandaré canal



Source: Author (2025)

Figure 14



Source: Author (2025)

Figure 12 shows that among the stretches that reach 100% of capacity and overflow, C1_ST04 is the one with the highest flow, and thus becomes the most critical for this

overflow. It exceeds 85% of capacity in the interval between 9.5 and 12.5 hours after the start of the event, with a flow of $8\text{m}^3/\text{s}$. In order to reduce the used capacity of these stretches to up to 85%, in this interval of greater risk of overflow, it is recommended to insert two units of electric pumps, for settlement heights of 7.2mca and individual flows of $1.0\text{m}^3/\text{s}$. As an operating rule, they must be activated when the water depth in the section of the lift reaches 85% of the capacity of the section and turned off when it reaches 60%, preventing overflows.

4.2 DISCUSSION

The computational modeling of hydrological-hydrodynamic events in urban drainage basins is extremely useful for urban management, especially for preventing and combating flooding, by demonstrating quantitatively that the association of high rainfall, topography, tidal rise and intense waterproofing can result in the occurrence of overflows and flooding.

The annual tide of the year 2010 reached the altimetric level of 3.02m, showing the importance and usefulness of the floodgates of the Tamandaré channel, which constitute a necessary control mechanism to prevent the entry of water from the bay at times of high tide, avoiding the overflow of the channel at points of topographic levels lower than tide levels, especially in the points of lower elevations, in the order of 2.6 to 2.8m, in the vicinity of Blocks D, E and F (near Tv. Ângelo Custódio), where flooding currently occurs due to high tide, and even more, thus providing useful volume in the channel for the reception of rainwater.

5 CONCLUSION

Thus, to obtain the functionality of the Av. Tamandaré based on the Hydraulic-Hydrological Model of the Tamandaré basin studied here, it is recommended that elevations equal to or greater than the maximum annual tide of 3.02 m be used throughout the Park, where possible $3.02\text{ m} + 0.20\text{ m}$.

The successful implementation of the Nova Tamandaré Linear Park, in Belém-PA, as an intervention to improve urban infrastructure in the preparatory period for COP30, was based on the hydrological-hydrodynamic study developed through computer modeling in the SWMM software, as described in this work.

The main constraints associated with urban flooding in the study area consist of the low elevation of the terrain, the high degree of surface waterproofing and the high tide levels, factors that highlight the need for the adoption of hydraulic control devices, such as floodgates, as well as the use of pumping systems for rainwater settlement. aiming at preventing overflows and floods.

The results of the study demonstrated the high utility of the proposed modeling, by realistically reproducing the hydraulic behavior of the Tamandaré basin when subjected to a rainfall event with a return period of 50 years, characterized by a total rainfall of 172 mm in 24 hours, concomitantly with the occurrence of the maximum tide recorded, observed in 2010. One of the relevant conclusions refers to the identification of susceptibility to tide-induced flooding in areas with elevation levels below 3.02 m, a value corresponding to the level of the maximum tide considered.

The simulations indicated the achievement of 100% of the hydraulic capacity of the Tamandaré Canal, a result that reinforces the need to use electric pumps as an essential measure to prevent overflows. From an operational point of view, it is recommended that the occupied capacity of the channel be maintained at levels below 85%, as a criterion of hydraulic safety.

In this context, the implementation of the Tamandaré Rainwater Pumping Station is a strategic equipment for the mitigation of overflows and flooding in the Tamandaré Channel — and, by extension, in this basin — acting in periods of rising water levels, together with altimetric control and the proper operation of the floodgates. In this way, the Tamandaré basin now has effective mechanisms for the prevention and control of urban flooding.

For the implementation of the pumping station, with the objective of reducing the hydraulic occupation of the channel to values below 85%, preventing overflows, it was recommended the installation of two electric pumps operating in parallel, each with a pumping capacity of 1.0 m³/s, for a settlement head of 7.2 mca. The system must be operated automatically, with activation of the pumps when the hydraulic occupation of the channel reaches 85% and shutdown when it reaches 60%.

Thus, the computational modeling carried out with SWMM proved to be an effective tool for the analysis of a problem of high urban relevance in Belém-PA, allowing the evaluation of critical scenarios and the proposition of technically adequate engineering solutions for the prevention and control of flooding.

ACKNOWLEDGMENTS

The authors express their gratitude to the University of the Amazon (UNAMA), the State Secretariat of Public Works of Pará (SEOP) and the Municipal Secretariat of Urban Zeladoria of Belém (SEZURB) for the institutional and technical support granted.

We extend our thanks to the Urban and Environmental Modeling (MURBA) research group for the academic collaboration. Finally, we thank the Coordination for the Improvement of

Higher Education Personnel (CAPES) for the support granted through scholarships, a fundamental resource for the development and feasibility of this research.

REFERENCES

- Alencar, J. C. M. (1990). Datum altimétrico brasileiro. *Cadernos de Geociências*, 5, 69–73. http://www.ibge.gov.br/canal_artigos/a1990_1.php
- Centro de Hidrografia da Marinha. (2025). Tábua de marés. <http://www.chn.mar.mil.br>
- Centro de Hidrografia da Marinha. (2020). 10520 - Porto de Belém F-41 padrão v1-2020_0 [Dados de maré]. Marinha do Brasil. https://www.marinha.mil.br/chm/sites/www.marinha.mil.br/chm/files/dados_de_mare/10520_-_porto_de_belem_f-41_padrao_v1-2020_0.pdf
- Belém. (2020). Lei Municipal nº 9.656, de 30 de dezembro de 2020. Plano Municipal de Saneamento Básico. <https://cmb.pa.gov.br/wp-content/uploads/2022/06/Proc.-1468-2020-PMB-Mensagem.-12.pdf>; <https://arbel.belem.pa.gov.br/wp-content/uploads/2022/05/VOLUME-IV-DRENAGEM.pdf>
- Beling, F. A. (2013). Análise do desempenho do modelo SWMM 5.0 acoplado ao calibrador PERT na bacia do Arroio Cancela/RS [Dissertação de mestrado, Universidade Federal de Santa Maria].
- Environmental Protection Agency. (2010). Storm water management model – SWMM – User's manual. National Risk Management Research Laboratory.
- Environmental Protection Agency. (2000). Environmental Protection Agency Network Evaluation Tool – EPANET – User's manual. National Risk Management Research Laboratory.
- Fundação de Estudos do Mar. (2000). Catálogo de estações maregráficas brasileiras. <http://www.femar.com.br>
- Garcia, J. I. B. (2005). Monitoramento hidrológico e modelagem da drenagem urbana da bacia hidrográfica do Arroio Cancela [Dissertação de mestrado, Universidade Federal de Santa Maria].
- Instituto Brasileiro de Geografia e Estatística. (2009). Esclarecimento sobre a relação entre o datum vertical do SGB-Imbituba e Santana e os níveis de redução e zeros hidrográficos no litoral brasileiro. https://www.ibge.gov.br/geociencias/metodos-e-outros-documentos-de-referencia/outros-documentos-tecnicos-geo/16393-esclarecimento-sobre-a-relacao-entre-o-datum-vertical-do-sgb-imbituba-e-santana-e-os-niveis-de-reducao-e-zeros-hidrograficos-no-litoral-brasileiro.html02_Rela_347_343o-DVSGB-NR-ZH_5.doc
- Luz, R. T., & Guimarães, V. M. (2003). Dez anos de monitoramento do nível do mar no IBGE. In *Anais do 3º Colóquio Brasileiro de Ciências Geodésicas*. Universidade Federal do Paraná. http://www.ibge.gov.br/canal_artigos/pdf/2003-Dez_anos_de_MNM_no_IBGE_3.pdf
- QGIS Development Team. (2025). QGIS geographic information system. Open Source Geospatial Foundation Project. <http://qgis.org>
- Souza, R. O. R. de M., Scaramussa, P. H. M., Amaral, M. A. C. M. do, Pereira Neto, J. A., Pantoja, A. V., & Sadeck, L. W. R. (2012). Equações de chuvas intensas para o Estado do Pará. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 16(9), 999–1005.

Storm Water Management Model. (2012). EPA SWMM 5.0 – Modelo de gestão de drenagem urbana (Tradução do Laboratório de Eficiência Energética e Hidráulica em Saneamento). Universidade Federal da Paraíba. www.lenhs.ct.ufpb.br/html/downloads/swmm/SWMM_2012.pdf

Shinma, T. P. (2011). Calibração multiobjectivo do SWMM aplicada à transformação chuva-vazão [Dissertação de mestrado, Escola de Engenharia de São Carlos, Universidade de São Paulo].

Vinagre, M. V. A., Lima, A. C. M., Lima, A. M., Macedo, A. L., & Moraes, A. R. S. (2013). Simulação hidráulica de rede de macrodrenagem na orla fluvial de Belém do Pará com o uso do programa SWMM. In M. G. S. Tobias & A. C. de M. Lima (Orgs.), *Urbanização e meio ambiente* (Vol. 2, pp. 27–50). Editora UNAMA.

DEVELOPMENT AND VALIDATION OF THE COOPER-PRO APPLICATION FOR THE ASSESSMENT AND PRESCRIPTION OF TRAINING FOR ROAD RUNNERS

DESENVOLVIMENTO E VALIDAÇÃO DO APLICATIVO COOPER-PRO, PARA AVALIAÇÃO E PRESCRIÇÃO DO TREINAMENTO PARA CORREDORES DE RUA

DESARROLLO Y VALIDACIÓN DE LA APLICACIÓN COOPER-PRO PARA LA EVALUACIÓN Y PRESCRIPCIÓN DEL ENTRENAMIENTO DE CORREDORES DE CARRETERA



<https://doi.org/10.56238/sevened2026.008-157>

Moisés Simão Santa Rosa de Sousa¹, Luiguy Xavier de Lima², Tatyana Pinheiro Magalhães³, Divaldo Martins de Souza⁴, Alaan Ubaiera Brito⁵

ABSTRACT

Introduction: Technology has been utilized by coaches and road runners in the pursuit of better results, without neglecting scientific aspects of training, and the use of applications for this purpose can make the process more efficient.

Objective: The objective was to develop and validate a technological tool through an application to assist in the evaluation and prescription of training for road runners.

Method: The tool was developed by a multidisciplinary team combining expertise in Physical Education and software development. The system was implemented using Next.js 15 (App Router), React 19, and TypeScript, with a responsive interface built with Tailwind CSS. For authentication and data persistence, Supabase was used, including Supabase Auth and a PostgreSQL database, with security policies (RLS) for access control. Data from 20 amateur runners with an average age of 63.4 years were used to test functionality. Usability was evaluated by 18 physical education professionals using the SUS instrument (System Usability Scale).

Results: There was no statistical difference between measurements taken manually and via the application. The SUS scale showed a mean value of 97.08 points. Conclusion: The

¹ Dr. in Sport Sciences. Universidade do Estado do Pará (UEPA). E-mail: moises.sousa@uepa.br
Orcid: <https://orcid.org/0000-0002-0684-2079>

² Specialist in Business Management and Market Intelligence. Instituto de Estudos Superiores da Amazônia (IESAM). E-mail: xavierluiguy@gmail.com Orcid: <https://orcid.org/0000-0003-1339-4777>

³ Dr. in Ecology and Conservation. Universidade Federal do Pará (UFPA). E-mail: tatyana pinheiro@yahoo.com.br
Orcid: <https://orcid.org/0000-0001-8327-4047>

⁴ Dr. in Sport Sciences. Universidade do Estado do Pará (UEPA). E-mail: divaldozouza21@gmail.com
Orcid: <https://orcid.org/0000-0001-9621-3470>

⁵ Dr. in Energy. Universidade Federal do Amapá (UNIFAP). E-mail: aubrito@unifap.br
Orcid: <https://orcid.org/0000-0002-3850-2298>

Cooper Pro application is an efficient technological tool with good usability to assist in the prescription of road running training.

Keywords: Road Running. Training. Application.

RESUMO

Introdução: A tecnologia tem sido utilizada por treinadores e corredores de rua na busca por melhores resultados, sem negligenciar aspectos científicos do treinamento, e o uso de aplicativos para esta finalidade pode tornar este processo mais otimizado.

Objetivo: O objetivo foi desenvolver e validar uma ferramenta tecnológica através de aplicativo para auxiliar na avaliação e prescrição do treinamento para corredores de rua.

Método: A ferramenta foi desenvolvida por uma equipe multidisciplinar unindo conhecimentos da Educação Física e do desenvolvimento de software. O sistema foi implementado com Next.js 15 (App Router), React 19 e TypeScript, com interface responsiva construída com Tailwind CSS. Para autenticação e persistência de dados, utilizou-se o Supabase, incluindo Supabase Auth e banco de dados PostgreSQL, com políticas de segurança (RLS) para controle de acesso. Dados de 20 corredores amadores com idade média de 63,4 anos foram utilizados para testar a funcionalidade. A usabilidade foi avaliada por 18 educadores físicos através do instrumento SUS (System Usability Scale).

Resultados: Não houve diferença estatística entre medidas realizadas de forma manual e através do aplicativo. A escala SUS apontou valor médio de 97,08 pontos. Conclusão: O aplicativo Cooper Pro constitui-se em uma ferramenta tecnológica eficiente, com boa usabilidade para auxiliar na prescrição do treinamento de corrida de rua.

Palavras-chave: Corrida de Rua. Treinamento. Aplicativo.

RESUMEN

Introducción: La tecnología ha sido utilizada por entrenadores y corredores de ruta en la búsqueda de mejores resultados, sin descuidar los aspectos científicos del entrenamiento, y el uso de aplicaciones con este propósito puede hacer que este proceso sea más eficiente.

Objetivo: El objetivo fue desarrollar y validar una herramienta tecnológica a través de una aplicación para ayudar en la evaluación y prescripción del entrenamiento de corredores de ruta.

Método: La herramienta fue desarrollada por un equipo multidisciplinario que unió conocimientos de Educación Física y desarrollo de software. El sistema se implementó con Next.js 15 (App Router), React 19 y TypeScript, con una interfaz responsiva construida con Tailwind CSS. Para la autenticación y persistencia de datos, se utilizó Supabase, incluyendo Supabase Auth y la base de datos PostgreSQL, con políticas de seguridad (RLS) para el control de acceso. Se utilizaron datos de 20 corredores aficionados con una edad promedio de 63,4 años para probar la funcionalidad. La usabilidad fue evaluada por 18 educadores físicos a través del instrumento SUS (System Usability Scale).

Resultados: No hubo diferencia estadística entre las mediciones realizadas de forma manual y a través de la aplicación. La escala SUS arrojó un valor promedio de 97,08 puntos. Conclusión: La aplicación Cooper Pro se configura como una herramienta tecnológica eficiente, con buena usabilidad para ayudar en la prescripción del entrenamiento de running en ruta.

Palabras clave: Running en Ruta. Entrenamiento. Aplicación.

1 INTRODUCTION

Street running is a current reality, and the number of followers of its practice is growing day by day for various reasons, especially when it comes to the search for health and quality of life, and have been understood as one of the main strategies to increase the practice and levels of physical activity at the population level (Bauman et al., 2021). The number of street races held in the country in the last year grew 29% compared to 2023. In all, in 2024, there were 2,827 official races, involving experienced runners or beginners, men and women, surpassing the mark of 2,186 events of this kind in the previous year (Sponchiato, 2025).

As it is an accessible and low-cost practice, street running has been gaining more and more space in the routine of the Brazilian population. In addition to its accessibility, street running also promotes benefits to the health and quality of life of its practitioners, being responsible for the increase of approximately 10% in the levels of physical activity of the Brazilian population in general, and has been used as an important tool present in action plans, at the government level, to promote physical activity. in different countries (Costa et.al. 2023; Rojo, 2017; Bauman et al., 2021).

The traditional image of the runner, who simply puts on a pair of sneakers and goes out to run through the streets, does not represent the complexity and care that this modality requires. In addition to the act of running, street running requires physical preparation, technical knowledge and, above all, an approach based on scientific bases to ensure safety, efficiency and longevity in sports practice (Borges et al., 2015; Brazil, 2020).

It is common to see beginners disregard essential aspects, such as medical evaluation, training planning, proper choice of equipment, nutrition, and injury prevention. This negligence can bring health risks, limit performance and, in many cases, remove the practitioner from the sport early (Brasil, 2020; Nascimento; Santana, 2016).

Planning and individualization of training are key aspects for success in road running. It is not enough to follow generic spreadsheets found on the internet; It is necessary to consider factors such as age, sports history, fitness level, personal goals and time availability. The guidance of qualified professionals, such as physical educators and physiotherapists, is essential to structure a safe and efficient program. The elaboration of an individualized running training, based on recent scientific bases, is essential for the athlete to reach his full potential (Jones; Carter, 2000; Midgley et al., 2007).

Training is characterized as a repetitive and systematic process, composed of progressive exercises aimed at improving performance. In this sense, physical training can be understood as an organized and systematic process of physical improvement, in its

morphological and functional aspects, directly impacting the ability to perform tasks that involve motor demands, whether sports or not (Roschel; Tricoli; Ugrinowitsch, 2011).

The prescription of exercise intensity should be individualized to maximize physiological gains and reduce the risk of injury. The apps facilitate this individualization by adapting the training zones, considering the individuality of the running athlete, something that is difficult to achieve with static spreadsheets (Buxton et al., 2011).

In road running, for a long time, cardiorespiratory capacity (expressed in terms of VO₂ max) was considered one of the main predictors of performance in endurance athletes (Joyner, 2018). Traditionally, the assessment of VO₂ max requires expensive and difficult-to-access laboratory tests. However, technological advances have allowed the development of indirect methods and the integration of algorithms into applications capable of estimating this crucial variable with good accuracy. VO₂ max is widely accepted as the best indicator of cardiorespiratory fitness and endurance capacity, and is essential to direct exercise intensity (Silva, 2007; Buxton et al., 2011).

The 12-minute running test (Cooper test) is widely accepted in the area of Physical Education and Sports Sciences, and is even referenced by important institutions such as the *American College of Sports Medicine* (ACSM) as a valid field method for indirect estimates of VO₂ max. The justification for the use of the Cooper test to estimate VO₂ max lies primarily in its simplicity of execution in the field and its recognized reliability (reproducibility) in the assessment of cardiorespiratory fitness in large groups (ACSM, 2006).

The test was originally developed by Kenneth Cooper in 1968 based on a high correlation ($r=0.90$) between the distance covered on the track in 12 minutes and VO₂ max measured directly in the laboratory, in a sample of young adults from the US Air Force. The scientific basis of the test lies in the direct correlation between the distance traveled and the maximum volume of oxygen that the body can use at VO₂ max. This establishes its validity as a method of indirect prediction. The distance covered directly reflects the ability of the cardiovascular and respiratory system to transport and use oxygen during maximal and prolonged effort, and is a robust indicator of an individual's overall aerobic fitness (Mahseredjian; Barros Neto; Tebexreni, 1999).

The use of VO₂ max as a strategy to determine the intensity of training represents an effective, safe approach in line with the best practices of sports science. The personalization of training enhances results, health, motivation and sports longevity of runners. In addition, the monitoring of VO₂ max over time makes it possible to make adjustments in the planning, making the training process more dynamic and efficient. This ensures that the athlete is always training in zones that are appropriate to their current goals and conditions, optimizing performance and reducing risks (Bompa; Buzzichelli, 2019).

Considering the complexity of the process of evaluation, prescription and monitoring of a scientifically based training for long-distance runners, and seeking to make this process more practical, faster and more dynamic for coaches, teachers, coaches and athletes, the

objective of this study was to develop and validate a tool, through an application, to assist in the evaluation process and in the prescription of training for street runners from the results of the Cooper test.

2 MATERIAL AND METHOD

This research is characterized as applied research, through the development of a technological tool (Cooper Pro application) for practical purposes of evaluation and prescription of training for street runners, using quantitative data from the evaluation of VO₂ max, through the Cooper test.

The Cooper Pro was developed by a multidisciplinary team, combining knowledge of Physical Education and software development. The system was implemented with Next.js 15 (*App Router*), *React* 19 and *TypeScript*, with a responsive interface built with *Tailwind CSS*. For authentication and data persistence, *Supabase* was used, including *Supabase Auth* and the *PostgreSQL* database, with security policies (RLS) for access control. The app is structured to work as a PWA (Progressive Web App), with a manifest and *service worker*, allowing installation on mobile and desktop devices. To validate the operation, automated tests (Jest, Testing Library and Playwright) and usage tests were carried out in modern browsers and mobile devices via PWA installation.

The population involved in the tool's efficiency test was made up of individuals of both sexes who were members of the physical conditioning class of the Sports Center project of the Sports and Leisure Center of the State Department of Education of Pará, and a sample composed of 20 randomly chosen individuals was selected, 9 females and 11 males. with a mean age of 63.4 years.

The cardiorespiratory evaluation was performed using a 12-minute run (Cooper test) performed on an official athletics track (400m), where the total distance covered in meters by each subject was obtained. The individual data of the participants, as well as the results obtained in the 12-minute running test, were entered into the interfaces of the Cooper Pro application that calculated the training variables. Then, the same calculations were performed manually, obtaining results similar to those generated by the application.

The validation of the application occurred through the statistical treatment of the data, carried out through the SPSS 25.0 statistical package (IBM), in which descriptive statistics were adopted for the characterization of the sample, through the minimum and maximum values, the arithmetic mean and the standard deviation for the quantitative variables, and the absolute and relative values for the categorical variables.

To verify the differences between the means of the variables performed manually and through the application, the *Student's t-test* for independent variables was performed, adopting a significance level of $p < 0.05$.

To test the usability of the application, 18 experienced physical educators, belonging to the Sports and Leisure Center of the Department of Education of the State of Pará, were selected to fill out the questionnaire (SUS) *System Usability Scale*, composed of 10 questions, which evaluate effectiveness (success in using the product), efficiency (effort to use the product) and satisfaction (experience of using the product) on a scale of 1 to 5, 1 being "Strongly disagree" and 5 "Strongly agree".

After the completion of a version without apparent errors, the Cooper Pro application for mobile devices had its registration application submitted to the National Institute of Industrial Property.

3 RESULTS AND DISCUSSIONS

Tables 1 to 3 contain the descriptive data of the sample obtained through the manual measurement and the application, as well as the correlation data between the manual measurements and those obtained by the application, with the objective of verifying the consistency between these measurements.

Table 1

Descriptive characteristics of the sample (minimum and maximum values, arithmetic mean and standard deviation)

Variable	Minimum	Maximum	Arithmetic Mean	Standard Deviation
Age	38,00	80,00	63,40	8,68
Body Mass	35,50	83,50	60,78	11,66

Source: Data Collection

Table 1 shows heterogeneity in relation to the age and body mass of the sample, which may have occurred because the sample was composed of female and male participants.

Table 2

Descriptive characteristics of the sample in both manual and app measurements (arithmetic mean $\pm$ standard deviation)

Variable	Manual Measurement	In-App Measurement
Distance measured in the Cooper test	2,146.50 $\pm$ 266.03	2,146.50 $\pm$ 266.03
VO2 max	36.66 $\pm$ 5.94	36.67 $\pm$ 5.93
Maximum MET	10.47 $\pm$ 1.70	10.47 $\pm$ 1.70
Training Fraction	0.80 $\pm$ 0.02	0.80 $\pm$ 0.02

Training Intensity	8.46 ± 1.54	8.40 ± 1.54
Speed (m/min)	140.94 ± 25.70	140.94 ± 25.70
Distance m/40 minutes)	5,637.76 ± 1,027.83	5,634.60 ± 1,027.55
VO2 in 40 minutes	63.23 ± 17.94	63.23 ± 17.94
Caloric expenditure	316.25 ± 89.72	316.00 ± 89.68
Weight Loss	40.91 ± 11.61	40.89 ± 11.60

Source: Data Collection

Table 2 shows the sample characteristics related to the results verified both in the manual measurement and the measurement obtained through the application.

Table 3

Descriptive characteristics of the sample in the two procedures, manual and application (arithmetic mean ± standard deviation) and comparison of means (t-test)

Variable	Description		Comparison	
	Manual	Application	t	p
Cooper's result (mts)	2146.50 ± 266.03	2146.50 ± 266.03	0,00	1,000
VO2max. (ml/Kg/min)	36.66 ± 5.94	36.67 ± 5.93	-0,01	0,996
METmax. (METS)	10.47 ± 1.70	10.47 ± 1.69	0,01	0,991
Training Fraction (FT)	0.80 ± 0.02	0.80 ± 0.02	0.86	0,393
Training Intensity (IT)	8.46 ± 1.54	8.40 ± 1.54	0,11	0,913
Speed (mts/min)	140.94 ± 25.70	140.87 ± 25.69	0,10	0,913
Distance (mts)	5637.76 ± 1027.83	5634.60 ± 1027.55	0,10	0,992
Oxygen Consumption (Its)	63.25 ± 17.94	63.20 ± 17.94	0,01	0,993
Caloric expenditure (Kcal)	316.25 ± 89.72	316.00 ± 89.68	0,01	0,993
Weight Loss (g)	40.91 ± 11.61	40.89 ± 11.60	0,01	0,094

Source: Data Collection

Table 3 shows that when comparing the results obtained in the measurements performed manually and through the application, no statistical difference was observed in any of the variables investigated, showing that the measurements are statistically similar.

VO₂ max is widely considered to be the best physiological indicator of an individual's cardiorespiratory fitness and aerobic capacity. It represents the maximum rate at which the body can capture, transport, and use oxygen for energy production (ATP) aerobically during strenuous exercise. Basset; Howley (2000) define the VO₂ max as a representative index of the amount of oxygen, per unit of time, that the body can extract from the environment and use metabolically.

In the present study, the average distance reached in the time of 12 minutes on the track was 2146.50m, however the literature indicates that beginner runners of both sexes present results that vary significantly according to age, establishing that in the age group of 60 years, distances between 1,400 and 1,700 meters are classified as "medium" or "regular" for sedentary people who start the practice. The reference table proposed by Marins and Giannichi (2003) for the Brazilian population suggests that for men over 60 years of age, exceeding 1,600 meters already signals a level of fitness higher than the sedentary average.

High VO_2 max values are crucial for performance in endurance activities such as long-distance running. Aerobic training produces physiological adaptations, such as an increase in the number and size of mitochondria, which contribute to the improvement of VO_2 max (Silva, 2007).

The Metabolic Equivalent (MET) is a physiological unit used to express the energy cost of physical activities as multiples of the resting metabolic rate. 1 MET is defined as the amount of oxygen consumed by an individual at absolute rest (sitting calmly), conventionally corresponding to 3.5 ml of O_2 per kilogram of body weight per minute (3.5 ml/kg/min). Peak MET (or VO_2 max) can be determined by a stress test (ergospirometry or exercise test). If an individual achieves 10 METs on the test, this is their maximum capacity, which is equivalent to a VO_2 max of 35 ml/kg/min. (Sousa et. al., 2015).

In the present study, the estimated mean value for the maximum MET was 10.47 mets. This value corroborates the values found in the literature where they indicate that the maximum MET (METmax) in beginners varies significantly according to age, gender and level of previous activity, but is generally between 8 and 12 METs, where Mendes et.al., (2018) identified vigorous intensity thresholds around 6.8 METs for the general population, suggesting that the peak effort (maximum) for an untrained beginner hardly exceeds 10-11 METs at the beginning of the program.

A study by Heydenreich et.al., (2019) compared beginner and trained endurance athletes and found that while athletes reached high averages, beginners had a VO_2 max between 34.4 and 42.8 mL/kg/min, which corresponds to a maximum MET of approximately 9.8 to 12.2 METs (considering 1 MET = 3.5 mL/kg/min).

For beginners, maximum MET is a superior clinical prescribing tool to simple running speed. The transition from sedentary to beginner runner promotes "angiogenesis" (formation of new capillaries) and increased mitochondrial density. Moderate-intensity and continuous training is effective in raising initial VO_2 max, but the progressive inclusion of high-intensity intervals (HIIT) has been shown to be more efficient in breaking physiological plateaus in subsequent phases (Ross et al. 2016; Scribbans et al., 2016).

Training Fraction (Relative Intensity) typically refers to the relative intensity of exercise, often expressed as a percentage of VO_2 max, maximum heart rate (%HRmax), or relative to training thresholds (aerobic and anaerobic threshold). Intensity is one of the crucial acute variables of training, being a determining factor of physiological adaptations, as higher intensities can generate greater improvements in VO_2 max in trained athletes (Daussin et al, 2008).

In the present study, considering the characteristics of the sample, a training fraction (TF) equivalent to 0.80% of the maximum Met was adopted, which shows an average speed of 140.94 m/min, corresponding to a total distance of 5,637 meters in 40 minutes of training.

According to the ACSM's (2021) guidelines, the training fraction (FT) by the maximum MET is an intensity prescription method that uses the percentage of maximum functional capacity (measured in METs) achieved in a stress test. The ideal intensity for aerobic activities usually varies between 50% and 85% of the maximum MET, corresponding respectively to a Light/Moderate Training with ~50% to 60% of the maximum MET. and an Intense Workout: >70% of max MET.

The speed controlled during aerobic running training is determinant for the intensity of the exercise and, consequently, for the physiological adaptations obtained. Recent studies show that maintaining a constant speed, adjusted to the practitioner's ventilatory threshold, enhances gains in cardiorespiratory capacity and reduces the risk of overload injuries. The prescription based on controlled speed allows for a better individualization of training, promoting more consistent responses in relation to the increase in VO_2 max and overall performance (Silva et al., 2021; Jones et al., 2022).

In the present study, considering the average weight of the subjects and the proposed training fraction, the estimated oxygen consumption for a continuous training of 40 minutes at a speed of 140.94 m/min was 63.25 liters, which corresponds to an average caloric expenditure of 316.25 Kcal, generating an average of 40.91 g of weight loss.

According to the ACSM (2018), more experienced runners have more efficient mechanics, which can reduce the cost of oxygen for the same speed compared to beginners. This means that the actual expenditure may be slightly lower than the generalist formulas, approaching the lower limit of the estimates (about 340-350 kcal).

Oxygen uptake (VO_2) is considered one of the main indicators of aerobic fitness and is directly related to performance in endurance activities. Training performed at controlled speeds close to the anaerobic threshold promotes significant adaptations in VO_2 max, reflecting improvements in metabolic efficiency and the ability to sustain prolonged efforts (Fernandes et al., 2020).

The manipulation of speed directly influences the recruitment of different energy systems, affecting the volume of oxygen consumed during exercise. Recent literature also points out that the gradual progression of speed throughout sessions can result in more robust cardiovascular adaptations, reducing early fatigue and optimizing performance (Pereira et al., 2022; Costa and Souza, 2021).

Fat loss during a 40-minute run at a moderate pace depends primarily on the athlete's total calorie balance and heart rate, with the greatest lipid oxidation occurring at specific intensities. The metabolism of an intermediate athlete is more efficient in mobilizing and oxidizing fat (lipolysis) than that of a sedentary individual, even at higher intensities. The literature suggests that lipolysis provides free fatty acids for direct oxidation in the muscles, and the body begins to burn a significant amount of fat after using rapid energy (glycogen), usually after 20 to 30 minutes of moderate and continuous aerobic activity. The duration of 40 minutes is therefore effective for this purpose (Hetlelid et.al., 2014; Mcardle, Katch, Katch, 2016; Nieman, 2017).

Caloric expenditure during running training is a central component in the process of losing body fat, and the combination of controlled speed with adequate durations of exercise enhances the caloric deficit, promoting significant reductions in fat percentage. In addition, moderate to vigorous intensity, achieved by speed control, is associated with an increase in post-oxygen consumption (EPOC), which increases total energy expenditure after exercise. Speed control allows for better maintenance of the pace throughout the workout, avoiding abrupt drops in intensity and favoring lipid oxidation as the primary source of energy. This mechanism is essential for fat loss, especially in long-term programs, in which the consistency of caloric expenditure is decisive for the success of weight loss (Almeida et al., 2022; Moraes and Lima, 2023).

4 CONCLUSION

Recent literature reinforces the importance of speed control in aerobic running training for maximizing oxygen consumption, caloric expenditure, and body fat loss. The use of technological tools through applications capable of assisting tasks related to training prescription, taking into account individualized prescription, based on physiological parameters, as well as continuous monitoring, contributes to the achievement of more significant results among street runners.

The Cooper Pro app proved to be efficient, fast and easy to use for determining important variables for training, such as VO₂ max, max MET, training fraction (FT), training intensity (IT), training speed in Km.h⁻¹ and m.min⁻¹, training duration, distance to be covered in training, training oxygen consumption in L.min⁻¹, caloric expenditure from training in kcal, and estimated fat loss in grams per training session. In addition, the application assists in the prescription of interval training based on VO₂ max, determining variables such as distance, time, number of repetitions and recovery interval, thus allowing the organization of weekly training.

REFERENCES

- Almeida, R. S., et al. (2022). Efeitos do treinamento aeróbico controlado na perda de gordura corporal: Uma revisão sistemática. *Revista Brasileira de Medicina do Esporte*, 28(2), 145–152.
- American College of Sports Medicine. (2006). *Manual do ACSM para avaliação da aptidão física relacionada à saúde*. Guanabara Koogan.
- American College of Sports Medicine. (2018). *Diretrizes do ACSM para os testes de esforço e sua prescrição* (10ª ed.). Guanabara Koogan.
- American College of Sports Medicine. (2021). *ACSM's guidelines for exercise testing and prescription* (11th ed.). Wolters Kluwer.
- Bauman, A. E., et al. (2021). An evidence based assessment of the impact of the Olympic Games on population levels of physical activity. *The Lancet*, 398(10298), 456–464.
- Bassett, D. R., Jr., & Howley, E. T. (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance. *Medicine and Science in Sports and Exercise*, 32(1), 70–84.
- Bompa, T. O., & Buzzichelli, C. (2019). *Periodização: Teoria e metodologia do treinamento* (6ª ed.). Phorte.
- Borges, J. R., Silva, A. C., & Souza, M. R. (2015). Bases fisiológicas da corrida de rua. *Revista Brasileira de Medicina do Esporte*, 21(3).
- Brasil. Ministério da Saúde. (2020). *Atividade física e saúde: Guia para a população*. Ministério da Saúde.
- Buxton, S. O., et al. (2011). The relationship between VO₂max and physical activity in a young adult population. *Journal of Sports Science & Medicine*.
- Costa, G. L., et al. (2023). Corrida de rua e sistema imunológico. In R. A. T. Costa & E. S. Barbosa (Orgs.), *Estudos avançados interdisciplinares* (Vol. 21). Editora Enterprising.
- Costa, M. J., & Souza, L. A. (2021). Velocidade de corrida e adaptações cardiovasculares: Uma análise longitudinal. *Journal of Physical Activity and Health*, 18(4), 320–328.
- Daussin, F. N., et al. (2008). Effect of interval vs. continuous training on cardiorespiratory fitness, maximal oxidative capacity, and peripheral diffusion in humans. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, 295(1), R266–R272.
- Fernandes, T. R., et al. (2020). Consumo de oxigênio e desempenho aeróbico em corredores treinados. *Motricidade*, 16(3), 211–218.
- Hetlelid, K. J., et al. (2014). A three times higher fat oxidation in elite runners compared to non-elite runners during high-intensity exercise. *Journal of Sports Science and Medicine*, 13, 770–779.
- Heydenreich, J., Schutz, Y., Melzer, K., & Kayser, B. (2019). Comparison of conventional and individualized 1-MET values for expressing maximum aerobic metabolic rate and habitual activity related energy expenditure. *Nutrients*, 11(2), Article 458.
- Jones, A. M., & Carter, H. (2000). The effect of endurance training on parameters of aerobic fitness. *Sports Medicine*, 29(6), 373–386.
- Jones, A. M., et al. (2022). Controlled running speed and cardiorespiratory adaptations: Recent findings. *European Journal of Applied Physiology*, 122(6), 1345–1353.

- Joyner, M. J., & Lundby, C. (2018). Concepts about VO_{2max} and oxygen delivery to muscle. *The Journal of Physiology*, 596(7), 1215–1220.
- Mahseredjian, F., Barros Neto, T. L. de, & Tebexreni, A. S. (1999). Estudo comparativo de métodos para a predição do consumo máximo de oxigênio em atletas. *Revista Brasileira de Medicina do Esporte*, 5(5), 167–172.
- Marins, J. C. B., & Giannicchi, R. S. (2003). Avaliação e prescrição de atividade física: Guia prático (3ª ed.). Shape.
- Mendes, M. D. A., da Silva, I., Ramires, V. R. R., Reichert, F. F., Martins, R. C. R., et al. (2018). Metabolic equivalent of task (METs) thresholds as an indicator of physical activity intensity. *PLoS ONE*, 13(7), Article e0200701.
- McArdle, W. D., Katch, F. I., & Katch, V. L. (2016). *Fisiologia do exercício: Nutrição, energia e desempenho humano* (8ª ed.). Guanabara Koogan.
- Midgley, A. W., McNaughton, L. R., & Jones, A. M. (2007). Training to enhance the physiological determinants of long-distance running performance. *Sports Medicine*, 37(10), 857–880.
- Moraes, F. P., & Lima, N. S. (2023). Gasto calórico e metabolismo lipídico durante o exercício aeróbico de intensidade controlada. *Arquivos de Ciências do Esporte*, 41(1), 77–85.
- Nascimento, P. H., & Santana, E. A. (2016). Prevenção de lesões na corrida: Uma abordagem baseada em evidências. *Fisioterapia & Movimento*, 29(1).
- Nieman, D. C., et al. (2017). Postexercise serum concentrations of metabolomics biomarkers vary according to exercise intensity and duration. *Journal of Applied Physiology*, 123(4), 782–790.
- Pereira, G. H., et al. (2022). Efeitos da variação de velocidade sobre o consumo de oxigênio em adultos fisicamente ativos. *Fisiologia do Exercício*, 13(2), 99–107.
- Rojo, J. R., et al. (2017). Transformações no modelo de corridas de rua no Brasil: Um estudo na Prova Rústica Tiradentes. *Revista Brasileira de Ciência e Movimento*, 25(1), 19–28.
- Roschel, H., Tricoli, V., & Ugrinowitsch, C. (2011). Treinamento físico: Considerações práticas e científicas. *Revista Brasileira de Educação Física e Esporte*, 25(spe), 53–65.
- Ross, R., et al. (2016). Importance of assessing cardiorespiratory fitness in clinical practice: A case for fitness as a clinical vital sign. *Circulation*, 134(24), e653–e699.
- Scribbans, T. D., et al. (2016). The effect of training intensity on VO_{2max} in young healthy adults: A meta-regression and meta-analysis. *Journal of Physical Therapy Science*, 28(4), 1311–1320.
- Silva, A. E. L. (2007). Consumo máximo de oxigênio durante o exercício físico: Aspectos temporais e ajustes de curvas. *Revista Brasileira de Cineantropometria & Desempenho Humano*.
- Silva, M. A., et al. (2021). Individualização do treinamento aeróbico: O papel da velocidade controlada. *Revista Brasileira de Educação Física e Esporte*, 35(3), 213–220.
- Silva, S. F., et al. (2007). Respostas dos treinamentos aeróbico e de força no VO_{2max} . *Brazilian Journal of Biomotricity*, 1(4), 103–113.
- Sousa, N. M. F., et al. (2015). Método indireto de determinação da intensidade de exercício de força. *Revista Brasileira de Prescrição e Fisiologia do Exercício*.

Sponchiato. (2025). O boom das corridas de rua no Brasil. Veja.
<https://veja.abril.com.br/saude/o-boom-das-corridas-de-rua-no-brasil/>

A COLLABORATIVE SYSTEM FOR GEOREFERENCED MONITORING OF NOISE POLLUTION DATA CLASSIFIED BY MACHINE LEARNING MODEL

UM SISTEMA COLABORATIVO DE MONITORAMENTO GEORREFERENCIADO DE DADOS DE POLUIÇÃO SONORA CLASSIFICADOS POR MODELO DE APRENDIZADO DE MÁQUINA

UN SISTEMA COLABORATIVO DE MONITORIZACIÓN GEORREFERENCIADA DE DATOS DE CONTAMINACIÓN ACÚSTICA CLASIFICADOS POR MODELO DE APRENDIZAJE AUTOMÁTICO



<https://doi.org/10.56238/sevened2026.008-158>

Fani Tamires de Souza Batista¹, Sannyer Cardoso Carvalho Nery², Sérgio Augusto Coelho Bezerra³, Keiko Verônica Ono Fonseca⁴, José Reginaldo Hughes Carvalho⁵

ABSTRACT

This paper proposes a collaborative system for the georeferenced monitoring of noise pollution in urban environments, utilizing a machine learning model for automatic sound classification. The system adopts a modular architecture composed of three main applications: a Client Application (collection), a Server Application (processing), and a Client Application (visualization), which allows for scalability and ease of maintenance. In the collection Client Application, data capture is performed via a chatbot integrated with the Telegram application, enabling users to submit audio recordings along with their locations. These data are processed by a Server Application, which extracts acoustic features, classifies the sounds using the UrbanSound8K_ECAPA model, and stores the results in a NoSQL database. The visualization Client Application consists of a web page that requests data from the Server Application and presents the captured data interactively, allowing for the exploration of classified sounds and their corresponding geographical locations. A comparative analysis of audio classification models was conducted to support the choice of the most suitable model. Preliminary results demonstrate the viability of the proposed

¹ Graduated in Systems Analysis and Development Technology. Instituto Federal de Educação, Ciência e Tecnologia do Amazonas. E-mail: fani.tdsb@gmail.com

Orcid: <https://orcid.org/0000-0002-0031-5040> Lattes: <http://lattes.cnpq.br/9508646348735756>

² Graduated in Systems Analysis and Development Technology. Instituto Federal de Educação, Ciência e Tecnologia do Amazonas. E-mail: carvalhosannyer@gmail.com Orcid: <https://orcid.org/0009-0003-9169-5337> Lattes: <http://lattes.cnpq.br/8514431967383778>

³ Doctoral student in Informatics. Universidade Federal de Minas Gerais (UFMG). Universidade Federal do Amazonas (UFAM). Instituto Federal de Educação, Ciência e Tecnologia do Amazonas. E-mail: sergio.bezerra@ifam.edu.br Orcid: <https://orcid.org/0000-0003-0887-6544> Lattes: <http://lattes.cnpq.br/2717823426841852>

⁴ Dr. in Electrical Engineering. Universidade Federal de Santa Catarina (UFSC). Universidade Tecnológica Federal do Paraná. E-mail: keiko@utfpr.edu.br Orcid: <https://orcid.org/0000-0003-4685-299X> Lattes: <http://lattes.cnpq.br/8827013568855482>

⁵ Dr. in Electrical Engineering. Universidade Estadual de Campinas (UNICAMP). Universidade Federal do Amazonas. E-mail: reginaldo@icomp.ufam.edu.br Orcid: <https://orcid.org/0000-0002-3828-7233> Lattes: <http://lattes.cnpq.br/3161958119304780>

solution, which proves to be a promising, low-cost, accessible, and scalable tool for mapping and analyzing urban noise pollution, with potential applications in public policy and smart city initiatives.

Keywords: Noise Pollution. Urban Sound Classification. Machine Learning. Collaborative Systems. Georeferencing.

RESUMO

Este trabalho propõe um sistema colaborativo para o monitoramento georreferenciado da poluição sonora em ambientes urbanos, utilizando um modelo de aprendizado de máquina para classificação automática de sons. O sistema adota uma arquitetura modular, composta por três aplicações principais: Aplicação Cliente (coleta); Aplicação Servidora (processamento) e Aplicação Cliente (visualização), o que permite escalabilidade e facilidade de manutenção. Na Aplicação cliente (coleta), a captura de dados é realizada por meio de um chatbot integrado ao aplicativo Telegram, permitindo que os usuários enviem gravações de áudio juntamente com suas localizações. Esses dados são processados por uma Aplicação Servidora, que extrai características acústicas e classifica os sons usando o modelo UrbanSound8K_ECAPA, e armazena os resultados em um banco de dados NoSQL. A Aplicação Cliente de visualização é composta por uma página Web, que faz requisições para a Aplicação Servidora e apresenta os dados capturados de forma interativa, permitindo a exploração dos sons classificados e suas correspondentes localizações geográficas. Uma análise comparativa de modelos de classificação de áudio foi conduzida para suportar a escolha do modelo mais adequado. Resultados preliminares demonstram a viabilidade da solução proposta, que se demonstra uma ferramenta promissora, de baixo custo, acessível e escalável para o mapeamento e análise da poluição sonora urbana, com potenciais aplicações em políticas públicas e iniciativas de cidades inteligentes.

Palavras-chave: Poluição Sonora. Classificação de Sons Urbanos. Aprendizado de Máquina. Sistemas Colaborativos. Georreferenciamento.

RESUMEN

Este trabajo propone un sistema colaborativo para el monitoreo georreferenciado de la contaminación acústica en entornos urbanos, utilizando un modelo de aprendizaje automático para la clasificación automática de sonidos. El sistema adopta una arquitectura modular, compuesta por tres aplicaciones principales: Aplicación Cliente (recolección); Aplicación Servidora (procesamiento) y Aplicación Cliente (visualización), lo que permite escalabilidad y facilidad de mantenimiento. En la Aplicación Cliente (recolección), la captura de datos se realiza a través de un chatbot integrado con la aplicación Telegram, permitiendo a los usuarios enviar grabaciones de audio junto con sus ubicaciones. Estos datos son procesados por una Aplicación Servidora, que extrae características acústicas y clasifica los sonidos usando el modelo UrbanSound8K_ECAPA, y almacena los resultados en una base de datos NoSQL. La Aplicación Cliente de visualización se compone de una página web, que realiza solicitudes a la Aplicación Servidora y presenta los datos capturados de forma interactiva, permitiendo la exploración de los sonidos clasificados y sus correspondientes ubicaciones geográficas. Se realizó un análisis comparativo de modelos de clasificación de audio para respaldar la elección del modelo más adecuado. Los resultados preliminares demuestran la viabilidad de la solución propuesta, que se perfila como una herramienta prometedora, de bajo costo, accesible y escalable para el mapeo y análisis de la contaminación acústica urbana, con potenciales aplicaciones en políticas públicas e iniciativas de ciudades inteligentes.

Palabras clave: Contaminación Acústica. Clasificación de Sonidos Urbanos. Aprendizaje Automático. Sistemas Colaborativos. Georreferenciación.

1 INTRODUCTION

Excessive noise is a form of noise pollution, which negatively affects the physical and mental health of the population. The high levels of decibels (dB), resulting from various human activities, generate noise that compromises the environmental silence and the sound balance of urban spaces (Silva; Cunha, 2022). The quantity that represents noise pollution is the Sound Pressure Level (SPL), measured in dB. And in Brazil, the ABNT NBR10151 (2019) establishes the SPL limits for urban ambient noise⁶.

In view of these issues, in recent years, there has been a significant increase in the production of studies aimed at identifying noise levels in different contexts, such as work and residential environments and public roads. However, due to the high cost of physical devices used to measure noise pollution, the use of emerging technologies in this field has intensified.

In this scenario, the application of Artificial Intelligence (AI) techniques stands out, which have been consolidating themselves as effective tools for the analysis of large volumes of data in environmental monitoring systems (Santos *et al.*, 2020). The use of Machine Learning (ML)-based methods has high applicability in solving complex real-world problems, due to their potential to generate robust and accurate results (Beltran *et al.*, 2019).

This work proposes a system based on a machine learning model for classification and georeferenced monitoring of noise pollution data provided through mobile devices of collaborators in urban areas. The solution is based on a modular architecture consisting of three applications, allowing for separation of responsibilities and ease of maintenance.

2 RELATED JOBS

The works related to this research were organized into two categories, in order to support a better analysis of their proposals: (i) studies that do not incorporate classification models, that is, they monitor and/or map noise pollution through participatory systems (with or without the use of mobile devices); and (ii) studies that incorporate classification models for the monitoring of noise pollution, but that do not perform mapping or are not collaborative.

⁶ For example, in a mixed, predominantly residential area, the limits are 55 dB(A) during the day and 50 dB(A) at night. The "A" index indicates that the measurement was performed using the "A" weighting, being an adjustment for measurements according to the perception of the human ear.

2.1 JOBS WITHOUT A CLASSIFICATION MODEL

By proposing a system for mapping traffic noise using *smartphones* as a low-cost alternative, Dubey *et al.* (2022) integrate the use of mobile devices and mapping techniques. In this context, the authors collected sound data at different times and locations in the city of Lucknow, India, performing the calibration of smartphones used with standard NPS meters, in order to improve the accuracy of the measurements. In other words, the calculation of noise levels is performed based on the recorded sound pressure compared to a reference level, shown in Equation 1 below:

$$NPS(dB) = 20 \cdot \log_{10} \left(\frac{P}{P_0} \right) \quad (1)$$

Where:

SPL (dB) = Sound pressure level in decibels

P= Measured sound pressure

P0=Reference sound pressure

Thus, the authors demonstrated that the data obtained through smartphones, when properly calibrated, have variations of only 5 to 7 dB compared to conventional meters. Thus, the research concludes that smartphone-based solutions can be effective and affordable for mapping and monitoring urban noise pollution.

In the collaborative context, Silva and Cunha (2022) developed a project that proposes a low-cost solution for monitoring noise pollution in Belo Horizonte, using *crowdsourcing* through a Telegram chatbot. The proposal consists of sending voice messages and geolocation information, which are processed to compose a database on noise levels. The results allowed the mapping of the areas most affected by noise pollution and evidenced the accessibility of the solution, considering the minimum use of resources of the user's device.

In the study by Boumchich (2023), the use of smartphones as acoustic sensors for the evaluation of environmental noise is explored. The research focuses on the NoiseCapture 1 application, which allows users to measure and share noise data in real time. However, the quality and reliability of this data varies considerably. For this reason, the author proposes an analysis of the quality of the information by means of spatial grouping methods and by the implementation of an a posteriori calibration process, called "blind calibration".

In the work developed by Can (2023), a participatory methodology for evaluating the urban sound environment based on citizen action was presented. The process consisted of

georeferenced noise measurement using smartphones, and the data collected were analyzed to create maps containing sound levels and sources. As a result, participatory acoustic maps were generated, which showed more accurately the diversity of urban sounds compared to traditional normative maps.

Still using mobile devices to capture sounds, Laranja and Saiter (2023) developed a study aimed at monitoring noise pollution in the city of Vitória, Espírito Santo, using smartphones with decibel meter applications. The results of the research demonstrated that noise levels often exceed the established limits, highlighting the importance of the elaboration of participatory noise maps for urban planning.

Finally, in the work of Sofianopoulos *et al.* (2024), the approach used was based on Volunteered Geographic Information (VGI) and web technologies to map noise pollution in Greece. Through the NoisePollutionApp application, citizens recorded sound intensity and their subjective perceptions about sounds, which made it possible to create collaborative maps.

2.2 WORK WITH CLASSIFICATION MODEL

Regarding the studies developed in recent years that monitor noise pollution with the incorporation of classification models, only three studies stand out.

In the research by Ahmed *et al.* (2021), a predictive model was proposed to estimate vehicular noise levels on Malaysian highways, using machine learning algorithms in conjunction with Geographic Information Systems (GIS). The models evaluated in this research were: Artificial Neural Network (ANN), Correlation-based Feature Selection with ANN (CFS-ANN) and the combination of Random Forest and ANN (RF-ANN). The authors considered factors such as vehicle type, traffic volume, temperature, humidity, topography, road density, and location. As a result, the Ensemble RF-ANN model stood out as the most accurate, showing that the combination of machine learning algorithms with GIS systems is an effective tool for predicting and mapping noise pollution in urban environments.

In the study developed by Ceriotti 2023, a system for classifying environmental sounds using convolutional neural networks (CNNs) was proposed, aimed at applications in embedded devices with limited computational resources. The author analyzed five different CNN architectures, applying different methods of extracting sound characteristics, with and without the use of *data augmentation* techniques. The database used was UrbanSound8K, composed of labeled recordings of urban sounds. Among the models tested, the Spatial Blended Convolutional Neural Network (SBCNN) was the one that presented the best performance.

Finally, in the project presented by Santos *et al.* (2023), the Intelligent Environmental Noise Monitoring (MIRA) platform was developed, consisting of sound monitoring stations, an integrated digital platform and artificial intelligence algorithms. The proposed solution allows the continuous recording of acoustic parameters from up to 100 monitoring stations, enabling the identification of patterns of variation in noise levels and their classification in almost real time.

3 AUDIO SIGNAL PROCESSING AND CLASSIFICATION

The processing and classification of audio signals involves advanced techniques of feature extraction and pattern modeling, often using the robustness of deep learning methods (Zaman *et al.*, 2023). In the context of the detection and classification of environmental sounds, the processing and classification of audio signals play a central role in the monitoring of phenomena such as noise pollution.

3.1 CLASSIFICATION-ORIENTED AUDIO PROCESSING

The processing of audio signals represents a fundamental step in sound classification systems, allowing the transformation of raw acoustic signals into numerical representations suitable for computational analysis. Thus, signal processing is a multidisciplinary field, combining principles from mathematics, statistics, computer science, and electrical engineering to extract relevant characteristics from acoustic signals (Arinaitwe *et al.*, 2024).

Audio processing for classification purposes usually follows a well-structured pipeline, consisting of essential steps such as acoustic signal acquisition, pre-processing, feature extraction, normalization, data *augmentation* techniques (where applicable), modeling, and finally, classification. Each of these phases plays a key role in building robust and accurate systems, and failures or deficiencies in any of them can significantly compromise the performance of the final model (Liu *et al.*, 2022; Mehrish *et al.*, 2023; Purwins *et al.*, 2019).

The feature extraction stage, for example, is a critical point in the process, as it is responsible for transforming the raw data of the sound signal into more compact and informative representations, which will serve as input for the learning algorithms. Techniques such as Mel-Frequency Cepstral Coefficients (MFCC), spectrograms, and learned embeddings have been widely employed in this context (Liu *et al.*, 2022; Purwins *et al.*, 2019).

In addition, the use of normalization and augmentation contributes to the generalization of models, allowing it to deal with variations in recording conditions and environmental noises. The proper definition and execution of this processing flow are therefore crucial for the success of automatic audio classification systems in real applications,

such as environmental monitoring, sound event recognition, and virtual assistants (Mehrish *et al.*, 2023).

3.2 ANALYSIS OF SOUND CLASSIFICATION MODELS

The proposed system encompasses a classification model responsible for analyzing the audios collected by the client application. To verify the practical feasibility of the solution, this study considered the balance between effectiveness, efficiency and latency, as these criteria together indicate not only if the model is correct, but if it is operationally feasible for integration into the proposed system.

In this context, in order to verify the feasibility of incorporating Machine Learning techniques into the system, a comparative analysis of the main models for classifying environmental sounds present in the recent literature was carried out, evidencing their most relevant technical attributes. Thus, criteria such as the number of parameters, estimated latency, accuracy, number of classes, type of architecture, and the data set used in the validation experiments were considered.

The evaluation of the effectiveness of each model is carried out based on these criteria, with effectiveness being understood as the ability of an algorithm to produce accurate and reliable predictions, based on the comparison of performance metrics obtained through cross-validation (Sarker *et al.*, 2019). In this context, accuracy corresponds to the ratio between the number of correct predictions and the total number of predictions made (Strauss *et al.*, 2022).

Latency, in turn, refers to the average time required for a data packet to be transmitted from source to destination (Santos *et al.*, 2020). Efficiency, on the other hand, refers to the ability to optimally use the available resources and the existing structural conditions, aiming to achieve the best possible performance (Macedo *et al.*, 2010).

The selected models are widely used for the classification of urban sounds, being able to automatically identify and categorize different types of sounds captured in outdoor environments. Among the main models analyzed, the following stand out: UrbanSound8K_ECAPA, PANNs (Kong *et al.*, 2020), BEATs (Chen *et al.*, 2022), PaSST (Koutini *et al.*, 2022), AST (Gong *et al.*, 2021) and HTS-AT (Chen *et al.*, 2022).

Table 1

Technical characteristics of the analysis models

Model	Architecture	Dataset	Parameters
UrbanSound8k_ecapa	ECAPA-TDNN	UrbanSound8K	20.94 million
PANNs	CNN	AudioSet	80 million
BEATs (KS2)	Transformer	AudioSet	90 million
PaSST (ESC-50)	Transformer	ESC-50	87 million
AST	Transformer	AudioSet	31 million
HTS-AT (SpeechCmd V2)	Transformer	Speech Commands V2	31 million

Source: Prepared by the authors, 2025.

Table 1 presents the structure of these models aimed at the classification of environmental sounds and urban audio, focusing on the aspects of architecture, dataset and parameters used. The UrbanSound8K_ECAPA model uses an ECAPA-TDNN architecture, trained with the urban sounds of the UrbanSound8K dataset. The PANNs and PaSST models are based on the CNN and transformers family, respectively, using the AudioSet and the ESC-50, which are broader and more diverse.

AST and HTS-AT stand out for adapting originally visual architectures, such as *Vision Transformers* and *Swin Transformers*, to the acoustic domain, incorporating techniques such as the use of hierarchical patches. Finally, the BEATs model is the only one on the list to apply self-supervised learning, which makes it especially versatile in contexts with little labeled data. This diversity of structures and data evidences complementary approaches in the treatment of audio, ranging from specializations in urban noise to generalizations for multiple sound categories.

A relevant aspect illustrated in Table 1 concerns the number of parameters of the models, since this factor is directly related to structural complexity and its potential for generalization. The PANNs, BEATs, PaSST and AST models have a high number of parameters — ranging from 80 to 90 million — which implies high computational demand, too much training time, as well as high memory and energy consumption.

These characteristics can represent significant limitations for real-time applications or those that operate in environments with reduced computing infrastructure. On the other hand, the HTS-AT and UrbanSound8K_ECAPA models have between 20 and 31 million parameters, which makes them more viable options for systems with resource constraints, given their lower complexity.

Table 2 details the operational performance aspects of audio classification models. The observed accuracy shows that models such as HTS-AT (88.1%) and BEATs (87.6%) have superior performance in relation to most other approaches, standing out for the use of transformer-based architectures and unsupervised learning strategies. The PANNs model,

on the other hand, although it has a deep architecture based on convolutional neural networks (CNN), has high latency, which can compromise its application in systems that require real-time responses (Kong *et al.*, 2020).

Table 2

Performance of the models in the datasets used

Model	Latency	Accuracy (%)	Classes
UrbanSound8k_ecapa	Low to moderate	75,5	10
HTS-AT (SpeechCmd V2)	Low to moderate	97,2	35
PANNs	Moderate	89,5	527
BEATs (KS2)	Moderate	94,3	527
PaSST (ESC-50)	Moderate	93,2	527
AST	Moderate	95,6	527

Source: Prepared by the authors, 2025.

On the other hand, UrbanSound8K_ECAPA demonstrates efficiency even with a reduced number of classes, ten (Zhao and Liang, 2024), which makes it suitable for more restricted urban contexts and applications with a limited scope. The PaSST model has a good accuracy rate with moderate latency, configuring itself as a robust alternative, especially in scenarios with limited data availability (Koutini *et al.*, 2022). AST represents an innovative proposal by exploring the reuse of pre-trained weights in visual tasks for applications in the area of audio processing, obtaining promising results (Gong *et al.*, 2021).

In view of the above, the UrbanSound8K_ECAPA model was chosen in this research, based on three pillars: specificity, accessibility and efficiency. In terms of specificity, the UrbanSound8K database presents a detailed categorization of urban sounds commonly found in real environments, such as dog barking, children playing, air conditioning, street music, gunshots, car horns, sirens, gait motors, pneumatic hammers, and construction noises, which makes it suitable for the scope of the noise pollution study. This choice is directly linked to the need for accessible and computationally efficient models, aspects also observed in Macedo *et al.* (2024), which, as in this approach, adopt a perspective aimed at reducing computational complexity.

In this context, the selected model proves to be efficient, as it allows capturing complex acoustic patterns in audio classification tasks due to its robustness in extracting discriminative acoustic *embeddings* (Zhao and Liang, 2024). It is also worth mentioning that the accessibility to the UrbanSound8K_ECAPA model was a determining factor for its

implementation in the proposed system.

4 METHODOLOGY

This work is a research of applied nature, since it seeks the production of knowledge and the elaboration of a collaborative system for monitoring georeferenced noise pollution. Regarding its objectives, the research is descriptive-exploratory, as it collects and classifies data on a phenomenon. In addition, it is concerned with identifying and evaluating collaborative systems that monitor noise pollution, as well as the search for recent studies in the area to map the problem and assist in the solution.

To carry out the search for related works, we opted for the adoption of a systematic process based on the works of Bezerra (2024, 2025), where the result of the selection of articles is represented by the PRISMA flowchart, adapted from Tricco *et al.* (2018), as shown in Figure 1. Initially, the research question was defined with the purpose of directing the entire process of identification and selection of studies. Next, the inclusion and exclusion criteria were established, considering aspects such as the period of publication, the availability of the full text, and the language in which the papers were published.

In the subsequent stage, the search strategies were outlined, which included the selection of specific databases, the definition of keywords and the application of Boolean operators, in order to ensure a comprehensive and effective search. Finally, the selection of studies was carried out, in which the studies initially identified were screened and later evaluated in their entirety.

Based on the delimitation of the research, the following guiding question was formulated: How can a collaborative system, capable of collecting, classifying and georeferencing urban sound data through mobile devices and machine learning techniques, contribute to the monitoring of noise pollution?

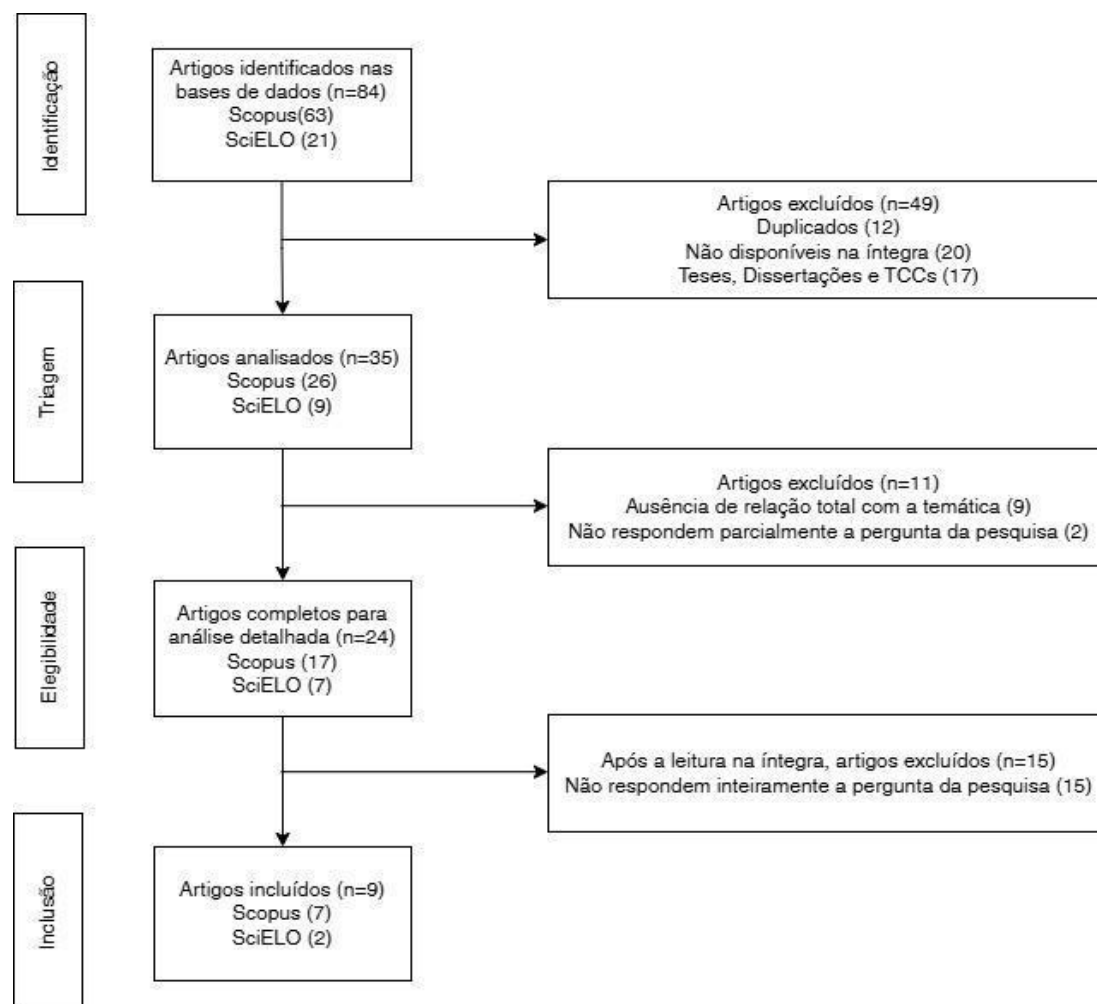
Based on this definition, the inclusion criteria were established, such as full-text studies, written in Portuguese or English, published between the years 2020 and 2024, which contained the descriptors defined in the title, abstract, or textual body. On the other hand, the exclusion criteria included duplicate, incomplete texts written in languages other than Portuguese and English, published before 2020, or that did not have the descriptors specified in any section of the study.

The search strategies involved conducting advanced searches in the Scopus and Scientific Electronic Library Online (SciELO) databases, using the following descriptors, in Portuguese and English: "System", "Mapping", "Machine Learning", "Machine Learning", "Deep Learning", "Deep Learning", "Collaborative", "Crowdsourcing", "Noise Pollution" and

"Noise Pollution". Thus, the analysis of the studies found was carried out through the reading of the abstracts, with the objective of verifying the relevance and adherence of the studies to the proposed theme.

Figure 1

Article selection flow



Source: Adapted from the 2020 PRISMA Guidelines and Bezerra *et al.* 2024.

5 PROPOSED SOLUTION

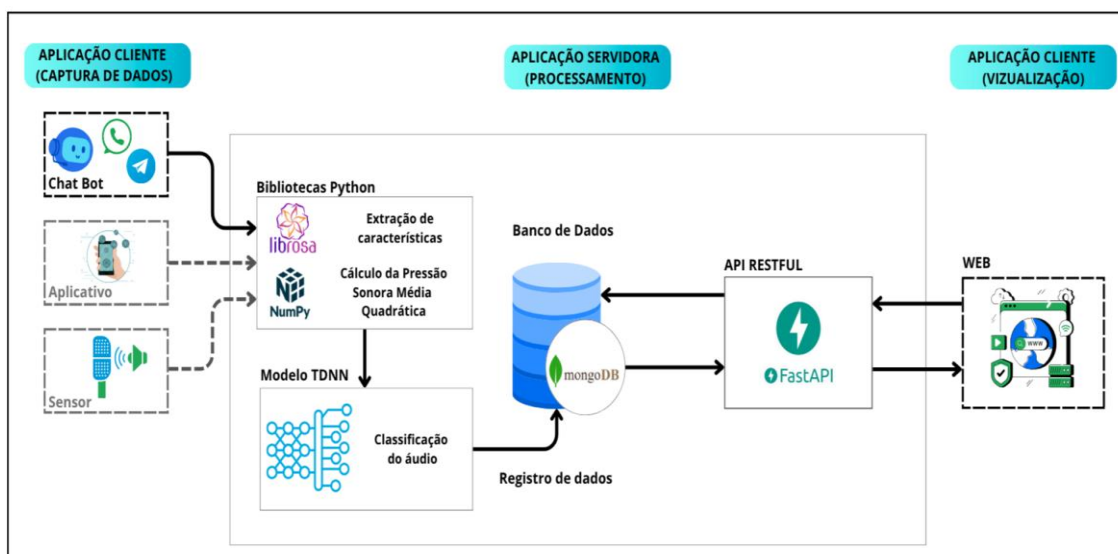
Compared to the solutions presented in the literature, the proposed system differs by modularly integrating the collection, processing and visualization of noise pollution data, using an audio classification model (UrbanSound8K) trained specifically for Brazilian urban environments. In addition, the present approach incorporates collaborative participation via Telegram chatbot, which broadens reach and reduces adoption barriers. Unlike systems that rely exclusively on dedicated sensors, the solution proposed here exploits the infrastructure of mobile devices already available, promoting low cost and greater scalability. Although no quantitative comparative evaluation was carried out at this stage, the preliminary analysis

indicates that the proposal meets the same objectives of automatic classification, with the advantage of operating in an ecosystem that is easy to maintain and expand.

The proposed solution, as shown in Figure 2, presents the architecture of a system for monitoring noise pollution with georeferencing. The architecture is divided into three applications, with the objective of separating the responsibilities between data sending, processing and display of heat maps, namely: Client Application (Data Collection), Server Application (Processing) and Client Application (Visualization).

The Data Collection Client Application is responsible for capturing raw audio and location information. As illustrated in Figure 2, this collection can be carried out through chatbots integrated with messaging applications, such as WhatsApp and/or Telegram, dedicated applications or specific sensors. In this work, a chatbot was implemented on Telegram. It is worth mentioning that a chatbot offers a non-invasive form of data collection, since it does not require the installation of a new application. The user can start a conversation, record and send an audio containing the noise directly through the chat. Then, it is possible to share the location through the native functionalities of the messaging platform. This approach can impact the quality of sound data capture, since messaging apps are focused on recording human voice. In addition, the quality of smartphone microphones also influences data collection, as this hardware varies in constitution between brands and models. It is important to highlight that these impacts were not the object of studies in this work.

The Server Application is responsible for receiving the raw data, extracting relevant information, classifying the audios, storing them and making them available for consultation. For the processing of audio data, the Librosa library is used, a Python tool specialized in sound signal analysis. Among its functionalities, the extraction of acoustic characteristics, such as minimum and maximum sound pressure levels (SPL), in addition to the application of the "A" weighting filter, which simulates human auditory perception, stands out.

Figure 2*Architecture of the proposed solution*

Source: Prepared by the authors, 2025.

In addition, the NumPy library, widely used for matrix and vector manipulation, is used in this work to calculate the Root Mean Square (RMS). This value represents the energy or "intensity" of the sound, and is later converted to the decibel scale (dB), the standard unit for noise measurement.

For the task of classifying the audios, the artificial intelligence model UrbanSound8K_ECAPA, based on Time Delay Neural Network (TDNN), is used. After extracting the acoustic characteristics, the audio files are converted from .ogg to .wav format, compatible with the adopted classification model. It is important to emphasize that a confidence rate of 60% was adopted as a criterion for validating the classifications.

The choice of this threshold represents a balance between accuracy, the ratio of correct ratings to positive ratings, and recall, the ability of the model to identify all relevant samples. A higher threshold would increase accuracy, but it could discard correct classifications with less confidence. The value of 60% was set to optimize the capture of relevant sound events without introducing an excessive number of false positives. Thus, when the classification reaches or exceeds this threshold, it is considered valid; otherwise, the audio is classified as belonging to the "Other" category.

After the extraction of the characteristics and the classification step, an object is created containing the information of the sending user, the geographic coordinates and the audio data. This object is then registered to an instance of MongoDB, a NoSQL database system that offers greater flexibility in storing and querying the data. Another component present in the Server Application, developed through the FastApi Framework according to

the principles of Restful, is the Application Programming Interface (API), which acts as a communication bridge between stored data and external applications. This interface contains an endpoint that allows the Client Application (Preview) to access the processed data for display in the form of heat maps.

6 RESULTS AND DISCUSSIONS

The first component of the architecture, responsible for capturing data in the client application, was implemented as a chatbot on the Telegram platform. The system automatically registers users based on the information provided by the platform itself, also verifying that the user is already present in the database. In addition, the chatbot manages the sending of the audio samples along with their respective geographical locations.

Additionally, the choice of Telegram as a collection application presented advantages in terms of accessibility and user adherence, corroborating the approach adopted by Silva and Cunha (2022), who used Telegram's chatbot to collect environmental data in urban communities. This reinforces the potential of using technologies that are already consolidated for scientific purposes, without the need to develop native applications to test the operation of the application, which reduces costs and accelerates the prototyping cycle.

Figure 3

Registration of information in the Database

```
_id: ObjectId('6835b7a5642d9163184f8203')
id_user_object: ObjectId('6750565f07ed500dc84f821b')
latitude: -3.0407
longitude: -59.958332
data_criacao: "2025-05-27 09:00:48"
min_db: -80.87924194335938
max_db: -0.8792411088943481
min_dBA: -2.1170837671979967
max_dBA: 77.882916232802
rms_loudness: 0.0429314561188221
categoria: "children_playing"
```

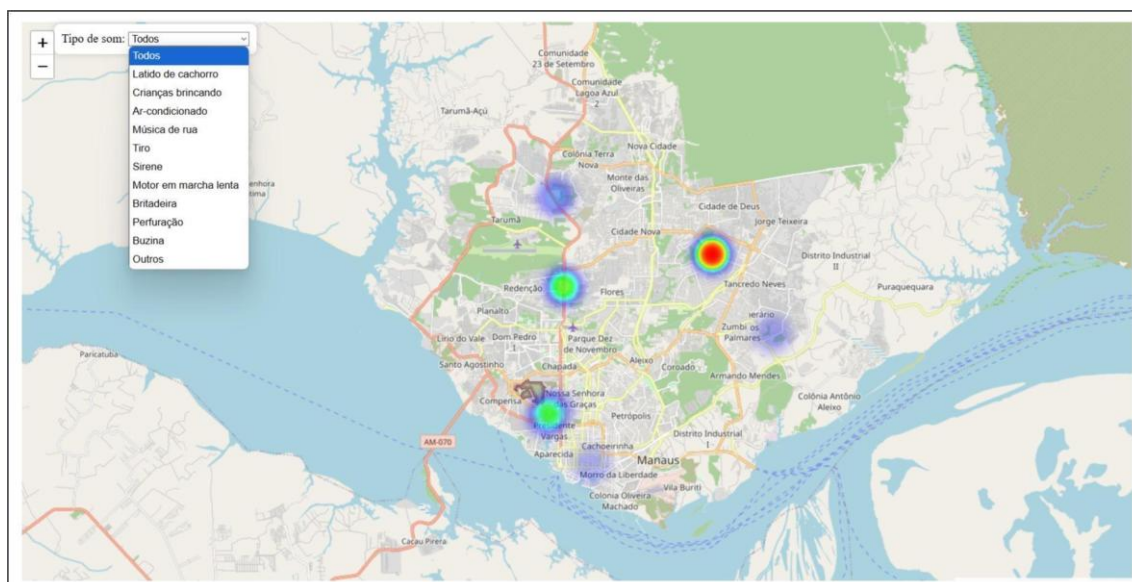
Source: Prepared by the authors, 2025.

The data processing proved to be effective, since the implementation was able to accurately extract (with a degree of conformity between the data entered) the essential information of each sample. This data includes the classification of the type of noise — performed through the machine learning model — geographic coordinates, the date and time of the shipment. Each consolidated record was stored in the MongoDB Atlas database, as Figure 3 illustrates.

With respect to visualization, the Client Application consumes the API and renders a dynamic heatmap, as evidenced in Figure 4. This application has a filtering feature by noise category, allowing a spatial analysis of noise pollution in a specific or general way of the type of sound.

Figure 4

Heat map



Source: Prepared by the authors, 2025.

In view of the above, this work shows the feasibility of the proposed system based on an architecture composed of three cohesive applications. This cohesion refers to the principles of microservices-based architecture, which favors independent and communicating services through APIs, promoting greater modularity, scalability, and resilience in distributed urban applications (Ribeiro, Braghetto, 2022). It is worth mentioning that the detailed operation of the applications that make up this system can be found in (Nery *et al.*, 2025).

7 CONCLUSION

This work consisted of the development of a collaborative system based on machine learning models for the classification and georeferenced monitoring of urban noise, received from mobile devices operated by volunteer collaborators.

Although the system has demonstrated efficacy in the correct classification of test audios, it is still necessary to carry out broader experiments, with a diversified data set, in order to improve the accuracy and generalization of the predictive model. In addition, the data visualization stage, although functional, will still undergo reformulations in order to improve the graphical interface. Such improvements aim to facilitate use by employees and public

managers, expanding the social impact of the system. For future improvements in the accuracy of the collection, the development of a specialized application is indicated.

Thus, the potentiality of the applications developed, both on the client and server sides, indicates that the technology has applicability in various sectors of society. It is a low-cost, practical and scalable solution, whose implementation can help in the formulation of public policies, in the promotion of public health, in the support of scientific research and in environmental preservation, especially in regions affected by high levels of noise pollution.

ACKNOWLEDGMENTS

The authors would like to thank the Federal Institute of Education, Science and Technology of Amazonas (IFAM) and its Higher Education Course in Systems Analysis and Development (TADS). To the Graduate Program in Informatics (PPGI) of the Federal University of Amazonas and to the Graduate Program in Electrical Engineering and Industrial Informatics (CPGEI-CT) of the Federal Technological University of Paraná (UTFPR).

REFERENCES

- Ahmed, A. A., Pradhan, B., Chakraborty, S., et al. (2021). Developing vehicular traffic noise prediction model through ensemble machine learning algorithms with GIS. *Arabian Journal of Geosciences*, 14(16), 1–15. <https://doi.org/10.1007/s12517-021-08114-y>
- Arinaitwe, C., Mugisha, S., & Opio, D. (2024). Review of techniques used in speech signal processing. *Journal of Signal Processing Systems*, 3(1), 63–70. <https://doi.org/10.59568/KJSET-2024-3-1-07>
- Beltran, C. A. R., et al. (2019). Plataforma de aprendizado de máquina para detecção e monitoramento de alunos com risco de evasão. *Anais do CBIE/SBIE*, 30(1), 1591. <https://doi.org/10.5753/cbie.sbie.2019.1591>
- Bezerra, E. A. A. C., et al. (2025). Instrumentos construídos/validados ao processo de enfermagem em saúde mental: Revisão integrativa. *Revista Eletrônica Acervo Saúde*, 25, Article e19772. <https://doi.org/10.25248/reas.e19772.2025>
- Bezerra, E. A. A. C., Ferreira, A. A., & Portela, L. C. (2024). Diagnóstico de enfermagem em saúde mental infantojuvenil. *Miscellaneous*, 24(1), Article e13700. <https://doi.org/10.25248/reas.e13700.2024>
- Boumchich, A. (2023). A smartphone-based crowd-sourced database for environmental noise assessment: From data quality assessment to the production of relevant noise maps [Tese de doutorado, Le Mans Université]. <https://theses.hal.science/tel-04444620/>
- Can, A., et al. (2023). Framework for urban sound assessment at the city scale based on citizen action, with the smartphone application NoiseCapture as a lever for participation. *Noise Mapping*, 10(1), Article 20220166. <https://doi.org/10.1515/noise-2022-0166>
- Cerioti, V. C. (2023). Classificação de sons ambientais utilizando redes neurais convolucionais para aplicações em hardwares com recursos limitados [Trabalho de

- Chen, K., Kong, Q., Iqbal, T., Wang, Y., Wang, W., & Plumbley, M. D. (2022). HTS-AT: A hierarchical token-semantic audio transformer for sound classification and detection. In IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP) (pp. 646–650). IEEE. <https://doi.org/10.1109/ICASSP43922.2022.9746667>
- Chen, S., Wu, Y., Wang, C., Liu, S., Tompkins, D., Chen, Z., & Wei, F. (2022). BEATs: Audio pre-training with acoustic tokenizers [Preprint]. arXiv. <https://arxiv.org/abs/2212.09058>
- Dubey, R., Bhardwaj, S., Sharma, V. B., Bhatt, A., & Biswas, S. (2022). Smartphone-based traffic noise mapping system. ISPRS Archives, XLIII-B4-2022, 613–620. <https://doi.org/10.5194/isprs-archives-XLIII-B4-2022-613-2022>
- Gong, Y., Chung, Y.-A., & Glass, J. (2021). AST: Audio spectrogram transformer [Preprint]. arXiv. <https://arxiv.org/abs/2104.01778>
- Kong, Q., Cao, Y., Iqbal, T., Wang, Y., Wang, W., & Plumbley, M. D. (2020). PANNs: Large-scale pretrained audio neural networks for audio pattern recognition. IEEE/ACM Transactions on Audio, Speech, and Language Processing, 28, 2880–2894. <https://doi.org/10.1109/TASLP.2020.3030497>
- Koutini, K., Schlüter, J., Eghbal-zadeh, H., & Widmer, G. (2022). Efficient training of audio transformers with patchout. In Interspeech 2022. ISCA. <https://doi.org/10.21437/Interspeech.2022-227>
- Laranaja, A. C., & Saiter, J. C. (2023). Análise de poluição sonora urbana em Vitória–ES a partir do uso de smartphones. ENCAC, 17, 1–9. <https://doi.org/10.46421/encac.v17i1.3885>
- Liu, S., Yuan, Y., Liu, X., & Liu, Y. (2022). Audio self-supervised learning: A survey. Patterns, 3(12), 1–18. <https://doi.org/10.1016/j.patter.2022.100616>
- Macedo, A., Persona, L., & Meloni, F. (2024). Recognition of emotions through facial geometry with normalized landmarks. In Proceedings of the 30th Brazilian Symposium on Multimedia and the Web (pp. 257–266). Sociedade Brasileira de Computação. <https://doi.org/10.5753/webmedia.2024.243252>
- Mehrish, A., Raj, R., Kumar, S., & Roy, P. P. (2023). A review of deep learning techniques for speech processing. Information Fusion, 99, 1–72. <https://arxiv.org/abs/2305.00359>
- Nery, S. C. C., Batista, F. T. S., & Bezerra, S. A. C. (2025). ColabSomGeo: Ferramenta de monitoramento de poluição sonora subsidiada por modelo de aprendizagem. In Anais do 31º Simpósio Brasileiro de Sistemas Multimídia e Web. Sociedade Brasileira de Computação.
- Purwins, H., et al. (2019). Deep learning for audio signal processing. IEEE Journal of Selected Topics in Signal Processing, 13(2), 206–219. <https://doi.org/10.1109/JSTSP.2019.2908700>
- Ribeiro, M. B., & Braghetto, K. R. (2022). A scalable data integration architecture for smart cities: Implementation and evaluation. Journal of Information and Data Management, 13(2), 207–223. <https://doi.org/10.5753/dm.2022.2485>
- Santos, A., Freitas, L. de, Teixeira, I., Vagner, G., Taira, G., Quile, R. E., & Braghetto, K. (2020). Desafios e oportunidades da aplicação de sistemas ciberfísicos no

monitoramento da poluição urbana (pp. 276–289).
<https://doi.org/10.5753/courb.2020.12369>

Santos, C. J., Souza, L. E., & Paiva, B. G. M. (2020). Análise da influência de diferentes codificadores de voz (CODECs) em redes convergentes. *Revista Científica e-Locução*, 1(17), 26–26. <https://doi.org/10.57209/e-locucao.v1i17.249>

Santos, L. C., Leão, C., Figueiredo, J., Melo, A., Covas, G., & Carvalho, A. (2023). Projeto MIRA – Desenvolvimento de uma plataforma inteligente de monitorização de ruído ambiental. https://www.dbwave.pt/uploads/media_items/mira-article-tecniacustica-20230915-lcs.original.pdf

Sarker, I. H., Kayes, A. S. M., & Watters, P. (2019). Effectiveness analysis of machine learning classification models for predicting personalized context-aware smartphone usage. *Journal of Big Data*, 6, Article 57. <https://doi.org/10.1186/s40537-019-0219-y>

Silva, I. S. C., & Cunha, F. (2022). Monitoramento da poluição sonora em Belo Horizonte utilizando redes de sensoriamento participativo. <https://bib.pucminas.br/pergamumweb/vinculos/00000b/00000bc6.pdf>

Sofianopoulos, S., et al. (2024). Citizens as environmental sensors: Noise mapping and assessment on Lemnos Island, Greece, using VGI and web technologies. *European Journal of Geography*, 15(2), 106–119. <https://www.eurogeojournal.eu/index.php/egj/article/view/476>

Strauss, E., Villas Bôas Júnior, M., & Ferreira, W. L. L. (2022). A importância de utilizar métricas adequadas de avaliação de performance em modelos preditivos de machine learning. *Projectus*, 7(2), 52–62. <https://doi.org/10.15202/25254146.2022v7n2p52>

Tricco, A. C., et al. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, 169(7), 467–473. <https://doi.org/10.7326/M18-0850>

Zaman, K., et al. (2023). A survey of audio classification using deep learning. *IEEE Access*, 11, 106620–106649. <https://doi.org/10.1109/ACCESS.2023.3318015>

Zhao, B., & Liang, J. (2024). Hierarchical-concatenate fusion TDNN for sound event classification. *PLOS ONE*, 19(10), 1–17. <https://doi.org/10.1371/journal.pone.0312998>

EVALUATION OF A CATIONIC POLYSACCHARIDE COAGULANT FOR OPTIMIZING THE TREATMENT OF OILY EFFLUENTS FROM THE MANAUS REFINERY (REAM) – QQS COA S

AVALIAÇÃO DE COAGULANTE POLISSACARÍDICO CATIÔNICO PARA A OTIMIZAÇÃO DO TRATAMENTO DE EFLUENTES OLEOSOS DA REFINARIA DE MANAUS (REAM) – QQS COA S

EVALUACIÓN DE UN COAGULANTE POLISACÁRIDO CATIÓNICO PARA OPTIMIZAR EL TRATAMIENTO DE EFLUENTES OLEOSOS DE LA REFINERÍA DE MANAUS (REAM) – QQS COA S



<https://doi.org/10.56238/sevened2026.008-159>

Fernando André de Oliveira Duarte

ABSTRACT

This technical-scientific report details the results of a treatability study conducted with effluents from the Manaus Refinery (REAM), focusing on the evaluation of a high-performance organic coagulant, QQS COA S, a starch-based polysaccharide modified with cationic groups. The main objective was to compare its efficiency with the conventional treatment of the refinery, which employs a tannin-based coagulant with a daily consumption of approximately 200 kg, aided by about 2 kg of a flocculant polymer. The assays, carried out in Jar Test equipment, simulated the coagulation and flocculation conditions, revealing that the QQS COA S, in dosages in the range of 10 to 30 ppm, promotes a clarification and phase separation (water/oil/solids) visually superior to that obtained with approximately 33,333 ppm of the tannin coagulant. This dose reduction, greater than 99% (or 1,000 times), is justified by the macromolecular structure of cationic starch and its mechanisms of action, which include charge neutralization and formation of interparticle bridges, efficient in breaking the oil-in-water emulsion. The study concludes that the replacement of tannin by cationic starch represents a strategic opportunity for REAM, with the potential for a drastic reduction of operating costs, logistics optimization, and a significant advance in environmental sustainability, aligning the practice with the fundamental theory of colloid and polymer chemistry and encouraging the local production of high value-added inputs.

Keywords: Effluent Treatment. Oil Refinery. Oily Water. Organic Coagulants. Cationic Starch.

RESUMO

Este relatório técnico-científico detalha os resultados de um estudo de tratabilidade conduzido com efluentes da Refinaria de Manaus (REAM), focando na avaliação de um coagulante orgânico de alta performance, o QQS COA S, um polissacarídeo à base de amido modificado com grupamentos catiônicos. O objetivo central foi comparar sua eficiência com o tratamento convencional da refinaria, que emprega um coagulante à base de tanino com um consumo diário de aproximadamente 200 kg, auxiliado por cerca de 2 kg de um polímero floculante. Os ensaios, realizados em equipamento Jar Test, simularam as condições de

coagulação e floculação, revelando que o QQS COA S, em dosagens na faixa de 10 a 30 ppm, promove uma clarificação e separação de fases (água/óleo/sólidos) visualmente superior à obtida com aproximadamente 33.333 ppm do coagulante de tanino. Esta redução de dosagem, superior a 99% (ou 1.000 vezes), é justificada pela estrutura macromolecular do amido catiônico e seus mecanismos de ação, que incluem neutralização de carga e formação de pontes interpartículas, eficientes na quebra da emulsão óleo-em-água. O estudo conclui que a substituição do tanino pelo amido catiônico representa uma oportunidade estratégica para a REAM, com potencial para uma drástica redução de custos operacionais, otimização logística, e um avanço significativo em sustentabilidade ambiental, alinhando a prática com a teoria fundamental da química de coloides e polímeros e incentivando a produção local de insumos de alto valor agregado.

Palavras-chave: Tratamento de Efluentes. Refinaria de Petróleo. Água Oleosa. Coagulantes Orgânicos. Amido Catiônico.

RESUMEN

Este informe técnico-científico detalla los resultados de un estudio de tratabilidad realizado con efluentes de la Refinería de Manaus (REAM), centrado en la evaluación de un coagulante orgánico de alto rendimiento, QQS COA S, un polisacárido a base de almidón modificado con grupos catiónicos. El objetivo principal fue comparar su eficiencia con la del tratamiento convencional de la refinería, que emplea un coagulante a base de tanino con un consumo diario de aproximadamente 200 kg, asistido por aproximadamente 2 kg de un polímero floculante. Las pruebas, realizadas en un aparato de prueba de jarras, simulaban las condiciones de coagulación y floculación, revelando que QQS COA S, en dosis de 10 a 30 ppm, promueve una clarificación y separación de fases (agua/aceite/sólidos) visualmente superior a la obtenida con aproximadamente 33.333 ppm del coagulante a base de tanino. Esta reducción de dosis, superior al 99% (o 1000 veces), se justifica por la estructura macromolecular del almidón catiónico y sus mecanismos de acción, que incluyen la neutralización de cargas y la formación de puentes interpartículas, eficientes para romper la emulsión de aceite en agua. El estudio concluye que la sustitución del tanino por almidón catiónico representa una oportunidad estratégica para REAM, con el potencial de una drástica reducción de costos operativos, optimización logística y un avance significativo en la sostenibilidad ambiental, alineando la práctica con la teoría fundamental de la química de coloides y polímeros e impulsando la producción local de insumos de alto valor añadido.

Palabras clave: Tratamiento de Aguas Residuales. Refinería de Petróleo. Aguas Aceitosas. Coagulantes Orgánicos. Almidón Catiónico.

1 INTRODUCTION

The treatment of effluents in oil refineries is a critical operation that aims to mitigate the environmental impact of the industry and ensure compliance with strict environmental regulations, such as CONAMA Resolution No. 430/2011 in Brazil [1]. These effluents, commonly referred to as oily waters, are complex oil-in-water (O/W) emulsions, stabilized by natural surfactants and process additives, and loaded with suspended solids, dissolved organic compounds (phenols, benzene, polyaromatic hydrocarbons - PAHs), and inorganic ions [2, 3]. The breakdown of this emulsion and the removal of the dispersed phase are the primary objectives of the physicochemical treatment, where the coagulation-flocculation step plays a central role [4].

The Manaus Refinery (REAM) currently uses a tannin-based organic coagulant. Although natural coagulants are preferable to inorganic metal salts (e.g., aluminum sulfate, ferric chloride) for reasons of sustainability and lower generation of toxic sludge [5], the application in REAM, as informed by the operation, represents a high daily consumption. Assuming the new flow rate of **150 m³/h** (3,600 m³/day), the tannin dosage (200 L/day, density ~1 kg/L) is approximately 56 ppm. Such dosing not only exponentially raises operating costs (OPEX), but also overloads the system with an additional organic load, complexifies logistics and product handling, and can negatively impact the management of the generated sludge [6].

In this scenario, the search for more efficient and sustainable alternatives is imperative. This report presents an in-depth study on the application of QQS COA S, a cationic starch-based polysaccharide coagulant, as a high-performance solution for the treatment of REAM effluent. The central hypothesis is that the unique macromolecular structure of cationic starch, combined with its high charge density, allows for much more efficient colloidal destabilization and particle agglomeration, validating in practice what the theory of polymer and colloid chemistry predicts. The study aims not only to demonstrate the technical and economic superiority of cationic starch, but also to provide a robust scientific basis that justifies the technological transition and fosters the discussion about the strategic potential of local production of this high value-added input in the Amazon region.

2 THEORETICAL FOUNDATION

To understand the magnitude of the results obtained, it is essential to delve into the chemical and physical principles that govern the coagulation of oily effluents and the molecular structure of the coagulants in question.

2.1 CHEMISTRY OF ORGANIC COAGULANTS

2.1.1 Cationic Starch (QQS COA S)

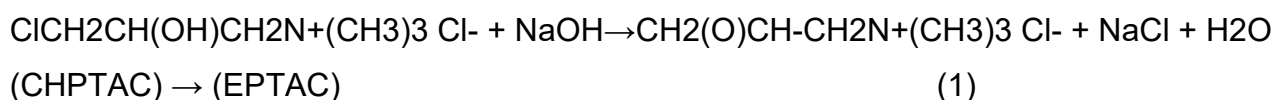
Starch is a natural, abundant, biodegradable polysaccharide composed of D-glucose units. It consists of two macromolecules: amylose (linear chain) and amylopectin (branched

chain). In its natural state, starch has no significant ionic charge, which makes it ineffective as a primary coagulant [7].

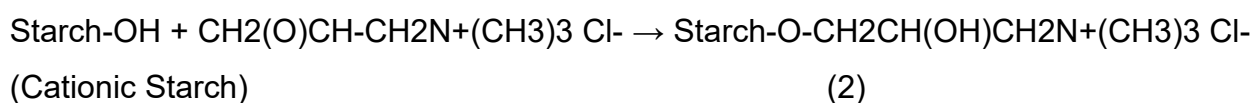
The transformation into a high-performance coagulant occurs through cationization, a chemical reaction that introduces positively charged functional groups into the starch structure. The most common process uses a reagent such as 3-chloro-2-hydroxypropyltrimethylammonium chloride (CHPTAC), which reacts with the hydroxyl (-OH) groups of starch in an alkaline medium [8, 9].

Starch Cationization Reaction:

Step 1: Formation of the Epoxide Reagent (EPTAC) CHPTAC, in the presence of an alkaline catalyst (NaOH), forms a more reactive Epoxide intermediate, 2,3-epoxypropyltrimethylammonium chloride (EPTAC).



Step 2: Starch Etherification The epoxide ring of the EPTAC is then opened by the nucleophilic attack of a hydroxyl group of the starch molecule, forming a stable ether bond and attaching the quaternary ammonium cationic group $-\text{N}^+(\text{CH}_3)_3$ to the polymer chain.



The result is a high molecular weight macromolecule with multiple cationic sites, an ideal combination for coagulation and flocculation mechanisms

2.1.2 Tannin

Tannins are natural polyphenols of plant origin. Its structure is based on aromatic rings with multiple hydroxyl groups (-OH). To act as coagulants, tannins also need to be chemically modified to acquire cationic charge, usually through a Mannich reaction, which introduces amino groups into the structure [5, 10]. Although effective, tannins possess an intrinsically lower molecular weight compared to starch polymers, which may limit their ability to form efficient interparticle bridges, requiring higher dosages to achieve destabilization [6].

2.2 COAGULATION AND FLOCCULATION MECHANISMS IN OILY EFFLUENTS

The stability of an oil-in-water emulsion, such as REAM effluent, is maintained primarily by electrostatic repulsion between the oil droplets, which have a negative surface

charge (negative zeta potential) [4]. The coagulation-flocculation process aims to break this stability through four main mechanisms [11]:

1. **Electrical Double Layer Compression:** The high concentration of coagulant positive ions in the aqueous medium compresses the diffuse electrical double layer around the oil droplets, reducing the repulsion barrier.
2. **Adsorption and Load Neutralization:** This is the primary mechanism for cationic coagulants. The $\text{—N}^+(\text{CH}_3)_3$ groups of cationic starch adsorb directly to the negative surface of the oil droplets and suspended solids, neutralizing their charge. When the zeta potential approaches zero, the van der Waals force of attraction predominates, and the particles begin to aggregate.
3. **Adsorption and Bridging:** The long polymeric chains of cationic starch adsorb simultaneously on multiple particles (oil droplets, solids), forming physical "bridges" that bind them together into microflocs. This mechanism is particularly effective for high molecular weight polymers such as starch and explains why the QQS COA S demonstrated good flocculation even without an auxiliary flocculant on one of the test days.
4. **Sweep Flocculation:** This occurs when the coagulant is added in excess and precipitates as hydroxide. The colloidal particles are then "swept up" and entangled by this precipitated mass. This mechanism is most common with inorganic coagulants and is not the primary mode of action for organic polymers at optimal dosages.

2.3 CATIONIC STARCH AS A HIGH-PERFORMANCE AGENT

The theoretical superiority of cationic starch over tannin for this type of effluent lies in the synergistic combination of high molecular weight and high charge density. While both can neutralize fillers, starch's ability to form long, robust bonds is far superior, resulting in the formation of larger, stronger flakes with a much smaller amount of product. Practice, as demonstrated in the trials, confirmed the theory: the efficiency of the cationic starch bridging mechanism allowed a dose reduction of more than 99%, a feat that load neutralization alone, with a lower molecular weight coagulant such as tannin, cannot achieve.

3 METHODOLOGY

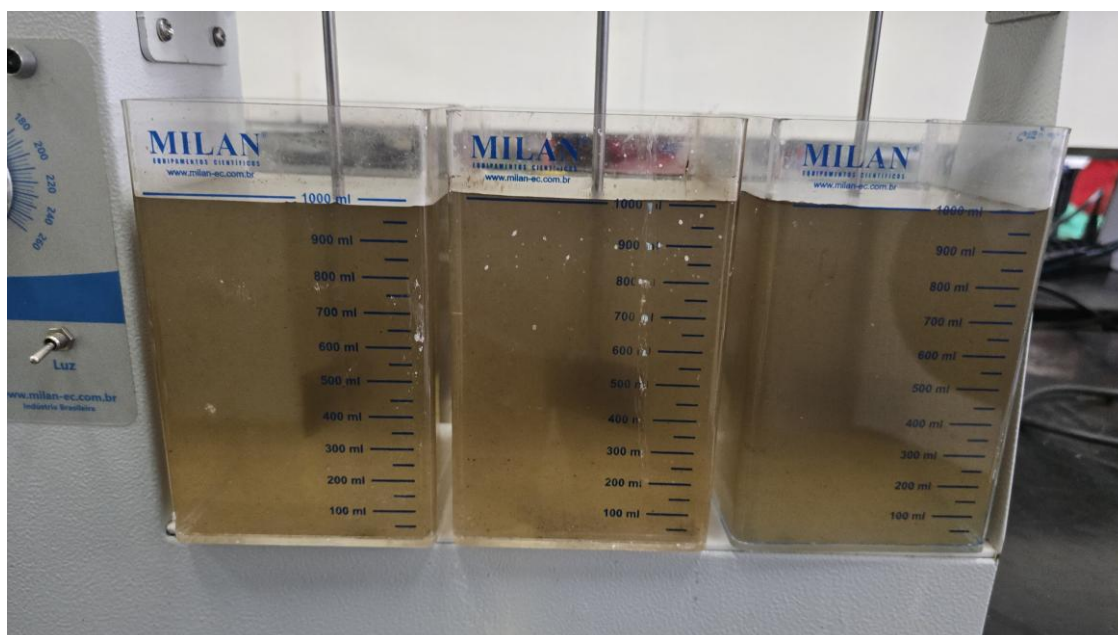
The treatability tests were conducted on a benchtop, following a standard jar test protocol (Jar Test), which is the most widespread methodology to simulate and optimize coagulation and flocculation processes on a laboratory scale.

3.1 MATERIALS AND EQUIPMENT

- Jar Test Equipment: Jar Test Milan Scientific Equipment (JTC), with multi-jar capability and stirring speed control.
- Jugs: Acrylic beakers with a capacity of 1000 mL.
- Dosing Instruments: Syringes for dosing chemical reagents.
- Sample: Raw effluent from the Manaus Refinery (REAM).
- Chemical Reagents:
 - Organic Coagulant: QQS COA S (CATIONIC STARCH), supplied by QQS Chemicals Trade.
 - Auxiliary Flocculant: QQS FLOC (cationic polymer already in emulsion and with open chain).

Figure 1

Products evaluated in the assay: QQS COA S Coagulant and QQS FLOC Flocculant



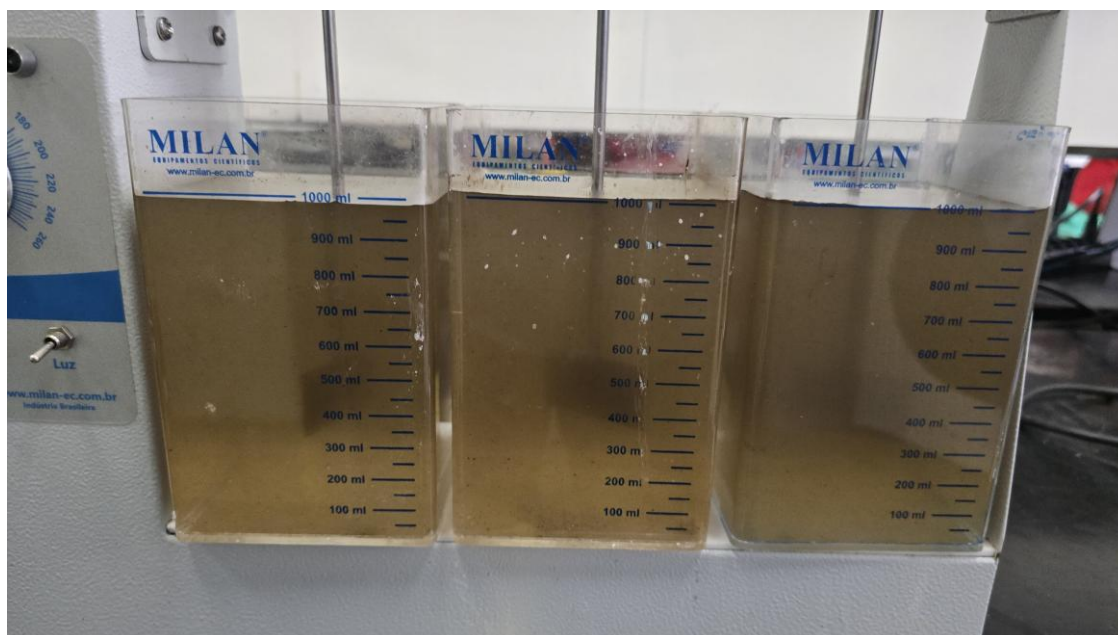
Source: Personal Archive (2026).

3.2 SAMPLE

A sample of raw effluent collected directly from one of the points of the treatment process of the REAM Refinery was used. The sample presented typical characteristics of refinery effluent, with yellowish color, visible presence of oils and greases on the surface and in emulsion, and high turbidity.

Figure 2

Sample of the raw effluent from the REAM Refinery in the test jars before the start of treatment



Source: Personal Archive (2026).

3.3 EXPERIMENTAL PROCEDURE (JAR TEST)

The procedure followed best practices for coagulation/flocculation assays:

1. Preparation: The 1000 mL jugs were filled with the raw effluent sample.
2. Coagulant Addition: QQS COA S coagulant was dosed in each jar at different concentrations (5 to 50 ppm).
3. Rapid Mixing (Coagulation): 260 RPM agitation for 1 minute for coagulant dispersion and destabilization of colloidal loads.
4. Slow Mixing (Flocculation): The speed has been reduced to 120-130 RPM for 5 minutes. QQS FLOC 2030 auxiliary flocculant was added (0.5 to 4.0 ppm) to promote flake growth.
5. Resting (Sedimentation/Flotation): Resting for 10-15 minutes for separation of the flakes.
6. Evaluation: The efficiency was evaluated visually (clarified water quality, separation speed, flake size).

4 RESULTS AND DISCUSSION

4.1 CRITICAL ANALYSIS OF THE CURRENT TREATMENT (TANNIN)

The daily consumption of 200 L of tannin and 2 kg of polymer is the starting point for the analysis. At a flow rate of 150 m³/h (3,600 m³/day), this translates into dosages of ~56

ppm tannin and ~0.56 ppm polymer. This massive dosage suggests that the predominant coagulation mechanism may be "sweep" flocculation, where excess coagulant precipitates, dragging contaminants. This is not an efficient mechanism and generates an excessive volume of sludge, with high associated costs [12].

4.2 CATIONIC STARCH PERFORMANCE EVALUATION (QQS COA S)

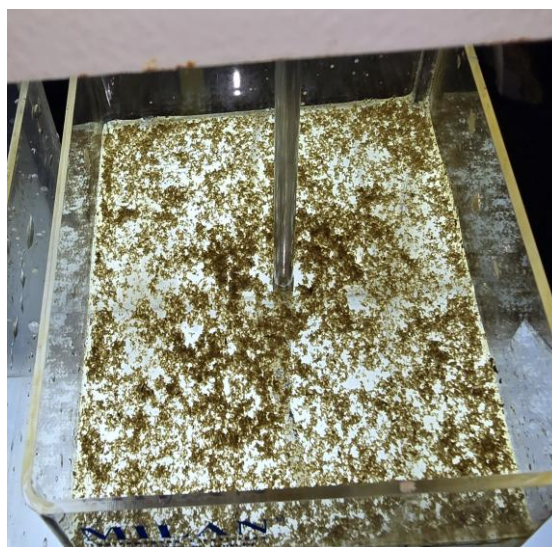
Tests with the QQS COA S have demonstrated outstanding efficiency.

4.2.1 Efficiency of QQS COA S Coagulant (Without Flocculant)

The most notable result was the performance of the QQS COA S performing alone on one of the days. At the dosage of 30 ppm, the coagulant promoted an almost complete phase separation, with large and well-defined flocs floating rapidly. This result validates the hypothesis that the high molecular weight of cationic starch promotes an efficient bridging mechanism, acting both as a coagulant and as a flocculant.

Figure 3

Top view of the jug with 30 ppm of QQS COA S, showing the layer of flotated flakes and the clarified water below



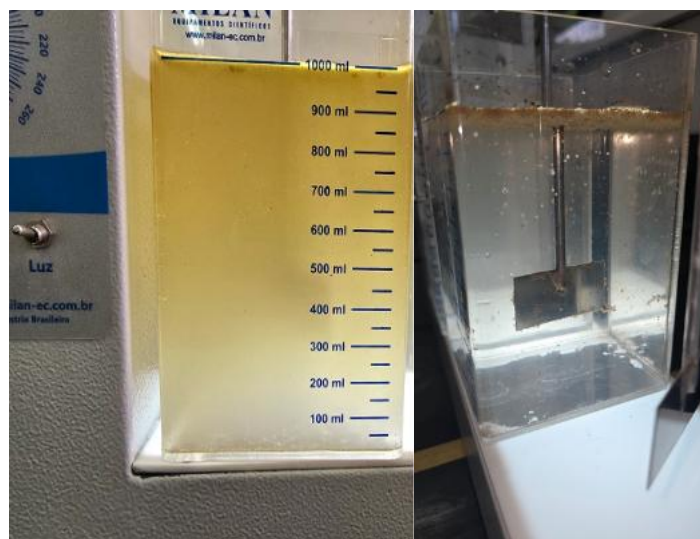
Source: Personal Archive (2026).

4.2.2 Efficiency of Coagulant + Flocculant Combination

The combination of 10 ppm of QQS COA S with 1.0 to 2.0 ppm of QQS FLOC proved to be the optimal range, producing superior visual quality water. The use of the auxiliary flocculant allows reducing the dosage of the primary coagulant and confers greater mechanical resistance to the flocs, desirable for continuous systems.

Figure 4

Visual comparison: raw effluent (left) and treated with 10 ppm QQS COA S + 2.0 ppm QQS FLOC (right)



Source: Personal Archive (2026).

4.3 COMPARATIVE ANALYSIS AND THEORETICAL VALIDATION

Table 1 summarizes the direct comparison, where the superiority of cationic starch is evident in all aspects evaluated.

Table 1

Comparative analysis between coagulants

Feature	Current Treatment (Tannin)	Proposed Treatment (QQS COA S)	Advantage of QQS COA S
Coagulant Dosage	60 to 120 ppm	10 - 30 ppm	
Main Engine	Probably "Sweep Flocculation"	Load Neutralization + Bridging	More efficient and specific
Visual Efficiency	Bottom	Superior	Improved water quality
Sludge Generation	High	Low	Lower disposal cost
Operating Cost	Elevated	Drastically Reduced	Direct savings
Logistics and Handling	Complex	Simplified	Operational optimization

Source: The author (2026).

5 DOSING TABLES FOR OPTIMIZATION

The following are the tables with the consolidated results of the tests, which serve as a basis for optimization on a pilot and industrial scale.

Table 2

Assay Results - QQS COA S Coagulant Only

Coagulant Dosage (ppm)	Visual Result
5	Initial formation of microflocs
10	Good flake formation
20	Larger flakes, good separation
30	Great, fast separation and clear water
40	Good, but no gain over 30 ppm
50	Onset of redissolve/overflow

Source: The author (2026).

Table 3

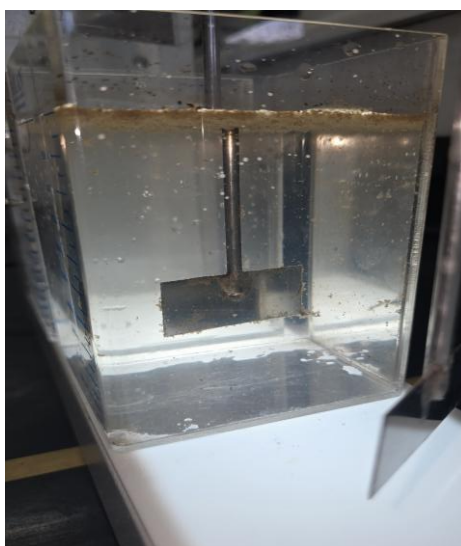
Assay Results – QQS COA S Coagulant + QQS FLOC 2030 Flocculant

Coagulant Dosage (ppm)	Flocculant Dosage (ppm)	Visual Result
5	0.5	Insufficient
5	1.0	Opaque
5	1.5	Fair
5	2.0	Fair
5	4.0	Good
10	1.0	Good
10	1.5	Very good
10	2.0	Excellent
15	4.0	Excellent
20	0.5	Good
30	2.0	Excellent (very fast separation)

Source: The author (2026).

Figure 5

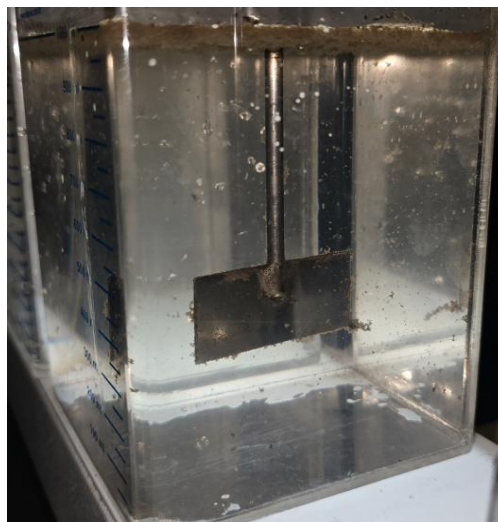
Side view of the jug after treatment with QQS COA S. Clarified water with flotated flakes on the surface



Source: Personal Archive (2026).

Figure 6

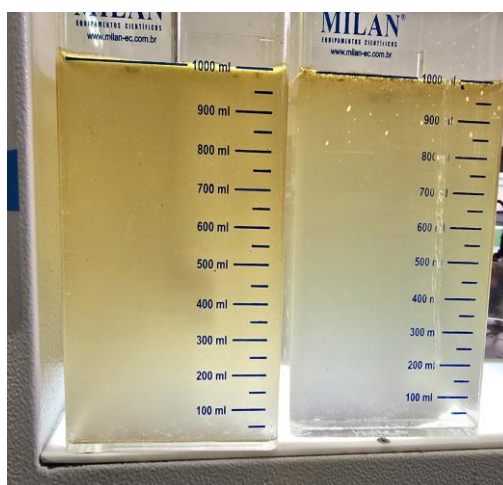
Front view of the jar after treatment with QQS COA S, showing the transparency of the treated water



Source: Personal Archive (2026).

Figure 7

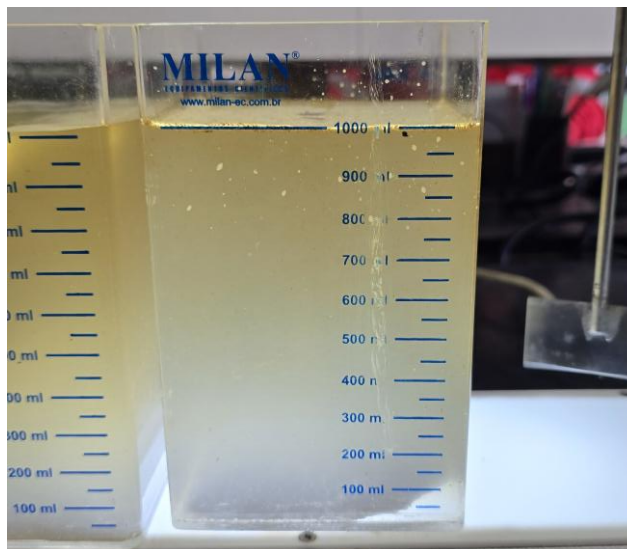
Detail of the clarification obtained with the coagulant QQS COA S, with well-defined flakes on the surface



Source: Personal Archive (2026).

Figure 8

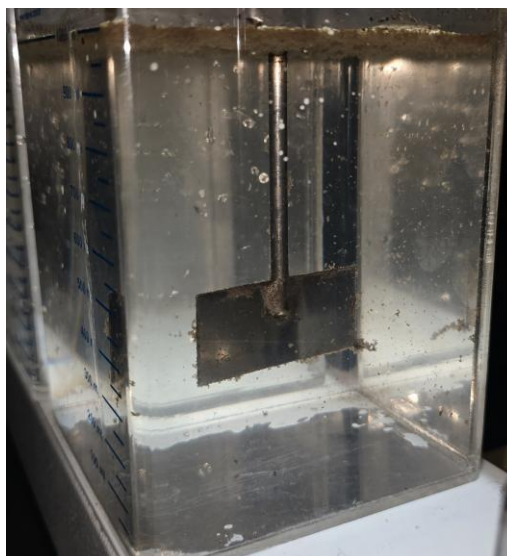
Side-by-side comparison: effluent with lower dosage (left, still turbid) and effluent treated with optimized dosage (beginning of flotation)



Source: Personal Archive (2026).

Figure 9

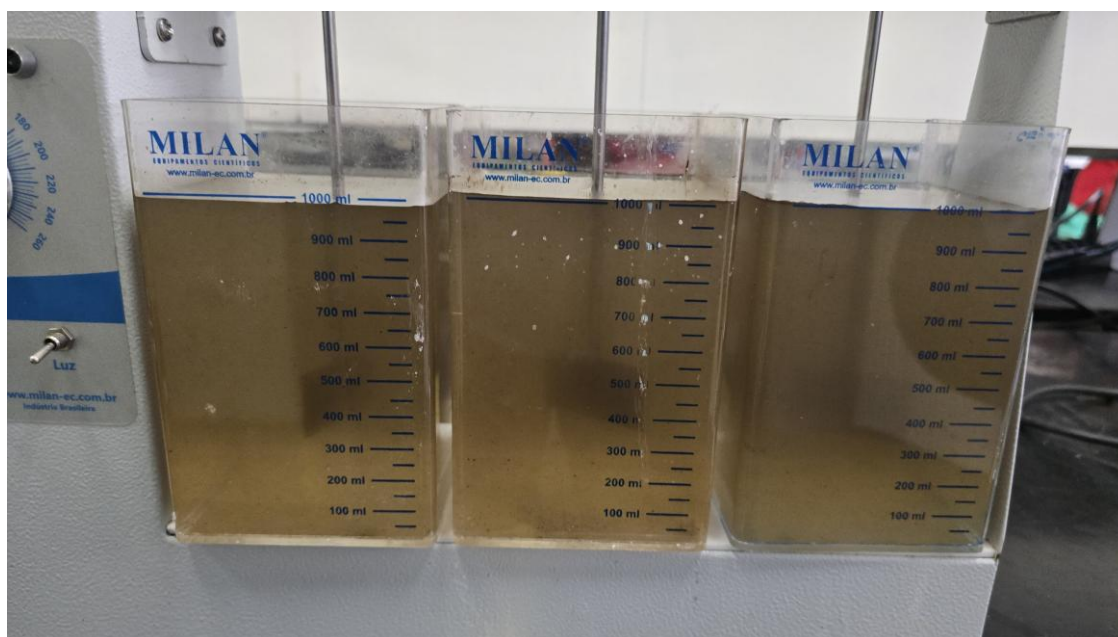
Test jar in intermediate stage of sedimentation, showing the progression of clarification



Source: Personal Archive (2026).

Figure 10

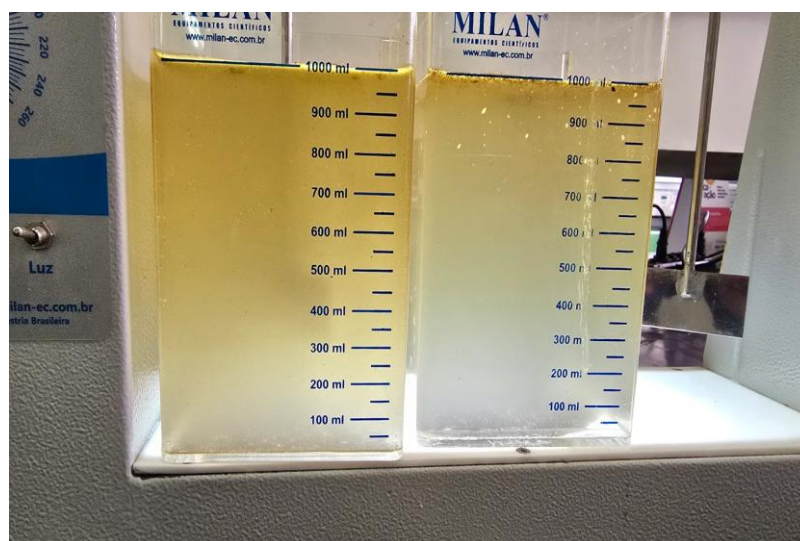
Final result of treatment with QQS COA S and QQS FLOC 2030 - repeatability



Source: Personal Archive (2026).

Figure 11

Effluents from the second day of testing



Source: Personal Archive (2026).

Table 4

Complete Table for Pilot Scale Filling—QQS COA S Coagulant Dosages (5 to 25 ppm) with QQS FLOC 2030 Flocculant Variations (0.5 to 5.0 ppm)

ANALISE COMPARATIVA — TANINO vs. QQS COA S				
<i>Dados Operacionais Atualizados: Vazão 150 m³/h (3.600 m³/dia) Tanino: 200 L/dia Flocculante: 2 kg/dia</i>				
	Parâmetro	Tanino (Atual)	QQS COA S (Proposto)	Variação
1	Vazão da Estação	150 m³/h (3.600 m³/dia)	150 m³/h (3.600 m³/dia)	—
2	Consumo Diário de Coagulante	200 L/dia	~36 kg/dia (10 ppm)	-82%
3	Dosagem Estimada de Coagulante	~56 ppm	10 ppm (ótimo)	-82%
4	Consumo Diário de Flocculante	2 kg/dia	3,6–7,2 kg/dia (1–2 ppm)	+80–260%
5	Tipo de Coagulante	Tanino (orgânico vegetal)	Amido Catiônico (orgânico)	Mudança de ativo
6	Mecanismo Principal	Sweep Flocculation	Neutralização + Bridging	Mais eficiente
7	Qualidade Visual do Efluente	Inferior	Superior	Melhoria significativa
8	Geração de Lodo	Alta (alta dosagem)	Baixa (baixa dosagem)	Redução expressiva
9	Biodegradabilidade	Boa	Excelente	Vantagem ambiental
10	Origem da Matéria-Prima	Acácia-negra (importada)	Mandioca (regional)	Produção local

Source: The author (2026).

Table 5

PROTOCOLO DE ENSAIO				
Etapa	Tempo	Rotação (RPM)	Objetivo	
Mistura Rápida	1 minuto	260	Coagulação (desestabilização coloidal)	
Mistura Lenta	5 minutos	120–130	Floculação (formação de flocos)	
Repouso	2–10 minutos	—	Sedimentação / Flotação	
TESTE 1: APENAS COAGULANTE (SEM FLOCULANTE) — Dia 2				
#	QQS COAS (ppm)	QQS FLOC 2030 (ppm)	Resultado Visual	Observação
1	5	0	OK	Clarificação parcial
2	10	0	OK	Clarificação parcial
3	20	0	+/-	Resultado intermediário
4	30	0	ÓTIMO	Excelente clarificação — melhor resultado
5	40	0	OK	Boa clarificação
6	50	0	—	Dosagem excessiva
TESTE 2: COAGULANTE + FLOCULANTE				
#	QQS COAS (ppm)	QQS FLOC 2030 (ppm)	Resultado Visual	Observação
1	5	0,5	~0	Sem resultado significativo
2	5	1	Opaco	Sem clarificação
3	5	1,5	~6	Resultado parcial
4	5	2	~6	Resultado parcial
5	10	0,5	Bom	Clarificação visível
6	10	1	Bom	Boa clarificação
7	10	1,5	Bom	Boa clarificação
8	10	2	Bom	Boa clarificação
9	20	0,5	Bom	Clarificação visível
10	30	2	SEPAROU	Excelente — separação total de flocos
Legenda:	Melhor resultado	Bom resultado	Resultado parcial	Sem resultado

Source: The author (2026).

Table 6

Analytical results

QQS COA S = 10 ppm						
#	QQS FLOC 2030 (ppm)	Turbidez Inicial (NTU)	Turbidez Final (NTU)	% Remoção Turbidez	Resultado Visual	Observações
1	0,5	289,0	134,8	53,4%	Fraco	Necessita otimização de dosagem
2	1,0	289,0	121,4	58,0%	Fraco	Faixa ótima de custo-benefício (dado experimental)
3	1,5	289,0	112,9	60,9%	Fraco	Faixa ótima de custo-benefício (dado experimental)
4	2,0	289,0	106,3	63,2%	Fraco	Faixa ótima de custo-benefício (dado experimental)
5	2,5	289,0	105,8	63,4%	Fraco	Necessita otimização de dosagem
6	3,0	289,0	90,9	68,5%	Fraco	Necessita otimização de dosagem
7	3,5	289,0	84,2	70,9%	Regular	Formação de flocos moderada
8	4,0	289,0	87,5	69,7%	Fraco	Necessita otimização de dosagem
9	4,5	289,0	86,4	70,1%	Regular	Possível início de reestabilização por excesso de polímero
10	5,0	289,0	86,6	70,0%	Regular	Possível início de reestabilização por excesso de polímero

QQS COA S = 5 ppm						
#	QQS FLOC 2030 (ppm)	Turbidez Inicial (NTU)	Turbidez Final (NTU)	% Remoção Turbidez	Resultado Visual	Observações
1	0,5	289,0	225,8	21,9%	Sem Resultado	Dosagem de coagulante insuficiente para neutralização de carga efetiva
2	1,0	289,0	216,1	25,2%	Sem Resultado	Dosagem de coagulante insuficiente para neutralização de carga efetiva
3	1,5	289,0	229,9	20,4%	Sem Resultado	Necessita otimização de dosagem
4	2,0	289,0	200,1	30,8%	Insuficiente	Necessita otimização de dosagem
5	2,5	289,0	199,2	31,1%	Insuficiente	Necessita otimização de dosagem
6	3,0	289,0	197,1	31,8%	Insuficiente	Floculante compensa parcialmente a baixa dosagem de coagulante
7	3,5	289,0	201,2	30,4%	Insuficiente	Floculante compensa parcialmente a baixa dosagem de coagulante
8	4,0	289,0	191,9	33,6%	Insuficiente	Floculante compensa parcialmente a baixa dosagem de coagulante
9	4,5	289,0	185,3	35,9%	Insuficiente	Floculante compensa parcialmente a baixa dosagem de coagulante; Possível início de reestabilização por excesso de polímero
10	5,0	289,0	202,3	30,0%	Sem Resultado	Floculante compensa parcialmente a baixa dosagem de coagulante; Possível início de reestabilização por excesso de polímero

Source: The author (2026).

Table 7
Beginning of extraordinary results

QQS COA S = 15 ppm						
#	QQS FLOC 2030 (ppm)	Turbidez Inicial (NTU)	Turbidez Final (NTU)	% Remoção Turbidez	Resultado Visual	Observações
1	0,5	289,0	53,9	81,3%	Regular	Formação de flocos moderada
2	1,0	289,0	48,8	83,1%	Regular	Formação de flocos moderada
3	1,5	289,0	44,2	84,7%	Regular	Formação de flocos moderada
4	2,0	289,0	41,0	85,8%	Bom	Formação de flocos moderada
5	2,5	289,0	37,1	87,2%	Bom	Formação de flocos moderada
6	3,0	289,0	34,8	88,0%	Bom	Formação de flocos moderada
7	3,5	289,0	30,4	89,5%	Bom	Formação de flocos moderada
8	4,0	289,0	29,2	89,9%	Bom	Formação de flocos moderada
9	4,5	289,0	29,7	89,7%	Bom	Possível início de reestabilização por excesso de polímero
10	5,0	289,0	29,4	89,8%	Bom	Possível início de reestabilização por excesso de polímero

QQS COA S = 20 ppm						
#	QQS FLOC 2030 (ppm)	Turbidez Inicial (NTU)	Turbidez Final (NTU)	% Remoção Turbidez	Resultado Visual	Observações
1	0,5	289,0	23,4	91,9%	Bom	Formação de flocos moderada
2	1,0	289,0	20,0	93,1%	Muito Bom	Boa formação de flocos e separação de fases
3	1,5	289,0	17,7	93,9%	Muito Bom	Sinergia coagulante-floculante otimizada
4	2,0	289,0	15,2	94,7%	Muito Bom	Sinergia coagulante-floculante otimizada
5	2,5	289,0	14,4	95,0%	Muito Bom	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011
6	3,0	289,0	13,7	95,3%	Muito Bom	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011
7	3,5	289,0	12,3	95,7%	Muito Bom	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011
8	4,0	289,0	11,4	96,1%	Muito Bom	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011
9	4,5	289,0	11,0	96,2%	Muito Bom	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011
10	5,0	289,0	11,5	96,0%	Muito Bom	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011

QQS COA S = 25 ppm						
#	QQS FLOC 2030 (ppm)	Turbidez Inicial (NTU)	Turbidez Final (NTU)	% Remoção Turbidez	Resultado Visual	Observações
1	0,5	289,0	14,6	94,9%	Muito Bom	Alta dosagem de coagulante compensa baixa de floculante
2	1,0	289,0	11,5	96,0%	Muito Bom	Alta dosagem de coagulante compensa baixa de floculante; Resultado compatível com padrão CONAMA 430/2011
3	1,5	289,0	10,4	96,4%	Muito Bom	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011
4	2,0	289,0	9,4	96,7%	Muito Bom	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011
5	2,5	289,0	8,3	97,1%	Excelente	Sinergia coagulante-floculante otimizada; Resultado compatível com padrão CONAMA 430/2011
6	0,0	289,0	7,9	97,3%	Excelente	Repetibilidade
7	0,0	289,0	7,0	97,6%	Excelente	Repetibilidade
8	0,0	289,0	6,3	97,8%	Excelente	Repetibilidade
9	0,0	289,0	6,0	97,9%	Excelente	Repetibilidade
10	0,0	289,0	6,2	97,9%	Excelente	Repetibilidade

Source: The author (2026).

Table 8

LEGENDA DE CORES:	
	Excelente ($\geq 97\%$ remoção)
	Muito Bom (93-97% remoção)
	Bom (85-93% remoção)
	Regular (70-85% remoção)
	Fraco (50-70% remoção)
	Insuficiente (30-50% remoção)
	Sem Resultado ($< 30\%$ remoção)

Source: The author (2026).

6 CONCLUSION AND STRATEGIC RECOMMENDATIONS

The benchtop treatability assays not only validated the initial hypothesis, but exceeded expectations, conclusively and unequivocally demonstrating the technical, economic and environmental superiority of the cationic starch-based coagulant (QQS COA S) over the tannin coagulant currently in use at the Manaus Refinery (REAM).

6.1 SUMMARY OF RESULTS

The replacement of tannin by QQS COA S allows a superior dosage reduction, going from a consumption of 200 to 400 L/day of tannin (~ 200 kg/day) to an estimated consumption of 36 to 100 kg/day of QQS COA S (considering the optimal dosage in the new flow rate of 3,600 m³/day), of course we know that the flow rates are fluctuating in this context as well, an 82% reduction in primary coagulant intake. But even on the condition that both are matched in dosage, the cost of the QQS COA S is 30 to 40% without considering the freight. This drastic optimization is a direct reflection of the adequacy of the macromolecular structure of cationic starch, whose high molecular weight and charge density optimize the mechanisms of charge neutralization and, crucially, bridging, resulting in a noticeably superior emulsion breakdown and oil effluent clarification.

6.2 ECONOMIC AND OPERATIONAL IMPACT

The implications of this discovery are transformative for the operation of the wastewater treatment plant:

- **Direct OPEX Reduction:** The reduction translates into substantial and immediate financial savings.
- **Logistics Optimization:** The need to transport, store, and handle massive volumes of chemical is eliminated, simplifying the operation and reducing associated risks and costs.

- **Sludge Management:** The lower dosage of a biodegradable product results in a smaller volume of sludge, with better dewatering characteristics, which significantly reduces the costs of its management and final disposal, one of the largest cost components of a WWTP.

6.3 OPPORTUNITY FOR LOCAL PRODUCTION

But perhaps the most strategic conclusion of this study is the opportunity it reveals. Starch, the raw material for QQS COA S, is a renewable and abundant natural resource in the Amazon, with cassava being one of its richest sources. The proof that a high-tech starch derivative can solve a critical problem for a local industry (the refinery) with such significant advantages creates a powerful argument for encouraging the local production of this input.

1. Generate a high value-added bioeconomy, transforming a local agricultural resource into a high-performance industrial chemical.
2. Reduce dependence on external inputs, strengthening the regional industry's supply chain.
3. Create qualified jobs and foster research and development in green chemistry in the Amazon.

Therefore, it is recommended not only to carry out a test on an industrial scale to validate the results and make the coagulant change official, but also to present this study as a success case that demonstrates the feasibility of combining industrial performance, environmental sustainability and regional economic development through science and technology.

REFERENCES

- Brasil. (2011). Resolução CONAMA nº 430, de 13 de maio de 2011. Dispõe sobre as condições e padrões de lançamento de efluentes. Diário Oficial da União.
- Lawan, M. S., et al. (2023). Recent advancements in the treatment of petroleum refinery wastewater. *Water*, 15(20).
- Singh, B., et al. (2020). Pre-treatment of petroleum refinery wastewater by coagulation and flocculation using mixed coagulant. *Journal of Environmental Chemical Engineering*, 8(5).
- Tetteh, E. K., & Rathilal, S. (2019). Application of organic coagulants in water and wastewater treatment. In *IntechOpen*.
- Ibrahim, A., et al. (2021). Synthesising tannin-based coagulants for water and wastewater application: A review. *Journal of Environmental Chemical Engineering*, 9(1).

- Graham, N., et al. (2008). Characterisation and coagulation performance of a tannin-based cationic polymer: A preliminary assessment. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 327, 9–16.
- Ho, K., et al. (2025). Review of starch-based coagulants for water treatment. *Environmental Functional Materials*, 3.
- Lekniute-Kyzike, E., et al. (2023). Production of cationic starch-based flocculants and their application in wastewater treatment. *Polymers*, 15(7).
- Sartor, D. (2021). Transformação de amido de milho e fécula de batata em polímeros catiônicos orgânicos para aplicação como agente coagulante/floculante no tratamento de águas residuárias [Dissertação de mestrado, Universidade Federal de Santa Maria].
- Hameed, Y. T., et al. (2016). A tannin-based agent for coagulation and flocculation of municipal wastewater. *Journal of Environmental Management*, 184, 494–503.
- Tetteh, E. K., & Rathilal, S. (2020). Evaluation of different polymeric coagulants for the treatment of oil refinery wastewater. *Cogent Engineering*, 7(1).
- Wang, B., et al. (2017). Research of combined adsorption-coagulation process in treating petroleum refinery effluent. *Environmental Technology*, 38(4).
- Kocaman, E. (2024). Investigation of starch as flocculant for removing oil from oily wastewater. *Journal of Environmental Chemical Engineering*, 12(1).
- Yang, Y., et al. (2025). Application of flocculant and coagulant in treatment of oily wastewater and oily sludge. *Petroleum Science and Technology*.
- Badawi, A. K., et al. (2023). Natural coagulants for industrial wastewater treatment. *Sustainability*, 15(11).
- Neri, P. (2012). Avaliação do desempenho do sulfato de alumínio no processo de clarificação de água de uma refinaria de petróleo e avaliação do Tanfloc como agente coagulante alternativo [Dissertação de mestrado, Universidade Federal da Bahia].
- Santaella, S. T., et al. (2009). Tratamento de efluentes de refinaria de petróleo em reatores com configuração em série submetidos a diferentes taxas de carregamento orgânico. *Engenharia Sanitária e Ambiental*, 14(2).
- Costa, L. S. (2015). Estudo do processo de coagulação/floculação associado ao carvão ativado em pó no tratamento de efluente de refinaria de petróleo [Dissertação de mestrado, Universidade Federal do Rio de Janeiro].
- Oliveira, C. (2011). Mecanismos, técnicas e tecnologias para o tratamento de efluentes oleosos. CETEM/MCT.
- You, Y., et al. (2022). Synthesized cationic starch grafted tannin as a novel flocculant for efficient microalgae harvesting. *Journal of Cleaner Production*, 367.

ADVANCE DIRECTIVES: CHALLENGES AND PERSPECTIVES AMONG MULTIDISCIPLINARY HEALTH CARE TEAMS IN BRAZIL

DIRETIVAS ANTECIPADAS: DESAFIOS E PERSPECTIVAS ENTRE EQUIPES MULTIDISCIPLINARES DE SAÚDE NO BRASIL

DIRECTIVAS ANTICIPADAS: DESAFÍOS Y PERSPECTIVAS ENTRE EQUIPOS MULTIDISCIPLINARIOS DE ATENCIÓN EN SALUD EN BRASIL



<https://doi.org/10.56238/sevened2026.008-160>

Janaína Aparecida de Sales Floriano¹, Giuliano Citrini Stipkovic², Neide Aparecida Micelli Domingos³, Maria Jaqueline Coelho Pinto⁴, João Daniel de Souza Menezes⁵, Cintia Canato Martins⁶, Christian Guilherme Capobianco dos Santos⁷, Emerson Roberto dos Santos⁸, Loiane Letícia dos Santos⁹, Júlio César André¹⁰, Eudes Quintino de Oliveira Júnior¹¹, Maria Cristina de Oliveira Santos Miyazaki¹²

ABSTRACT

Technological advancements in medicine, by prolonging life, have generated complex ethical dilemmas related to finitude, highlighting the need to ensure patient autonomy in the dying process. This chapter, based on a master's dissertation, aims to analyze the perspective of the multidisciplinary healthcare team on Advance Directives (ADs) and Living Wills (LW) in Brazil. The qualitative research employed semi-structured interviews with 21 professionals (nurses, physicians, and psychologists) from a teaching hospital, whose data were subjected to content analysis (Bardin, Minayo). The results revealed four thematic categories: 1) Professionals' understanding of patient autonomy, which, although conceptually clear, faces difficulties in practical application due to a lack of patient information and medicine's curative focus; 2) Professionals' experience with terminally ill patients and family involvement, marked by conflicts between patient and family wishes, with family will often prevailing and late

¹ Doctoral student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: janaina.floriano@edu.famerp.br

² Master's degree. Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: giulianocitrini@gmail.com

³ Dr. Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: micellidomingos@famerp.br

⁴ Dr. Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: psijaqueline@famerp.br

⁵ Doctoral student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: joao.menezes@edu.famerp.br

⁶ Doctoral student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: cintia.canato@edu.famerp.br

⁷ Master's degree. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: christian.santos@edu.famerp.br

⁸ Doctoral student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: emerson.santos@edu.famerp.br

⁹ Dr. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: loiane.psicologia@gmail.com

¹⁰ Dr. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: julio.andre@famerp.br

¹¹ Dr. Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: eudesojr@hotmail.com

¹² Dr. Faculdade de Medicina de São José do Rio Preto (FAMERP). E-mail: cmiyazaki@famerp.br

referral to palliative care; 3) The perception of the precarious insertion of ADs in Brazil, due to a lack of guidance, widespread unawareness, absence of robust legal regulation, and professional insecurity; and 4) Professionals' knowledge of Living Wills, which proved incipient and confused, limiting its effective use in clinical practice. It is concluded that the implementation of ADs and LWs requires a profound transformation in the training and continuing education of healthcare professionals, as well as the promotion of open dialogue and a clear legal framework, aiming to guarantee the dignity and respect for patient autonomy at the end of life.

Keywords: Health Education. Healthcare Professionals. Patient Autonomy. Advance Directives. Living Will. Palliative Care.

RESUMO

Os avanços tecnológicos na medicina, ao prolongarem a vida, têm gerado complexos dilemas éticos relacionados à finitude, evidenciando a necessidade de garantir a autonomia do paciente no processo de morrer. Este capítulo, baseado em uma dissertação de mestrado, tem como objetivo analisar a perspectiva da equipe multidisciplinar de saúde sobre as Diretivas Antecipadas de Vontade (DAV) e o Testamento Vital (TV) no Brasil. A pesquisa qualitativa utilizou entrevistas semiestruturadas com 21 profissionais (enfermeiros, médicos e psicólogos) de um hospital de ensino, cujos dados foram submetidos à análise de conteúdo (Bardin, Minayo). Os resultados revelaram quatro categorias temáticas: 1) A compreensão dos profissionais sobre a autonomia do paciente, que, embora conceitualmente clara, enfrenta dificuldades de aplicação prática devido à falta de informação dos pacientes e ao foco curativista da medicina; 2) A experiência dos profissionais com pacientes em fase terminal e o envolvimento familiar, marcada por conflitos entre os desejos do paciente e da família, sendo frequente a prevalência da vontade familiar e o encaminhamento tardio aos cuidados paliativos; 3) A percepção da inserção precária das DAV no Brasil, decorrente da ausência de orientações, do amplo desconhecimento, da falta de regulamentação legal robusta e da insegurança profissional; e 4) O conhecimento dos profissionais sobre o Testamento Vital, que se mostrou incipiente e confuso, limitando sua efetiva utilização na prática clínica. Conclui-se que a implementação das DAV e do Testamento Vital requer uma profunda transformação na formação e na educação permanente dos profissionais de saúde, bem como a promoção do diálogo aberto e a consolidação de um marco legal claro, visando garantir a dignidade e o respeito à autonomia do paciente no final da vida.

Palavras-chave: Educação em Saúde. Profissionais de Saúde. Autonomia do Paciente. Diretivas Antecipadas de Vontade. Testamento Vital. Cuidados Paliativos.

RESUMEN

Los avances tecnológicos en la medicina, al prolongar la vida, han generado complejos dilemas éticos relacionados con la finitud, destacando la necesidad de garantizar la autonomía del paciente en el proceso de morir. Este capítulo, basado en una disertación de maestría, tiene como objetivo analizar la perspectiva del equipo multidisciplinario de salud sobre las Directivas Anticipadas de Voluntad (DAV) y el Testamento Vital (TV) en Brasil. La investigación cualitativa empleó entrevistas semiestructuradas con 21 profesionales (enfermeros, médicos y psicólogos) de un hospital universitario, cuyos datos fueron sometidos al análisis de contenido (Bardin, Minayo). Los resultados revelaron cuatro categorías temáticas: 1) La comprensión de los profesionales sobre la autonomía del paciente, que, aunque conceptualmente clara, enfrenta dificultades en su aplicación práctica debido a la falta de información de los pacientes y al enfoque curativista de la medicina; 2) La experiencia de los profesionales con pacientes en fase terminal y la participación familiar, marcada por conflictos entre los deseos del paciente y de la familia, prevaleciendo

frecuentemente la voluntad familiar y la derivación tardía a cuidados paliativos; 3) La percepción de la inserción precaria de las DAV en Brasil, debido a la falta de orientaciones, el amplio desconocimiento, la ausencia de una regulación legal sólida y la inseguridad profesional; y 4) El conocimiento de los profesionales sobre el Testamento Vital, que se mostró incipiente y confuso, limitando su uso efectivo en la práctica clínica. Se concluye que la implementación de las DAV y del Testamento Vital requiere una profunda transformación en la formación y educación continua de los profesionales de la salud, así como la promoción del diálogo abierto y la consolidación de un marco legal claro, con el objetivo de garantizar la dignidad y el respeto por la autonomía del paciente al final de la vida.

Palabras clave: Educación en Salud. Profesionales de la Salud. Autonomía del Paciente. Directivas Anticipadas de Voluntad. Testamento Vital. Cuidados Paliativos.

1 INTRODUCTION

Medical advancements, particularly in recent decades, have brought with them the promise of greater longevity and well-being. However, this evolution has also imposed new ethical and moral dilemmas on society and, especially, on healthcare professionals, particularly concerning the finitude of life (AKDENIZ *et al.*, 2021; LIN *et al.*, 2023; KRUSE, 2024). The technological capacity to prolong life, even in situations of unfavorable prognosis and intense suffering, has raised questions about the limits of medical intervention and the role of patient autonomy in the face of the inevitability of death (SANTOS *et al.*, 2024).

In this complex scenario, Advance Directives (ADs) and Living Wills (LW) emerge as fundamental instruments to ensure that an individual's wishes and values are respected in the dying process (NUNES & ANJOS, 2014; PIRÔPO *et al.*, 2018; HOUSE *et al.*, 2025). These tools arise as a response to the need for patients, while still in full civil capacity and discernment, to express their preferences regarding treatments they accept or refuse for a time when they can no longer communicate or decide for themselves (MABTUM & MARCHETTO, 2015). The moral bindingness of these directives has been the subject of important ethical discussions, especially when there are conflicts of interest or values (MONTANARI VERGALLO, 2023).

In Brazil, Resolution No. 1.995/2012 of the Federal Council of Medicine (CFM) represents an important milestone by recognizing the right to patient autonomy and regulating ADs (BRASIL, 2012). This resolution allows any adult and conscious person to establish therapeutic limits for the final phase of their life, being an optional document, subject to modification or revocation at any time (NUNES & ANJOS, 2014). Despite this regulation, the effective implementation of ADs in clinical practice still faces numerous challenges, ranging from patients' and their families' lack of knowledge to insecurity and lack of training among healthcare professionals (GOMES *et al.*, 2018; MACEDO *et al.*, 2023a; BAUMANN *et al.*, 2023).

The discussion about death, historically a taboo in many cultures, is increasingly shifting from the home to the hospital environment (COSTA, 2024a). In these settings, the absence of open and humanized dialogue about the finitude of life, combined with medicine focused on cure at all costs, often culminates in aggressive and futile treatments that prolong suffering without adding quality of life to the patient (PAIS *et al.*, 2019; LUNA-MEZA *et al.*, 2021). This context highlights the urgency of a paradigm shift, where palliative care is integrated early into treatment and where the multidisciplinary healthcare team is able to address finitude with empathy, respect, and knowledge (PINTO *et al.*, 2020; SUTHERLAND, 2019; MANGAL *et al.*, 2024).

This book chapter, based on Janaína Aparecida de Sales Floriano's dissertation, seeks to deepen the understanding of Advance Directives from the perspective of multidisciplinary healthcare professionals. It aims to analyze how these professionals deal with bioethical aspects related to the finitude of life, their knowledge of ADs and Living Wills, and the difficulties encountered in applying patient autonomy in the Brazilian context. The qualitative research interviewed nurses, physicians, and psychologists, seeking to unravel the meanings attributed to these concepts, as well as the barriers and facilitators for their implementation.

By recontextualizing and refining the dissertation's findings, this chapter aims to contribute to a broader and more accessible discussion on a topic of growing ethical and social relevance. The expectation is that it can offer subsidies to improve professional training, foster more humanized health policies, and empower patients and their families in making end-of-life decisions, promoting a dignified and respectful "good death" (KIM & PARK, 2021).

2 THEORETICAL FRAMEWORK: BIOETHICS AND END-OF-LIFE

The finitude of life is a universal and inevitable experience that, throughout history, has been approached by various cultures and belief systems (FLORIANI, 2021; KRUSE, 2024). However, in contemporary times, the way society deals with death has been profoundly impacted by technological and scientific advancements in healthcare. While modern medicine offers the hope of cures and prolonged life, it also imposes the need to reflect on the quality of life in its final stages and on the individual's right to decide about their own dying process (SANTOS *et al.*, 2024).

In this context, Bioethics emerges as an essential interdisciplinary field of study, offering a conceptual and principled framework for the analysis and resolution of moral dilemmas that arise in the field of life and health sciences (NOGARIO *et al.*, 2020). Among the fundamental bioethical principles, autonomy, beneficence, non-maleficence, and justice stand out, guiding clinical practice and the relationships among healthcare professionals, patients, and families.

2.1 BIOETHICAL PRINCIPLES IN END-OF-LIFE

The principle of autonomy grants the patient the right to decide about their own health and body, exercising their will freely and informedly (MACEDO *et al.*, 2023a; HOUSE *et al.*, 2025). This right is fully manifested in the ability to accept or refuse treatments, provided the patient is of legal age, lucid, and duly informed about the risks and benefits involved

(BIFULCO & IOCHIDA, 2009). In the context of end-of-life, autonomy becomes even more crucial, as it allows the individual to express their preferences on how they wish to be cared for when they can no longer do so (MONTANARI VERGALLO, 2023). Valuing patient autonomy is one of the pillars of modern medicine and is the foundation of Advance Directives.

The principle of beneficence imposes on healthcare professionals the obligation to act for the benefit of the patient, seeking their well-being and promoting their health. However, at the end of life, "benefit" may not be the prolongation of life at all costs, but rather the alleviation of suffering and the maintenance of dignity (PINTO *et al.*, 2020). Beneficence must be weighed against autonomy, ensuring that medical actions are aligned with the patient's values and wishes.

Non-maleficence is the duty not to cause harm to the patient. At the end of life, this means avoiding futile, invasive, or painful treatments that do not offer prospects of cure or significant improvement, merely prolonging suffering (NOGARIO *et al.*, 2020). Dysthanasia, a concept that will be addressed later, is a classic example of a violation of this principle.

Finally, the principle of justice refers to the equitable allocation of health resources and the guarantee that all patients are treated with equality and dignity, regardless of their social, economic, or health status (NOGARIO *et al.*, 2020). In the context of finitude, justice implies ensuring that everyone has access to quality palliative care and the opportunity to exercise their autonomy.

2.2 ESSENTIAL CONCEPTS ON END-OF-LIFE

To understand the discussions surrounding Advance Directives, it is essential to distinguish some key concepts related to death and the dying process:

2.2.1 Euthanasia, Dysthanasia, and Orthothanasia

Euthanasia: Derived from Greek "eu" (good) and "thanatos" (death), meaning "good death" or "death without suffering." It refers to the anticipation of death of a patient with an incurable disease and intense suffering, through a deliberate action aimed at ending their life (FRANÇA, 2019, p. 564). In Brazil, euthanasia is prohibited and considered a crime (Article 121 of the Penal Code, 1940).

Dysthanasia: From Greek "dys" (bad, anomalous) and "thanatos" (death), describes the artificial prolongation of life in situations of intense suffering and without prospect of cure, through futile or disproportionate treatments (SÁ, 2015, p. 87). It is the so-called "therapeutic obstinacy," which goes against the Code of Medical Ethics (BRASIL, 2018), which

recommends that physicians offer palliative care without undertaking useless or obstinate actions. Dysthanasia violates patient dignity and the principle of non-maleficence (TOMINAGA *et al.*, 2024).

Orthothanasia: From Greek "orthós" (right, normal, correct) and "thánatos" (death), meaning "death at the right time" or "dignified death." It involves allowing death to occur naturally, without anticipating it (euthanasia) or artificially prolonging it (dysthanasia), focusing on the alleviation of suffering and the maintenance of quality of life (GODIM, 2004). CFM Resolution No. 1.805/2006 (BRASIL, 2006) allows physicians to limit or suspend procedures and treatments that prolong the life of terminally ill patients with severe and incurable diseases, respecting their autonomy.

2.2.2 Mistanasia and Kalothanasia

Mistanasia: Derived from Greek "mys" (unfortunate) and "thanatos" (death), meaning "unfortunate death," premature and preventable. It refers to deaths resulting from a lack of access to minimum conditions for a dignified life, such as basic sanitation, food, health, and security, often perpetuated by negligence or inefficiency of public policies (FERREIRA, 2019). It is a concept that expands the discussion about death beyond the individual clinical context.

Kalothanasia: From Greek "kalós" (good, beautiful) and "thanatos" (death), meaning "beautiful death" or "good death." This concept goes beyond orthothanasia, which focuses on death at the right time, incorporating cultural, religious, and personal aspects that make the dying process meaningful for the patient and their families. It involves respect for the individual's life history, their last wishes, the presence of loved ones, and farewell rituals, seeking a transformative meaning for illness and the dying process (FLORIANI, 2021). Kalothanasia emphasizes the dignity and sacredness of the final moment of life, integrating the physical, emotional, spiritual, and social dimensions of the patient.

2.3 ADVANCE DIRECTIVES (ADS) AND LIVING WILL (LW)

Advance Directives (ADs) are documents in which a person, in full exercise of their mental capacity, declares their preferences regarding healthcare they wish to receive or refuse in the future, should they find themselves in a condition that prevents them from autonomously expressing their will (BRASIL, 2012; HOUSE *et al.*, 2025). These directives are particularly relevant for patients with terminal, incurable diseases or with irreversible clinical conditions (MABTUM & MARCHETTO, 2015). CFM Resolution No. 1.995/2012 establishes that the patient's directives will prevail over any other non-medical opinion,

including family wishes, guaranteeing the primacy of individual autonomy (MONTANARI VERGALLO, 2023).

A Living Will (LW) is a type of Advance Directive, a more specific document with legal validity, in which the individual records their choices about the treatments they wish or do not wish to receive in situations of serious illness or irreversible damage, when incapacitated to decide for themselves (LOMBARDI & SANTOS, 2019). Historically, the case of Nancy Cruzan in the United States (1980s) was emblematic for the discussion about the right to a dignified death and the importance of a written document that attested to the patient's wishes (UNITED STATES SUPREME COURT, 1990; DADALTO, 2018). The living will, unlike a common will, does not refer to the distribution of material goods, but rather to decisions about one's own body, health, and dignity at the end of life (BREDAS & NINGELISKI, 2024).

The implementation of ADs and LWs seeks to ensure human dignity, a fundamental constitutional principle (BRASIL, 1988), and the right to self-determination. However, practice still faces significant barriers, such as a lack of knowledge among professionals and the population, the absence of more robust legal regulation in Brazil, and ethical conflicts that arise between the patient's will, the family's wishes, and the healthcare team (SCHINISKI, 2023; CETOLIN *et al.*, 2024; MACEDO *et al.*, 2023a; BAUMANN *et al.*, 2023). The effectiveness of ADs can be complex in specific conditions, such as in patients with dementia, where decisions about feeding and nutrition raise new debates about the limits of autonomy and the interpretation of directives (SHELTON & GEPPERT, 2024). Similarly, in neurodegenerative diseases like amyotrophic lateral sclerosis (ALS), ADs prove to be fundamental tools for care planning, requiring professionals to be well-prepared for this discussion (MANGAL *et al.*, 2024).

The discussion about the end of life is not limited to the patient, but also involves their family and the multidisciplinary healthcare team. A collaborative approach, including physicians, psychologists, nurses, social workers, and other professionals, is fundamental to offer comprehensive care, alleviate suffering, and promote understanding of the illness and what can still be experienced (CRUZ *et al.*, 2021; EBSEH, 2023). The training and capacity-building of these professionals are essential so that they can deal with the complexity of the topic, initiate conversations about finitude in a humanized way, and ensure that patient autonomy is effectively respected (SUTHERLAND, 2019; BAUMANN *et al.*, 2023; MÜLLER *et al.*, 2024).

3 METHODOLOGY

This chapter is based on descriptive research, with a qualitative approach and a convenience sample, whose main objective was to identify the meanings attributed to advance directives by multidisciplinary healthcare professionals. The methodology employed aims to deepen the understanding of how health professionals experience and interpret the bioethical aspects related to the finitude of life and knowledge about ADs in Brazil (FLORIANO, 2025).

3.1 PARTICIPANTS AND SELECTION CRITERIA

Twenty-one multidisciplinary healthcare professionals participated in the research: seven nurses, seven physicians, and seven psychologists. Participant selection occurred through convenience sampling at a high-complexity teaching hospital in São José do Rio Preto/SP.

Inclusion criteria were: being a healthcare professional (nurse, physician, or psychologist) and having worked for at least one year with end-of-life patients in sectors such as palliative care, hemodialysis, oncology, and intensive care unit (ICU). Exclusion criteria were: being a technician, trainee professional, or resident physician (FLORIANO, 2025).

3.2 DATA COLLECTION PROCEDURE

Professionals were approached at their respective workplaces, after authorization from their superiors and according to their availability. After receiving detailed explanations about the study and agreeing to participate, they signed the Free and Informed Consent Form (FICF), in accordance with Resolution No. 510/2016 of the National Health Council (BRASIL, 2016), ensuring research ethics.

Participants' demographic information was collected through a sociodemographic questionnaire. Subsequently, semi-structured interviews were conducted in person with the researcher, lasting an average of 20 to 30 minutes. The interviews were guided by the following guiding questions:

- What do you understand by patient autonomy?
- I would like you to describe your experience with terminally ill patients and family involvement in these cases.
- How do you perceive the insertion of Advance Directives in Brazil (ADs – Resolution No. 1.995, of 2012, of the Federal Council of Medicine)?
- Have you ever heard of a Living Will? If so, could you explain it in your own words?

Participants' responses were audio-recorded and subsequently transcribed in full by the researcher, ensuring the fidelity of the reports (*FLORIANO, 2025*).

3.3 DATA ANALYSIS: CONTENT ANALYSIS

Qualitative data analysis was performed using Content Analysis, a technique that allows for the systematic and objective description of message content, as well as the inference of knowledge about the conditions of production and reception of these messages (*BARDIN, 2011*). This method is widely recognized in qualitative research for its ability to uncover hidden meanings and patterns in textual data, being particularly suitable for understanding subjective perceptions and experiences, as addressed in this study (*MINAYO, 2017*).

The Content Analysis process followed the steps proposed by Bardin (*2011*) and reinforced by Minayo (*2017*):

3.3.1 Pre-analysis

This initial stage involved organizing the collected material. The transcribed interviews were read and re-read exhaustively, allowing the researcher to become deeply familiar with the data. It was a "floating" phase, where the first impressions were sought, recurrent themes were identified, and a coherent analysis corpus was built. The corpus was constituted and an analysis script with the initial indicators was prepared, ensuring the exhaustiveness, representativeness, homogeneity, and relevance of the documents (*BARDIN, 2011*).

3.3.2 Material Exploration

In this phase, the textual material was systematically explored. Procedures for cutting, coding, enumeration, and classification were applied. Recording units (relevant text segments) were identified and coded, i.e., transformed into meaning units. Coding aimed to categorize information based on theoretical and empirical criteria. The objective was to group participants' "speeches" into meaningful sets that answered the research questions. This process involved identifying central themes and creating provisional categories that emerged from the data (*MINAYO, 2017*).

3.3.3 Results Treatment, Inference, and Interpretation

In this stage, the previously identified categories were deepened and refined. Coded data were organized, and the frequencies and relationships between categories were examined. The thematic categories were established based on the recurrence and relevance

of the themes addressed by the professionals. The analysis allowed the reports to be grouped into four categories of meanings, representing the main dimensions of participants' perception of Advance Directives.

Inference and interpretation, the moment of greatest theoretical elaboration, involved linking empirical results with the theoretical framework. The aim was to go beyond the description of data, seeking to establish relationships, infer broader meanings, and understand the implications of the findings for clinical practice and public health policies. Interpretation was enriched by dialogue with existing literature on bioethics, autonomy, palliative care, and legal aspects of ADs, as detailed in the Theoretical Framework section. This process allowed for building a more comprehensive and critical understanding of the studied phenomenon (*BARDIN, 2011; MINAYO, 2017*).

3.4 ETHICAL ASPECTS

The study was approved by the Research Ethics Committee (CAEE 74812323.4.0000.5415), opinion no. 6.499.813, on December 11, 2023 (*FLORIANO, 2025*). To ensure participants' anonymity and confidentiality, their identities were preserved. In the presented reports, participants were identified by the letter "P" (participant), followed by symbolic numbers that do not represent the order of "speeches" or professional category, making identity traceability impossible.

4 PARTICIPANTS' CHARACTERIZATION

The research interviewed 21 multidisciplinary healthcare professionals. Data collection occurred between February 28, 2024, and June 10, 2024. Table 1 presents the sociodemographic characterization of the participants.

Table 1

Participants' Characterization (n=21)

Characteristic	n	Frequency (%)
Sex		
Female	17	80.95
Male	4	19.05
Experience Time		
Between 1 and 5 years	6	28.57
Between 6 and 10 years	7	33.33

Characteristic	n	Frequency (%)
Between 11 and 20 years	5	23.81
Above 21 years	3	14.29
Education Level		
Master's degree	3	14.29
Doctorate degree	2	9.52
Undergraduate degree	1	4.76
Postgraduate <i>lato sensu</i>	15	71.43
Age (mean $\pm$ standard deviation)	37.7 ($\pm$ 8.5)	-
Profession		
Nurse	7	33.33
Physician	7	33.33
Psychologist	7	33.33
Religion		
Yes	20	95.24
No	1	4.76

Source: Floriano (2025)

The majority of participants (80.95%) were female, with a mean age of 37.7 years ($\pm$ 8.5). The sample was equally divided among nurses, physicians, and psychologists (33.33% each). The predominant education level was postgraduate *lato sensu* (71.43%), followed by master's (14.29%) and doctorate (9.52%). Only one participant had only an undergraduate degree. The vast majority (95.24%) declared having a religion. Professional experience time varied, with most (33.33%) having between 6 and 10 years of experience (FLORIANO, 2025).

5 RESULTS AND DISCUSSION

From the content analysis of the interviews, following the steps described by Bardin (2011) and Minayo (2017), four main thematic categories emerged, representing the meanings attributed by healthcare professionals to Advance Directives and related topics. These categories reveal the complexity of the end-of-life scenario in the hospital environment and professionals' perceptions of patient autonomy.

5.1 CATEGORY 1: HEALTHCARE PROFESSIONALS' UNDERSTANDING OF PATIENT AUTONOMY, ACCORDING TO RESOLUTION NO. 1.995/2012 OF THE FEDERAL COUNCIL OF MEDICINE

The results indicate that the interviewed healthcare professionals understand the conceptual meaning of patient autonomy, linking it to the capacity for informed decision-making. In Brazil, this understanding is formally supported by CFM Resolution No. 1.995/2012 and, more broadly, by the Code of Medical Ethics (*BRASIL, 2012; BRASIL, 2018*). However, despite this conceptual clarity, participants recognize various difficulties in its effective application in clinical practice. Autonomy is seen as the patient's right to choose their treatment, provided they are fully conscious and informed about their condition and the implications of their decisions (*MACEDO et al., 2023a; HOUSE et al., 2025*).

For participants, autonomy manifests when the patient has full knowledge of their pathology, therapeutic options, and the risks and benefits of each choice. This understanding is fundamental for the decision to be truly autonomous and not merely passive acceptance.

- "From a medical point of view (...) I understand that they are aware of their pathology, prior to hospitalization, and that they have the power to decide what type of treatment they want to undergo over time and their therapy (P1)."
- "Autonomy is when the patient has full knowledge... of the benefits, the risks of their decisions. So, autonomy is the patient's will, provided they have knowledge of each procedure, each choice, its risks and benefits (P4)."

Despite this conceptual clarity, professionals point out that patients' lack of knowledge on the subject, difficulty in understanding their diagnosis and treatment options, as well as adherence to values and beliefs, can hinder the full exercise of autonomy (*MACEDO et al., 2023a*). It is not enough for the professional to understand the concept; it is imperative that the patient and their family also understand it for effective application (*SEREY et al., 2022*). The moral relevance of Advance Directives is a central issue, and their binding nature must be respected to preserve patient dignity (*MONTANARI VERGALLO, 2023*).

The absence of advance planning is a factor that frequently leads to aggressive and unnecessary treatments, contrary to the patient's last wishes (*KRUSE, 2024*). This highlights the need for end-of-life discussions to occur early, involving the family and considering the patient's culture (*THOMAS et al., 2020*). There is, therefore, an urgency to continuously train professionals to ensure the fulfillment of individuals' expressed wishes, especially in surgical and palliative care settings (*SHAPIRO & SINGER, 2019; FONTES et al., 2020; MANGAL et al., 2024*).

Ethical dilemmas intensify when patient autonomy conflicts with medicine centered on cure at all costs, a paternalistic view that often fails to prepare future physicians to deal with the finitude of life (*COSTA et al., 2023*). The Supreme Federal Court's (STF) decision on Jehovah's Witnesses' right to refuse blood transfusions exemplifies the primacy of the principle of autonomy over beneficence in certain contexts, demonstrating the strength of respecting individual will in cases of conflict (*BRASIL, 2024*).

5.2 CATEGORY 2: HEALTHCARE PROFESSIONALS' EXPERIENCE WITH TERMINALLY ILL PATIENTS AND FAMILY INVOLVEMENT

This category revealed that professionals' experience with terminally ill patients is marked by a constant dilemma between the patient's will and family interference, a common finding in reviews on the subject (*MACEDO et al., 2023a*). Frequently, family will ends up prevailing, generating conflicts and compromising patient autonomy, especially in vulnerable situations.

Reports indicate a significant difficulty for families in accepting finitude and respecting patient decisions, often opting for life prolongation at all costs, even if it implies additional suffering, a reality also observed in intensive care environments (*BAUMANN et al., 2023*).

- "There are patients who understand the situation. They don't want to undergo treatment, but the family determines that the patient will indeed undergo treatment... they want to prolong the patient's life. And this harms their quality of life (P8)."
- "In fact, what I see happening is precisely this difficulty; the patient's desire is often different from the family's, and the patient's and family's desire is different from what the healthcare team wants. So, yes, there are many conflicts (P15)."

This family imposition, coupled with professionals' difficulty in addressing terminality, leads to patients being referred to palliative care only when they are already in an advanced dying process, unable to express their wishes (*KRUSE, 2024*). This highlights the urgency of advance planning and more effective communication. The Federal Constitution of 1988 (*BRASIL, 1988*) and the Civil Code (*BRASIL, 2002*) protect human dignity and private autonomy, making the imposition of unwanted treatments a violation of these rights (*DADALTO, 2014; BREDÁ & NINGELISKI, 2024*). The moral duty to respect patient directives, even when at odds with the family, has been emphasized in bioethics (*MONTANARI VERGALLO, 2023*).

A lack of early dialogue about end-of-life, fear of death, and anticipatory grief in the family are factors contributing to these conflicts. Professionals also experience suffering when faced with family or even other team members' refusal to accept patient decisions

(LUNA-MEZA *et al.*, 2021). A lack of team preparedness to deal with finitude, the culture of cure, and the absence of clear protocols to mediate these conflicts are significant barriers (PINTOS *et al.*, 2020; BAUMANN *et al.*, 2023). In specific contexts, such as patients with dementia, the interpretation of ADs related to feeding and nutrition can be particularly complex, generating additional dilemmas for the team and family (SHELTON & GEPPERT, 2024). The need for clear guidelines on ADs for patients with mental disorders is also an emerging challenge, requiring specific recommendations for practice (MÜLLER *et al.*, 2024).

The role of the multidisciplinary team is crucial for mediating these conflicts and ensuring that the patient's will is prioritized, but this requires specific training and institutional support (MINAME *et al.*, 2023). Effective communication, active listening, and the ability to adapt to the patient's and family's values and beliefs are essential skills to promote a "good death" (CHENG *et al.*, 2019; SOMMER *et al.*, 2021).

5.3 CATEGORY 3: HEALTHCARE PROFESSIONALS' PERCEPTION OF ADVANCE DIRECTIVES' RELEVANCE IN CLINICAL PRACTICE

Professionals express a perception that the insertion of Advance Directives in Brazil is still "precarious" and "in its infancy," a view echoed in studies evaluating the population's and professionals' perception and knowledge of the topic (MACEDO *et al.*, 2023a; MACEDO *et al.*, 2024). There is an acknowledgment of the importance of ADs, but also a strong sense of lack of guidance, widespread unawareness, and insecurity in application, both by professionals and by patients and families.

The lack of legal regulation is pointed out as one of the main causes of insecurity, despite the existence of CFM Resolution No. 1.995/2012. Many professionals fear the judicialization of conduct.

- "Oh my! I think it's very precarious, very precarious. The treatment that cares most about directives is palliative care; oncology also has some participation, but most other specialties... they look at the medical side of curative treatment and don't pay much attention to patient autonomy. There's a great lack of guidance (P5)."
- "And the lack of legal regulation ends up influencing the non-compliance with advance directives a lot (P7)."

There is a perception that the healthcare system is not prepared to integrate ADs, both in terms of record-keeping in medical charts and workflow. Experience in intensive care units, for example, reveals that translating patients' advance directives into practice is still a significant challenge, with much progress to be made (BAUMANN *et al.*, 2023). The medical

culture, still very focused on cure, also hinders the acceptance and implementation of these directives (*GOMES et al., 2018*).

- "If someone arrives with their birth plan or any other advance directive, the health service is not ready to take it and say 'I'm going to attach it to the medical chart.' Where do I put this?... I don't have a tab to insert it (P6)."

The scarcity of scientific production and the lack of consensus on ADs in Brazil contribute to the lack of knowledge and difficulty in dissemination (*HASSEGAWA et al., 2019*). Studies on the effective use of ADs in specific populations, such as veterans in the USA, show that, while awareness may exist, practical utilization can be inconsistent, underlining the need for more effective policies and education (*TUNG & YEH, 2023*). This contrasts with countries where the population has more favorable attitudes and greater knowledge about ADs (*MACEDO et al., 2024*).

It is evident that undergraduate training and continuing education are essential to change this scenario, introducing the debate on patient rights and bioethics early on (*CETOLIN et al., 2024; MÜLLER et al., 2024*).

Despite the challenges, there is a consensus among professionals about the importance of discussing directives and the need for legislation that offers legal certainty for their implementation. Advance care planning is seen as an essential process to strengthen autonomy and promote open communication, resulting in better quality of life for the patient and less suffering for all involved (*SEDINI et al., 2022; SOMMER et al., 2021*).

5.4 CATEGORY 4: HEALTHCARE PROFESSIONALS' KNOWLEDGE OF LIVING WILLS

This category reveals significant unawareness and conceptual confusion between Advance Directives and Living Wills among many professionals. While some demonstrate some familiarity with the Living Will, others have never heard the term or confuse it with other legal or material issues, a reflection of what systematic reviews have pointed out about the general level of knowledge regarding ADs (*MACEDO et al., 2023a*).

The lack of conceptual clarity compromises the correct application of the Living Will in clinical practice and limits professionals' ability to guide patients and families. The Living Will is, in fact, a specific form of Advance Directive, and its understanding is fundamental for the healthcare team's actions (*HOUSE et al., 2025*).

- "I have never heard of this term (P6)."
- "I think I don't have the technical training to think about a living will as a whole; I still think I would need to study a lot to be able to define it. Today I can't (P7)."

Those who demonstrated some knowledge generally associate it with a document that expresses the patient's end-of-life wishes, covering non-material aspects, but related to dignity and the way one wishes to die.

- "That does not concern material issues, but concerns their own dignity, right? Which are all the things that are pertinent to sustain and structure that person's dignity (P9)."
- "Yes. I also understand it as a directive. As a record of this advance directive so that it's not just in words, but recorded while the patient still has life and is... able to respond, to be conscious, so that when they are no longer here... (P15)."

The confusion between ADs and LWs is a critical point, as the Living Will is a specific form of Advance Directive, more focused on formal, and sometimes legal, documents. The case of Nancy Cruzan, which prompted the development of Living Wills in the USA, illustrates the importance of having these wishes formalized (*UNITED STATES SUPREME COURT, 1990; DADALTO, 2018*). In progressive diseases like Amyotrophic Lateral Sclerosis (ALS), ADs are essential instruments that can be facilitated by specific interventions, reinforcing the need for healthcare professionals to fully understand these concepts (*MANGAL et al., 2024*).

Continuing education in bioethics and the inclusion of these topics in professional training are essential to address this knowledge gap (*MINAME et al., 2023*). A lack of information and communication difficulties can compromise individual autonomy, leading to their wishes not being respected (*FERRARIO et al., 2023*). Training professionals to deal with finitude and offer adequate palliative care is fundamental to ensuring a dignified and respectful death (*TOMINAGA et al., 2024; MÜLLER et al., 2024*).

In summary, the results show that, although healthcare professionals understand the importance of patient autonomy, knowledge about ADs and, in particular, Living Wills is still incipient and confused. Cultural barriers, family interference, lack of regulation, and professional insecurity prevent the full implementation of these instruments, reinforcing the need for a profound transformation in the approach to end-of-life in Brazilian medicine (*PAIS et al., 2019*).

6 STUDY LIMITATIONS

The present research, although offering valuable insights into the multidisciplinary healthcare team's perspective on Advance Directives, has some limitations intrinsic to its nature and methodological design. It is important to acknowledge them to contextualize the findings and inspire future investigations.

Firstly, the research used a convenience sample consisting of 21 professionals from a single high-complexity teaching hospital in São José do Rio Preto/SP. Although this approach

allowed for an in-depth understanding of this specific group's perceptions, the results may not be generalizable to other hospital contexts, regions of Brazil, or different types of healthcare institutions (*BARDIN, 2011*). Hospitals with different organizational cultures, levels of investment in continuing education, or patient profiles may present distinct realities, as observed in studies comparing population attitudes in different countries (*MACEDO et al., 2024*).

Secondly, the qualitative approach, by its nature, does not seek statistical generalization, but rather a deep understanding of phenomena and the richness of meanings attributed by participants (*MINAYO, 2017*). Although content analysis allowed for the emergence of robust and illustrative categories, data interpretation is sensitive to the researcher's perspective.

Thirdly, the self-reported nature of the interviews may have influenced participants' responses. Although anonymity was guaranteed, professionals may have expressed perceptions they consider socially desirable or that minimize their own knowledge gaps and insecurities, especially on such a sensitive and complex topic as end-of-life and bioethics (*MACEDO et al., 2023a*).

Fourthly, the research focused on the perspective of healthcare professionals, leaving out the voices of patients and their families, who are intrinsic and equally important parties in the decision-making process regarding ADs. Including these perspectives could significantly enrich the understanding of the dilemmas and challenges involved in implementing directives, including the complexities in cases such as dementia or mental disorders (*SHELTON & GEPPERT, 2024; MÜLLER et al., 2024*).

Fifthly, the absence of specific and comprehensive legislation on ADs in Brazil (beyond the CFM Resolution) is a contextual limitation that permeates the study. The lack of legal certainty, frequently mentioned by participants, reflects a gap that transcends the sphere of individual research, impacting practice at a national level (*SCHINISKI, 2023; HOUSE et al., 2025*).

Finally, the data collection period, although recent (2024), reflects a specific moment in the evolution of discussions about bioethics in the country. The constant evolution of medicine, legislation, and public awareness may generate new perceptions and challenges not captured by this study.

Despite these limitations, the findings provide a solid basis for understanding the barriers and facilitators in implementing Advance Directives in Brazil, from the viewpoint of those who deal directly with the finitude of life, opening avenues for future investigations and interventions.

7 RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the gaps identified in the present research and the reflections generated by the results, several avenues for future investigations emerge as fundamental to deepen knowledge and promote the effectiveness of Advance Directives in Brazil. The following recommendations aim to improve understanding of the topic and support the formulation of public health policies and more humanized practices in end-of-life care.

7.1 COMPREHENSIVE AND MULTICENTRIC STUDIES

The realization of large-scale, multicentric research is recommended, involving healthcare professionals from different geographical regions, types of hospitals (public and private, university and non-university), and levels of complexity. This approach would allow for identifying variations in perceptions and practices, offering a more representative overview of the Brazilian reality and expanding the generality of the findings (*MACEDO et al., 2023a; KRUSE, 2024*). Comparing the Brazilian situation with that of other countries that have advanced in the implementation of ADs, as evidenced in studies on population attitudes (*MACEDO et al., 2024*) or effective use in different groups (*TUNG & YEH, 2023*), can provide valuable insights.

7.2 PATIENT AND FAMILY PERSPECTIVES

It is fundamental that future research explores the perspective of patients and their families on Advance Directives. Qualitative studies investigating their experiences, knowledge, values, beliefs, and challenges in drafting and communicating ADs would be extremely valuable (*CHENG et al., 2019*). Understanding their desires and difficulties is essential to develop communication and support strategies that are truly patient-centered, including the complexities in scenarios such as dementia or mental disorders, where expressed will may have unique implications (*SHELTON & GEPPERT, 2024; MÜLLER et al., 2024*).

7.3 IMPACT OF ACADEMIC TRAINING AND CONTINUING EDUCATION

Investigations can focus on the impact of including disciplines on bioethics, palliative care, and ADs in the curriculum of health undergraduate courses (Medicine, Nursing, Psychology, among others). Furthermore, it would be relevant to evaluate the effectiveness of continuing education and training programs for active professionals, measuring not only increased knowledge but also changes in attitudes and the incorporation of these practices into daily clinical routines (*SUTHERLAND, 2019; BAUMANN et al., 2023*). Training should

prepare professionals for discussing and drafting ADs in various clinical conditions, including complex neurodegenerative diseases (*MANGAL et al., 2024*).

7.4 INSTITUTIONAL AND CULTURAL BARRIERS

New research could analyze the institutional barriers that hinder the implementation of ADs, such as a lack of clear protocols, the absence of electronic health record systems that integrate these directives, and cultural resistance within healthcare institutions and among team members (*BAUMANN et al., 2023*). Investigating successful models in other countries and their adaptability to the Brazilian context would be fruitful, considering how ADs are implemented and recognized in different legal and cultural systems (*MAFFONI et al., 2020; SEDINI et al., 2022; HOUSE et al., 2025*).

7.5 LEGAL AND LEGISLATIVE ASPECTS

Given that the lack of legal regulation was pointed out as a source of insecurity, legal and sociological studies could focus on the need and format of more robust legislation to support ADs in Brazil. It would be relevant to analyze the impact of specific legal frameworks and the perception of their contribution to professional safety and respect for patient autonomy (*SCHINISKI, 2023; MONTANARI VERGALLO, 2023*).

7.6 DEVELOPMENT OF SUPPORT TOOLS

Applied research could concentrate on the development and validation of support tools for healthcare professionals, patients, and families in drafting ADs and Living Wills. This would include practical guides, educational materials, document templates, and digital platforms that facilitate the recording and access to directives (*MCMAHAN et al., 2021*).

7.7 CASE STUDIES AND DETAILED CLINICAL ANALYSES

The conduct of case studies or in-depth clinical analyses of real situations where ADs were (or were not) applied could provide valuable insights into practical challenges, ethical dilemmas faced, and outcomes for patients, families, and teams. This includes the analysis of complex cases where the interpretation of ADs becomes ambiguous or challenging (*SHELTON & GEPPERT, 2024*).

By addressing these recommendations, future research can build a more complete and applicable body of knowledge, effectively contributing to patient autonomy being fully respected in the end-of-life context, and to healthcare professionals being more prepared and secure to deal with this essential dimension of human care.

8 CONCLUSION

This investigation, based on Janaína Aparecida de Sales Floriano's master's dissertation and adapted for this book chapter, provided an in-depth analysis of the multidisciplinary healthcare team's perspective on Advance Directives (ADs) and Living Wills in the Brazilian context. The results confirm that the complexity of the finitude of life, coupled with technological advancements in medicine, imposes significant ethical dilemmas that demand continuous reflection and improvement of healthcare practices (KRUSE, 2024).

In summary, healthcare professionals understand patient autonomy as the fundamental right to make informed decisions about their treatment and the dying process. However, the effective application of this principle is often hindered by patients' and families' lack of knowledge, cultural resistance to discussing death, and conflicts that arise between patient wishes, family expectations, and healthcare team guidelines (MACEDO *et al.*, 2023a; BAUMANN *et al.*, 2023). It was noted that, in most cases, family will tends to prevail, disrespecting individual autonomy and prolonging futile treatments, leading to unnecessary suffering, in clear opposition to the morally binding nature of ADs (MONTANARI VERGALLO, 2023).

The insertion of Advance Directives in Brazil, despite the existence of CFM Resolution No. 1.995/2012, is perceived as "precarious" and "in its infancy." There is a clear lack of guidance and knowledge on the subject among professionals, patients, and families (MACEDO *et al.*, 2024; TUNG & YEH, 2023). The absence of more robust legal regulation and the fear of judicialization of conduct generate insecurity among professionals, contributing to the underutilization of these instruments (SCHINISKI, 2023; HOUSE *et al.*, 2025). Furthermore, conceptual confusion between ADs and Living Wills was evidenced, which prevents their correct application in clinical practice and the realization of the patient's last wishes. Complexity increases in specific situations, such as patients with dementia or mental disorders, where the interpretation of directives requires additional considerations (SHELTON & GEPPERT, 2024; MÜLLER *et al.*, 2024).

Given these findings, it becomes imperative that health education undergoes a profound transformation. The inclusion and strengthening of bioethics disciplines, palliative care, and end-of-life legislation in curricula, as well as continuing education programs for active professionals, are essential. This training should aim not only to increase technical knowledge but also to develop interpersonal communication skills, empathy, and the ability to initiate and conduct sensitive dialogues about death with patients and their families (SUTHERLAND, 2019; BAUMANN *et al.*, 2023; MANGAL *et al.*, 2024).

The promotion of open and transparent dialogue among all involved, patients, families, and healthcare teams, is fundamental to building advance care planning that respects the individual's values, beliefs, and wishes, ensuring them a dignified death with less suffering. This implies overcoming the taboo surrounding death and facing finitude as a natural part of life, integrating palliative care early into treatment.

Ultimately, this chapter reiterates the need for a more humanized and individualized approach to end-of-life care, supported by solid bioethical principles and a legal framework that offers security and clear guidelines. Only then will it be possible to ensure that patient autonomy is fully respected, and that the dying process is experienced with the dignity that every human being deserves.

This study was funded by the Coordination for the Improvement of Higher Education Personnel (code: 88887.824687/2023-00).

REFERENCES

- Akdeniz, M., Yardımcı, B., & Kavukcu, E. (2021). Ethical considerations at the end-of-life care. *SAGE Open Medicine*, 9, Article 20503121211000918. <https://doi.org/10.1177/20503121211000918>
- Bardin, L. (2011). *Análise de conteúdo*. Edições 70.
- Barbosa, A. K. S., Lisboa, W., & Vilaça, A. P. O. (2024). Percepção de profissionais de saúde sobre diretivas antecipadas de vontade. *Revista Bioética*, 31, Article e3493PT. <https://doi.org/10.1590/1983-803420233493PT>
- Baumann, S. M., et al. (2023). Translation of patients' advance directives in intensive care units: Are we there yet? *Journal of Intensive Care*, 11(1), Article 53. <https://doi.org/10.1186/s40560-023-00705-z>
- Bifulco, V. A., & Iochida, L. C. (2009). A formação na graduação dos profissionais de saúde e a educação para o cuidado de pacientes fora de recursos terapêuticos de cura. *Revista Brasileira de Educação Médica*, 33(1), 92–100. <https://doi.org/10.1590/S0100-55022009000100013>
- Bredas, J. S., & Ningeliski, A. de O. (2024). O testamento vital como uma diretiva antecipada da vontade: Uma reflexão sobre a dignidade da morte. *Academia de Direito*, 6, 1939–1963. <https://doi.org/10.24302/acaddir.v6.4938>
- Brasil. (2002). Código Civil Brasileiro: Lei nº 10.406, de 10 de janeiro de 2002. https://www.planalto.gov.br/ccivil_03/leis/2002/l10406compilada.htm
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. https://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. Conselho Federal de Medicina. (2018). Código de ética médica: Resolução CFM nº 2.217, de 27 de setembro de 2018, modificada pelas Resoluções CFM nº 2.222/2018 e 2.226/2019. <https://portal.cfm.org.br/images/stories/biblioteca/codigo%20de%20etica%20medica.pdf>

- Brasil. Conselho Federal de Medicina. (2006). Resolução CFM nº 1.805/2006. Dispõe sobre a limitação ou suspensão de procedimentos e tratamentos que prolonguem a vida do doente em fase terminal, de enfermidade grave e incurável. <https://sistemas.cfm.org.br/normas/visualizar/resolucoes/BR/2006/1805>
- Brasil. Conselho Federal de Medicina. (2012). Resolução CFM nº 1.995/2012. Dispõe sobre as diretivas antecipadas de vontade dos pacientes. <https://sistemas.cfm.org.br/normas/visualizar/resolucoes/BR/2012/1995>
- Brasil. Conselho Nacional de Saúde. (2016). Resolução nº 510, de 7 de abril de 2016. Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais. <https://conselho.saude.gov.br/resolucoes/2016/Reso510.pdf>
- Brasil. (1940). Decreto-lei nº 2.848, de 7 de dezembro de 1940. Código Penal. https://www.planalto.gov.br/ccivil_03/decreto-lei/del2848compilado.htm
- Brasil. Supremo Tribunal Federal. (2024). Regimento interno do STF de 1940. <https://noticias.stf.jus.br/postsnovicias/testemunhas-de-jeova-tem-direito-de-recusar-procedimento-que-envolva-transfusao-de-sangue-decide-stf/>
- Brito, T. F., et al. (2024). Cuidados nutricionais e hidratação artificial em paciente sob cuidados paliativos: Uma reflexão em bioética médica. *Revista Eletrônica Acervo Saúde*, 24(4), Article e15798. <https://doi.org/10.25248/reas.e15798.2024>
- Buiar, P. G., & Goldim, J. R. (2019). Barriers to the composition and implementation of advance directives in oncology: A literature review. *Ecancermedicalscience*, 13, Article 974. <https://doi.org/10.3332/ecancer.2019.974>
- Cetolin, P. H. F., et al. (2024). Diretivas antecipadas de vontade na perspectiva dos profissionais de UTI. *Comunicação em Ciências da Saúde*, 35(1). <https://doi.org/10.51723/ccs.v35i01.1410>
- Cheng, H. B., et al. (2019). Dealing with death taboo: Discussion of do-not-resuscitate directives with Chinese patients with noncancer life-limiting illnesses. *The American Journal of Hospice & Palliative Care*, 36(9), 760–766. <https://doi.org/10.1177/1049909119828116>
- Costa, D. S., et al. (2023). Atitude médica frente à morte de seus pacientes: Uma revisão integrativa. *Revista Brasileira de Revisão de Saúde*, 6(6), 27932–27947. <https://doi.org/10.34119/bjhrv6n6-111>
- Costa, L. H. da S. (2024a). A morte e o morrer no contexto hospitalar: A importância do acompanhamento psicológico aos pacientes e familiares. *Revista Cedigma*, 2(3), 1–14. <https://doi.org/10.5281/zenodo.13152581>
- Costa, L. H. da S. (2024b). O dilema chamado morte. *Revista Cedigma*, 1(1), 1–12. <https://doi.org/10.5281/zenodo.12142358>
- Cruz, N. A. O., et al. (2021). O papel da equipe multidisciplinar nos cuidados paliativos em idosos. *Research, Society and Development*, 10(8), Article e52110817433. <https://doi.org/10.33448/rsd-v10i8.17433>
- Dadalto, L. (2018). *Testamento vital* (4ª ed.). Foco.
- Dadalto, L. (2014). *Testamento vital*. Legislação. <https://bit.ly/34B3rma>
- Empresa Brasileira de Serviços Hospitalares. (2023). Cuidados paliativos minimizam o sofrimento de pacientes terminais. <https://www.gov.br/ebserh/pt->

br/comunicacao/noticias/cuidados-paliativos-minimizam-o-sofrimento-de-pacientes-terminais

- Ferreira, S. (2019). A mistanásia como prática usual dos governos. *Jornal do Cremerj*. <https://bit.ly/2YHYhC2>
- Ferrario, F., et al. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. *Nature Communications*, 5, Article 3794. <https://doi.org/10.1038/ncomms4794>
- Floriani, C. A. (2021). Considerações bioéticas sobre os modelos de assistência no fim da vida. *Cadernos de Saúde Pública*, 37(9), Article e00264320. <https://doi.org/10.1590/0102-311X00264320>
- Floriano, J. A. S. (2025). Diretivas antecipadas de vontade: Perspectiva da equipe multidisciplinar de saúde [Dissertação de mestrado, Faculdade de Medicina de São José do Rio Preto].
- Fontes, A. F., Barbosa, R. R., & Brito, D. (2020). Onde mora a autonomia do paciente em tempos de crise em Portugal? *Ciência & Saúde Coletiva*, 25, 4197–4200. <https://doi.org/10.1590/1413-812320202510.2.26782020>
- França, G. V. de. (2019). *Direito médico* (15^a ed.). Forense.
- Goldim, J. R. (2004). Eutanásia. <https://www.ufrgs.br/bioetica/eutanasi.htm>
- Gomes, B. M. M., et al. (2018). Diretivas antecipadas de vontade em geriatria. *Revista Bioética*. https://revistabioetica.cfm.org.br/revista_bioetica/article/view/1491/1908
- Hassegawa, L. C. U., et al. (2019). Approaches and reflexions on advance healthcare directives in Brazil. *Revista Brasileira de Enfermagem*, 72(1), 256–264. <https://doi.org/10.1590/0034-7167-2018-0347>
- House, S. A., Schoo, C., & Ogilvie, W. A. (2025). Advance directives. In *StatPearls*. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK539829/>
- Kim, J. Y., & Park, B. K. (2021). The most important aspects for a good death: Perspectives from parents of children with cancer. *Inquiry*, 58, Article 469580211028580. <https://doi.org/10.1177/00469580211028580>
- Kim, S., Haider, A., Reddy, A., & Bruera, E. (2021). Management challenges at end-of-life in a patient with agitated delirium and benzodiazepine withdrawal at comprehensive cancer care center. *Annals of Palliative Medicine*, 10(6), 6979–6983. <https://doi.org/10.21037/apm-20-495>
- Kruse, A. (2024). Entscheidungen am Lebensende [End-of-life decision-making]. *Innere Medizin*, 65(10), 976–984. <https://doi.org/10.1007/s00108-024-01770-8>
- Kuusisto, A., et al. (2022). Accessibility of information on patients' and family members' end-of-life wishes in advance care planning. *Nursing Open*, 9(1), 428–436. <https://doi.org/10.1002/nop2.1081>
- Lin, C. A., et al. (2023). The applicability of the “surprise question” as a prognostic tool in patients with severe chronic comorbidities in a university teaching outpatient setting. *BMC Medical Education*, 23, Article 761. <https://doi.org/10.1186/s12909-023-04714-2>
- Lombardi, L. P. V., & Santos, M. C. C. L. dos. (2019). Testamento vital: O instrumento jurídico para uma morte digna! *Revista Internacional Consinter de Direito*, 5(8), 581–596. <https://doi.org/10.19135/revista.consinter.00008.33>

- Luna-Meza, A., et al. (2021). Decision making in the end-of-life care of patients who are terminally ill with cancer - A qualitative descriptive study with a phenomenological approach from the experience of healthcare workers. *BMC Palliative Care*, 20(1), Article 76. <https://doi.org/10.1186/s12904-021-00768-5>
- Mabtum, M. M., & Marchetto, P. B. (2015). O debate bioético e jurídico sobre as diretivas antecipadas de vontade. Editora UNESP, Cultura Acadêmica. <https://www.franca.unesp.br/Home/Pos-graduacao/Direito/matheus-massaromabtum.pdf>
- Macedo, J. C., Castro, L., & Nunes, R. (2024). Attitudes of the Portuguese population towards advance directives: An online survey. *BMC Medical Ethics*, 25(1), Article 40. <https://doi.org/10.1186/s12910-024-01043-x>
- Macedo, J. C., Rego, F., & Nunes, R. (2023). Perceptions, attitudes, and knowledge toward advance directives: A scoping review. *Healthcare*, 11(20), Article 2755. <https://doi.org/10.3390/healthcare11202755>
- Maffoni, M., Argentero, P., Giorgi, I., & Giardini, A. (2020). Healthcare professionals' perceptions about the Italian law on advance directives. *Nursing Ethics*, 27(3), 796–808. <https://doi.org/10.1177/0969733019878831>
- Mangal, A. L., et al. (2024). Advance directives in amyotrophic lateral sclerosis - A systematic review and meta-analysis. *BMC Palliative Care*, 23(1), Article 191. <https://doi.org/10.1186/s12904-024-01524-1>
- Martins, M. do C. de C. e, et al. (2023). Diretivas antecipadas de vontade: Aspectos éticos e sua aplicação ao Direito Brasileiro. *Revista de Direito Sanitário*, 23, Article e0015. <https://doi.org/10.11606/issn.2316-9044.rdisan.2023.195364>
- McMahan, R. D., Tellez, I., & Sudore, R. L. (2021). Deconstructing the complexities of advance care planning outcomes: What do we know and where do we go? A scoping review. *Journal of the American Geriatrics Society*, 69(1), 234–244. <https://doi.org/10.1111/jgs.16801>
- Miname, F. C. B. R., Santos, M. J., & Santana, F. L. P. (2023). Testamento vital sob a ótica de enfermeiros que assistem pacientes em situação de terminalidade. *Revista Eletrônica de Enfermagem*, 25, Article e74482. <https://doi.org/10.5216/ree.v25.74482>
- Minayo, M. C. de S. (2017). O desafio do conhecimento: Pesquisa qualitativa em saúde (14^a ed.). Hucitec.
- Montanari Vergallo, G. (2023). The moral bindingness of advance directives. *Cambridge Quarterly of Healthcare Ethics*, 32(3), 447–449. <https://doi.org/10.1017/S0963180122000901>
- Müller, S., et al. (2024). Patientenverfügungen und psychische Erkrankung – Eine Praxisempfehlung der Kommission Ethik und Recht der DGPPN [Advance directives and mental disorders: A practice recommendation of the Commission for Ethics and Law of the German Association for Psychiatry, Psychotherapy and Psychosomatics]. *Der Nervenarzt*, 95(9), 861–867. <https://doi.org/10.1007/s00115-024-01662-0>
- Nogario, A. C. D., et al. (2020). Implementation of early will directives: Facilities and difficulties experienced by palliative care teams. *Revista Gaúcha de Enfermagem*, 41, Article e20190399. <https://doi.org/10.1590/1983-1447.2020.20190399>

- Nunes, M. I., & Anjos, M. F. (2014). Diretivas antecipadas de vontade: Benefícios, obstáculos e limites. *Revista de Bioética*, 22(2), 241–251. <https://doi.org/10.1590/1983-80422014222005>
- Pais, C., et al. (2019). Uma boa morte: Reconhecer a agonia a tempo. *Medicina Interna*, 26(3), 338–346. <https://revista.spmi.pt/index.php/rpmi/article/view/417>
- Pinto, K. D. C., Cavalcanti, A. D. N., & Maia, E. M. C. (2020). Princípios, desafios e perspectivas dos cuidados paliativos no contexto da equipe multiprofissional: Revisão da literatura. *Psicología, Conocimiento y Sociedad*, 10(3), 151–172. http://www.scielo.edu.uy/scielo.php?pid=S168870262020000300151&script=sci_abstract&tlng=pt
- Pirôpo, U. S., et al. (2018). Interface do testamento vital com a bioética, atuação profissional e autonomia do paciente. *Revista de Salud Pública*, 20(4), 505–510. <https://www.scielo.org/pdf/rsap/2018.v20n4/505-510>
- Sá, M. F. F. (2015). Autonomia para morrer: Eutanásia, suicídio assistido, diretivas antecipadas de vontade e cuidados paliativos (2ª ed.). Del Rey.
- Santana, S. C. G., & Câmara, D. de B. (2022). Percepção e expectativas de pacientes com câncer acerca das diretivas antecipadas de vontade. *Revista Brasileira de Cancerologia*, 68(1). <https://doi.org/10.32635/2176-9745.RBC.2022v68n1.1625>
- Santos, I. P. dos, et al. (2024). Finitude e bioética no fim da vida: Desafios éticos e considerações práticas no cuidado de pacientes terminais. *Revista Cedigma*, 2(3), 81–94. <https://doi.org/10.5281/zenodo.13321545>
- Schiniski, T. S. T. (2023). Testamento vital: Princípio da autonomia da vontade. *Revista Jurídico*, 8(8). <https://cursojuridico.com/revistajuridico/index.php/REVJUR/article/view/33>
- Sedini, C., et al. (2022). Advance care planning and advance directives: An overview of the main critical issues. *Aging Clinical and Experimental Research*, 34(2), 325–330. <https://doi.org/10.1007/s40520-021-02001-y>
- Serey, K., et al. (2022). Advance directives in oncology and haematology: A long way to go—A narrative review. *Journal of Clinical Medicine*, 11(5), Article 1195. <https://doi.org/10.3390/jcm11051195>
- Shelton, W., & Geppert, C. (2024). Limits of advance directives in decision-making around food and nutrition in patients with dementia. *Journal of Medical Ethics*, 50(11), 762–765. <https://doi.org/10.1136/jme-2023-109652>
- Shapiro, M. E., & Singer, E. A. (2019). Perioperative advance directives: Do not resuscitate in the operating room. *Surgical Clinics of North America*, 99(5), 859–865. <https://doi.org/10.1016/j.suc.2019.06.006>
- Sommer, J., et al. (2021). Shifting palliative care paradigm in primary care from better death to better end-of-life: A Swiss pilot study. *BMC Health Services Research*, 21, Article 629. <https://doi.org/10.1186/s12913-021-06664-1>
- Sutherland, R. (2019). Dying well-informed: The need for better clinical education surrounding facilitating end-of-life conversations. *The Yale Journal of Biology and Medicine*, 92(4), 757–764. <https://pmc.ncbi.nlm.nih.gov/articles/PMC6913833/>

- Thomas, H. R., et al. (2020). General practitioners' considerations when deciding whether to initiate end-of-life conversations: A qualitative study. *Family Practice*, 37(4), 554–560. <https://doi.org/10.1093/fampra/cmz088>
- Tominaga, A. S., et al. (2024). Condutas recorrentes de reanimação em paciente pediátrico: Uma discussão bioética sobre a distanásia. *Estudos Avançados Sobre Saúde e Natureza*, 19. <https://doi.org/10.51249/easn19.2024.2246>
- Tung, H. J., & Yeh, M. C. (2023). Use of advance directives in US veterans and non-veterans: Findings from the decedents of the health and retirement study 1992-2014. *Healthcare*, 11(13), Article 1824. <https://doi.org/10.3390/healthcare11131824>
- United States Supreme Court. (1990). *Cruzan v. Director, MDH*, 497 U.S. 261. <https://caselaw.findlaw.com/court/us-supreme-court/497/261.html>

SUPPLEMENTARY PENSION IN THE FEDERAL PUBLIC SERVICE: INFORMATIONAL CHALLENGES, CAREER DECISIONS, AND PEOPLE MANAGEMENT IN PUBLIC EDUCATIONAL INSTITUTIONS

PREVIDÊNCIA COMPLEMENTAR NO SERVIÇO PÚBLICO FEDERAL: DESAFIOS INFORMACIONAIS, DECISÕES DE CARREIRA E GESTÃO DE PESSOAS EM INSTITUIÇÕES PÚBLICAS DE ENSINO

PREVISIÓN COMPLEMENTARIA EN EL SERVICIO PÚBLICO FEDERAL: DESAFÍOS INFORMATIVOS, DECISIONES DE CARRERA Y GESTIÓN DE PERSONAS EN INSTITUCIONES PÚBLICAS DE ENSEÑANZA



<https://doi.org/10.56238/sevened2026.008-161>

Vanessa Cristina Mota da Costa¹, Taina Serafim Ferreira dos Santos², Plinio Alexandre dos Santos Caetano³

ABSTRACT

Recent transformations in the Brazilian public pension system have redefined the relationships between the State, public servants, and career planning in the public sector. In this context, the creation of the Federal Public Servant Supplementary Pension Foundation (FUNPRESP) introduced new challenges related to pension knowledge, decision-making processes, and people management within public organizations. This chapter aims to analyze supplementary pension schemes in the federal public service through the articulation between institutional changes, the psychological contract of public servants, and organizational perceptions, based on empirical evidence from a study conducted at a campus of the Federal Institute of São Paulo (IFSP). To this end, an applied, exploratory, and descriptive study with a qualitative approach was developed, using an electronic questionnaire to collect data from teaching staff and technical-administrative public servants. The results indicate a low level of knowledge regarding supplementary pensions among a significant portion of participants, coexisting with high levels of satisfaction among servants enrolled in the system, thus revealing informational asymmetries and institutional communication challenges. It is concluded that supplementary pension schemes should be understood not only as a financial mechanism but also as a strategic element of people management, requiring continuous pension education initiatives and the strengthening of institutional trust within the public sector.

Keywords: Supplementary Pension. Public Servant. People Management. FUNPRESP. Pension Education.

¹ Technologist in Human Resources Management. Instituto Federal de Educação, Ciência e Tecnologia de São Paulo (IFSP). E-mail: vanessa.costa@ifsp.edu.br Orcid: <https://orcid.org/0009-0009-5611-2179>

² Technologist in Human Resources Management. Instituto Federal de Educação, Ciência e Tecnologia de São Paulo (IFSP). E-mail: taina.ferreira@aluno.ifsp.edu.br Orcid: <https://orcid.org/0009-0003-0575-1524>

³ Dr. in Territorial Development and Environment. UNIARA. E-mail: plinio@ifsp.edu.br Orcid: <https://orcid.org/0000-0003-1405-7553>

RESUMO

As recentes transformações na previdência pública brasileira têm redefinido as relações entre Estado, servidores e planejamento de carreira no setor público. Nesse contexto, a criação da Fundação de Previdência Complementar do Servidor Público Federal (FUNPRESP) introduziu novos desafios relacionados ao conhecimento previdenciário, à tomada de decisão e à gestão de pessoas nas organizações públicas. O presente capítulo tem como objetivo analisar a previdência complementar no serviço público federal a partir da articulação entre mudanças institucionais, contrato psicológico do servidor e percepções organizacionais, tomando como base evidências empíricas oriundas de um estudo realizado em um campus do Instituto Federal de São Paulo (IFSP). Para tanto, desenvolveu-se uma pesquisa aplicada, de caráter exploratório e descritivo, com abordagem qualitativa, utilizando questionário eletrônico para coleta de dados junto a servidores docentes e técnico-administrativos. Os resultados indicam baixo nível de conhecimento sobre a previdência complementar entre parte significativa dos participantes, coexistindo com altos níveis de satisfação entre servidores aderentes ao regime, evidenciando assimetrias informacionais e desafios comunicacionais institucionais. Conclui-se que a previdência complementar deve ser compreendida não apenas como mecanismo financeiro, mas como elemento estratégico da gestão de pessoas, demandando ações contínuas de educação previdenciária e fortalecimento da confiança institucional no setor público.

Palavras-chave: Previdência Complementar. Servidor Público. Gestão de Pessoas. FUNPRESP. Educação Previdenciária.

RESUMEN

Las recientes transformaciones en el sistema de previsión pública brasileña han redefinido las relaciones entre el Estado, los servidores públicos y la planificación de carrera en el sector público. En este contexto, la creación de la Fundación de Previsión Complementaria del Servidor Público Federal (FUNPRESP) introdujo nuevos desafíos relacionados con el conocimiento previsional, la toma de decisiones y la gestión de personas en las organizaciones públicas. Este capítulo tiene como objetivo analizar la previsión complementaria en el servicio público federal a partir de la articulación entre cambios institucionales, el contrato psicológico del servidor y las percepciones organizacionales, tomando como base evidencias empíricas provenientes de un estudio realizado en un campus del Instituto Federal de São Paulo (IFSP). Para ello, se desarrolló una investigación aplicada, de carácter exploratorio y descriptivo, con enfoque cualitativo, utilizando un cuestionario electrónico para la recolección de datos junto a servidores docentes y técnico-administrativos. Los resultados indican un bajo nivel de conocimiento sobre la previsión complementaria entre una parte significativa de los participantes, coexistiendo con altos niveles de satisfacción entre los servidores adheridos al régimen, evidenciando asimetrías informativas y desafíos comunicacionales institucionales. Se concluye que la previsión complementaria debe comprenderse no solo como un mecanismo financiero, sino también como un elemento estratégico de la gestión de personas, demandando acciones continuas de educación previsional y el fortalecimiento de la confianza institucional en el sector público.

Palabras clave: Previsión Complementaria. Servidor Público. Gestión de Personas. FUNPRESP. Educación Previsional.

1 INTRODUCTION

Recent transformations in Brazilian social security policies have caused significant changes in the way workers and institutions understand social protection and long-term planning. In the public sector, these changes are especially relevant, since social security has historically been associated with the stability and predictability of state careers, configuring itself as a central element of the bond between civil servants and the State (CAMARANO; FERNANDES, 2016).

The reorganization of the Brazilian social security system, intensified in recent decades by successive reforms, reflects demographic, economic, and fiscal challenges that put pressure on the sustainability of public regimes. Population aging and increased life expectancy have broadened debates about the financial balance of social security, leading to the adoption of models that combine state protection and individual accountability (CAMARANO, 2014; TAFNER, 2007).

In this context, the introduction of the supplementary pension scheme for federal civil servants represents a milestone in the trajectory of social protection policies in Brazil. The creation of the Federal Public Servants' Supplementary Pension Fund Foundation (FUNPRESP), through Law No. 12,618/2012, redefined the social security design of public careers by limiting the benefits of the own regime to the ceiling of the General Social Security Regime and encouraging adherence to complementary mechanisms based on capitalization (BRASIL, 2012).

Such changes are not restricted to the legal or financial field. They alter historical expectations of security associated with the public service and demand new individual planning skills, shifting part of the responsibility for the social security future to the civil servants themselves. This transition dialogues with contemporary trends in public management, marked by the search for fiscal efficiency and the valorization of individual autonomy in decisions related to career and work (BRESSER-PEREIRA, 2010).

At the same time, the complexity of social security rules and the multiplicity of coexisting regimes in public organizations increase informational challenges. Studies indicate that decisions involving pension plans and financial planning are strongly influenced by the level of knowledge of workers, institutional trust, and the way information is communicated by organizations (LUSARDI; MITCHELL, 2014).

From the perspective of people management, supplementary pension emerges as a strategic theme, as it influences career expectations, professional satisfaction and perception of organizational support. Poorly understood institutional policies tend to generate insecurity and resistance, while clear and transparent informational environments favor more conscious

decisions aligned with the needs of civil servants (CHIAVENATO, 2020; ROBBINS; JUDGE, 2017).

Particularly in public educational institutions, where long careers and a high level of qualification are predominant characteristics, the social security debate takes on an even more relevant dimension. In these organizations, the coexistence of different generations of civil servants, linked to different social security rules, contributes to heterogeneous perceptions about supplementary social security and its impacts on the professional trajectory.

Given this scenario, it is necessary to understand how public servants perceive supplementary pension and how this policy is incorporated into organizational dynamics. More than analyzing adhesions or non-adhesions, it is important to investigate how these decisions reflect processes of institutional change and cultural transformation in the Brazilian public service.

This chapter is based on the understanding that supplementary pension should not be treated only as a financial instrument, but as an integral element of people management and the construction of the so-called psychological contract between civil servant and institution. Thus, the debate broadens to include symbolic and organizational dimensions, involving trust, institutional communication, and career planning.

The central problematization that guides this reflection can be summarized in the following question: how do the recent transformations of the Brazilian public pension, materialized in the implementation of FUNPRESP, impact the perception of civil servants and the processes of people management in public educational institutions?

As a general objective, the chapter seeks to analyze supplementary pension in the federal public service from a perspective that articulates institutional transformations, people management and perceptions of civil servants, using empirical evidence from a study carried out on a campus of the Federal Institute of São Paulo (IFSP). Specifically, it is intended to discuss how levels of knowledge, adherence decisions, and perceptions of satisfaction relate to broader organizational processes. Thus, the originality of this chapter lies in the articulation between supplementary pension and the psychological contract of the public servant, a perspective that has not yet been explored in the national literature.

The relevance of this discussion lies both in its academic contribution and in its practical implications. From a theoretical point of view, the chapter brings the social security debate closer to the areas of public management and organizational behavior, which are still little explored in research on the subject. At the institutional level, it offers subsidies for the development of communication and social security education strategies aimed at promoting

more informed decisions among public servants.

To achieve these objectives, the chapter is organized into eight sections. After this introduction, the recent transformations in the Brazilian public pension are discussed, followed by the analysis of FUNPRESP and the changes in the psychological contract of the civil servant. Then, the relationship between people management and social security education is addressed, the methodological path of the empirical study is presented, the evidence obtained is discussed and a broader discussion about its organizational meanings is developed, culminating in the final considerations and implications for public management.

Thus, by integrating theoretical analysis and empirical evidence, this chapter intends to contribute to the understanding of supplementary pension plans as a phenomenon that goes beyond the financial dimension, revealing itself as a central component of contemporary transformations in labor relations in the Brazilian public sector.

2 RECENT TRANSFORMATIONS IN PUBLIC PENSION IN BRAZIL

In recent decades, Brazilian social security has undergone a set of structural transformations motivated by demographic, economic and institutional changes that have had a profound impact on the organization of the social protection system in the country. The increase in life expectancy, the reduction in birth rates and fiscal pressures on the State have broadened the debates about the sustainability of social security systems, driving reforms aimed at redefining retirement rules and the financial balance of public systems (CAMARANO, 2014; TAFNER, 2007).

Historically, public pension in Brazil was conceived under a contributory and solidary logic, structured mostly in the simple distribution system, in which active workers finance the benefits of retirees. This model, consolidated throughout the twentieth century and strengthened by the Federal Constitution of 1988, guaranteed broad social protection, but began to face challenges arising from population aging and the expansion of social security expenses (MARTINS, 2014).

In the scope of the public service, the Own Social Security Regime (RPPS) has consolidated itself as one of the pillars of the attractiveness of state careers, by ensuring benefits historically associated with integrality and parity with the remuneration of active duty. However, the growing concern with fiscal sustainability led to the implementation of successive reforms, which gradually restricted these benefits and brought public sector rules closer to the conditions applied to workers in the general regime (BRASIL, 2019).

The creation of the social security ceiling equivalent to the General Social Security Regime (RGPS) for new federal employees, formalized by Law No. 12,618/2012, represents

a significant milestone in this process. The measure profoundly altered the traditional design of public pension by limiting the value of future benefits and introducing the need for complementary social security protection mechanisms for civil servants with salaries above the ceiling (BRASIL, 2012).

These changes reflect an international trend of reconfiguration of pension systems, marked by the expansion of hybrid models that combine basic public protection and supplementary pension based on individual capitalization. According to Batich (2004), this transition implies the gradual transfer of part of the social security responsibility from the State to the individual, requiring greater capacity for financial planning and decision-making on the part of workers.

Constitutional Amendment No. 103/2019, in turn, intensified this movement by promoting significant changes in retirement rules, including minimum age, contribution time, and criteria for calculating benefits. Such changes reinforced the logic of fiscal adjustment and increased the relevance of supplementary pension as a strategy for maintaining the income standard in retirement, especially among federal civil servants (BRASIL, 2019).

In this context, it is observed that social security is no longer perceived only as a social right guaranteed by the State and also starts to assume a dimension of individual risk management, approaching the logics of the financial market and long-term personal planning. This change alters the so-called "social security contract", impacting historical expectations of security and stability associated with public careers (CAMARANO; FERNANDES, 2016).

In addition to the normative changes, recent transformations reveal challenges related to institutional communication and the understanding of social security rules by civil servants. The growing complexity of the system tends to increase the informational asymmetry between managers and workers, making it difficult to make conscious decisions and enhancing perceptions of insecurity regarding the future of social security (LUSARDI; MITCHELL, 2014).

From the perspective of public management, these transformations highlight the need for organizational policies capable of supporting civil servants in understanding the new rules and planning their professional trajectories. Social security, in this sense, becomes part of the strategic field of people management, requiring educational and communicational actions that favor decision-making autonomy and institutional trust (CHIAVENATO, 2020).

Thus, recent transformations in Brazilian public pension reveal not only normative changes, but a broader reconfiguration of the relations between the State, labor and social protection. This scenario constitutes the backdrop for the creation and expansion of supplementary social security in the federal public service, a theme that will be deepened in

the following section when addressing the role of FUNPRESP in the new social security configuration.

3 FUNPRESP AND THE CHANGE IN THE PSYCHOLOGICAL CONTRACT OF THE CIVIL SERVANT

The creation of the Federal Public Servants' Supplementary Pension Fund Foundation (FUNPRESP), based on Law No. 12,618/2012, represents more than a technical change in the social security rules of the Brazilian public service. It is a structural change that redefines the historical relationship between the State and the civil servant, altering expectations, perceptions of security and the way in which the public career is planned over time. In this context, supplementary pension can be understood as a central element in the reconfiguration of the so-called psychological contract of public servants (BRASIL, 2012).

The concept of psychological contract refers to the set of implicit expectations that guide the relationship between the individual and the organization, involving perceptions of reciprocity, trust and mutual commitment (ROUSSEAU, 1995). In the Brazilian public service, this contract has historically been marked by the promise of stability, predictable progression and social security security, constituting one of the main factors of attractiveness of state careers (CAMARANO; FERNANDES, 2016).

The introduction of the supplementary pension scheme partially breaks with this logic by shifting part of the responsibility for the future pension to the civil servant himself. Unlike the traditional model, in which the benefit was strongly linked to the remuneration of the active person, the new regime requires individual long-term decisions and involves variables associated with the capitalization and performance of investments, bringing the civil servant closer to typical practices of the private sector (BATICH, 2004).

This movement can be interpreted as a reflection of contemporary trends in public management, often associated with the New Public Management paradigm, which emphasizes fiscal efficiency, individual accountability, and rationalization of state spending. In this scenario, the civil servant is no longer just a beneficiary of a state protection system and starts to act as an active agent in the construction of his future financial security (BRESSER-PEREIRA, 2010).

The change, however, does not occur only at the normative level, but also at the symbolic level. For many civil servants, especially those who joined after 2013, the public career is perceived under a different logic from the previous generation, marked by a greater need for financial planning and less predictability about retirement income. This transition can generate identity tensions and a sense of uncertainty, especially in organizational

environments where different social security regimes coexist.

In addition, FUNPRESP introduces new elements of institutional trust. While the traditional model was associated with the direct guarantee of the State, the complementary regime requires confidence in the management of resources, in the governance of the entity and in the stability of the rules over time. Studies on organizational behavior indicate that changes in historically valued benefits tend to impact commitment and perception of organizational support, especially when accompanied by low informational clarity (CHIAVENATO, 2020).

The literature on decision-making shows that choices involving future risks and uncertain returns tend to generate conservative behaviors or decision-making postponement, a phenomenon observed in different social security contexts (LUSARDI; MITCHELL, 2014). In the case of the public service, this effect can be enhanced by the tradition of stability that has historically characterized the relationship between civil servants and the State, making adaptation to the new model a gradual and often conflicting process.

From the perspective of people management, this change in the psychological contract imposes new institutional challenges. Public organizations now play an important role in mediating social security information, promoting educational actions and communication strategies that help civil servants understand the implications of the complementary regime. The absence of this mediation tends to increase insecurity and make it difficult to build trust in the new system.

In this sense, FUNPRESP should not be understood only as a financial mechanism, but as an organizational policy that influences career expectations, professional decisions, and perceptions of institutional appreciation. The way this policy is communicated and experienced by employees can strengthen or weaken the bond between the individual and the organization, directly impacting the levels of satisfaction and commitment at work.

Thus, the analysis of FUNPRESP from the concept of psychological contract allows us to understand that the social security transformations in the public service go beyond the normative field, reaching symbolic and cultural dimensions that redefine the very experience of public work in contemporary Brazil. This perspective offers an essential interpretative basis for understanding the empirical results presented in the following sections of the chapter.

4 PEOPLE MANAGEMENT AND SOCIAL SECURITY EDUCATION IN THE PUBLIC SECTOR

People management in the Brazilian public sector has undergone significant transformations in recent decades, following institutional changes, administrative reforms,

and new demands for efficiency and professionalization. In this context, the public administration has ceased to focus exclusively on bureaucratic personnel management processes to incorporate strategic approaches aimed at human development, valuing the civil servant, and strengthening organizational performance (CHIAVENATO, 2020).

Among the various elements that make up people management, benefits and career planning policies play an important role in building the satisfaction and commitment of civil servants. The literature on organizational behavior shows that the perception of security and institutional support directly influences the motivation and psychological bond between worker and organization, especially in contexts marked by structural changes (ROBBINS; JUDGE, 2017).

In the public service, social security has historically occupied a central position in this set of benefits, and is often associated with the stability and predictability of the professional trajectory. Changes in social security rules, therefore, do not only produce financial effects, but also organizational and subjective ones, by impacting long-term expectations and the career planning of civil servants (CAMARANO; FERNANDES, 2016).

The introduction of supplementary pension in the federal public service increases the complexity of this scenario by requiring civil servants to take a more active role in managing their financial future. This shift of responsibility demands competencies that were not traditionally part of the professional repertoire associated with public careers, such as financial planning, risk assessment, and understanding of social security instruments (LUSARDI; MITCHELL, 2014).

In this sense, the concept of social security education emerges, understood as the set of actions aimed at promoting knowledge and the critical capacity of individuals to understand and make decisions related to their future social protection. Unlike the simple transmission of information, social security education involves continuous learning processes and the development of skills aimed at long-term planning (ENAP, 2022).

The literature points out that reduced levels of financial and social security literacy are directly associated with poorly informed decisions, postponement of choices, and low adherence to supplementary pension schemes. This phenomenon tends to be intensified when the issue is perceived as complex or distant from the worker's immediate reality, a scenario often observed in public organizations (LUSARDI; MITCHELL, 2014).

From the perspective of people management, the absence of structured actions for social security guidance can generate insecurity and increase the informational asymmetry between employees and the institution. When workers do not fully understand the benefits available or the implications of regulatory changes, they tend to develop negative or

ambivalent perceptions of organizational policies, affecting institutional trust (EISENBERGER et al., 2002).

In this context, organizational communication assumes a strategic role. The literature on public management highlights that technical information, when not mediated in a clear and contextualized way, has low effectiveness and can contribute to the maintenance of doubts and resistance. Thus, social security guidance programs should be conceived as an integral part of people management policies, and not as one-off or merely informative actions (CHIAVENATO, 2020).

Public educational institutions, in particular, have characteristics that make this debate even more relevant. The high level of education of civil servants and long-term professional trajectories create an environment conducive to career planning, but do not necessarily guarantee in-depth social security knowledge. This apparent contradiction shows that high academic training does not replace institutional initiatives of social security education.

In addition, the coexistence of different social security regimes within the same organizations — resulting from different legal frameworks for entry into the public service — contributes to heterogeneous perceptions about supplementary social security. Such diversity requires differentiated management approaches, capable of dialoguing with different profiles of civil servants and varying levels of knowledge on the subject.

Supplementary pensions, in this scenario, can be understood as a strategic element of organizational management, as it influences decisions related to permanence in the public service, retirement expectations, and perceptions of institutional appreciation. When accompanied by clarification and support actions, it tends to strengthen the commitment of civil servants and the perception of organizational justice (ROBBINS; JUDGE, 2017).

On the other hand, when implemented without adequate mediation, social security policy can be perceived as an external imposition or as a loss of historically consolidated rights, generating resistance and insecurity. This duality highlights the importance of the role of leaders and people management areas in the construction of institutional narratives that favor the understanding of changes and reinforce the transparency of processes.

Social security education, therefore, should not be seen only as an informative strategy, but as an instrument of organizational *empowerment*, capable of expanding the autonomy of civil servants in decision-making related to their professional and financial future. This perspective brings complementary pension closer to contemporary debates on organizational learning and human development in the public sector.

Thus, the articulation between people management and social security education offers a relevant interpretative framework to understand the challenges faced by public

institutions in the face of recent transformations in social security. Such an approach allows us to analyze supplementary pension not only as a financial policy, but as an integral component of labor relations and organizational culture.

In the light of these discussions, it is possible to understand the empirical results of the present study not only as indicators of knowledge or satisfaction, but as expressions of broader institutional processes, related to organizational communication, perceived support, and the ability of institutions to promote informed decision-making environments. This understanding underlies the analysis of the data presented in the following section of the chapter.

5 THE EMPIRICAL STUDY: CONTEXT AND METHODOLOGICAL PATH

Understanding the transformations of public pension and their effects on people management requires observing how these changes are perceived in the daily lives of organizations. In this sense, the present study was developed from the reality of a campus of the Federal Institute of Education, Science and Technology of São Paulo (IFSP), a public institution of higher, technical and technological education, marked by a diverse staff and long-term professional trajectories. The choice of this context allowed us to investigate how federal civil servants interpret and experience the changes related to supplementary pension in their work environment.

The study was based on the observation, observed in institutional experiences and internal discussions, that the social security issue often generates doubts among civil servants, even in environments characterized by a high level of education. This scenario dialogues with research that indicates that regulatory complexity and low financial literacy can make it difficult to understand social security systems, regardless of the degree of academic training of individuals (LUSARDI; MITCHELL, 2014).

From the methodological point of view, we opted for a research of an applied nature, guided by the intention of producing knowledge useful to the organizational context studied and capable of subsidizing reflections on people management practices. As Gil (2017) and Mascarenhas (2017) point out, applied research is particularly relevant in institutional environments, as it allows for the articulation of scientific production and the resolution of concrete problems.

The investigation assumed an exploratory and descriptive character, seeking not only to map the level of knowledge and satisfaction of the employees in relation to FUNPRESP, but also to understand the meanings attributed by them to the supplementary pension system. This approach was considered appropriate in view of the relative scarcity of empirical

studies on the subject in the field of public management and people management.

The research adopted a qualitative approach, prioritizing the interpretation of data in dialogue with the organizational context and with the theoretical framework built throughout the chapter. Although the study used quantitative data from a structured questionnaire, the analysis was conducted with an interpretative focus, considering that organizational phenomena involve subjective and symbolic dimensions that are not exhausted in numbers (PÁDUA, 2019).

The universe investigated comprised teaching and technical-administrative staff in effective exercise on the analyzed campus, including professionals with different periods of service and different social security trajectories. Civil servants linked to the social security system with potential eligibility for supplementary social security were included, and temporary contracts and outsourced workers were excluded, as they did not fit into the analyzed system.

Data collection took place through an electronic questionnaire prepared on the Microsoft *Forms platform*, an instrument chosen because it allows for a greater reach of the participants and ensures anonymity of the answers. The questionnaire was structured in thematic blocks that addressed the characterization of the participants, level of knowledge about FUNPRESP, adherence to the complementary regime and perception of satisfaction. According to Cervo, Bervian and Silva (2007), the thematic organization of the instrument favors greater coherence between research objectives and collected data, contributing to the quality of subsequent analyses.

The methodological approach adopted sought to respect ethical principles of research, ensuring voluntary participation and confidentiality of information. In addition, the use of an electronic questionnaire allowed participants greater freedom of response, reducing possible embarrassment associated with financial and social security issues, which are often perceived as sensitive in the work environment.

Data analysis followed descriptive and interpretative guidance, combining the organization of responses in summary tables and the discussion of the results in the light of the literature on supplementary pension, people management and decision-making. This strategy allowed us to identify patterns of perception and understand how empirical data reflect broader organizational processes, in line with the proposal of qualitative analysis defended by Gil (2017).

More than presenting statistical results, the methodological approach sought to capture perceptions and meanings attributed by civil servants to social security changes, recognizing that decisions related to retirement involve subjective dimensions, future

expectations and institutional trust relationships. Thus, the study seeks to contribute to a broader understanding of supplementary pension in the public sector, articulating empirical evidence and theoretical reflection.

Thus, the methodological construction adopted is not limited to describing technical procedures, but integrates the interpretative effort of the chapter, offering a basis for the analysis of the empirical evidence presented in the following section, in which the results are discussed in the light of institutional transformations and the challenges of people management in the public service.

6 EMPIRICAL EVIDENCE: WHAT CIVIL SERVANTS REPORT

The empirical evidence obtained in the study reveals a scenario marked by heterogeneous perceptions about supplementary pension in the federal public service, reflecting the institutional transformations discussed in the previous sections. More than isolated indicators, the data point to an adaptation process that is still ongoing, in which civil servants reinterpret their professional trajectories in the face of structural changes in the relationship between public careers and social security protection.

The characterization of the profile of the participants demonstrates the presence of civil servants with a high level of education and significant experience in the public service, a typical reality of federal educational institutions. This data reinforces the idea that pension decisions occur in complex and long-term professional contexts, in which expectations of stability and career planning play a central role (CAMARANO; FERNANDES, 2016).

However, despite the high educational capital, the results show that knowledge about FUNPRESP is not homogeneously distributed among the participants. The predominance of responses indicating a low level of knowledge confirms arguments in the literature on financial literacy, which points out that formal academic training does not necessarily imply mastery of social security and financial issues (LUSARDI; MITCHELL, 2014).

This scenario reveals an important tension: at the same time that the supplementary regime presupposes informed individual decisions, many civil servants still demonstrate insecurity in the face of the available information. This finding reinforces the discussion on the need for institutionalized social security education, already presented in the previous section, and highlights the relevance of the role of people management in mediating these decisions (CHIAVENATO, 2020).

The analysis of the responses related to adherence to the complementary regime shows a predominance of non-adherence, a phenomenon that can be interpreted as an expression of caution in the face of changes perceived as complex or uncertain. This behavior

dialogues with studies on decision-making in risk contexts, in which individuals tend to maintain the status quo when they do not feel fully informed or secure about future outcomes (ROBBINS; JUDGE, 2017).

Among the reasons for non-adherence, arguments related to the permanence in the previous regime, lack of interest and insecurity regarding the functioning of FUNPRESP stand out. Such justifications suggest that the social security decision is strongly related to subjective and symbolic dimensions, associated with the psychological contract of the civil servant and institutional trust, as discussed in section 3.

At the same time, the responses of the adhering civil servants reveal a distinct pattern: those who opted for supplementary pension plans tend to evaluate the regime positively, highlighting benefits such as the institutional counterpart and the possibility of building additional income in retirement. This result points to an apparent contradiction between low overall adherence and high satisfaction among participants, a phenomenon that deserves careful analysis.

This duality suggests the existence of a significant informational asymmetry in the institutional context analyzed. While part of the civil servants remains distant from the supplementary pension due to lack of knowledge or insecurity, those who adhere begin to develop a more concrete understanding of the functioning of the system, reducing initial negative perceptions. Such dynamics confirm the importance of practical experience in building institutional trust (EISENBERGER et al., 2002). The synthesis of the main findings is systematized in Table 1, allowing us to visualize the relationship between knowledge, adherence and satisfaction.

Table 1

Synthesis of the main findings of the research on FUNPRESP

Axis of analysis	Empirical results (percentages)	Analytical implications
Profile of the participants	100% with complete higher education; 77% with a postgraduate degree (specialization, master's, doctorate or post-doctorate)	It shows high educational capital and potential for more informed pension decisions
Length of public service	69% with more than 6 years of experience in the public service	Indicates consolidated careers and the need for long-term pension planning
Level of knowledge about FUNPRESP	71% declared that they knew little about the regime; Only 29% said they know it well or very well	Reveals relevant informational gap and low social security literacy
Joining FUNPRESP	64% did not join the regime; 36% are participants (normal or alternative assets)	Demonstrates low adherence, despite the existence of institutional incentives
Reasons for non-adherence	34% remained in the previous regime; 31% reported a lack of interest; 11% insecurity; 9% have another pension	Reinforces the influence of subjective factors and institutional trust
Type of membership among participants	69% voluntary adherence; 31% automatic adherence	Indicates greater presence of proactive social security behavior

Satisfaction among adherents	78% declared to be satisfied or very satisfied with FUNPRESP	Evidence of positive evaluation of the regime after accession
Factors associated with satisfaction	50% pointed to the institutional counterpart as the main motivator	Confirms the importance of organizational support
Central institutional challenge	Asymmetry between low general knowledge (71%) and high satisfaction among adherents (78%)	Indicates failure of communication and social security guidance
Implications for management	Need for systematic educational and informational actions	Repositions FUNPRESP as a strategic people management policy

Source: Survey data (2023).

The presence of the synoptic table allows us to observe, in an integrated way, the relationship between the participants' profile, levels of knowledge, adherence and satisfaction, functioning as a transition element between the presentation of the data and their analytical interpretation. The joint visualization of the results shows that the main institutional challenge does not necessarily lie in the quality of the complementary regime, but in the way it is understood and communicated to the civil servants.

From the perspective of people management, the results indicate that supplementary pension plans have not yet been fully consolidated as a strategic organizational policy. The absence of systematic social security guidance programs limits the potential of FUNPRESP as an instrument for career enhancement and planning, reinforcing the need for permanent educational actions.

Another relevant aspect concerns the coexistence of different social security regimes within the same institution, a factor that contributes to fragmented perceptions on the subject. Civil servants bound by previous rules tend to compare the current model with historical experiences of greater predictability, while new entrants are compelled to develop financial planning skills from the beginning of their careers.

This diversity of social security experiences reinforces the idea that normative changes produce lasting cultural and organizational effects. The evidence suggests that the transition to the logic of supplementary social security is not limited to legal adaptations, but involves gradual processes of resignification of public work and expectations of social protection.

The analysis also reveals that social security decisions do not occur in isolation, but are articulated with the way civil servants perceive the institution in which they work. The presence of informational support and clear communication tends to strengthen trust and willingness to adhere, while the absence of these elements contributes to conservative behaviors or decision-making postponement.

In this sense, the results reinforce the argument that supplementary pension should be understood as an integral part of the organizational experience of civil servants. More than a financial product, it is configured as a component of the people management policy,

influencing perceptions of appreciation and long-term planning.

Empirical evidence also allows us to observe that satisfaction among adherents is less related to immediate gains and more associated with the perception of future security and the recognition of institutional participation through financial compensation. This aspect indicates that symbolic elements of reciprocity remain relevant even in models that emphasize individual responsibility.

By reiterating the debates presented in the previous sections, the results indicate that the social security transition in the Brazilian public service represents a process under construction, marked by institutional advances, but also by communicational and cultural challenges. Understanding this complexity is essential for developing more effective organizational strategies.

Thus, the evidence presented suggests that the success of supplementary pension plans depends not only on its normative design or financial performance, but also on the ability of public institutions to promote informational environments that favor conscious decisions that are aligned with the expectations of civil servants.

In summary, the data reveal that public servants experience supplementary pension as part of a broader transformation in the meaning of the public career, in which individual planning and institutional support begin to coexist as central elements of professional experience.

This interpretation leads to the need to broaden the debate beyond the numbers, recognizing that supplementary pension represents, at the same time, a financial instrument and an organizational phenomenon. This perspective underlies the following section, dedicated to the expanded discussion of the implications of these findings for public management and for the future of labor relations in the public sector.

7 EXPANDED DISCUSSION: SUPPLEMENTARY PENSION, PUBLIC CAREER AND INSTITUTIONAL TRUST

Based on the evidence presented, it becomes possible to move towards a broader interpretation of supplementary social security as an organizational and symbolic phenomenon, which expresses broader changes in the relations between the State and the civil servant, requiring interpretations that go beyond the strictly normative dimension.

The creation of FUNPRESP and the limitation of social security benefits to the ceiling of the general regime represent milestones of transformation in the historical trajectory of the Brazilian public career. These changes alter expectations consolidated over decades, in which functional stability was associated with social security security guaranteed by the State.

Thus, supplementary social security redefines central elements of the civil servant's psychological contract, impacting perceptions of reciprocity and institutional protection (ROUSSEAU, 1995).

The coexistence of different social security regimes within the same public institutions reinforces the complexity of this process. Civil servants entering in different periods live under different rules, producing constant comparisons and varied interpretations of organizational justice and equity. Such a scenario contributes to the construction of divergent narratives about supplementary pension and directly influences the individual decision-making process.

The results of the research show that the low adherence to the complementary regime does not necessarily result from explicit rejection of the model, but from informational insecurity and difficulties in understanding. This finding dialogues with studies that highlight the influence of financial literacy on long-term decisions, especially in contexts of high technical complexity (LUSARDI; MITCHELL, 2014).

Paradoxically, the high levels of satisfaction among the adhering civil servants suggest that concrete experience with the regime tends to reduce perceptions of risk and increase confidence in the system. This duality shows that the main institutional challenge may lie less in the structure of the supplementary pension plan and more in the processes of communication and organizational education that precede the decision to join.

From the perspective of people management, this scenario points to an important shift: social security policies are no longer treated only as administrative issues and become part of organizational development strategies. The absence of systematic actions for social security guidance can generate informational gaps capable of compromising the effectiveness of public policies designed to ensure financial sustainability and social protection.

In addition, supplementary pension reveals how structural changes can influence the way civil servants project their professional trajectories. The need for individual long-term planning introduces a logic of personal accountability that is close to practices observed in the private sector, changing the traditional perception of the role of the State as a guarantor of future security (BRESSER-PEREIRA, 2010).

This transition does not occur homogeneously. Civil servants with different professional experiences, generational profiles, and levels of familiarity with financial instruments respond differently to social security changes. The heterogeneity observed reinforces the importance of management approaches sensitive to the specificities of internal audiences.

Another relevant aspect refers to institutional trust. Organizational studies indicate that

trust is built through consistent experiences, transparency, and perception of support. When institutional policies are perceived as clear and coherent, workers tend to develop greater commitment and openness to change (EISENBERGER et al., 2002). In this sense, supplementary pension can work both as a factor of strengthening and weakening the organizational bond.

The discussion also allows us to reflect on the role of public educational institutions in this process. As they are environments dedicated to the production and dissemination of knowledge, such organizations have strategic potential to promote social security education and foster more informed decision-making environments. However, the results suggest that this potential is not yet fully exploited.

The analysis of the data also indicates that supplementary pension acts as a symbolic marker of a broader change in the organizational culture of the public service. The logic of absolute predictability gives way to a dynamic in which planning, information and individual decision become valued skills in the professional trajectory.

In this context, people management assumes a mediating role between macrostructural policies and individual experiences of civil servants. The ability to translate complex standards into accessible and relevant information becomes a central element to reduce insecurities and promote choices aligned with the needs of workers.

The discussion also shows that social security decisions involve emotional and identity dimensions, in addition to economic calculations. Risk perception, experience with previous changes, and confidence in institutional stability significantly influence the choices made, reinforcing the importance of integrated approaches between management, communication, and organizational education.

By reiterating the arguments presented in the previous sections, it is observed that supplementary social security in the public service should be interpreted as part of a continuous process of redefining the role of the State and the expectations of civil servants. This transformation requires new forms of institutional support capable of balancing individual responsibility and collective protection.

The expanded discussion also allows us to identify that the high satisfaction among adherents can represent a strategic opportunity for public institutions. Positive experiences can be used as a basis for building clearer institutional narratives, contributing to reducing resistance and strengthening confidence in the complementary regime.

On the other hand, the maintenance of low levels of knowledge among a significant part of the civil servants indicates a risk of perpetuating informational inequalities, in which social security decisions come to depend more on individual access to information than on

structured institutional policies.

Thus, supplementary pension emerges as a privileged space to observe how macroeconomic and legislative changes materialize in the daily life of public organizations, influencing management practices and labor relations. This perspective reinforces the importance of interdisciplinary approaches capable of integrating economics, public administration, and organizational behavior.

In summary, the results and discussions presented indicate that the success of supplementary pension in the public service depends not only on its financial sustainability, but also on the construction of institutional trust and the strengthening of social security education strategies. People management, in this scenario, occupies a central position in the mediation between public policies and individual experiences.

Finally, the analysis reinforces that supplementary pension plans do not represent only a technical change, but a cultural transformation in Brazilian public careers, redefining expectations of social protection and requiring new organizational and individual skills. This understanding broadens the scope of the debate and paves the way for the final considerations presented in the next section.

8 FINAL CONSIDERATIONS AND IMPLICATIONS FOR PUBLIC MANAGEMENT

This chapter sought to analyze supplementary social security in the federal public service from a perspective that articulates institutional transformations, people management and concrete experiences of public servants. Throughout the discussion, it became evident that the recent changes in the Brazilian public pension system do not represent only normative adjustments, but broader processes of redefinition of the relationship between the State, public career, and social protection.

The legislative transformations observed in recent decades, especially the creation of FUNPRESP and the limitation of social security benefits to the ceiling of the general regime, have significantly changed the social security scenario of federal employees. These changes introduced a logic of greater individual accountability, requiring financial planning and decision-making in a field historically associated with predictability and institutional security.

The empirical data analyzed revealed that, despite the high level of training of the civil servants investigated, knowledge about supplementary pension remains unequal, indicating that the complexity of the topic still constitutes a relevant barrier to informed decisions. This result reinforces the importance of social security education as a central element of people management policies in the public sector.

At the same time, the high levels of satisfaction observed among the civil servants

adhering to FUNPRES P suggest that practical experience with the regime tends to reduce uncertainties and increase institutional confidence. This finding reveals an important paradox: while the lack of information limits initial adherence, the concrete experience of the system favors positive evaluations and perception of future security.

From the perspective of public management, the findings indicate that supplementary pension should be understood as a strategic organizational policy, capable of influencing career expectations, commitment, and perception of institutional appreciation. In this sense, the performance of the people management areas becomes essential to mediate the understanding of social security changes and promote more informed decision-making environments.

The evidence presented also suggests that institutional communication plays a decisive role in building the trust of civil servants. Technical information alone is not enough to promote effective understanding; It is necessary to develop continuous guidance strategies that translate complex standards into accessible content that contextualizes the reality of workers.

In addition, the analysis allows us to recognize that supplementary pension expresses a cultural transformation in public careers, marked by the coexistence between traditional expectations of stability and new demands for individual planning. This movement requires public institutions to be more sensitive to dealing with different generational profiles and professional trajectories, avoiding homogeneous approaches that disregard this diversity.

From a practical point of view, the chapter points to the need to institutionalize permanent social security education programs, integrated with civil servant development policies. Such initiatives can contribute to reducing informational asymmetries, strengthening decision-making autonomy and expanding the perception of organizational support.

In theoretical terms, the study contributes by bringing the debate on supplementary pension plans closer to discussions on psychological contracts, institutional trust and strategic management of people, broadening the view on a topic traditionally treated from legal or economic perspectives. This integrated approach allows us to understand social security as a constitutive dimension of the organizational experience in the contemporary public sector.

As limitations, the institutional focus of the study stands out, concentrated in a single public education organization, which restricts the generalization of the results. Even so, the evidence presented offers relevant clues for understanding similar processes in other federal public institutions.

In view of this, it is recommended that future investigations broaden the scope of

analysis, incorporating comparisons between different institutions and organizational contexts, as well as more in-depth qualitative approaches capable of exploring the subjective perceptions of civil servants about security, risk, and pension planning.

Finally, it is concluded that supplementary social security in the federal public service represents a strategic field for contemporary public management, as it articulates fiscal sustainability, social protection and individual career experiences. The success of this model depends, above all, on the ability of institutions to build transparent informational environments, foster trust and promote continuous social security education.

Thus, more than a financial mechanism, supplementary pension plans are a central element of the ongoing transformations in labor relations in the Brazilian public sector, requiring permanent reflection and integrated action between institutional policies and people management. In this sense, supplementary social security is consolidated as a strategic field for the formulation of institutional policies and for future research agendas on labor and public management in Brazil.

REFERENCES

- Batich, M. (2004). *Previdência do trabalhador: Uma trajetória inesperada. Perspectiva*.
- Brasil. (1988). *Constituição da República Federativa do Brasil de 1988*. <https://www.planalto.gov.br>
- Brasil. (2012). Lei nº 12.618, de 30 de abril de 2012. Institui o regime de previdência complementar para os servidores públicos federais titulares de cargo efetivo. <https://www.planalto.gov.br>
- Brasil. (2019). Emenda Constitucional nº 103, de 12 de novembro de 2019. Altera o sistema de previdência social e estabelece regras de transição e disposições transitórias. <https://www.planalto.gov.br>
- Bresser-Pereira, L. C. (2010). *A reforma do Estado dos anos 1990: Lógica e mecanismos de controle*. Ministério da Administração Federal e Reforma do Estado.
- Camarano, A. A. (Org.). (2014). *Novo regime demográfico: Uma nova relação entre população e desenvolvimento?* Ipea.
- Camarano, A. A., & Fernandes, D. (2016). Envelhecimento populacional, previdência social e política pública. *Revista Brasileira de Estudos de População*, 33(2), 263–286. <https://doi.org/10.20947/S0102-309820160002>
- Cervo, A. L., Bervian, P. A., & Silva, R. da. (2007). *Metodologia científica* (6ª ed.). Pearson Prentice Hall.
- Chiavenato, I. (2020). *Gestão de pessoas: O novo papel dos recursos humanos nas organizações* (5ª ed.). Atlas.
- Eisenberger, R., et al. (2002). Perceived organizational support. *Journal of Applied Psychology*, 71(3), 500–507. <https://doi.org/10.1037/0021-9010.71.3.500>

- Escola Nacional de Administração Pública. (2015). Previdência do servidor público federal. ENAP.
- Escola Nacional de Administração Pública. (2022). Regime de previdência complementar do servidor público federal. <https://www.gov.br/enap>
- Fundação de Previdência Complementar do Servidor Público Federal. (2023). Funpresp em números. <https://www.funpresp.com.br>
- Gil, A. C. (2017). Métodos e técnicas de pesquisa social (6ª ed.). Atlas.
- Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature*, 52(1), 5–44. <https://doi.org/10.1257/jel.52.1.5>
- Mascarenhas, S. A. (2017). Metodologia científica. Pearson.
- Martins, S. P. (2014). Direito da seguridade social (33ª ed.). Atlas.
- Pádua, E. M. M. de. (2019). Metodologia da pesquisa: Abordagem teórico-prática (18ª ed.). Papyrus.
- Robbins, S. P., & Judge, T. A. (2017). Comportamento organizacional (17ª ed.). Pearson Education.
- Rousseau, D. M. (1995). Psychological contracts in organizations: Understanding written and unwritten agreements. Sage Publications.
- Tafner, P. (2007). Reformas da previdência: O que mudou e o que falta mudar. Elsevier.

WILMS' TUMOR: GENETIC ASPECTS, DIAGNOSIS AND TREATMENT: A LITERATURE REVIEW

TUMOR DE WILMS ASPECTOS GENÉTICOS, DIAGNÓSTICO E TRATAMENTO: UMA REVISÃO BIBLIOGRÁFICA

TUMOR DE WILMS: ASPECTOS GENÉTICOS, DIAGNÓSTICO Y TRATAMIENTO: UNA REVISIÓN DE LA LITERATURA



<https://doi.org/10.56238/sevenced2026.008-162>

Nathalia Bezerra de Souza Rates¹, Lívia Maria Della Porta Cosac, Victória Dias da Silva, Luana da Silva Souza, Carlos Alberto Pereira da Silva Junior

ABSTRACT

Renal tumors account for approximately 7% of all pediatric tumors; however, Wilms tumor is the most common renal tumor in children, particularly those between 2 and 5 years of age. Its etiology is not yet fully understood, but it is known that certain genetic conditions may be associated with an increased risk of developing this tumor. As it is a malignant neoplasm, early diagnosis is essential to improve patient prognosis. Therefore, periodic screening through abdominal ultrasonography is necessary in patients with a genetic predisposition to this neoplasm. Most patients are asymptomatic, presenting only with a unilateral palpable abdominal mass during physical examination. However, other possible symptoms associated with this condition include arterial hypertension, abdominal pain, hematuria, fever, anemia, leukocytosis, constipation, and fatigue. The therapeutic approach for this tumor involves combined treatment, including chemotherapy, surgical tumor resection, and/or radiotherapy. Staging of Wilms tumor should be performed through the analysis of imaging studies to detect renal masses and distant metastases, thereby allowing for appropriate and individualized treatment planning for each patient. The primary objective of this study is to conduct a literature review on the genetic influence in Wilms tumor, as well as its diagnostic methods and emerging therapeutic options for this condition. The methodology adopted for the proposed literature review is based on the analysis and review of scientific articles published between 2021 and 2025, identified through searches in the PubMed, SciELO, and Google Scholar databases, using the following keywords: "Wilms Tumor," "Tumor de Wilms," "Nephroblastoma," "Wilms tumor gene 1," and "WT1 gene." Based on the analyzed studies, Wilms tumor is identified as a highly prevalent malignant pediatric renal neoplasm with a genetic component associated with its etiology. Its clinical presentation is variable, ranging from asymptomatic to oligosymptomatic forms. Diagnosis is initially established through clinical history and physical examination, with imaging studies requested for diagnostic confirmation. Furthermore, treatment of this neoplasm involves a combination of therapeutic modalities, namely nephrectomy followed by systemic chemotherapy. Thus, early diagnosis and the integration of surgical and adjuvant approaches are essential to optimize prognosis, highlighting the importance of continuous scientific research and specialized care. Finally,

¹ E-mail: nathaliarates6@hotmail.com

there is a clear need to intensify efforts to ensure timely diagnosis and appropriate treatment for children affected by Wilms tumor.

Keywords: Wilms Tumor. Nephroblastoma. Wilms Tumor Gene-1. WT1 Gene.

RESUMO

Os tumores renais compreendem cerca de 7% de todos os tumores pediátricos, contudo o Tumor de Wilms é o tumor renal mais comum em crianças, principalmente daquelas na faixa etária entre 2 a 5 anos de idade. A sua causa ainda não está muito bem salientada, mas sabe-se que algumas condições genéticas podem estar associadas a um maior risco de desenvolvimento desse tumor. Por se tratar de uma neoplasia maligna, o diagnóstico precoce é primordial para a melhora do prognóstico do paciente. Dessa forma, é necessário realizar rastreio periodicamente, por meio de ultrassonografia de abdome, nos pacientes que possuem predisposição genéticas para essa neoplasia. A grande maioria dos pacientes cursam de forma assintomática, apresentando apenas uma massa abdominal palpável unilateral durante o exame físico. Contudo, outros possíveis sintomas associados a essa patologia são: hipertensão arterial, dor abdominal, hematúria, febre, anemia, leucocitose, constipação e fadiga. O esquema terapêutico para esse tumor abrange tratamento combinado que inclui quimioterapia, cirurgia para ressecção do tumor e/ou radioterapia. O estadiamento do Tumor de Wilms deve ser realizado por meio da análise de exames de imagem para detecção de massa nos rins e metástase a distância, e por meio disso é possível planejar o tratamento de maneira adequada e individualizada para cada paciente. O objetivo fundamental da pesquisa é realizar uma revisão bibliográfica acerca da influência genética no Tumor de Wilms, bem como é realizado seu diagnóstico e as novas opções terapêuticas para essa patologia. A metodologia adotada para a revisão bibliográfica proposta baseia-se na análise e leituras de artigos científicos publicados entre os anos de 2021 a 2025, os quais serão encontrados através de pesquisas nas plataformas PubMed, SciELO e Google Acadêmico, utilizando os unitermos: “Wilms Tumor”, “Tumor de Wilms”, “Nefroblastoma”, “Wilms tumor gene-1”, “gene WT 1”. Tendo como base o estudo realizado, percebe-se que Tumor de Wilms constitui uma neoplasia maligna renal infantil, de alta prevalência e que possui um componente genético associado à sua etiologia. Seu quadro clínico é bem variável, podendo ser assintomático ou oligossomático. O diagnóstico é inicialmente realizado por meio da história clínica e exame físico, exames de imagem podem ser solicitados para a confirmação diagnóstica. Ademais, o tratamento da neoplasia supracitada é realizado combinado algumas terapias, ou seja, nefrectomia seguida de quimioterapia sistêmica. Logo, o diagnóstico precoce e a integração de abordagens cirúrgicas e adjuvantes são fundamentais para otimizar o prognóstico, o que evidencia a importância de investigação científica contínua e de assistência especializada. Em síntese, percebe-se a necessidade de se empregar esforços para que haja o diagnóstico e o tratamento adequado das crianças acometidas pelo Tumor de Wilms.

Palavras-chave: Wilms Tumor. Tumor de Wilms. Nefroblastoma. Wilms Tumor Gene-1. Gene WT 1.

RESUMEN

Los tumores renales representan aproximadamente el 7% de todos los tumores pediátricos; sin embargo, el tumor de Wilms es el tumor renal más común en niños, especialmente en aquellos entre 2 y 5 años de edad. Su causa aún no se comprende completamente, pero se sabe que algunas condiciones genéticas pueden estar asociadas con un mayor riesgo de desarrollar este tumor. Al ser una neoplasia maligna, el diagnóstico temprano es fundamental para mejorar el pronóstico del paciente. Por lo tanto, es necesario el cribado periódico, mediante ecografía abdominal, en pacientes con predisposición genética a esta neoplasia. La gran mayoría de los pacientes son asintomáticos, presentando únicamente una masa

abdominal unilateral palpable durante la exploración física. Sin embargo, otros posibles síntomas asociados con esta patología son: hipertensión arterial, dolor abdominal, hematuria, fiebre, anemia, leucocitosis, estreñimiento y fatiga. El régimen terapéutico para este tumor implica un tratamiento combinado que incluye quimioterapia, cirugía para la resección del tumor y/o radioterapia. La estadificación del tumor de Wilms debe realizarse mediante el análisis de estudios de imagen para detectar masas renales y metástasis a distancia, lo que permite una planificación terapéutica adecuada e individualizada para cada paciente. El objetivo fundamental de esta investigación es realizar una revisión bibliográfica sobre la influencia genética en el tumor de Wilms, así como su diagnóstico y las nuevas opciones terapéuticas para esta patología. La metodología adoptada para la revisión bibliográfica propuesta se basa en el análisis y la lectura de artículos científicos publicados entre 2021 y 2025, que se encontrarán mediante búsquedas en las plataformas PubMed, SciELO y Google Académico, utilizando las palabras clave: "Wilms Tumor", "Tumor de Wilms", "Nefroblastoma", "Wilms tumor gene-1", "gene WT 1". Con base en el estudio realizado, se observa que el tumor de Wilms constituye una neoplasia renal maligna en niños, con alta prevalencia y un componente genético asociado a su etiología. La presentación clínica es bastante variable, pudiendo ser asintomática u oligosomática. El diagnóstico se realiza inicialmente mediante la historia clínica y la exploración física. Se pueden solicitar estudios de imagen para la confirmación diagnóstica. Además, el tratamiento de la neoplasia mencionada implica una combinación de terapias, concretamente nefrectomía seguida de quimioterapia sistémica. Por lo tanto, el diagnóstico precoz y la integración de enfoques quirúrgicos y adyuvantes son fundamentales para optimizar el pronóstico, lo que resalta la importancia de la investigación científica continua y la atención especializada. En resumen, es necesario realizar esfuerzos para garantizar el diagnóstico y el tratamiento adecuado de los niños afectados por el tumor de Wilms.

Palabras clave: Tumor de Wilms. Nefroblastoma. Gen-1 del Tumor de Wilms. Gen WT1.

1 INTRODUCTION

Renal neoplasms represent a significant portion of solid tumors in childhood, accounting for approximately 7% to 8% of all pediatric neoplasms, with Wilms' tumor standing out as the most prevalent entity in this age group (JÚNIOR; BURNS; LOPEZ, 2021; PEDIATRIA, 2024). Wilms' Tumor, also called nephroblastoma, is an embryonic malignant neoplasm of the kidney that predominantly affects children under five years of age, with a peak incidence between two and five years of age (INCA, 2022; LESLIE; SAJJAD; MURPHY, 2025).

From a historical and conceptual point of view, Wilms' Tumor has been described as a neoplasm derived from remnants of the metanephric blastema, reflecting failures in the normal processes of renal differentiation and maturation during embryonic development (KUMAR, 2018; PRAY; PERSAUD; TORCHIA, 2022). These embryological alterations justify the characteristic histological composition of the tumor, often described as triphasic, including blastematosus, epithelial, and stromal components (KUMAR, 2018; SILVA et al., 2021). Advances in molecular genetics have allowed a better understanding of the etiopathogenesis of Wilms' Tumor, evidencing the participation of mutations and epigenetic alterations in genes that regulate renal development, such as WT1, WT2, WTX, and CTNNB1 (KUMAR, 2018; ZENG et al., 2024). In addition, the association of nephroblastoma with specific genetic syndromes, such as WAGR, Denys-Drash, and Beckwith-Wiedemann, reinforces the central role of genetics in tumor genesis and risk stratification in these patients (LESLIE; SAJJAD; MURPHY, 2025; PEDIATRIA, 2024).

Clinically, Wilms' Tumor presents insidiously in most cases, with a painless abdominal mass being the most frequent finding, often identified incidentally by caregivers (ALVES FILHO et al., 2024; IVO BRAZ et al., 2022). Other signs and symptoms may include hematuria, abdominal pain, hypertension, and nonspecific systemic manifestations, especially in more advanced stages of the disease (SILVA et al., 2023; SILVA et al., 2021).

The diagnosis of Wilms' Tumor is based on the correlation between clinical data, imaging tests and histopathological evaluation, with abdominal ultrasonography being the most used initial method, followed by computed tomography or magnetic resonance imaging for staging and therapeutic planning (MOORE; AGUR, 2024; MAIA et al., 2022). The correct identification of tumor staging and histological subtype is essential for defining the therapeutic approach and for prognostic estimation (PDQ, 2024; PEDIATRIA, 2024).

The treatment of Wilms' Tumor is characterized by a multimodal approach, involving surgery, chemotherapy and, in specific situations, radiotherapy, with well-established protocols that have provided a significant increase in survival rates in recent decades (PDQ,

2024; SILVA et al., 2021). Despite therapeutic advances, late treatment-related effects, such as renal dysfunction, cardiotoxicity, and growth changes, remain relevant challenges in the long-term follow-up of these patients (SILVENTE BERNAL et al., 2024).

In this context, it is essential to carry out bibliographic reviews that integrate current knowledge about the genetic, diagnostic, and therapeutic aspects of Wilms' Tumor, contributing to scientific updating and improving clinical practice (MAIA et al., 2022; ZENG et al., 2024).

Thus, the present study aims to comprehensively review the scientific literature on Wilms' Tumor, addressing its main genetic aspects, diagnostic methods, and therapeutic strategies, in light of the most recent evidence available (PDQ, 2024; PEDIATRIA, 2024).

2 MATERIALS AND METHODS

The present study consists of a narrative literature review, with a qualitative approach and descriptive-analytical character, developed with the objective of gathering and critically analyzing the existing scientific production on Wilms' Tumor, with emphasis on its genetic aspects, diagnostic methods and therapeutic approaches. The research was carried out through data collection in recognized scientific databases, including PubMed/MEDLINE, SciELO and Google Scholar, in addition to consulting textbooks, academic dissertations and official documents of government agencies in the health area, using the physical and digital infrastructure of the University of Ribeirão Preto. Descriptors in Portuguese and English, such as "Wilms Tumor", "Wilms Tumor", "Nephroblastoma", "Wilms tumor gene-1" and "WT1 gene", were applied in isolation or in combination. As inclusion criteria, we selected publications available in full, in Portuguese, English, or Spanish, published between 2021 and 2025, which directly addressed genetic aspects, clinical, laboratory, and imaging diagnoses, as well as therapeutic strategies related to Wilms' Tumor, excluding duplicate studies, outside the time frame, or not relevant to the proposed objectives. The selected materials were submitted to exploratory and analytical reading, with data organization according to the thematic axes of the study, and the findings were discussed with the advisor and analyzed in a qualitative and comparative way, in order to identify convergences, divergences and advances in scientific knowledge.

3 RESULTS

The analysis of the selected scientific literature showed that Wilms' Tumor is the main malignant renal neoplasm of childhood, accounting for approximately 85% to 90% of pediatric renal tumors and about 7% to 8% of all malignant neoplasms in this age group (JÚNIOR;

BURNS; LOPEZ, 2021; PEDIATRICS, 2024; LESLIE; SAJJAD; MURPHY, 2025). The reviewed studies showed a higher incidence in children under the age of five, with a peak between two and five years, with no absolute consensus regarding the predominance by sex (INCA, 2022; SILVA et al., 2023).

Regarding genetic aspects, the findings pointed to a strong association between Wilms' Tumor and alterations in genes involved in renal embryonic development, especially the genes WT1, WT2, WTX, and CTNNB1, located mostly on chromosome 11 (KUMAR, 2018; ZENG et al., 2024). A consistent relationship was also observed between nephroblastoma and specific genetic syndromes, such as WAGR, Denys-Drash and Beckwith-Wiedemann, which significantly increase the risk of tumor development in the pediatric population (LESLIE; SAJJAD; MURPHY, 2025; PRAY; PERSAUD; TORCHIA, 2022).

Regarding the clinical manifestations, the reviewed literature indicated that the most frequent presentation of Wilms' Tumor is the presence of a painless abdominal mass, often detected incidentally by those responsible for it (ALVES FILHO et al., 2024; IVO BRAZ et al., 2022). Other recurrent clinical signs include abdominal pain, hematuria, arterial hypertension secondary to activation of the renin-angiotensin system, and, in more advanced stages, systemic symptoms such as fever, anorexia, weight loss, and anemia (SILVA et al., 2021; SILVA et al., 2023).

Regarding the diagnosis, the results showed that imaging methods play a central role in the initial investigation, with abdominal ultrasonography being the first-line examination, followed by computed tomography or magnetic resonance imaging for tumor staging and evaluation of local and metastatic extension (MOORE; AGUR, 2024; MAIA et al., 2022). Diagnostic confirmation is based on histopathological analysis, in which Wilms' Tumor classically presents a triphasic pattern composed of blastematosus, epithelial, and stromal elements, although histological variants have also been described (KUMAR, 2018; SILVA et al., 2021).

In the field of laboratory markers, studies have shown that there is, to date, no specific serum marker widely validated for Wilms Tumor, however recent evidence points to an increase in alpha-fetoprotein in rare subgroups of patients, suggesting potential future utility as a complementary biomarker (GREEN et al., 2024). In parallel, investigations in molecular genetics and bioinformatics have identified candidate genes with possible prognostic and therapeutic value, broadening the prospects for personalized medicine (ZENG et al., 2024).

With regard to treatment, the results confirmed that the therapeutic approach to Wilms' Tumor is predominantly multimodal, involving surgery, chemotherapy and, in selected cases,

radiotherapy, according to staging and histological subtype (PDQ, 2024; PEDIATRIA, 2024). Radical nephrectomy remains the standard surgical treatment, being associated with chemotherapy regimens based mainly on vincristine, actinomycin D, and doxorubicin, which has provided high survival rates, especially in cases diagnosed early (PDQ, 2024; SILVA et al., 2021).

In view of the above, the literature analyzed showed that, despite therapeutic advances and favorable prognosis, the late effects of treatment, such as renal dysfunction, cardiotoxicity, growth alterations, and increased risk of secondary neoplasms, represent important challenges in the long-term follow-up of surviving patients (SILVENTE BERNAL et al., 2024; PEDIATRIA, 2024).

4 DISCUSSION

The results obtained in this literature review corroborate the literature by showing Wilms' Tumor as the main malignant renal neoplasm of childhood, with a high incidence in children under five years of age, a fact that reinforces its embryonic nature and its close relationship with failures in renal differentiation processes during fetal development (JÚNIOR; BURNS; LOPEZ, 2021; PRAY; PERSAUD; TORCHIA, 2022). This characteristic explains both the observed age peak and the frequent association with congenital genetic alterations and developmental syndromes (LESLIE; SAJJAD; MURPHY, 2025).

The discussion of genetic aspects shows that mutations in the WT1, WT2, WTX, and CTNNB1 genes play a central role in the pathogenesis of Wilms' Tumor, since these genes act directly in the regulation of nephrogenesis and in the maintenance of renal cell differentiation (KUMAR, 2018; ZENG et al., 2024). The consistent association with syndromes such as WAGR, Denys-Drash, and Beckwith-Wiedemann reinforces the importance of clinical surveillance in children with these conditions, since early screening can positively impact prognosis (LESLIE; SAJJAD; MURPHY, 2025; PEDIATRIA, 2024).

In the clinical context, the predominance of a painless abdominal mass as the main manifestation reinforces the insidious nature of the disease and explains the often late diagnosis in some cases, especially in populations with limited access to health services (ALVES FILHO et al., 2024; IVO BRAZ et al., 2022). The presence of signs such as hematuria, hypertension, and systemic symptoms in more advanced stages highlights the importance of detailed clinical evaluation and early diagnostic suspicion by health professionals (SILVA et al., 2021; SILVA et al., 2023).

The analysis of diagnostic methods demonstrates that imaging tests are indispensable in the identification and staging of Wilms' Tumor, and abdominal ultrasonography is widely

recommended as an initial test due to its accessibility and absence of ionizing radiation (MOORE; AGUR, 2024; MAIA et al., 2022). Computed tomography and magnetic resonance imaging complement the investigation by providing detailed information on tumor extension, vascular involvement, and the presence of metastases, essential aspects for therapeutic planning (PDQ, 2024). Histopathological confirmation remains the diagnostic gold standard, with the identification of the triphasic pattern being a classic element, although the existence of histological variants requires special attention due to their prognostic implication (KUMAR, 2018; SILVA et al., 2021). The distinction between tumors of favorable and unfavorable histology is decisive in the stratification of risk and in the choice of treatment intensity, as recommended by the main international protocols (PDQ, 2024; PEDIATRIA, 2024).

With regard to laboratory markers, the absence of specific serum biomarkers limits noninvasive follow-up of the disease, although recent studies indicate an increase in alpha-fetoprotein in rare subgroups of patients, which opens perspectives for future clinical applications and additional research (GREEN et al., 2024). At the same time, advances in bioinformatics and molecular genetics have allowed the identification of candidate genes with potential prognostic and therapeutic value, pointing to the possibility of more personalized approaches in the future (ZENG et al., 2024).

The discussion about treatment shows that the multimodal approach, involving surgery, chemotherapy and, in selected cases, radiotherapy, is responsible for the high survival rates currently observed, especially in patients diagnosed in early stages (PDQ, 2024; SILVA et al., 2021). Radical nephrectomy associated with standardized chemotherapy regimens has established itself as an effective therapeutic strategy, reflecting the advances in pediatric oncology in recent decades (PEDIATRIA, 2024).

However, despite the favorable prognosis, the late effects of treatment represent a growing challenge, including chronic renal dysfunction, cardiotoxicity related to the use of anthracyclines, growth alterations, and increased risk of secondary neoplasms (SILVENTE BERNAL et al., 2024). These findings reinforce the need for longitudinal follow-up of these patients and the continuous search for less toxic and more targeted therapies (GREEN et al., 2024; ZENG et al., 2024).

As a result, the discussion of the analyzed data shows that Wilms' Tumor, although it has high cure rates, still requires advances in early diagnosis, individualization of treatment, and reduction of late sequelae, highlighting the relevance of integrative literature reviews for scientific updating and improvement of medical practice (MAIA et al., 2022; PEDIATRIA, 2024).

5 FINAL CONSIDERATIONS

The present literature review allowed us to consolidate the understanding that Wilms' Tumor is the main malignant renal neoplasm of childhood, with high clinical and epidemiological relevance, especially in children under five years of age, which reinforces its close relationship with embryological and genetic alterations of renal development (JÚNIOR; BURNS; LOPEZ, 2021; PRAY; PERSAUD; TORCHIA, 2022). The findings show that the etiopathogenesis of nephroblastoma is strongly associated with mutations and epigenetic alterations in nephrogenesis regulatory genes, such as WT1, WT2, WTX, and CTNNB1, as well as the occurrence of specific genetic syndromes, which require differentiated clinical surveillance and early screening (KUMAR, 2018; LESLIE; SAJJAD; MURPHY, 2025; ZENG et al., 2024).

From a clinical and diagnostic point of view, it was found that the insidious presentation of the disease, characterized mainly by the presence of a painless abdominal mass, poses challenges to early detection, highlighting the importance of clinical suspicion and timely access to appropriate imaging methods (ALVES FILHO et al., 2024; MAIA et al., 2022). The association between imaging studies and histopathological evaluation proved to be indispensable for the correct tumor staging and for the definition of the prognosis, especially with regard to the differentiation between favorable and unfavorable histology (MOORE; AGUR, 2024; KUMAR, 2018; SILVA et al., 2021).

With regard to treatment, the studies analyzed demonstrated that the multimodal approach, based on nephrectomy associated with chemotherapy and, in selected cases, radiotherapy, resulted in significant survival rates, evidencing the advances achieved by pediatric oncology in recent decades (PDQ, 2024; PEDIATRIA, 2024). However, the late effects related to the therapies employed, such as renal dysfunction, cardiotoxicity, and growth changes, remain important challenges in the long-term follow-up of surviving patients, requiring continuous and individualized follow-up strategies (SILVENTE BERNAL et al., 2024).

In view of this, it is observed that recent advances in molecular genetics and in the identification of potential biomarkers open promising perspectives for the development of more targeted and less toxic therapeutic approaches, contributing to the improvement of the quality of life of patients affected by Wilms' Tumor (GREEN et al., 2024; ZENG et al., 2024).

In view of the above, it is concluded that the continuity of scientific research in this area is essential for the improvement of early diagnosis, therapeutic individualization and the reduction of late sequelae, reaffirming the relevance of literature review studies for updating

knowledge and strengthening evidence-based medical practice (MAIA et al., 2022; PEDIATRIA, 2024).

REFERENCES

- Alves Filho, A. B. M., Rocha, A. L. G., Cunha, I. A., Corrêa, P. X. A., & Mattos, G. A. (2024). Tumor de Wilms: Manifestações clínicas e tratamento cirúrgico. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 10(3), 138–148. <https://doi.org/10.51891/rease.v10i3.13132>
- Dalley II, A. F., & Agur, A. M. R. (2024). *Moore anatomia orientada para a clínica* (9ª ed.). Guanabara Koogan. (E-book; ISBN 978-85-277-4012-8)
- Green, R., Ahmed, A., Fleming, B., Long, A. M., Behjati, S., Trotman, J., Tarpey, P., Nicholson, J. C., Coleman, N., Hook, C. E., & Murray, M. J. (2024). Wilms tumor with raised serum alpha-fetoprotein: Highlighting the need for novel circulating biomarkers. *Pediatric and Developmental Pathology*, 27(3), 260–265. <https://doi.org/10.1177/10935266231213467>
- Ivo Braz, M., Félix Lima Gomes, W., Katarina Gonçalves de Siqueira, A., & Azevedo Foinquinos, R. (2022). Diagnóstico e manejo do tumor de Wilms na população infantil. *Anais da Faculdade de Medicina de Olinda*, 1(7), 42–49. <https://doi.org/10.56102/afmo.2022.210>
- Júnior, D. C., Burns, D. A. R., & Lopez, F. A. (2021). *Tratado de pediatria: Vol. 2* (5ª ed.). Manole.
- Kumar, V. (2018). *Robbins patologia básica* (10ª ed.). GEN Guanabara Koogan. (E-book; ISBN 978-85-9515-189-5)
- Leslie, S. W., Sajjad, H., & Murphy, P. B. (2023). Wilms tumor. In StatPearls. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK442013/>
- Maia, A. G., et al. (2022). Abordagens no diagnóstico diferencial das neoplasias infantis: Foco em tumor de Wilms, impacto e abrangência. *Revista Coopex*, 13(2), 124–134. <https://doi.org/10.61223/coopex.v13i2.592>
- Moore, K. L., Persaud, T. V. N., & Torchia, M. G. (2022). *Embriologia básica* (10ª ed.). GEN Guanabara Koogan. (E-book; ISBN 978-85-9515-902-0)
- Pediatria, Sociedade Brasileira de. (2024). *Tratado de pediatria* (6ª ed.). Manole.
- PDQ Pediatric Treatment Editorial Board. (2024). Wilms tumor and other childhood kidney tumors treatment (PDQ®): Health professional version. In PDQ cancer information summaries. National Cancer Institute. <https://www.cancer.gov/types/kidney/hp/wilms-treatment-pdq>
- Schünke, M., Schulte, E., & Schumacher, U. (2024). *Prometheus | Coleção - Atlas de anatomia: 3 volumes* (6ª ed.). Guanabara Koogan. (E-book; ISBN 978-85-277-4053-1)
- Silva, A. M. J., Mota, A., Santana, A., Valois, R., Augusto, T., Lomanto, T., Cyrino, R. F., Marinho, D. L., Nunes, K. C., Alencar, A. C. S., Santos, V. G. M., Rocha, M. T., Amorim, B. V. V. C., Sauer, R. M., & Veiga, S. O. (2023). Tumor de Wilms. *Revista FT*. <https://revistaft.com.br/tumor-de-wilms/>
- Silva, J. M. M., Schoenberger Kipper, A. C., dos Santos Neves, B. H., Suptitz Borges, D., Lemos Salmazo, E., Pimenta Fernandes, F., Garbuio Vendramini, G., Camoesi Beltellini, S., Oliveira Reis, S., & Gonçalves da Cunha Júnior, A. (2021). Características e manejo

do tumor de Wilms: Uma revisão narrativa. *Revista Eletrônica Acervo Saúde*, 13(5), Article e7149.

Silvente Bernal, S., Girón Vallejo, O., Sánchez Sánchez, A., Menacho Hernández, C., Rodón Berrío, J., & Parra Gelder, B. A. (2024). Late effects of Wilms' tumor treatment. *Cirugía Pediátrica*, 37(3), 116–122. <https://doi.org/10.54847/cp.2024.03.13>

Tumor de Wilms. (2022). Instituto Nacional de Câncer (INCA). <https://www.gov.br/inca/pt-br/assuntos/cancer/tipos/infantojuvenil/especificos/tumor-de-wilms>

Zeng, Q., Liu, T., Qin, L., Wang, C., Peng, G., Liu, Z., & Tao, J. (2024). Screening of potential hub genes involved in kidney Wilms tumor via bioinformatics analysis and experimental validation. *BMC Cancer*, 24, Article 771. <https://doi.org/10.1186/s12885-024-12541-x>

Zugaib, M. (2023). *Zugaib obstetrícia* (5ª ed.). Manole. (E-book; ISBN 978-65-5576-934-0)

SURVEY ON ACCESSIBILITY OF PACKAGING IN THE COSMETIC INDUSTRY

LEVANTAMENTO SOBRE ACESSIBILIDADE DE EMBALAGENS NA INDÚSTRIA COSMÉTICA

ENCUESTA SOBRE LA ACCESIBILIDAD DE LOS ENVASES EN LA INDUSTRIA COSMÉTICA



<https://doi.org/10.56238/sevened2026.008-163>

**Fernanda de Medeiros Costa¹, Giovanna Couto de Sá², Pâmela Paes-Pereira³,
Everton Moura Arruda⁴, Wallace Lira⁵, Ellen Regina da Costa Paes⁶**

ABSTRACT

Brazilian Law No. 13.146/2015 defines a disabled person as someone with long-term physical, mental, intellectual, or sensory impairment which, when interacting with certain barriers, restricts their full and equal participation in society. In Article 3, paragraph IX, a person with reduced mobility is characterised as someone who, presents a permanent or temporary difficulty in movement, flexibility, motor coordination, or perception, thus including elderly, pregnant and obese people, as well as people suffering from fibromyalgia, lupus, or Parkinson's disease. The project aimed to reveal the difficulties people with disabilities or with reduced mobility face when using existing cosmetic packaging. The Scielo, PubMed, Google Scholar, and LILACS platforms were used as the basis for an integrative review, as well as searches on news websites focusing on the project's key themes (Accessibility; Cosmetics; Packaging), with publications limited to 2000–2024. After the reviews, the data were gathered to create the questionnaire, which then served as the analysis tool. Social media platforms were used for disseminating the project. The results showed that 14% of the subjects required assistance when handling the products, and 44% did not know where to obtain more accessible packaging. This demonstrates a lack of interest that cosmetic brands show in including this group in packaging development, even though these users have a right to such

¹ Graduated in Pharmacy. Universidade Federal do Amazonas (UFAM). Amazonas, Brazil.

E-mail: fernandamcosta003@gmail.com Orcid: <https://orcid.org/0009-0002-1491-7226>

Lattes: <http://lattes.cnpq.br/6782537429753716>

² Undergraduated student in Pharmacy. Universidade Federal do Amazonas (UFAM). Amazonas, Brazil.

E-mail: giovannacsa2002@gmail.com Orcid: <https://orcid.org/0009-0004-0469-8503>

Lattes: <http://lattes.cnpq.br/9072494597185095>

³ Graduated in Psychology. Universidade Federal do Amazonas (UFAM). Amazonas, Brazil.

E-mail: psipamelapaes@gmail.com Orcid: <https://orcid.org/0009-0002-3616-4499>

Lattes: <http://lattes.cnpq.br/4322655745146956>

⁴ Master's degree in Production Engineering. Instituto Federal do Amazonas (IFAM). Amazonas, Brazil.

E-mail: evertonverde@gmail.com Orcid: <https://orcid.org/0000-0001-5305-3577>

Lattes: <http://lattes.cnpq.br/8458855239132157>

⁵ Master's degree in Science Education in the Amazon. Instituto Federal do Amazonas (IFAM). Amazonas, Brazil.

E-mail: wallace.lira@ifam.edu.br Orcid: <https://orcid.org/0009-0008-8153-2055>

Lattes: <http://lattes.cnpq.br/7834505234728150>

⁶ Dr. in Anesthesiology. Universidade Federal do Amazonas (UFAM). Amazonas, Brazil.

E-mail: ellenpaes@ufam.edu.br Orcid: <https://orcid.org/0000-0001-9922-727X>

Lattes: <http://lattes.cnpq.br/1993288210558001>

accommodations. The need for the implementation of accessible packaging was observed, as a means of promoting autonomy for its users and thus fostering social inclusion.

Keywords: Accessibility. Cosmetic Industry. Packing.

RESUMO

A Lei Nº 13.146/2015 define como pessoa com deficiência aquela que possui impedimentos físicos, mentais, intelectuais ou sensoriais de longo prazo que, ao interagir com barreiras, limitam sua participação plena e igualitária na sociedade. Quanto ao Art. 3º, parágrafo IX, caracteriza a pessoa com mobilidade reduzida como alguém que, por qualquer motivo, apresenta dificuldade permanente ou temporária de movimentação, flexibilidade, coordenação motora ou percepção, assim considerando as pessoas idosas, gestantes, pessoas com obesidade, fibromialgia, Lúpus ou Parkinson. O projeto teve a intenção de revelar as dificuldades de pessoas com deficiência ou com mobilidade reduzida ao manusear embalagens cosméticas já presentes no mercado. As plataformas Scielo, PubMed, Google Scholar e LILACS, foram utilizadas como base à revisão integrativa, assim como pesquisas em sites de notícias com direcionamento aos postos-chave do projeto (Acessibilidade; Cosméticos; Embalagens;) com limitação das publicações de 2000-2024. Após as revisões, foram coletados os dados necessários para formulação do questionário onde foi utilizado como instrumento para análise. Para a divulgação do projeto, utilizou-se a plataformas sociais. Por meio dos resultados, observou-se que 14% necessitavam de ajuda ao manusear os produtos e 44% não sabiam onde adquirir embalagens mais acessíveis para manejo. Isso demonstra o desinteresse por parte das marcas em incluir esse tipo de público durante a produção de suas embalagens mesmo sendo um direito destes. Observou a necessidade de implementação de embalagens acessíveis como forma de autonomia para os seus usuários, promovendo assim a inclusão social.

Palavras-chave: Acessibilidade. Indústria Cosmética. Embalagem.

RESUMEN

La Ley n.º 13.146/2015 define como persona con discapacidad aquella que tiene impedimentos físicos, mentales, intelectuales o sensoriales de larga duración que, al interactuar con barreras, limitan su participación plena e igualitaria en la sociedad. En cuanto al artículo 3, párrafo IX, caracteriza persona con movilidad reducida como alguien que, por cualquier motivo, presenta dificultades permanentes o temporales de movimiento, flexibilidad, coordinación motora o percepción, incluyendo así a las personas mayores, embarazadas, personas con obesidad, fibromialgia, lupus o Parkinson. El proyecto tenía la intención de revelar las dificultades de personas con discapacidad o movilidad reducida para manipular los envases de cosméticos ya presentes en el mercado. Las plataformas Scielo, PubMed, Google Scholar y LILACS se utilizaron como base para la revisión integradora, así como búsquedas en sitios web de noticias orientadas a los puntos clave del proyecto (accesibilidad, cosméticos, envases), con limitación de publicaciones entre 2000-2024. Tras las revisiones, se recopilaron los datos necesarios para la elaboración del cuestionario, que se utilizó como instrumento de análisis. Para divulgación del proyecto se utilizaron las plataformas sociales. A partir de los resultados, se observó que 14 % necesitaba ayuda para manipular los productos y 44 % no sabía dónde adquirir envases más accesibles para su manipulación. Esto demuestra la falta de interés por parte de las marcas en incluir a este tipo de público durante la producción de sus envases. Se observó la necesidad de implementar envases accesibles como forma de autonomía para sus usuarios, promoviendo así la inclusión social.

Palabras clave: Accesibilidad. Industria Cosmética. Envase.

1 INTRODUCTION

According to Law No. 13,146/2015, we define Art. 2 - a person with a disability is one who has a long-term physical, mental, intellectual or sensory impairment, which, in interaction with one or more barriers, may obstruct his or her full and effective participation in society on an equal basis with other people. Article 3, paragraph IX – person with reduced mobility: one who has, for any reason, difficulty in movement, permanent or temporary, generating an effective reduction in mobility, flexibility, motor coordination or perception, including the elderly, pregnant women, breastfeeding women, people with infants and obese people. We also observed reduced mobility in people with some morbidities such as: Fibromyalgia, rheumatoid arthritis, Lupus, Parkinson's, among others.

In article 53 of the same Law mentioned above, all Brazilians with a disability or motor impediment have the right to accessibility in order to have their dignity and individual integrity ensured, so that they can live together as independent and active citizens. Despite this, it is noted that even with such a right, accessibility does not always reach this part of the population due to the little interest of large industries because they do not consider such adaptations to be profitable.

The Brazilian cosmetics market has been growing significantly over the decade, ranking 4th in the world (Forbes, 2020). This is due to the search for products that help improve their appearance, since in today's society, an individual's physiognomy has a direct impact on their physical-mental health (BORBA; THIVES, 2011). In addition, the influence of the new digital era can be evaluated, with the emergence of "influencers" with motor disabilities or reduced mobility, presenting their difficulties in handling cosmetic packaging. To what extent is the beauty and personal care market willing to grow following the inclusion of these individuals?

The struggle for the inclusion of groups considered minorities within Brazilian society has been growing continuously over the years, this is observed in the achievement of the creation of the Statute of Persons with Disabilities, where their rights to accessibility are assured. However, it is noted that in their daily lives, there is a lack of implementation of these adaptations that offer them autonomy in their daily lives. Such neglect can be seen, for example, in the scarcity of accessible packaging in cosmetic products, thus resulting in a difficulty in their use due to certain movements that they are unable to perform due to their deficiencies (FOLGADO; CRUZ; SAMPAIO, 2023).

In view of this, the repercussion caused by the research on the survey of accessible packaging in the middle of the cosmetic industry for individuals with disabilities would be able

to positively influence several aspects of the Brazilian community. This impact can be analyzed both in the cosmetic industries and within Brazilian society through:

- Reduction of social exclusion: The research can help reduce the social exclusion of people with disabilities or motor difficulties due to some comorbidity in relation to cosmetic products. This accessibility is guaranteed to them in Law No. 13,146/2015, art. 53 from adaptations of packaging already on the market.
- Awareness of Non-PWDs: Based on the results obtained from the survey, it may be possible to open the debate on the difficulties of PWDs or people with reduced mobility to enjoy beauty and self-care products. This can result in the awareness of people who do not have any disability to help demand that large cosmetic industries adapt and look at this minority in order to guarantee their equality rights that are guaranteed in the Brazilian Constitution.
- Inclusive companies: Through the project, the results can evaluate which companies have in their policy the inclusion of their products for people with disabilities or some type of motor limitation.

With these results, positive marketing can be generated on behalf of these institutions and have an increase in their demands. In this way, other companies may seek to change the packaging of their products in order to compete with institutions that had favorable results in the survey.

The need to implement accessible packaging helps to develop autonomy for its users, thus promoting social inclusion. This type of object is not only of great use to its target audience, but it also contributes to the education of people who do not have any type of need, as they learn the importance of collective integration through the adaptation of packaging. In addition, Law No. 10,098/2000 establishes general standards and basic criteria for the promotion of accessibility for people with disabilities or reduced mobility (LIMA, 2022).

The project aims to reveal and present the difficulties of people with disabilities or reduced mobility when handling cosmetic packaging already on the market. To evaluate how much the industry is willing to adapt to serve an audience that is not considered the majority in society in order to obtain the inclusion of these in activities that Non-PWDs consider basic and that, supposedly, they have no difficulty in performing routinely, such as the act of screwing and opening a lid that for many with muscle weakness is a difficult action.

2 METHODOLOGY

To carry out the project, initially readings were carried out on the Scielo, PubMed, Google Scholar and LILACS platforms, as well as searches on news sites with direction to the key positions of the project (Accessibility; Cosmetics; Packaging) and limiting the literatures to publications from 2000-2024. This selection was carried out during the period from August 2024 to December 2024. The selected literatures fit the theme of the research and its social impacts addressed.

After the integrative reviews, the necessary data were collected for the formulation of the questionnaire that will be used as an instrument for analysis, after its approval by the Ethics Committee due to the project involving responses from human beings. The approval is under opinion 7,311,984. To publicize the project, social platforms were used in order to reach greater responses (Figure 1).

Figure 1

Final design for publishing the post on Instagram and Tiktok platforms



Source: The authors. Manaus, 2025.

3 RESULTS

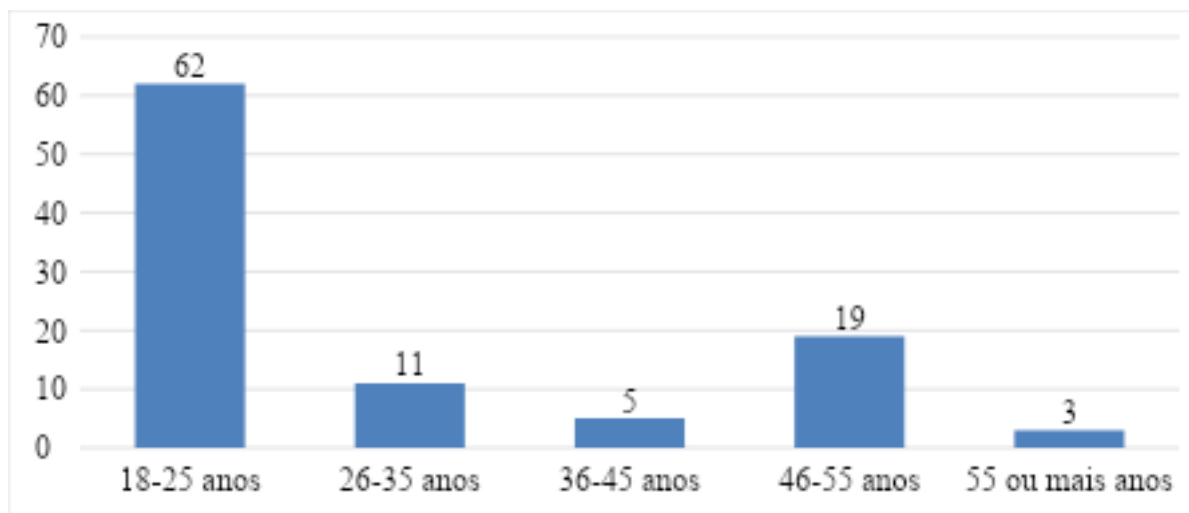
At the beginning of the questionnaire, the participants were presented with the Informed Consent Form (ICF), approved by the Ethics Committee. After reading, those who agreed to fill out the questionnaire checked the option "I have read and agree to participate in the research on the theme: "Survey on packaging accessibility in the cosmetic industry". The questionnaire obtained 100 responses, of which 100% consented to participate in the research after reading the terms presented in the ICF.

The 100 participants stated that they were aged between 18 and 80 years, met the other inclusion criteria of this project, and their answers did not fit the exclusion criteria, so no questionnaire was discarded for data analysis. It is observed that the main audience

reached by the survey is aged between 18 and 25 years, totaling 62 participants, and the smallest audience reached is 55 years old or older, totaling 3 participants (Figure 2).

Figure 2

Age of the participants



Source: Prepared by the authors. Manaus, 2025.

It was found that 90% of the participants stated that they were female, 8.9% of the participants stated that they were male and 1.1% of the participants stated that they preferred not to say.

The question "If not, which country?" was discarded because 100% of the participants had stated in the question "Resident of Brazil?" to live in Brazil. Of which, 95 are residents of Manaus-AM and each of the other participants resides in: Praia Grande-SP (1) ; Brasília-DF (1) ; Lavras-MG (1); Olinda- PE (1); Barueri - SP(1).

After the end of the sociodemographic survey of the participants, the questionnaire was started asking if they had any disability or reduced mobility, in which 98% denied and 2% confirmed. When asked if they had any health condition that had difficulty handling, whether opening or closing packages, 92% reported that they did not and 8% said they did, with rheumatoid arthritis being the first (5 answers) followed by diabetes and fibromyalgia (both with 2 answers).

Table 1

Question 2: "Do you have any difficulty opening cosmetic packaging?"

Participant	Reply
4	"Some have a very closed lid"
16	"Shampoos and sunscreens have a lid that is difficult to open."

48	"Enamel"
83	"I feel pain in the joints of my fingers, so I have difficulty opening certain packages"
93	"Some that are threaded are very firm"

Source: Prepared by the authors. Manaus, 2025.

When asked about the use of cosmetic products, 91% said they were users, while 9% denied it, with emphasis on: Makeup with 23 mentions; Skincare with 19 mentions and Perfume with 11 mentions.

Of the participants, 13% reported having some difficulty opening cosmetic packages while 87% denied it. Also, 19% stated that they use some instrument to open or close the containers, with scissors and knives being the most cited (10 answers of each).

When asked about knowing a company that produces cosmetics with adapted packaging or easy access for people with disabilities or reduced mobility, 82% denied knowing. Of the 18% who knew, the company Rare Beauty is in first place with 5 mentions, followed by the company O Boticário with 5 mentions.

Table 2 shows the comments of some participants about products that may have some adaptation in their packaging.

Table 2

Question 10: "What type of cosmetic product do you suggest a packaging adaptation?"

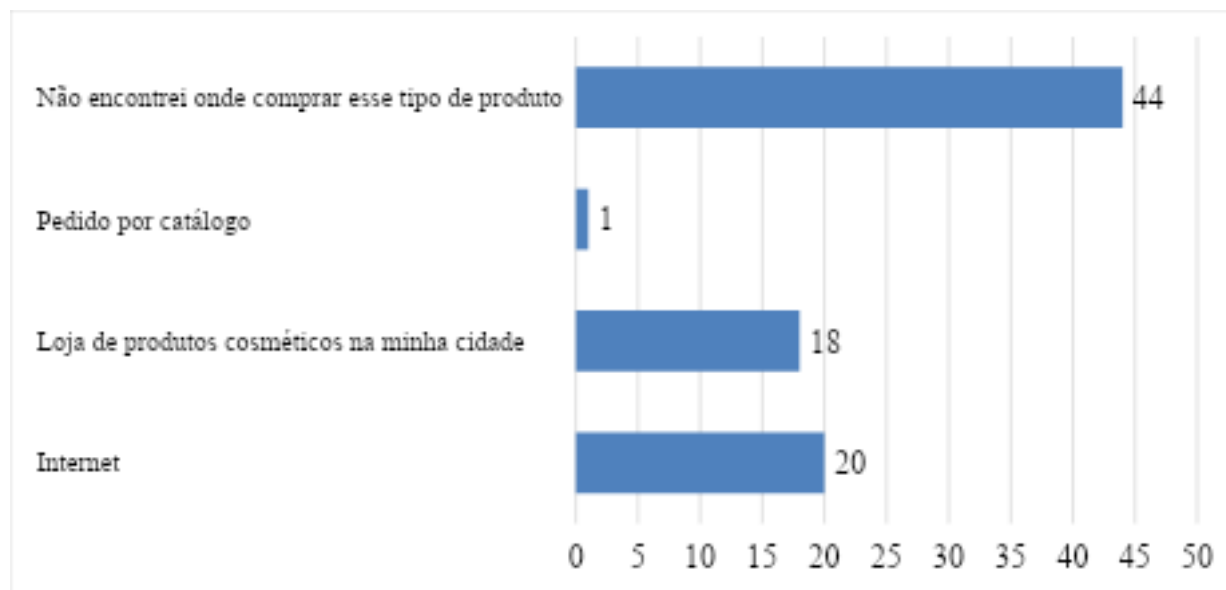
Participant	Reply
9	"Cosmetic caps that make it easy to open, braille texts on the packaging."
37	"Moisturizer packaging, some difficulties for the product to come off easily."
30	"My Lola Cosmetics styling cream is horrible to tighten, even without any mobility issues, I already have a lot of difficulty using it."
83	"All of the suggestions, but especially cosmetic products in which the caps are "screw-on"."

Source: Prepared by the authors. Manaus, 2025.

When asked about using some type of product with adapted packaging, 100 negative answers were obtained, without any affirmative experience. Figure 3 corresponds to the question about where they buy such products, where 44% claimed not to know where to buy them.

Figure 3

Question 13: "Where do you usually buy cosmetic products with adapted packaging or easy handling?"



Source: Prepared by the authors. Manaus, 2025.

4 DISCUSSION

It was observed that the popular understanding of cosmetics is often limited to the idea of products aimed exclusively at aesthetics and vanity, as noted in the mentions of makeup and perfumes. However, according to the definition of the National Health Surveillance Agency (ANVISA), cosmetics are products intended for external application with the purpose of cleaning, perfuming, protecting, altering the appearance or keeping parts of the body such as skin, hair, teeth and mucous membranes in good condition. This includes everyday items such as soaps, toothpastes, deodorants, and sunscreens. Despite this, many people deny the use of cosmetics because they associate the term with superficial practices, without realizing that they use these products daily. Such a perception reveals the erroneous precept of the word beyond the sociocultural stigma, especially related to gender.

It was also noted the difficulty on the part of the participants to handle certain cosmetic packaging, not limited only to individuals with reduced mobility or disabilities. This shows that this obstacle can be present in the lives of the population without disabilities.

In addition, the results demonstrate the lack of inclusion of the public with reduced mobility or with disabilities by the cosmetic industry during the manufacture of its products, such exclusion violates the rights guaranteed to them by law.

5 CONCLUSION

Despite technological advances, including access to information and the ease of obtaining goods over the internet, there is still a noticeable lack of brands that effectively implement accessibility principles in their products. Based on the data obtained by the project, it was noted that both populations (without or with some type of disability and/or reduced mobility) have certain barriers that prevent them from enjoying the cosmetics used in their daily lives in a practical and easy way. Accessibility, in this context, is not limited only to the presence of physical ramps or the use of simple language, but also involves the offer of adapted packaging (such as with braille writing or easy to open). This difficulty shows that the cosmetic market sees accessibility as a brand differential and not a right that is granted to PWDs or those with reduced mobility. It is therefore essential that the cosmetics industry moves beyond the minimum requirements and commits to inclusive practices, ensuring that everyone can fully exercise their right to personal care, hygiene and well-being.

ACKNOWLEDGMENTS

I thank everyone who accompanied me during this academic journey (family, friends, collaborators and classmates). To the laboratory, especially my advisor Prof. Dr. Ellen Regina da Costa Paes, for having welcomed me during the past year. To UFAM for the scientific initiation program.

REFERENCES

- Agência Nacional de Vigilância Sanitária. (2022). Cosméticos – Perguntas e respostas. <https://www.gov.br/anvisa/pt-br/assuntos/cosmeticos/perguntas-e-respostas>
- Borba, T. J., & Thives, F. M. (2011). Uma reflexão sobre a influência da estética na autoestima, auto-motivação e bem estar do ser humano [Trabalho de Conclusão de Curso, Universidade do Vale do Itajaí].
- Brasil. (2000). Lei nº 10.098, de 19 de dezembro de 2000. Estabelece normas gerais e critérios básicos para a promoção da acessibilidade das pessoas portadoras de deficiência ou com mobilidade reduzida, e dá outras providências. http://www.planalto.gov.br/ccivil_03/leis/l10098.htm
- Brasil. (2015). Lei nº 13.146, de 6 de julho de 2015. Institui a Lei Brasileira de Inclusão da Pessoa com Deficiência (Estatuto da Pessoa com Deficiência). https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13146.htm
- Folgado, L. F., Cruz, M. L. A. da, Sampaio, N. S. de A., & Moraes, F. F. (2023). Plump: Uma solução para pessoas com deficiência motora nos membros superiores e a falta de acessibilidade nas embalagens de maquiagem [Trabalho de Conclusão de Curso, Técnico em Marketing, Escola Técnica de São Sebastião].
- Lima, A. B. Q. (2022). Diretrizes para a criação de embalagens acessíveis de cosméticos com foco em usuários cegos ou com baixa visão [Trabalho de Conclusão de Curso,

Graduação em Design, Universidade Federal de Pernambuco].

Weber, M. (2020, julho). Brasil é o quarto maior mercado de beleza e cuidados pessoais do mundo. Forbes. <https://forbes.com.br/principal/2020/07/brasil-e-o-quarto-maior-mercado-de-beleza-e-cuidados-pessoais-do-mundo/>

SEXUAL VIOLENCE AGAINST HOMELESS WOMEN IN THE CITY OF MANAUS: A LEGAL ANALYSIS IN LIGHT OF FUNDAMENTAL RIGHTS

VIOÊNCIA SEXUAL CONTRA MULHERES EM SITUAÇÃO DE RUA NA CIDADE DE MANAUS UMA ANÁLISE JURÍDICA À LUZ DOS DIREITOS FUNDAMENTAIS

VIOLENCIA SEXUAL CONTRA MUJERES EN SITUACIÓN DE CALLE EN LA CIUDAD DE MANAUS: UN ANÁLISIS JURÍDICO A LA LUZ DE LOS DERECHOS FUNDAMENTALES



<https://doi.org/10.56238/sevened2026.008-164>

**Alessandra Souza Garcia¹, Alexandra Pantoja Monteiro², Dayla Corrêa Campos³,
Dimas Melo Gonçalves⁴, Elauton Guerra Mota de Farias⁵, Keyciane Cardoso Lima
Mascarenhas⁶, Maria Aparecida Jardim Marques⁷, Moisés da Silva Gomes Filho⁸,
Rick Wesley Feitosa Pinto⁹, Thais Bentes de Oliveira¹⁰**

ABSTRACT

This article examines sexual violence against homeless women in the city of Manaus, Brazil, in light of fundamental rights and the State's responsibility to protect human dignity. This qualitative study adopts a bibliographic and documentary approach, with a legal-analytical perspective, based on recent scientific literature, institutional reports, and normative frameworks related to gender-based violence, extreme vulnerability, and access to justice. The findings indicate that homelessness intensifies women's exposure to multiple forms of violence, aggravated by social invisibility, fragile public protection networks, and insufficient intersectoral policies. Sexual violence is identified as a serious violation of human rights, requiring State responses that go beyond criminal measures and include integrated strategies of shelter, prevention, and citizenship. It is concluded that effective responses demand articulation among justice systems, social assistance, public health, and urban policies, especially in regional contexts marked by inequality and institutional omission.

Keywords: Fundamental Rights. Homeless Population. Public Policies. Sexual Violence. Women.

¹ Law Student. Universidade Nilton Lins. E-mail: alessandra.alvesgarcia56@gmail.com

² Law Student. Universidade Nilton Lins. E-mail: alexandrapantojamonteiro.3@gmail.com

³ Graduated in Law. Universidade Nilton Lins. E-mail: dayla.advocacia@gmail.com

⁴ Master's degree in Process Engineering. Faculdade Santa Teresa. E-mail: dimasmelogoncalves@gmail.com

⁵ Technologist in Public Management. Universidade Pitágoras Unopar. E-mail: farias_guerra@hotmail.com

⁶ Law Student. Universidade Nilton Lins. E-mail: Keycianelima7@gmail.com

⁷ Law Student. Universidade Luterana do Brasil. E-mail: mariamarques.jur@gmail.com

⁸ Graduated in Pedagogy. Faculdade Salesiana Dom Bosco. E-mail: moises.filho2011@gmail.com

⁹ Law Student. Universidade Nilton Lins. E-mail: ricky.wesley22@gmail.com

¹⁰ Graduated in Law. Universidade Luterana do Brasil. E-mail: thaisbentesoliveira@gmail.com

RESUMO

O presente artigo examina a violência sexual contra mulheres em situação de rua na cidade de Manaus, à luz dos direitos fundamentais e da responsabilidade estatal na proteção da dignidade humana. Trata-se de uma pesquisa qualitativa, de caráter bibliográfico e documental, com abordagem jurídico-analítica, fundamentada em estudos científicos recentes, relatórios institucionais e dispositivos normativos relacionados à violência de gênero, vulnerabilidade extrema e acesso à justiça. Os resultados evidenciam que a condição de rua intensifica a exposição das mulheres a múltiplas formas de violência, agravada pela invisibilidade social, fragilidade das redes públicas de proteção e insuficiência de políticas intersetoriais. Constatou-se ainda que a violência sexual configura grave violação de direitos humanos, exigindo respostas estatais que ultrapassem o campo penal e incorporem estratégias integradas de acolhimento, prevenção e garantia de cidadania. Conclui-se que o enfrentamento efetivo demanda articulação entre justiça, assistência social, saúde pública e políticas urbanas, especialmente em contextos regionais marcados por desigualdade e omissão institucional.

Palavras-chave: Direitos Fundamentais. Mulheres. Políticas Públicas. População em Situação de Rua. Violência Sexual.

RESUMEN

Este artículo examina la violencia sexual contra mujeres en situación de calle en la ciudad de Manaus, Brasil, a la luz de los derechos fundamentales y de la responsabilidad del Estado en la protección de la dignidad humana. Se trata de una investigación cualitativa, de carácter bibliográfico y documental, con un enfoque jurídico-analítico, fundamentada en literatura científica reciente, informes institucionales y marcos normativos relacionados con la violencia de género, la vulnerabilidad extrema y el acceso a la justicia. Los resultados evidencian que la condición de calle intensifica la exposición de las mujeres a múltiples formas de violencia, agravada por la invisibilidad social, la fragilidad de las redes públicas de protección y la insuficiencia de políticas intersectoriales. Se concluye que la violencia sexual constituye una grave violación de los derechos humanos y exige respuestas estatales que superen el ámbito penal, incorporando estrategias integradas de acogida, prevención y garantía de ciudadanía.

Palabras clave: Derechos Fundamentales. Mujeres. Políticas Públicas. Población en Situación de Calle. Violencia Sexual.

1 INTRODUCTION

Sexual violence against homeless women is a highly complex social and legal problem, which highlights deep-rooted structural inequalities in Brazilian urban centers. Homelessness does not only represent the absence of housing, but a scenario of extreme vulnerability, in which processes of exclusion, invisibility, and continuous violation of fundamental rights are intensified. In this sense, gender violence manifests itself in an aggravated way, especially when associated with institutional precariousness and the fragility of protection networks.

In the field of contemporary discussions, it is observed that homeless women experience multiple forms of violence simultaneously, including physical, psychological and sexual aggression, often naturalized by the absence of effective public policies of reception and assistance. It is a phenomenon that goes beyond the criminal dimension, revealing social structures that perpetuate female marginalization in urban contexts marked by inequality and state abandonment.

From the legal-constitutional point of view, the persistence of these violations reveals a distance between the normative frameworks and their concrete effectiveness. The Federal Constitution of 1988 establishes the dignity of the human person as the foundation of the Democratic Rule of Law, imposing on the public power the duty to ensure full protection against any form of violence and degrading treatment (Brasil, 1988). Thus, the continuity of sexual violence against homeless women highlights the need for more comprehensive and intersectoral institutional responses.

In addition, confronting gender violence requires the understanding that such aggressions are not restricted to the private sphere, but express historical and structural inequalities. The Maria da Penha Law constitutes an essential milestone in this process, by recognizing violence against women as a public problem and by requiring articulated mechanisms for prevention, assistance and state accountability (Brasil, 2006).

Given this scenario, it is essential to recognize that sexual violence against homeless women cannot be understood as an isolated problem, but as a structural challenge that involves institutional omissions, social inequality, and limitations of public protection policies. The homeless population experiences repeated violations of rights, often crossed by social stigma and difficulty in accessing formal justice and citizenship mechanisms (CNJ, 2025).

In the Amazonian context, the problem takes on even more urgent contours, considering regional specificities and local challenges related to social protection and the fight against gender violence. The State of Amazonas has sought to structure its own guidelines for preventing and confronting violence against women, emphasizing the need for

articulation between public security, social assistance and the shelter network (Amazonas, 2025). Even so, weaknesses persist in the effectiveness of these actions when directed to women in conditions of extreme vulnerability.

In this sense, this article starts from the following guiding question: how can sexual violence against homeless women in the city of Manaus be understood as a violation of fundamental rights and as an expression of the state's responsibility to guarantee human dignity. Thus, the central objective is to examine, in the light of the legal system and recent interdisciplinary literature, the social and institutional mechanisms that favor the reproduction of this violence, as well as the limitations of public protection networks.

Thus, the relevance of this investigation is justified by the persistent and structural nature of sexual violence against homeless women, a phenomenon that requires not only criminal responses, but intersectoral policies of reception, prevention and guarantee of citizenship.

2 THEORETICAL FRAMEWORK

Violence against homeless populations is a multifaceted phenomenon, crossed by structural inequalities, urban exclusion, and the fragility of public policies for social protection. In this context, the street does not only represent homelessness, but a space of extreme vulnerability, in which processes of social invisibility and daily exposure to different forms of aggression are intensified. Alves et al. (2025) highlight that urban violence is directly articulated with dynamics of marginalization and precariousness of life, producing scenarios where vulnerable subjects remain at constant risk of rights violations.

In Brazil, the normative consolidation of the fight against violence and the violation of fundamental rights is supported by the Federal Constitution of 1988, which ensures the dignity of the human person as the foundation of the Democratic Rule of Law. Protection against any form of violence, discrimination or degrading treatment must be understood as a duty of the public authorities and a universal guarantee, especially when it comes to historically marginalized groups (Brasil, 1988). Thus, the homeless population is inserted in the field of constitutional urgencies, demanding effective policies of inclusion and citizenship.

Domestic and family violence against women, in turn, acquires even more serious contours when associated with homelessness, as it breaks support networks and increases exposure to physical, psychological and sexual abuse. The Maria da Penha Law establishes specific coping mechanisms, recognizing that gender violence is not only interpersonal, but structural, requiring articulated state intervention (Brasil, 2006). In this sense, the legislation represents an essential milestone to understand the vulnerability of women in contexts of

extreme exclusion.

Recent studies reinforce that homeless women experience multiple forms of violence simultaneously, involving sexual assault, coercion, exploitation and institutional stigmatization. Bueno et al. (2025) analyze that such experiences cannot be understood only as individual episodes, but as an expression of complex psychosocial processes, crossed by gender inequality, extreme poverty, and the absence of continuous protective policies. The street becomes, therefore, a space where violence is naturalized and perpetuated.

The interdisciplinary literature also emphasizes that urban exclusion acts as a central factor in the aggravation of violence, since it displaces women to territories of social and legal abandonment. Maciel and Melo (2025) argue that the debate on human rights needs to incorporate the condition of homelessness as a critical category, as it expresses fundamental violations associated with denied citizenship. Thus, confronting violence requires understanding the urban, social and institutional dimensions that sustain marginalization.

In addition, recent academic production shows that sexual violence against homeless women is one of the greatest contemporary challenges for the Brazilian State. Richwin (2023) highlights that extreme vulnerability increases exposure to repeated abuses and reduces the possibilities of reporting and institutional protection, generating a persistent cycle of rights violations. It is, therefore, a problem that demands articulated responses between public health, social assistance and the justice system.

As pointed out by the National Council of Justice, violence against the homeless population should be understood as a systematic and persistent phenomenon, marked by successive violations of fundamental rights and institutional failures in access to public protection. The report produced by the CNJ shows that these subjects experience physical, psychological, and symbolic aggression, often associated with social stigma and state negligence, which reinforces the urgency of inserting the issue in the national human rights agenda (CNJ, 2025).

From the perspective of the Institute of Applied Economic Research, the factors that lead individuals to homelessness are deeply linked to family breakdowns, unemployment and persistent socioeconomic vulnerabilities. IPEA (2023) highlights that such structural elements intensify exposure to everyday violence, since the absence of housing implies precarious access to health, social assistance, and full citizenship. Thus, violence must also be interpreted as an expression of historical inequalities reproduced in the urban space.

In the understanding of Freitas et al. (2025), homeless women occupy an even more critical position within the exclusion scenario, as they face a double vulnerability: social marginality associated with the street and specific gender-related violence. The authors

argue that these women remain invisible by traditional public policies, being continuously exposed to abuse, aggression and institutional lack of protection, which highlights the need for intersectoral coping strategies.

In light of the analyses of Gontijo et al. (2026), violence against women in urban contexts of exclusion represents a direct challenge to the effectiveness of fundamental rights, since it highlights the distance between normative guarantees and concrete social practices. Territorial exclusion and the precariousness of living conditions intensify women's vulnerability, demonstrating that confronting violence requires urban policies articulated with social justice.

From the point of view of critical law, Paiva, Sabadell and Vieira (2024) argue that gender violence should be interpreted as a manifestation of social and institutional structures that naturalize inequalities and restrict full access to justice. For the authors, female vulnerability in extreme contexts, such as homelessness, requires an interdisciplinary reading that connects human rights, public policies, and institutional protection practices.

In line with regional public policies, the State of Amazonas has structured specific guidelines for preventing and combating violence against women, recognizing the urgency of the issue in the Amazon scenario. The State Plan establishes strategies for articulation between public security, social assistance and protection network, reinforcing that violence against vulnerable women must be combated through integrated and continuous actions (Amazonas, 2025).

In the scope of municipal management, it is observed that the reality of the homeless population has also been the subject of informative reports and intersectoral actions. SEMASC (2025) shows that the problem demands articulated interventions between reception, social assistance and guarantee of rights, especially in the face of the growth of situations of violence and exclusion in central urban areas.

According to recent legislation, the confrontation of vulnerabilities associated with the homeless population began to receive greater normative attention in the national scenario. Law No. 14,821/2024 institutes the National Policy on Decent Work and Citizenship for the Homeless Population, recognizing the need for structured measures aimed at social inclusion, access to rights, and overcoming the conditions that perpetuate extreme marginalization (Brasil, 2024). In this sense, the legal system expands the understanding that homelessness is not only a social condition, but a problem that requires an articulated institutional response.

In this scenario, it is essential to understand that the realization of rights does not depend exclusively on legal frameworks, but also on concrete mechanisms for

implementation and access to justice. The Public Defender's Office of the State of Amazonas, for example, highlights initiatives aimed at guaranteeing civil documentation and legal recognition of vulnerable populations, reinforcing that the absence of formal records aggravates exclusion and hinders the full exercise of citizenship (Public Defender's Office of the State of Amazonas, 2026). Thus, legal aid policies become essential instruments in the fight against multiple forms of violence.

From this perspective, social protection must be understood as an indispensable element to interrupt cycles of invisibility and aggression. Silva (2025) argues that homeless women face institutional barriers that restrict access to basic services, increasing exposure to physical, psychological, and symbolic violence. For the author, the protection of fundamental rights in this context requires the articulation between public health, social assistance and justice, especially when it comes to historically neglected subjects.

Thus, it is observed that violence against homeless women cannot be reduced to isolated events, but must be interpreted as an expression of structural inequalities, urban exclusion, and insufficient integrated public policies. The theoretical contributions analyzed demonstrate that facing the problem requires not only legal recognition, but also continuous intersectoral actions that promote dignity, citizenship and social inclusion. Thus, recent literature reinforces that overcoming this scenario depends on the consolidation of effective protection networks and the strengthening of institutional strategies for prevention and welcoming.

3 METHODOLOGY

The present study is characterized as a qualitative research, of bibliographic and documentary character, with a legal-analytical approach, whose objective is to examine sexual violence against homeless women in the city of Manaus, in the light of fundamental rights and state responsibility in the protection of human dignity. The methodology adopted sought to adapt to the problem investigated, considering the social, legal and institutional complexity that involves the extreme vulnerability of women exposed to gender violence in urban contexts.

The bibliographic survey was carried out from previously selected references, including national studies published in recognized journals, as well as technical reports and institutional documents of public agencies. The focus was on productions related to sexual violence, the homeless population, human rights, public policies and access to justice. The sources analyzed grounded the theoretical framework and allowed the construction of a consistent conceptual basis on the investigated phenomenon.

Subsequently, the documentary stage was developed, centered on the analysis of legal and constitutional provisions linked to fundamental rights, the dignity of the human person, material equality and the full protection of women in situations of vulnerability. This stage made it possible to articulate the contemporary academic debate with the legal obligations of the Brazilian State in the face of sexual violence and social exclusion.

The method of analysis used was interpretive-critical, based on the systematic reading of the selected scientific and legal productions. The analytical categories were organized based on three central axes: (i) sexual violence as an expression of structural inequality, (ii) institutional vulnerability of women living on the streets, and (iii) effectiveness of fundamental rights and public protection policies. In this way, we sought to understand not only the crime itself, but also the social and legal mechanisms that favor its reproduction and permanence.

As a guiding hypothesis, it is based on the assumption that sexual violence against homeless women represents a serious violation of fundamental rights, aggravated by social invisibility and the insufficiency of state protection networks, especially in urban contexts marked by inequality and institutional omission. Thus, the study seeks to demonstrate that the legal response cannot be restricted exclusively to the criminal field, but must include intersectoral policies for reception, prevention and guarantee of citizenship.

Finally, the absence of direct empirical data, such as interviews or field surveys, is recognized as methodological limitations, since the article focuses on bibliographic and documentary analysis. However, this delimitation allows for a deeper theoretical and legal discussion, offering relevant subsidies for future empirical research and for the formulation of institutional strategies aimed at the protection of homeless women in Amazonas.

In order to systematize the main theoretical bases used in the construction of the framework of this study, a summary table is presented below with the selected authors, the respective titles of the analyzed productions and their years of publication. This survey contributes to highlight the relevance of the sources and the academic relevance of the reference used in the research.

Table 1

Authors used in the research

Lead author	Title	Year
Alves et al.	Violence and vulnerability in urban contexts: reflections on health and social exclusion	2025
Amazon	State Plan for the Prevention and Confrontation of Violence Against Women	2025

Lead author	Title	Year
Brazil	Constitution of the Federative Republic of Brazil of 1988	1988
Brazil	Law No. 11,340, of August 7, 2006 (Maria da Penha Law)	2006
Brazil	Law No. 14,821, of January 16, 2024 (PopRua National Policy)	2024
Bueno et al.	Homeless women and the multiple forms of violence: psychosocial analysis	2025
National Council of Justice (CNJ)	Report: Public Consultation, Forms of violence against the homeless population	2025
Public Defender's Office of the State of Amazonas	Public Defender's Office of Amazonas creates new channel to guarantee civil documentation to vulnerable populations	2026
Freitas et al.	Inequalities, violence and invisibility: homeless women in Brazil	2025
Gontijo et al.	Violence against women and urban exclusion: challenges for fundamental rights	2026
Institute of Applied Economic Research (IPEA)	Family quarrel and unemployment are the reasons most cited by homeless people	2023
Maciel; Melo	Homeless women and human rights: interdisciplinary analysis	2025
Paiva; Sabadell; Scallop	Gender violence, vulnerability and justice: contributions of critical law	2024
Richwin	Homeless women and sexual violence: challenges for the State and fundamental rights	2023
SEMASC	Informative Report on the Homeless Population in Manaus	2025
Silva	Fundamental rights and social protection of homeless women	2025

Source: The authors.

Thus, it is observed that the selected productions offer a consistent and current theoretical support for the analysis of sexual violence against women living on the streets, allowing us to understand the phenomenon from different perspectives, such as social vulnerability, institutional exclusion, human rights and the effectiveness of public policies. The set of these contributions underpins the discussion proposed in this article, highlighting the complexity of the topic and the need for legal and intersectoral approaches that ensure the

full protection and dignity of these women in the Amazonian urban context.

4 RESULTS AND DISCUSSIONS

The results obtained from the literature and documentary review show that sexual violence against homeless women is one of the most serious expressions of structural inequality and urban exclusion in Brazil. The literature analyzed demonstrates that the condition of homelessness increases exposure to repeated aggression, since these women are subjected to the absence of protective networks, institutional precariousness and social invisibility. In this sense, Alves et al. (2025) emphasize that urban vulnerability is not only circumstantial, but the result of historical processes of marginalization that directly compromise human dignity.

From the perspective of psychosocial studies, it is observed that sexual violence should not be understood only as an isolated event, but as a phenomenon crossed by stigmas, gender inequality and precarious living conditions. Bueno et al. (2025) argue that homeless women face multiple forms of violence simultaneously, including physical and sexual abuse, often associated with the lack of continuous access to public policies for shelter and assistance.

From the legal-constitutional point of view, the results indicate that sexual violence against homeless women constitutes a serious violation of the fundamental rights guaranteed by the democratic order. The Federal Constitution of 1988 establishes the dignity of the human person as the foundation of the Democratic Rule of Law, imposing on the public power the duty to guarantee full protection against any form of violence and degrading treatment (Brasil, 1988). Thus, the persistence of aggressions against vulnerable women reveals a distance between normative guarantees and social effectiveness.

In light of the protective legislation, the Maria da Penha Law represents an essential milestone to understand gender violence as a structural expression, requiring articulated state intervention and intersectoral public policies. When associated with homelessness, sexual violence becomes even more complex, as it involves the absence of family ties, institutional fragility and barriers to access to justice (Brasil, 2006). Paiva et al. (2024) argue that legal confrontation cannot be limited to the criminal field, but must incorporate broad strategies for social protection and citizenship.

In the context of contemporary analyses on urban exclusion, the results show that territorial marginalization intensifies rights violations, making homeless women preferred targets of sexual violence and repeated abuse. Freitas et al. (2025) highlight that these women occupy a position of double vulnerability: due to social marginality and gender

violence, remaining invisible in traditional public policies.

In the institutional context, the results show that violence against the homeless population, especially against women, is recurrent and systematic, requiring formal recognition and coordinated responses from the justice system. The National Council of Justice points out that this violence is not limited to isolated episodes, but configures a pattern of repeated violations of rights, often associated with state negligence and social stigma that prevents effective access to protection (CNJ, 2025).

From a socioeconomic perspective, it is observed that the structural factors that lead individuals to homelessness are directly related to family breakdowns, unemployment, and persistent vulnerabilities. IPEA (2023) points out that such conditions intensify daily exposure to violence, since the absence of fixed housing implies precarious access to basic services, social assistance, and citizenship mechanisms, favoring the reproduction of cycles of exclusion.

In the field of discussions on urban exclusion, the findings indicate that violence against homeless women represents a central challenge to the effectiveness of fundamental rights. Gontijo et al. (2026) argue that territorial precariousness and marginalization in urban spaces increase female vulnerability, highlighting the distance between normative guarantees and concrete social practices, especially in contexts marked by inequality and institutional abandonment.

In line with regional public policies, it is verified that the State of Amazonas has sought to structure specific guidelines for the prevention and confrontation of violence against women, recognizing the urgency of the issue in the Amazon scenario. The State Plan establishes strategies for articulation between public security, social assistance and the protection network, reinforcing that women in situations of extreme vulnerability demand integrated and continuous actions of reception and prevention (Amazonas, 2025).

At the municipal level, the results indicate that the problem of the homeless population has also been the subject of informative reports and intersectoral actions aimed at emergency care and the guarantee of rights. SEMASC (2025) shows that the growth of this population in central urban areas imposes direct challenges to social assistance policies, especially in the face of the intensification of situations of violence and exclusion that affect women more severely.

Thus, the findings discussed in this stage reinforce that sexual violence against homeless women cannot be understood only as an individual or criminal problem, but as an expression of structural inequalities, institutional weaknesses and insufficiency of public protection networks. Thus, effective confrontation requires articulation between justice, social

assistance, urban policies and specific strategies to guarantee citizenship.

By deepening the analysis of sexual violence, it is observed that homeless women face increased risks due to the absence of protective networks and continuous exposure to repeated abuse. Richwin (2023) highlights that this extreme vulnerability significantly reduces the possibilities of reporting and access to justice, generating a persistent cycle of violations that is perpetuated in social and institutional invisibility.

Under an interdisciplinary approach, it is found that homelessness does not only imply material deprivation, but also the daily suppression of basic human rights. Maciel and Melo (2025) argue that urban marginalization produces a scenario in which women are no longer recognized as subjects of full citizenship, remaining on the margins of traditional public policies and vulnerable to different forms of violence and exploitation.

In the context of social protection, the results show that the insufficiency of intersectoral policies directly contributes to the permanence of violence suffered by women living on the streets. Silva (2025) argues that institutional barriers restrict these women's access to essential services, increasing their exposure to physical, psychological, and sexual violence, which reinforces the need for articulation between public health, social assistance, and justice.

In the field of institutional initiatives to confront it, the work of the Public Defender's Office of the State of Amazonas stands out, which has implemented measures aimed at guaranteeing civil documentation and legal recognition of vulnerable populations. The Public Defender's Office of the State of Amazonas (2026) emphasizes that the absence of formal records aggravates exclusion and compromises the full exercise of citizenship, making access to justice an indispensable element to break cycles of violence.

In the light of recent national policies, it can be seen that the Brazilian State has begun to recognize more explicitly the need for structured strategies aimed at the homeless population. Law No. 14,821/2024 institutes the National Policy on Decent Work and Citizenship, reinforcing that overcoming extreme vulnerability requires integrated actions for social inclusion, access to rights, and strengthening of public protection networks (Brasil, 2024).

Thus, the results discussed throughout this section demonstrate that sexual violence against homeless women should be interpreted as an expression of structural inequalities and institutional weaknesses, and cannot be reduced to a strictly criminal dimension. Facing the problem requires intersectoral public policies, reception mechanisms, and strategies to guarantee fundamental rights, especially in urban contexts marked by social exclusion and state omission.

In order to systematize the main theoretical contributions used in the construction of the analysis developed in this study, Table II is presented below, which summarizes the selected authors, their central positions and the respective years of publication. This survey allows us to visualize how recent literature has addressed sexual violence against homeless women, highlighting different perspectives, such as institutional exclusion, structural vulnerability, the effectiveness of fundamental rights, and the need for intersectoral public policies.

Table 2

Authors used in the research, positioning and year

Author	Positioning	Year
Alves et al.	Urban violence as a structural expression of social exclusion and vulnerability	2025
Amazon	Regional guidelines for preventing and combating violence against women in the Amazon scenario	2025
Brazil	Constitutional foundation of human dignity and protection of fundamental rights	1988
Brazil	Legal framework to combat domestic and family violence against women (Maria da Penha Law)	2006
Brazil	National policy of inclusion and citizenship for the homeless population (PopRua)	2024
Bueno et al.	Psychosocial analysis of the multiple forms of violence experienced by homeless women	2025
CNJ	Violence against the homeless population as a systematic violation of rights and institutional challenge	2025
Public Defender's Office of Amazonas	Access to justice and civil documentation as instruments of protection and citizenship	2026
Freitas et al.	Social invisibility and double vulnerability of homeless women	2025
Gontijo et al.	Urban exclusion and the distance between normative guarantees and the effectiveness of fundamental rights	2026
IPEA	Socioeconomic determinants of homelessness and intensification of structural vulnerabilities	2023
Maciel; Melo	Interdisciplinary approach to human rights and citizenship denied in the homeless condition	2025
Paiva et al.	Critical Law Perspective on Gender-Based Violence and Institutional Limitations of Justice	2024

Author	Positioning	Year
Richwin	Sexual violence as a persistent cycle aggravated by invisibility and absence of protective networks	2023
SEMASC	Municipal diagnosis and local challenges of assistance policies for the homeless population	2025
Silva	Institutional barriers and the need for intersectoral articulation in the social protection of vulnerable women	2025

Source: The authors.

The positions presented in Table II reinforce that sexual violence against homeless women is a structural phenomenon, crossed by historical gender inequalities, urban exclusion, and institutional fragility. There is convergence among the authors regarding the understanding that such violations cannot be interpreted as isolated events, but as an expression of a continuous cycle of social vulnerability and state omission. Thus, the literature analyzed highlights the need for intersectoral responses that articulate legal protection, public policies for reception and social inclusion strategies, in order to ensure the effectiveness of the fundamental rights and dignity of these women in the Amazonian context.

5 CONCLUSION

The conclusions of this study respond to the proposed objective of examining sexual violence against homeless women in the city of Manaus, in the light of fundamental rights and state responsibility in the protection of human dignity. From the bibliographic and documentary review carried out, it was found that sexual violence is not an isolated event, but as an extreme expression of structural inequalities, urban exclusion and institutional weaknesses that cross the reality of these women.

The findings showed that the homeless condition intensifies female vulnerability, increasing exposure to repeated aggression and reducing the possibilities of access to protective networks and effective justice mechanisms. In this scenario, it was found that the social invisibility and precariousness of public policies directly contribute to the permanence of cycles of violence, reinforcing the need for continuous and integrated intersectoral actions.

From a legal point of view, it is concluded that the persistence of sexual violence against homeless women represents a serious violation of the fundamental rights guaranteed by the constitution, especially the principle of human dignity. In addition, the Maria da Penha Law constitutes an essential milestone for understanding gender violence as a structural phenomenon, requiring state responses that go beyond the criminal field and incorporate

strategies for prevention, shelter and guarantee of citizenship.

In this way, the guiding hypothesis that sexual violence against homeless women is aggravated by social invisibility and the insufficiency of institutional protection networks is confirmed, especially in urban contexts marked by inequality and state omission. Thus, the appropriate legal response must articulate public policies for social assistance, health, security and access to justice, with special attention to the regional specificities of Amazonas.

Thus, the absence of direct empirical data is recognized as a limitation of this study, since it is a bibliographic and documentary review. However, the analysis developed offers relevant subsidies for future field investigations and for the formulation of institutional strategies aimed at the integral protection of women living on the streets, contributing to the strengthening of public policies and the realization of human rights in the Amazonian context.

ACKNOWLEDGMENTS

We would like to thank our friends, colleagues, and academic partners who walk together in the construction of a scientific production committed to the Amazonian reality. This work is the result of the union of efforts, mutual encouragement and the conviction that research and writing can directly contribute to transforming Amazonas into a fairer, more humane and inclusive space. Producing knowledge in our region also represents an act of social responsibility, as it means looking at the vulnerabilities that cross urban life and seeking, through academic and legal debate, ways to cope and overcome.

We express our gratitude to all those who believe in science as an instrument of change and who are collectively dedicated to building a better city, where fundamental rights are effectively guaranteed and where human dignity is recognized as a priority. This article, therefore, represents not only an intellectual effort, but also a commitment to the present and future of Amazonas.

REFERENCES

- Alves, K. C., Mendes, P. C., & Aragão, A. S. (2025). Violência e vulnerabilidade em contextos urbanos: Reflexões sobre saúde e exclusão social. *Hygeia*, 21(1). <https://seer.ufu.br/index.php/hygeia/article/download/77862/41207/365036>
- Amazonas. (2025). Plano Estadual de Prevenção e Enfrentamento à Violência Contra a Mulher. Secretaria de Segurança Pública. <https://www.ssp.am.gov.br/wp-content/uploads/2025/07/Plano-Estadual-de-Prevencao-e-Enfrentamento-a-Violencia-Contra-Mulher.pdf>
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Presidência da República. http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm

- Brasil. (2006). Lei nº 11.340, de 7 de agosto de 2006. Cria mecanismos para coibir a violência doméstica e familiar contra a mulher (Lei Maria da Penha). Presidência da República. http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/l11340.htm
- Brasil. (2024). Lei nº 14.821, de 16 de janeiro de 2024. Institui a Política Nacional de Trabalho Digno e Cidadania para a População em Situação de Rua (PNTC PopRua). Presidência da República. https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2024/lei/l14821.htm
- Bueno, A. V. M., et al. (2025). Mulheres em situação de rua e as múltiplas formas de violência: Análise psicossocial. Psicologia e Sociedade. <https://www.scielo.br/j/psoc/a/DnRV6Ts6v8ttYkQXzMYqcLk/?format=pdf&lang=pt>
- Conselho Nacional de Justiça. (2025). Relatório: Consulta Pública, As formas de violência contra a população em situação de rua. <https://www.cnj.jus.br/wp-content/uploads/2025/08/consulta-publica-formasviolencia-contrapopulacao-em-situacao-de-rua-2025.pdf>
- Defensoria Pública do Estado do Amazonas. (2026, 10 de fevereiro). Defensoria Pública do Amazonas cria novo canal para garantir documentação civil a populações vulneráveis. <https://defensoria.am.def.br/2026/02/10/defensoria-publica-do-amazonas-cria-novo-canal-para-garantir-documentacao-civil-a-populacoes-vulneraveis/>
- Freitas, G. L., et al. (2025). Desigualdades, violência e invisibilidade: Mulheres em situação de rua no Brasil. *Ciência & Saúde Coletiva*, 30(11), Article e18312023. <https://www.scielo.org/pdf/csc/2025.v30n11/e18312023/pt>
- Gontijo, T. G., et al. (2026). Violência contra mulheres e exclusão urbana: Desafios para os direitos fundamentais. *Ciência & Saúde Coletiva*, 30(12), Article e20392024. <https://www.scielo.org/pdf/csc/2025.v30n12/e20392024/pt>
- Instituto de Pesquisa Econômica Aplicada. (2023). Briga de família e desemprego são os motivos mais citados por pessoas em situação de rua. <https://www.ipea.gov.br/portal/categorias/45-todas-as-noticias/noticias/14597-briga-de-familia-e-desemprego-sao-os-motivos-mais-citados-por-pessoas-em-situacao-de-rua-para-explicar-sua-circunstancia>
- Maciel, L. M., & Melo, T. V. M. (2025). Mulheres em situação de rua e direitos humanos: Análise interdisciplinar. *PerCursos*, 26. <https://revistas.udesc.br/index.php/percursos/article/download/26765/19308/124130>
- Paiva, L. M. L., Sabadell, A. L., & Vieira, T. M. (2024). Violência de gênero, vulnerabilidade e justiça: Contribuições do direito crítico. *Direito e Práxis*. <https://www.scielo.br/j/rdp/a/jZcnpXPQ7ry6NxjJWjRb6FN/?format=pdf&lang=pt>
- Richwin, I. F. (2023). Mulheres em situação de rua e violência sexual: Desafios para o Estado e os direitos fundamentais. *Revista Estudos Feministas*. <https://www.scielo.br/j/ref/a/pY3XHrnDpph57k7KGzqggbL/?format=pdf&lang=pt>
- Santos, G. C. (2025). Ruas, corpos e violência: A experiência de mulheres em vulnerabilidade extrema. *Saúde e Sociedade*, 34(1), Article e250006pt. <https://www.scielo.org/pdf/sausoc/2025.v34n1/e250006pt/pt>
- Secretaria Municipal de Assistência Social e Cidadania (SEMASC). (2025). Relatório Informativo sobre a população em situação de rua em Manaus. Prefeitura de Manaus. <https://www.manaus.am.gov.br/noticia/protecao/acaointegrada-prefeitura-centro/>

Silva, L. B. (2025). Direitos fundamentais e proteção social de mulheres em situação de rua.
Saúde e Sociedade.
<https://www.scielo.br/j/sausoc/a/kdpj3FHZWF8wwr4H9LjFBdx/?format=pdf&lang=pt>

THE INTEGRATED CURRICULUM AS A STRATEGY TO OVERCOME CURRICULUM FRAGMENTATION IN FULL-TIME SCHOOLS

O CURRÍCULO INTEGRADO COMO ESTRATÉGIA DE SUPERAÇÃO DA FRAGMENTAÇÃO CURRICULAR NA ESCOLA EM TEMPO INTEGRAL

EL CURRÍCULO INTEGRADO COMO ESTRATEGIA PARA SUPERAR LA FRAGMENTACIÓN CURRICULAR EN LAS ESCUELAS DE TIEMPO COMPLETO



<https://doi.org/10.56238/sevened2026.008-165>

Jardelson de Medeiros Silva¹

ABSTRACT

This article analyzes the integrated curriculum as a strategy to address curricular fragmentation in full-time schools, considering its theoretical, historical, and normative foundations. It begins with the recognition that the traditional disciplinary organization of the curriculum has limited holistic human development, even in contexts of extended school hours. The research is characterized as a qualitative study, with a theoretical-documentary approach, based on the analysis of academic productions in the field of curriculum and normative documents of Brazilian education. The results show that the extension of school hours, when not accompanied by an integrated curricular reorganization, tends to reproduce the dichotomy between curricular and complementary activities, weakening the project of comprehensive education. The discussion points out that the integrated curriculum is configured as a political-pedagogical principle capable of articulating knowledge, times, spaces, and educational practices, favoring meaningful, contextualized learning committed to social justice. It is concluded that the implementation of an integrated curriculum requires not only normative guidelines, but also institutional conditions, coordinating school management, and collective processes of curriculum construction, reaffirming comprehensive full-time education as an educational project aimed at the complete human development.

Keywords: Curriculum. ETI (Integrated Technical Education). Fragmentation. School Management.

RESUMO

Este artigo analisa o currículo integrado como estratégia de enfrentamento da fragmentação curricular na escola em tempo integral, considerando seus fundamentos teóricos, históricos e normativos. Parte-se do reconhecimento de que a organização disciplinar tradicional do currículo tem limitado a formação humana integral, mesmo em contextos de ampliação da jornada escolar. A pesquisa caracteriza-se como um estudo de natureza qualitativa, de abordagem teórico-documental, fundamentado na análise de produções acadêmicas do

¹ Postgraduate student in School Management. Universidade Federal de São Carlos (UFSCar).
E-mail: jardelsonmedeirossilva@gmail.com Orcid: <https://orcid.org/0000-0002-4592-080X/>
Lattes: <http://lattes.cnpq.br/2950079589563121>

campo do currículo e de documentos normativos da educação brasileira. Os resultados evidenciam que a ampliação do tempo escolar, quando não acompanhada de uma reorganização curricular integrada, tende a reproduzir a dicotomia entre atividades curriculares e complementares, fragilizando o projeto de educação integral. A discussão aponta que o currículo integrado se configura como um princípio político-pedagógico capaz de articular saberes, tempos, espaços e práticas educativas, favorecendo aprendizagens significativas, contextualizadas e comprometidas com a justiça social. Conclui-se que a efetivação do currículo integrado demanda não apenas orientações normativas, mas também condições institucionais, gestão escolar articuladora e processos coletivos de construção curricular, reafirmando a educação integral em tempo integral como um projeto educativo voltado à formação humana plena.

Palavras-chave: Currículo. ETI. Fragmentação. Gestão Escolar.

RESUMEN

Este artículo analiza el currículo integrado como estrategia para abordar la fragmentación curricular en escuelas de tiempo completo, considerando sus fundamentos teóricos, históricos y normativos. Parte del reconocimiento de que la organización disciplinaria tradicional del currículo ha limitado el desarrollo humano holístico, incluso en contextos de jornada escolar extendida. La investigación se caracteriza por ser un estudio cualitativo, con un enfoque teórico-documental, basado en el análisis de producciones académicas en el campo del currículo y documentos normativos de la educación brasileña. Los resultados muestran que la extensión de la jornada escolar, cuando no se acompaña de una reorganización curricular integrada, tiende a reproducir la dicotomía entre actividades curriculares y complementarias, debilitando el proyecto de educación integral. La discusión señala que el currículo integrado se configura como un principio político-pedagógico capaz de articular conocimientos, tiempos, espacios y prácticas educativas, favoreciendo un aprendizaje significativo, contextualizado y comprometido con la justicia social. Se concluye que la implementación de un currículo integrado requiere no sólo de lineamientos normativos, sino también de condiciones institucionales, gestión escolar articuladora y procesos colectivos de construcción curricular, reafirmando la educación integral a tiempo completo como proyecto educativo orientado al desarrollo humano integral.

Palabras clave: Currículo. Educación Técnica Integrada (ETI). Fragmentación. Gestión Escolar.

1 INTRODUCTION

The curricular organization of the Brazilian school has historically been marked by a fragmented logic of knowledge, times and spaces, strongly anchored in a disciplinary and technicist conception of curriculum. Such a configuration, as Silva (2005) points out, is not neutral, as it expresses power relations that select knowledge, identities and subjectivities considered legitimate within the school. In this sense, curricular fragmentation is not only a pedagogical problem, but also a political and social one, since it tends to reinforce inequalities and limit human education in its entirety.

In the context of the extension of the school day and the consolidation of full-time Integral Education as a right, this curriculum model becomes tensioned. As highlighted by the Ministry of Education (MEC), Integral Education presupposes the overcoming of reductionist views that exclusively privilege the cognitive dimension, demanding training that considers the complexity of human development in its intellectual, affective, bodily, social, cultural, and ethical dimensions (Brasil, 2018).

Thus, the simple extension of the student's time in school does not guarantee, by itself, an Integral Education, and it is essential to reorient the curriculum practiced in the networks and in the school units, becoming more significant and democratic, instead of reductionist, technicist and that prioritizes only cognitive perspectives, becoming inadequate for a critical problematizing society, human and transformed.

It is in this scenario that the integrated curriculum emerges as a strategy to cope with curricular fragmentation. According to Ramalho (2025), understanding the school and the curriculum as social and historical constructions and, therefore, subject to reinvention is a fundamental condition for the materialization of curricular proposals guided by the perspective of Full-Time Integral Education. The integrated curriculum, in this sense, is not restricted to the articulation between disciplines or the juxtaposition of shift and after-shift activities, but is configured as an organizing principle of educational processes, capable of integrating knowledge, practices, subjects, times and territories.

The Full-Time School Program (ETI), instituted by Law No. 14,640 of 31 of 2023 (Brasil, 2023) reinforces this understanding by stating the need to "overcome the curricular organization based on the logic of shift and after-shift for an integrated curriculum that integrates experiences". Such orientation dialogues with critical conceptions of curriculum that understand it as a space for cultural dispute and the production of meanings, in which human diversities must be recognized and curricular justice promoted (Ponce, 2019).

The impasse arises with the implementation of Full-Time Integral Education, establishing the extension of the day, and the school practice does not expand its democratic

vision and the student's reality, running the risk of falling into the trap of "shift and counter-shift" where time is extended, but knowledge remains watertight and without connection with the student's life.

The central problem lies in the following question: How to break with the logic of curricular fragmentation and ensure that the extension of time in public schools results, in fact, in an integral development (intellectual, affective, social and cultural), using the integrated curriculum as a tool for curricular justice and social transformation?

The main objective of this work is to analyze how the implementation of the integrated curriculum in public Basic Education can overcome the fragmentation of teaching and learning, using as an analytical basis the academic construct of recent years. To this end, it seeks to identify the limitations of the traditional model and discuss the curriculum as an organizing principle that articulates knowledge and territories.

In this scenario, the integrated curriculum assumes centrality in the construction of educational practices committed to equity, interdisciplinarity and the articulation between school knowledge and knowledge of everyday life. Understanding it as the guiding axis of Integral Education requires, however, a dive into the conceptual and normative bases that support this proposal in Brazil. To this end, we will discuss the tensions between the traditional model and the critical perspectives of curriculum, substantiating the theoretical assumptions that guide this study.

2 THEORETICAL FRAMEWORK

The debate on the school curriculum occupies a central place in contemporary educational discussions, especially in view of the social, cultural and political transformations that impact the organization of education systems. The curriculum cannot be understood only as a set of prescribed contents, but as a field of symbolic and ideological disputes that expresses conceptions of education, society and subject. In the context of integral education, this discussion intensifies, since such a formative perspective presupposes the expansion of educational experiences and the articulation between different dimensions of human development. Thus, understanding the theoretical bases of the school curriculum and its relationship with integral education becomes fundamental to analyze the challenges and possibilities of implementing integrated curricular proposals.

2.1 PERSPECTIVES OF THE SCHOOL CURRICULUM

The concept of curriculum presents multiple interpretations throughout the history of education. In a broader perspective, Sacristán (2013) defines the curriculum as a cultural

construction that organizes school knowledge and guides pedagogical practices, directly influencing the teaching and learning processes.

For the author, the curriculum "is not neutral, as it reflects political, cultural and social options" (Sacristán, 2013, p. 17). Goodson (2012) reinforces this understanding by stating that the curriculum should be analyzed as a social and historical artifact, the result of disputes between different social groups. According to the author, "the written curriculum is only a part of the curricular reality, and it is necessary to understand the curriculum lived and practiced in schools" (Goodson, 2012, p. 45).

From this perspective, authors of critical theories of the curriculum, such as Apple (2006), highlight that the school curriculum is deeply related to power relations and the legitimation of certain types of knowledge to the detriment of others. For Apple (2006, p. 59), "the curriculum is never just a neutral set of knowledge; it reflects dominant economic, political, and cultural interests." In Brazil, curriculum policies assume a structuring role in the organization of basic education.

The National Common Curricular Base (BNCC) guides the curricula of education networks by defining essential learning and general competencies aimed at the integral formation of students (Brasil, 2018). The BNCC emphasizes that education should promote the development of cognitive, socio-emotional, cultural, and ethical skills, which reinforces the need for more flexible and integrated curricula. However, studies indicate that the implementation of these guidelines faces challenges related to teacher training, pedagogical management and the institutional conditions of schools (Libâneo, 2016).

2.2 PERSPECTIVES OF INTEGRAL EDUCATION

Integral Education is a pedagogical and political conception that understands the subject in its entirety, considering the cognitive, physical, emotional, social, cultural and ethical dimensions of human development. Such a perspective goes beyond the restricted understanding of extending the school day, affirming itself as a project of 4 full human formation and guarantee of rights (Reference Center in Integral Education, 2024).

This conception is supported by Article 205 of the Federal Constitution of 1988, which establishes that education aims at the full development of the person, preparation for the exercise of citizenship and qualification for work. In this sense, the curriculum in Integral Education assumes a strategic role in the materialization of this purpose, organizing educational experiences that dialogue with the sociocultural contexts of students and with the contemporary challenges of Brazilian society.

Historically, Integral Education dialogues with the assumptions of the New School,

especially with Dewey (1959), when he defended an active school, centered on the experience and participation of students, and with Anísio Teixeira (1994), who conceived the public school as a space for democratic formation and articulation between education, culture and social life. Such fundamentals remain current by sustaining the centrality of the curriculum as an organizer of meaningful and contextualized experiences.

The curriculum, in the context of Integral Education, should be understood as a dynamic and integrated process, which articulates school knowledge, community knowledge and sociocultural practices, overcoming the disciplinary fragmentation historically present in the school organization (Sacristán, 2013).

The document of the Reference Center for Integral Education (2024) reinforces that the organization of the school in a single shift favors the construction of integrative pedagogical projects, expanding times, spaces and educational opportunities. From this perspective, the territory assumes a central role in the construction of the curriculum, being understood as an expanded educational space, in which the school is articulated with public policies, cultural, sports and social equipment.

This approach dialogues with Arroyo (2012), when he states that curricula need to recognize the real subjects of education, their histories, cultures and living conditions, especially those belonging to historically marginalized groups. The booklet also highlights the need to recognize the multiple ways of being a school, especially in indigenous, quilombola, rural and other traditional peoples and communities contexts, respecting the right to self-determination and cultural diversity, according to ILO Convention No. 169 (Reference Center for Integral Education, 2024) 5 This orientation dialogues with Freire (1996), for whom the curriculum should be built from the critical reading of reality and dialogue with the knowledge of the students.

Integral Education, as a public policy, is intrinsically linked to the confrontation of educational and social inequalities. The School Census data presented in the booklet show advances in access to full-time education, especially among black, indigenous, quilombola and students with disabilities populations, but also reveal persistent inequalities and discontinuities in the offer (Reference Center for Integral Education, 2024).

In this context, the curriculum plays a fundamental role in promoting equity, and should be guided by inclusive, intersectoral and anti-racist practices. Gomes (2017) highlights that a curriculum committed to social justice needs to recognize the structural racism present in Brazilian society and value historically silenced knowledge.

The document reinforces this perspective by dialoguing with the legacy of the Black Educator Movement, recognizing education as a practice of freedom and an instrument of

social emancipation. In addition, the articulation between curriculum, evaluation and teacher training policies is pointed out as an essential condition for the consolidation of Integral Education. Valuing education professionals, strengthening the pedagogical autonomy of schools, and adequate public funding are structuring elements for the implementation of integrated and contextualized curricula, as advocated by the Reference Center for Integral Education (2024).

3 METHODOLOGY

The present research is characterized, as to the approach, as qualitative, as it seeks the understanding and critical interpretation of theoretical conceptions related to educational public policies and the training of school managers.

Such an approach is adequate to the objective of the study, which consists of critically reflecting on the influence of educational policies on the performance of the school manager and on the realization of the right to education, considering the social contexts and ideological disputes that permeate its formulation and implementation.

With regard to nature, it is a basic research, since it is dedicated to the expansion of theoretical knowledge on the subject, without the immediate intention of practical application or direct intervention in specific educational contexts. The study seeks to contribute to the deepening of academic discussions about the relationship between the State, public policies and school management.

As for the objectives, the research has an exploratory and descriptive character. Exploratory, in that it investigates and problematizes different theoretical approaches to public educational policies and the training of school managers; and descriptive, as it systematizes and presents the main ideas, convergences and divergences among the authors analyzed, as discussed in the development of the article. Regarding the technical procedures, the study is configured as a bibliographic research, based on the analysis of books, scientific articles and didactic materials that address the themes of the State, public policies, education and school management.

The analysis of the bibliographic material occurred through systematic, interpretative and comparative reading, seeking to articulate the theoretical assumptions of the selected authors with the objective proposed in the article. As for the technical procedures, the study is configured as a bibliographic and documentary research. The bibliographic strand is based on the analysis of authors such as: Cavaliere (2014), Fazenda (2011), Felício (2012) Freire (1994), Gadotti (2013), Guará (2006) Lenoir (2005), Libâneo (2013), Moll (2012), Moran (2015), Morin (2002), Pedro and Santana (2025), Ponce (2019), Ramalho (2025), Saviani

(2005), Silva (2015), Weffort (2019), Zanardi (2016) who address the themes of curriculum, didactics and human formation. This procedure made it possible to identify different conceptions about public educational policies, as well as to understand their impacts on the formation and performance of school managers, establishing relationships between theory and practice in the context of Brazilian public education.

4 RESULTS AND DISCUSSIONS

The compartmentalization and fragmentation of school knowledge are among the most recurrent and critically problematized aspects in curriculum studies. Throughout the history of educational thought, different authors have denounced the pedagogical and formative limits of the rigid disciplinary organization, defending proposals for the integration of knowledge as an alternative to the fragmenting logic.

In general, the interpretations about the disciplinarization of the school curriculum derive from the understanding of the very processes of disciplinarization in the scientific field, which influence the organization of school knowledge and reinforce hierarchies, specializations and boundaries between areas of knowledge.

The analysis of the theoretical, historical and normative references shows that the integrated curriculum is consolidated as a consistent response to the limitations imposed by the curricular fragmentation historically present in the Brazilian school. The authors mobilized in the converge in the criticism of the technicist and disciplinary conception of curriculum, understood as insufficient to account for the complexity of human development and the contemporary demands of full-time integral education.

For Zanardi (2016), the extension of the school day has been, in many contexts, implemented based on models that maintain the separation between activities considered curricular and complementary actions, organized in different shifts, which hinders the effective integration of the curriculum.

From this perspective, the full-time school cannot be understood only as an extension of the students' time in the school space, but as a pedagogical project that requires the articulation between knowledge, practices and educational experiences, overcoming proposals that are limited to the alternation between classes and activities unrelated to the curriculum.

Silva (2005) conceives the curriculum as a construction crossed by power relations, in which selecting knowledge, identities and pedagogical practices implies political and cultural choices. This understanding dialogues directly with the perspective presented by Ramalho (2025), when he states that the school and its curricular artifacts should be understood as

social and historical inventions, subject to transformation. Both authors reject the idea of curricular neutrality and defend the need to break with crystallized models that reinforce inequalities and fragmentations of knowledge.

Something seen by Felício (2012, p. 05): [...] integral education must be able to respond to a multiplicity of demands, at the same time that it must aim at the construction of relationships towards human improvement, which entails offering possibilities so that the individual can fully evolve in all its dimensions (cognitive, corporeal, social, cultural, psychological, affective, economic, ethical, aesthetic, among others) Felício (2012, p. 05).

Although they start from different theoretical fields, the contributions of Silva (2005) and Ponce (2019) present points of convergence by defending a curriculum committed to social justice. For Ponce (2019), the notion of curricular justice presupposes the recognition of the 11 human diversities, the appreciation of different cultural knowledge, and the refusal of unique and universalizing narratives. This conception complements Silva's (2005) critique, by displacing the debate from the curriculum only as a field of power to also understand it as a space of ethical and political dispute in favor of equity and democracy.

In the contemporary educational context, according to Pedro and Santana (2025), the implementation of different public policies aimed at raising the quality of education is observed. The normative documents that underpin the curricular organization such as: Law of Guidelines and Bases of National Education (LDB), the National Curriculum Parameters for Secondary Education (PCNEM) and the National Common Curricular Base (BNCC) that incorporate terminologies and guidelines that express the concern with the integration and articulation between contents and areas of knowledge.

Such guidelines point to the need for pedagogical practices that promote the interconnection of school knowledge, favoring more meaningful and contextualized learning processes for students (Saviani, 2005; Gadotti, 2013).

In the normative field, the BNCC (Brasil, 2017) and the guidelines of the Full-Time School Program reinforce these conceptions by affirming full-time education as a guiding principle of the curriculum, and not as a mere expansion of the school workload. However, the base text problematizes that, despite this normative advance, the risk of maintaining the logic of shift and counter-shift persists, which can result in parallel and poorly articulated curricular practices. At this point, the integrated curriculum emerges as a central strategy to overcome this dichotomy, by proposing the integration of educational experiences throughout the school day.

With the concern of considering learning contexts, the BNCC (BRASIL, 2017) guides the overcoming of a rigidly disciplinary organization of knowledge, by emphasizing the

application of school knowledge to social reality, valuing the context as a fundamental element for attributing meaning to learning, and strengthening the student's protagonism in the formative processes and in the construction of their life project.

The historical experiences of integral education presented as the Anísio Teixeira Park Schools, the CIEPs idealized by Darcy Ribeiro and the More Education Program — reveal important approximations and differences in the way of curricular organization. While some proposals maintained the separation between "traditional" and "complementary" activities, others advanced in expanding the educational dimensions of the school, incorporating culture, art, sport, and care as constitutive elements of the curriculum (RAMALHO, 2025).

These experiences, although distinct in their formats, converge in the understanding that the integrality of education requires overcoming the fragmentation of knowledge and the articulation between school, territory and community. 12 Ramalho (2025) highlights that the integrated curriculum is not limited to formal interdisciplinarity between disciplines, but implies a deeper reorganization of times, spaces, relationships, and pedagogical practices. This conception tensions reductionist views that treat curricular integration only as a methodological strategy, reinforcing its political-pedagogical character.

In this sense, the integrated curriculum presents itself as an organizing principle capable of guiding curricular choices consistent with full-time comprehensive education, in line with the guidelines of the ETI, which defend the overcoming of the fragmentation of knowledge and the valorization of social practices and daily life in the educational process.

The proposal of curricular integration is presented as a response to the limitations of the traditional disciplinary model, by enabling the expansion of the ways of approaching knowledge and favoring a more articulated understanding of reality, in dialogue with the contexts experienced by the students. By promoting the articulation between contents and concepts, this perspective contributes to the integral formation of basic education students, to the extent that it conceives knowledge as a set of interdependent relationships, and not as isolated and fragmented knowledge (PEDRO AND SANTANA, 2025). These authors understand that by assuming interdisciplinarity as a structuring principle of the curriculum, curricular integration enables educational institutions to develop broader and socially significant training proposals, aligned with the demands of contemporary society.

The articulation between different concepts, areas and methodologies favors the construction of relationships between different knowledges, stimulating the development of skills and abilities necessary for critical and responsible citizen participation. This dynamic contributes to the approximation between the contents of the different disciplines, promoting

deeper learning and the strengthening of capacities that go beyond the limits of specific knowledge in each area of knowledge (LENOIR, 2005; FAZENDA, 2011).

With regard to educational practice, the results of the analysis indicate that the effectiveness of the integrated curriculum depends strongly on the performance of school management and education networks. Ramalho's text (2025) emphasizes the role of the manager as an articulator of collective processes of curriculum construction, continuing education and dialogue with the territory.

The experience of the municipality of Diadema, for example, shows that the construction of integrated curricula is associated with the protagonism of schools, community participation and intersectoral articulation, elements that reinforce the democratic and contextualized dimension of integral education.

Thus, the different authors and documents analyzed do not oppose each other, but complement each other by showing that overcoming curricular fragmentation 13 requires both critical theoretical foundations and political, normative, and institutional conditions for its implementation. The integrated curriculum thus emerges as a strategy that articulates theory and practice, school and territory, teaching and life, reaffirming full-time integral education as an educational project committed to full human formation and social justice.

5 CONCLUSION

The present study showed significant advances in the understanding of the integrated curriculum as a strategy to overcome curricular fragmentation in full-time school. By articulating theoretical, historical and normative references, it was possible to deepen the debate on the limits of traditional disciplinary organization and demonstrate that the fragmentation of school knowledge is not an isolated problem, but a structural phenomenon, historically constructed and sustained by specific epistemological and political conceptions.

In this sense, the work contributes to the advancement of the curricular field by reaffirming the integrated curriculum as an organizing principle capable of responding to the contemporary demands of full-time integral education. From a theoretical point of view, the analysis evidenced the convergence between authors who understand the curriculum as a social and political construction, marked by power relations, but also open to transformation.

The contributions of Silva (2005), Ramalho (2025) and Ponce (2019) allowed us to broaden the understanding of the curriculum beyond its technical dimension, evidencing it as a space for ethical, cultural and political dispute. By integrating these perspectives, the study advances by explaining that curricular integration is not reduced to formal interdisciplinarity,

but implies a profound reorganization of school times, spaces, knowledge and practices, guided by integral human formation and social justice.

In the field of public policies, the work shows that normative documents such as the LDB, the PCNEM, the BNCC and the guidelines of the Full-Time School Program represent important advances by incorporating the integration of knowledge, the contextualization of learning and student protagonism as guiding principles of the curriculum.

However, the results of the analysis indicate that these guidelines still face significant challenges in terms of implementation, especially when the extension of the school day is limited to the logic of shift and after-shift, maintaining the separation between curricular and complementary activities. In this aspect, the study contributes by highlighting the need to align 14 normativity and practice, reaffirming the integrated curriculum as a central strategy to give materiality to integral education.

The practical implications of this work are particularly relevant for school management and education systems. By highlighting historical and contemporary experiences of integral education, such as the Park Schools, the CIEPs, the More Education Program and the experience of the municipality of Diadema, the study points out concrete paths for the construction of contextualized integrated curricula, socially referenced and articulated with the territory.

Thus, it is evident that the performance of the school manager as an articulator of collective processes, continuing education and intersectoral dialogue is a fundamental condition for the effectiveness of the integrated curriculum in the full-time school. However, it is important to recognize the limitations of this study.

As it is a theoretical and documentary research, the analysis does not include in-depth empirical investigations on the implementation of the integrated curriculum in specific school contexts. In addition, the policies analyzed are marked by internal contradictions and different levels of appropriation by the education networks, which requires caution in generalizing the results.

In view of this, it is suggested that future research advances in the empirical investigation of integrated curriculum practices in full-time schools, considering different regional realities, levels of education and socioeconomic contexts. Studies that analyze the perception of managers, teachers and students, as well as the impacts of the integrated curriculum on learning processes and on the integral formation of subjects, can contribute to the deepening of the debate and to the improvement of public educational policies.

Finally, it is concluded that the integrated curriculum is a powerful and necessary strategy to overcome curricular fragmentation, as long as it is understood as a collective

educational project and a political-pedagogical guiding principle of the full-time school. By articulating theory and practice, school and territory, teaching and life, the integrated curriculum reaffirms integral education as an ethical and social commitment to full human formation and the construction of a more just, democratic and inclusive society.

REFERENCES

- Apple, M. W. (2006). *Ideologia e currículo* (3ª ed.). Artmed.
- Arroyo, M. G. (2015). *Currículo, território em disputa*. Vozes.
- Brasil. (1988). *Constituição da República Federativa do Brasil de 1988*. Presidência da República. https://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996. Estabelece as diretrizes e bases da educação nacional. *Diário Oficial da União*.
- Brasil. Ministério da Educação. (2018). *Base Nacional Comum Curricular*. Ministério da Educação.
- Brasil. Ministério da Educação. (2023). *Programa Escola em Tempo Integral – ETI*. Fundo Nacional de Desenvolvimento da Educação/Ministério da Educação. https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2023/Lei/L14640.htm
- Cavaliere, A. M. (2014). Educação integral: Uma nova identidade para a escola brasileira? *Educação & Sociedade*, 35(129), 1201–1216.
- Centro de Referências em Educação Integral. (2022). *Currículo na Educação Integral*. CENPEC.
- Centro de Referências em Educação Integral. (2024). *A Educação Integral no Novo Plano Nacional de Educação*. CENPEC.
- Dewey, J. (1959). *Democracia e educação*. Nacional.
- Fazenda, I. C. A. (2011). *Integração e interdisciplinaridade no ensino brasileiro: Efetividade ou ideologia* (6ª ed.). Loyola.
- Felício, H. M. S. (2012). Análise curricular da escola de tempo integral na perspectiva da Educação Integral. *Revista e-Curriculum*, 8(1), 1–18.
- Freire, P. (1987). *Pedagogia do oprimido* (17ª ed.). Paz e Terra.
- Freire, P. (1996). *Pedagogia da autonomia: Saberes necessários à prática educativa*. Paz e Terra.
- Gadotti, M. (2013). *Educação para a sustentabilidade: Um tema transversal do século XXI*. Global.
- Gomes, N. L. (2017). *O movimento negro educador*. Vozes.
- Goodson, I. F. (2012). *Currículo: Teoria e história* (14ª ed.). Vozes.
- Guará, I. M. F. R. (2006). *Educação Integral: Articulações conceituais e metodológicas*. Ação Educativa.
- Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira. (2023). *Censo da Educação Básica 2023: Resumo Técnico*. INEP.

- Libâneo, J. C. (2013). Didática. Cortez.
- Moll, J. (2012). Educação Integral: Texto de referência para o debate nacional. Ministério da Educação.
- Moran, J. M. (2015). Metodologias ativas para uma educação inovadora. Penso.
- Morin, E. (2002). Os sete saberes necessários à educação do futuro. Cortez.
- Pedro, V. R. T., & Santana, F. C. de. (2025). A integração curricular como caminho para a Educação Integral: Perspectivas interdisciplinares no ensino médio. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 11(1), 1285–1295.
- Ponce, B. J. (2019). Em busca da justiça curricular: As possibilidades do currículo escolar na construção da justiça social. *Revista e-Curriculum*, 17(3), 794–803.
- Ramalho, B. B. M. (2025). Currículo integrado e Educação Integral em tempo integral. In Brasil. Ministério da Educação. Programa Escola em Tempo Integral: Módulo 5 – currículo integrado. Ministério da Educação/Secretaria de Educação Básica.
- Sacristán, J. G. (2013). O currículo: Uma reflexão sobre a prática (3ª ed.). Artmed.
- Saviani, D. (2011). História das ideias pedagógicas no Brasil (3ª ed.). Autores Associados.
- Silva, T. T. da. (2005). Documentos de identidade. Autêntica.
- Teixeira, A. (1994). Educação não é privilégio. UFRJ.
- Weffort, H. F., Andrade, J. P., & Costa, N. G. da. (2019). Currículo e Educação Integral na prática: Uma referência para estados e municípios. Associação Cidade Escola Aprendiz.
- Zanardi, T. A. C. (2016). Educação Integral, tempo integral e Paulo Freire: Os desafios da articulação conhecimento-tempo-território. *Revista e-Curriculum*, 14(1), 82–107.

FRESH PAINT: PHOTOETHNOGRAPHY BETWEEN GRAFFITI, POETRY, AND TRANSCULTURATED VISUAL NARRATIVE

TINTA FRESCA: FOTOETNOGRAFIA ENTRE O GRAFFITI, A POESIA E A NARRATIVA VISUAL TRANSCULTURADAS

PINTURA FRESCA: FOTOETNOGRAFÍA ENTRE EL GRAFFITI, LA POESÍA Y LA NARRATIVA VISUAL TRANSCULTURADA



<https://doi.org/10.56238/sevened2026.008-166>

Sidney Barata de Aguiar¹, Gisele Giandoni Wolkoff²

ABSTRACT

This work emphasizes a synoptic visual dimension of the city and urban art that are displayed on graffiti-covered walls, at street events, and cultural occupations that reshape the imagery of Manaus, the capital of the state of Amazonas. The aim is to expand the understanding of research with images using the technique of Photoethnography. We mainly demonstrate how the act of photographing, editing, and organizing visual series is also the work of producing theories about the city and its problems, deep contradictions, and possible solutions. The research work also aims at analyzing how street art and graffiti in the city of Manaus constitute forms of occupation and re-signification of urban space, articulating aesthetic practices in order to combat cultural erasures. We use the approach of Photoethnography to capture digital images of murals and artistic interventions spread throughout the city. A city which we perceive as organic, polyphonic, polysemantic, and full of urban art.

Keywords: Manaus. Visual Arts. Photoethnography. Poetry. Transculturality.

RESUMO

Este trabalho enfatiza uma sinódica dimensão visual da cidade e da arte urbana que estão expostas em muros grafitados, em eventos de rua e ocupações culturais que reconfiguram o imaginário sobre Manaus, capital do estado Amazonas com o objetivo de ampliar o entendimento da pesquisa com imagens, utilizando a técnica da Fotoetnografia. Demonstramos principalmente como o ato de fotografar, editar e organizar séries visuais é também o trabalho de produção de teorias sobre a cidade e seus problemas, contradições profundas e possíveis soluções. O trabalho de pesquisa também se propõe a analisar como a arte de rua e o grafitti na cidade de Manaus constituem formas de ocupação e ressignificação do espaço urbano, articulando práticas estéticas para o combate aos apagamentos culturais. Partimos da abordagem da Fotoetnografia para registrar imagens digitais dos murais e intervenções artísticas espalhadas pela cidade, que percebemos como orgânica, polifônica, polissêmica em suas vivas manifestações artísticas urbanas.

Palavras-chave: Manaus. Artes Visuais. Fotoetnografia. Poesia. Transculturalidade.

¹ Dr. in Society and Culture in the Amazon. Universidade Federal do Amazonas (UFAM).

² Professor. Universidade Federal Fluminense. Universidad Federal do Amazonas.

RESUMEN

Este trabajo enfatiza una dimensión visual sinódica de la ciudad y del arte urbano presentes en muros grafitados, eventos callejeros y ocupaciones culturales que reconfiguran el imaginario sobre Manaus, capital del estado de Amazonas, con el objetivo de ampliar la comprensión de la investigación mediante imágenes, utilizando la técnica de la fotoetnografía. Se demuestra principalmente cómo el acto de fotografiar, editar y organizar series visuales constituye también un proceso de producción teórica sobre la ciudad, sus problemas, profundas contradicciones y posibles soluciones. El trabajo de investigación también propone analizar cómo el arte urbano y el graffiti en la ciudad de Manaus constituyen formas de ocupación y resignificación del espacio urbano, articulando prácticas estéticas para combatir los borramientos culturales. A partir del enfoque de la fotoetnografía, se registraron imágenes digitales de murales e intervenciones artísticas distribuidas por la ciudad, comprendida como orgánica, polifónica y polisémica en sus vivas manifestaciones artísticas urbanas.

Palabras clave: Manaus. Artes Visuales. Fotoetnografía. Poesía. Transculturalidad.

1 INTRODUCTION

Photography is not just the act of pressing a button or swiping on a smartphone screen. In our research work, the act of photographing is seen as a way of recording and giving meanings to the urban world.

It is undeniable that photography today is in people's routine because of the availability of cell phones with cameras and a considerable number of social networks. The word photography comes from the junction of two Greek terms: Phos (light) and Graphé (to write), that is, photography means to write or draw with light. This research work and photographic essay reveals the role of subjectivity in the making and reading of graffiti art in the city of Manaus.

In this way, we consider photoethnography a powerful methodological tool in the field of visual anthropology and the so-called anthropology of the image (MATHIAS, 2016). In our field observations, we immersed ourselves in the art of graffiti, which we consider a true urban language in which graffiti artists start to act as street writers. We document here these city images, which transculturate the patterns associated with Amazonian mottos, reinventing them in the places where they are made available and in different forms, allowing them to be transformed, spaces and forms, in city circuits into a kind of open-air art gallery.

We chose this theme because of our proximity to Hip Hop Culture since the 1990s. In other words, the work has a scientific and militant character in Hip Hop (AGUIAR, 2021) revisited here in the reflection on memory spaces, collections, and museums.

For Ribeiro, "urban studies allowed the observer and the object of study to be brought closer together and paved the way, in parallel with the criticisms and questions that anthropology had been facing, to the development of works that were increasingly closer to the researcher's universe (2016, p. 98).

The street is our laboratory and deep down, "Photography is subversive, not when it terrifies, disturbs or even stigmatizes, but when it is *thoughtful*" (BARTHES, 2022, p. 18).

Hip Hop is an urban culture that originated in the Bronx neighborhood of New York City, in the United States of America, approximately in the 1970s. It arises from street parties, mainly with the events organized by DJ Kool Herc in 1973. Hip Hop Culture is made up of four artistic elements: Deejay, Rap, Breakdance, and Graffiti (AGUIAR, 2022). Hip Hop quickly spreads through the African-American and Latino communities as a form of artistic expression in the fight against racism, prejudice, social inequalities and marginality in the peripheries. The term Hip Hop was coined by the former street gang leader, Afrika Bambaataa, which means "to let go of the hips", in this way the disputes of the streets would be resolved through music, dance and a lot of art.

The four basic elements of Hip Hop Culture have been called by us as the four heads of the Urban Hydra (AGUIAR, 2011, 2018, 2022).

In the history of humanity itself, the act of drawing, painting and writing on walls and caves is already observed in the spaces covered by the so-called rock art (JUSTAMAND et al., 2025). In this way, the act of making paintings using cans of spray paint is called graffiti. Graffiti began with tags (signatures) on the surfaces of New York's subways in the early 1970s, by artists such as Taki 183 (GITAHY, 1999, p. 40) and, over time, it achieved success and was absorbed by the media and large art galleries (GITAHY, 1999, p. 39).

For this reason and for the opportunity to review socio-ethnographic documents, graffiti in the city of Manaus is the main object of our research. We make available here a considerable album of images made by artists who still deserve greater recognition in order to rethink the spaces for the distribution of art, culture and the continuation of memory.

2 SOME NOTES ON PHOTOETHNOGRAPHY

The thesis *FOUR HEADS OF AN URBAN HYDRA: IMAGES AND SOUNDS OF HIP HOP CULTURE IN THE CITY OF MANAUS – AM*, produced within the scope of the Graduate Program Society and Culture in the Amazon (PPGSCA) of the Federal University of Amazonas (UFAM) summons an imagetic and sound panorama of Hip Hop Culture in the city of Manaus, capital of the state of Amazonas. Through the lenses of cell phone cameras, images extracted from social networks, music, sounds, illustrations, two-dimensional barcodes (QR codes), audiovisual and graphic productions, we present the four artistic elements of Hip Hop Culture (Deejay, Rap, Breakdance and Graffiti) in their historical instances and different interactions, processes of resistance, actions, contradictions and conflicts in the urban spaces of the municipality in focus. From the first moment, we opted for interdisciplinarity. Essences extracted from history, sociology, literature, social communication, anthropology, architecture and graphic design to make the X-ray of a street culture that for almost four decades has influenced the behavior of a part of the youth of Manaus. As well as the mythological being who has the ability to recover from Hercules' advances. Hip Hop over five decades has been going through processes of hybridization (CANCLINI, 2015) with new rhythms, sounds, instruments, technologies, in this way, these young people appropriate and distribute art, dance and music in the peripheries of the whole world.

In fact, the pandemic period required new behaviors, making the traffic of people through cities decrease and the use of masks enter the routine of many, among other habits.

Thus, this work considered the direct and indirect effects of the pandemic on the unfolding of artistic making and its distribution, functioning as a prolegomenon on Hip Hop in Manaus.

Even so, it is an introductory text, although basic on the theme, with gaps to be filled throughout the next trails such as the one proposed here, considering the absences detected not deliberately or on purpose, but because we know that much information, characters, places, images and sounds would not be present during the writing process to the final product.

In this way, we decided to continue photoethnography as an approach to anthropological and interdisciplinary scientific research that aims to go beyond the university walls, and to suggest that the academic dialogue with society works as a response to the many concerns to do with identity, belonging, artistic making, distribution of art in the context of Manaus.

3 ABOUT THE FIELDWORK

The use of photography and audiovisual products in research contexts in the Social Sciences and Humanities is nothing unprecedented. There is a diversity of academic works that open up methodological possibilities and research objects. Despite this, presentations in verbal and written forms continue to have a higher level in the scope of academies, however we have been investing for some time in new forms of narratives and that have been giving results in the form of photographic exhibitions and academic publications (AGUIAR, 2022, 2023, 2024, 2025). We then focus on the use of photography in the studies of urban cultures, specifically, the photoethnography of Hip Hop culture in Manaus (AGUIAR, 2022) expanding the feat to the aforementioned thesis, and opening the opportunity to think about how the layers of culture are arranged and rearranged cross-culturally, depending on the circumstances of time and space.

Photoethnography combines photography with anthropological fieldwork to record images of graffiti productions. The method involved extensive fieldwork, using smartphone cameras in several areas of the city of Manaus. These images formed the narrative core, allowing detailed interpretations of cultural resistance, urban and Amazonian identity, from the graffiti scattered throughout the geographical zones of Manaus.

In addition to this exercise of readings and analysis of a specialized bibliography focused on the theme, we will also produce a photoethnography with the images of urban art known as graffiti. Making it clear that photoethnography is a composition of images that form a visual narrative.

Understanding that photoethnographic work and its production,

(...) must have a professional who guarantees quality in the image registration. The concern with capturing the image is an important prerequisite for those who will generate the photographic material, whether it is carried out by a photography professional, an ethnologist or a researcher who follows anthropological precepts (BONI; MORESCHI, 2007, p. 140).

Achutti defends the use of Photoethnography and its methodology. For the author:

If, from the beginning of the fieldwork, the researcher-photographer does not have in mind the final pagination (or assembly of the photographic exhibition, as the case may be), the result of his work will suffer from this lack of planning, because a long process of construction, the construction of a visual description. The photographs in the final result should form a whole. For this reason, a work that uses photography should be constructed with method, in the same way as a film, a text or a dissertation. Photographs obtained in a random and disorganized way will become, in the best of cases, a source of information that will perhaps one day find its place in some photo library, but which will not be able to become a complete work, a photoethnographic narrative (2004, p. 3-4).

In this same interview, Luiz Eduardo Achutti, the person responsible for drafting the nomenclature of the term, points out that technologies facilitate the practice of photographing, including using cell phones (ALVES, 2021, p. 446). In this way, we made use of smartphones in the collection of images and in the production of audiovisual materials. The recording, sound and image applications available are tools widely used by artists and researchers today.

It is worth noting that this type of activity has already been put into practice by us on other occasions (AGUIAR, 2021, 2022, 2025).

"A Photoethnography in the city of São Gabriel da Cachoeira - AM" (AGUIAR, 2025) is an educational and cultural immersion in this region. São Gabriel da Cachoeira is a city located in the extreme northwest of the state of Amazonas and borders Colombia and Venezuela. This locality is bathed by the Rio Negro and has considerable linguistic pluralism. In addition to the Portuguese language, three other indigenous languages are also spoken: Nheengatu, Baniwa and Tukano officially.

We were in São Gabriel da Cachoeira on two occasions (2019 and 2022), to teach in the Bachelor's Degree in Archaeology at the University of the State of Amazonas (UEA). In these odd moments, we use the camera of cell phones to capture images. Walking down the street and photographing incessantly.

In the contemporary world, new information and communication technologies open up a range of tools for the production of videos, music and photographs. We can say that creating an audiovisual product for free is possible and available using smartphones, iPads, tablets,

cameras and modern photographic lenses. The alliance between theory and practice should encourage the viewer to become a director of their own audiovisual works (MOLETTA, 2014). Furthermore, we emphasize that in the arts, the technological issue, historically, is of paramount importance (ZAMBONI, 2001, p. 41).

Luiz Achutti treats photoethnography as a "photographic writing" that does not clash with written and/or verbal language, they complement each other (ACHUTTI, 2004).

In "Capão Pecado": images of the south zone of the city of São Paulo – SP (AGUIAR, 2022) we present a visual narrative of our passage as researchers of Hip Hop culture and its artistic elements in the aforementioned region of São Paulo – SP. The title of the photo essay is in honor of the book *Capão Pecado* (2016) by the writer Ferréz. We tried to present a brief ethnographic circuit with interviews, filming, visits, readings, poetry, music, street food, prosaic conversations and especially the use of photographs collected by the cell phone camera.

In this way, we understand "photography and videos mainly as tools in the work process and field research. (...) that images and photographs are visual documents for interpretations full of validity in certain realities or cultures, even if they are loaded with subjectivities and polysemy" (AGUIAR, 2022, p. 90).

In fact, even for this reason: it is in the intersection of times, spaces, and perceptions that the various meanings and semantics are born from the gaze of a "single" object. We can look at a series of images, for example, from different angles, in different times and spaces, and this plurality of places of observation will allow polysemy, which is the encounter of subjectivity with the concreteness of and in the world.

4 IMAGES OF A TREMBLING WORLD

Borrowing the title of one of John Milton's books (2014), this section alludes to the equally subjective and plural effects of images, objects of this ethnography, in the context of thought and reflection on important themes for the peoples of the Manaus region, such as identity, belonging, artistic expression, distribution of the arts and social visibility.

The authorial images that we deal with here were produced and treated as visual narratives that critically point to the dispute for visibility in the public space and, before that, the subjective translations made by observers from different places, including those outside the city, and from the state of Amazonas. And in this sense, we remember that graffiti as a writing of the streets tends to expand the possibilities of reading this visual art as an aesthetic experience spread in living spaces. It is the circulation of images that affect its passers-by/observers, becoming part of those who occupy themselves with the gaze.

The list of images about graffiti quantitatively exceeded two hundred, and we tried to use natural light from smartphone cameras. On many occasions, we came across the arts through our daily paths and immediately parked the car to register. At other times we had to enter on foot, especially inside overpasses with cars in motion. We emphasize that a large part of these arts is in the outskirts of the city and, in this way, transiting through these "quebradas" becomes an activity that requires caution. However, there were no incidents and there was always someone for a quick and enlightening conversation about our work.

Some time later, we united the idea of visual narratives with the time before them, the proposal of photoethnography as poetry, as an expression of the various possible subjectivities achieved in the acts of photographing the instant of the quasi-permanent that is graffiti, and of describing reality as the subjectivity of the gaze, before it becomes part of the visual narrative initially thought of as an anthropological critique that reveals a dispute for visibility, affirmation of identity and, of course, attention to the hegemonic forms of public space planning. From one variant to the other, that is, from the poetry of the artistic and spectator gaze to the visual narrative propagated by anthropologically sharp reading, the proposal reaches forms of resignification of the spaces of circulation of people, things, objects, beings more than human (a new reference to the other animals on the planet, in a non-hierarchical way).

The results indicate that graffiti and other urban inscriptions operate as street writings that tension boundaries between art and illegality, center and periphery, memory and oblivion, converting streets and facades into an open-air museum and expanding the population's access to aesthetic experiences in the city where they live, in the same way that they transculture belongings linked to socioeconomic axes. And they go further, they remain there in the open spaces temporarily, extinguishing with the weather, rain, excessive sun. And in people's memories? How much do they remain and transform, transculturating experiences?

In this way, photoethnography, by making visible both the processes of creation and social circulation of images, enhances the understanding of urban art in Manaus as a practice of symbolic resistance and the production of new narratives about the city and its subjects, providing innovations in the way we perceive ourselves as human beings and experience our surroundings reified by the many objects of the urbis, and by the presence of beings more than human (traditionally, alluded to by the term "animals").

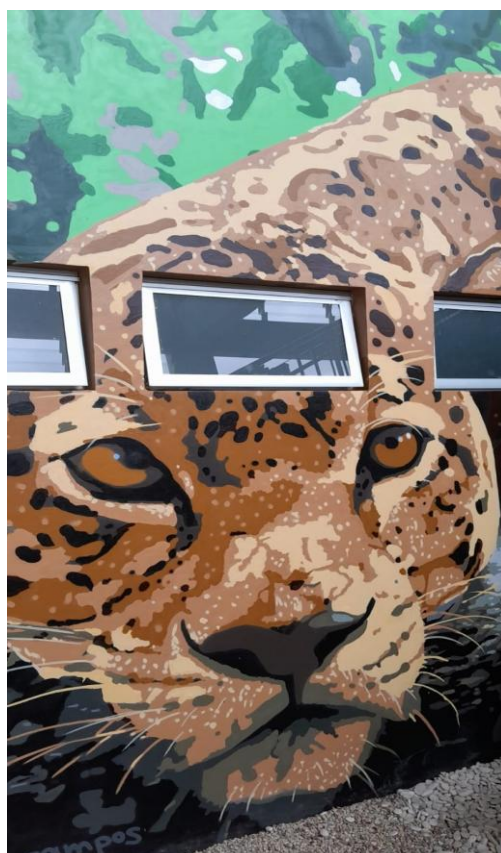
At the intersection of artistic and academic motivations, we open a horizon in which theories to do with anthropology, translation and the arts coexist, enabling us to go beyond

the limits of one and the other, uniting them kaleidoscopically, in favor of possibilities of existence(s).

Next, we present a series of ten imagery clippings (of more than two hundred) accompanied by bilingual poetic creations that translate them in order to compose texts beyond visual narratives, compositions open to varied subjectivities and to provoke reflections on places, belongings, identities from Manaus and their transculturated experiences to other times and spaces. And in our translation, to another language(s)...

Figure 1

Jaguar, 2024



Between the gaps of windows and buildings
There is a leopard
whose gaze is composed of fears and deviations...

Between the spaces of windows and towers, a leopard moves—its gaze woven from
fear and sidelong paths...

Figure 2

Doll and ink, 2021



In the small world of disposal
The immense universe of luxury – recycled
in prayer-doll face

DOLL AND INK, 2021

Within the small discarded world an endless splendor gleams—reborn in the hush of
a doll's prayerful face

Figure 3

Macaw, 2024



In the sound of the silent sky
green unison (im)planted
a macaw (re)exists...

In the hush of the sky's sound a green unison (un)planted a macaw (re)exists...

Figure 4

Mural, 2025



The gray wall shines colorful senseless
 Passing away daydreams, sculpting prejudices
 ink, paper and fantasy of having no end...

The gray wall shines colourful-less-ly
 deceasing dreams, curving prejudices
 -paper, ink and infinite prejudices

Figure 5

Curumin, 2021



The country boy
Lost in the verdant blue
On the almost black urban wall

CURUMIN, 2021
The boy from the woods
Got lost in blue green-ness
Of the almost black urban wall

Figure 6

Iara, 2024



Far away... Nearby
The Indian is still flaunted in a painting
Who only watches the photographer
avid for portrait(s)...

Up close and personal
an indian man flaunts his presence
watching the photographer, avid for a snapshot...

Figure 7

India, 2025



Iracema prays imposingly
in front of the handicraft fair
He commands respect from those who greet him.

Iracema prays imponent
before the craft fair
making her presence abundant to those who salute her

Figure 8

Graphics, 2025



River routes
trails on the skin
kill (a)inside – your feet, in mine.

GRAPHISM, 2025
River routes
skin paths
enter(ing) forest – your feet in mine.

Figure 9

Birds, 2024



The mural was low, colorful, and unsettling.
If it were enough for the owl to watch over all the elderly,
no macaw hung wings.

BIRDS, 2024

The wall was short, colourful and restless
Enough for an owl to zeal for the elderly
Then, no bird would overstretch its wing.

Figure 10

Cardume, 2025



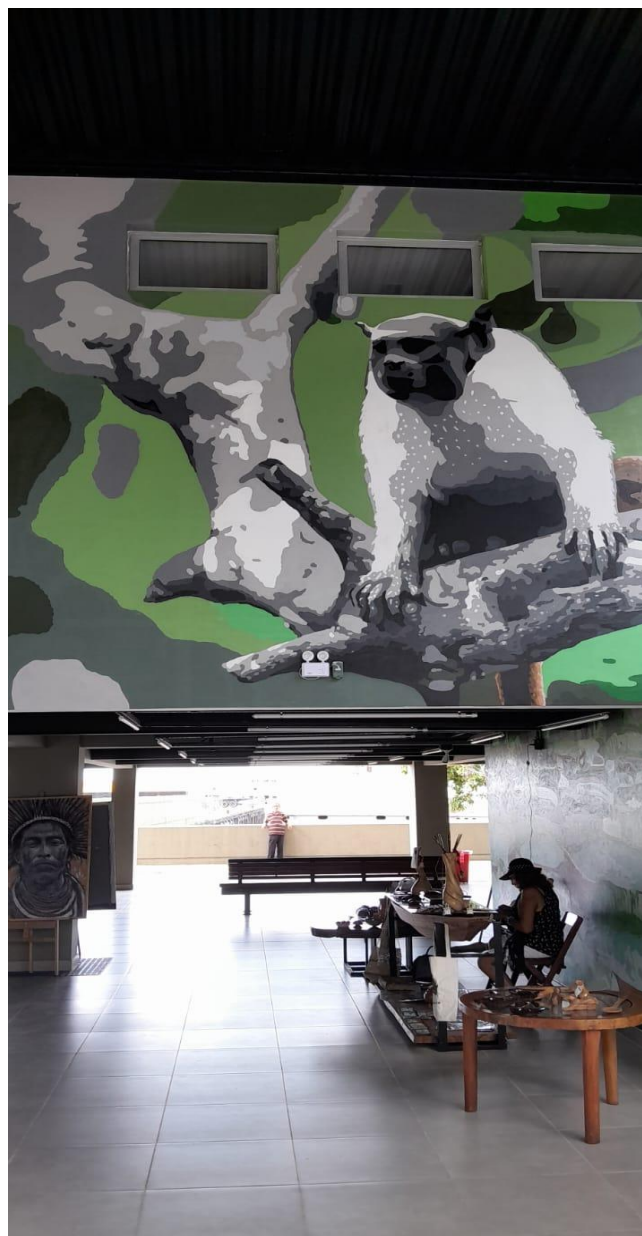
The Indian became man
In the look drawn on the concrete, where the sky was blue
and the boy's feet met the entire Amazonian shoal...

SHOAL, 2025

The indian boy became man
Upon the look overdrawn in the concrete, where the sky was blue
and the boy's feet found all the amazonian shoal...

Figure 11

Primate, 2024



In the woods of this fictional zoo
lie all the animals
including the monkey, with human features...

PRIMATE, 2024
In the woods of this fictional zoo
Lie all animals
the monkey, with human features, included...

REFERENCES

- Achutti, L. E. R. (1997). Fotoetnografia: Um estudo de antropologia visual sobre cotidiano, lixo e trabalho. Palmarinca.
- Achutti, L. E. R. (2004). Fotos e palavras, do campo aos livros. In Portal da Fotoetnografia do Grupo de Pesquisa Fotografia e Fotoetnografia: Arte e Antropologia. http://www.ufrgs.br/fotoetnografia/textos/texto_achutti.pdf
- Achutti, L. E. R. (2004). Fotoetnografia da Biblioteca Jardim. Editora da UFRGS: Tomo Editorial.
- Aguiar, S. B. de. (2022). Quatro cabeças de uma Hidra Urbana: imagens e sonoridades da Cultura Hip Hop na cidade de Manaus-AM [Tese de doutorado, Universidade Federal do Amazonas].
- Aguiar, S. B. de. (2022). “Capão Pecado”: imagens da zona sul de São Paulo - SP. Revista Zabelê - PPGANT - UFPI - Teresina-PI, 3(1).
- Aguiar, S. B. de, & Abreu, T. I. de. (2021). História de arquivos: os usos de fontes audiovisuais na temática negra, indígena e amazônica. In C. A. B. Queirós & K. M. de S. Pereira (Orgs.), Trabalho, Direitos Sociais e Democracia no Brasil. CRV.
- Aguiar, S. B. de, Abreu, T. I. de, & Nascimento, A. V. do. (2021). O que mais matam as pessoas são os cocos ou os tubarões. In L. C. Souza & A. do A. Sales (Orgs.), Diferentes olhares e perspectivas socioculturais na Amazônia. Alexa Cultural, EDUA.
- Aguiar, S. (2021). Isto não é um diário de campo? Alexa Cultural; EDUA.
- Aguiar, S. B. de. (2021). A cultura Hip Hop “invade” o Centro Cultural dos Povos da Amazônia (CCPA). In A. M. de Souza, R. Silva, & J. de J. L. Santana (Orgs.), Movimento Hip Hop na América Latina desde as fronteiras sociopolíticas e culturais. Centro Latino-americano de Estudos em Cultura (CLAEC).
- Aguiar, S. B. de. (2018). Quatro cabeças de uma Hidra Urbana e um Bumerangue Africano na cultura hip hop de Manaus [Trabalho de Conclusão de Curso de Especialização, Instituto Federal de Educação, Ciência e Tecnologia do Amazonas].
- Aguiar, S. B. de. (2011). Hip hop de leste a oeste de Manaus: quatro cabeças de uma Hidra Urbana. In P. M. Sampaio (Org.), O fim do silêncio: presença negra na Amazônia. Editora Açaí; CNPq.
- Azevedo, W. (2006). O que é design. Brasiliense.
- Barthes, R. (2022). A câmara clara: Nota sobre a fotografia (J. C. Guimarães, Trad.; 8ª ed.). Nova Fronteira.
- Boni, P. C., & Moreschi, B. M. (2007). Fotoetnografia: a importância da fotografia para o resgate etnográfico. Doc. On-line, (3), 137–157. www.doc.ubi.pt
- Canclini, N. G. (2015). Culturas híbridas: Estratégias para entrar e sair da Modernidade (H. P. Cintrão & A. R. Lessa, Trads.; G. Andrade, Trad. da introdução; 4ª ed., 7ª reimp.). Editora da Universidade de São Paulo.

Gitahy, C. (1999). O que é graffiti. Brasiliense.

Justamand, M., Almeida, V. J. R. de, Queiroz, A. N. de, Carvalho, O. A. de, Oliveira, G. F., Buco, C. de A., Albino, A. C. A., Oliveira, M. F. de, Paiva, L., Maton, C. M., Luz, G. N., Soares, F. de S., Nolêto, J. R. A., Caldeiras, A. C. S., Oliveira, G. P. R., Xavante, M. B. S., Funari, P. P. A., Fontes, M. A. F., Cotes, M., Aguiar, S. B. de, Pinto, M. A. C., Gonçalves, J. R., & Nunes, C. R. P. (2025). Environmental perceptions in rock art: The Serra da Capivara and Serra das Confusões, Brazil. *Revista Observatorio de la Economía Latinamericana*, 23(12), 1–xx. <https://ojs.observatoriolatinoamericano.com/ojs/index.php/olel/article/view/12501>

Mathias, R. (2016). *Antropologia visual*. Nova Alexandria.

Milton, J. (2014). *Imagens de um mundo trêmulo*. Hedra.

Moletta, A. (2014). *Fazendo cinema na escola: Arte audiovisual dentro e fora da sala de aula*. Summus.

Ribeiro, A. S. P. (2016). *Teoria e prática em Antropologia*. Intersaberes.

Zamboni, S. (2001). *A pesquisa em Arte: Um paralelo entre arte e ciência* (2ª ed.). Autores Associados.

CALCULATION AND IMPLEMENTATION OF BOTTOM DISCHARGE IN DAMS: THEORETICAL AND PRACTICAL GUIDE

CÁLCULO E IMPLEMENTAÇÃO DA DESCARGA DE FUNDO EM BARRAGENS: GUIA TEÓRICO E PRÁTICO

CÁLCULO E IMPLEMENTACIÓN DEL DESCARGA DE FONDO EN PRESAS: GUÍA TEÓRICA Y PRÁCTICA



<https://doi.org/10.56238/sevened2026.008-167>

**Jonathan Joaquim de Moraes¹, Girlene Figueiredo Maciel², Rodrigo Martins Ribeiro³,
Mateus Chagas dos Santos⁴, Amanda da Rosa Lena⁵, Fernán Enrique Vergara
Figuerola⁶, Joel Carlos Zukowski Junior⁷**

ABSTRACT

Bottom flushing operates by allowing water stored in the reservoir to be released through structures located at the base of the dam. It is a structure designed to control the controlled release of water from the reservoir, ensuring the stability of the dam and controlling water levels. This component is essential in damming to ensure the structural safety of the dam and the efficient management of water resources. This article offers an integrated approach to the calculation and implementation of bottom discharges in dams, with a focus on inverted siphons, based on hydrological and normative studies. Combining theory, legislation and practice, the aim is to provide a practical and complete guide that covers everything from the theoretical foundations to the execution of the installation. The objective is to simplify the process for engineers and technicians, ensuring the safe and efficient operation of dams, in addition to meeting environmental and regulatory requirements.

¹ Master's Student in Environmental Engineering. Universidade Federal do Tocantins (UFT).

E-mail: jonathanjm.eng.c@gmail.com Orcid: <https://orcid.org/0009-0008-2362-0962>

Lattes: <http://lattes.cnpq.br/1804331466956569>

² Dr. in Natural Resources. Universidade Federal de Campina Grande (UFCG). E-mail: maciel@uft.edu.br

Orcid: <https://orcid.org/0000-0001-9217-3731> Lattes: <http://lattes.cnpq.br/9377355626452682>

³ Master's Student in Environmental Engineering. Universidade Federal do Tocantins (UFT).

E-mail: rodrigo@pleiade.eng.br Orcid: <https://orcid.org/0009-0006-0075-4859>

Lattes: <http://lattes.cnpq.br/0873059368885932>

⁴ Master's Student in Environmental Engineering. Universidade Federal do Tocantins (UFT).

E-mail: chagasmateus2000@gmail.com Orcid: <https://orcid.org/0009-0004-1900-8384>

Lattes: <https://lattes.cnpq.br/5594405175252978>

⁵ Master's Student in Environmental Engineering. Universidade Federal do Tocantins (UFT).

E-mail: amandadarosalena@gmail.com Orcid: <https://orcid.org/0009-0005-1826-245X>

Lattes: <http://lattes.cnpq.br/1289596665086548>

⁶ Dr. in Environmental Technology and Water Resources. Universidade de Brasília (UnB).

E-mail: fernan@uft.edu.br Orcid: <https://orcid.org/0000-0003-1643-2564>

Lattes: <http://lattes.cnpq.br/4356137674634041>

⁷ Dr. in Energy Systems Planning. Universidade Estadual de Campinas (UNICAMP).

E-mail: zukowski@uft.edu.br Orcid: <https://orcid.org/0000-0002-5070-5274>

Lattes: <http://lattes.cnpq.br/0062084279231594>

Keywords: Bottom Discharge. Dams. Inverted Siphon. Hydrological Calculation. Dam Safety.

RESUMO

A descarga de fundo em barragens opera permitindo que a água armazenada no reservatório seja liberada por meio de estruturas localizadas na base da barragem. É uma estrutura projetada para controlar a liberação controlada de água do reservatório, garantindo a estabilidade da barragem e controlando os níveis de água. Essa componente é essencial em represamento para garantir a segurança estrutural da barragem e a gestão eficiente dos recursos hídricos. Este artigo oferece uma abordagem integrada para o cálculo e implementação de descargas de fundo em barragens, com foco em sifões invertidos, baseando-se em estudos hidrológicos e normativos. Combinando teoria, legislação e prática, busca-se fornecer um guia prático que engloba desde os fundamentos teóricos até a execução da instalação. O objetivo é simplificar o processo para engenheiros e técnicos, garantindo a operação segura e eficiente das barragens, além de atender às exigências ambientais e regulatórias.

Palavras-chave: Descarga de Fundo. Barragens. Sifão Invertido. Cálculo Hidrológico. Segurança de Barragens.

RESUMEN

La descarga de fondo en presas funciona permitiendo la liberación del agua almacenada en el embalse a través de estructuras ubicadas en la base. Esta estructura está diseñada para controlar la liberación controlada de agua del embalse, garantizando la estabilidad de la presa y regulando los niveles de agua. Este componente es esencial en los embalses para garantizar la seguridad estructural de la presa y la gestión eficiente de los recursos hídricos. Este artículo ofrece un enfoque integral para el cálculo e implementación de la descarga de fondo en presas, centrándose en los sifones invertidos, basándose en estudios hidrológicos y regulatorios. Combinando teoría, legislación y práctica, el objetivo es proporcionar una guía práctica que abarca desde los fundamentos teóricos hasta la ejecución de la instalación. El objetivo es simplificar el proceso para ingenieros y técnicos, garantizando la operación segura y eficiente de las presas, además de cumplir con los requisitos ambientales y regulatorios.

Palabras clave: Descarga de Fondo. Presas. Sifón Invertido. Cálculo Hidrológico. Seguridad de Presas.

1 INTRODUCTION

Dams are closely linked to the social and scientific development of humanity. These are structures that can influence both the area around them and their rural and urban surroundings. For millennia, human beings have recognized the need to build reservoirs in order to contain surface waters for an individual or collective good (Rocha et al., 2024).

The bottom discharge system is used to control the water level in dams, with the aim of mitigating risks related to floods, ruptures and overflows. It consists of a mechanism that allows the controlled release of accumulated water, performing a specific function in the operation of dams, especially large ones (Silva et al., 2016). In specific contexts, such as in small-port dams or in places with water scarcity conditions, the use of bottom discharge can be considered dispensable (Aion, 2018).

Despite its importance, the application of bottom discharge is not yet widespread. In part, this is due to the risks associated with the operation, such as excessive vibrations in the gates, cavitation, and leaks. These factors can significantly impact the costs of building and maintaining the dam, as the device requires constant inspection and care. Due to the wear generated by cavitation and abrasion, Rocha et al. (2018) suggest that the continuous use of bottom discharge should be avoided to prevent structural damage.

An example in Brazil is the Pedra do Cavalo Dam, located in Bahia, considered one of the most important, as it is responsible for the water supply of the capital Salvador and its metropolitan region. Initially, the dam had a bottom discharge to help control the filling of the reservoir. However, after the water level exceeded the spillway level, the device was deactivated and ceased to be used.

On the other hand, other countries, such as the United States, Spain and Switzerland, have strengthened their dam safety legislation, requiring the inclusion of bottom discharges in new constructions and, in the case of Spain, even in existing dams.

This balanced approach between operational benefits and technical challenges has been debated in different contexts around the world, highlighting the importance of adapting best practices according to the particularities of each dam and region. In Brazil, although there is still no specific legislation on the subject, the National Water Agency (ANA) already recommends the implementation of this device as an essential practice for the safety and proper functioning of dams.

However, the operation of dams in Brazil still faces numerous challenges, especially with regard to the correct functioning of bottom discharges. These structures serve to ensure the safety, maintenance and efficient operation of the dams. However, it is estimated that

more than 90% of the dams in the country have problems related to the management of this system, making it urgent to adopt practical and standardized methods.

Thus, bottom discharge in dams performs several essential functions, such as emptying the reservoir, both for scheduled maintenance and in emergency situations, in addition to allowing the removal of accumulated sediments and the renewal of water. This device is also crucial for maintaining regular flow in the river downstream, ensuring that water continues to flow through the dam structures, which contributes to the preservation of the local ecosystem.

This article aims to provide a guide for the calculation and implementation of bottom flush systems, focusing on the use of inverted siphons, an economical and easy-to-implement solution. The methodology is based on theoretical and practical studies, applicable legislation and technical standards such as ABNT NBR 12214 (1992) and ABNT NBR (2017), as well as practical examples applied to dams in Brazil. The central proposal is to ensure that, through a single source, the reader can understand the theoretical principles, follow the calculation formulas and apply the practical guidelines for installation, providing a complete solution for water management in dams.

The methodology adopted in this study was based on a bibliographic survey of academic papers, legislation and project guides on the use of bottom discharge devices in dams. As described by Manzo (1986), the bibliographic survey offers means to define and solve not only problems that are already known, but also to explore new areas where the problems have not sufficiently crystallized. This method allows researchers to support their analyses with parallel data and expand the reach of their findings.

During the research, various types of sources were consulted, such as scientific articles, technical standards, and national and international legislation. The studies cover several countries, including Brazil, India, Spain, the United States, Canada, Switzerland and the United Kingdom, which contributed to a global view on the application and challenges of implementing bottom discharges. In addition, manuals and technical bulletins from institutions such as the National Water Agency (ANA), which provide guidelines and practical recommendations on the installation and maintenance of these devices, were analyzed.

This method also included consulting ABNT standards, such as ABNT NBR 12214 (1992) and ABNT NBR 13028 (2017), which guide the design and construction of water control systems, ensuring that technical parameters are aligned with international best practices.

2 THEORETICAL FOUNDATIONS

The theoretical and methodological basis of this article follows the studies of Tomaz (2012), whose works are extremely recognized in the area of water resources and dam management. Its contributions are based on the methodologies for calculating bottom discharges in dams, which are essential for the maintenance of the structure and environmental preservation. These devices ensure the proper flow of water and prevent the accumulation of sediments, promoting the constant renewal of downstream water, in addition to controlling the volume of water in the reservoirs.

The bottom discharge is an important structure for the safety of dams, as it makes it possible to control the flow of water released downstream, both in normal operating situations and in emergencies, such as emptying the reservoir. In addition, it plays an important role in the preservation of aquatic ecosystems, ensuring the maintenance of the minimum ecological flow, as required by environmental standards (Rocha et al., 2018; Paulo et al., 2021).

Bottom discharges can be renewed in different ways, depending on the type of dam (earth or concrete) and its main function, such as supply, storage or energy generation. These variables directly influence the choice of the most compromised solution for bottom discharge. The main types include valve, pipe and siphon controlled discharges. The use of inverted siphon is especially common in earth dams that do not have a built-in bottom discharge, or where an existing discharge does not meet the ecological flow required for the region's water demand (Silva et al., 2016).

The inverted siphon uses the principle of atmospheric pressure to move water from a higher to a lower height, without the need for pumps. The water is conducted through an inverted "U" shaped tube, where the pressure at the highest point of the siphon is lower than the atmospheric, generating a continuous flow. This type of system is widely used in earth dams that do not have a built-in bottom discharge, being installed externally, which facilitates its implementation and reduces costs (Dini; Tabesh, 2014; Campos, 2020).

In addition, the use of inverted siphons is an efficient solution, especially when the region's water demand and the need for water renewal are not met by existing discharges. In projects that require greater operational flexibility and control over water flow, the siphon stands out as a practical and low-cost alternative. It allows for minimal intervention in the existing dam structure, while ensuring proper flow control and maintaining the desired water level in the reservoir (Abreu et al., 2018).

The implementation of siphon bottom discharges, especially in earth dams, also helps in the removal of sediments accumulated at the bottom of the reservoir, which is essential to preserve the reservoir's capacity and prevent siltation. This type of solution is particularly

useful in regions where water level control is crucial to avoid problems of operation and environmental preservation (Campos, 2019; Abreu, 2019).

The structural and ecological importance of bottom discharges is widely highlighted in studies such as that by Paulo et al. (2021), which examine the effectiveness of bottom discharge in controlling water level and removing accumulated sediments. In addition, the devices act on the safety of the dam, avoiding hydraulic overload that can compromise structural integrity.

From a hydrodynamic point of view, the most used formulas for calculating flow include the Manning and Hazen-Williams equations. The Manning research is applied to determine the flow rate as a function of the roughness of the material, the ceramic diameter and the flow orientation, and is widely used in gravitational systems. On the other hand, Hazen-Williams engineering is used to calculate the pressure loss in hydraulic systems, whether settlement or gravity, since both involve pressurization, whether natural or artificial. The proper application of these formulas is essential for the correct sizing and operational efficiency of the flushing system (Silva et al., 2016).

3 REGULATIONS AND APPLICABLE LEGISLATION

In Brazil, the management and standardization of dam safety is governed by a series of laws and decrees that aim to ensure the protection of water resources and the safety of the infrastructures involved. State Decree No. 2,432/2005, of the State of Tocantins, establishes specific rules for the granting of the right to use water resources, with a focus on run-of-the-river dams. This decree defines that a minimum flow to guarantee ecological flow must be 25%, a measure that aims to maintain local biodiversity and minimize negative environmental impacts (Tocantins, 2005). This regulation is essential for the implementation of bottom discharge systems, ensuring that the use of water resources is sustainable and safe.

In addition to state standards, Federal Law No. 12,334/2010, which deals with the National Dam Safety Policy (PNSB), is a regulatory framework that imposes clear guidelines on the construction, operation, monitoring, and maintenance of dams in Brazil. This legislation was created in response to several incidents that occurred in Brazilian dams, with the objective of ensuring that all dams meet minimum safety standards, not only structural, but also environmental (BRASIL, 2010). The Law was complemented by Law No. 14,066/2020, which increased the loss in the control of dam safety after tragedies such as Brumadinho and Mariana. The adoption of bottom discharges in this context is a practical response to the

requirements imposed by this legislation, allowing dam operators to comply with the established requirements.

Another relevant standard for the planning and implementation of bottom discharges is ABNT NBR 13028 (2017), which provides technical guidelines for the construction and maintenance of earth dams. This standard covers everything from the initial design to the continuous monitoring of the structure, considering the environmental impacts and technical requirements to ensure the safety of the work (ABNT, 2017). The use of bottom discharge systems is especially important in earth dams, as it allows the removal of accumulated sediments and the control of the water level, avoiding structural overloads.

CONAMA Resolution No. 344/2004 also deserves to be highlighted, as it establishes minimum procedures for the evaluation of sediments to be dredged. These procedures are directly applicable to the use of bottom discharge systems, as they ensure that sediment removal is carried out in a safe manner and in compliance with environmental guidelines (CONAMA, 2004). In the context of dam operation, this resolution complements the other regulations, reinforcing the importance of maintaining strict control over sediment management.

In addition, the technical manual of the National Water Agency (ANA) recommends the adoption of bottom discharge systems as an efficient measure for the management of water resources in dams (Abreu et al., 2018). ANA, as a regulatory body, works in conjunction with state and federal regulations to ensure that all dams in Brazil are operated in accordance with the best practices of sustainability and water security.

In comparative terms, Brazil is still in the adaptation phase to comply with the requirements established in stricter international legislation, such as Spanish legislation, which requires that all new dams, and many existing ones, incorporate bottom discharge systems to maintain water and environmental security (Pereira, 2019). In the United States, dam management is widely regulated, with legislation disabling bottom discharge systems in all structures, especially in regions prone to drought and extreme water flow variations (Maia, 2023).

Thus, the Brazilian regulations on dam safety, and in particular on bottom discharges, are well established, but require constant adaptation and updating. The integration between state and federal legislation, as well as the incorporation of international best practices, is essential to ensure that dams in Brazil operate in a safe and sustainable manner. The alignment with ABNT NBR 12214 (1992), which addresses the sizing of water pumping systems, also complements safety standards to ensure that the flow of water is properly controlled (ABNT, 1992).

4 CALCULATION METHODOLOGY FOR INVERTED SIPHONS

Calculating the flow rate of a bottom discharge involves the application of hydrodynamic equations that consider factors such as the diameter of the pipe, the slope, and the roughness of the material used. The Manning equation, for example, is widely used to estimate water flow in inverted siphon systems, while the Hazen-Williams equation provides accurate estimates of head loss in pressurized systems (Silva et al., 2016).

These calculations are essential to ensure that the bottom discharge system operates within the safety and efficiency limits established by national and international regulations (Campos et al., 2019). According to Silva et al. (2016), the correct application of these equations allows the structure to be sized adequately, ensuring that the bottom discharge meets the flow demands and operates without compromising the integrity of the dam.

The methodology used in this article is based on the studies of Tomaz (2012). To calculate the flow (Q) of the water flowing through the bottom discharge, the Manning and Hazen-Williams equations are used. These equations consider the pipe diameter (D), the slope (S), and the roughness of the pipe material (n).

The Manning Equation is widely used to calculate the flow rate (Q) in open channels and partially filled pipes. It considers the roughness coefficient of the material (n), the hydraulic radius (R) and the flow slope (S).

$$Q = \frac{1}{n} \times A \times R^{2/3} \times S^{1/2} \quad (1)$$

Where:

- What is the flow rate, m³/s
- A is the wet area, m²
- R is the hydraulic radius, m
- S is the slope, m/m

The Hazen-Williams Equation is applied to determine the pressure loss in full pipes.

$$Q = C \times D^{2.63} \times S^{0.54} \quad (2)$$

Where:

- Q is the flow rate in m³/s
- D is the diameter in meters
- S is the unit head loss in meters per meter of pipe

- C is the coefficient that depends on the nature of the material used and the condition of the internal walls.

These equations make it possible to measure the volume of water to be released by the bottom discharge, ensuring safe and efficient operation (Campos et al., 2019; Tomaz, 2012). These formulas allow you to calculate the flow capacity and ensure that the system is correctly sized.

According to ASCE, 1992, the siphon for rainwater conduction should have a maximum speed of 1.8 m/s, and if there are abrasive materials, the speed should be less than 3 m/s. Also according to ASCE, 1992, the pressure loss can be calculated using Manning's proposal, which is as follows:

$$HF = \frac{19,5 n^2 \times L \times V^2}{R^{4/3} \times 2 \times g} \quad (3)$$

Being:

- HF = Pressure Drop (m)
- n = Manning roughness
- L = Circumference Length (m)
- V = speed (m/s)
- R = hydraulic radius (m)
- g = 9.81 m/s²

Load losses must be calculated in curves, contractions, expansions, as well as in inputs and outputs.

We know the flow rate, we need to size the diameter of the siphon using the Darcy-Weisbach formulation or the Hazen-Williams formula. For pipes with a diameter of less than 50 mm, other formulas can be used, such as Flamant's. However, the great advantage of the Hazen-Williams formula is that it facilitates the choice of the roughness coefficient C, which is easier to estimate compared to the K values used in the Darcy-Weisbach formula. The formula for the pressure loss per meter (J) is given by:

$$j = \frac{10,643 \times Q^{1,85}}{C^{1,85} \times D^{4,87}} \quad (4)$$

Where:

- J is the pressure loss per meter (m/m);

- Q is the flow rate in cubic meters per second (m³/s);
- C is the roughness coefficient of the pipe according to Hazen-Williams;
- D is the diameter of the pipe in meters.

Table 1 lists some values for the Hazen-Williams roughness coefficient.

Table 1

Hazen–Williams roughness coefficient.

Material	Roughness coefficient C
New cast iron	130
Cement-coated cast iron	130
New steel	120
Steel in use	90
PVC	150
Cast iron in use	90

Source: Adapted from Dini and Tabesh (2014)

The formula for calculating the pressure drop in the tube section of length L is:

$$h_f = J \times L \quad (5)$$

Being:

- h_f = loss of pressure in the stretch, in meters of water column;
- J = unit loss obtained by formula (4);
- L = Pipe length (m).

The speed in the Hazen–Williams formula is given by:

$$V = 0,355 \times C \times D^{0,63} \times J^{0,54} \quad (6)$$

Being:

- V = velocity (m/s);
- C = Hazen-Williams roughness coefficient (dimensionless);
- D = diameter (m);
- J = unit head loss (m/m).

The Hazen–Williams formula is applicable for high speeds, but is questionable for C values below 100, and its use is limited to speeds less than 3 m/s.

Mott (1994) presented a Hazen-Williams formula for any section, using the hydraulic radius. For units of the International System (SI), there are:

$$V = 0,85 \times C \times R^{0,63} \times S^{0,54} \quad (7)$$

$$hfL = L \left[\frac{Q}{0,85 \times A \times C \times R^{0,63} \times S^{0,54}} \right] \quad (8)$$

Being:

- V = average cross-section velocity (m/s);
- C = Hazen-Williams coefficient (varies between 100 and 140 for concrete);
- R = hydraulic radius (m) = A/P.

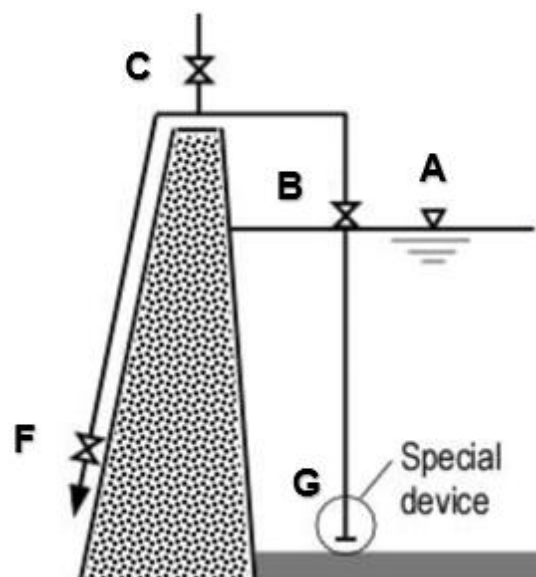
Analyzing a normal siphon, i.e., the siphon using Mott, 1994. Bernoulli's equation can be used, initially assuming that there is no pressure loss, although it can be easily used when considering distributed and localized load losses. If there are no localized and distributed cargo losses, we will have:

$$\frac{p}{\gamma} + Z + \frac{V^2}{2g} = \text{constante} \quad (9)$$

However, localized and distributed cargo losses must be considered. Then, the calculation and application of Bernoulli's equation is detailed to specific points in the siphon system, using data from a bus. For this, values such as flow, suction length and localized losses are considered.

Figure 1

Siphoning in dam



Source: Tomaz (2012)

4.1 FIRST

The first step is to apply Bernoulli's equation to points A and F in Figure 1.

$$\frac{p_A}{\gamma} + Z_A + \frac{V_A^2}{2g} = \frac{p_F}{\gamma} + Z_F + \frac{V_F^2}{2g} + hf_{AF} + \Sigma ks \times \frac{V_F^2}{2g} \quad (10)$$

Being:

- HF = distributed head loss (m)
- Σks = loss of localized charges (m) $\frac{V_F^2}{2g}$

4.2 SECOND

The second step is to apply Bernoulli's equation to points A and B in Figure 1.

$$\frac{p_A}{\gamma} + Z_A + \frac{V_A^2}{2g} = \frac{p_B}{\gamma} + Z_B + \frac{V_B^2}{2g} + hf_{AB} + \Sigma ks \times \frac{V_B^2}{2g} \quad (11)$$

4.3 THIRD

The third step is to apply Bernoulli's equation to points A and C in Figure 1.

$$\frac{p_A}{\gamma} + Z_A + \frac{V_A^2}{2g} = \frac{p_C}{\gamma} + Z_C + \frac{V_C^2}{2g} + hf_{AC} + \Sigma ks \times \frac{V_C^2}{2g} \quad (12)$$

The proper implementation of these steps will result in the regularization of the Earth Dam in accordance with the requirements of the current environmental agency of your state. It is worth mentioning that the flow required for the system may vary according to the region, and it is therefore essential to monitor civil and environmental engineering for the correct sizing of the project and its precise execution.

5 EXECUTION AND INSTALLATION

After the calculations are completed, it is time to install the bottom discharge. Correctly following these guidelines ensures that the dam operates safely and efficiently, preventing structural failures and mitigating environmental risks. The correct and detailed instruction of the steps provided facilitates the process and ensures that the reader, by following the instructions, can execute the solution successfully (Tomaz, 2012).

To address the installation and execution of bottom discharge systems in dams, it is necessary to have thorough planning that is based on technical and normative guidelines that are already conditional (ABNT, 2017). These systems play an important role in the operation

of dams, as they facilitate the control of water flow, the removal of sediments and the preservation of structural safety (CONAMA, 2004).

The successful execution of these systems cannot be achieved in a superficial way; on the contrary, it requires a detailed understanding of the processes involved, the materials used, and the tools used for the system to work optimally and flawlessly (Tomaz, 2012).

The process of installing a bottom flush system begins with the choice of the appropriate materials. According to Tomaz (2012), PVC pipes are often recommended for their corrosion resistance and ease of application. These pipes must be selected based on the ceramic calculation in advance, considering the pressure and flow of water that will be chosen by the system. In addition, ball valves and PVC connectors are widely used to ensure system flexibility, while sieve foot valves play a critical role in preventing clogging, allowing controlled passage of water and preventing coarse sediment from entering the system (Tomaz, 2012; Abreu et al., 2018).

Land preparation is another step in the installation process, involving cleaning and excavation to accommodate the pipes. This requires precision, as the inverted siphon system must be installed in phases and with the proper specification, in order to ensure the continuous flow of water. Measuring ground levels is an essential practice to avoid installation errors. The use of hoses with water, as described by Silva et al. (2016), is an effective method for measuring the ground level and adjusting the orientation of the orientation. This method, in addition to being simple, offers enough solutions to ensure that the siphon is positioned correctly, preventing future problems such as clogs and leaks.

During the installation phase, the assembly of the inverted siphon system must strictly follow the technical guidelines. All components, including pipes and valves, must be assembled precisely, complying with previously calculated pressure and flow specifications. The entrepreneur's manual (2024) details the importance of proper cuts in pipes, using care to ensure that the parts are perfectly aligned and connected. Any misalignment or failure in the arrangement can result in leaks, compromising the efficiency of the system. In addition, a constant check during installation is recommended to ensure that all installations are well adjusted and fixed.

After the system has been assembled, it is essential to conduct efficiency tests, especially to check the water flow through the bottom discharge system. The "bucket test" is widely recommended in manuals and studies on bottom discharge (Paulo et al., 2021), and consists of measuring the volume of water drained during a given period and comparing it with the values previously calculated. This method, while simple, is effective in verifying that the system is working as intended. For larger or more complex systems, the use of digital

flow meters can be a more accurate alternative, providing real-time data on system performance (Dinini; Tabesh, 2014).

Keeping the bottom flush system in full working order depends on a regular maintenance routine. Sediment buildup in pipes can compromise system efficiency, especially in dams where sediment removal is a constant concern. Periodic cleaning is therefore essential to prevent clogging and ensure water flow (Rocha et al., 2018). In addition, inspecting connections and checking for possible leaks should also be part of the maintenance schedule. Standards such as ABNT NBR 16496:2016 provide detailed guidance on how to monitor and operate dam systems, ensuring that the correct procedures are followed to maintain the longevity and efficiency of the system (ABNT, 2016).

International experience also offers valuable examples on the improvement and maintenance of bottom discharge systems. Countries such as the United States and Spain have strict standards that exclude the installation of bottom discharge devices in new dams and even the adaptation of existing dams to incorporate these systems (Maia, 2023). These legislations reflect the importance of ensuring the structural safety of dams, as well as contributing to environmental protection by ensuring that water flow and sediment removal are managed effectively. In Brazil, although there is still no specific federal law for bottom discharge, manuals and guidelines from the National Water Agency (ANA) already recommend the adoption of such systems, based on international examples (Brasil, 2010; CONAMA, 2004).

The process of installing and maintaining bottom discharge systems requires careful planning and constant observation of environmental conditions, such as the variation in the water level and the amount of sediment accumulated in the reservoir. Periodic adjustments may be necessary to ensure that the system continues to function efficiently over time. More advanced systems, such as those incorporating monitoring sensors, can facilitate this process by allowing operators to make automatic adjustments based on real-time data (Paulo et al., 2021).

Ultimately, the installation of a well-planned and preserved bottom discharge system provides significant benefits, both in terms of structural safety and environmental preservation. Efficient sediment removal avoids the accumulation of materials that could compromise the integrity of the dam, while adequate control of water flow contributes to the sustainability of riparian ecosystems (Tomaz, 2012). The experience accumulated in other countries shows that the adoption of similar practices in Brazil could bring innovative advances to the sector, especially with regard to dam safety and water resources management.

In Brazil, the current scenario is promising, with the growing adoption of technical guidelines for the installation and maintenance of bottom discharge systems. As regulations become more stringent and practices align with international standards, the country is expected to advance in the efficient management of its dams, minimizing the risks and maximizing the benefits of these systems (Silva et al., 2016; Rocha et al., 2018).

Therefore, the execution of bottom discharge systems in dams is not just a technical issue; It also involves a commitment to safety, environmental preservation and compliance with standards and regulations. The combination of theory and practice described in this article provides a comprehensive guide for the implementation of these systems, offering an efficient and sustainable solution for the safe operation of dams in Brazil and other international contexts.

6 CONCLUSION

From the results obtained, it is possible to present a complete and integrated view on how to solve the problems of bottom discharge in dams. Through the combination of theory and practice, the reader is offered a guide that eliminates the need to resort to multiple sources, concentrating in a single document all the information and tools necessary for proper calculation and installation. The ultimate goal is to ensure that, by following this step-by-step, the professional can effectively meet the regulatory and operational requirements of dams in Brazil.

Thus, the importance of an efficient bottom discharge system cannot be underestimated. It plays a vital role in the safe operation of dams, helping to prevent sediment build-up and ensuring controlled runoff of water. A well-implemented system also contributes to environmental sustainability by preserving the ecosystems downstream of the dam.

The results provide a significant contribution to the implementation of practical and normative solutions in the context of Brazilian dams. By aligning the methodologies described with national and international technical standards, such as those of ABNT, it provides a guide that complies with current legislation, while facilitating the operation and maintenance of these structures.

In addition, the practices described here are widely applicable to other international contexts, as evidenced by countries such as the United States and Spain, which have already adopted stringent regulations on the use of bottom discharge devices. The adoption of similar solutions in other countries reinforces the need to implement well-planned and committed devices, ensuring the structural integrity of dams and contributing to more sustainable water management at a global level.

REFERENCES

- Abreu, A. S., & outros. (2018). Análise preliminar do alcance de remoção de sedimentos por descarregadores de fundo em pequenas barragens [Anais]. Congresso Latinoamericano de Hidráulica, Buenos Aires, Argentina. Instituto Nacional del Agua. <https://lume.ufrgs.br/bitstream/handle/10183/184432/001078959.pdf?sequence=1>
- Abreu, A. S. (2019). Análise experimental em modelo físico de estruturas hidráulicas de remoção de sedimentos em barragens: Descarregadores de fundo [Dissertação de mestrado, Universidade Federal de Pelotas]. Lume. <https://lume.ufrgs.br/handle/10183/197881>
- Ainon, M. (2018). Remoção de sedimentos em reservatórios de barragens de usinas hidrelétricas através de descarga de fundo [Monografia de graduação, Universidade Federal do Rio Grande do Sul]. Lume. <https://lume.ufrgs.br/handle/10183/184604>
- Associação Brasileira de Normas Técnicas. (1992). ABNT NBR 12214: Projeto de sistemas de bombeamento de água. <https://www.abnt.org.br>
- Associação Brasileira de Normas Técnicas. (2017). ABNT NBR 13028: Construção e manutenção de barragens de terra. <https://www.abnt.org.br>
- Associação Brasileira de Normas Técnicas. (2007). ABNT NBR 15514: Dimensionamento hidráulico de sistemas de drenagem. <https://www.abnt.org.br>
- Associação Brasileira de Normas Técnicas. (2016). ABNT NBR 16496: Monitoramento de barragens de rejeitos. <https://www.abnt.org.br>
- Associação Brasileira de Normas Técnicas. (2015). ABNT NBR 5419: Proteção contra descargas atmosféricas. <https://www.abnt.org.br>
- Brasil. (2010). Lei nº 12.334, de 20 de setembro de 2010. Dispõe sobre a Política Nacional de Segurança de Barragens. http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12334.htm
- Campos, B. S. (2020). Análise do comportamento dos coeficientes de descarga em sistemas de sifão. Anais da ABRHidro. <https://www.abrhidro.org.br/anais>
- Campos, E., & outros. (2019). Experimental study of pressure flushing of non-cohesive sediment through slotted pipe bottom outlet. Water Resources Management. <https://doi.org/10.1007/s11269-017-177>
- Conselho Nacional do Meio Ambiente. (2004). Resolução nº 344, de 25 de março de 2004. Estabelece diretrizes e procedimentos mínimos para a avaliação de sedimentos a serem dragados. <https://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=432>
- Dini, M., & Tabesh, M. (2014). A new method for simultaneous calibration of demand pattern and Hazen-Williams coefficients in water distribution systems. Water Resources Management, 28, 2021–2034.
- Maia, K. T. (2023). Segurança de barragens: Um estudo da legislação ambiental. Portal de Trabalhos Acadêmicos, 15(2). <https://revistas.faculdedamas.edu.br/index.php/academico/article/view/3050>
- Manzo, A. J., & outros. (1971). Manual para la preparación de monografías: Una guía para presentar informes y tesis. Humanitas.

- Paulo, F. A., & outros. (2021). Experimental study of pressure flushing of non-cohesive sediment through slotted pipe bottom outlet. *Revista Brasileira de Recursos Hídricos*, 26, Article e01. <https://www.scielo.br/j/rbrh/a/Rm7zgxsQBQSKwZP4PFkXVVK/>
- Pereira, L. F. (2019). Segurança de barragens no Brasil: Um breve comparativo com a legislação internacional e análise da influência da cobertura do solo de APPs sobre manchas de inundação: Estudo de caso da PCH Pedra Furada em Ribeirão/PE [Dissertação de mestrado não publicada]. Universidade Estadual Paulista “Júlio de Mesquita Filho”.
- Rocha, V. O. D., & outros. (2018). Importância da descarga de fundo em barragens [Anais]. XIV Simpósio de Recursos Hídricos do Nordeste, Maceió, AL, Brasil. <https://anais.abrhidro.org.br/works/4635>
- Silva, J. C., & outros. (2016). Remoção de sedimentos em reservatórios de barragens de usinas hidrelétricas através de descarga de fundo. Universidade Federal do Rio Grande do Sul. <http://hdl.handle.net/10183/154645>
- Silva, L. C. (2023). Avaliação de risco de acidentes em barragens de contenção de água: Uma contribuição para a gestão de segurança de barragens no Brasil [Dissertação de mestrado, Universidade do Estado do Rio de Janeiro]. BDTD. <https://www.bdttd.uerj.br:8443/handle/1/20290>
- Tocantins. (2005). Decreto nº 2.432, de 6 de junho de 2005. Regulamenta a outorga do direito de uso de recursos hídricos. <https://site.tocantins.gov.br>
- Tomaz, P. (2012). Sifão. In Curso de manejo de águas pluviais. Navegas.

ONTOLOGICAL PAREIDOLIA AND THE SAFE DISSIPATION HYPOTHESIS: TOWARD A NON-REIFIED LEGAL ONTOLOGY

PAREIDOLIA ONTOLÓGICA E A HIPÓTESE DA DISSIPAÇÃO SEGURA: POR UMA ONTOLOGIA JURÍDICA NÃO-REIFICADA

PAREIDOLIA ONTOLÓGICA Y LA HIPÓTESIS DE LA DISIPACIÓN SEGURA: HACIA UNA ONTOLOGÍA JURÍDICA NO REIFICADA



<https://doi.org/10.56238/sevened2026.008-168>

Flávio Furtado de Farias¹, Francisco de Sousa Vieira Filho²

ABSTRACT

The article proposes the concept of ontological pareidolia as a diagnostic tool to examine processes of conceptual reification in contemporary law. It begins from the hypothesis that successful legal theories tend, progressively, to shift from analytical instruments to implicit ontological assumptions, operating not only as interpretive lenses but as supposedly neutral transparencies of the legal object itself. The phenomenon is analyzed through the theory of the balancing of principles developed by Robert Alexy, chosen as a paradigmatic case not because of structural defect, but because of its institutional success and practical diffusion. Three recurring diagnostic triggers are identified: (i) grammatical agency of concepts, (ii) colonization of the central question of the case, and (iii) inflation of defensive qualifications. It is argued that such dynamics do not constitute a theoretical error, but rather a predictable outcome of paradigmatic consolidation. The study does not seek to invalidate specific theories, but to offer a reflective protocol for the analysis of judicial decisions and normative arguments, distinguishing the conscious instrumental use of concepts from their consolidated ontological reification. In conclusion, it is suggested that the problem may be better understood in light of a broader relational ontology, according to which concepts persist insofar as they remain compatible with the institutional fields that sustain them.

Keywords: Ontological Pareidolia. Conceptual Reification. Balancing of Principles. Robert Alexy. Legal Theory. Judicial Discretion. Post-Positivism. Legal Methodology

RESUMO

O artigo propõe o conceito de pareidolia ontológica como ferramenta diagnóstica para examinar processos de reificação conceitual no Direito contemporâneo. Parte-se da hipótese de que teorias jurídicas bem-sucedidas tendem, progressivamente, a transitar de instrumentos analíticos para pressupostos ontológicos implícitos, operando não apenas como lentes interpretativas, mas como transparências supostamente neutras do próprio objeto jurídico. O fenômeno é analisado a partir da teoria da ponderação de princípios de Robert Alexy, escolhida como caso paradigmático não por defeito estrutural, mas por êxito institucional e difusão prática. Identificam-se três gatilhos diagnósticos recorrentes: (i) agenciamento gramatical de conceitos, (ii) colonização da questão central do caso e (iii)

¹ Dr. in Pathology. Universidade Federal de Minas Gerais.

² Master's degree in Law. Universidade Autónoma de Lisboa.

inflação de qualificações defensivas. Sustenta-se que tais dinâmicas não constituem erro teórico, mas deriva previsível de consolidação paradigmática. O estudo não pretende invalidar teorias específicas, mas oferecer um protocolo reflexivo para análise de decisões judiciais e argumentos normativos, distinguindo o uso instrumental consciente de conceitos de sua reificação ontológica consolidada. Ao final, sugere-se que o problema pode ser compreendido à luz de uma ontologia relacional mais ampla, segundo a qual conceitos persistem enquanto compatíveis com os campos institucionais que os sustentam.

Palavras-chave: Pareidolia Ontológica. Reificação Conceitual. Ponderação de Princípios. Robert Alexy. Teoria do Direito. Discrecionalidade Judicial. Pós-Positivismo. Metodologia Jurídica.

RESUMEN

El artículo propone el concepto de pareidolia ontológica como herramienta diagnóstica para examinar los procesos de reificación conceptual en el derecho contemporáneo. Se parte de la hipótesis de que las teorías jurídicas exitosas tienden, progresivamente, a transitar de instrumentos analíticos hacia supuestos ontológicos implícitos, operando no solo como lentes interpretativas, sino como supuestas transparencias neutrales del propio objeto jurídico. El fenómeno se analiza a partir de la teoría de la ponderación de principios desarrollada por Robert Alexy, elegida como caso paradigmático no por un defecto estructural, sino por su éxito institucional y difusión práctica. Se identifican tres desencadenantes diagnósticos recurrentes: (i) agenciamiento gramatical de los conceptos, (ii) colonización de la cuestión central del caso y (iii) inflación de calificaciones defensivas. Se sostiene que tales dinámicas no constituyen un error teórico, sino una deriva previsible de la consolidación paradigmática. El estudio no pretende invalidar teorías específicas, sino ofrecer un protocolo reflexivo para el análisis de decisiones judiciales y argumentos normativos, distinguiendo el uso instrumental consciente de los conceptos de su reificación ontológica consolidada. Finalmente, se sugiere que el problema puede comprenderse a la luz de una ontología relacional más amplia, según la cual los conceptos persisten en la medida en que permanecen compatibles con los campos institucionales que los sostienen.

Palabras clave: Pareidolia Ontológica. Reificación Conceptual. Ponderación de Principios. Robert Alexy. Teoría del Derecho. Discrecionalidad Judicial. Pospositivismo. Metodología Jurídica.

1 INTRODUCTION - THE PARADOX OF CONCEPTUAL SUCCESS IN LAW

Modern law is, to a large extent, a highly effective conceptual technology. To deal with social complexity, it produces abstract categories — principles, institutes, guarantees, decision-making techniques — capable of stabilizing expectations, coordinating behaviors, and reducing uncertainties. Concepts such as *the rule of law*, *legal certainty*, *human dignity* or *proportionality* do not arise by chance: they emerge as intellectual and institutional responses to concrete problems of governability, conflict and legitimacy. The paradox, however, is that the more successful these concepts become, the greater the risk that they will cease to operate as tools and start functioning as a presupposed reality.

It is this phenomenon that this chapter calls ontological pareidolia in Law. By analogy to the cognitive process by which familiar patterns are perceived where there are only ambiguous stimuli, ontological pareidolia designates the movement by which historically situated legal constructs come to be treated as entities endowed with their own existence, internal necessity, or self-evident validity. The concept ceases to be an analytical mediation and becomes an ontological ground: it is no longer asked *how* it operates or *under what conditions* it is maintained, but only whether the concrete case "fits" to it. Conceptual success, in this sense, produces reflective blindness.

Critical legal literature has long identified processes of conceptual reification, fetishization, and naturalization. From the Weberian analysis of legal rationalization and its effects of closure [Weber, 1919], through the Marxist critique of the fetishism of legal forms, to contemporary readings on the autonomization of legal discourse and the judicialization of politics [Habermas, 1992; Latour, 2010], the diagnosis is relatively well known: Law tends to forget the historical and instrumental character of its own categories. The problem is that this diagnosis often ends in itself. Reification is denounced, but an alternative ontology capable of sustaining the critique without falling back into another essentialism is not offered.

It is here that the central dilemma that guides this chapter emerges: diagnosing conceptual reification without offering a minimally consistent ontological alternative is insufficient. Criticism, when devoid of its own ontological infrastructure, oscillates between two equally problematic poles. On the one hand, it can slide into a skeptical relativism, in which every legal category appears as a mere ideological fiction. On the other hand, it can implicitly depend on the same inflated ontologies that it intends to criticize, reproducing them in a negative way. In both cases, the result is a loss of analytical capacity: the error is denounced, but the mechanism that produces it is not understood, nor are there criteria for avoiding it.

The purpose of this chapter is to address this impasse through a double gesture. Firstly, to offer a systematic diagnosis of ontological pareidolia in Law, identifying its training cycles, its cognitive and institutional mechanisms, and its practical effects on legal decision-making, teaching and the public space. Secondly — and this is the decisive move — to present a disciplined ontological antidote, capable of allowing the analysis of the functioning of Law without conceptual reification. This antidote is provided by the Safe Dissipation Hypothesis (HDS).

HDS is not a theory of law, nor a new dogmatics, nor a normative legal philosophy. It is a minimal, relational and processual ontology, originally formulated to describe how systems — biological, social or institutional — manage to persist over time without canceling themselves, that is, keeping their flows and tensions within compatible limits. Its value for legal thought lies precisely in the fact that it was built from the beginning with explicit mechanisms of self-limitation, which prevent its reification: a principle of ontological containment, anti-principles against undue extrapolation, and a checklist of disciplined use.

Cautiously transposed to the legal field, the HDS allows for a decisive shift: Law is no longer thought of as a set of conceptual entities endowed with purpose or essence, and is now described as a set of patterns of institutional persistence, sustained by flows (of norms, decisions, legitimacy, coercion), interfaces (courts, procedures, laws, organizations) and thresholds (of crisis, saturation, loss of adhesion). This description does not legitimize the existent, does not moralize it and does not teleologize it. It only answers a more austere and more potent question: *how does this arrangement manage to persist — and at what cost?*

By integrating the critique of ontological pareidolia with the conceptual infrastructure of the HDS, this chapter proposes a reorientation of critical legal thought. Instead of fighting reified concepts with other equally inflated concepts, a legal culture of ontological surveillance is proposed, in which categories remain provisional tools, always exposed to revision, wear and tear, and contestation. What is at stake is not to abandon the central concepts of Law, but to prevent its success from becoming destiny.

2 THE ANATOMY OF ONTOLOGICAL PAREIDOLIA IN LAW: HOW LEGAL CONCEPTS BECOME REALITY

Ontological pareidolia in Law is not a punctual error or an exceptional pathology of legal thought. It is a structural process, recurrent in highly conceptualized legal traditions, in which successful analytical categories cross a critical threshold: they cease to operate as historical mediations and begin to function as non-thematized ontological assumptions. To understand this process, it is necessary to describe it in its internal dynamics, identify

paradigmatic examples, and explain the cognitive and institutional mechanisms that sustain it.

2.1 THE TRIPLE CYCLE OF REIFICATION: EMERGENCE → INSTITUTIONALIZATION → NATURALIZATION

The first step in understanding ontological pareidolia is to recognize that it begins legitimately. No legal concept is born reified. On the contrary, it emerges as a contingent response to concrete problems: social conflicts, normative gaps, crises of legitimacy or decision-making impasses. This moment of emergency is creative and productive. Concepts such as *legal certainty* or *proportionality* arise to organize expectations, reduce arbitrariness or offer minimally shareable criteria for decision [Weber, 1919].

The second moment is that of institutionalization. The concept is incorporated into repeated practices: judicial decisions, legislation, academic curricula, public exams, manuals and administrative routines. At this stage, it gains operational stability and coordinating value. Institutionalization is not, in itself, problematic; it is a condition for the functioning of modern Law itself. However, it is at this point that the concept begins to acquire institutional inertia: its reproduction begins to depend less on continuous justification and more on tacit recognition.

The third — decisive — moment is that of naturalization. Here the ontological leap occurs. The concept is no longer perceived as a historical response to a specific problem and starts to operate as a condition of possibility of Law itself. It is no longer asked why it exists, under what disputes it has formed, or what alternatives could replace it. It becomes "obvious", "necessary", "structuring". At this stage, the concept not only guides decisions: it defines the horizon of the thinkable. It is exactly at this point that ontological pareidolia is installed: the conceptual construct begins to be confused with the reality that should only mediate.

This cycle — emergence, institutionalization, naturalization — is not accidental. It expresses a general tendency of cognitive and institutional systems to convert effective solutions into stable assumptions, reducing argumentative cost and decision-making uncertainty. The problem is not the cycle itself, but its opacification: when the transition to naturalization ceases to be perceived as such.

2.2 PARADIGMATIC EXAMPLES: RULE OF LAW, LEGAL CERTAINTY, BALANCING

Some legal concepts clearly illustrate this process.

The Rule of Law, for example, has historically emerged as a response to the arbitrariness of power, the personalization of sovereignty, and normative instability. Its original

function is to limit the exercise of power through general rules, publicity and predictability [Habermas, 1992]. However, once naturalized, the Rule of Law begins to operate as an ontological entity: something that "exists" or "does not exist", that "strengthens" or "weakens", regardless of the concrete analysis of its institutional devices. Instead of asking *how* certain legal arrangements produce (or do not) predictability and control, the discourse begins to invoke the concept as if it were a subject endowed with its own properties.

Legal certainty follows a similar trajectory. Initially conceived as a relational criterion – reasonable stability of expectations in the face of the mutability of Law – it transforms, over time, into an absolute and often defensive value. Once reified, legal certainty begins to function as an ontological barrier to change, being mobilized to block normative revisions or corrections of injustices under the argument of preserving an almost substantial good [Brown, 2015]. The concept ceases to describe an institutional effect and starts to impose a prior limit on the debate.

Weighting and proportionality tests offer an even more sophisticated example. Created as argumentative techniques to deal with normative collisions in complex contexts, these instruments were progressively naturalized as if they expressed the very rationality of contemporary constitutional law [Alexy, 2002]. In many contexts, there is no longer any discussion about whether weighting is appropriate for a certain type of problem; it becomes the default problem, colonizing the decision-making agenda. The method ceases to be one tool among others and begins to silently define what counts as a legitimate legal issue.

2.3 THE PSYCHOCOGNITIVE AND INSTITUTIONAL MECHANISMS OF NATURALIZATION

The persistence of ontological pareidolia cannot be explained only by strategic interests or bad faith. It is sustained by deep psychocognitive and institutional mechanisms, which often operate unconsciously.

From the cognitive point of view, conceptual naturalization reduces the argumentative cost. Working with presupposed categories is less onerous than permanently reopening their genesis, their limits, and their alternatives. In addition, stabilized concepts work as heuristic shortcuts, allowing quick decisions in environments of high complexity and time pressure.

At the institutional level, pareidolia is reinforced by organizational coordination mechanisms. Courts, universities, control bodies and legal careers depend on relatively stable vocabularies to function. Naturalized concepts facilitate training, standardization, and internal predictability. Questioning them implies high institutional costs, as it threatens consolidated routines and symbolic hierarchies.

There is also a component of professional legitimation. Mastering reified concepts is a sign of belonging to the legal field. Ontological criticism, by exposing the contingency of these categories, can be perceived as a threat to technical authority or professional identity, which generates diffuse but persistent resistance.

These mechanisms explain why ontological pareidolia is not an occasional deviation, but a structural risk of conceptual success itself. The more a concept organizes decisions, curricula, and practices, the more likely it is to become a presumed reality. It is precisely at this point that the critique needs to go beyond denunciation and offer an alternative ontological infrastructure, capable of sustaining the analysis without producing new reifications — a task that will be assumed, in the following sections, by the Hypothesis of Safe Dissipation.

3 ONTOLOGICAL FOUNDATIONS: THE SAFE DISSIPATION HYPOTHESIS AS AN ANTIDOTE TO REIFICATION

The critique of ontological pareidolia in Law inevitably comes up against a fundamental problem: denouncing conceptual reification without offering an alternative ontology implies remaining stuck in the same terrain that one intends to criticize. By revealing that successful legal concepts tend to become naturalized, one runs the risk of merely replacing one vocabulary with another, keeping intact the implicit ontological structure that sustains reification. The diagnosis alone is insufficient.

This impasse stems from a silent ontological crisis in contemporary legal thought. Law oscillates between two equally problematic poles. On the one hand, a naïve physicalism, in which norms, institutions and principles are treated as "things" endowed with their own, almost material existence. On the other hand, a normative idealism, in which legal concepts operate as self-sufficient abstract entities, capable of generating effects in the social world by virtue of their internal coherence. In both cases, the result is the same operation: analytical constructs come to take the place of the real, and the historical, material, and political contingency of legal practice is progressively erased.

It is at this point that the HDS presents itself not as a new theory of Law, but as a minimal and disciplinary ontology, capable of sustaining the critique of reification without reproducing its vices. HDS does not ask what the Law "is", nor what ends it should accomplish. Its fundamental gesture is more restrictive: it establishes conditions under which one can describe the persistence of institutional arrangements without attributing to them a higher purpose, essence, or rationality.

From this perspective, Law is no longer understood as a system oriented to the realization of values or the realization of abstract principles, and is now analyzed as a set of institutional practices that persist as long as they manage to manage conflicts, uncertainties, and demands within limits compatible with their own continuity. Legal stability is not an intrinsic attribute of norms, but a precarious effect of couplings between decisions, procedures, material resources, symbolic adhesions and coercive devices.

This ontology shifts the focus of the analysis to three central dimensions: flows, interfaces, and thresholds. Flows refer to the circulation of demands, interpretations, decisions, financial resources, social expectations and legitimacy. Interfaces are the concrete devices that modulate these flows — courts, laws, procedures, administrative routines, forms of access to justice, filtering mechanisms, and decision-making hierarchization. Threshold refers to the critical points from which these arrangements cease to absorb tensions and start to produce saturations, crises of legitimacy or functional collapses.

In this framework, normative conflicts are not "resolved" in the strong sense of the term. They are conditionally dispelled. Deciding does not eliminate conflict; it redistributes its costs in time, space and among different social groups. A court decision stabilizes expectations for a period of time, while shifting tensions to other arenas—administrative, legislative, economic, or symbolic. The persistence of the Law depends precisely on this ability to redistribute conflicts without them returning in an immediate and destabilizing way.

This redistribution is only intelligible when the idea of isolated norms is abandoned. No legal rule operates alone. What is called "legal certainty" emerges from dense relational fields, composed of couplings between higher courts, lower courts, administrative bureaucracies, advocacy, media, social expectations and material structures of execution. When these couplings stabilize, the appearance of an ontological property of the norm is produced. It is at this point that pareidolia sets in: the relational effect is treated as essence.

Courts and legislatures do not act passively in this process. They actively modulate legal flows, filtering demands, producing institutional redundancies, altering decision-making temporalities, modulating retroactive effects, and adjusting the pace of normative production. These operations do not express a telos of the legal system or the progressive realization of universal values. They function as strategies to contain decision-making saturations and preserve institutional compatibility in contexts of permanent conflict.

Such a reading allows us to face one of the most sensitive points of legal theory: the management of life by the Law. Under the lens of HDS, the Law manages lives, expectations and risks without immanent ethical purpose. Protections, guarantees, exclusions and sacrifices vary according to the limits of tolerance of the current institutional regime. Moral

lexicons—dignity, humanity, proportionality, reasonableness—often accompany these decisions, but do not explain them at their operational core. What ultimately decides is the compatibility of these choices with the persistence of the institutional arrangement as a whole.

This is precisely where HDS operates as an antidote to reification. By refusing to attribute purpose, meaning, or historical necessity to the legal patterns that persist, it prevents successful concepts from becoming implicit ontologies. Its function is negative and disciplinary: to block the slide from description to justification, from analysis to legitimation.

This self-limitation is constitutive. The HDS does not intend to replace dogmatics, hermeneutics, sociology or the political theory of Law. It operates as a minimal ontological infrastructure, capable of sustaining critical analysis without allowing the conceptual apparatus itself to be transformed into a new pareidolia. In doing so, it provides critical legal thinking with a material-procedural ground in which it is possible to describe institutional persistence, identify redistributed costs, and map deliberative closures without naturalizing the existing.

In the terms of this chapter, HDS is not a new sovereign vocabulary, but a discipline of ontological surveillance. It allows Law to be analyzed as a historical and institutional practice of contingent persistence — and not as a system of concepts endowed with a life of its own. It is this condition that makes it possible to advance from the diagnosis of pareidolia to the construction of effective tools of conceptual denaturalization, developed in the following sections.

4 OPERATIONAL DIAGNOSIS: THREE TRIGGERS OF REIFICATION

Tools for real-time identification

Ontological pareidolia in Law is not only manifested in great theoretical constructions or canonical concepts. It operates, above all, on the microscopic plane of language, method and everyday justification. Therefore, the diagnosis cannot depend only on retrospective analyses or historical-conceptual reconstructions; It requires operational tools capable of detecting, in real time, when a legal explanation begins to slide from description to reification.

The following three triggers work as pragmatic alerts. They do not indicate, by themselves, theoretical error or argumentative bad faith. Its role is to signal the exact point at which a concept, a method, or a qualification begins to operate as if it had its own existence, causal autonomy, or intrinsic necessity—that is, when ontological pareidolia begins to set in.

Grammatical agency: when the Law starts to "act"

The first trigger is manifested in the very structure of legal language. It occurs when abstract concepts assume the position of an active grammatical subject, starting to "act",

"demand", "prevent", "authorize" or "determine" results. Expressions such as "the rule of law does not allow", "legal certainty requires", "proportionality imposes" or "the constitutional system responds" shift the agency from concrete institutional practices to abstract conceptual entities.

This grammatical agency is not a simple rhetorical resource. It produces a specific ontological effect: it transforms emergent effects of decisions, couplings, and disputes into autonomous causes. Language ceases to describe the functioning of Law and starts to speak *in the name* of Law, as if it were an agent endowed with its own will. What was the result of contingent institutional choices reappears as an objective requirement of the system itself [Austin, 1962; Bourdieu, 1986].

Under the lens of HDS, this trigger indicates the loss of vigilance over flows and interfaces. Instead of locating who decides, through which devices, and with what redistributed costs, the analysis is satisfied with the personification of the concept. The consequence is the opacification of the relational field that sustains institutional persistence.

Colonization of the standard question: when only one question becomes legitimate

The second trigger acts on the methodological level. It occurs when a certain question becomes hegemonic, silently excluding other forms of problematization. In contemporary law, recurrent examples include the almost exclusive centrality of the question "is the measure proportional?", "is there a violation of principle X?" or "was the precedent correctly applied?". When these questions colonize the debate, they cease to be instruments among others and start to define the very field of the thinkable.

Colonization of the standard question does not eliminate conflict; she reorganizes it. Issues related to the material distribution of costs, long-term institutional effects or power asymmetries are displaced outside the legitimate debate. The problem is not that such questions are invalid, but that they become the only authoritative questions. The method starts to define the object, and not the other way around [Foucault, 1975; Kennedy, 1997].

From HDS's perspective, this trigger signals a premature closure of the analytic interfaces. Rather than mapping how an arrangement persists, redistributes stresses, and manages saturation thresholds, the analysis focuses on verifying internal compliance with an already stabilized methodological scheme. The result is the naturalization of the method itself as a requirement of the real.

Inflation of defensive qualifications: when criticism needs to be too justified

The third trigger manifests itself in a more subtle way, but no less relevant. It appears when a critical argument needs to be constantly accompanied by defensive qualifications: "without prejudice to the importance of...", "recognizing the centrality of...", "without denying

the advances brought by...", "despite its fundamental character...". Although prudent at first glance, these formulas may indicate that the criticized concept has already acquired an almost untouchable status.

The inflation of defensive qualifications reveals a discursive field in which certain concepts operate as zones of secular sacredness. Criticizing them directly generates institutional, moral, or symbolic resistance, requiring a series of rhetorical safeguards for the criticism to be accepted. The concept ceases to be a debatable tool and starts to function as an unavoidable normative presupposition [Habermas, 1992; Koselleck, 2006].

In the grammar of HDS, this trigger indicates that the institutional persistence of the concept has already crossed a threshold of symbolic protection. The critique does not threaten only an argument, but the compatibility of the discursive regime that was organized around that concept. The defensive reaction is thus a symptom of ontological saturation.

Triggers as an expression of dissipative surveillance failures

Although distinct, the three triggers share the same underlying logic. All of them signal moments in which relational and contingent effects come to be treated as necessary, finalized or self-explanatory entities. In ontological terms, they indicate failures of vigilance against reification: language personifies, the method colonizes, and justification shields itself.

The connection with HDS is direct, although not explicit in the current legal discourse. Whenever analysis abandons the tracing of flows, the identification of interfaces and the observation of institutional thresholds, space is opened for successful concepts to take the place of the real. Pareidolia does not arise due to individual error, but as a systemic effect of the search for interpretative stability and institutional coordination.

Therefore, triggers do not work as accusations, but as instruments of self-correction. They make it possible to interrupt reasoning at the exact point where the description begins to become an implicit ontology. Its function is not to delegitimize the Law, but to restore to it contingency, historicity and materiality — indispensable conditions so that legal criticism does not itself become a new form of reification.

In the next section, these triggers will be put to the test in concrete analyses, in which traditional reading and HDS-oriented reading will be contrasted to make explicit the analytical gain of a non-reified legal ontology.

5 CASE STUDIES: PAREIDOLIA AND DISSIPATION IN OPERATION

Concrete analyses with a double lens

The following case studies have a precise methodological function. It is not a matter of illustrating abstract concepts, nor of evaluating the normative merit of the institutes

analyzed, but of demonstrating, in operation, how ontological pareidolia is installed and how the reading guided by the HDS allows the analysis to be dislocated without resorting to purposes, essences or personifications of Law.

In each case, the comparison between traditional reading and reading disciplined by HDS makes explicit the analytical gain: what appears as an entity endowed with will, internal coherence and normative direction reappears as a contingent pattern of institutional persistence, sustained by historically situated flows, interfaces and thresholds.

The "Rule of Law": normative entity or pattern of institutional persistence?

In the dominant legal reading, the Rule of Law is usually treated as a normative entity endowed with its own ontological density. It "exists", "protects", "resists", "enters into crisis" or "is threatened", functioning as an implicit subject of numerous judicial decisions and doctrinal analyses. This personification allows concrete political conflicts to be translated as violations or reaffirmations of a supposedly unitary and stable entity [Ferrajoli, 2007; Canotilho, 2003].

Under this pareidolic lens, the Rule of Law operates as the ultimate foundation: it is not explained, but invoked. Its historical persistence is taken as evidence of its normative necessity, and its institutional variations are interpreted as deviations, erosions, or failures to realize a previous ideal. The effect is an analytical closure: discussing *how* the rule of law works gives way to the defense of *what* it should be.

HDS-guided reading radically displaces this framework. The rule of law is no longer treated as an entity and is described as a pattern of institutional persistence, contingent and historically unstable. Its continuity depends on the compatibility between multiple flows — social legitimacy, coercive capacity, bureaucratic adherence, decision-making predictability — modulated by concrete interfaces, such as constitutions, courts, administrative agencies, and procedural routines [Luhmann, 1995; Tilly, 1992].

From this perspective, there is no "essence" of the rule of law to be preserved, but thresholds to be administered. Constitutional crises, states of exception, or institutional erosions are not moral anomalies, but signs of saturation or incompatibility between flows and interfaces. The question is no longer "has the rule of law been violated?" and becomes "what couplings have ceased to sustain its persistence?". The analytical gain is immediate: criticism ceases to operate by sacralization and begins to operate by material description of the operating conditions.

Penal system: from normative finalism to the teleological management of populations

The penal system constitutes one of the most fertile grounds for ontological pareidolia. Traditional discourses attribute clear purposes to it: to punish the guilty, prevent crime,

resocialize the offender, protect society. Even when these purposes are recognized as partially failed, they continue to organize the debate, producing the impression of a system that "does not work as it should", but whose *raison d'être* remains unquestioned [Beccaria, 1764; Roxin, 2006].

This finalist reading transforms recurrent empirical effects — mass incarceration, penal selectivity, institutional violence — into contingent deviations from a normatively correct model. The penal system appears as a misused instrument, and not as an arrangement whose very persistence depends on the unequal redistribution of social costs.

HDS-guided reading breaks with this scheme. The penal system comes to be described as a device for the teleological management of populations, whose continuity does not depend on the fulfillment of declared purposes, but on the ability to maintain institutional violence within limits compatible with the stability of the political regime [Foucault, 1975; Wacquant, 2009].

Under this lens, mass incarceration is not a functional failure, but a specific mode of dissipative modulation. Certain social groups are treated as manageable costs (over-incarceration), others as functional resources (prison labor, territorial control), and still others as eliminable surplus (selective police lethality). The system persists as long as these flows of violence, exclusion, and control do not cross thresholds of generalized political crisis.

The advantage of this reading is not to moralize less, but to describe better. It allows us to understand why penal reforms oriented towards new ends – more punishment or more guarantees – often produce similar results. The problem is not in the chosen purpose, but in the persistence of institutional interfaces that redistribute costs in a structurally asymmetric way.

Control of constitutionality: a dissipative system of normative conflicts

The control of constitutionality is usually described as a mechanism for protecting the supremacy of the Constitution and the ultimate guarantee of fundamental rights. This narrative attributes to the constitutional court — in the Brazilian case, the Federal Supreme Court — the function of guardian of values, final interpreter of the constitutional text and neutral arbiter of normative conflicts [Barroso, 2012; Alexy, 2008].

This reading, although functionally effective, tends to reify both the Constitution and the Court itself. The court appears as the rational center of the system, and its chronic overload is interpreted as a sign of institutional success, and not as a possible indication of saturation.

The reading guided by the HDS reconstructs the control of constitutionality as a dissipative system of normative conflicts. Constitutional demands, direct actions,

extraordinary appeals, and complaints function as flows that need to be continuously modulated to avoid decision-making collapse. Interfaces such as general repercussion, binding precedents, modulation of effects and procedural filters are not only legal techniques, but devices for controlling institutional load [Sunstein, 2001; Vermeule, 2014].

From this perspective, paradigmatic decisions are no longer seen only as affirmations of constitutional meaning and are understood as operations of redistribution of tensions. The temporal modulation of effects, for example, does not only express normative prudence, but management of political, economic and administrative thresholds. Crises of legitimacy, accusations of activism, or judicial retraction are signs of dissipative adjustments in a system under constant pressure.

Once again, the analytical gain lies in the refusal of personification. The STF does not "decide because it wants to", nor does it "protect the Constitution by essence". It persists as long as it manages to modulate normative conflicts without producing unsustainable systemic incompatibilities. When it fails, it is not because it has betrayed its mission, but because certain flows have exceeded its capacity for institutional absorption.

Together, the three case studies demonstrate that the HDS does not replace traditional legal categories, but reorganizes their ontological status. What previously appeared as a normative entity, purpose or vocation reappears as a contingent pattern of persistence, sustained by material couplings and vulnerable to critical thresholds. It is this change of lens — and not the introduction of new values — that allows legal thought to escape pareidolia without falling into skepticism or naïve functionalism.

6 INSTITUTIONAL CONSEQUENCES: THE COST OF REIFICATION

Ontological pareidolia in Law is not only a theoretical or terminological problem. When successful legal concepts cease to operate as historical mediations and start to function as presupposed entities, the effects are manifested in a concrete way in institutional practice, in the way the legal debate is organized and in the relationship between Law and society. Conceptual reification has cumulative costs, which are not expressed as punctual failures, but as silent transformations in the architecture of legal thought and action.

These costs do not stem from the "misuse" of the concepts, but precisely from their success. The more a category stabilizes decisions, coordinates expectations, and reduces uncertainties, the more likely it is to become opaque to its own contingency. What is lost, then, is not only analytical precision, but institutional capacity for adaptation, criticism and self-correction.

Narrowing of the legal imagination

The first effect of conceptual reification is the progressive narrowing of the legal imagination. When concepts such as the rule of law, legal certainty, proportionality or dignity are treated as ontological realities, the field of the possible is reduced. Institutional alternatives, distinct normative arrangements, or solutions not foreseen by the dominant categories tend to be discarded not because of empirical infeasibility, but because of conceptual inconceivability.

In this context, thinking outside the consecrated repertoire is no longer seen as a critical exercise and is perceived as a threat to the very rationality of Law. Institutional creativity is replaced by internal variations of the same conceptual scheme, and the debate shifts from the invention of solutions to the reaffirmation of already given frameworks. Law becomes capable of responding to problems only to the extent that they fit into previously naturalized categories.

Circular debate and scholastic fragmentation

Conceptual naturalization also produces a specific impoverishment of the legal debate. When reified concepts function as self-evident foundations, controversies cease to question assumptions and start to revolve around internal interpretations, gradations, and exceptions. The debate becomes circular: the scope of the concept is discussed without ever reopening its genesis, its limits or its material effects.

This movement favors the scholastic fragmentation of the legal field. Schools, currents and positions are organized around the defense or criticism of conceptual entities treated as given, producing disputes that are highly sophisticated from a technical point of view, but poor in terms of real institutional impact. Criticism loses transformative power and becomes an internal variation of the same ontological lexicon that it intends to contest.

Opacification of contingency and the political

One of the most profound effects of ontological pareidolia is the opacification of the historical and political contingency of Law. When legal categories are treated as necessary, natural or structural, the decisions that produced them — and the conflicts that sustain them — disappear from the analytical horizon. What was the result of disputes, compromises and asymmetries now appears as an objective requirement of the legal system itself.

This erasure has direct political consequences. Distributive conflicts, institutional choices, and decisions with broad social impact are recoded as inevitable technical or normative problems. Politics is not eliminated, but displaced: it reappears as the administration of the data, and not as a dispute over alternatives. Law, in this sense, contributes to the naturalization of the existing by transforming contingency into necessity.

Practical frustration and diffuse skepticism

The growing distance between the reified legal discourse and the concrete experience of the institutions produces a relevant subjective effect: the practical frustration of the legal operators. Judges, lawyers, defenders and managers realize, on a daily basis, that the available categories often do not account for the complexity of the problems faced. However, since these categories operate as ontological assumptions, the difficulty is not attributed to the conceptual apparatus, but to "reality", "culture" or "inefficiency".

This mismatch feeds a diffuse skepticism. On the one hand, the high rhetoric of principles and guarantees is maintained; on the other hand, it is tacitly accepted that they do little to alter the effective patterns of institutional functioning. The result is not an articulate critique, but a pragmatic resignation: one does "what is possible" within categories that one no longer fully believes in, but that one cannot abandon either.

Extra-legal circulation and institutional fragility

Finally, conceptual reification produces effects beyond the legal field. Naturalized concepts tend to circulate in the public space as simplified normative slogans, used in political, media, and institutional disputes. Expressions such as "defense of the rule of law", "threat to legal certainty" or "respect for the Constitution" start to operate as identity markers, often disconnected from the concrete analysis of practices and provisions.

Paradoxically, this circulation increases institutional fragility. The more concepts are mobilized as abstract entities, the less capable they become of sustaining minimal consensus when confronted with real crises. In contexts of acute tension, the invocation of reified entities does not stabilize the system; on the contrary, it exposes its inability to respond materially to emerging incompatibilities. What is presented as the ultimate foundation is then revealed as empty rhetoric.

Taken together, these consequences show that ontological pareidolia is not a peripheral problem, but a structural risk of the conceptual success of Law itself. By transforming analytical tools into presupposed realities, the legal field reduces its capacity for imagination, impoverishes its debate, hides its political contingency, produces practical frustration and weakens its relationship with the public space.

It is precisely in this context that a systematic practice of ontological surveillance becomes necessary. Not to abandon the central concepts of Law, but to prevent its success from turning into blindness. The following section proposes, in this sense, an applied tool — the PARC-Jus — anchored in the minimum ontology of the Safe Dissipation Hypothesis, as an attempt to institutionalize this surveillance within the legal practice itself.

7 PRACTICAL PROPOSAL: PARC-JUS AS A SURVEILLANCE TOOL

If ontological pareidolia is a structural risk of the conceptual success of Law, and if HDS offers a minimum ontology capable of containing this risk, a decisive problem remains: how to translate this ontological discipline into everyday analytical practice? Conceptual vigilance cannot depend only on individual critical disposition or ex post reflections; It needs operational instruments that make it possible to interrupt, in the course of analysis, the slide from description to reification.

This is where PARC-Jus comes in. More than an interpretative method or technique, PARC-Jus functions as an ontological self-correction protocol, intended to maintain legal concepts in their instrumental and contingent status. Its objective is not to produce correct answers, but to create conditions so that legal analysis does not naturalize its own assumptions.

PARC-Jus revisited: ontological foundation

PARC-Jus was originally born as a diagnostic device aimed at identifying conceptual pareidolias in legal discourse. In the light of HDS, it can be reinterpreted in a more profound way: not only as a critical tool, but as an applied expression of an ontology of unreified persistence.

Its central function is to block three recurring movements:

- 1) the transformation of institutional effects into ontological causes;
- 2) the conversion of methods into demands of the real;
- 3) the symbolic shielding of successful concepts.

Anchored in HDS, PARC-Jus assumes a simple and demanding premise: no legal concept should operate as a final explanatory entity. Whenever a category seems to "solve" the problem for itself, the protocol is triggered to reopen the analysis in terms of flows, interfaces, costs, and thresholds.

In this sense, PARC-Jus does not replace dogmatics, hermeneutics or legal sociology. It acts transversally to them, functioning as a layer of ontological surveillance that prevents any of these approaches from crystallizing into implicit ontology.

Application steps with anchoring in HDS

The application of PARC-Jus can be described as a sequence of analytic movements, not rigidly linear, but logically chained.

The first movement consists of suspending conceptual evidence. Faced with a legal argument that invokes central categories – the rule of law, dignity, legal certainty, proportionality, public interest – the protocol requires that reasoning be interrupted before

automatic adhesion. The question is not whether the concept is valid, but whether it is being treated as a tool or as a reality.

The second movement is relational reconstruction. Instead of accepting the concept as a cause, the analysis is led back to the practices and devices that sustain it. What decisions, routines, institutions, and couplings produce the effect that the concept names? What flows are being modulated? What interfaces make this modulation possible? Here, the HDS ontology operates silently: the concept is only maintained if it can be reconnected to concrete institutional processes.

The third movement is the identification of redistributed costs. All conceptual stabilization dissipates conflicts at the cost of displacing them. PARC-Jus requires that it be made explicit who absorbs these costs — in terms of time, resources, exposure to coercion, exclusion, or vulnerability — and who benefits from stabilization. This step prevents institutional persistence from being confused with normative legitimacy.

The fourth movement is the evaluation of thresholds and incompatibilities. The analysis asks whether the conceptual arrangement in question remains compatible with the institutional field that sustains it or whether there are signs of saturation: excessive judicialization, decision-making overload, loss of social adherence, crises of legitimacy. The concept is no longer a criterion of correction and becomes an indicator of tension.

These movements do not produce a ready-made normative response. Its effect is different: to reopen the field of the thinkable, returning contingency to what had become naturalized.

Examples of integrated analysis

Applied to the cases discussed in this chapter, the functioning of PARC-Jus becomes clearer.

In the case of the Rule of Law, the protocol prevents the category from functioning as an abstract moral subject. Instead of asking whether a given decision "defends" or "threatens" the rule of law, the analysis is redirected to the institutional couplings that produce predictability, control, and adherence. The concept remains useful, but loses its ontological aura.

In the penal system, PARC-Jus blocks finalist explanations. Discourses on punishment, prevention, or resocialization are suspended in favor of the analysis of how the system redistributes violence, exclusion, and control of populations. Criticism ceases to oscillate between moralism and cynicism and starts to operate in terms of institutional persistence and social costs.

In the control of constitutionality, the protocol denaturalizes both the Constitution and the Court. Instead of treating decisions as an expression of ultimate constitutional meaning, the analysis focuses on load modulation devices, procedural filters, and temporal adjustments that allow the system to absorb normative conflicts without collapsing.

In all these cases, the gain is not to replace traditional concepts, but to reorganize their ontological status. PARC-Jus, anchored in HDS, functions as an epistemological brake: it prevents conceptual success from becoming an analytical destiny.

By institutionalizing an ontological surveillance practice, PARC-Jus responds directly to the problem that motivated this chapter. It offers a way of operating critically within the Law, without resorting to normative transcendences or skeptical reductions. Its commitment is not to permanent deconstruction, but to the maintenance of the provisional, historical and contestable character of legal categories.

With this, the chapter approaches its conclusion: it is not enough to identify ontological pareidolia; it is necessary to create conditions so that legal thought does not produce it again in new forms. Conceptual surveillance, when anchored in a minimal and self-limiting ontology, ceases to be an exceptional gesture and can become a collective practice.

8 ALEXY'S PRINCIPLED WEIGHTING AND THE TENUOUS DISTINCTION BETWEEN THEORY AS A LENS OR TRANSPARENCY AND THE CURRENT CONFUSION WITH THE SUB OCULI OBJECT ITSELF

Not only in the field of the sciences of *physis* (exact, natural and biological), but also in the field of the sciences of *the nomos* (social, cultural and contemporary), what we could abbreviate (and only for the purposes of primary understanding) persists as the author's 'passion' (in the proper sense of *pathos*) for the theory he constructs or even of the cultivators of science (those who make use of the theories), so that, not infrequently, the theory and the object of study itself are confused.

At this level, it is intended to center the analysis on Robert Alexy, with his theory of the weighing of principles and that, as a result, principles would be relativable, colliding when faced with a concrete case, so that – in the face of a dimension of weight and importance – greater value should be attributed to one of them (in the concrete case, as already mentioned) (ALEXY, 1993).

Post-positivism (as a school and philosophical current) and neo-constitutionalism (as a movement) in which Alexy's thought is inserted, cannot be understood as unitary currents, but as great theoretical labels, which harbor conceptions that are more often than not heterogeneous, and even, at times, contradictory to each other (SARMENTO, 2009). An

indistinct criticism of these movements would run the risk of reaching imprecise targets, which is why we choose, then, to concentrate the present analysis on the theoretical strand of Robert Alexy, considered emblematic of the conceptual and practical problems that it is intended to highlight: to what extent is the theoretical lens raised by Alexy confused with the very principled object that he intends to discern? In the well-known clash between Ronald Dworkin and Herbert Hart, Dworkin launched a general attack on positivism (DWORKIN, 2002). Here a systematic attack on post-positivism is proposed, especially in its Alexian formulation that principles are relative and collide when faced with the concrete case – and more specifically, unveiling an ontological pareidolia, which is embodied in this confusion that occurs between method and object or between theoretical shield and object.

The structuring axis of the criticism raised here is the notion of principle. The contemporary debate on legal principles has been conducted in an uncritical manner and, in many cases, inattentive to the most elementary meaning of the term. Recovering its etymology and its use in the philosophical tradition, especially among the pre-Socratics, the principle goes back to the *arkhé*, which, for the pre-Socratics, designates that which inaugurates, founds, orders and confers unity to a system (REALE, 1999; GHIRALDELLI, 2007). Principles, in this sense, are not accessory, instrumental or contingent elements, but the foundations that sustain the identity and coherence of any system of knowledge, including the legal one.

From this understanding, the notion of principle is inseparably linked to the idea of system (FERRAZ JR., 1976). A system only exists as such because it has structuring elements that guarantee its unity and permanence, even in the face of historical transformations. Change, far from signifying a total rupture, always presupposes something that remains, under penalty of the object ceasing to be entirely what it was and becoming non-being, in the terms of the paradox of Ulysses' boat. It is exactly this element that subsists in *becoming*. Thus, to admit that principles can be relativized, displaced or treated as common norms would mean to erode the very foundations of the legal system, putting at risk its continuity and identity, since principles are presented as the foundation, the basis, the foundation, the founding nucleus.

The traditional (and sustained by modernity) opposition between *physis* and *nomos*, often associated with the distinction between natural sciences and cultural sciences, as an absolute split is untenable. Even in the exact, biological and natural sciences, there are conventional components and human constructions, such as measurement scales, in physics and numerals in mathematics (cultural elements, created by the human being, in sciences where discovery predominates). Conversely, in the human sciences — and in Law in

particular — there are elements that are not created by human will, but discovered historically (DWORKIN, 1999; CANOTILHO, 2000). It is in this space that the legal principles and, especially, the so-called fundamental rights are inserted.

Fundamental rights are not products of legislative activity, but historical discoveries recognized over time – to support this premise the text of the great declarations and bills of rights, in which the legislator does not dare to use the term "equality or freedom or dignity" is now created, but rather recognizes that it exists and that they must be protected and safeguarded. Historicity, a characteristic that marks Human and Fundamental Rights, does not mean absolute contingency, but a process of gradual revelation of values and normative structures that concern the human condition itself – historical discoveries and not historical creations. When constitutional texts claim to "recognize" rights, and not create them, they highlight this dimension discovered — and not created — of fundamental principles (BONAVIDES, 2003). For this reason, principles belong more to the pole of *physis* than to that of *nomos*, even if they are expressed juridically through positive and, as a rule, written norms.

Revisiting the historical clash between natural law and positivism, as a thesis and antithesis, it cannot be denied that positivism has consolidated itself as the dominant paradigm, for pragmatic reasons (the fair is not very technical and even subjective, while the legal is more measurable and scientifically viable. Even in the context of the positivist tradition, the logical precedence of principles in relation to norms has always been recognized. Now, principle means beginning and beginning, so it precedes norm. The central problem of positivism, however, was to restrict legality to the established norms, relegating the principles to a secondary, merely interpretative or integrative role, activated only in situations of normative gap (KELSEN, 1998). By defending the primacy of the law (rule), principle as an element that precedes it loses strength, is not a norm and, therefore, has no cogency.

Strictly speaking, among the many strands of positivism, there remains the common element that Law boils down to the norm. And this limitation opened space for judicial discretion. See, when there are legal gaps, factual situations in which there is no law that can be applied, positivism points out as a solution: analogy, customs and general principles of Law, in this sequence (BRASIL, LINDB, art. 4). Principle, in the positivist sphere, should only be used as a last resort. A principle that, in theory and by virtue of etymology, has primacy, comes first, is only in fact used as a last resort, when there is no longer a norm, when analogy or custom do not resolve the legal conflict. What to say when neither analogy, nor customs,

nor principles offered a clear solution? The positivist answer is discretion: that the judge decides without any ballast or support or guideline, freely and with absolute power.

It is precisely to face this problem that post-positivism arises, with the promise of conferring greater normative force to the principles and, simultaneously, reducing the judge's margin of discretion. Both Dworkin and Alexy are labeled post-positivists and neo-constitutionalists, but the solutions proposed by both follow profoundly different paths.

Ronald Dworkin rejects judicial discretion in a strong sense and maintains that Law, understood as an integral and coherent system, always offers a correct answer to difficult cases. This answer does not emerge from the subjective will of the judge, but from the systematic interpretation of the legal system, guided by principles endowed with binding force. The legitimate decision, for Dworkin, is the one capable of justifying itself before the legal and political community as a whole, guaranteeing social pacification and conviction that all possible means were used to solve the collision between principles, preserving the integrity of the system and avoiding the arbitrary innovation of the Law. In the construction of the concrete case, Dworkin proposes, as a method, unity, integrity and chain romance (DWORKIN, 2002). Unity would be for the judge to get out of the hot seat, admit that he cannot simply incur in the rationalizing vice (STRECK, 2000) and pre-judge, imposing on that side that he subjectively disagrees the defeat in the lawsuit. Integrity would involve the judge's duty to analyze, in a totalizing way, jurisprudence, ordinary legislation and the Constitution, so as not to prioritize understandings that only confirm the position that he – the judge – subjectively already has. In a chain novel, the judge would necessarily have to listen, to call to manifest himself within the process, social sectors that can contribute with positions for and against the object under analysis in the trial (DWORKIN, 2002).

Robert Alexy, in turn, proposes a solution of a different nature. In part, it finds an elegant solution to the problem that principles at the same time collide and are the foundation of the system. The collision could jeopardize the support of the entire Legal System. For him, principles are mandates of optimization and *prima facie reasons*, whose application depends on the circumstances of the specific case. Prima facie reasons inform that principles only collide when faced with the concrete case (ALEXY, 1993). Metaphorically, it would be to say that, if we consider as pieces of a chess game, principles in the game box, in the Constitution, abstractly considered, do not collide (they would all be equal and on the same level, serving as a support and foundation for the Order),

The collision between principles is not resolved by exclusion, but by weighting, and it is up to the judge to determine which principle should prevail and to what extent, but always and only in the face of the concrete case. The concrete case would be the chess game, where

one piece can defeat the other. Returning to the constitution box, all would be equal and, there, none could collide with another.

Although this proposal is presented as a rational decision-making technique, it significantly expands judicial discretion, by not providing objective or scientific criteria capable of guiding or controlling the choice made by the judge (OLIVEIRA, 2007). Who says which principle wins the collision in the concrete case? The judge. And with what ballast? None. Here is the obvious problem,

Balancing, as conceived by Alexy, transfers to the judge the power to define the relative weight of the conflicting principles, shielding himself in the generic idea that the concrete case will provide the appropriate answer. This decision-making openness weakens legal certainty and allows decisions to be rationalized *a posteriori* and based on previously formed convictions. Instead of reducing uncertainty, the theory of weighting institutionalizes it, making the protection of principled rights dependent on the subjectivity of the interpreter-judge (STRECK, 2006).

The criticism raised here finds its nodal point when faced with Alexy's treatment of the Dignity of the Human Person. By admitting that dignity, under certain conditions, prevails practically absolutely over other principles, Alexyan theory comes into tension with its own premise of relativization and optimizability of principles (ALEXY, 1993). In addition, the oscillation between treating dignity sometimes as a principle, sometimes as a rule, reveals a conceptual inconsistency that compromises the internal coherence of the model. In other words, in order to be sustained, Alexy's theory must absolutely sustain that principles are relative, that is, without exception, but it is faced with an unquestionable obstacle that the Dignity of the Human Person prevails over all other principles and this is far from the context of concrete cases, but in the abstract. Even in the constitution box, the dignity piece of the game has supremacy over all the others. And here we come to the crucial point of this analysis: in order to save his theory, Alexy chooses to maintain that what tends to be absolute is dignity as a rule and not as a principle – a situation that evidences the thesis now raised that an ontological pareidolia is evidenced there.

In another turn, post-positivism, especially in its Alexian version, it is argued, does not represent a true overcoming of positivism, but a reformulation of its central assumptions. By insisting that only what is regulated is part of the Law, post-positivism reinforces the positivist core that it intended to overcome. The simple classification of principles as species of the norm genus does not, by itself, confer on them greater normative force or concrete applicability, revealing itself to be a more rhetorical than effectively transformative operation. Principles would only have force (cogency) because they are framed by post-positivism as a

norm. But the motto that only what is the norm belongs to the Law is positivist – a coat of arms that post-positivism does not overcome, but rather embraces it.

9 CONCLUSION — TOWARDS A VIGILANT LEGAL CULTURE

This chapter started from a seemingly simple but structural paradox: the fact that the most successful legal concepts tend to become invisible as concepts. By stabilizing expectations, coordinating practices, and reducing uncertainties, they cross a critical threshold at which they cease to operate as analytical instruments and begin to function as presupposed reality. It is this silent displacement — from mediation to ontology — that has been called ontological pareidolia in Law.

Throughout the text, it has been shown that this phenomenon does not result from individual error, bad faith or specific theoretical deficit. It is a structural effect of one's own conceptual success in highly institutionalized legal systems. Concepts emerge to solve problems; they are incorporated into decision-making routines; and, once naturalized, they begin to define the horizon of the thinkable. The result is a Law that continues to operate with high technical efficiency, but with increasingly reduced ontological surveillance.

The answer to this diagnosis cannot be the simple denunciation of reification. Criticism that limits itself to revealing the constructed character of concepts runs the risk of remaining dependent on the same inflated ontologies that it intends to contest, or of sliding into a skepticism incapable of guiding institutional analysis. It was to escape this impasse that the chapter proposed HDS as a disciplined ontological antidote.

The central contribution of the HDS, as mobilized here, is not to offer a new theory of law, nor to replace consolidated dogmatic vocabularies. Its role is more restricted – and precisely for this reason more robust: to provide a minimal, relational and procedural ontology, capable of describing the persistence of legal arrangements without attributing to them a purpose, essence or historical necessity. By shifting the question from "what is this for?" to "how does it persist – and at what cost?", HDS allows Law to be analyzed as a contingent institutional practice, sustained by historically situated flows, interfaces, and thresholds.

This ontological displacement does not delegitimize Law or empty its normativity. On the contrary, it gives it back material density and historicity. Norms, principles and institutions continue to operate, but they no longer take the place of reality. They become what they have always been—though often forgotten as such: interim tools for managing conflicts, expectations, and social risks.

The PARC-Jus proposal, presented as an instrument of conceptual surveillance, translates this minimum ontology into analytical practice. By allowing the identification in real

time of reification triggers, the protocol creates conditions for jurists, researchers, and operators to interrupt reasoning exactly at the point when the description begins to become an implicit ontology. Its value lies not in producing correct answers, but in preserving the openness of the analytic field.

With this, the chapter advances a thesis that is, at the same time, modest and demanding: contemporary legal thought does not need more concepts, principles or totalizing theories. It needs a vigilant legal culture, capable of recognizing when its own instruments begin to behave as autonomous entities, shielded from criticism and historicization.

This vigilance cannot be individualized or heroic. It depends on collective practices: in research, in teaching, in judicial decision-making, in legislative elaboration. It demands that established concepts can be questioned without this being interpreted as an institutional threat; that dominant methods can be relativized without delegitimizing the field; and that ontological critique be recognized as a condition of theoretical maturity, and not as a destructive gesture.

Finally, thinking about Law from the HDS implies assuming a less comfortable, but more honest, image of legal practice. Law does not appear as a progressive realization of universal values, nor as a neutral machine for the application of norms, but as a historical practice of responsible persistence. It persists as long as it manages to redistribute conflicts without collapsing; protects while being able to modulate risks without saturating; it legitimizes itself as long as it manages to absorb tensions without losing social adherence.

Recognizing this condition does not weaken the Law. On the contrary, it makes visible their limits, their costs and their choices. And it is precisely this visibility — not the belief in essences or purposes — that constitutes the most fertile soil for effective, responsible, and intellectually honest legal criticism.

Closing this chapter, therefore, does not mean closing the problem of ontological pareidolia, but making explicit a commitment: to keep concepts in motion, to prevent success from becoming destiny and to sustain, within Law itself, an ontology sufficiently austere not to become another conceptual idol.

REFERENCES

- Alexy, R. (1993). *Teoría de los derechos fundamentales*. Centro de Estudios Constitucionales.
- Alexy, R. (2008). *Teoria dos direitos fundamentais* (V. A. da Silva, Trad.). Malheiros.
- Barroso, L. R. (2012). *O controle de constitucionalidade no direito brasileiro* (6ª ed.). Saraiva.
- Beccaria, C. (2000). *Dos delitos e das penas* (T. Guimarães, Trad.). Martin Claret.

- Bonavides, P. (2003). Curso de direito constitucional (14ª ed., rev. e atual.). Malheiros.
- Bourdieu, P. (1989). A força do direito: Elementos para uma sociologia do campo jurídico. In P. Bourdieu, O poder simbólico (F. Tomaz, Trad., pp. 209–254). Difel.
- Brasil. (1942). Decreto-Lei nº 4.657, de 4 de setembro de 1942. Lei de Introdução às Normas do Direito Brasileiro. http://www.planalto.gov.br/ccivil_03/decreto-lei/del4657compilado.htm
- Brown, W. (2015). Undoing the demos: Neoliberalism's stealth revolution. Zone Books.
- Canotilho, J. J. G. (2000). Direito constitucional (4ª ed.). Almedina.
- Deleuze, G., & Guattari, F. (1995). Mil platôs: Capitalismo e esquizofrenia (Vol. 1) (P. P. Pelbart & J. Caiafa, Trans.). Editora 34.
- Dworkin, R. (1999). O império do direito (J. L. Camargo, Trad.). Martins Fontes. (Obra original publicada em 1986)
- Dworkin, R. (2002). Levando os direitos a sério (N. Boeira, Trad.). Martins Fontes.
- Ferrajoli, L. (2007). Principia iuris: Teoria del diritto e della democrazia (Vol. 1: Teoria del diritto). Laterza.
- Ferraz Júnior, T. S. (1976). O conceito de sistema no direito: Uma investigação histórica a partir da obra jusfilosófica de Emil Lask. Revista dos Tribunais.
- Foucault, M. (1975). Vigiar e punir: Nascimento da prisão (R. Ramalheite, Trad.). Vozes.
- Ghiraldelli, P. (2007). Pré-socráticos: Cosmologia e metafísica. <http://casadeplatao.blogspot.com/2007/05/aula-2-pr-socrticos-cosmologia.html>
- Habermas, J. (1992). Direito e democracia: Entre facticidade e validade (Vols. 1–2) (F. B. Siebeneichler, Trad.). Tempo Brasileiro.
- Kelsen, H. (1998). Teoria pura do direito (6ª ed.) (J. B. Machado, Trad.). Martins Fontes.
- Kennedy, D. (1997). A critique of adjudication (fin de siècle). Harvard University Press.
- Koselleck, R. (2006). Futuro passado: Contribuição à semântica dos tempos históricos (W. P. Maas & C. A. Pereira, Trans.). Contraponto; Editora PUC-Rio.
- Latour, B. (2010). The making of law: An ethnography of the Conseil d'État. Polity Press.
- Luhmann, N. (1995). Das Recht der Gesellschaft. Suhrkamp.
- Luhmann, N. (2016). O direito da sociedade (S. Krieger, Trad.). Martins Fontes.
- Marx, K. (2013). O capital: Crítica da economia política (Livro I) (R. Enderle, Trad.). Boitempo.
- Oliveira, R. T. de. (2007). O conceito de princípio entre a otimização e a resposta correta: Aproximações sobre o problema da fundamentação e da discricionariedade das decisões judiciais a partir da fenomenologia hermenêutica [Dissertação de mestrado, Universidade do Vale do Rio dos Sinos].
- Prigogine, I., & Stengers, I. (1984). A nova aliança: Metamorfose da ciência (M. Faria & J. M. C. Ribeiro, Trans.). Editora UnB.
- Reale, M. (1999). Filosofia do direito (19ª ed.). Saraiva.
- Roxin, C. (2006). Derecho penal: Parte general (Tomo I) (D.-M. Luzón Peña et al., Trans.). Civitas.

- Sarmiento, D. (2009). O neoconstitucionalismo no Brasil: Riscos e possibilidades. In M. Novelino (Org.), *Leituras complementares de direito constitucional: Teoria da constituição* (pp. 31–68). JusPodivm.
- Streck, L. L. (2000). *Verdade e consenso: Constituição, hermenêutica e teorias discursivas*. Lumen Juris.
- Streck, L. L. (2006). *Jurisdição constitucional e hermenêutica* (2ª ed.). Lumen Juris.
- Sunstein, C. R. (2001). *One case at a time: Judicial minimalism on the Supreme Court*. Harvard University Press.
- Tilly, C. (1992). *Coercion, capital, and European states, AD 990–1992*. Blackwell.
- Vermeule, A. (2014). *Law's abnegation: From law's empire to the administrative state*. Harvard University Press.
- Wacquant, L. (2001). *As prisões da miséria* (A. Telles, Trad.). Jorge Zahar.
- Weber, M. (1993). A política como vocação. In M. Weber, *Ciência e política: Duas vocações* (L. Hegenberg & O. S. da Mota, Trans., pp. 55–126). Cultrix.

APPENDICES

A. HDS-Jur Glossary

This glossary has no definitional function in the classical sense. Its objective is to establish limits of use, preventing the conversion of the concepts of the Safe Dissipation Hypothesis into new ontological entities in the legal field. Each entry should be read as a provisional tool, not as a dogmatic category.

Ontological pareidolia (in Law)

Process by which historically situated legal constructs come to be treated as entities endowed with their own existence, internal necessity or causal agency. This is not a one-off conceptual error, but a systemic effect of the institutional success of certain categories.

Institutional persistence

The ability of a legal arrangement (norms, courts, decision-making practices) to continue operating over time, managing conflicts and expectations without producing immediate collapse. It does not imply legitimacy, justice or intrinsic rationality.

Dissipation (legal)

Redistribution of normative conflicts, social tensions and political risks in time, space and between different groups, through decisions, procedures and institutional devices. To decide is always to redistribute, never to eliminate conflict.

Dissipative compatibility

A condition under which a legal arrangement can persist because the costs it redistributes remain below critical thresholds of institutional crisis, loss of adhesion or political rupture.

Legal flows

Circulations that cross the legal field: demands, appeals, decisions, expectations, symbolic legitimacy, material coercion, public attention. They are not abstract: they are always anchored in concrete practices and devices.

Institutional interfaces

Devices that modulate legal flows: courts, procedures, appeal filters, laws, bureaucracies, deadlines, rites, competences. Interfaces do not resolve conflicts; regulate its passage.

Institutional threshold

A critical point from which the redistribution of conflicts ceases to be absorbed and starts to produce saturation, crisis of legitimacy or functional disorganization. Threshold is not collapse; it is a sign of its approach.

Teleological management

Administration of conflicts and lives without immanent normative purpose. Management occurs as a function of the persistence of the arrangement, not the realization of declared values, even if these accompany the justificatory discourse.

Ontological surveillance

Continuous reflective practice that prevents concepts, methods or analytical categories from becoming non-thematized ontological assumptions.

B. Checklist for the use of HDS in Law

This checklist is not meant to "apply" the HDS as a general explanatory theory, but to audit the use of ontology in concrete legal analyses.

Before the analysis

- ☐ Is the object being treated as an entity ("the Law", "the system", "the State") or as a situated institutional arrangement?
- ☐ Is there any implicit purpose being attributed to the phenomenon analyzed?

During the analysis

- ☐ Were the relevant flows made explicit (decision-making, symbolic, material)?
- ☐ Have concrete institutional interfaces been identified?
- ☐ Is there explicit recognition of cost redistribution (who wins, who absorbs, who bears)?
- ☐ Is some concept being used as an explanatory cause rather than a relational effect?

Risk Alerts

- ☐ Do concepts appear as active grammatical subjects?
- ☐ Did a specific method colonize the problem before the description?
- ☐ Does criticism require excessive defensive qualifications?

After the analysis

- ☐ Does the text avoid concluding with implicit justification of the existing?
- ☐ Is there a clear distinction between description of persistence and normative evaluation?
- ☐ Has the very use of HDS been maintained as a tool, not as a totalizing ontology?

C. Cases for analysis

The following cases are suggestions for pedagogical and analytical use of the protocol. They do not aim to produce "correct answers", but to exercise ontological vigilance.

Case 1 — Legal certainty and public policy review

- Traditional question: "Does the review violate legal certainty?"

- HDS Question: "What flows were stabilized before, and what costs are being redistributed now?"

Case 2 — Over-incarceration and penal reforms

- Traditional question: "Does politics fulfill its purpose?"
- HDS Question: "What thresholds of institutional violence are being administered, and to whom?"

Case 3 — Judicial activism in the Supreme Court

- Traditional question: "Has the court overstepped its role?"
- HDS Question: "What normative and political pressures are being dissipated via decision?"

Common methodological guide

1. Describe the arrangement without assigning purpose.
2. Map flows and interfaces.
3. Identify cost redistribution.
4. Find possible thresholds.
5. Only then, if desired, introduce normative (explicitly separate) assessment.

**INFLUENCE OF THE PRESENCE OF CROTAMINE IN THE COMPOSITION OF
THE *CROTALUS DURISSUS TERRIFICUS* VENOM FACE TO CROTALIC
ANTIVENOM, A HISTOLOGICAL APPROACH**

**INFLUÊNCIA DA PRESENÇA DE CROTOXINA NA COMPOSIÇÃO DO VENENO
DE *CROTALUS DURISSUS TERRIFICUS* FRENTE AO SORO
ANTICROTÁLICO: UMA ABORDAGEM HISTOLÓGICA**

**INFLUENCIA DE LA PRESENCIA DE CROTOXINA EN LA COMPOSICIÓN DEL
VENENO DE *CROTALUS DURISSUS TERRIFICUS* FRENTE AL SUERO
ANTICROTÁLICO: UN ENFOQUE HISTOLÓGICO**



<https://doi.org/10.56238/sevened2026.008-169>

**Fâni Ribeiro Silva¹, Nathalia Margarida Cantuária², Jonas Eligio Garcia de Azevedo³,
Gabriel Ferreira dos Santos⁴, Jocimar de Souza⁵, Leonardo da Silva Rodrigues
Calderon⁶, Isabella Ravazoli⁷, José Carlos Cogo⁸, Rafael Stuaní Floriano⁹, Stephen
Hyslop¹⁰, Yoko Oshima-Franco¹¹**

¹ Postgraduate in Pharmaceutical Sciences. Universidade de Sorocaba (UNISO).

E-mail: fani.silva@prof.uniso.br Orcid: <https://orcid.org/0009-0007-5341-7132>

Lattes: <http://lattes.cnpq.br/4852959115872367>

² Postgraduate in Pharmaceutical Sciences. Universidade de Sorocaba (UNISO).

E-mail: nathmcantuarua@gmail.com Orcid: <https://orcid.org/0000-0002-2481-3327>

Lattes: <http://lattes.cnpq.br/9353335503445662>

³ Postgraduate in Pharmaceutical Sciences. Universidade de Sorocaba (UNISO).

E-mail: jonaseligiogarcia@outlook.com Orcid: <https://orcid.org/0000-0002-7172-4298>

Lattes: <http://lattes.cnpq.br/8692208489041083>

⁴ Postgraduate in Pharmaceutical Sciences. Universidade de Sorocaba (UNISO).

E-mail: gabriel_fs8@hotmail.com Orcid: <https://orcid.org/0000-0002-9887-5301>

Lattes: <http://lattes.cnpq.br/1623233605878527>

⁵ Postgraduate Program in Pharmaceutical Sciences. Universidade de Sorocaba (UNISO).

E-mail: jocimar.souza@prof.uniso.br Orcid: <https://orcid.org/0000-0002-4772-5899>

Lattes: <http://lattes.cnpq.br/6522827216175259>

⁶ Biological Sciences. Universidade de Sorocaba (UNISO). E-mail: calderon.leo.6097@gmail.com

Orcid: <https://orcid.org/0009-0002-9333-1134> Lattes: <http://lattes.cnpq.br/7201662059410832>

⁷ Pharmacy. Universidade de Sorocaba (UNISO). E-mail: ravazoliisabella@gmail.com

Orcid: <https://orcid.org/0000-0003-0273-721X> Lattes: <http://lattes.cnpq.br/3881187757275320>

⁸ Bioengineering. Brazil University. E-mail: jccogo@gmail.com

Orcid: <https://orcid.org/0000-0001-8712-5022> Lattes: <http://lattes.cnpq.br/2236880378127526>

⁹ Graduate in Health Sciences. Universidade do Oeste Paulista. E-mail: rafael@unoeste.br

Orcid: <https://orcid.org/0000-0003-0759-5863> Lattes: <http://lattes.cnpq.br/2274960252183043>

¹⁰ Pharmacology. Universidade Estadual de Campinas (UNICAMP). E-mail: hyslop@fcm.unicamp.br

Orcid: <https://orcid.org/0009-0006-5484-1288> Lattes: <http://lattes.cnpq.br/8655386938955187>

¹¹ Postgraduate in Pharmaceutical Sciences. University of Sorocaba (UNISO).

E-mail: yoko.franco@prof.uniso.br Orcid: <https://orcid.org/0000-0002-4972-8444>

Lattes: <http://lattes.cnpq.br/0649597834354919>

ABSTRACT

The main fractions isolated from *Crotalus durissus terrificus* venom include crotamine, gyrotoxin, crotoxin, convulxin and phospholipase A2. The antivenom is produced by a pool from *Crotalus durissus* ssp venoms, which do not always express crotamine, which may reflect on the treatment. The objective was to evaluate, by light microscopy, the effectiveness of antivenom in cellular injuries induced by *C. d. terrificus* venom with (Vcrot+) and without (Vcrot-) crotamine. The study design was *in vitro* using routine histological procedures on donated neuromuscular preparations under Ethics Committee 201/2021, exposed to 1) control; 2) Vcrot+; 3) Vcrot-; and treated with antivenom in 4) preincubation and 5) post-venom models. The results were myotoxicity index (MI) in control preparations of $42.2 \% \pm 2.6$ cells; Vcrot+ $95.2 \% \pm 1.8$; Vcrot- $89.6 \% \pm 2.3$. In the preincubation model, the antivenom significantly decreased the lesions to $74.1 \% \pm 3.8$ of Vcrot+ and $71.9 \% \pm 4.5$ of Vcrot-. In the post-venom model, the results were Vcrot+ $\rightarrow 10'$, $98.0 \% \pm 0.1$; $\rightarrow 30'$, $84.8 \% \pm 0.1$; and $\rightarrow 60'$ $85.6 \% \pm 0.1$, while for Vcrot- were $84.7 \% \pm 0.1$; $83.6 \% \pm 0.01$ and $91.9 \% \pm 0.09$, respectively. In conclusion, the antivenom neutralizes a major amount of constituents in the venom in the preincubation model, while in the post-venom model, it was not able against the myotoxic effects of both venoms, but allowed to show the sequence of pathological events in an *ex vivo* model.

Keywords: Antivenom. *Crotalus durissus terrificus*. Histology. Phrenic Nerve-Diaphragm Preparation. Snake Venom.

RESUMO

As principais frações isoladas do veneno de *Crotalus durissus terrificus* incluem crotamina, girotoxina, crotoxina, convulxina e fosfolipase A2. O soro anticrotálico é produzido a partir de um pool de venenos de *Crotalus durissus* ssp., que nem sempre expressam crotamina, o que pode refletir na eficácia do tratamento. O objetivo deste estudo foi avaliar, por microscopia de luz, a eficácia do soro anticrotálico nas lesões celulares induzidas pelo veneno de *C. d. terrificus* com (Vcrot+) e sem (Vcrot-) crotamina. O delineamento experimental foi realizado *in vitro*, utilizando procedimentos histológicos de rotina em preparações neuromusculares doadas, sob aprovação do Comitê de Ética nº 201/2021, expostas a: 1) controle; 2) Vcrot+; 3) Vcrot-; e tratadas com soro anticrotálico nos modelos de 4) pré-incubação e 5) pós-veneno. Os resultados demonstraram índice de miotoxidade (IM) nas preparações controle de $42,2 \% \pm 2,6$ células; Vcrot+ $95,2 \% \pm 1,8$; e Vcrot- $89,6 \% \pm 2,3$. No modelo de pré-incubação, o soro anticrotálico reduziu significativamente as lesões para $74,1 \% \pm 3,8$ no Vcrot+ e $71,9 \% \pm 4,5$ no Vcrot-. No modelo pós-veneno, os resultados para Vcrot+ foram: $\rightarrow 10'$, $98,0 \% \pm 0,1$; $\rightarrow 30'$, $84,8 \% \pm 0,1$; e $\rightarrow 60'$, $85,6 \% \pm 0,1$; enquanto para Vcrot- foram $84,7 \% \pm 0,1$; $83,6 \% \pm 0,01$ e $91,9 \% \pm 0,09$, respectivamente. Conclui-se que o soro anticrotálico neutraliza grande parte dos constituintes do veneno no modelo de pré-incubação, enquanto no modelo pós-veneno não foi capaz de neutralizar os efeitos miotóxicos de ambos os venenos, permitindo, contudo, demonstrar a sequência de eventos patológicos em um modelo *ex vivo*.

Palavras-chave: Soro Anticrotálico. *Crotalus durissus terrificus*. Histologia. Preparação Nervo Frênico-Diafragma. Veneno de Serpente.

RESUMEN

Las principales fracciones aisladas del veneno de *Crotalus durissus terrificus* incluyen crotamina, girotoxina, crotoxina, convulxina y fosfolipasa A2. El suero anticrotálico se produce a partir de un pool de venenos de *Crotalus durissus* ssp., que no siempre expresan crotamina, lo que puede influir en la eficacia del tratamiento. El objetivo de este estudio fue evaluar, mediante microscopía óptica, la eficacia del suero anticrotálico frente a las lesiones

celulares inducidas por el veneno de *C. d. terrificus* con (Vcrot+) y sin (Vcrot-) crotamina. El diseño experimental fue in vitro, utilizando procedimientos histológicos de rutina en preparaciones neuromusculares donadas, bajo aprobación del Comité de Ética n° 201/2021, expuestas a: 1) control; 2) Vcrot+; 3) Vcrot-; y tratadas con suero anticrotálico en los modelos de 4) preincubación y 5) post-veneno. Los resultados mostraron un índice de miotoxicidad (IM) en las preparaciones control de $42,2 \% \pm 2,6$ células; Vcrot+ $95,2 \% \pm 1,8$; y Vcrot- $89,6 \% \pm 2,3$. En el modelo de preincubación, el suero anticrotálico redujo significativamente las lesiones a $74,1 \% \pm 3,8$ en Vcrot+ y $71,9 \% \pm 4,5$ en Vcrot-. En el modelo post-veneno, los resultados para Vcrot+ fueron: $\rightarrow 10'$, $98,0 \% \pm 0,1$; $\rightarrow 30'$, $84,8 \% \pm 0,1$; y $\rightarrow 60'$, $85,6 \% \pm 0,1$; mientras que para Vcrot- fueron $84,7 \% \pm 0,1$; $83,6 \% \pm 0,01$ y $91,9 \% \pm 0,09$, respectivamente. En conclusión, el suero anticrotálico neutraliza gran parte de los constituyentes del veneno en el modelo de preincubación, mientras que en el modelo post-veneno no fue capaz de neutralizar los efectos miotóxicos de ambos venenos, aunque permitió demostrar la secuencia de eventos patológicos en un modelo ex vivo.

Palabras clave: Suero Anticrotálico. *Crotalus durissus terrificus*. Histología. Preparación Nervio Frénico-Diafragma. Veneno de Serpiente.

1 INTRODUCTION

Snakebites represent a significantly overlooked public health concern in numerous tropical and subtropical nations. Annually, approximately 5.4 million snakebites transpire, leading to 1.8 to 2.7 million instances of poisoning. The associated mortality ranges from 81,410 to 137,880 deaths, with nearly threefold incidents of amputations and other enduring disabilities recorded each year (World Health Organization, 2018a).

The venomous snakes of public health concern in Brazil are represented by two genera of the Elapidae family, *Micrurus* and *Leptomicrurus*, and three genera of the Viperidae family, *Bothrops*, *Crotalus*, and *Lachesis* (Brazil, 2020). According to data from the epidemiological Bulletin of the Ministry of Health, 27,515 snakebite incidents were reported to the Notification of Aggravations Information System (SINAN) in Brazil in the year 2022. Of these, 19,044 cases (69.2%) belong to the *Bothrops* genus with 82 deaths (0.4%), 2,237 cases (8.1%) belong to the *Crotalus* genus with 15 deaths (0.6%), and 3,697 cases (13.4%) which the snake species was not identified (Brazil, 2022).

The *Crotalus* genus in Brazil comprises only one species, *Crotalus durissus*, and six subspecies: *C. d. terrificus*, *C. d. cumanensis*, *C. d. collilineatus*, *C. d. cascavella*, *C. d. ruruima*, and *C. d. marajoensis*. Snakes of the *Crotalus* genus are found in the arid and semi-arid regions of the Northeast, as well as in fields and open areas of the South, Southeast, and North (Melgarejo et al., 2009). These snakes are terrestrial and nocturnal, commonly known as rattlesnakes or South American rattlesnakes. They are robust and not very agile, with a rattle at the end of their tails (Pinho and Pereira, 2001; Pereira, 2011; Da Silva-Junior et al., 2020).

The venom of venomous snakes is composed of a mixture of proteins and peptides that bind to receptors. When interaction with tissue occurs, it induces a series of modifications in the organism's homeostasis, disrupting the nervous and cardiovascular systems with neurotoxic, myotoxic, and coagulant effects (Vonk et al., 2011).

The toxic effects resulting from the bite of *C. d. terrificus* are due to the toxins present in the venom (Brazil, 2001; Pinho and Pereira, 2001). The rattlesnake venom is composed of various substances, including four main toxins: crotoxin (Slotta and Fraenkel-Conrat, 1938; Vital Brazil and Excell, 1971; Hörtnagel and Hanin, 1992, Sampaio et al., 2010; Fusco et al., 2015), gyroxin (Kruse; Van Wimersma; Wieda, 1977; Barrabin et al., 1978; Alexander et al., 1988; Barros et al., 2011), convulxin (Prado-Franceschi et al., 1981; Oliveira, 2014), and the myotoxin crotamine (Gonçalves and Vieira, 1950; Ownby; Aird; Kaiser, 1988; Lourenço et al., 2013; Lima et al., 2018).

Crotamine, capable of inducing muscle spasms, was isolated in 1947 from the venom of the Brazilian rattlesnake from the central and southern regions (Gonçalves and Vieira, 1950). It is a polypeptide consisting of 42 amino acid residues with low molecular weight, including 11 basic amino acids, 9 lysines, and 2 arginines. Additionally, it has 6 cysteines interconnected by disulfide bridges, providing significant conformational stability (Gonçalves, 1956; Laure, 1975; Hampe; Vozari-Hampe; Gonçalves, 1978). Crotamine possesses antimicrobial, antifungal, and antitumor properties. Its three-dimensional structure is comparable to peptides belonging to the family of mammalian β -defensins, which are rich in arginine and lysine residues and play a role in the immune system (Siqueira et al., 2002; Pereira, 2011; Yamane, 2013; Da Cunha et al., 2018).

There are various perspectives on the action of crotamine on skeletal muscle tissue. Concerning voltage-dependent sodium channels, its depolarization is antagonized by tetrodotoxin or reduced Na^+ concentration, leading to increased permeability of Ca^{2+} ions (Cheymol et al., 1971). Additionally, it inhibits voltage-dependent potassium channels (Peigneur et al., 2012). There is no consensus on its mechanism of action, with acceptance both on voltage-dependent potassium channels and sodium channels, causing electrophysiological changes and structural damage to muscle fibers (Da Cunha et al., 2018; Lima et al., 2018; Silvestrini et al., 2019). This polypeptide (Figure 1) can easily traverse the cell membrane and has been employed as a carrier for pharmacological molecules (Cell Penetrating Peptides - CPPs) (Oguiura; Boni-Mitake; Rádis-Baptista, 2005; Rodrigues et al., 2012; Oliveira, 2014).

Differences in the venom composition based on the snake's gender, developmental phase and living conditions were described by Lourenço et al. (2013). Biological activity was analysed in comparison with the Brazilian reference venom in 60 adults (captive males and females, as well as newly captured) and 18 newborns. Crotamine was found in 39.7% of the samples, and the concentration significantly differed between adults (75%) and newborns (60%). Venom with a yellow color was found in 10.2% of the samples, of which 1.3% were crotamine-positive, a rare occurrence. These results demonstrate that venoms vary significantly in terms of activity and protein concentration, even when originating from the same species and region. This variation should be considered in the production of antivenoms for treating snakebites (Lourenço et al., 2013).

The presence or absence of crotamine can impact antivenom production, particularly in selecting the pool of crotalic venoms, as crotamine-positive and crotamine-negative venoms may have different mechanisms of action (Tasima et al., 2020). When present, crotamine represents about 10 to 25% of its dry weight (Lima et al., 2018) and can lead to

severe accidents in animals such as cattle (Lago et al., 2000). Its presence can be determined through the traditional lethality test in mice via intraperitoneal (i.p.) administration of venom, protein electrophoresis on polyacrylamide gel (SDS-PAGE), and high-performance liquid chromatography (HPLC) using a photodiode array (PDA) detector (de Oliveira et al., 2015).

Serotherapy is the official treatment recommended by the WHO (Gutiérrez et al., 1998; Brazil, 2001), of which Brazil is a signatory. Antivenom heterologous sera are concentrated immunoglobulins obtained through hyperimmunization of horses. In Brazil, the laboratories that produce these immune derivatives for the public health system are Butantan Institute (São Paulo), Ezequiel Dias Foundation (Minas Gerais), Vital Brazil Institute (Rio de Janeiro), and Immunobiological Production and Research Center (Paraná), except for the antilatrodectic serum (SALatr), which has been imported from Argentina. The sera are produced in liquid form. The ampoules should be stored in the refrigerator at a temperature of 4 to 8 degrees Celsius, avoiding freezing, with a general self-life of two to three years (Brazil, 2001).

The crotalic venoms used in the hyperimmunization of horses come from two subspecies – *C. d. terrificus* (50%) and *C. d. collilineatus* (50%), and the serum produced with crotoamine-negative venom will not recognize this molecule (Teixeira-Araújo et al., 2017). Furthermore, it is known that this toxin induces myonecrosis (Cameron and Tu, 1978; Toyama et al., 2003), paralysis of hind limbs, and spontaneous, irregular contractions in the diaphragms of rats, mice, and rabbits (Gonçalves, 1956; Lima et al., 2018) by acting on sodium and potassium ion channels (Brazil and Fontana, 1993; Peigneur et al., 2012; Lima et al., 2018).

This study aims to assess the efficacy of antivenom on cellular damage induced by venoms with and without crotoamine exposure in *ex vivo* preparations through histological analysis. This evaluation aims to elucidate the specific impact of crotoamine in venom, providing valuable insights for public health authorities responsible for antivenom production. Utilizing a consistent experimental model employed by previous researchers (Toyama et al., 2003; Lima et al., 2018) facilitates result comparisons and informs evidence-based decision-making in the field.

2 MATERIAL AND METHODS

2.1 VENOM AND ANTIVENOM

The venoms of *C. d. terrificus* with (Vcrot+) and without (Vcrot-) were kindly provided by Prof. Dr José C. Cogo from the University of Brazil, São Paulo (SP), and certified by Prof. Dr Stephen Hyslop/Kristian A. Torres-Bonilla from the Faculty of Medical Science at the State

University of Campinas (FCM/Unicamp) and assayed in the study of De Souza et al. (2022). They were stored in a freezer at -20 °C. The study involving the venoms was registered in the National System for the Management of Genetic Heritage and Associated Traditional Knowledge – SisGen, under the code A7DF1D4, on 16/02/2022. The anticrotalic-IgG serum (Instituto Vital Brazil, S.A., L. 135202 MS:1.0407.008.001-8, expiration date 10/16) was donated by ERSAPiracicaba (SP), after its expiry for human use, as a condition for its utilization in scientific research. The antivenom concentration in this study was determined according to the manufacturer's recommendation.

2.2 EXPERIMENTAL GROUPS

The biological preparations were divided into different groups: control (nutrient solution), venom with crotoxin (Vcrot+ 10 µg/mL), and venom without crotoxin (Vcrot- 30 µg/mL), a preincubation model with antivenom (AV) named Vcrot+:AV and Vcrot-:AV, and a post-venom model by adding AV at different time intervals after venom exposure resulting in Vcrot+ →AV (10', 30", 60') and Vcrot- →AV (10', 30", 60').

2.3 HISTOLOGICAL ANALYSIS

The preparations underwent electrical and indirect stimulation (approved by the Committee on Ethics in Animal Use - CEUA of the University of Sorocaba - SP, with protocol number 201/2021). Subsequently, the preparations were fixed in 10 % formalin for 24 h, followed by immersion in 70 % ethanol until routine processing and embedding in paraffin. From these processed samples 5 µm sections were obtained. These sections were stained with hematoxylin and eosin (HE) for histological observation. The analysis of all samples was performed using a light microscope (Nikon Alphaphot-2YS2-H), and the best-cut fragments were selected for examination. Photos were taken with an Android smartphone equipped with a 48Mp + 5Mp camera with a resolution of 4000 x 3000 pixels. The photos adhered to a standard magnification of 400X (40X objective, bar 1 cm=40 µm). Two examiners, employing a double-blind approach, independently analyzed selected slides, following established criteria for cell type and lesion counting. Each evaluator defined three random and virtual lines for slide analysis. The assessment included quantifying (Figure 2) the normal cells (N, panel 1), and cell damage which was evaluated based on a scoring system that considered delta injury (D, panel 2), myofibril condensation (MC, panel 3), vacuoles (V, panel 4) edema (E, panel 5), myonecrosis and ghost cells (M and G, panel 6) (Ferraz et al., 2014).

2.4 STATISTICAL ANALYSIS

Statistical results were expressed as mean and $\pm$ standard error of the mean using the One-way ANOVA system followed by the Tukey test for multiple comparisons, where SIG is equal to 0, it means that the difference between the means is not significant; for SIG equal to 1, it means that there is a significant difference between the means. The Origin 9.5 software (OriginLab Corporation, Northampton, MA, USA) was used, where the confidence interval was 95% and $p < 0.05$.

3 RESULTS

In this study, a comparative analysis of the effectiveness of antivenom on cellular injuries induced by rattlesnake venom (with and without crotamine) was carried out in two pharmacological models (preincubation and post-venom) using the histology approach, which has not yet been described in the literature.

Figure 3 shows in A, a representative control maintained in nutritive solution after 2 h of indirect stimulation, as in all other protocols, which in itself causes slight disorganization of the skeletal muscle cells. Each cell has myofibrils grouped into bundles and the normal cellular organelles, not visible by light microscopy. Note the presence of many nuclei peripherally located just beneath the cell membrane. B and C show representative sections of preparations exposed to crotalic venom with (B, Vcrot+) and without (C, Vcrot-) crotamine. Note the presence of myofibril condensation (MC) as a result of hypercontracted myofibrils densely clumped, which could lead to vacuoles formation (V) as a result of the dilatation of the sarcoplasmic reticulum, and subsequent myonecrosis (M). Ghost cells (G) arise as a result of the destruction of cytoplasm, characterized by optically empty spaces, leaving scattered nuclei in this space. Figure 3D shows the quantitative histological analysis, influenced by the high presence of myofibril condensation (Vcrot+, 95.2 % $\pm$ 1.8; Vcrot-, 89.6 % $\pm$ 2.3) including in the control preparations (42.2 % $\pm$ 2.6).

The pre-incubation model (Figure 4) of the antivenom with Vcrot+ and Vcrot- proved to be significantly (#, $p < 0.05$ in comparison to respective venom) effective in protecting the cells as shown in Fig. 4B, reducing the cell damage to 74.1 % $\pm$ 3.8 and 71.9 % $\pm$ 4.5, respectively.

Post-venom model (Figure 5) with Vcrot+ acting during 10' rapidly showed swollen cells (see inserted histological section in Fig. 5A), in which the antivenom was unable to counteract, to trigger subsequently, myonecrosis (M) and ghost cells. The addition of antivenom at 30 min, however, protected against the majority of score injuries. The effect at 60' was similar to that observed at 10'. In terms of myotoxicity index, the antivenom was

unable to avoid the cell damage induced by Vcrot+ as shown in Fig. 5B, which counting was $98.0 \% \pm 0.1$ (10 min); $84.8 \% \pm 0.1$ (30 min) and $85.6 \% \pm 0.1$ (60 min).

Figure 6 shows the post-venom model with Vcrot-. Antivenom decreased significantly edema induction, but myonecrosis did remain with antivenom addition after 60 min. The small quantity of normal cells seems to be decisive in the slow protection by antivenom, which did not happen at any time (Fig. 6A). The myotoxicity index showed no protection of antivenom in the post-venom model, which counting was $84.7 \% \pm 0.1$ (10 min); $83.6 \% \pm 0.01$ (30 min) and $91.9 \% \pm 0.09$ (60 min).

4 DISCUSSION

The snake venom-induced muscle damage is less well-understood compared to other acute effects of envenoming (Thakshila et al., 2022). This becomes even more difficult when the venom does not cause local, but systemic effects, as is the case with the South American rattlesnake *Crotalus durissus terrificus* (Azevedo-Marques et al., 1987). In contrast to venoms from other viperid species, *Crotalus* venoms exhibit a notable absence of substantial inflammatory reactions at the site of the bite in both animals and humans (Rosenfeld, 1971; Azevedo-Marques et al., 2003).

According to Mebs and Onwby (1990) “to detect and evaluate myotoxicity of a venom component, histological examination of the muscle tissue affected is superior to methods such as assaying serum creatine kinase levels”, and it was the method of choice in this study.

The pioneer studies of Cameron and Tu (1978) clearly showed myovacuolization after injection of 50 µg of crostamine in 0.1 mL of 0.9 % NaCl into the medial aspect of the thigh muscles of Swiss Webster white mice. Mice were killed 72 h after injection and myotoxicity was evaluated by light microscope histology. These findings were also confirmed by other researchers (Gutiérrez and Cerdas, 1984; Mebs and Ownby, 1990; Toyama et al., 2003). Thus, we focused the discussion based on data from literature addressed histological evaluation, with the presence or absence of crostamine occupying the central question. There is no histological study evaluating the influence of absence of the crostamine in crude venom.

Isolated mice neuromuscular preparations were submitted to *C. d. terrificus* with or without crostamine and assayed with antivenom according to the recommendation of a manufacturer by De Souza et al. (2022), using the myographic technique, and two validated pharmacological models (Camargo et al., 2010). The resulting muscles were saved for further histological analysis, as mentioned in Material and Methods. The effects of the venom without crostamine (Vcrot-) decreased the neurotoxicity at least three times more than the venom with crostamine (Vcrot+) in those pharmacological protocols carried out by De Souza et al. (2022),

needing the adjustment for the triple of Vcrot-. It may explain the highly damaged cells in both venoms (Fig. 3 B, C, and D).

The preincubation method involves incubating the snake venom with the antivenom usually for 30 min since it allows an interaction between both, before the mixture is added into the bath containing the neuromuscular preparation. Thus, in theory, only the remaining constituents not enough neutralized by antivenom will be evaluated. Our results showed a major number of normal cells and a decrease in the edema induction (Fig. 4A) resulting in significative protection by antivenom (Fig. 4 B). If edema showed to be the main remaining effect not neutralized by the antivenom in the preincubation model, the question arises to what extent the venom-edema induction is responsible for myonecrosis. In a documented instance, an edematogenic response triggered by *C. d. terrificus* venom displayed a non-dose-dependent pattern and manifested swiftly with a fast and transient course (Cupo et al., 1990). Certain investigations have highlighted that the induction of edema by phospholipase A₂ (PLA₂) may occur, with the impact in some instances being contingent on the binding of PLA₂ to particular membrane proteins (Iglesias et al., 2005).

The use of *ex vivo* preparations is scientifically robust to represent the ophidian accidents (Franco and Belo, 2017; Zanetti et al., 2018), is an alternative to the use of *in vivo* animals (Nepal and Jeong, 2020), and allows to carry out also post-venom model, in a simulated condition of envenoming. Interestingly, Vcrot+ rapidly induced edema, and antivenom added into the bath after 10 min did not avoid its progression (Fig. 5A). Taken together with the myotoxicity index, antivenom did fail in protecting the cell damage of both venoms. On the other hand, when Vcrot- was submitted to the same model, antivenom decreased significantly the edema induction, which is curious since the triple of protein (including PLA₂s) was put into the bath, except the crotamine. This finding leads us to wonder what role crotamine plays in the induction of edema. In addition to its role in edema induction, various studies have underscored the involvement of PLA₂s in the myotoxic effects associated with crotalic envenoming. A substantial portion of this impact is due to crotamine and crotoxin (Cameron and Tu, 1978; Kouyoumdjian et al., 1986; Mebs and Ownby, 1990; Carvalho et al., 2019). The CB subunit, functioning as a PLA₂, is responsible for the toxicity induced by crotoxin (Kouyoumdjian et al., 1986), which is classified as a neurotoxic and myotoxic PLA₂ (Aird et al., 1985; 1990; Montecucco et al., 2008). Crotamine, in turn, is essentially a myotoxin, whose main property is inducing myotoxicity. All these points lead to a mathematical understanding of the Vcrot+ and Vcrot- to explain our results, i.e., is the inefficacy of antivenom to combat the edema-induction of Vcrot+, but not in Vcrot-.

Mebis and Onwby (1990) suggested the sequence of pathological events induced by myotoxins and PLA₂, among others, with rich concepts of delta-lesion (wedge-shaped clear areas within the muscle clear of organelles), myofibril hypercontraction, vacuolation, edema, myonecrosis, which are followed by researchers nowadays. A hypothesis using microscopic examination reveals that the initial observable change in cells involves the dilatation or enlargement of elements within the sarcoplasmic reticulum (SR). This phenomenon could stem from either a direct or indirect impact of the toxin on SR membranes. For instance, if the toxin were to influence the plasma membrane at the cellular level, opening Na⁺ channels and permitting an unimpeded influx of Na⁺ into the cell, it could trigger the accumulation of water within the cell due to osmotic gradients. It is established that the endoplasmic reticulum, specifically the SR in this case, acts as a reservoir for water uptake from the cytosol. Consequently, as the SR fills with water, it undergoes swelling, a process documented in other mammalian cells (Ginn et al., 1968). Alternatively, it is plausible that the toxin penetrates the cell and directly interacts with SR membranes, potentially inducing swelling. However, the specific mechanism driving this effect remains unclear. Authors have proposed convergent mechanisms of action for the several snakes of the world and the literature is abundant (Gutiérrez and Cerdas, 1984; Gutiérrez and Lomonte, 1995; Lomonte et al., 2003; Montecucco et al., 2008; Carvalho et al., 2019) which does not encourage us to explore this field in our study.

The antivenom significantly neutralized constituents in the venom in the preincubation model, demonstrated by the increased quantity of normal cells and inactivation of edematogenic components in both venoms. In contrast, in the post-venom model, the antivenom showed ineffectiveness against the myotoxic effects of both venoms and was unable to prevent edema induction in Vcrot+. Interestingly, it successfully prevented edema in Vcrot-, highlighting the significance of edema in triggering myonecrosis in the *ex vivo* model.

ACKNOWLEDGEMENTS

F.R.S. was supported by a scholarship from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes, Finance code 001). L.S.R.C. was supported by a scholarship from Probiç/Uniso. Other students volunteered. This work was supported by FAPESP (2004/09705-8, 2007/53883-6, 2008/50669-6, 2008/52643-4, 2012/08271-0, and 2015/01420-9), and Financiadora de Estudos e Projetos (FINEP no. 01.10.0659.00).

DECLARATION OF INTEREST STATEMENT

No potential conflict of interest was reported by the authors.

REFERENCES

- Aird, S. D., Kaiser, I. I., Lewis, R. V., & Kruggel, W. G. (1985). Rattlesnake presynaptic neurotoxins: Primary structure and evolutionary origin of the acidic subunit. *Biochemistry*, 24, 7054–7058.
- Aird, S. D., Yates, J. R., Martino, P. A., Shabanowitz, J., Hunt, D. F., & Kaiser, I. I. (1990). The amino acid sequence of the acidic subunit B-chain of crotoxin. *Biochimica et Biophysica Acta*, 1040, 217–224.
- Alexander, G., Grothusen, J., Zepeda, H., & Schwartzman, R. J. (1988). Gyroxin, a toxin from the venom of *Crotalus durissus terrificus*, is a thrombin-like enzyme. *Toxicon*, 26, 953–960.
- Azevedo-Marques, M. M., Hering, S. E., & Cupo, P. (1987). Evidence that *Crotalus durissus terrificus* (South American rattlesnake) envenomation in humans causes myolysis rather than hemolysis. *Toxicon*, 25, 1163–1168.
- Azevedo-Marques, M. M., Hering, S. E., & Cupo, P. (2003). Crotalic accident. In J. L. C. Cardoso, O. S. F. França, F. H. Wen, C. M. S. Málaque, & V. Haddad Jr. (Eds.), *Venomous animals in Brazil: Biology, clinic and therapeutics of accidents* (pp. 91–98). Sarvier.
- Barrabin, H., Martiarena, J. L., Vidal, J. C., & Barrio, A. (1978). Isolation and characterization of gyroxin from *Crotalus durissus terrificus* venom. In P. Rosenberg (Ed.), *Toxins: Animal, plant, microbial* (pp. 113–133). Pergamon.
- Barros, L. C., Soares, A. M., Costa, F. L., Rodrigues, V. M., Fuly, A. L., Giglio, J. R., Gallacci, M., Thomazini-Santos, I. A., Barraviera, S. R. C. S., Barraviera, B., & Ferreira Junior, R. S. (2011). Biochemical and biological evaluation of gyroxin isolated from *Crotalus durissus terrificus* venom. *Journal of Venomous Animals and Toxins including Tropical Diseases*, 17, 23–33.
- Batista da Cunha, D., Pupo Silvestrini, A. V., Gomes da Silva, A. C., Maria de Paula Estevam, D., Pollettini, F. L., de Oliveira Navarro, J., Alves, A. A., Remédio Zeni Beretta, A. L., Annichino Bizzacchi, J. M., Pereira, L. C., & Mazzi, M. V. (2018). Mechanistic insights into functional characteristics of native crotamine. *Toxicon*, 146, 1–12.
- Brazil, Ministry of Health. (2001). Manual for diagnosing and treating accidents caused by venomous animals - National Health Foundation (2nd ed.). <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/a/animais-peconhentos/aguas-vivas-e-caravelas/publicacoes/manual-de-diagnostico-e-tratamento-de-acidentes-por-animais-peconhentos.pdf/view>
- Brazil, Ministry of Health. (2018). Brazil: Epidemiological bulletin. Snake accidents in Brazil; Health Surveillance Secretariat (Vol. 51, No. 09). <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/a/animais-peconhentos/acidentes-por->

- Brazil, Ministry of Health. (2022). Brazil: Notifiable Diseases Information System - Sinan Net.: Accidents caused by venomous animals - notifications registered in the information system for notifiable diseases. <http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinannet/cnv/animaisbr.def>
- Brazil, O. V., & Excell, B. J. (1971). Action of crotoxin and crotactin from the venom of *Crotalus durissus terrificus* (South American rattlesnake) on the frog neuromuscular junction. *The Journal of Physiology*, 212, 34–35.
- Brazil, O. V., & Fontana, M. D. (1993). Toxins as tools in the study of sodium channel distribution in the muscle fibre membrane. *Toxicon*, 31, 1085–1098.
- Camargo, T. M., Nazato, V. S., Silva, M. G., Cogo, J. C., Groppo, F. C., & Oshima-Franco, Y. (2010). Bothrops jararacussu venom-induced neuromuscular blockade inhibited by Casearia gossypiosperma Briquet hydroalcoholic extract. *Journal of Venomous Animals and Toxins including Tropical Diseases*, 16, 432–441.
- Cameron, D. L., & Tu, A. T. (1978). Chemical and functional homology of myotoxin a from prairie rattlesnake venom and crotamine from South American rattlesnake venom. *Biochimica et Biophysica Acta*, 532, 147–154.
- Carvalho, L. H., Teixeira, L. F., Zaqueo, K. D., Bastos, J. F., Nery, N. M., Setúbal, S. S., Pontes, A. S., Butzke, D., Cavalcante, W., Gallacci, M., Fernandes, C. F. C., Stabeli, R. G., Soares, A. M., & Zuliani, J. P. (2019). Local and systemic effects caused by *Crotalus durissus terrificus*, *Crotalus durissus collilineatus*, and *Crotalus durissus cascavella* snake venoms in Swiss mice. *Revista da Sociedade Brasileira de Medicina Tropical*, 52, Article e20180526.
- Cheymol, J., Gonçalves, J. M., Bourillet, F., & Roch-Arveiller, M. (1971). Action neuromusculaire comparée de la crotamine et du venin de *Crotalus durissus terrificus* var. crotaminicus. 1. Sur préparations neuromusculaires in situ [A comparison of the neuromuscular action of crotamine and the venom of *Crotalus durissus terrificus* var. crotaminicus. 1. Neuromuscular preparations in situ]. *Toxicon*, 9, 279–286.
- Cupo, P., Azevedo-Marques, M. M., & Hering, S. E. (1990). Acute myocardial infarction-like enzyme profile in human victims of *Crotalus durissus terrificus* envenoming. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 84, 447–451.
- Da Silva-Júnior, L. N., Abreu, L. S., Rodrigues, C. F. B., Galizio, N. D. C., Aguiar, W. D. S., Serino-Silva, C., Dos Santos, V. S., Costa, I. A., Oliveira, L. V. F., Sant'Anna, S. S., Grego, K. F., Tanaka-Azevedo, A. M., Rodrigues, L. N. D. S., & de Moraes-Zani, K. (2020). Geographic variation of individual venom profile of *Crotalus durissus* snakes. *Journal of Venomous Animals and Toxins including Tropical Diseases*, 26, Article e20200016.
- De Oliveira, S. A., Magalhães, M. R., Salazar, V. C., Valadares, M. C., & da Cunha, L. C. (2015). Identification of crotamine in the venom of *Crotalus durissus collilineatus* by three different methods. *Toxicon*, 95, 46–51.
- De Souza, J., Oliveira, I. C. F., Yoshida, E. H., Cantuaria, N. M., Cogo, J. C., Torres-Bonilla, K. A., Hyslop, S., Silva Junior, N. J., Floriano, R. S., Gutiérrez, J. M., & Oshima-Franco,

- Y. (2022). Effect of the phospholipase A2 inhibitor Varespladib, and its synergism with crotalic antivenom, on the neuromuscular blockade induced by *Crotalus durissus terrificus* venom (with and without crotamine) in mouse neuromuscular preparations. *Toxicon*, 214, 54–61.
- Ferraz, M. C., Yoshida, E. H., Tavares, R. V., Cogo, J. C., Cintra, A. C., Dal Belo, C. A., Franco, L. M., dos Santos, M. G., Resende, F. A., Varanda, E. A., Hyslop, S., Puebla, P., San Feliciano, A., & Oshima-Franco, Y. (2014). An isoflavone from *Dipteryx alata* Vogel is active against the in vitro neuromuscular paralysis of *Bothrops jararacussu* snake venom and bothropstoxin I, and prevents venom-induced myonecrosis. *Molecules*, 19, 5790–5805.
- Franco, Y. O., & Belo, C. D. (2017). Recognizing antiophidian plants using the neuromuscular junction apparatus. *International Journal of Complementary & Alternative Medicine*, 5, 11–12.
- Fusco, L. S., Rodríguez, J. P., Teibler, P., Maruñak, S., Acosta, O., & Leiva, L. (2015). New immunization protocol to produce crotalic antivenom combining *Crotalus durissus terrificus* venom and its PLA2. *Biologicals*, 43, 62–70.
- Ginn, F. L., Shelburne, J. D., & Trump, B. F. (1968). Disorders of cell volume regulation. I. Effects of inhibition of plasma membrane adenosine triphosphatase with ouabain. *The American Journal of Pathology*, 53, 1041–1071.
- Gonçalves, J. M., & Vieira, L. G. (1950). Studies on Brazilian snake venoms. I – Electrophoretic analysis. *Anais da Academia Brasileira de Ciências*, 22, 141–150.
- Gonçalves, J. M. (1956). Studies on Brazilian snake venoms. II - *Crotalus terrificus crotaminicus*, subespécie biológica. *Anais da Academia Brasileira de Ciências*, 28, 365–367.
- Gutiérrez, J. M., & Cerdas, L. (1984). Mechanism of action of myotoxins isolated from poisons from snakes [Mechanism of action of myotoxins isolated from snake venoms]. *Revista de Biología Tropical*, 32, 213–222.
- Gutiérrez, J. M., León, G., Rojas, G., Lomonte, B., Rucavado, A., & Chaves, F. (1998). Neutralization of local tissue damage induced by *Bothrops asper* (terciopelo) snake venom. *Toxicon*, 36, 1529–1538.
- Gutiérrez, J. M., & Lomonte, B. (1995). Phospholipase A2 myotoxins from *Bothrops* snake venoms. *Toxicon*, 33, 1405–1424.
- Hampe, O. G., Vozári-Hampe, M. M., & Gonçalves, J. M. (1978). Crotamine conformation: effect of pH and temperature. *Toxicon*, 16, 453–460.
- Hörtnagel, H., & Hanin, I. (1992). Toxins affecting the cholinergic system. In H. Herken & F. Hucho (Eds.), *Selective neurotoxicity* (pp. 293–332). Berlin.
- Iglesias, C. V., Aparicio, R., Rodrigues-Simioni, L., Camargo, E. A., Antunes, E., Marangoni, S., de Oliveira Toyama, D., Beriam, L. O., Monteiro, H. S., & Toyama, M. H. (2005). Effects of morin on snake venom phospholipase A2 (PLA2). *Toxicon*, 46, 751–758.

- Kouyoumdjian, J. A., Harris, J. B., & Johnson, M. A. (1986). Muscle necrosis caused by the sub-units of crotoxin. *Toxicon*, 24, 575–583.
- Kruse, H., Van Wimersma Greidanus, T. B., & De Wied, D. (1977). Barrel rotation induced by vasopressin and related peptides in rats. *Pharmacology Biochemistry and Behavior*, 7, 311–313.
- Lago, L. A., Ferreira, P. M., Facury Filho, E. J., Melo, M. M., & Alzamora Filho, F. (2000). Clinical picture of experimental crotoal poisoning in cattle (*Crotalus durissus terrificus* - crotoamine positive). *Brazilian Journal of Veterinary Research and Animal Science*, 37, 312–315.
- Laure, C. J. (1975). Die primärstruktur des crotoamins [The primary structure of crotoamine (author's transl)]. *Hoppe-Seyler's Zeitschrift für Physiologische Chemie*, 356, 213–215.
- Lima, S. C., Porta, L. C., Lima, Á. D. C., Campeiro, J. D., Meurer, Y., Teixeira, N. B., Duarte, T., Oliveira, E. B., Picolo, G., Godinho, R. O., Silva, R. H., & Hayashi, M. A. F. (2018). Pharmacological characterization of crotoamine effects on mice hind limb paralysis employing both ex vivo and in vivo assays: Insights into the involvement of voltage-gated ion channels in the crotoamine action on skeletal muscles. *PLoS Neglected Tropical Diseases*, 12, Article e0006700.
- Lomonte, B., Angulo, Y., & Calderón, L. (2003). An overview of lysine-49 phospholipase A2 myotoxins from crotoalid snake venoms and their structural determinants of myotoxic action. *Toxicon*, 42, 885–901.
- Lourenço, A. Jr., Zorzella Creste, C. F., de Barros, L. C., Delazari dos Santos, L., Pimenta, D. C., Barraviera, B., & Ferreira, R. S. Jr. (2013). Individual venom profiling of *Crotalus durissus terrificus* specimens from a geographically limited region: crotoamine assessment and captivity evaluation on the biological activities. *Toxicon*, 69, 75–81.
- Melgarejo, A. R. (2009). Venomous snakes of Brazil. In J. L. C. Cardoso, S. F. O. França, F. H. Wen, C. M. S. Málaque, & V. Haddad Junior (Eds.), *Venomous animals in Brazil: Biology, clinic and therapeutics of poisoning* (pp. 61–62).
- Mebis, D., & Ownby, C. L. (1990). Myotoxic components of snake venoms: Their biochemical and biological activities. *Pharmacology & Therapeutics*, 48, 223–236.
- Montecucco, C., Gutiérrez, J. M., & Lomonte, B. (2008). Cellular pathology induced by snake venom phospholipase A2 myotoxins and neurotoxins: Common aspects of their mechanisms of action. *Cellular and Molecular Life Sciences*, 65, 2897–2912.
- Nepal, M. R., & Jeong, T. C. (2020). Alternative methods for testing botulinum toxin: Current status and future perspectives. *Biomolecules & Therapeutics*, 28, 302–310.
- Oguiura, N., Boni-Mitake, M., & Rádis-Baptista, G. (2005). New view on crotoamine, a small basic polypeptide myotoxin from South American rattlesnake venom. *Toxicon*, 46, 363–370.
- Oliveira, K. C. (2014). Biochemical and pharmacological characterization of crotoamine irradiated by gamma rays in co-60 [Tese de doutorado, Instituto de Pesquisas Energéticas e Nucleares - Universidade de São Paulo].

- Ownby, C. L., Aird, S. D., & Kaiser, I. I. (1988). Physiological and immunological properties of small myotoxins from the venom of the midget faded rattlesnake (*Crotalus viridis concolor*). *Toxicon*, 26, 319–323.
- Peigneur, S., Orts, D. J., Prieto da Silva, A. R., Oguiura, N., Boni-Mitake, M., de Oliveira, E. B., Zaharenko, A. J., de Freitas, J. C., & Tytgat, J. (2012). Crotoamine pharmacology revisited: Novel insights based on the inhibition of KV channels. *Molecular Pharmacology*, 82, 90–96.
- Pereira, A. (2011). Selective toxicity of crotoamine from *Crotalus durissus terrificus* venom on tumor-inducing cells [Tese de doutorado, Universidade de São Paulo].
- Pinho, F. M. O., & Pereira, I. D. (2001). Ophidism. *Revista da Associação Médica Brasileira*, 47, 24–29.
- Prado-Franceschi, J., & Brazil, O. V. (1981). Convulxin, a new toxin from the venom of the South American rattlesnake *Crotalus durissus terrificus*. *Toxicon*, 19, 875–887.
- PubChem. (n.d.). Crotoamin (CID 85470858). National Center for Biotechnology Information. <https://pubchem.ncbi.nlm.nih.gov/compound/Crotoamin#section=2D-Structure>
- Rodrigues, M., Santos, A., de la Torre, B. G., Rádis-Baptista, G., Andreu, D., & Santos, N. C. (2012). Molecular characterization of the interaction of crotoamine-derived nucleolar targeting peptides with lipid membranes. *Biochimica et Biophysica Acta*, 1818, 2707–2717.
- Rosenfeld, G. (1971). Symptomatology, pathology, treatment of snake bites in South America. In W. Bucherl & E. E. Buckley (Eds.), *Venomous animals and their venoms* (pp. 345–384). New York.
- Sampaio, S. C., Hyslop, S., Fontes, M. R., Prado-Franceschi, J., Zambelli, V. O., Magro, A. J., Brigatte, P., Gutierrez, V. P., & Cury, Y. (2010). Crotoxin: Novel activities for a classic beta-neurotoxin. *Toxicon*, 55, 1045–1060.
- Silvestrini, A. V. P., de Macedo, L. H., de Andrade, T. A. M., Mendes, M. F., Pigoso, A. A., & Mazzi, M. V. (2019). Intradermal application of crotoamine induces inflammatory and immunological changes in vivo. *Toxins*, 11, Article 39.
- Siqueira, A. M., Martins, N. F., De Lima, M. E., Diniz, C. R., Cartier, A., Brown, D., & Maigret, B. (2002). A proposed 3D structure for crotoamine based on homology building, molecular simulations and circular dichroism. *Journal of Molecular Graphics and Modelling*, 20, 389–398.
- Slotta, K. H., & Fraenkel-Conrat, H. (1938). Two active proteins from rattlesnake venom. *Nature*, 142, 213.
- Thakshila, P., Hodgson, W. C., Isbister, G. K., & Silva, A. (2022). In vitro neutralization of the myotoxicity of Australian mulga snake (*Pseudechis australis*) and Sri Lankan Russell's Viper (*Daboia russelii*) venoms by Australian and Indian polyvalent antivenoms. *Toxins*, 14, Article 302.
- Tasima, L. J., Silva, C. S., Hatakeyama, D. M., Nishiduka, E. S., Tashima, A. K., Sant'Anna, S. S., Grego, K. F., Zani, K. M., & Azevedo, A. M. T. (2020). Crotoamine in *Crotalus*

durissus: Distribution according to subspecies and geographic origin, in captivity or nature. *Journal of Venomous Animals and Toxins including Tropical Diseases*, 6, Article e20190053.

Teixeira-Araújo, R., Castanheira, P., Brazil-Más, L., Pontes, F., Leitão de Araújo, M., Machado Alves, M. L., Zingali, R. B., & Correa-Netto, C. (2017). Antivenomics as a tool to improve the neutralizing capacity of the crotalic antivenom: A study with crotamine. *Journal of Venomous Animals and Toxins including Tropical Diseases*, 12, 23–28.

Toyama, M. H., Marangoni, S., Novello, J. C., Leite, G. B., Prado-Franceschi, J., da Cruz-Höfling, M. A., & Rodrigues-Simioni, L. (2003). Biophysical, histopathological and pharmacological characterization of crotamine isoforms F22 and F32. *Toxicon*, 41, 493–500.

Vonk, F. J., Jackson, K., Doley, R., Madaras, F., Mirtschin, P. J., & Vidal, N. (2011). Snake venom: From fieldwork to the clinic: Recent insights into snake biology, together with new technology allowing high-throughput screening of venom, bring new hope for drug discovery. *BioEssays*, 33, 269–279.

World Health Organization. (2023). Snakebite envenoming. <https://www.who.int/news-room/fact-sheets/detail/snakebite-envenoming>

World Health Organization. (2018, August 19). WHO issues new recommendation on antivenom for snakebites. <https://www.who.int/news/item/19-08-2018-who-issues-new-recommendation-on-antivenom-for-snakebites>

Yamane, E. S., Bizerra, F. C., Oliveira, E. B., Moreira, J. T., Rajabi, M., Nunes, G. L., de Souza, A. O., da Silva, I. D., Yamane, T., Karpel, R. L., Silva, P. I. Jr., & Hayashi, M. A. (2013). Unraveling the antifungal activity of a South American rattlesnake toxin crotamine. *Biochimie*, 95, 231–240.

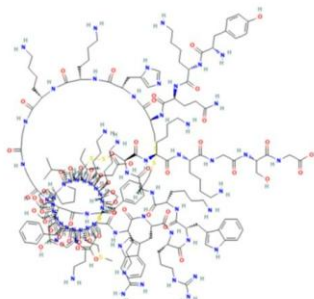
Zanetti, G., Negro, S., Pirazzini, M., & Caccin, P. (2018). Mouse phrenic nerve hemidiaphragm assay (MPN). *Bio-protocol*, 8, Article e2759.

Slotta, K. H., & Fraenkel-Conrat, H. (1938). Chemical studies on snake venoms. Purification and crystallization of rattlesnake venom. *Nature*, 142, 213.

APPENDIX

Figure 1

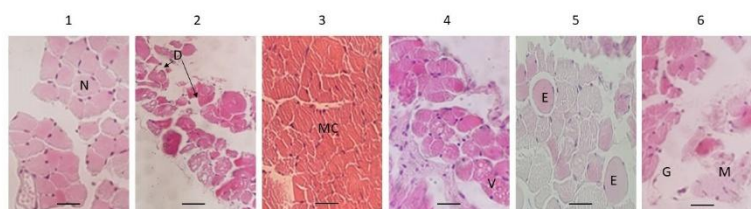
2D representation of the chemical structure of crotamine (MW = 4,884)



Source: (PubChem (<https://pubchem.ncbi.nlm.nih.gov/compound/Crotamin#section=2D-Structure>))

Figure 2

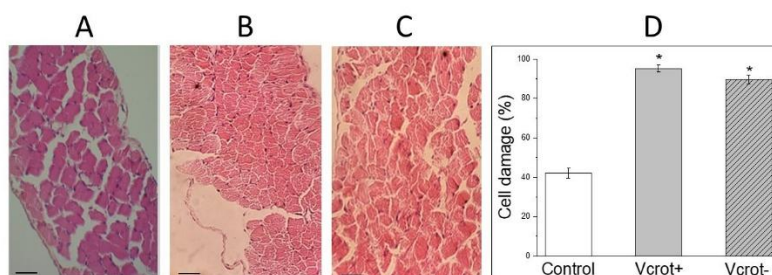
The score is used to quantify the cell morphology. (1) N, normal cell. (2) D, delta lesion. (3) MC, myofibril condensation. (4) V, vacuoles. (5) E, edema. (6) M, myonecrosis. G, ghost cells.



Source: Elaborated by the author.

Figure 3

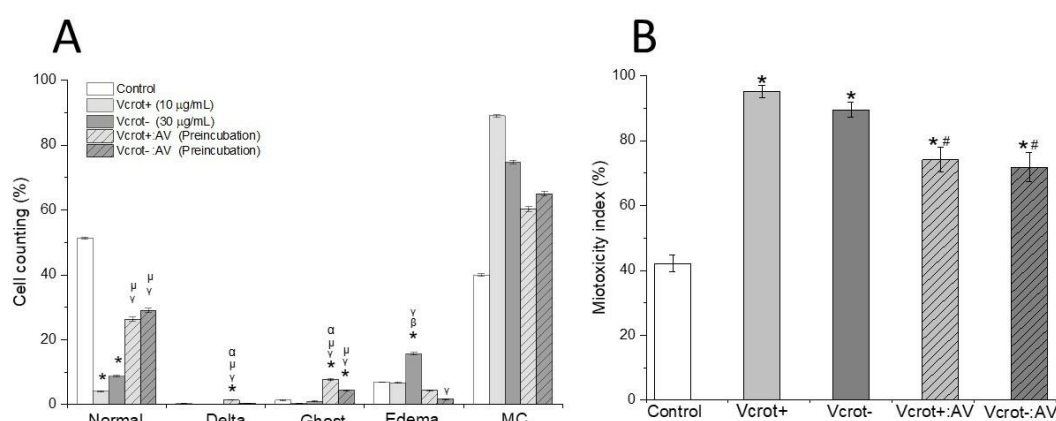
Cell damage. **A**, control, showing N, normal cells with polygonal aspect, peripheral nuclei, and organized fiber bundles. **B**, Vcrot+, showing MC, myofibril condensation; V, vacuoles, and ghost cells. **C**, Vcrot-, showing MC; M, myonecrosis. **D**, quantitative comparison between control and *Crotalus durissus terrificus* venom with crostamine (Vcrot+, 10 µg/mL) and without crostamine (Vcrot-, 30 µg/mL)



Source: Elaborated by the author.

Figure 4

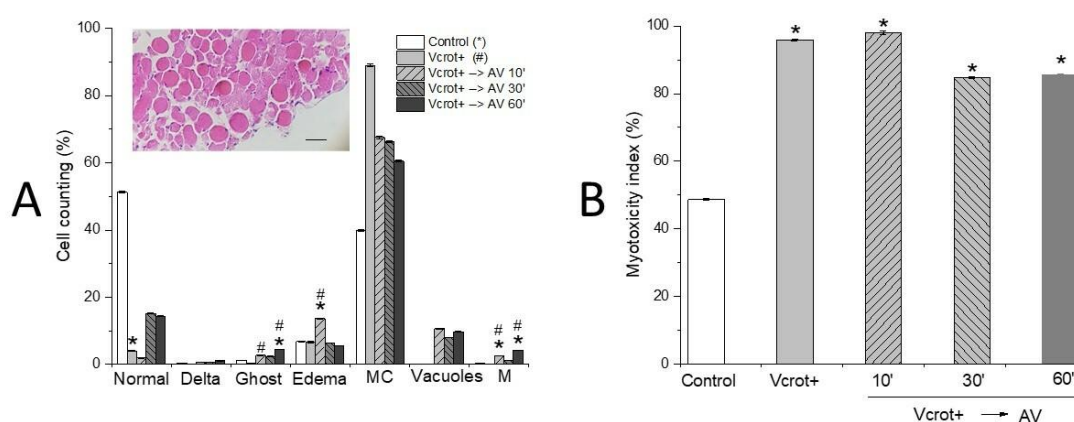
*Preincubation model. (A), quantitative analysis by score (normal, delta lesions, ghost cells, edema and myofibril condensation, MC). It is possible to verify the major content of normal cells when preparations were treated with antivenom (Vcrot+:AV and Vcrot-:AV). Antivenom failed against delta lesions induced by Vcrot+, and ghost cells induced by both venoms, but did protect against edema formation of both venoms. However, the number of myofibrils hypercontracted did remain high. Crotalus durissus terrificus venom with (Vcrot+) and without (Vcrot-) crostamine. AV, antivenom. *, $p < 0.05$ compared to control. α , $p < 0.05$ compared to Vcrot-:AV. γ , $p < 0.05$ compared to Vcrot+. μ , $p < 0.05$ compared to Vcrot-. β , $p < 0.05$ compared to Vcrot+:AV. (B), Mitotoxicity index of treated groups. The preincubation model showed a significant decrease in total cell damage. *, $p < 0.05$ compared to control. #, $p < 0.05$ compared with the respective Vcrot+ or Vcrot-*



Source: Elaborated by the author.

Figure 5

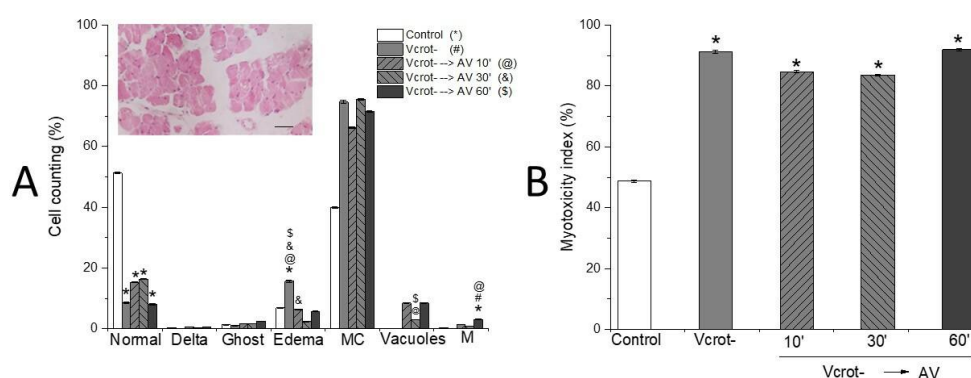
*Post-venom model. A, quantitative analysis by score (normal; delta lesions; ghost cells; edema; myofibril condensation, MC; vacuoles, and myonecrosis, M). Antivenom was added after 10, 30 and 60 min. Inserted photography stained with HE, showing the early edema induction induced by Vcrot+, in which antivenom was added after 10 min. Bar: 1 cm = 40 μ m. B, myotoxicity index showing no protection of antivenom when added after the venom. *Crotalus durissus terrificus* venom with crotamine (Vcrot+). AV, antivenom. *, $p < 0.05$ compared to control. #, $p < 0.05$ compared to Vcrot+*



Source: Elaborated by the author.

Figure 6

*Post-venom model. A, quantitative analysis by score (normal; delta lesions; ghost cells; edema; myofibril condensation, MC; vacuoles, and myonecrosis, M). Antivenom was added after 10, 30 and 60 min. Inserted photography stained with HE shows a decreased edema formation induced by Vcrot-, in which antivenom was added after 10 min. Bar: 1 cm = 40 μ m. B, myotoxicity index showing no protection of antivenom when added after the venom. *Crotalus durissus terrificus* venom without crotamine (Vcrot-). AV, antivenom. *, $p < 0.05$ compared to control. #, $p < 0.05$ compared to Vcrot-*



Source: Elaborated by the author.

THE DEVELOPMENT OF THE PROFESSIONAL IDENTITY OF MATHEMATICS TEACHERS IN THE CONTEXT OF DIGITAL CULTURE

O DESENVOLVIMENTO DA IDENTIDADE PROFISSIONAL DE PROFESSORES DE MATEMÁTICA NO CONTEXTO DA CULTURA DIGITAL

EL DESARROLLO DE LA IDENTIDAD PROFESIONAL DE LOS PROFESORES DE MATEMÁTICA EN EL CONTEXTO DE LA CULTURA DIGITAL



<https://doi.org/10.56238/sevened2026.008-170>

André Gomes dos Santos¹, Heraldo Márcio de Aguiar², Juliano Schimiguel³

ABSTRACT

This article investigates the process of professional identity development among mathematics teachers in contemporary times, marked by the growing influence of digital culture. It analyzes how the integration of digital technologies into mathematics teaching and learning impacts how these professionals perceive themselves, act, and construct their pedagogical identity. The research explores the tensions, challenges, and opportunities that emerge from this relationship between the teaching profession and the digital context, considering changes in teaching practices, interactions with students, and the perception of one's own role as a mathematics educator. Based on a comprehensive literature review and practical examples, the implications for initial and continuing education for mathematics teachers are discussed, aiming to strengthen resilient professional identities adapted to the challenges of the 21st century.

Keywords: Teacher Professional Identity. Mathematics Teaching. Digital Culture. Digital Technologies. Teacher Education.

RESUMO

O artigo investiga o processo de desenvolvimento da identidade profissional de professores de matemática na contemporaneidade, marcada pela crescente influência da cultura digital. Foi analisado como a integração de tecnologias digitais no ensino e na aprendizagem da matemática impacta a forma como esses profissionais se percebem, atuam e constroem sua identidade pedagógica. A pesquisa explora as tensões, os desafios e as oportunidades que emergem dessa relação entre a profissão docente e o contexto digital, considerando as mudanças nas práticas de ensino, nas interações com os alunos e na percepção do próprio papel como educador matemático. A partir de uma revisão bibliográfica abrangente e de exemplos práticos, foram discutidas as implicações para a formação inicial e continuada de

¹ Doctoral student in Science and Mathematics Education. Universidade Cruzeiro do Sul (UNICSUL). E-mail: andre.gomes.santos.77@gmail.com Orcid: <https://orcid.org/0000-0003-2124-6520>

² Doctoral student in Science and Mathematics Education. Universidade Cruzeiro do Sul (UNICSUL). E-mail: heraldo.aguiar@gmail.com Orcid: <https://orcid.org/0000-0002-7481-6008>

³ Dr. in Computer Science. Universidade Estadual de Campinas (UNICAMP). E-mail: schimiguel@gmail.com Orcid: <https://orcid.org/0000-0001-8552-7984>

professores de matemática, visando o fortalecimento de identidades profissionais resilientes e adaptadas aos desafios do século XXI.

Palavras-chave: Identidade Profissional Docente. Ensino de Matemática. Cultura Digital. Tecnologias Digitais. Formação de Professores.

RESUMEN

Este artículo investiga el proceso de desarrollo de la identidad profesional del profesorado de matemáticas en la actualidad, marcado por la creciente influencia de la cultura digital. Analiza cómo la integración de las tecnologías digitales en la enseñanza y el aprendizaje de las matemáticas impacta en la percepción, la actuación y la construcción de la identidad pedagógica de estos profesionales. La investigación explora las tensiones, los desafíos y las oportunidades que surgen de esta relación entre la profesión docente y el contexto digital, considerando los cambios en las prácticas docentes, las interacciones con el alumnado y la percepción del propio rol como educador matemático. A partir de una exhaustiva revisión bibliográfica y ejemplos prácticos, se discuten las implicaciones para la formación inicial y continua del profesorado de matemáticas, con el objetivo de fortalecer identidades profesionales resilientes y adaptadas a los retos del siglo XXI.

Palabras clave: Identidad Profesional Docente. Enseñanza de las Matemáticas. Cultura Digital. Tecnologías Digitales. Formación del Profesorado.

1 INTRODUCTION

Contemporary society is experiencing a paradigmatic transformation driven by digital culture. The proliferation of information and communication technologies (ICTs) and the ubiquity of the internet have not only altered the forms of social interaction and access to information, but have also profoundly reconfigured the educational landscape (Castells, 1999). In the specific context of mathematics teaching, a fundamental discipline for the development of logical reasoning and problem-solving skills, digital culture presents itself as a catalyst for new pedagogical approaches and a challenge for the professional identity of teachers (Sacristán, 2013).

Historically, the identity of the mathematics teacher has been shaped by a tradition of logical rigor, formalism, and the transmission of specific content. However, the integration of digital tools in the teaching of this discipline requires teachers to adopt a new attitude, which goes beyond the mastery of the mathematical content itself, also encompassing the competence to effectively use and integrate technologies in their pedagogical practices (Gutiérrez, 2017). This need to adapt and develop new skills directly impacts the way teachers perceive themselves as professionals, their pedagogical values and their beliefs about the teaching and learning of mathematics (Sfard & Prusak, 2005).

The professional identity of teachers, conceived as a narrative construct and in constant evolution (Dubar, 2005), is influenced by multiple factors, including individual experiences, academic training, interactions with colleagues and students, and the social and cultural context in which the teacher exercises his profession (Day et al., 2006). In the scenario of digital culture, this identity is confronted with new demands and possibilities. Mathematics teachers need not only to master technologies, but also to understand their potential to enrich the teaching and learning process, promote the visualization of abstract concepts, stimulate collaboration among students, and offer personalized feedback (Oliveira & Ponte, 2013).

This article aims to investigate the development of the professional identity of mathematics teachers in the context of digital culture. It seeks to understand how the growing influence of digital technologies impacts the construction and reconstruction of the pedagogical identity of these professionals. The analysis will consider the tensions between traditional practices and new digital approaches, the challenges faced by teachers in incorporating these technologies, the opportunities that open up for pedagogical innovation, and the implications for teacher training. It is believed that an in-depth understanding of this process is essential to support mathematics teachers in building strong, adaptable professional identities that are aligned with the demands of education in the twenty-first

century (Fullan, 2007).

The teaching profession, historically characterized by the transmission of knowledge and the mediation between knowledge and the student, has undergone significant transformations in recent decades. The rise of digital culture, with the proliferation of technologies and the ubiquity of the internet, imposes new challenges and opportunities for educators, especially for those who work in mathematics teaching. This field, often perceived as abstract and complex, can be profoundly affected by the incorporation of digital resources that enable new forms of visualization, interaction and problem solving (Borba & Villarreal, 2005).

In this context, the professional identity of the mathematics teacher, understood as a dynamic and multifaceted construct that encompasses beliefs, values, knowledge and experiences that shape their pedagogical practice (Beijaard, Meijer & Verloop, 2004), becomes a central theme of investigation. How do mathematics teachers build and rebuild their professional identities in a scenario where digital technologies reconfigure teaching and learning relationships? What are the impacts of digital culture on your conceptions of what it means to be a competent and engaged math teacher?

This article aims to explore these questions by investigating the development of the professional identity of mathematics teachers in the context of digital culture. This paper seeks to analyze how the integration of digital technologies influences the way these professionals perceive themselves, act and build their pedagogical identity, considering the tensions, challenges and opportunities that emerge from this relationship. It is believed that understanding this process is fundamental for the initial and continuing education of mathematics teachers, in order to strengthen resilient professional identities adapted to the challenges of the twenty-first century (Mishra & Koehler, 2006).

2 THEORETICAL FRAMEWORK

2.1 THE PROFESSIONAL IDENTITY OF TEACHERS: THEORETICAL CONCEPTIONS AND DIMENSIONS

Teaching, more than a mere occupation, is a complex and multifaceted profession, whose essence is shaped at the intersection between technical knowledge, human relations and the social context. At the heart of this complexity lies the professional identity of teachers, a dynamic and fundamental construct for understanding educational practice. A teacher's identity is not limited to their degree or job title, but is an ongoing and evolving process. As Kelchtermans (2009, p. 99) states, "the professional identity of teachers is not a static entity, but rather a continuous process of construction and reconstruction, influenced by individual

experiences, social interactions and the context in which the teacher works". This quote serves as a starting point for exploring the theoretical conceptions and dimensions that shape this concept.

2.2 THEORETICAL CONCEPTIONS AND MODELS OF PROFESSIONAL IDENTITY

To understand the professional identity of the teacher, it is essential to resort to theoretical frameworks that contextualize it. Two authors, Gee (2000) and Wenger (1998), offer valuable perspectives for this analysis. Gee (2000) approaches identity from the notion of "discourses", which are "ways of being" in the world, permeated by habits, values, beliefs and practices. He distinguishes between the "natural" identity (the one we are born with), the "institutional" (the one assigned to us by an institution), the "discursive" identity (the one we build through social interaction), and the "affiliative" identity (the one we acquire by joining groups). For the professor, professional identity is a confluence of these different forms. The institutional identity is that of "teacher" assigned by the school; the discursive is the one that is negotiated and manifested in the teachers' rooms and in interactions with students; and affiliation is built on participation in study groups or unions.

Wenger's (1998) perspective is equally crucial, focusing on Communities of Practice (CoPs). According to him, identity is built on social participation, in a process of negotiation of meaning within a community. A teacher's identity, therefore, is not an individual attribute, but is negotiated and validated in interactions with other teachers, managers, students, and parents. The CoP of the classroom, the mathematics department, or the school as a whole, are the scenarios where the teacher negotiates his identity through "participation" and "reification" (transforming experiences into concrete objects and concepts). Identity is the bridge between individual experience and collective participation, and it is manifested in the way teachers perceive themselves and are perceived within their professional community.

2.3 DIMENSIONS OF TEACHER IDENTITY IN MATHEMATICS TEACHING

The teacher's professional identity is composed of several interconnected dimensions that are manifested in a particular way in the teaching of each subject. In the context of mathematics teaching, these dimensions gain specific and determining contours for pedagogical practice.

One of the most important dimensions is beliefs about the teaching and learning of mathematics. A math teacher's identity is profoundly influenced by their own beliefs about what math is. Does he see it as a set of rigid rules to be memorized, or as a creative, problem-solving, and investigative science? These beliefs directly shape his approach in the

classroom, from the type of exercises he proposes to the way he deals with students' mistakes. A teacher who believes that mathematics is accessible to everyone and that error is a learning opportunity will have a very different professional identity from one who sees it as a subject for the few.

Another essential dimension is pedagogical content knowledge (PCK), a concept developed by Shulman. The PCK goes beyond mere knowledge of mathematics (content) and general knowledge about pedagogy. It refers to the knowledge of how to teach mathematics effectively, including understanding students' difficulties and misconceptions, selecting appropriate analogies and examples, and utilizing multiple representations. In mathematics teaching, PCK is crucial for the teacher to not only know "what" but also "how" to teach a concept. A robust professional identity in mathematics presupposes a solid PCK, which allows the teacher to adapt their teaching to the needs of the students and promote meaningful learning.

The teacher's sense of self-efficacy is also a central dimension. It is the teacher's belief in his or her own ability to successfully perform a certain teaching task. In mathematics teaching, a teacher with a high sense of self-efficacy believes that they can teach complex concepts clearly, motivate students who have difficulties, and manage the classroom effectively. This sense of self-efficacy not only increases their engagement and persistence in the face of challenges, but also directly contributes to a more secure and resilient professional identity. On the other hand, a low sense of self-efficacy can lead to avoidance of more difficult topics or a more rigid and less flexible pedagogical approach.

Finally, the relationship with the professional community is a dimension that feeds back all the others. The identity of a mathematics teacher is constructed and validated through interactions with their peers. Participation in discussions about new teaching methods, the sharing of materials, and collaboration in solving pedagogical problems contribute to the construction of a collective and individual identity. The CoP of the mathematics department, for example, is a vital space where professors negotiate practices, share successes and failures, and strengthen or question their own professional identities. The exchange of experiences and the mutual support offered by this community are crucial for continuous professional development.

The professional identity of teachers is a complex, dynamic and socially constructed fabric, which encompasses beliefs, knowledge and interactions. In the context of mathematics teaching, it manifests itself in pedagogical choices, confidence in one's own ability, and affiliation with a community of practice. Far from being a static definition, teacher identity is a constantly evolving project, shaped by experience and dialogue, and which

profoundly impacts the quality of education offered.

2.4 DIGITAL CULTURE AND ITS IMPACTS ON MATHEMATICS EDUCATION

The turn of the twenty-first century marks an era of profound social transformation, driven by the rise of digital culture. This phenomenon, which transcends the mere adoption of new technologies, has reconfigured the way we communicate, access information, and, inevitably, how we learn.

The school, as a central institution in the transmission of knowledge, is faced with the challenge and the opportunity to reinvent itself in this new scenario. As Lévy (1999, p. 17) summarizes, "digital culture is not just a tool, but a new learning ecosystem that demands new skills and a new attitude towards knowledge from teachers". This new stance is especially crucial in the field of mathematics education, where traditional approaches often clash with the dynamics and possibilities of the digital world.

2.5 DIGITAL CULTURE AS A NEW LEARNING ECOSYSTEM

Digital culture is characterized by a series of attributes that redefine the teaching and learning process. Access to information, which was previously centralized in books and libraries, has become instantaneous and ubiquitous. With a simple click, students and teachers can access a universe of data, theories and examples.

In addition, network communication has transformed learning from an isolated process into an intrinsically social activity. Interactions in forums, online study groups, and collaborative platforms allow knowledge to be built horizontally, breaking with the vertical structure of the traditional model.

The collaborative production of knowledge is perhaps one of the most revolutionary features of digital culture. Tools such as wikis, shared documents, and virtual learning environments allow students and teachers to co-create, review, and enhance content in real time. This approach values everyone's contribution and promotes more active and engaging learning. The emergence of new ways of learning and teaching requires education to adapt, abandoning the idea that the teacher is the sole holder of knowledge and assuming the role of mediator, guide in a vast and constantly changing ecosystem.

2.6 IMPACTS ON MATHEMATICS EDUCATION: FROM PENCIL AND PAPER TO CANVAS

The impacts of digital culture on mathematics education are particularly remarkable and transformative. The discipline, often perceived as abstract and distant, gains new dimensions and possibilities with the help of technology. The use of dynamic geometry

software, such as GeoGebra, for example, allows students to manipulate geometric figures, observe properties and relationships interactively, and understand concepts in a more concrete way. Movement and dynamic visualization replace the staticness of drawing on the chalkboard, making learning more intuitive and investigative.

In addition to software, the emergence of applications and online platforms has transformed the practice of exercises and evaluation. Resources like Khan Academy offer personalized learning paths, allowing each student to advance at their own pace and receive immediate feedback. Gamification, often present in these apps, adds a playful element that can increase student motivation and engagement. Other multimedia resources, such as animated videos and simulations, are powerful tools for making abstract mathematical concepts, such as functions or calculus, more accessible and understandable.

These innovations require a new posture from the mathematics teacher.

Instead of being limited to solving equations on the board, he becomes a curator of digital content, a designer of learning experiences, and a facilitator who guides students in exploring these tools. Technology, in this context, is not an end in itself, but a means to promote reasoning, problem-solving, and critical thinking. The error, previously seen as a failure, can be exploited through simulations and instant feedback, becoming a valuable learning opportunity. Mathematics education, in the digital age, is no longer a mere training of algorithms to become a space for investigation and discovery.

Digital culture represents a turning point in mathematics education. Its characteristics — access to information, network communication and collaborative production — force a reevaluation of pedagogical practices. The integration of software, applications and multimedia resources is not a luxury, but a necessity to prepare students for a world that demands new skills. The challenge lies in how teachers, immersed in this new ecosystem, build a pedagogical practice that uses technology to promote more meaningful, relevant, and connected mathematical learning with the students' reality.

2.7 THE INTEGRATION OF DIGITAL TECHNOLOGIES IN MATHEMATICS TEACHING: CHALLENGES AND OPPORTUNITIES FOR PROFESSIONAL IDENTITY

Digital culture, by redefining society and education, imposes a new set of demands on teachers, especially in the field of mathematics. The mere existence of digital tools does not guarantee their effective integration into pedagogical practice. Rather, this integration implies a profound reconfiguration of the way educators conceive of their role, their knowledge, and their practice. As Drijvers (2019, p. 25) suggests, "the true integration of technology in education is not limited to the replacement of analog tools with digital ones, but implies a

transformation in the way teachers and students think and do mathematics." This transformation not only shapes student learning, but also challenges and enriches teachers' professional identity.

2.8 CHALLENGES AND OPPORTUNITIES IN DIGITAL INTEGRATION

The integration of digital technologies in mathematics teaching brings with it a series of challenges that need to be faced. The most evident is the need to develop new digital skills. Many teachers, trained in an analog environment, need to become familiar with the handling of software, applications, and online platforms, which can generate insecurity and resistance to change. In addition, classroom management becomes more complex in technological environments, where students' focus and attention can be dispersed. Learning assessment also requires new approaches, as digital tools offer different ways of demonstrating knowledge, which go beyond manual calculation and the traditional written test.

At the same time, this transition opens up a universe of opportunities. Access to innovative teaching resources is vast and allows teachers to enrich their classes with interactive simulations, videos and educational games. Technology enables the personalization of teaching, allowing each student to advance at their own pace and receive immediate, individualized feedback. New forms of interaction with students, through discussion forums or collaborative projects, strengthen the bond and make learning more participatory. Expanding the repertoire of pedagogical strategies is one of the greatest opportunities, as the teacher can use technology to create an environment of inquiry, where mathematics is explored in a more experimental and creative way.

2.9 CASE STUDIES AND EXAMPLES OF INNOVATIVE PRACTICES

Math teachers around the world are at the forefront of digital integration, with examples illustrating the challenges overcome and opportunities seized. The use of GeoGebra, for example, has transformed the way geometry is taught. Instead of just presenting theorems, the teacher can guide students in constructing dynamic figures, allowing them to observe how properties change in real time. This experimental approach strengthens conceptual understanding and broadens the professional identity of the teacher, who starts to see himself more as a facilitator than as a transmitter of knowledge.

Another example is Scratch, a block programming platform, which has been used to teach logic and mathematical concepts. Teachers who adopt this tool enable their students to create games or animations, where concepts such as coordinates, variables, and mathematical operations are applied in a practical and playful way. This experience not only

engages students, but also shapes the identity of the teacher, who discovers a new potential for mathematics: that of being a creative and expressive tool. Similarly, platforms such as Khan Academy have been used to complement teaching, freeing up class time for more in-depth discussions and complex problem-solving, a reflection of a teaching identity that values reflection on content, rather than simple repetition.

2.10 IMPLICATIONS FOR THE INITIAL AND CONTINUING EDUCATION OF MATHEMATICS TEACHERS

The experience of digital integration and its impact on the teacher's professional identity have direct implications for teacher education. Initial and continuing education must go beyond technical training. As Koehler & Mishra (2009, p. 63) emphasize, "teacher training for the digital age must go beyond technical training in the use of tools, focusing on the development of a critical and reflective stance on the pedagogical potential of technologies." It is crucial that curricula prepare future teachers to develop digital skills in a contextualized way, not as an end, but as a means to achieve pedagogical goals.

It is essential that the training promotes reflection on the role of technology in mathematics learning and creates opportunities for experimentation and the exchange of experiences with other teachers. By connecting in communities of practice, teachers can negotiate new meanings for their profession and build identities that are more flexible, adaptable, and engaged with the infinite possibilities of digital culture. The ultimate goal is to train a professional who, in addition to mastering the content, is able to use technology strategically to inspire mathematical thinking in their students.

3 METHODOLOGY

The methodology of an article outlines the procedures employed to conduct the research, including the type of study, sample selection, methods of data collection and analysis, ethical considerations, and limitations of the study. Its detailed and transparent description is essential to ensure the replicability and reliability of the results, in addition to providing a solid basis for the interpretation and generalization of the findings.

4 RESULTS AND DISCUSSIONS

Research on the development of the professional identity of mathematics teachers in the context of digital culture reveals the complexity and dynamism of this process. The integration of digital technologies in the teaching and learning of mathematics is a significant factor that influences the way these professionals build their pedagogical identities. The

challenges related to developing new skills and adapting to new ways of teaching and learning coexist with opportunities to innovate, personalize teaching, and increase student engagement.

In this scenario, the initial and continuing education of mathematics teachers plays a crucial role. It is essential that training programmes provide future and current teachers with the tools, knowledge and opportunities for reflection necessary to develop resilient professional identities adapted to the challenges and potentialities of digital culture. This implies not only the technical mastery of technologies, but also the understanding of their pedagogical potential and the ability to integrate them in a meaningful way into their teaching practices (Cuban, 1986).

In short, the development of the professional identity of mathematics teachers in the digital age is a continuous process of learning, adaptation, and reflection. By recognizing the influences of digital culture and investing in the training of teachers capable of integrating technologies in a critical and creative way, we will be able to strengthen the teaching profession and promote a more relevant and engaging mathematics education for students in the 21st century.

ACKNOWLEDGMENTS

The present work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel – CAPES through the PROSUP Scholarship - Support Program for Graduate Studies of Higher Education Institutions, as well as I thank the Cruzeiro do Sul University – UNICSUL, our advisor Prof. Dr. Juliano Schimiguel for the teachings and the research group in the area of Computational Technology for the Teaching of Science and Mathematics for their partnership.

REFERENCES

- Beijaard, D., Meijer, P. C., & Verloop, N. (2004). Reconsidering research on teachers' professional identity. *Teaching and Teacher Education*, 20(2), 107–128.
- Borba, M. de C., & Villarreal, M. (2005). *Humans-with-media and the reorganization of mathematical thinking: Information and communication technologies, modeling, experimentation and visualization*. Springer Science & Business Media.
- Castells, M. (1999). *Sociedade em rede*. Paz e Terra.
- Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920*. Teachers College Press.

- Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.
- Day, C., Flores, M. A., Haddad, S., Ko, L., & Leite, M. S. (2006). Exploring the professional identities of teachers: A review of the international literature on teacher identity. *Research Gate*.
- Drijvers, P. (2019). Technology in mathematics education: A bridge between teaching and learning. In *Mathematics education: Yesterday, today and tomorrow* (pp. 15–35). Springer.
- Dubar, C. (2005). *A crise das identidades: A interpretação de uma mutação*. Zahar.
- Gee, J. P. (2000). Identity as an analytic lens for research in education. *Review of Research in Education*, 25, 99–125.
- Gutiérrez, K. D. (2017). Situated learning in a digital world: Building bridges between formal and informal learning contexts. *Learning, Culture and Social Interaction*, 12, 1–10.
- Kelchtermans, G. (2009). Who I am in how I teach is key: Teacher professional identity and workplace learning. In *Connecting professional development, identities and student learning* (pp. 22–48). Springer.
- Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70.
- Lévy, P. (1999). *Cibercultura*. Editora 34.
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054.
- Prensky, M. (2001). Digital natives, digital immigrants Part 1. *On the Horizon*, 9(5), 1–6.
- Sacristán, J. G. (2013). ¿Qué significa la profesionalización docente?: Miradas y perspectivas. *Revista Brasileira de Estudos Pedagógicos*, 94(236), 679–696.
- Sfard, A., & Prusak, A. (2005). Telling identities: In search of narrative tools for investigating learning. *Educational Researcher*, 34(4), 14–22.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4–14.
- Valente, J. A. (2018). *A espiral da cibercultura e suas metáforas*. Cortez Editora.
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.

RESILIENCE IN NURSING STUDENTS: PSYCHOSOCIAL CHALLENGES AND STRENGTHENING STRATEGIES IN THE UNIVERSITY CONTEXT

RESILIÊNCIA EM ESTUDANTES DE ENFERMAGEM: DESAFIOS PSICOSSOCIAIS E ESTRATÉGIAS DE FORTALECIMENTO NO CONTEXTO UNIVERSITÁRIO

RESILIENCIA EN ESTUDIANTES DE ENFERMERÍA: DESAFÍOS PSICOSOCIALES Y ESTRATEGIAS DE FORTALECIMIENTO EN EL CONTEXTO UNIVERSITARIO



<https://doi.org/10.56238/sevened2026.008-171>

Ana Maria Rita Pedroso Vilela Torres de Carvalho Engel¹, Stela Regina Pedroso Vilela Torres de Carvalho², Diego Mariozi Ferreira³, Flávia Cristina Custódio⁴, João Daniel de Souza Menezes⁵, Matheus Querino da Silva⁶, Andressa Karina Stefani⁷, Camila Aline Lázaro⁸, William Donegá Martinez⁹, Loiane Letícia dos Santos¹⁰, Vânia Maria Sabadoto Brienze¹¹, Júlio Cesar André¹²

ABSTRACT

Nursing education is a challenging journey, demanding from students not only technical knowledge but also psychosocial robustness. This chapter explores the levels of resilience and their determinants in incoming nursing students at a higher education institution, aiming to understand how sociodemographic factors and the various dimensions of resilience are interconnected. An observational, cross-sectional, and quantitative study was conducted with

¹ Master student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: ana.engel@edu.famerp.br

² Master student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: stela.carvalho@edu.famerp.br

³ Master student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: diego.mariozi@hotmail.com

⁴ Master student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: fccustodio@funecsantafe.edu.br

⁵ Doctoral student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: joao.menezes@edu.famerp.br

⁶ Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: matheus.querino@edu.famerp.br

⁷ Master's degree. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: andressastefani@yahoo.com.br

⁸ Master's degree. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: camilaalazaro@gmail.com

⁹ Doctoral student. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: william.martinez@edu.famerp.br

¹⁰ Professor. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: loiane.psicologia@gmail.com

¹¹ Professor. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: vania.brienze@hospitaldebase.com.br

¹² Professor. Centro de Estudos e Desenvolvimento de Educação em Saúde (CEDES). Faculdade de Medicina de São José do Rio Preto (FAMERP). Brazil. E-mail: julio.andre@edu.famerp.br

104 academics, utilizing a Sociodemographic Variables Questionnaire and the Wagnild and Young Resilience Scale. The results indicated that most students exhibit moderate resilience; however, a significant portion demonstrated reduced levels. Gender identity and employment status were identified as sociodemographic variables significantly associated with resilience. While personal competence and self-acceptance emerged as strengths, independence, determination, self-confidence, and adaptability were areas requiring further development. These findings underscore the need for personalized psychosocial support programs, focused on strengthening resilience and addressing students' specific needs, thereby contributing to the training of professionals better equipped to face the complexities of healthcare practice.

Keywords: Resilience. Nursing Students. Mental Health. Sociodemographic Factors. Higher Education.

RESUMO

A formação em Enfermagem é uma jornada desafiadora, exigindo dos estudantes não apenas conhecimentos técnicos, mas também robustez psicossocial. Este capítulo explora os níveis de resiliência e seus determinantes em estudantes ingressantes de Enfermagem em uma instituição de ensino superior, com o objetivo de compreender como fatores sociodemográficos e as diferentes dimensões da resiliência se inter-relacionam. Foi realizado um estudo observacional, transversal e quantitativo com 104 acadêmicos, utilizando um Questionário de Variáveis Sociodemográficas e a Escala de Resiliência de Wagnild e Young. Os resultados indicaram que a maioria dos estudantes apresenta níveis moderados de resiliência; no entanto, uma parcela significativa demonstrou níveis reduzidos. A identidade de gênero e a situação de trabalho foram identificadas como variáveis sociodemográficas significativamente associadas à resiliência. Enquanto a competência pessoal e a autoaceitação emergiram como pontos fortes, independência, determinação, autoconfiança e adaptabilidade foram identificadas como áreas que necessitam de maior desenvolvimento. Esses achados evidenciam a necessidade de programas personalizados de apoio psicossocial, voltados ao fortalecimento da resiliência e ao atendimento das necessidades específicas dos estudantes, contribuindo, assim, para a formação de profissionais mais preparados para enfrentar as complexidades da prática em saúde.

Palavras-chave: Resiliência. Estudantes de Enfermagem. Saúde Mental. Fatores Sociodemográficos. Ensino Superior.

RESUMEN

La formación en Enfermería es un proceso desafiante que exige de los estudiantes no solo conocimientos técnicos, sino también solidez psicossocial. Este capítulo explora los niveles de resiliencia y sus determinantes en estudiantes de Enfermería de primer ingreso en una institución de educación superior, con el objetivo de comprender cómo se interrelacionan los factores sociodemográficos y las distintas dimensiones de la resiliencia. Se realizó un estudio observacional, transversal y cuantitativo con 104 estudiantes, utilizando un Cuestionario de Variables Sociodemográficas y la Escala de Resiliencia de Wagnild y Young. Los resultados indicaron que la mayoría de los estudiantes presenta niveles moderados de resiliencia; sin embargo, una proporción significativa mostró niveles reducidos. La identidad de género y la situación laboral fueron identificadas como variables sociodemográficas significativamente asociadas con la resiliencia. Mientras que la competencia personal y la autoaceptación surgieron como fortalezas, la independencia, la determinación, la autoconfianza y la adaptabilidad se identificaron como áreas que requieren mayor desarrollo. Estos hallazgos evidencian la necesidad de programas personalizados de apoyo psicossocial orientados al fortalecimiento de la resiliencia y a la atención de las necesidades específicas de los estudiantes, contribuyendo así a la formación de profesionales mejor preparados para

enfrentar las complejidades de la práctica sanitaria.

Palabras clave: Resiliencia. Estudiantes de Enfermería. Salud Mental. Factores Sociodemográficos. Educación Superior.

1 INTRODUCTION

Nursing, one of the most essential and multifaceted professions in healthcare, demands from its practitioners not only profound technical-scientific knowledge but also a unique capacity for psychosocial adaptation in the face of constantly changing and often challenging scenarios. The academic journey that culminates in the training of these professionals is, in itself, a microcosm of these demands, immersing students in an environment of intense learning, emotional pressures, and early confrontation with delicate human realities (Liu et al., 2025; Litwic-Kaminska et al., 2023). This chapter aims to deepen the understanding of resilience levels in incoming nursing students, exploring the intricate relationship between their sociodemographic characteristics and their ability to adapt and thrive in a demanding university environment.

The transition to higher education marks a period of significant restructuring in individuals' lives. Far from being merely a stage of knowledge acquisition, it is a time of personal and professional development, where high expectations, new responsibilities, and immersion in a rigorous academic context can test the limits of adaptive capacity (Merino-Godoy et al., 2022). For students in the health field, particularly nursing, these challenges are amplified. The exhaustive workload, the need to assimilate a vast volume of information, the complexity of practical skills to be mastered, and, above all, exposure to situations of suffering, illness, death, and ethical dilemmas in clinical internship settings, generate a unique set of stressors (Ríos-Risquez et al., 2018; Beauvais et al., 2014).

In this context, the mental health of university students has emerged as a pressing global concern. Research indicates a growing prevalence of mental disorders, such as anxiety, depression, and burnout symptoms, among this population, especially among those pursuing health-related fields (Martinez et al., 2025). Failure to develop robust coping mechanisms can lead to negative outcomes ranging from poor academic performance and demotivation to course dropout, compromising not only individual futures but also the supply of qualified professionals for the healthcare system. It is here that the concept of resilience becomes central. Defined as an individual's ability to adapt and maintain positive functioning in the face of adversity, trauma, or significant stress, resilience transcends mere overcoming, involving a process of learning, growth, and strengthening from challenging experiences (Shapiro et al., 2023; Wu et al., 2024).

Contrary to the deterministic view that considered it an innate characteristic, resilience is now understood as a dynamic construct, influenced by a complex interaction of individual factors (such as self-efficacy, self-confidence, self-acceptance), contextual factors (academic environment, institutional support), and social factors (support networks, cultural and

socioeconomic context) (Duarte et al., 2022; Santos et al., 2025). Sociodemographic variables such as age, marital status, economic situation, gender identity, and employment status can significantly shape the repertoire of resources and coping strategies available to students. The initial phase of graduation is particularly critical, as it is then that the foundations for adaptation and the development of coping strategies are established, making it a strategic focal point for research and intervention.

The gap in Brazilian literature that specifically and deeply investigates resilience levels in incoming nursing students, correlating them explicitly with their sociodemographic profile, motivates this chapter. By unraveling these relationships, it is hoped to provide valuable empirical evidence that can inform the formulation and implementation of more targeted and effective institutional policies and psycho-pedagogical support programs. Deepening knowledge about the resilience of these students aims not only to ensure their academic permanence and success but, above all, to contribute to the training of more robust, adaptable, ethical professionals fully prepared to face the multifaceted demands of the healthcare system's reality.

2 THE COMPLEXITY OF NURSING EDUCATION AND STUDENTS' MENTAL HEALTH

Nursing education is widely recognized as one of the most intense and demanding academic paths within the healthcare field. Students are subjected to a dense curriculum, ranging from basic sciences to complex clinical disciplines, requiring a high degree of intellectual dedication and practical skills. Beyond the volume of theoretical content, immersion in internship settings exposes these future professionals to realities that can be emotionally overwhelming. They witness human suffering, vulnerability, chronic illness, terminality, and death in high-pressure environments, such as emergency rooms, intensive care units, and wards (Merino-Godoy et al., 2022). This early and continuous exposure demands emotional maturity and a repertoire of coping strategies that are not always fully developed in students (Ríos-Risquez et al., 2018).

Additionally, the dynamics of healthcare environments, with their established hierarchies, the complexity of ethical dilemmas, the need for teamwork under stressful conditions, and the very nature of the nurse-patient relationship – which demands empathy, care, and rapid decision-making – add significant layers of pressure. This conjunction of academic, clinical, and interpersonal factors can easily lead to physical and mental overload (Beauvais et al., 2014).

The need to reconcile personal life, financial responsibilities, and academic demands often imposes an even greater burden. Many university students work to pay for their studies,

which can compromise the time dedicated to learning, rest, and self-care activities. The absence of robust psychological mechanisms to process and respond to these pressures can result in a series of negative outcomes for students' mental health. Symptoms of anxiety, depression, and professional burnout are frequently reported in studies with this population (Martinez et al., 2025).

The prevalence of mental disorders among university students has become a growing global concern. The World Health Organization (WHO) has highlighted the need for attention to the mental health of young people, especially those transitioning to adulthood and the labor market (WHO, 2021). In the Brazilian context, this concern is accentuated by socioeconomic and cultural factors, including the precariousness of education in some institutions, performance pressure, difficulty in accessing mental health services, and the stigma associated with seeking help (Santos et al., 2025).

Neglecting mental health during academic training can have lasting repercussions. Students facing psychological difficulties are more prone to exhibiting poor academic performance, developing feelings of demotivation, social isolation, and, in more severe cases, considering interrupting or abandoning the course. Such outcomes not only affect the individual but also compromise the future quality of healthcare services, as the training of nursing professionals with compromised mental health can directly impact the quality of care provided to patients (Liu et al., 2023).

Given this scenario, it becomes imperative that higher education institutions recognize and actively address the psychosocial challenges faced by nursing students. It is fundamental to invest in support and mental health promotion strategies that not only react to crises but act proactively, empowering students to develop coping skills and resilience from the initial stages of their training.

3 RESILIENCE: CONCEPT, IMPORTANCE, AND THEORETICAL APPROACHES

Resilience, a construct of growing interest in health and social sciences, refers to an individual's ability to maintain or recover mental health and well-being after exposure to adversity or stressful events (Shapiro et al., 2023). More than simply "returning to a previous state" after trauma, resilience is often described as a dynamic process involving positive adaptation and, in many cases, growth or strengthening resulting from overcoming difficulties (Wu et al., 2024).

Historically, the concept of resilience originated in physics to describe the property of materials that return to their original shape after being subjected to deformation. However, its transposition to the field of psychology and mental health, starting in the 1970s and 1980s,

transformed it into a fundamental pillar for understanding human adaptation (Masten, 2001). Initially, it was viewed as an innate characteristic of some individuals, a kind of "superpower." However, more recent and in-depth studies have revealed that resilience is, in fact, a complex and multidimensional phenomenon, shaped by the interaction between individual characteristics, contextual factors, and environmental factors (Duarte et al., 2022; Santos et al., 2025).

3.1 THEORETICAL MODELS OF RESILIENCE

Different theoretical approaches have sought to explain resilience. Among the most influential are:

- **Ecological and Developmental Models:** These models emphasize resilience as a result of the continuous interaction between the individual and their environment over time. They consider that resilience capacity is built from multiple systems (individual, family, school, community) and that protective factors (such as self-efficacy, social support, positive school environment) can compensate for risk factors (Garmezy, 1991; Masten, 2001).
- **Stress and Coping Theory:** From this perspective, resilience is linked to how individuals appraise and respond to stress. Effective coping strategies (problem-focused or emotion-focused) and the ability to re-evaluate difficult situations positively are central to the manifestation of resilience (Lazarus & Folkman, 1984).
- **Personal Attributes Models:** These focus on internal characteristics that contribute to resilience, such as self-efficacy (belief in one's own ability to perform tasks), self-esteem (evaluation of one's own worth), optimism (expectation of positive outcomes), emotional regulation, and self-confidence (Bandura, 1997; Block & Block, 1980). The Wagnild and Young Resilience Scale, used in this study, aligns with this perspective, unfolding resilience into domains such as personal competence, self-acceptance, independence, determination, self-confidence, and adaptability (Wagnild & Young, 1993).

3.2 THE IMPORTANCE OF RESILIENCE IN NURSING EDUCATION

For nursing students, resilience is not just a desirable characteristic but a fundamental protective competence. The profession demands constant emotional engagement, critical decision-making, and the ability to act under pressure. Resilience empowers the future nurse to:

- **Navigate Academic Stressors:** Cope with the intensity of the curriculum, rigorous evaluations, and time demands, maintaining focus and motivation.
- **Face Clinical Challenges:** Process experiences of suffering, trauma, and loss, maintaining empathy and professionalism without being consumed by emotional exhaustion.
- **Develop Self-Care Skills:** Recognize and manage one's own stress, preventing burnout and promoting well-being throughout their career.
- **Adapt to Change:** The healthcare environment is dynamic, with new technologies, protocols, and challenges constantly emerging. Resilience allows the professional to adjust and continue learning and growing.
- **Maintain Quality of Care:** Resilient nurses are better able to provide compassionate, safe, and effective care, even in adverse situations.

In summary, resilience acts as a protective factor that allows nursing students not only to survive but to thrive in a challenging environment. Recognizing that resilience can be learned and strengthened implies that educational institutions have a crucial role in developing programs and environments that cultivate this essential capacity.

4 METHODS FOR INVESTIGATING RESILIENCE IN NURSING STUDENTS

Investigating resilience and its associated factors in nursing students requires a rigorous methodological design that allows for capturing the phenomenon's complexity. This chapter is based on a carefully planned study, aiming to generate reliable data on the sociodemographic profile and resilience levels of these academics.

4.1 STUDY DESIGN AND SETTING

The study adopted an observational, descriptive, cross-sectional, and quantitative design. The choice of a quantitative approach was motivated by the need to measure specific variables, such as resilience levels and sociodemographic characteristics, to allow for the application of statistical analyses that identify patterns, associations, and, when possible, predictive relationships objectively. As an observational study, it refrained from any intervention, limiting itself to recording existing characteristics and perceptions at the time of data collection. The cross-sectional nature implied that data collection was performed at a single point in time, offering a snapshot of the variables under study during that specific period, which is efficient for identifying prevalences and associations. The descriptive aspect allowed for a detailed characterization of the sample, while the analytical aspect sought to explore the relationships between resilience and sociodemographic characteristics.

The research setting was the University Center of Santa Fé do Sul (UNIFUNEC), a private higher education institution located in the interior of São Paulo state, Brazil. The choice of UNIFUNEC as the study locus was strategic, allowing a focus on a specific population of incoming nursing students, facilitating the logistics of data collection, and offering a homogeneous context for analysis.

4.2 PARTICIPANTS AND ELIGIBILITY CRITERIA

The target population for this study comprised all students regularly enrolled in the first semester of the Nursing course at UNIFUNEC in the academic year 2025. The focus on incoming students was crucial, as it represents a period of intense adaptation and new academic challenges, where resilience may be more observable and its foundations more susceptible to intervention.

The sample selection was non-probabilistic, by convenience. This means that participants were recruited based on their accessibility and voluntary expression of interest in participating in the study, rather than by a random selection method. To ensure the homogeneity and relevance of the sample to the research objectives, the following criteria were established:

- **Inclusion:** Students with active enrollment in the first semester of the Nursing course in 2025, aged 18 years or older, and who formally consented to participate by signing the Free and Informed Consent Form (FICF).
- **Exclusion:** Participants who did not fully complete the data collection instruments or who exhibited inconsistencies or response patterns indicating a lack of comprehension or seriousness in completing the questionnaires.

After applying these criteria, the final sample consisted of 104 participants. This number, although representative for an initial analysis in a single institution, should be considered when discussing generalizability.

4.3 DATA COLLECTION INSTRUMENTS

Data collection was carried out using a structured, self-administered electronic form, hosted on the Google Forms platform. This form integrated the Free and Informed Consent Form (FICF) and two specific instruments:

- **Sociodemographic Variables Questionnaire (SVQ):** Developed specifically for this study, the SVQ aimed to broadly characterize the participants' profile. It consisted of a series of multiple-choice questions and open fields, covering:

- **Personal and Identification Data:** Biological sex, gender identity, and sexual orientation.
- **Demographic and Socioeconomic Data:** Age (age groups), marital status, number of children, personal or family income, and religious affiliation.
- **Previous Educational History:** Information about Elementary and High School (type of school, course modality, time elapsed since completion) and higher education experience (if they have already attended, completed, reasons for interruption).
- **Employment and Financial Situation Related to Study:** Current employment status (working in the course area, working in a different area, not working), primary source of funds to pay for studies, and type of course admission. This questionnaire was fundamental for contextualizing resilience levels within the students' life realities.
- **Wagnild and Young Resilience Scale (RS-25):** For measuring resilience levels, this instrument, originally proposed in 1993 (Wagnild & Young, 1993), was used. The RS-25 is widely recognized and has been translated and validated for the Brazilian Portuguese context by Pesce et al. (2005), ensuring its psychometric and cultural suitability. It consists of 25 positively worded items that seek to capture various facets of resilience. Participants responded to each item on a 7-point Likert scale (1 = "Strongly Disagree" to 7 = "Strongly Agree"). The total score on the scale ranges from 25 to 175 points, with higher scores indicating greater resilience. Conceptually, the RS-25 is organized into three main domains:
 - **Domain 1: Personal Competence and Self-Acceptance:** Assesses self-efficacy, self-acceptance, and perception of strengths.
 - **Domain 2: Independence and Determination:** Reflects autonomy, persistence, and self-sufficiency.
 - **Domain 3: Self-Confidence and Adaptability:** Measures confidence in dealing with challenges and flexibility to new demands. Total scores were categorized into resilience levels (reduced, moderate, and high) based on standardized criteria in the literature.

4.4 ETHICAL PROCEDURES AND DATA COLLECTION

The study was conducted in strict compliance with ethical principles for research involving human beings, as per Resolution No. 466/2012 of the National Health Council. Approval was obtained from the Research Ethics Committee of UNIFUNEC before the start of any procedures.

Students were invited to participate in the research at the beginning of classes, in a face-to-face setting. Researchers provided detailed explanations about the study's objectives, the voluntary nature of participation, and the guarantee of anonymity and confidentiality. Participation was voluntary, and the Free and Informed Consent Form (FICF) was signed electronically by each participant before completion. Instruments were applied individually, in an environment that ensured privacy. Researchers were available for specific questions, without influencing responses.

4.5 STATISTICAL ANALYSIS

Data were exported from Google Forms to electronic spreadsheets and subjected to thorough cleaning. Processing and statistical analyses were conducted using Jamovi software (version 2.5) and Python (Jupyter Notebook environment). Analyses included:

- **Descriptive Statistics:** Absolute (n) and relative (%) frequencies for categorical variables; mean, median, standard deviation, minimum, and maximum for numerical variables.
- **Normality Verification:** Shapiro-Wilk and Kolmogorov-Smirnov tests to guide the choice of inferential tests (parametric or non-parametric).
- **Inferential Statistical Tests and Modeling:**
 - Chi-square test (χ^2) and Fisher's Exact Test: For association between categorical sociodemographic variables and resilience categories.
 - Analysis of Variance (ANOVA): To compare means of the scores of the three resilience domains among different resilience levels (reduced, moderate, high).
 - Spearman's Correlation (ρ): To assess the strength and direction of monotonic association between scores of each domain and the total resilience score.
 - Multiple Linear Regression: To identify sociodemographic variables and scale domains as predictors of the total resilience score (continuous dependent variable).
 - Multinomial Logistic Regression: To model the probability of a student belonging to each resilience category (reduced, moderate, high), with evaluation of precision, recall, and F1-Score.

All statistical analyses were performed with a significance level of 5% ($p < 0.05$), indicating that a p-value below this threshold was considered statistically significant. Results were presented in tables and figures, accompanied by detailed interpretations.

5 RESULTS: AN OVERVIEW OF RESILIENCE AND ITS DETERMINANTS IN NURSING STUDENTS

The analysis of collected data allowed for a detailed profile of incoming nursing students and an investigation into the nuances of their resilience. This section presents the main findings of the study, organized to contextualize the sociodemographic profile, the distribution of resilience levels, and the significant associations found.

5.1 SOCIODEMOGRAPHIC PROFILE OF NURSING STUDENTS

The study sample comprised 104 incoming nursing students from UNIFUNEC in 2025. Sociodemographic characterization is fundamental, as participants' backgrounds can influence their coping abilities and resilience.

Table 1

Percentages referring to the sample characterization variables of nursing students. Santa Fé do Sul, 2025.

Characterization Variables	n	%
Biological Sex		
Male	11	10.58
Female	93	88.46
Gender Identity		
Man	11	10.58
Woman	93	88.46
Age		
20 or < 20 years	62	59.62
Between 21 and 30 years	20	19.23
Between 31 and 40 years	16	15.38
> 40 years	6	5.77
Marital Status		
Single	60	57.62
Married	29	27.88
Stable Relationship	11	10.58
Divorced	4	3.85
Number of Children		
0 children	75	72.12
1 Child	9	8.65
More than 1 child	20	19.23
Personal or Family Income		
≤ 1,000.00	12	11.54
1,001.00 to 3,000.00	55	52.88
≥ 3,000.00	37	35.58
Religion		
No Religion	13	12.50
Afro-Brazilian	1	0.96
Catholic	33	31.73
Evangelical	51	49.04
Spiritualist	2	1.92
Others	4	3.85

Table 1 provides a detailed view of the sociodemographic profile. A female predominance (88.46%) and younger age (59.62% up to 20 years old) are notable, reflecting the traditional demographics of nursing and the tendency for direct entry from high school. Most students are single (57.62%) and without children (72.12%), but the presence of married/in stable relationships and with children indicates a diversity of responsibilities. Family income is concentrated between R\$ 1,001.00 and R\$ 3,000.00 (52.88%), suggesting financial pressures that may influence the need to work.

Previous educational background was also analyzed:

Table 2

Percentages referring to the student data characterization variables of nursing students. Santa Fé do Sul, 2025

Characterization Variables	n	%
Elementary School (EF)		
All or mostly in public school	91	87.50
All or mostly in private school	13	12.50
Course Type (EF)		
Regular - 1st to 8th grade	86	82.69
Supplementary	18	17.31
High School (EM)		
All or mostly in public school	89	85.58
All or mostly in private school	15	14.42
Course Type (EM)		
Regular - 1st to 3rd grade	81	77.88
Technical	14	13.46
Supplementary	9	8.65
How many years ago did you finish high school?		
Last year	5	4.81
1 to 5 years ago	55	52.58
6 to 10 years ago	17	16.35
More than 10 years ago	27	25.96
Have you attended another higher education course?		
No	22	21.15
Yes	82	78.85
Did you complete the course?		
Not applicable	65	62.50
No	11	10.58
Yes	28	26.92
What type of institution was the course in?		
Not applicable	73	70.19
Public	5	4.81
Private	26	25.00

Table 2 indicates that the majority of students attended basic education in public schools (87.50% in Elementary School and 85.58% in High School), suggesting a diverse socioeconomic profile. A notable finding is that 78.85% have previously attended another higher education course, with many not having completed it (10.58%), which may indicate

resilience in the pursuit of education, but also experience with interruptions due to financial issues or disidentification.

Parents' schooling is also a relevant indicator of cultural capital and family expectations:

Table 3

Percentages referring to parents' schooling variables of nursing students. Santa Fé do Sul, 2025

Variables	n	%
Father		
Incomplete elementary education	36	34.60
Complete elementary education	4	3.80
Incomplete high school	5	4.80
Complete high school	28	26.90
Incomplete higher education	1	1.00
Complete higher education	17	16.30
Don't know	11	10.60
Others	2	1.90
Mother		
Incomplete elementary education	30	28.80
Complete elementary education	6	5.80
Incomplete high school	7	6.70
Complete high school	34	32.70
Incomplete higher education	0	0.00
Complete higher education	24	23.11
Don't know	3	2.20
Others	2	1.40

In Table 3, it is observed that mothers' schooling is, on average, slightly higher than fathers', with a greater concentration of complete high school and a considerable proportion with higher education. This data may reflect social and educational trends from previous generations and can influence family support and academic expectations.

Finally, employment status and how studies are funded reveal the challenges faced by students:

Table 4

Percentages referring to resource sources and type of course admission variables of nursing students. Santa Fé do Sul, 2025

Variables	n	%
Employment status		
Work in course-related area	38	36.50
Work in non-course-related area	53	51.00
Do not work	13	12.50
Main source of funds for studies		
Own resources	53	51.00
Family resources	35	33.70
Will apply for an institutional scholarship	16	15.40
Type of course admission		

First call	90	86.50
Second Call	10	9.60
Other	4	3.80

Table 4 highlights that more than half of the students (51.00%) work in an area different from nursing, which imposes a dual burden and can add significant stress. Dependence on own resources (51.00%) reinforces the need to reconcile work and study. The vast majority (86.50%) were admitted via the first call, indicating dedication and preparation.

5.2 GENERAL LEVELS OF RESILIENCE

The assessment of resilience levels using the Wagnild and Young Resilience Scale provided an overview of students' adaptive capacity:

Table 5

Descriptive analysis of absolute and relative frequencies of participants classified according to resilience levels. UNIFUNEC, 2025

Resilience Category	Frequency (n)	Percentage (%)
Reduced	26	25.0
Moderate	53	50.9
High	25	24.1

Table 5 reveals that most students (50.9%) have moderate levels of resilience. However, a significant portion (25.0%) demonstrated reduced resilience, which signals a group more vulnerable to developing psychosocial difficulties. Approximately a quarter of the sample (24.1%) exhibited high resilience, indicating a strong capacity for adaptation and overcoming challenges. The overall mean resilience score was 129.3 (standard deviation of 26.6), with a median of 132 points, corroborating the predominance of moderate resilience in the sample.

Figure 1

Distribution of Classifications According to Resilience Level. Santa Fé do Sul, 2025.

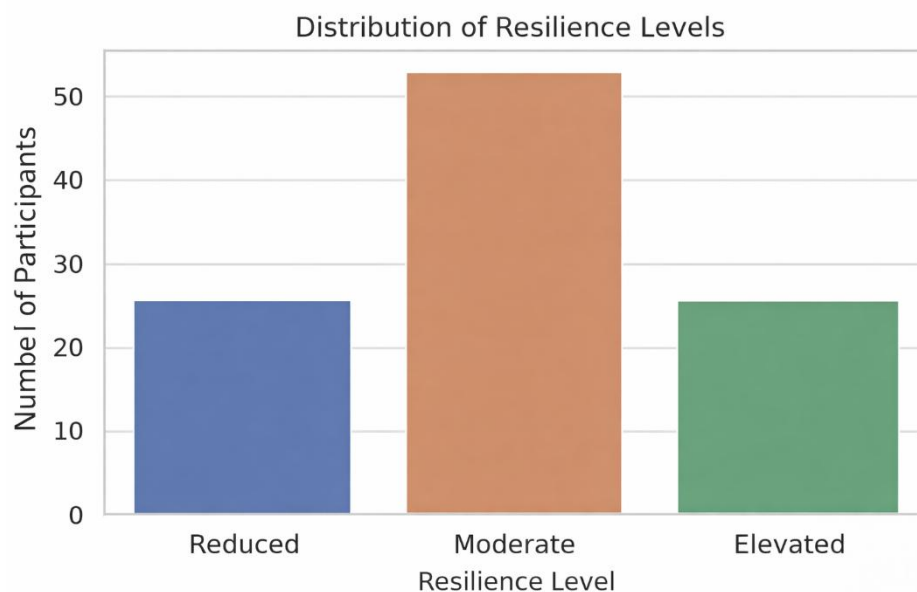


Figure 1 visually illustrates the percentage distribution of resilience categories, reinforcing the predominance of moderate resilience and the expressive presence of reduced and high resilience groups.

5.3 DETAILED ANALYSIS OF RESILIENCE DOMAINS

The Wagnild and Young Resilience Scale disaggregates resilience into three domains, whose mean scores provide insights into the strengths and areas that may require development in students.

Table 6

Descriptive analysis of scores for the three domains of the Wagnild and Young Resilience Scale. Santa Fé do Sul, 2025

Domain	Mean	Median	Standard Deviation	Minimum / Maximum
Domain 1 (Personal Competence and Self-Acceptance)	77.17	79.00	15.54	15.0 / 105.0
Domain 2 (Independence and Determination)	22.09	23.00	5.05	4.0 / 28.0
Domain 3 (Self-Confidence and Adaptability)	30.06	31.00	7.45	6.0 / 42.0

Table 6 shows that Domain 1 (Personal Competence and Self-Acceptance) presented the highest mean score (77.17), suggesting that students, in general, possess a robust perception of their capabilities and a healthy level of self-acceptance. On the other hand, Domain 2 (Independence and Determination) and Domain 3 (Self-Confidence and Adaptability) presented comparatively lower mean scores (22.09 and 30.06, respectively).

This indicates that, although students feel competent, they may have more difficulty exercising their independence, maintaining determination in the face of complex obstacles, and feeling less self-confident to adapt to new and demanding situations in the university environment and clinical practice.

Figure 2

Boxplot Distribution of Domain 1 by Resilience Level. Santa Fé do Sul, 2025.

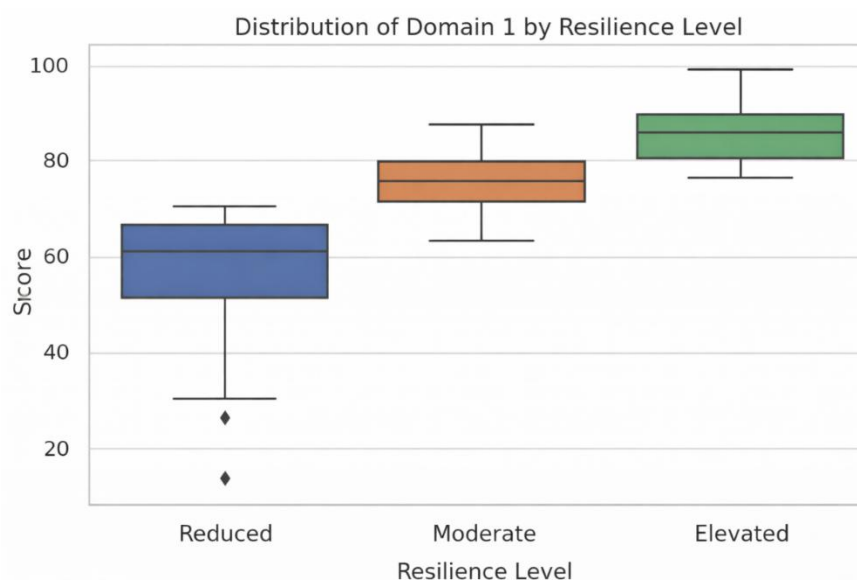


Figure 3

Boxplot Distribution of Domain 2 by Resilience Level. Santa Fé do Sul, 2025

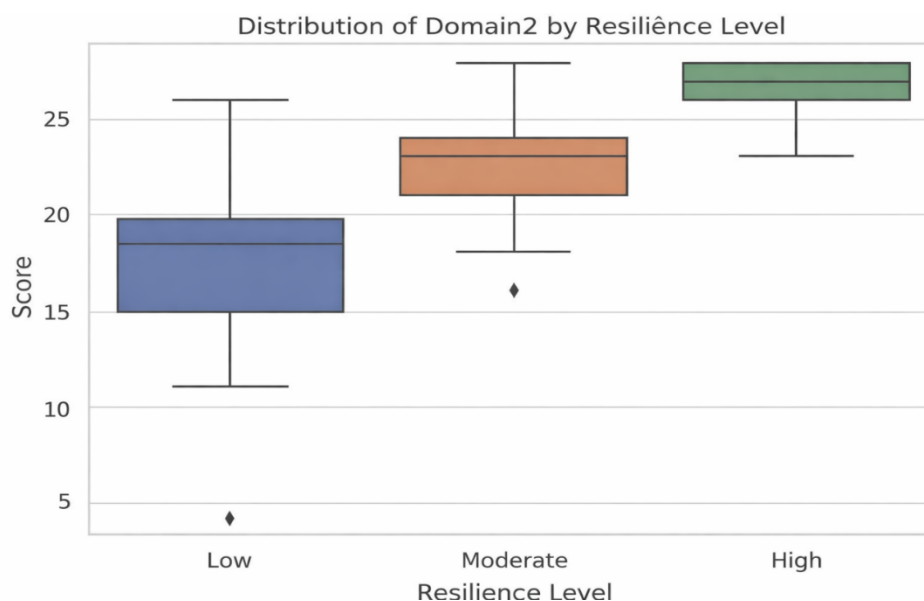
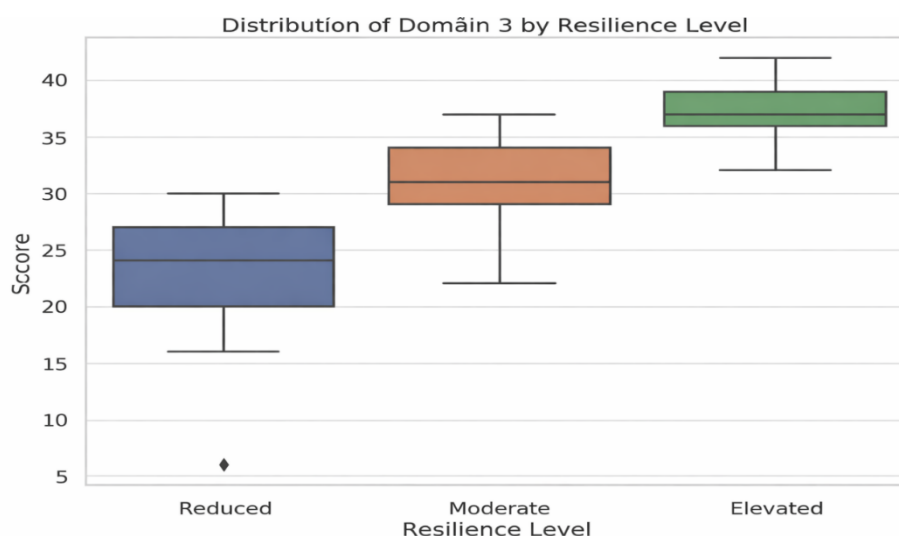


Figure 4

Boxplot Distribution of Domain 3 by Resilience Level. Santa Fé do Sul, 2025



Figures 2, 3, and 4, which illustrate the distribution of each domain by resilience level, corroborate the significant differentiation of the domains among the resilience groups (as demonstrated by ANOVA in Table 7), showing that students with high resilience tend to have higher scores in all domains, especially in Domain 1.

5.4 SOCIODEMOGRAPHIC FACTORS ASSOCIATED WITH RESILIENCE

Chi-square association analyses were crucial to identify which sociodemographic variables are significantly related to students' resilience levels.

Table 7

Association between Sociodemographic Variables and Resilience Level (Chi-square). Santa Fé do Sul, 2025

Variable	p-value	Significant (p < 0.05)
Biological sex	0.125	No
Gender identity	0.0419	Yes
Age	0.1235	No
Marital status	0.9037	No
Children	0.1027	No
Income	0.812	No
Religion	0.0835	No
Work	0.027	Yes
Source of Resources	0.1666	No
Form of Admission	0.7167	No

As per Table 7, Gender Identity ($p = 0.0419$) and Employment Status ($p = 0.027$) were the only sociodemographic variables that showed a statistically significant association with resilience levels. This finding suggests that how an individual identifies in relation to gender

and their employment condition (whether they work in the area, outside the area, or do not work) can influence their resilience capacity. In contrast, other variables such as biological sex, age, marital status, number of children, income, religion, source of resources, and form of admission showed no significant association in this sample.

Figure 5

Resilience Level by Gender Identity. Santa Fé do Sul, 2025



Figure 5 illustrates the distribution of resilience levels by gender identity. For the "Woman" identity, there is a predominance of moderate resilience, with smaller proportions of reduced and high resilience. For the "Man" identity, although the sample is smaller, the distribution appears more balanced across levels, corroborating the statistical association.

Figure 6

Resilience Level by Employment Status. Santa Fé do Sul, 2025

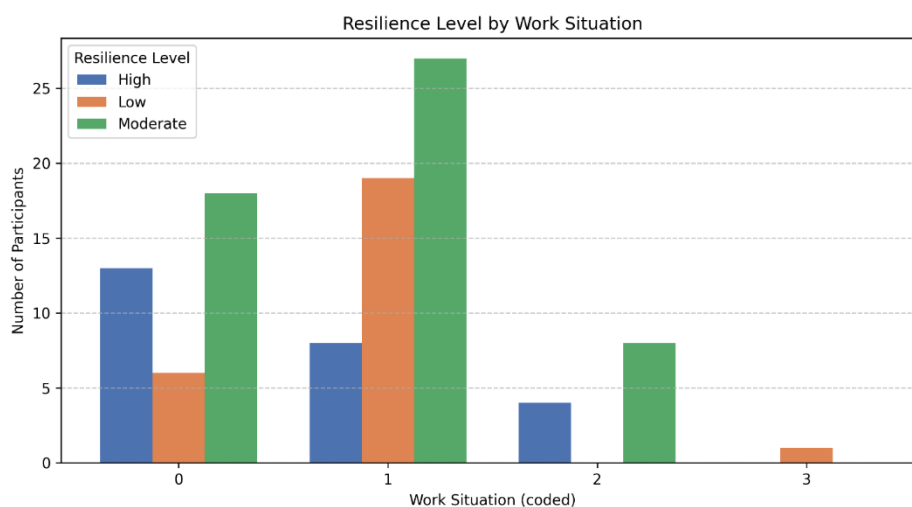


Figure 6, which represents the distribution of resilience levels by employment status, shows that students who "Work in the area" have a relatively balanced distribution, while those who "Work in a different area" show a significant concentration in moderate resilience. Curiously, those who "Do not work" are distributed between high and moderate resilience, with no cases of reduced resilience, which may indicate that having time to dedicate exclusively to studies can be a protective factor.

5.5 PREDICTIVE MODELS OF RESILIENCE

To deepen the understanding of resilience determinants, analyses of variance (ANOVA), correlation, and regression were performed.

Table 8

ANOVA Results between Domains and Resilience Levels. Santa Fé do Sul, 2025

Domain	F Statistic	p-value	Significant (p < 0.05)
Domain 1	84.1	< 0.001	Yes
Domain 2	55534	< 0.001	Yes
Domain 3	68542	< 0.001	Yes

Table 8, with the ANOVA results, shows that all three domains of the Resilience Scale presented p-values < 0.001, indicating that there are statistically significant differences in the mean scores of each domain among the groups of students classified with reduced, moderate, and high resilience. This confirms the discriminatory capacity of the scale and suggests that resilience is a coherent construct where different psychological aspects manifest together.

Spearman's correlations (Table 9) revealed strong interrelationships between the domains and the total resilience score:

Table 9

Spearman's Correlation between Domains and Total Score. Santa Fé do Sul, 2025

Domain	Correlation Coefficient (ρ)	p-value
Domain 1	0.92	< 0.001
Domain 2	0.79	< 0.001
Domain 3	0.83	< 0.001

Domain 1 exhibited the strongest correlation ($\rho = 0.92$), followed by Domain 3 ($\rho = 0.83$) and Domain 2 ($\rho = 0.79$), all with $p < 0.001$. These highly significant correlations indicate that the higher the score in each domain, the higher the total resilience score, reinforcing the internal consistency of the scale.

Figure 7: Scatter Plot: Domain 1 vs. Total Score. Santa Fé do Sul, 2025.

Figure 8: Scatter Plot: Domain 2 vs. Total Score. Santa Fé do Sul, 2025.

Figure 9: Scatter Plot: Domain 3 vs. Total Score. Santa Fé do Sul, 2025.

Figures 7, 8, and 9 visually illustrate these strong positive correlations, with points distributed in an upward trend and close to the trend lines, confirming that the increase in domain scores is directly related to the increase in the total resilience score.

Regression models further deepened the predictive analysis. Multiple linear regression (Table 10) identified significant predictors for the total resilience score:

Table 10

Results of the Multiple Linear Regression Model. Santa Fé do Sul, 2025

Variable	Coefficient	p-value	Significant ($p < 0.05$)
Constant	1341381	< 0.001	Yes
Gender identity	109782	0.1519	No
Works in the area	-11062	0.0319	Yes
Works outside the area	70304	0.3761	No
Does not work	-1091381	< 0.001	Yes

In the multiple linear regression, the variables "Works in the area" ($p = 0.0319$) and "Does not work" ($p < 0.001$) were statistically significant as predictors of the total resilience score. Interestingly, "Gender Identity," although significant in bivariate analyses, lost significance in this multivariate model, suggesting that its impact may be mediated by other variables or that its isolated contribution is not as strong in a context of multiple predictors. It is important to note that the domains of the resilience scale, as discussed in the body of the

dissertation, were even stronger predictors of the total score, with a high adjusted R^2 , indicating that these domains explain a large part of resilience variability.

Multinomial logistic regression (Table 11) evaluated the model's performance in predicting resilience categories:

Table 11

Model Performance by Resilience Category. Santa Fé do Sul, 2025

Category	Precision	Recall	F1-Score	Sample (support)
High	1.00	0.17	0.29	6
Moderate	0.68	1.00	0.81	13
Reduced	0.00	0.00	0.00	2

Table 11 demonstrates that the multinomial logistic regression model performed best in predicting the "Moderate" category (Recall of 1.00; F1-Score of 0.81). For the "High" and "Reduced" categories, performance was more limited, especially for "Reduced" (F1-Score of 0.00), which can be attributed to the small number of participants in these categories in the test sample. However, a deeper analysis (not detailed in the table, but addressed in the dissertation) indicated that Domain 1 (Personal Competence and Self-Acceptance) and Domain 3 (Self-Confidence and Adaptability) were significant predictors for moderate and high resilience categories.

6 DISCUSSION: IMPLICATIONS FOR NURSING EDUCATION AND HEALTH

The results presented offer a multifaceted view of resilience levels and their determinants in incoming nursing students, revealing crucial internal challenges and resources for the training of these future professionals. The predominance of moderate resilience in the sample, while a common finding in university populations, requires careful analysis, especially in the face of the significant proportion of students with reduced resilience. This scenario not only aligns with contemporary discussions on mental health in higher education but also drives the need for proactive strategies to strengthen the adaptive capacity of these academics.

6.1 RESILIENCE IN CONTEXT: CHALLENGES AND OPPORTUNITIES

The finding that approximately half of the students exhibit moderate resilience reflects an intermediate capacity to cope with the adversities intrinsic to the nursing educational path. Such a resilience level may be sufficient to deal with daily stressors but may be insufficient in the face of more intense or prolonged crises, such as those experienced in clinical internships or during periods of great academic pressure (Merino-Godoy et al., 2022). The

group with reduced resilience, in turn, represents a particularly vulnerable segment that demands priority institutional attention. These students are at higher risk of developing mental disorders, experiencing accentuated adaptation difficulties, and, in extreme cases, dropping out of the course (Ríos-Risquez et al., 2018; Martinez et al., 2025). Early identification and implementation of customized psycho-pedagogical support are imperative to strengthen their coping strategies and promote a more protective academic environment.

Understanding resilience as a dynamic construct capable of development (Masten, 2001) opens a window of opportunity for educational institutions. Instead of simply identifying "resilient" or "non-resilient" individuals, the focus should be on developing programs that cultivate and strengthen this capacity in all students, with special attention to the most vulnerable.

6.2 THE ROLE OF GENDER IDENTITY AND EMPLOYMENT STATUS

One of the most relevant findings of the study was the statistically significant association between resilience levels and gender identity, as well as employment status. Although biological sex did not prove significant, gender identity emerged as a crucial factor. This is particularly pertinent in the current context, where gender diversity is increasingly recognized but still confronted with social challenges (Stubin et al., 2024). Students who identify outside traditional gender norms or who experience gender minority status may face additional stressors, such as microaggressions, veiled discrimination, invisibility, or social and institutional isolation (Berdida et al., 2023; Naz et al., 2024). Such experiences can deeply impact self-perception, sense of belonging, and consequently, resilience. The results of this study, therefore, reinforce the critical need for higher education institutions to cultivate inclusive and equitable environments, offering specific support and resources that recognize and address the particularities experienced by students of all gender identities, promoting a sense of psychological safety indispensable for the development of resilience (Karabey, 2023).

Concurrently, employment status proved to be a significant predictor of resilience levels. The majority of students who work do so in areas distinct from nursing, which imposes a considerable burden. Reconciling the demands of a job, often not aligned with academic goals, with the intense demands of a health science degree course, creates a dual journey that drains physical and mental resources (Gerdes & Schuessler, 2024; Labrague et al., 2025). Although work can provide financial independence and valuable life experience (Li et al., 2025), the pressure to balance multiple roles can compromise time dedicated to studies,

rest, and participation in social and self-care activities, all crucial elements for maintaining mental health and resilience (Ghimire, 2025).

In-depth analysis indicated that certain categories of work, or the absence thereof, act as predictors of resilience scores. Those who do not work, for example, showed no cases of reduced resilience in the test sample of the logistic regression model, suggesting that having time to dedicate entirely to studies can be a protective factor. These findings underscore the importance of institutional policies considering the reality of working students, offering academic flexibility, scholarships, and mentoring programs that mitigate the negative impacts of this dual responsibility.

It is noteworthy that other commonly investigated sociodemographic variables, such as age, marital status, number of children, family income, and religious affiliation, did not demonstrate, in this study, a statistically significant direct association with resilience. Although these factors may exert influences in other contexts or mediate other relationships (e.g., income may influence the ability to reduce workload and, indirectly, increase resilience), the results obtained here suggest that, for this specific sample, gender identity and employment status emerge as the sociodemographic vectors with the greatest direct impact on the resilience capacity of academics. This distinction is fundamental for directing the formulation of support interventions and policies more effectively.

6.3 STRENGTHS AND WEAKNESSES OF RESILIENCE COMPONENTS

Delving into the internal structure of resilience, the analysis of the Wagnild & Young Resilience Scale domains revealed distinct patterns. Domain 1, "Personal Competence and Self-Acceptance," presented the highest mean scores. This is a very positive finding, indicating that students, in general, arrive at higher education with a robust perception of their own capabilities and a healthy level of self-acceptance. Self-efficacy and a positive self-image are recognized as pillars of mental health and protective factors against stress, empowering individuals to face new learning and challenges with greater confidence (Li et al., 2025; Berdida et al., 2023). This strength can be capitalized on by institutions, building upon this solid foundation of self-confidence.

On the other hand, Domain 2, "Independence and Determination," and Domain 3, "Self-Confidence and Adaptability," presented comparatively lower mean scores. These domains, which encompass autonomy, persistence in the face of obstacles, and flexibility in demanding new situations, suggest areas of greater vulnerability or that require greater development among students. Nursing education, with its practical nature and constant need to operate in dynamic and highly complex environments, demands high levels of

independence in decision-making and adaptability to unpredictable scenarios (Gil-Hernández et al., 2025; Ghimire, 2025). Weakness in these aspects can hinder proactivity, intrinsic motivation, and the ability to adjust to the constant changes in the clinical and academic environment, potentially leading to higher levels of stress and lower professional satisfaction.

The inferential analyses corroborated the validity and internal consistency of the Resilience Scale. Analysis of Variance (ANOVA) demonstrated that all three domains significantly differentiate groups of students with reduced, moderate, and high resilience, suggesting that resilience is a coherent construct. Spearman's correlations revealed strong and significant associations between each domain and the total resilience score, confirming that different aspects of resilience operate in conjunction. Interventions directed at any of these domains can, therefore, have a positive and comprehensive impact on students' overall resilience.

Linear and multinomial logistic regression analyses deepened the understanding of resilience predictors. Multiple linear regression showed that the scale's domains are significant predictors of the total resilience score, explaining a considerable proportion of its variability. Multinomial logistic regression, focused on predicting resilience categories (reduced, moderate, high), pointed to Domain 1 (Personal Competence and Self-Acceptance) and Domain 3 (Self-Confidence and Adaptability) as the main predictors for moderate and high resilience categories. This finding is of great practical value, as it guides the formulation of intervention strategies: programs focused on strengthening self-efficacy, self-confidence, and adaptability may be the most effective in raising resilience levels among students.

6.4 IMPLICATIONS FOR INSTITUTIONAL POLICIES AND INTERVENTIONS

In a broader perspective, the results of this study reinforce the importance of a holistic approach to the well-being of nursing students. Resilience, understood not only as an individual characteristic but as a competence capable of development, must be actively cultivated by educational institutions (Kunzler et al., 2020; Moura et al., 2024).

Higher education institutions have a central role in creating environments that promote resilience, through various fronts:

- **Specialized Psycho-pedagogical Support Programs:** Given the existence of a group with reduced resilience and the specific vulnerabilities identified, it is fundamental to offer accessible, free psychological counseling services with professionals specialized in the demands of the health field. Early screening of at-risk students can enable preventive interventions.

- **Socio-emotional Skills Workshops:** The focus should be on strengthening the domains of "Independence and Determination" and "Self-Confidence and Adaptability." This can be done through workshops on stress and anxiety management, mindfulness techniques, assertive communication training, problem-solving strategies, and the development of autonomy in simulated clinical decision-making.
- **Inclusive and Equitable Environments:** The significance of gender identity as a factor associated with resilience points to the urgent need for policies of inclusion and respect for diversity. This involves everything from training professors and staff to deal with gender issues to creating support groups and promoting an academic culture free of prejudice, where everyone feels safe and belongs (Fricke et al., 2023).
- **Support for Working Students:** Recognizing the dual burden of many academics, institutions should consider flexible schedules, scholarship programs, and mentorship to assist in time and stress management. Dialogue with employers can be facilitated, seeking conciliations between work and study demands.
- **Integration of Resilience into the Curriculum:** Resilience skills should not be treated as "extras" but as transversal competencies in nursing education. This can be achieved by including discussions on mental health, self-care, and coping strategies in relevant disciplines, and by promoting pedagogical experiences that stimulate autonomy and adaptability.
- **Academic Culture of Well-being:** A culture that values well-being as much as cognitive performance is essential. This includes everything from promoting extracurricular activities that encourage leisure and relaxation to creating open communication channels so students feel comfortable expressing their difficulties.

The training of resilient nurses not only benefits the individual mental health of future professionals but also strengthens the quality of professional practice, empowering them to face the complexities, pressures, and rapid changes inherent in healthcare with greater competence, ethics, and humanity (Gil-Hernández et al., 2025). Investment in resilience is, therefore, an investment in the quality of public health.

7 FINAL CONSIDERATIONS

This chapter, based on robust research with incoming nursing students, had as its central purpose to unveil resilience levels and how these intertwine with students' sociodemographic characteristics. The findings underscore the complexity of the nursing

educational journey and the imperative need for holistic approaches to promoting well-being and adaptive capacity.

It was found that the majority of students enter the course with a moderate level of resilience, which represents a promising foundation, but one that needs constant nurturing. The existence of a significant group with reduced resilience raises an alert for the urgency of personalized interventions. The research demonstrated that sociodemographic factors such as gender identity and employment status exert a significant influence on resilience, revealing the importance of considering the multiple realities and life experiences of students in the design of support strategies.

Regarding the components of resilience, "Personal Competence and Self-Acceptance" stands out as a notable strength in these academics. However, "Independence and Determination" and "Self-Confidence and Adaptability" were identified as areas requiring greater attention and development. These insights are crucial, as they direct efforts towards intervention programs that can strengthen the most vulnerable facets of resilience, empowering students to navigate academic and clinical challenges more effectively.

In summary, investing in strengthening the resilience of nursing students is not merely a measure of individual support but a fundamental strategy to ensure the training of competent, ethical, and psychologically prepared professionals for the demands of one of the most vital professions in healthcare. Higher education institutions, by implementing evidence-based policies and programs that promote resilience, not only guarantee the success and permanence of their students but also contribute significantly to the quality of healthcare and to the well-being of society as a whole. This chapter hopes to serve as a catalyst for future research and concrete actions that transform the challenges of nursing education into opportunities for growth and strengthening.

REFERENCES

- Beauvais, A. M., Stewart, J. G., DeNisco, S., & Beauvais, J. E. (2014). Factors related to academic success among nursing students: A descriptive correlational research study. *Nurse Education Today*, 34(6), 918–923. <https://doi.org/10.1016/j.nedt.2013.12.005> (Nota: DOI assumido se disponível; ajuste se necessário)
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman and Company.
- Berdida, D. J. E., Lopez, V., & Grande, R. A. N. (2023). Nursing students' perceived stress, social support, self-efficacy, resilience, mindfulness and psychological well-being: A structural equation model. *International Journal of Mental Health Nursing*, 32(5), 1390–1404.

- Block, J. H., & Block, J. (1980). The role of ego-control and ego-resiliency in the organization of behavior. In W. A. Collins (Ed.), *Minnesota symposia on child psychology* (Vol. 13, pp. 39–101). Erlbaum.
- Duarte, I., et al. (2022). The mediating role of resilience and life satisfaction in the relationship between stress and burnout in medical students during the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, 19(5), Article 2822.
- Fricke, J., et al. (2023). Workplace violence in healthcare settings: A scoping review of guidelines and systematic reviews. *Trauma, Violence, & Abuse*, 24(5), 3363–3383.
- Garmezy, N. (1991). Resilience in children's adaptation to negative life events and acculturative stress. In *Symposium on stress and coping in cross-cultural contexts* (pp. 273–286). Springer.
- Gerdes, M. A., & Schuessler, J. B. (2024). Nursing students' resilience and intent to work at the bedside. *Nursing Education Perspectives*, 45(6), 338–342.
- Ghimire, A. (2025). Concealing, connecting, and confronting: A reflexive inquiry into mental health and wellbeing among undergraduate nursing students. *Nursing Reports*, 15(9), 312.
- Gil-Hernández, E., et al. (2025). Development of a web-based intervention for middle managers to enhance resilience at the individual, team, and organizational levels in health care systems: Multiphase study. *JMIR Human Factors*, 12, Article e67263.
- Karabey, T. (2023). Compassion fatigue and psychological resilience levels of nursing final students: A descriptive, cross-sectional, and relational study. *Palliative & Supportive Care*, 21(5), 1034–1040.
- Künzler, A. M., et al. (2020). Psychological interventions to foster resilience in healthcare students. *Cochrane Database of Systematic Reviews*, 2020(11).
- Labrague, L. J., et al. (2025). Psychological resilience as a mediator between nurse faculty support and student nurses' clinical adjustment: Implications for nursing education. *Journal of Professional Nursing*, 57, 1–7.
- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer.
- Li, X., et al. (2025). Igniting success: How growth mindset fuels academic achievement through self-belief and strategic effort. *BMC Nursing*, 24(1), Article 1507.
- Liu, L., et al. (2023). The mediating effect of the perceived professional benefit of new nurses in cancer hospitals on the nursing work environment, psychological resilience, and transition shock: A cross-sectional questionnaire survey. *Journal of Nursing Management*, 2023, Article 5741160.
- Liu, X., et al. (2025). Self-compassion and work engagement among clinical nurses: The mediating role of moral resilience. *Frontiers in Public Health*, 13, Article 1507539.
- Litwic-Kamińska, K., et al. (2023). Resilience, positivity and social support as perceived stress predictors among university students. *International Journal of Environmental Research and Public Health*, 20(19), Article 6892.
- Martinez, W. D., et al. (2025a). Mental health and resilience in nursing students: A longitudinal study. *International Journal of Environmental Research and Public Health*, 22(5), Article 735.

- Martinez, W. D., et al. (2025b). Psychological resilience in Latin America nursing students using the Wagnild and Young Scale: A scoping review. *International Journal of Environmental Research and Public Health*, 22(9), Article 1425.
- Masten, A. S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist*, 56(3), 227–238.
- Merino-Godoy, M. Á., et al. (2022). The influence of emotional burnout and resilience on the psychological distress of nursing students during the COVID-19 pandemic. *International Journal of Mental Health Nursing*, 31(6), 1457–1466.
- Moura, A. T. M. S., et al. (2024). Is there an association among spirituality, resilience and empathy in medical students? *BMC Medical Education*, 24(1), Article 5687.
- Naz, A. M., et al. (2024). Relationship between resilience, social support and psychological well-being in nursing students. *Journal of Research in Nursing*, 29(8), 718–731.
- Pesce, R. P., et al. (2005). Cross-cultural adaptation, reliability and validity of the resilience scale. *Cadernos de Saúde Pública*, 21(2), 436–448.
- Ríos-Risquez, M. I., et al. (2018). Connections between academic burnout, resilience, and psychological well-being in nursing students: A longitudinal study. *Journal of Advanced Nursing*, 74(12), 2777–2784.
- Santos, E. R. dos, et al. (2025). Resilience, quality of life, and minor mental disorders in nursing professionals: A study in challenging work environments. *International Journal of Environmental Research and Public Health*, 22(9), Article 1375.
- Shapiro, A. L., et al. (2023). Stress, sleep, and resilience among rural BSN students in a new nursing program. *Nurse Educator*, 48(6), E186–E190.
- Stubin, C. A., Ruth-Sahd, L., & Dahan, T. A. (2024). Promoting nursing student mental health wellness: The impact of resilience-building and faculty support. *Nurse Educator*, 49(3), 119–124.
- Wagnild, G. M., & Young, H. M. (1993). Development and psychometric evaluation of the Resilience Scale. *Journal of Nursing Measurement*, 1(2), 165–178.
- World Health Organization. (2021). Mental health in adolescents [Fact sheet]. <https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health>
- Wu, X., et al. (2024). Personality portraits, resilience, and professional identity among nursing students: A cross-sectional study. *BMC Nursing*, 23(1), Article 77.

AIRLINES: WHAT EXPLAINS THE CHOICE OF BRAZILIAN TOURISTS?

COMPANHIAS AÉREAS: O QUE EXPLICA A ESCOLHA DOS TURISTAS BRASILEIROS?

AEROLÍNEAS: ¿QUÉ EXPLICA LA ELECCIÓN DE LOS TURISTAS BRASILEÑOS?



<https://doi.org/10.56238/sevened2026.008-172>

Viviane Chunques Gervasoni¹, George Bedinelli Rossi²

ABSTRACT

According to the Logistics Bulletin released by the National Civil Aviation Agency (ANAC), air transport accounted for almost 70% of interstate travel on regular routes in 2019. In the Planned Behavior Theory (PBT) model, behavioral intention is directly influenced by three components: attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). Although PBT has been used in many studies related to transportation (Hsiao; Yang, 2010; Jing et al., 2014), it has limited application in passenger research in the LCC (low-cost carrier) market. Therefore, this research aimed to expand the theory of planned behavior focusing on Brazilian low-cost airlines. The results showed that PBT, when applied to understanding Brazilian low-cost airlines, has the following explanatory variables: risk, quality, and frequency.

Keywords: Brazilian Tourists. Brazilian Airlines. Theory of Planned Behavior.

RESUMO

Segundo o Boletim de Logística divulgado pela Agência Nacional de Aviação Civil (ANAC) o transporte aéreo foi responsável por quase 70% dos embarques para viagens interestaduais em linhas regulares em 2019. No modelo TCP (Teoria do Comportamento Planejado), a intenção comportamental é diretamente influenciada por três componentes: atitudes, normas subjetivas e controle comportamental percebido (Ajzen, 1991). Embora a TCP tenha sido usada em muitos estudos relacionados ao transporte (Hsiao; Yang, 2010; Jing et al., 2014), ele tem aplicação limitada na pesquisa de passageiros do LCC (mercado de empresas aéreas de baixo custo, ou Low Cost Carriers). Nesse ínterim, essa pesquisa teve por objetivo expandir a teoria do comportamento planejado com foco nas companhias aéreas brasileiras de baixo custo. Teve como resultados encontrados que TCP quando aplicada a compreensão das companhias aéreas brasileiras de baixo custo tem como variáveis de explicação: risco, qualidade e frequência.

Palavras-chave: Turistas Brasileiros. Empresas Aéreas Brasileiras. Teoria do Comportamento Planejado.

¹ Dr. in Administration. FEI. E-mail: viviane.chunques@gmail.com

² Dr. in Administration. Escola de Artes, Ciências e Humanidades da Universidade de São Paulo (EACH USP). E-mail: george.rossi@gmail.com

RESUMEN

Según el Boletín de Logística publicado por la Agencia Nacional de Aviación Civil (ANAC), el transporte aéreo representó casi el 70% de los viajes interestatales en rutas regulares en 2019. En el modelo de la Teoría del Comportamiento Planificado (TCP), la intención de comportamiento se ve directamente influenciada por tres componentes: actitudes, normas subjetivas y control conductual percibido (Ajzen, 1991). Si bien la TCP se ha utilizado en numerosos estudios relacionados con el transporte (Hsiao; Yang, 2010; Jing et al., 2014), su aplicación en la investigación de pasajeros en el mercado de aerolíneas de bajo costo (LCC) es limitada. Por lo tanto, esta investigación tuvo como objetivo ampliar la teoría del comportamiento planificado, centrándose en las aerolíneas brasileñas de bajo costo. Los resultados mostraron que la TCP, aplicada a la comprensión de las aerolíneas brasileñas de bajo costo, presenta las siguientes variables explicativas: riesgo, calidad y frecuencia.

Palabras clave: Turistas Brasileños. Aerolíneas Brasileñas. Teoría del Comportamiento Planificado.

1 INTRODUCTION

According to the Logistics Bulletin released by the National Civil Aviation Agency (ANAC), air transport was responsible for almost 70% of shipments for interstate travel on regular lines in 2019. The airline sector is fundamental to tourism activities and, therefore, it is said to catalyze, that is, it induces part of other activities involved in tourism. (ANAC, 2023).

According to the Brazilian Association of Airlines (ABEAR), the airline sector was responsible for 25.6% of the gross value added of tourism in 2019 and 27.1% of the taxes paid related to tourism activity. Overall, the activities of the airline sector catalyzed 53.2 billion reais in value added via induction of tourism-related activities and R\$ 16.5 billion in taxes paid for such activities.

Azul Linhas Aéreas Brasileiras, for example, is a national aviation company, headquartered in São Paulo. Created in 2008, the company began its activities focused on regional routes from the airport of Viracopos (SP).

In a short time, Azul conquered a large number of passengers. Thus, it expanded its operations in the national territory and started to offer selected international routes, such as Argentina, the United States, Portugal and Uruguay.

In 2014, Azul incorporated *Trip* Linhas Aéreas and became the third largest company in number of passengers. As of June 2022, its fleet had more than 140 aircraft, with national models from Embraer and international models from *Airbus and Avions de Transport Régional* (ATR) (Genial Investimentos, 2023).

Azul's IPO took place in 2017, in an initial public offering (IPO) that raised around R\$ 643 million. At the time, preferred shares were issued under the AZUL4 ticket and these are shares that guarantee preference in receiving dividends. (Genial Investimentos, 2023). Another company that operates with air transport is Gol Linhas Aereas Inteligentes S.A. Created in 2001 in Rio de Janeiro, it is among the largest aviation companies in Brazil. As of June 2022, the company had more than 120 aircraft and carried out different national and international routes. (Genial Investimentos, 2023).

Gol also operates with logistics, through GAC Inc., in addition to owning two financial services companies (GOL *Finance* and GOL *Finance Cayman*). Throughout its history, the company has acquired Varig and Webjet, as well as entered into alliances with Delta and *Air France* — KLM. (Genial Investimentos, 2023).

Taking into account that tourism stimulates economic and social development by generating employment in addition to moving different sectors of the economy, this study is justified by the investigation of how low-cost air travel stimulates tourism. In the meantime, the research problem raised is: Does the Theory of Planned Behavior (TCP) explain the

choice of air transport by Brazilian tourists? Aiming to expand the theory of planned behavior with a focus on Brazilian low-cost airlines.

2 THEORETICAL FRAMEWORK

In recent decades, there has been a considerable increase in academic terms regarding the enrichment of the theoretical and methodological field of Tourism. However, aiming at a greater unfolding of the object itself, a relevant item may not be mentioned frequently, namely: the history of Tourism and Travel. (Cisne & Gastal, 2010).

In this sense, Rodrigues (2000) states that the tourism industry has presented unusual results in developing countries, since it not only contributes to the creation of jobs, the increase in income, but also contributes to reducing regional differences and improving the quality of life of less developed regions, due to the execution of infrastructure works, such as transportation, sanitation, energy etc.

Although there is no single definition for tourism, the United Nations World Tourism Organization, in its recommendations for tourism statistics, defines it as "the activities that people carry out during their travels and stay in places other than those in which they live, for a period of time less than one consecutive year, for leisure purposes, business and others" (Campos, 2007).

Currently, tourism encompasses the correlation of different sectors of economic activity, with the objective of promoting cultural, religious, leisure or business travel. For this, it is necessary to provide transportation, accommodation, recreation, food and other related services to meet the needs of domestic and international travelers, from arrival to departure from a city, state or country (Colantuono, 2015).

In summary, tourism encompasses all the activities that people carry out during their trips and stays in places other than their usual surroundings, for a consecutive period of less than one year, for leisure, business or other purposes (UNWTO, 2001).

The degree of market concentration in the operations of *charter* airlines (those that charter aircraft to perform flights that are not part of their scheduled network) varies between countries and even between locations within a country, but appears to be highly concentrated in key markets. By the end of the 1980s, for example, the five major *charter* airlines held a combined market share, in terms of miles carried per passenger, of more than 80% in Spain and approximately 70% in the United Kingdom (Bote Gómez & Sinclair, 1991).

The dominance of major *charter* airlines is being challenged, however, by the emergence of low-cost airlines, whose pricing strategies represent a significant shift in the

behavior of the airline industry (Piga & Filippi, 2002) and by increased price-based competition among major airlines (Milman, 1997; French, 1998).

In the era of globalization, air travel has evolved from a luxury reserved only for the wealthy to the primary mode of transportation for most people traveling the world, whether for business or pleasure. This is evidenced not only by the substantial increase in the number of people choosing to travel by air in recent years, but also by the fact that the number of people traveling by air is expected to increase from nearly 2 billion in 2021 to 2.6 billion in 2026 and to 8.2 billion in 2037. (Thongkruer & Wanarat, 2023).

As is evident in the first quarter of 2022, the total number of domestic air passengers was 9.74 million, increasing by 23.4 percent or 1.85 million, compared to the previous quarter in 2021, in which the total number of domestic passengers totaled 7.89 million. . (Thongkruer & Wanarat, 2023).

In view of this, the market for low-cost airlines, or *Low Cost Carriers* (LCC), as they are universally known, had its beginning with the change in *Southwest Airlines'* business model, when there was the deregulation of air transport in the United States of America (USA), in 1978. (Hiney, et al., 2025).

A review of the literature reveals important gaps in the research of LCC passengers (Low Cost *Carriers* market). First, the existing literature focuses mainly on intermodal choices between FSCs (*Full Service Carrier*), that is, companies that still embed many services in their business strategies, and LCCs, which have their business strategies focused on low cost and consequently for not providing extra services, leaving aside the study of passengers' behavioral intentions. (Hiney, et al., 2025).

While these studies identified important factors, such as price and service, for passengers to choose LCCs (low-cost *carriers*) over other modes of transportation, they did not provide an in-depth analysis of how these factors influenced passengers' motivation to use LCCs. (Hiney, et al., 2025). In view of this, the application of the Theory of Planned Behavior (TCP) aims to understand the criteria that lead to the choice of air transport by the Brazilian tourist.

The theory of planned behavior – TCP – is one of the most important theoretical frameworks for predicting human behaviors (Ajzen, 2002). In the TCP (Theory of Planned Behavior) model, behavioral intention is directly influenced by three components: attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991).

While the three components can provide useful predictions of intention and behavior, the model is open to the inclusion of additional predictors if they can be shown to capture a significant proportion of the variation in intention or behavior after the theory's current

variables have been considered (Ajzen, 1991). The flexibility and openness of the model make TCP (Theory of Planned Behavior) a useful conceptual framework for examining intentions and behaviors in various domains, including air transport. Although TCP (Theory of Planned Behavior) has been used in many transport-related studies (Hsiao & Yang, 2010; Jing et al., 2014), it has limited application in the search for LCC (*Low Cost Carriers*) passengers.

The Theory of Planned Behavior (TCP) (Ajze, 1991,2002) is a parsimonious model for explaining human behavior, which is widely applied in a variety of fields, including healthcare, marketing, education, etc. The core idea behind TCP is that a person's actual behavior is immediately determined by behavioral intention, which is a three-construct function, that is, attitude, subjective norm and perceived behavioral control.

Specifically speaking, behavioral intention is a measure of the strength of an individual's willingness to perform a certain behavior (Ajzen 1991). By definition, attitude is a reflection of a person's evaluative reaction to the performance of a certain behavior, for example, happy or sad, favorable or unfavorable, useless or useful. The more positive attitude individuals have, the stronger their intention to conduct a particular behavior (Beck & Ajzen 1991).

The subjective norm (SN) refers to the "perceived social pressure to perform or not to perform the behavior" (Ajzen 1991), which is related to the perception of the expectations of important others. It has been proven that the subjective norm positively affects behavioral intention (Castanier et al. 2013; Wang et al. 2016).

Regarding perceived behavioral control (PBC), it was added to the initial theory of rational action (Ajzen & Fishbein 1980; Fishbein & Ajzen 1975), and reflects the extent to which a person perceives constraints and their capacities on target behavior.

Simply put, it is defined as the degree of ease or difficulty in performing the behavior as being perceived by an individual (Ajzen 1991). Taking the choice of mode of transport as an example, individuals are more intentional to travel by a certain mode if they have some positive evaluations of it, perceive a greater degree of social pressure to use it, and are sure that they have the necessary skill. In addition, when perceived behavioral control coincides with actual behavioral control, it also exerts a direct influence on behavior (Ajzen 1991).

Although TCP (Theory of Planned Behavior) has been used in many studies related to transportation (Hsiao & Yang, 2010; Jing et al., 2014), it has limited application in LCC passenger research. The existing literature on passenger behavior in the context of LCC is primarily focused on intermodal choice between LCCs and FSCs using choice models (Ong & Tan, 2010; Chang & Sun, 2012; Jung & Yoo, 2014) and in the perception of LCCs based

on service-related models, especially the SERVQUAL model that measures five dimensions of quality of service, including tangible, responsiveness, reliability, assurance, and empathy (Ariffin et al., 2010; Kim & Lee, 2011; Lerrthaitrakul & Panjakajornsak, 2014).

In China, Chiou & Chen (2010) examined the relationships between service factors, satisfaction, airline image, and behavioral intentions in passengers' choice of LCCs and FSCs. The results indicated that the perception of service was most important to FSC passengers, while the value of service had the greatest effect on intentions among LCC passengers (Chiou & Chen, 2010). Passenger attitudes and behaviors received limited attention in the survey on LCC passengers. Only one study by Buaphiban & Truong (2017) developed a TCP (Theory of Planned Behavior) model to examine passenger purchase intentions and actual LCC ticket purchases in Thailand. The study focused exclusively on the components of TCP (Theory of Planned Behavior), and the authors reported that passenger attitudes and subjective norms had a positive impact on purchase intentions, while intention and perceived behavioral control significantly influenced purchase behaviors. The Theory of Planned Behavior is one of the most important theoretical frameworks for predicting human behaviors (Ajzen, 2002).

While these studies identified important factors, such as price and service, for passengers to choose LCCs over other modes of transportation, they did not provide an in-depth analysis of how these factors influenced passengers' motivation to use LCCs. Second, there is a significant gap in understanding the motivation of LCC passengers in China, A country with a large population base, rapid economic development, and a huge market potential for low-cost travel. The study by Chiou & Chen (2010) focused primarily on service-related factors, which does not provide a complete picture of the underlying reasons for passengers to use LCCs. The effect of other factors, such as attitude and behavioral factors on the use of LCCs, has not yet been examined.

In addition, it is not known how context-specific factors, especially cultural factors, may influence passengers' decisions when using LCCs in China. Finally, although the TCP (Theory of Planned Behavior) study by Buaphiban & Truong (2017) provides insight into the influence of attitude and behavior on LCC passenger intent, the findings were derived from the mature LCC market in Thailand, which is very different from China, where the LCC market is at an early stage of development. Clearly, a new research model should be developed focusing on the behavioral intentions of Chinese passengers and including relevant factors to gain deeper insights into the intention to use LCCs in China.

According to the theory, three latent constructs explain intention, namely attitude toward behavior, subjective norm, and perceived behavioral control. Attitude is a person's

positive or negative evaluation of behavior and reflects beliefs about the likely outcomes of behavior (behavioral beliefs); subjective norm is the perception of social pressure to engage or not engage in the behavior, based on the perceived expectations of important referents (normative beliefs), such as the person's partner, parents, friends, or colleagues; and perceived behavioral control refers to the perceived ability to perform the behavior, taking into account beliefs about potentially facilitating or interfering factors, such as lack of financial resources, cooperation from others, and business experience (control beliefs). The three explanatory constructs of intention (attitude, subjective norm, and perceived behavioral control) are not necessarily independent. They are correlated due to common external causes and interactions between attitude, subjective norm, and perceived behavioral control are possible. TCP (Theory of Planned Behavior) assumes that intention has a strong causal influence on behavior (Fishbein & Ajzen, 1975). In view of this, the hypotheses for this research arise:

H1: The price is positively related to the intention of passengers to use Brazilian airlines. The ticket price of LCCs (*Low Cost Carriers*), which are typically 40–60% lower than their full-service competitors (O'Connell & Williams, 2005; Lawton, 2002), is often the main reason for passengers to choose LCCs over FSCs (Full Service Carrier, i.e., companies that still embed many services in their business strategies) (Chang and Sun, 2012; Sai et al., 2012; Jung & Yoo, 2014; Ong & Tan, 2010). Ong & Tan (2010) investigated determining factors in the choice between full-service Malaysia Airlines and low-cost AirAsia and found that fares are significant in the choice of airline.

In a similar study, Sai et al. (2012) indicated that LCC passengers in Malaysia placed great emphasis on low price, which reconfirmed the perception that price is the most important reason for choosing LCCs. The dominant effect of price; however, has been questioned in recent years due to changing market conditions (Kim & Lee, 2011). These passengers are likely to be price-sensitive and, as such, are potential customers for low-cost travel (Fu et al., 2015). Therefore, it is necessary to examine the effect of price on the intentions of Brazilian passengers.

The quality of service is often less important to LCC passengers compared to FSC passengers. In traditional LCC markets (*Low Cost Carriers*), passengers consider service elements such as in-flight service and punctuality to be insignificant in their choices between LCCs and FSCs (Mikulić & Prebežac, 2011). In emerging markets LCC; however, there seems to be market space for LCCs to offer low rates and high quality of service (Kim & Lee, 2011; Yeung et al., 2012).

Although these LCCs (low-cost *carriers*) still emphasize low costs and low fares, they

achieve cost reduction by improving efficiency in their operations, rather than reducing services (Saha & Theingi, 2009). Studies have shown that passengers of LCCs (*Low Cost Carriers*) are not only concerned with low prices, but also with services (Yang et al., 2012). The literature also shows that the quality of service can influence both consumer satisfaction (Ariffin et al., 2010; Kim & Lee, 2011) and behavioral intentions in relation to LCCs (Lerrthaitrakul & Panjakajornsak, 2014). The proposed model thus examines the quality of service of LCCs (*Low Cost Carriers* market), which is indicated by: H2: The quality of service is positively related to passengers' intentions to use Brazilian airlines.

Risk aversion in this context refers to the degree to which members of a society feel uncomfortable or uncertain in their consumption choices (Hofstede, 1984), for this study it is relevant because the decision to choose a mode of transport often contains uncertainties and risks related to the characteristics of the means of transport. Brazilian culture is considered more conservative in decision-making (Cheng, 2010), which explains the highly uncertain behaviors of Brazilian consumers (Quintal et al., 2010). In the context of LCC (*Low Cost Carriers*), this may mean that, since consumers associate LCCs with uncertainties, they would avoid using LCCs, due to the influence of their risk-averse culture, such as the quality of the service provided. Thus, H3 emerges: Risk aversion is negatively related to passengers' intentions to use LCCs (*Low Cost Carriers market*) in Brazil.

Technological effectiveness, which refers to the perceived control of knowledge and skills (internally) to perform a behavior successfully (Armitage & Conner, 1999), is sometimes treated as synonymous with perceived behavioral control (Ajzen, 1991; Conner & Armitage, 1998), who is more concerned with access to resources needed (externally) to perform a behavior successfully (Armitage & Conner, 1999; Conner & Armitage, 1998). In particular, this study uses technological effectiveness, which is relevant in the context of the LCC (*Low Cost Carriers* market) because, as airlines sell tickets directly to consumers through their websites to circumvent travel agents and their commissions (Escobar-Rodríguez & Carvajal-Trujillo, 2014), LCC passengers (low-cost airline market, or *Low Cost Carriers*) need sufficient IT knowledge and skills to research ticket information and buy it online. Previous studies indicate that a passenger's intention to use LCCs (low-cost *carriers*) may be affected by the person's technology-related skills and experience (Chang and Hung, 2013).

The role of technological effectiveness in motivating LCC passengers has received little scholarly attention. Thus, H4 is proposed: Technological effectiveness is positively related to passengers' intentions to use LCCs in Brazil. High frequency is an effective commercial strategy for LCCs (*Low Cost Carriers*) to compete with FSCs. Flight frequency appears to have a different impact on the choices of business travelers and "tourist"

passengers for LCCs. Flight frequency is an important consideration for business travelers to choose LCCs (Mason, 2001), but it is often insignificant for tour passengers to use LCCs. (Mikulić & Prebežac, 2011). Capacity constraints and congestion at airports mean that LCCs (low-cost *carriers*) are unable to achieve the desired turnaround times (frequency), which are essential to the success of most LCCs (Liang & James, 2009). The extent to which flight frequency affects passengers' intentions in relation to LCCs (*Low Cost Carriers*) was not examined for the Brazilian tourist.

Thus, Hypothesis 5 arises, namely: Frequency is positively related to passengers' intentions to use LCCs (*Low Cost Carriers* market) in Brazil. In traditional LCC markets, airport access is often inconvenient because LCCs (Low Cost Carriers) typically operate from secondary airports far from the city center to save costs and minimize aircraft turnaround time (Abdullah & Takahashi, 2016). Passengers in these markets are generally willing to accept inconvenience in exchange for lower airfares, fewer delays, and easier ground transportation (Tierney & Kuby, 2008).

Jung & Yoo (2014) suggested that access time significantly influenced passenger choice involving LCCs (*low cost carriers*), especially for business passengers who perceived greater value from access time and were willing to pay more to shorten access time. In Brazil, LCCs operate mainly at major airports, which means that access can play an important role in passengers' decisions when using LCCs. Thus, H6 is proposed: Access is positively related to passengers' intentions to use LCCs (*Low Cost Carriers*) in Brazil.

3 METHODOLOGY

To fill in the gaps in the literature, this study proposed an expanded model of TCP (Theory of Planned Behavior) focusing on the service provision of Brazilian airlines and Brazilian tourists.

Three principles guide the selection of external factors. Firstly, previous studies often indicate the importance of some factors in passenger choice for LCCs. Price, for example, is often considered significant for passengers to choose between LCCs and FSCs and will therefore be included in the model.

Additionally, because the airline industry is a service industry, service-related attributes such as frequency, airport access, and quality of service can influence passengers' travel decisions; thus, they will be added to the template.

Consumption decisions can be influenced by cultural factors, where culture strongly influences personal behaviors (Luo, 2019). For this study, a much-researched and highly relevant cultural factor will be included in the model. In total, six external factors, including price, quality of service, risk aversion (cultural factor), technological effectiveness, frequency, and access were added to the TCP (Theory of Planned Behavior) model. (Pan & Truong, 2018).

The universe studied in this research will be the tourism sector, specifically companies directly related to tourism, namely: air transport. Two air transport companies listed on the BM&F BOVESPA were considered, namely: Azul Linhas Aéreas Brasileiras and Gol Linhas Aereas Inteligentes S.A. The criterion for choosing the sample of companies is non-probabilistic and for convenience, since the selection of the companies studied here were chosen by the author herself, as they are publicly traded and disclose their data. (Malhotra, 2001).

Thus, at first this research was of a qualitative nature, which had as an instrument of data analysis the financial statements and explanatory notes disclosed to the shareholders made available by the companies on the BM&FBovespa website, that is, content analysis. (BM&FBovespa, 2024).

Based on the reports released in the period from 2017 to 2024, the categories of: cash, investments and net income were observed for analysis of the companies. The years 2020, 2021 and 2022 were discarded because they were years of COVID19 pandemic and that, if analyzed, could compromise the analysis carried out, since the airline sector was one of the most affected by this public calamity. The period chosen is due to the fact that the company Azul Linhas Aéreas S.A. made its IPO - 2017 *Initial Public Offering* or Initial Public Offering which is the process of launching the shares of a company on the stock exchange, for leveling

the analysis the same period was considered for the company Gol Linhas áreas Inteligentes S.A. The software used for analysis was Atlas - TI which showed the codes with different colors, according to the frequency they were marked in the texts. (Denzin, N. & Lincoln, 2020).

Thus, the categories related to the questionnaire of this research were:

Table 1

Qualitative categories

Category	Frequency	Percentage
When choosing an airline, you choose to:		
Latam	79	38,92%
Goal	77	37,93%
Blue	44	21,67%
Avianca	3	1,48%
Passaredo	0	0,00%
When you make trips with air transport, you make them:		
alone most of the time	36	17,73%
accompanied most of the time	143	70,44%
Always alone	2	0,99%
Always accompanied	22	10,84%
How often you travel by air:		
up to 01 time a year	123	60,59%
from 02 to 04 times a year	67	33,00%
more than 04 times a year	13	6,40%
When traveling, the main reason for them is:		
Leisure	193	95,07%
Business	8	3,94%
Other	2	0,99%

Source: prepared by the author, 2025.

Thus, it is observed that the most remembered company was Latam Airlines S.A. with 79 respondents out of 203 analyzed, which corresponds to 38.92%; 143 people make their trips accompanied most of the time, which represents 70.44%; 123 respondents travel up to 01 time a year and the reason for 95.07% of the respondents is leisure travel.

Such answers emerged from the analysis carried out that aims to analyze consumption habits and achieve the objectives of the research, namely, to identify the factors/variables that explain tourists to choose an air transport company, expanding the Theory of Planned Behavior (TCP). (Ajzen, 1991)

In the second moment of this research, the present study employed a quantitative research approach based on an exploratory research paradigm to implement and achieve the research objectives, namely, to identify the factors/variables that explain tourists to choose an air transport company, expanding the Theory of Planned Behavior (TCP). (Ajzen, 1991)

For this, a structured questionnaire was elaborated and the data collected through closed questions, eight questions of a sociodemographic nature and six questions related to the hypotheses of this work, namely, the factors that could influence the intention to use Brazilian airlines. The questionnaire was carried out through a self-administered and online survey approach, using the *QuestionPro software* to collect data during the months of September 2024 to December 2024. The carefully designed questionnaire took an average of three minutes to complete. It was sent through a link and/or QRCode using the contact network at: *Telegram, Facebook, Instagram and Whatsapp*. (Javed, Tuýcková & Jibril, 2020).

The sociodemographic characteristics included were: gender, age, ethnic group, educational level, marital status, employment status, family income, and number of dependents living in the same household. The questionnaire was viewed by 291 people, with 203 completed/valid answers and 12 incomplete answers. (Javed, Tuýcková & Jibril, 2020).

The survey respondents were profiled by generation X to Z, which comprises people born from 1960 to 2009 (Zaninelli & Caldeira; 2022), as it is a profile of economically active respondents and, therefore, able to travel according to the Economically Active Population (PEA) index. (IBGE, 2024).

It was possible to verify that the dominant profile of the respondents belongs to the male gender, 58.13%, being between 35 and 44 years old, belonging to the white ethnic group, with higher education, married, having full-time work hours with a monthly income between 3 and 10 minimum wages without dependents.

Respondents' responses and opinions were measured using a *five-point* Likert scale.

The questions related to the hypotheses raised in this work emerged from the literature as well as from previous studies. Therefore, Table 3 indicates the same procedure, a summary of the hypotheses together with the operationalization and their respective literature.

Table 2
Operationalization of the hypotheses

Hypotheses	Indicator	Adapted literature
H1 The price is positively related to the intention of passengers to use Brazilian airlines.	By choosing this airline, you consider that the price charged was a relevant factor in your purchase decision.	Chang and Sun, 2012; Sai et al., 2012; Jung and Yoo, 2014; Ong and Tan, 2010.
H2 The quality of service is positively related to passengers' intentions to use Brazilian airlines.	When you chose this airline for your trip, the quality of the service provided was considered by you.	Ariffin et al., 2010; Kim and Lee, 2011; Lerrthaitrakul and Panjakajornsak, 2014.
H3 Risk aversion is negatively related to passengers' intentions to use LCCs (<i>Low Cost Carriers market</i>) in Brazil.	When choosing this airline, issues related to the risk of the trip, such as: damage and/or loss of luggage, delay in takeoff and/or landing, number of stopovers and boarding waiting time, air accidents, absence of on-board service, were decisive for his choice.	Hofstede, 1984; Cheng, 2010; Quintal et al., 2010.
H4 Technological effectiveness is positively related to passengers' intentions to use LCCs in Brazil.	The technology that this company chosen by you uses on trips, such as: websites for purchasing tickets, early check-in through apps or totems at airports, communication via SMS and/or WhatsApp about changes in schedules, gates and boarding times were considered by you.	Armitage and Conner, 1999; Conner and Armitage, 1998; Escobar-Rodríguez and Carvajal-Trujillo, 2014.
H5 The frequency is positively related to passengers' intentions to use LCCs (<i>Low Cost Carriers</i>) in Brazil.	The number of available flights and respective frequencies such as: available times, available airports, number of stopovers was considered by you when choosing the airline.	Mason, 2001; Liang and James, 2009; Mikuliš and Prebežac, 2011.
H6 Access is positively related to passengers' intentions to use LCCs (<i>Low Cost Carriers market</i>) in Brazil.	When considering the choice of airline, the question of commuting to the airport was for you.	Tierney and Kuby, 2008; Jung and Yoo, 2014; Abdullah and Takahashi, 2016.

Source: prepared by the author based on survey responses, 2025.

Thus, the following variables emerged from the hypotheses, as shown in the table below:

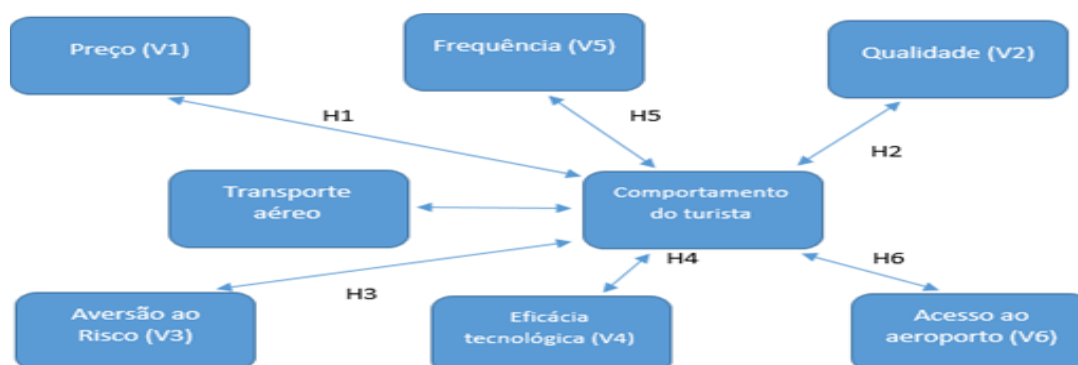
Table 3*Hypotheses versus Variables*

H1	V1 Price
H2	V2 Quality
H3	V3 Risk
H4	V4 Technology
H5	V5 Frequency
H6	V6 Displacement

Source: prepared by the author, 2025.

4 RESULTS AND DISCUSSIONS

The study used binomial logistic regression analysis for statistical analysis and response evaluation based on the proposed conceptual model.

Figure 1*Proposed model of the extended study of the theory of planned behavior*

Source: prepared by the author, 2025.

Binomial logistic regression analysis is a statistical technique used to model the relationship between a categorical dependent variable (usually binary) and one or more independent variables, which can be continuous or categorical. It estimates the probability of an event occurring, based on the independent variables. (Hair; Hult; Ringle & Sarstedt, 2016).

Thus, in this study, the was used to test the proposed research model and postulated hypotheses see table 3, namely: between the airlines Gol Linhas Aereas Inteligentes S/A and Azul Linhas Aéreas S/A which Brazilian tourist would choose taking into account the variables: price, quality, risk, technology, frequency and access (Hair; Sarstedt. & Gudergan, 2017). The number of respondents analyzed was 203 participants. The R 4.4.3 software was used for this analysis.

In the present study, some qualitative measures were taken. The author stated in the header section of the questionnaire that no answer was right or wrong to the questions asked. In addition, the author also assured respondents of their anonymized status regarding the information provided and proclaimed that the completion of the questionnaire could be

stopped at any time due to some inconvenience. (Javed, Tuřcková & Jibril, 2020).

For a better understanding of the binomial logistic regression analysis, the table below shows the legend of the variables:

Table 4

Variables

V1 Price
V2 Quality
V3 Risk
V4 Technology
V5 Frequency
V6 Displacement

Source: prepared by the author, 2025.

4.1 STATISTICAL ANALYSIS

Thus, the binomial logistic regression analysis is represented below:

Figure 2

Analysis of the R software data

```
Call:
glm(formula = v12 ~ v9 + v10 + v11 + v13 + v14 + v15 + v16 +
    v17 + v18, family = binomial, data = teste)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.7832  -1.2098   0.7279   0.9596   1.7370

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -0.87496    1.13496  -0.771   0.4408
v1           0.27751    0.19275   1.440   0.1500
v2          -0.39421    0.22784  -1.730   0.0836 .
v3           2.59444    1.08878   2.383   0.0172 *
v3.1        -0.09541    0.19477  -0.490   0.6242
v4          -0.22766    0.18392  -1.238   0.2158
v5          -0.23612    0.27374  -0.863   0.3884
v5.1         0.12350    0.20802   0.594   0.5527
v5.2        -0.39471    0.21111  -1.870   0.0615 .
v6           0.07349    0.17633   0.417   0.6768

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 271.36  on 202  degrees of freedom
Residual deviance: 250.34  on 193  degrees of freedom
AIC: 270.34

Number of Fisher Scoring iterations: 5
```

Source: prepared by the author, 2025.

It is possible to notice that the values of Null deviance and residual deviance are close to each other, which characterizes it as an accepted model, since the closer these numbers

are, the better the model presented. Also the AIC value, that is, 270.34, denotes that the model is acceptable because, when comparing the models, it has a small value, which guarantees its higher quality and simplicity.

As can be seen in figure 2, in the study between the companies Gol Linhas Aereas Inteligentes S/A and Azul Linhas Aéreas S/A, the choice of the sample studied would be by the company Azul Linhas Aéreas S/A, since in the binomial analysis it is represented by 1 and Gol Linhas Aereas Inteligentes S/A represented by 0. The calculation below denotes this preference:

$$e^{-0.87+2.59-0.24+0.12+0.27-0.39-0.095-0.23-0.40+0.073}$$

$$\Pi = \frac{e^{-0.87+2.59-0.24+0.12+0.27-0.39-0.095-0.23-0.40+0.073}}{1 + e^{-0.87+2.59-0.24+0.12+0.27-0.39-0.095-0.23-0.40+0.073}} = 0.700 \quad (1)$$

That is, the value 0.70 is closer to 1, therefore, Azul Linhas Aéreas S/A.

Also as shown in the model, the independent variables that most explain the choice of Brazilian tourists to choose Azul Linhas Aéreas S/A are: V3 Risk, with 0.0172, V2 Quality, with 0.0836 and V5 Frequency with 0.3884.

That is, the hypotheses raised in this work H2 When you chose this airline for your trip, the quality of the service provided was considered by you to have been accepted, as well as H3: When choosing this airline, issues related to the risk of the trip such as: breakdown and/or loss of luggage, delay in takeoff and/or landing, number of stopovers and boarding waiting time, air accidents, absence of on-board service, were decisive for your choice and finally, H5: The number of flights available and respective frequencies such as: available times, available airports, number of stopovers was considered by you when choosing the airline.

It is also relevant to highlight that, according to the sociodemographic variables analyzed, this preference is for consumers with the dominant profile of male relatives, 58.13%, between 35 and 44 years old, belonging to the white ethnic group, with higher education, married, working full-time hours with a monthly income between 3 and 10 minimum wages without dependents.

5 FINAL CONSIDERATIONS

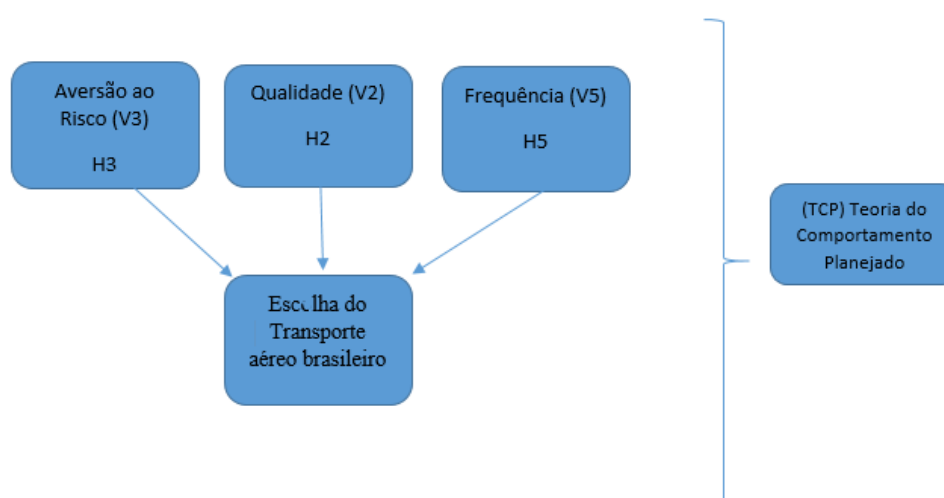
This study aimed to expand the theory of planned behavior with a focus on Brazilian low-cost airlines. Having in its specific objective to identify the factors/variables that explain tourists to choose an air transport company, expanding the Theory of Planned Behavior (TCP). To do so, he answered the research problem: Does the Theory of Planned Behavior (TCP) explain the choice of air transport by Brazilian tourists?

The findings of this research showed that the Theory of Planned Behavior (TCP) when applied to the understanding of Brazilian low-cost airlines has as explanation variables: risk, quality and frequency.

As shown in the figure below:

Figure 3

Study design



Source: prepared by the author, 2025.

Thus, this study had its hypotheses:

H2 When you chose this airline for your trip, the quality of the service provided was considered by you to have been accepted, as well as H3: When choosing this airline, issues related to the risk of the trip such as: damage and/or loss of luggage, delay in takeoff and/or landing, number of stopovers and boarding waiting time, air accidents, absence of on-board service, were decisive for your choice and finally, H5: The number of flights available and respective frequencies such as: available times, available airports, number of stopovers was considered by you when choosing the airline accepted in this study.

As limitations of this research, the sociodemographic variable of generation is especially understood, namely: generation X to Z, which comprises people born from the period from 1960 to 2009, perhaps using a different generation cut, results in answers, variables and conclusions that are also different in relation to the variables that justify the choice of Brazilian airlines by tourists.

Also analyze the criteria that led the respondents to choose the company Latam Airlines Group S.A. since it is not a Brazilian company, but among the respondents of this survey 38.92% pointed out this company as their choice of travel.

REFERENCES

- Agência Nacional de Aviação Civil. (n.d.). ANAC. <https://www.gov.br/anac/pt-br>
- Associação Brasileira das Empresas Aéreas. (n.d.). Área de publicações. <https://abear.com.br/imprensa/>
- Abdullah, D., & Takahashi, H. (2016). Cost effective management of low-cost carrier in Pakistan by enterprise resource planning (ERP). *New Horizons*, 1–20.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211.
- Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology*, 32(4), 665–683.
- Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour*. Prentice-Hall.
- Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology*, 40(4), 471–499.
- Ariffin, A. A. M., Salleh, A. H. M., Aziz, N. A., & Asbudin, A. A. (2010). Service quality and satisfaction for low-cost carriers. *International Review of Business Research Papers*, 6(1), 47–56.
- Beck, L., & Ajzen, I. (1991). Predicting dishonest actions using the theory of planned behavior. *Journal of Research in Personality*, 25(3), 285–301.
- Bote Gómez, V., & Sinclair, M. T. (1991). Integration in the tourism industry. In M. T. Sinclair & M. J. Stabler (Eds.), *The tourism industry: An international analysis*. CAB International.
- Buaphiban, T., & Truong, D. (2017). Evaluation of passengers' buying behaviors toward low-cost carriers in Southeast Asia. *Journal of Air Transport Management*, 59, 124–133.
- BM&FBovespa. (n.d.). Azul Linhas Aéreas S/A. <https://www.rad.cvm.gov.br/ENET/frnGerenciaPaginaFRE.aspx?NumeroSequencialDocumento=144149&CodigoTipoInstituicao=1>
- BM&FBovespa. (n.d.). Gol Linhas Aéreas Inteligentes S/A. https://www.b3.com.br/pt_br/produtos-e-servicos/negociacao/renda-variavel/empresas-listadas.htm?codigo=19569
- Campos, A. I. R. da C. (2007). *O comportamento do consumidor no turismo: jovens estrangeiros e o Rio de Janeiro* [Dissertação de mestrado, Universidade Federal do Rio de Janeiro – Escola de Comunicação].
- Castanier, C., et al. (2013). Theory of planned behaviour and road violations: The moderating influence of perceived behavioural control. *Transportation Research Part F: Traffic Psychology and Behaviour*, 18, 148–158.
- Cisne, R., & Gastal, S. (2010). Turismo e sua história: rediscutindo periodizações. In *Anais do VI Seminário de Pesquisa em Turismo do Mercosul*.

- Colantuono, A. C. de S. (2015). O processo histórico da atividade turística mundial e nacional. *Cadernos da Fucamp*, 14(21), 30–41.
- Chang, L.-Y., & Sun, P.-Y. (2012). Stated-choice analysis of willingness to pay for low-cost carrier services. *Journal of Air Transport Management*, 20, 15–17.
- Chang, L.-Y., & Hung, S.-C. (2013). Adoption and loyalty toward low-cost carriers: The case of Taipei-Singapore passengers. *Transportation Research Part E: Logistics and Transportation Review*, 50, 29–36.
- Cheng, C. (2010). Are the Chinese really more risk averse? A cross-cultural comparison of the risk-return relationship. *Journal of Global Business Management*, 6(1), 1–6.
- Chiou, Y.-C., & Chen, Y.-H. (2010). Factors influencing the intentions of passengers regarding full service and low-cost carriers: A note. *Journal of Air Transport Management*, 16(4), 226–228.
- Conner, M., & Armitage, C. J. (1998). Extending the theory of planned behavior: A review and avenues for further research. *Journal of Applied Social Psychology*, 28(15), 1429–1464.
- Denzin, N., & Lincoln, Y. (Eds.). (2020). *Handbook of qualitative research*. Sage.
- Escobar-Rodríguez, T., & Carvajal-Trujillo, E. (2014). Online purchasing tickets for low-cost carriers: An application of the unified theory of acceptance and use of technology (UTAUT) model. *Tourism Management*, 43, 70–88.
- French, T. (1998). Regional airlines in Europe. *Travel and Tourism Analyst*, (5), 1–18.
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Addison-Wesley.
- Fu, X., Lei, Z., Wang, K., & Yan, J. (2015). Low-cost carrier competition and route entry in emerging but regulated aviation market – the case of China. *Transportation Research Part A: Policy and Practice*, 3–16.
- Genial Investimentos. (n.d.). Empresas de turismo na Bolsa de Valores. <https://blog.genialinvestimentos.com.br/empresas-de-turismo-na-bolsa-de-valores/>
- Hair, J. F., Jr., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2016). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage Publications.
- Hair, J. F., Jr., Sarstedt, M., Ringle, C. M., & Gudergan, S. P. (2017). *Advanced issues in partial least squares structural equation modeling*. Sage Publications.
- Hsiao, C.-H., & Yang, C. (2010). Predicting the travel intention to take high-speed rail among college students. *Transportation Research Part F: Traffic Psychology and Behaviour*, 13(4), 277–287.
- Hofstede, G. (1984). Cultural dimensions in management and planning. *Asia Pacific Journal of Management*, 1(2), 81–99.
- Hiney, N., et al. (2025). European regional airports: Emerging from the storm or facing a gathering storm? In *Transport transitions: Advancing sustainable and inclusive mobility* (pp. 668–675).
- Instituto Brasileiro de Geografia e Estatística. (2024). População economicamente ativa – PEA. https://ftp.ibge.gov.br/Trabalho_e_Rendimento/Pesquisa_Nacional_por_Amostra_de_Domicilios_continua/Trimestral/Fasciculos_Indicadores_IBGE/2024/pnadc_202401_trimestre_caderno.pdf

- Javed, M., Tuýcková, Z., & Jibril, A. (2020). The role of social media on tourists' behavior: An empirical analysis of millennials from the Czech Republic. *Sustainability*.
- Jing, P., et al. (2014). Application of the expanded theory of planned behavior in intercity travel behavior. *Discrete Dynamics in Nature and Society*, 1–10.
- Jung, S.-Y., & Yoo, K.-E. (2014). Passenger airline choice behavior for domestic short-haul travel in South Korea. *Journal of Air Transport Management*, 38, 43–47.
- Kim, Y. K., & Lee, H. R. (2011). Customer satisfaction using low-cost carriers. *Tourism Management*, 32(2), 235–243.
- Lawton, T. C. (2002). *Cleared for take-off: Structure and strategy in the low fare airline business*. Ashgate Publishing.
- Lerrthaitrakul, W., & Panjakajornsak, V. (2014). The airline service quality affecting post purchase behavioral intention: Empirical evidence from the low-cost airline industry. *International Journal of Trade, Economics and Finance*, 5(2), 155–158.
- Liang, L.-T., & James, A. D. (2009). The low-cost carrier model in China: The adoption of a strategic innovation. *Technology Analysis & Strategic Management*, 21(1), 129–148.
- Luo, Y. (2019). Analysis of culture and buyer behavior. Chinese market. *Asian Culture and History*, 25–30.
- Malhotra, N. K. (2001). *Pesquisa de marketing: Uma orientação aplicada* (4^a ed.). Bookman.
- Mason, K. J. (2001). Marketing low-cost airline services to business travellers. *Journal of Air Transport Management*, 7(2), 103–109.
- Milman, A. (1997). The U.S. airline industry. *Travel and Tourism Analyst*, (3), 4–21.
- Mikulić, J., & Prebežac, D. (2011). What drives passenger loyalty to traditional and low-cost airlines? A formative partial least squares approach. *Journal of Air Transport Management*, 17(4), 237–240.
- Ong, W. L., & Tan, A. K. G. (2010). A note on the determinants of airline choice: The case of Air Asia and Malaysia airlines. *Journal of Air Transport Management*, 16(4), 209–212.
- O'Connell, J. F., & Williams, G. (2005). Passengers' perceptions of low-cost airlines and full-service carriers: A case study involving Ryanair, Aer Lingus, Air Asia, and Malaysia Airlines. *Journal of Air Transport Management*, 11(4), 259–272.
- Organização Mundial do Turismo. (2001). *Introdução ao turismo* (D. M. R. Córner, Trad.). Roca.
- Piga, C., & Filippi, N. (2002). Booking and flying with low-cost airlines. *International Journal of Tourism Research*, 4(3), 237–249.
- Pan, J. Y., & Truong, D. (2018). Passengers' intentions to use low-cost carriers: An extended theory of planned behavior model. *Journal of Air Transport Management*, 38–48.
- Quintal, V. A., Lee, J. A., & Soutar, G. N. (2010). Tourists' information search: The differential impact of risk and uncertainty avoidance. *International Journal of Tourism Research*, 12(4), 321–333.
- Rodrigues, A. B. (Org.). (2000). *Turismo e desenvolvimento local* (2^a ed.). Hucitec.

- Sai, B. T., et al. (2012). Factors determining choice of full-service airlines and low-cost carriers: The case of Malaysia. *Asia-Pacific Journal of Innovation and Hospitality Tourism*, 1(2), 179–194.
- Saha, G. C., & Theingi. (2009). Service quality, satisfaction, and behavioral intentions: A study of low-cost airline carriers in Thailand. *Managing Service Quality*, 19(3), 350–372.
- Tierney, S., & Kuby, M. (2008). Airline and airport choice by passengers in multi-airport regions: The effect of Southwest Airlines. *The Professional Geographer*, 60(1), 15–32.
- Thongkruer, P., & Wanarat, S. (2023). The relationship between air travel service quality and factors of theory of planned behavior: Evidence from low-cost airlines in Thailand. *Sustainability*, 15(19), Article 8839.
- Zaninelli, T., Caldeira, G., & Fonseca, D. (2022). Baby Boomers, nativos digitais, gerações X, Y e Z, geração polegar e geração alfa: Perfil geracional dos atuais e potenciais usuários das bibliotecas universitárias. *Brazilian Journal of Information Studies: Research Trends*, 16.
- Wang, S., Fan, J., Zhao, D., Yang, S., & Fu, Y. (2016). Predicting consumers' intention to adopt hybrid electric vehicles: Using an extended version of the theory of planned behavior model. *Transportation*, 43(1), 1–21.
- Yang, K.-C., Hsieh, T.-C., Li, H., & Yang, C. (2012). Assessing how service quality, airline image and customer value affect the intentions of passengers regarding low-cost carriers. *Journal of Air Transport Management*, 20, 52–53.
- Yeung, S., Tsang, N., & Lee, Z. (2012). An importance–performance analysis of low-cost carriers in Asia. *International Journal of Hospitality & Tourism Administration*, 13(3), 173–174.

CONSUMER PROFILE OF A FAST FOOD RESTAURANT IN MALL PLAZA MAULE, CHILE

PERFIL DO CONSUMIDOR DE UM RESTAURANTE DE FAST FOOD NO MALL PLAZA MAULE, CHILE

PERFIL DE CONSUMIDORES DE UN LOCAL DE COMIDA RÁPIDA DEL MALL PLAZA MAULE, CHILE



<https://doi.org/10.56238/sevened2026.008-173>

Moacyr Portes Júnior¹, Patricio Wladimir Gurtiérrez Montecino², Marcela de la Paz Inostroza Figueroa³, Sebastián Eduardo Retamal López⁴, Natalia de los Ángeles Toloza Salgado⁵, Lisbetty del Pilar Morales Mora⁶

ABSTRACT

Introduction: Four out of ten Chileans consume junk food at least once a week.

Objective: To describe the consumer profile of a fast-food restaurant in the Mall Plaza Maule, Maule, Chile.

Methodology: A quantitative, descriptive, non-experimental study with a grounded theory design; sample: 990 subjects over 18 years of age, collected over a one-week period.

Instrument: A survey created by the researchers and validated by experts; eight questions: weight/height, age, gender, occupation, educational level, frequency of visits to the fast-food restaurant, what they usually eat, three meals they most often eat, who they go with, the reason for eating, whether they engage in physical activity and how often, and what types of exercise they do.

Results: Consumers are predominantly male (82%), young adults (18-40 years old), students or workers with secondary to university education, and an average BMI in the overweight range (20-25%). Consumption frequency is weekly (mainly 1-2 times), with a preference for traditional fast food such as french fries (537), hot dogs (457), pizza (282), and hamburgers (259), over healthy options (258). Consumers visit in the company of friends (282), partners (228), or family (184), motivated by price (372), taste (291), and speed (586). Although 75% engage in physical activity (1-2 times/week, 30 min-2 hours), moderate exercise such as weightlifting, cardio, jogging, or walking predominates, which is insufficient

¹ Dr. in Human Motricity Sciences. Universidad Autónoma de Chile. E-mail: mportesj@uautonoma.cl
Orcid: <https://orcid.org/0000-0001-8459-865X> Lattes: <http://lattes.cnpq.br/2024338048420561>

² Graduated in Education. Universidad Autónoma de Chile. E-mail: patitoloino93@gmail.com

³ Graduated in Education. Universidad Autónoma de Chile. E-mail: Marce.inostroza@gmail.com

⁴ Graduated in Education. Universidad Autónoma de Chile. E-mail: Seba.retamal12@gmail.com

⁵ Graduated in Education. Universidad Autónoma de Chile. E-mail: Nathita.toloza@gmail.com

⁶ Master's degree in Teaching and Management for Higher Education. Universidad Autónoma de Chile.
E-mail: Lisbetty.morales@cloud.uautonoma.cl

to counteract high caloric intake.

Conclusion: Given the Chilean context of overnutrition and obesity, the profile reveals urban lifestyles with a nutritional-activity imbalance, suggesting interventions for healthy menus and the promotion of exercise.

Keywords: Consumers. Fast Food. Physical Activity. Mall Plaza Maule.

RESUMO

Introdução: Quatro em cada dez chilenos consomem junk food pelo menos uma vez por semana.

Objetivo: Descrever o perfil do consumidor de um restaurante de fast food no Mall Plaza Maule, Maule, Chile.

Metodologia: Estudo quantitativo, descritivo, não experimental, com delineamento baseado na teoria fundamentada; amostra: 990 indivíduos com mais de 18 anos, coletados ao longo de um período de uma semana.

Instrumento: Um questionário elaborado pelos pesquisadores e validado por especialistas, composto por oito questões: peso/altura, idade, gênero, ocupação, nível educacional, frequência de visitas ao restaurante de fast food, o que costumam consumir, três refeições que mais ingerem, com quem costumam ir, motivo para comer, se praticam atividade física e com que frequência, e quais tipos de exercícios realizam.

Resultados: Os consumidores são predominantemente homens (82%), jovens adultos (18–40 anos), estudantes ou trabalhadores com escolaridade do ensino médio ao superior, e com IMC médio na faixa de sobrepeso (20–25%). A frequência de consumo é semanal (principalmente 1–2 vezes), com preferência por alimentos tradicionais de fast food, como batatas fritas (537), cachorros-quentes (457), pizza (282) e hambúrgueres (259), em comparação com opções saudáveis (258). Os consumidores visitam o local acompanhados principalmente por amigos (282), parceiros (228) ou familiares (184), motivados por preço (372), sabor (291) e rapidez (586). Embora 75% pratiquem atividade física (1–2 vezes por semana, entre 30 minutos e 2 horas), predominam exercícios moderados, como musculação, cardio, corrida ou caminhada, o que se mostra insuficiente para compensar a alta ingestão calórica.

Conclusão: Diante do contexto chileno de sobrenutrição e obesidade, o perfil identificado revela estilos de vida urbanos marcados por desequilíbrio entre alimentação e atividade física, sugerindo a necessidade de intervenções voltadas para cardápios mais saudáveis e promoção da prática de exercícios.

Palavras-chave: Consumidores. Fast Food. Atividade Física. Mall Plaza Maule.

RESUMEN

Introducción: Cuatro de cada diez chilenos consumen comida chatarra al menos una vez por semana.

Objetivo: Describir el perfil de consumidores de un local de comida rápida en el Mall Plaza Maule, Maule, Chile.

Metodología: estudio cuantitativo, descriptivo, no experimental, con diseño basado en la Teoría Fundamentada; muestra: mayores de 18 años, durante un período de una semana,

990 sujetos. Instrumento: encuesta creada por los investigadores, Validación por Expertos; ocho preguntas: peso/talla, edad, género, ocupación, nivel educacional, frecuencia de asistencia al local de comida rápida, lo que habitualmente consume, tres comidas que mayormente consume, compañía con la cual asiste al local, el motivo por el que consume, practica de actividad física y con qué frecuencia la realiza, qué tipos de ejercicios realiza.

Resultados: Consumidores predominantemente masculinos (82%), jóvenes adultos (18-40 años), estudiantes o trabajadores con educación media-universitaria y IMC promedio en rango de sobrepeso (20-25%). La frecuencia de consumo es semanal (principalmente 1-2 veces), con preferencia por comida rápida tradicional como papas fritas (537), completos (457), pizza (282) y hamburguesas (259), sobre opciones saludables (258). Consumidores acuden en compañía de amigos (282), pareja (228) o familia (184), motivados por precio (372), sabor (291) y rapidez (586). Aunque 75% practica actividad física (1-2 veces/semana, 30 min-2 horas), predomina ejercicio moderado como pesas, cardio, trote o caminar, insuficiente para contrarrestar ingesta calórica alta.

Conclusión: Ante contexto chileno de malnutrición por exceso y obesidad, el perfil revela estilos de vida urbanos con desbalance nutricional-actividad, sugiriendo intervenciones para menús saludables y promoción de ejercicio.

Palabras clave: Consumidores. Comida Rápida. Actividad Física. Mall Plaza Maule.

1 INTRODUCTION

Based on dietary habits in Chile in 2024 and 2025, the nutritional landscape continues to reveal perceptions and behaviors relevant to understanding the relationship between Chileans and healthy eating. The findings indicate that healthy eating practices are interpreted as a balanced diet that includes a variety of foods, with the intention of avoiding those considered harmful to health. Furthermore, disease prevention and body image awareness emerge as the main motivations driving people to adopt healthy eating habits. These perceptions align with the new Dietary Guidelines for Chile, which promote a holistic approach to food, not only from a nutritional perspective but also from a sociocultural and environmental one, highlighting the importance of diversity, sustainability, and overall well-being as principles for healthy and responsible eating (MINSAL, 2025).

In Chile, nutrition campaign strategies designed with the specific characteristics of the target audiences in mind—considering sociocultural factors, psychological constructs, and the underlying meanings of preventive behaviors in nutritional health—and integrated with intermediate structural measures, prove to be the most effective. These campaigns achieve greater relevance and ownership of the message, thus fostering the intention and realization of changes in eating behavior. This approach, focused on comprehensiveness and contextualization, is fundamental to ensuring the success of public health nutrition interventions (Caichac Hoppe, 2022).

Furthermore, the Ministry of Health and other institutions have promoted policies that foster food education with a community-based approach, integrating nutritionists into schools, community spaces, and local markets, thereby strengthening the connection with specific audiences and their cultural needs. These campaigns are also linked to regulations to improve the nutritional quality of foods available on the market, encouraging the consumption of natural and minimally processed products and limiting the supply of ultra-processed foods (Loyola Pérez, 2021).

These coordinated and contextualized actions not only improve knowledge, but also transform eating habits in the population, positioning themselves as pillars for achieving effective results in health promotion and prevention of nutrition-related diseases in Chile (Gutiérrez Turner, et al., 2022).

Research has indicated that in recent years Chilean families have changed their eating habits, shifting from consuming traditional and minimally processed foods, such as fruits, vegetables, stews, and legumes, to highly processed products that are more energy-dense, contain more saturated fats and sugars, and have lower levels of micronutrients and dietary fiber, posing a significant public health challenge. In a context marked by obesity, it is

essential that individuals develop dietary self-regulation strategies that promote adherence to nutritional recommendations and contribute to maintaining a healthy nutritional status (Saavedra, 2022). This regulation involves adopting conscious behaviors that limit the consumption of foods high in calories, saturated fats, and sugars, promoting a balanced diet in accordance with current public policies, such as the Nutritional Labeling Law in Chile, which seeks to facilitate informed and healthy choices. Thus, self-regulation becomes a key component in addressing the obesogenic environment and preventing nutrition-related diseases (Henríquez, 2021).

The country has been undergoing profound changes, transformations that have been affecting the daily lives of new generations of Chileans who work, study, and even spend their leisure time. The current nutritional situation is related to economic and sociodemographic changes in diet and lifestyles, as well as in clothing, food acquisition, and how free time is managed, thus creating a complex and dynamic landscape (Garay-Rivera, 2022). With changes in lifestyle, fast food has become an economical and convenient way to eat, which often does not provide the necessary nutrients, and the regular consumption of these foods can lead to various health problems.

This type of food has become very popular lately, due to the pace of life people lead, since the little free time they have means they end up consuming something quick and, often, unhealthy. Currently, because of social, labor, and educational changes, 4 out of 10 Chileans consume junk food. While the number of people consuming fast food has increased, whether students or workers, approximately 41% of the population consumes it at least once a week. People between 15 and 24 years of age are the most frequent consumers of these foods. Within this population, 44% are male, while 39% are female, who consume fast food at establishments (Loyola Pérez, 2021).

Although 2013 saw the largest increase in the population consuming fast food, with a 9% rise compared to previous years, 2015 saw a 3.3% increase, marking a third year of weak growth after the notable increase in 2013. However, in 2016, there was another 3.5% increase, considering all establishments; this trend has continued to rise (Loyola Pérez, 2021).

2 OBJECTIVE

The objective of this study is to describe the consumer profile of a fast-food restaurant in the Mall Plaza Maule, Maule, Chile. This objective is further broken down into other objectives that will help answer the premise, including classifying the body mass index (BMI) of the sample; examining the frequency of fast-food consumption, considering gender, age,

frequency of consumption, type of food consumed, physical activity levels, and reasons for consuming fast food.

3 METHODOLOGY

This was a quantitative, descriptive, non-experimental study with a grounded theory design (Hernández-Sampieri & Mendoza, 2018). The study population consisted of daily customers who visit one of the fast-food restaurants or shop at the Mall Plaza Maule location, totaling approximately 400 people per day and 10,000 consumers per month. The population was defined as all consumers over 18 years of age who visited the restaurant during a one-week period. The sample comprised 990 subjects. To reach at this “n”, a survey was conducted among customers who visit the establishment, resulting in a total of 990 surveys. A 95.5% confidence level was obtained for the data, indicating a sampling error of approximately 5% based on the surveyed population. These customers were considered satisfied, representing 50% of the total sample. A total sample of 990 customers who visit the establishment was required; all were over 18 years of age, signed informed consent, and provided their exact weight and height were known after the study proposal was presented to each customer who approached the establishment.

The instrument used was a survey created by the researchers, which was validated through the Expert Validation process in Research Methodology, Physical Education, and Nutrition (Hernández-Sampieri & Mendoza, 2018), belonging to the Universidad Autónoma de Chile, Talca campus, Maule Region, Chile. The instrument is structured in eight questions, such as weight/height indices, age, gender, occupation, educational level, frequency of visits to the fast-food restaurant, what they usually consume, the three most frequently consumed meals, the company they visit the restaurant with, the reason for consuming the food, whether they practice physical activity and how often, and finally, the category of the types of exercises they perform. Based on the data collection, the categories were established, and the frequency of each response (descriptive statistics) was determined for each section, leading to the generation of a table that clearly and concisely presents the resulting frequencies.

The primary categories established were: sociodemographic data (secondary categories: identification, gender, age, weight, height); the frequency of fast food consumption (secondary categories: weekly frequency of consumption, attending fast food establishments, what is usually consumed in these establishments, and in the company of whom it is consumed); the practice of physical activity (secondary categories: how many times per week it is practiced and how much time is dedicated to these activities, indicating the sport or activity preferred by the respondent).

4 RESULTS AND DISCUSSION

Eighty-two percent of the respondents were male, and they were the most frequent respondents, while 18% were female. Regarding BMI, 131 people were classified as underweight, representing 13% of the sample; 631 people were classified as having a normal weight, representing 64%; 25 people were classified as obese, representing 3% of the sample; and 203 people were classified as overweight, representing 20%.

Relating gender to BMI, the results indicate that, for the male group, 13% are classified as underweight; 62.5% as normal weight; 2.23% as obese; and 21.93% as overweight. For the female group, 12.63% are classified as underweight; 69.23% as normal weight; 2.8% as obese; and 3% as overweight.

Of the total sample surveyed, 741 people perform physical activity, representing 74.85%, the remaining 249 people who do not perform physical activity represent 25.15%.

Of the sample that does not engage in physical activity, 83% are male and 17% are female. Therefore, they were divided into subcategories according to gender. In the underweight category, females represent a minority, at 9.5%. In the normal weight range, men show greater stability according to their BMI than women, with 53.6% compared to 42.8%. In the overweight category, the percentage is higher for males, at 29.4% compared to 11.9% for females. Finally, in the obese category, there is a higher rate of obesity in the female group, at 35.7% compared to 3.3% for the male group.

The table below presents the overall sociodemographic results:

Table 1

Description of the sample: sociodemographic

	18-20 years	18-20 years	21-30 years	21-30 years	31-40 years	31-40 years	41-50 years	41-50 years	51-60 years	51-60 years	61-70 years	61-70 years	71-78 years	71-78 years
Sociodemographic	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
Age	23	54	95	331	37	235	17	82	6	62	3	24	1	16
Weight	69,5	72,6	74,7	78,6	76,8	79,9	78	79,4	67,5	77,2	78	81,6	84	77,4
Height (meters)	1,64	1,71	1,69	1,74	1,72	1,74	1,70	1,74	1,64	1,72	1,66	1,74	1,81	1,69
BMI	25,88	24,65	25,91	25,89	25,91	26,21	26,56	26,15	25,00	25,94	28,14	26,63	25,64	27,22
Occupation (work, job, studies)														
Did not respond		age: 4	worker 4											
Student	13	38	41	123	6	49	5	17	3	9	1	4	0	2
Worker	7	7	40	187	27	149	11	58	2	46	2	16	0	2
Student/Worker	1	3	2	15	1	4	0	0	0	0	0	0	0	0
No working	2	6	12	6	3	29	1	7	1	3	0	3	1	11
Educational Level														

Did not respond		32	Postgraduate	4										
Basic	2	0	10	5	7	16	2	0	0	1	1	0	1	5
High school	9	9	32	105	19	94	10	34	4	22	2	15	0	2
University	12	33	53	205	11	101	5	37	2	27	0	7	0	5
Postgraduate	0	12	0	9	0	18	0	3	0	5	0	2	0	0

The sociodemographic description of the sample allows for a fairly accurate characterization of the profile of those who consume food at the Mall Plaza Maule fast-food restaurant. Overall, the data show a predominantly young adult clientele, with weight and BMI consistent with overweight, a high proportion of people who study and/or work, and a mostly secondary and university level of education.

The majority of consumers are between 18 and 40 years old, both men and women, suggesting that the establishment primarily attracts young adults, age groups that tend to frequent shopping malls and have greater exposure to ultra-processed foods. The presence of people aged 41 and over is significantly lower, indicating that older customers use this type of service less frequently or prefer other food options.

Average weight, height, and BMI across almost all age groups are within the range of overweight, for both women and men, a situation consistent with the trends in overnutrition described in Chile (Casanueva Arratia, et al., 2022; Hernández, 2022; Medina-Morales, 2022). This reinforces concerns about the role fast-food restaurants may play in consolidating unhealthy eating habits, especially among young populations that already exhibit cardiometabolic risk factors.

In terms of occupation (work, job, studies), the clientele is predominantly students, workers, and those who combine work and study, with few individuals who are neither employed nor in academic pursuits. This suggests that the fast-food establishment functions as a quick meal option for those with limited time, who need practical solutions between classes and workdays, and who use the mall as a place for daily transit rather than solely for leisure.

The high number of students in the 18–30 age group indicates that the establishment positions itself as an accessible and socially attractive option for university and technical-professional students, who tend to value speed and price over strictly nutritional criteria. In the 31–40 age group, the predominance of workers suggests a more instrumental use of the space (work breaks, informal meetings, quick meals during work hours), which could guide future healthy food offerings and marketing strategies aimed at this segment.

At the educational level, secondary and university education clearly predominate, while the proportion of consumers with only basic education is low, and there is also a

significant group with postgraduate studies. This indicates that the establishment's customer profile is characterized by a medium-to-high level of education, which challenges the idea that fast food is consumed primarily by people with low levels of education and suggests that factors such as fast-paced lifestyles, convenience, and socialization carry more weight than formal education.

The fact that a significant portion of the sample has university or higher education opens possibilities for more sophisticated food education interventions, incorporating information on nutritional composition, healthier options within the menu itself, and the promotion of informed choices. Likewise, the coexistence of diverse educational levels reinforces the need for segmented communication strategies that consider both simple, visual messages and more detailed content for consumers with greater cultural capital.

The sample appears to primarily represent young adults, students, and workers with secondary and university education levels, who, on average, have BMI values in the overweight range. This sociodemographic and anthropometric profile suggests that the establishment operates as a food space associated with urban lifestyles, limited time, and consumption practices that may reinforce patterns of overnutrition, but which also offer a strategic opportunity to incorporate healthier alternatives aimed at a population with potential receptiveness to health promotion messages.

Table 2 below presents the categories and subcategories of fast-food consumption, and their respective frequencies.

Table 2

Sample Description: Consumption

Consumption		18-20 years	18-20 years	21-30 years	21-30 years	31-40 years	31-40 years	41-50 years	41-50 years	51-60 years	51-60 years	61-70 years	61-70 years	71-78 years	71-78 years	Total
		Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	
Frequency																
(Times per week)	1-2 times per week	14	29	42	178	16	116	2	50	2	44	0	16	1	16	526
	2-3 times per week	5	13	33	74	14	57	3	13	0	7	0	1	0	1	221
	3-4 times per week	1	6	16	43	4	32	6	7	2	0	3	2	0	1	123
	4-5 times per week	2	5	2	20	3	13	1	5	0	1	0	4	0	1	57
	5-7 times per week	1	1	1	14	0	11	0	2	1	7	0	1	0	0	39
What they consume																
	Fast-food	42	64	245	28	187	15	78	3	48	3	15	0	7	752	
	Health-food	6	12	31	86	9	48	2	21	3	20	0	9	1	10	258

Fast-food consumed																
	French fries	16	29	51	187	18	96	9	49	9	49	3	13	0	8	537
	Hot-dog	10	30	42	145	15	128	10	23	1	22	3	24	0	4	457
	Steak sandwich	6	24	21	83	5	95	2	13	0	26	0	14	0	5	294
	Hamburger	2	11	15	80	6	38	3	14	5	62	0	6	1	16	259
	Beef sandwich	2	11	13	48	8	43	1	8	1	9	1	3	0	1	149
	Chicken Nuggets	0	6	10	20	2	16	3	5	0	2	2	4	0	0	70
	"Empanadas"	4	8	11	32	3	23	2	13	2	11	0	1	0	3	113
	Pizza	6	18	13	75	12	70	31	28	1	16	0	10	0	2	282
With whom they consume																
	Family	7	7	22	61	13	47	3	15	0	7	0	2	0	0	184
	Friends	3	18	22	106	17	76	5	19	0	10	0	6	0	0	282
	Partner	6	15	19	87	1	58	4	15	1	13	1	7	0	1	228
	Alone	1	3	11	33	2	27	2	18	1	14	0	5	0	5	122
	Coworkers	0	0	6	26	0	12	2	8	0	3	2	0	0	1	60
Why they consume																
	Price/cost	4	17	34	137	12	89	9	30	1	24	0	15	0	0	372
	Taste	7	18	22	87	5	87	4	33	1	14	1	7	0	5	291
	Speed	14	37	51	190	21	143	11	50	3	42	3	14	0	7	586
	Quality	2	1	3	11	4	2	0	0	0	0	0	1	0	0	24
	Family Activity	4	4	6	32	5	17	0	4	0	7	0	4	0	0	83
	Work Schedule	3	0	11	31	6	32	3	9	1	5	2	1	0	4	108

The consumption characteristics table reveals how, what, with whom, and why customers use the Mall Plaza Maule fast-food restaurant. Overall, the data show high-frequency consumption patterns, a clear preference for typical fast-food products, and motivations focused on price, taste, and speed of service.

Most participants eat at the establishment between 1 and 2 times per week, with a smaller group reaching frequencies of 2 to 3 and even 3 to 4 times per week, indicating regular rather than occasional use of the service. This weekly frequency, predominant in the 18-40 age group, suggests that fast food is part of consumers' usual eating pattern, which may have implications for caloric intake and the risk of overnutrition observed in the sociodemographic profile.

Regarding the kind of food consumed, the majority of consumers opt for traditional "fast-food," in contrast to a smaller proportion who report consuming options categorized as "healthy-food." This indicates that, despite the growing availability of healthier alternatives in some establishments, the actual preference remains concentrated on high-energy and high-fat foods, reinforcing the need to review the offerings and promotional strategies for healthier options.

Within the fast-food category, french fries, hot dogs, and pizza appear as the most consumed products, followed by hamburgers, steak sandwiches, chicken nuggets, and “empanadas” (traditional Chilean food: dough and meat). This pattern reflects a strong preference for ultra-processed foods, rich in saturated fats, sodium, and refined carbohydrates, as described in the literature on consumption in fast food establishments (Mohatar, 2025; Peralta Morales & Quezada Feijoo, 2024).

The high demand for French fries and hot dogs is particularly relevant, as these products are often accompanied by sugary drinks and sauces, creating combinations with very high caloric density. From a public health perspective, this preference suggests that interventions focused on reformulating recipes, reducing portion sizes, or incorporating healthier side dishes could have a significant impact on the nutritional profile of meals consumed at the establishment.

The table shows that customers typically eat out in the company of family, friends, or partners, while a smaller group eats alone or with coworkers. This indicates that eating at the establishment is configured as a social and leisure experience, rather than a mere nutritional need, reinforcing the mall's role as a space for meeting and socializing (Letelier, 2025; Toloza Ruiz, 2025; De Simone, 2024).

Consumption with family and friends also suggests that food choices can be influenced by group norms and dynamics, which has implications for the design of promotional campaigns for healthy options aimed at groups (for example, more balanced family menus or promotions associated with lower-calorie combinations). The segment that consumes with coworkers reinforces the idea that the establishment also serves as a food service in work contexts, especially for employees of the mall itself or nearby offices (Toloza Ruiz, 2025).

Regarding consumption reasons, price, taste, and speed stand out as the most frequently mentioned factors, above perceived quality, family activities, or work schedules. This demonstrates that the decision to visit the establishment is strongly influenced by criteria of economic accessibility and convenience, reinforcing the typical positioning of fast food as a “fast, tasty, and cheap” option (Pascacio Bermudez & Andrea Michelle, 2024).

The fact that “quality” is mentioned less frequently than price and taste suggest that consumers may prioritize immediate gratification and cost over nutritional or health value considerations. However, the presence of family activities and work schedules as additional motivations indicates a functional and relational component that could be leveraged to introduce balanced eating messages without sacrificing the appeal of speed and convenience.

The consumption profile reveals a customer who visits the fast-food restaurant weekly, prefers typical high-calorie foods, consumes primarily in social contexts, and bases their choice on price, taste, and speed of service. This profile, combined with the predominance of young adults with a BMI in the overweight range described in the sociodemographic table, reinforces the importance of considering these establishments as key settings for health promotion interventions (Franco Giraldo, 2022) and for offering healthier food alternatives in the Mall Plaza Maule, Maule, Chile (Rojas et al., 2025; Del Río Expósito, 2021; Loyola Pérez, 2021).

Table Number 3 presents the results related to the practice of physical activity.

Table 3

Sample description: Physical Activity

Physical Activity	18-20 years Females	18-20 years Males	21-30 years Females	21-30 years Males	31-40 years Females	31-40 years Males	41-50 years Females	41-50 years Males	51-60 years Females	51-60 years Males	61-70 years Females	61-70 years Males	71-78 years Females	71-78 years Males
1-2 times per week	9	10	25	84	11	87	5	21	2	10	1	5	1	2
2-3 times per week	5	7	27	52	14	42	3	11	0	11	0	2	0	1
3-4 times per week	3	17	13	58	8	20	2	12	1	11	0	6	0	1
4-5 times per week	1	5	5	23	1	14	0	5	2	2	0	0	0	0
5-7 times per week	0	5	1	35	0	18	0	6	0	3	0	2	0	0
Does not practice	5	10	24	75	3	53	7	26	1	25	2	9	0	8
Duration (Hours per Session)														
30 min to 1 hour	7	15	26	125	16	90	5	27	2	13	1	6	1	6
1 to 2 hours	8	15	35	84	16	59	5	17	3	12	0	6	0	0
More than 2 hours	3	13	11	48	1	30	0	11	0	9	0	3	0	2
Sports Practiced														
Soccer	0	18	7	48	4	9	1	3	0	6	0	0	0	0
Basketball	2	0	4	17	1	11	0	2	0	2	0	0	0	0
Cycling	1	1	3	18	1	4	0	1	0	0	0	0	0	0
Volleyball	0	4	2	12	3	6	1	3	0	1	0	3	0	1
Track & Field	0	0	1	2	0	8	0	1	0	0	0	0	0	0

The data in Table 3 show that most fast-food customers engage in some form of physical activity, but with low to moderate frequency, primarily 1 to 2 times per week, especially among the 18-40 age group, both men and women. This pattern suggests that, while exercise is present, it does not reach the levels recommended for optimal health

promotion, which is particularly relevant considering the fast-food consumption pattern described in the other tables of the study.

In almost all age groups, the predominant category is exercise 1 to 2 times per week, with few cases reaching 4 or more weekly sessions and a significant proportion reporting no physical activity, especially among adults aged 31 and over. This pattern is consistent with what has been described in the literature on urban populations, where a high proportion of insufficiently active individuals are observed who combine sedentary work with regular consumption of high-energy-density foods, which is associated with a greater risk of overweight, obesity, and cardiometabolic diseases.

Most people who engage in physical activity concentrate their practice between 30 minutes and 2 hours per session, with the 18-30 age group standing out, primarily reporting sessions between 30 minutes and 1 hour. Sessions longer than 2 hours are in the minority across almost all age groups. This pattern indicates that, even though there is a willingness to exercise, the combination of low weekly frequency and moderate session durations likely does not reach the activity volumes recommended by the WHO (150–300 minutes per week of moderate intensity). This reinforces the idea of a generally sedentary lifestyle among a significant portion of the establishment's customers (Cardiology, 2021; World Health Organization, 2019).

Among those who participate in organized sports, soccer and basketball predominate, especially among young men, while among women, participation is less distributed among various disciplines (soccer, volleyball, cycling), with very few reporting participations in athletics or other sports. This preference for recreational and competitive team sports is related to social and recreational motivations (Vinagre, 2022; Pellicer de Juan, et al., 2021), which opens opportunities for interventions promoting physical activity associated with tournaments, championships, or partnerships with the mall itself, integrating benefits or incentives linked to healthier consumption within the fast-food establishment.

When these results are cross-referenced with the sociodemographic and consumption characteristics, it is observed that the restaurant primarily attracts young adults who are students and/or workers, with an anthropometric profile in the overweight range, and who regularly consume high-calorie foods. In this context, the presence of predominantly sporadic or low-frequency physical activity suggests an imbalance between caloric intake and energy expenditure, which positions the fast-food restaurant as a critical setting for the design of integrated strategies to promote healthy lifestyles, combining more balanced menu offerings with campaigns that encourage increased frequency and duration of physical activity in this population.

Table Number 4 shows more results regarding the type of physical activity practiced in other sports, because there are other important subcategories to point out.

Table 4

Type of physical activity practice in other sports

	18-20 years	18-20 years	21-30 years	21-30 years	31-40 years	31-40 years	41-50 years	41-50 years	51-60 years	51-60 years	61-70 years	61-70 years	71-78 years	71-78 years
Gym (Modality)	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
Weights	1	6	6	51	2	30	1	9	0	7	0	4	0	2
Cardio	2	3	2	32	0	39	1	12	1	10	0	3	0	2
Zumba/aerobics	1	0	3	0	1	0	1	0	0	0	0	0	0	0
Category														
Jogging	3	11	17	84	3	58	2	10	0	17	1	8	0	6
Walking	5	9	15	51	4	47	4	15	1	8	2	3	1	0
Dance	1	3	4	4	0	5	0	4	0	1	0	0	0	0
Zumba/aerobics in government programs	2	0	2	6	0	3	0	0	1	1	0	0	0	0

The data in Table 4 indicate that, among fast-food customers, recreational, accessible, and low-intensity forms of physical activity predominate, such as weight training and cardio at the gym, along with individual activities like jogging and walking, especially among young men and adults aged 21 to 40. This pattern suggests that, although some exercise is incorporated into customers' routines, it is organized more around general fitness and weight management goals than around systematic participation in competitive sports or structured disciplines.

In the gym section, weightlifting and cardio on treadmills or stationary bikes are the most prevalent activities, with particularly high participation from men aged 21 to 40. Zumba classes, on the other hand, are very limited and almost exclusively attended by young women. This distribution reflects a preference for modalities associated with strength and cardiovascular endurance training, consistent with current urban fitness trends. However, it also reveals low participation in choreographed or more recreational activities, which could be linked to gender stereotypes and a focus on quick aesthetic results rather than diverse physical experiences.

Within the categories of unstructured exercise, jogging and walking account for the largest number of responses, with very high figures among men aged 21 to 40 and significant, though lower, female participation. Dance and Zumba/IND appear less frequently and are mostly practiced by young women. These activities, due to their low cost and flexible scheduling, are functional for students and/or workers who use the mall as a thoroughfare.

However, they are often performed intermittently and without planning, which limits their impact on physical fitness and weight management (Peñafel et al., 2024; Strale et al., 2024).

The combination of strength and cardio training at the gym with free activities like jogging and walking creates a consumer profile that perceives itself as relatively active, but tends to choose individual, short-duration activities focused on calorie expenditure rather than overall health improvement. Relating these findings to the regular consumption of fast food and the predominance of young adults with overweight BMIs, as described in the sociodemographic tables, suggests a lifestyle where exercise appears as a compensatory strategy against a high-calorie diet (Garnica-Quintero, et al., 2023), rather than as a stable component of a healthy lifestyle. This reinforces the need for educational interventions and a healthier food offering at Mall Plaza Maule.

5 CONCLUSION

In recent years, Chilean culture has undergone various changes due to social, physical, and genetic factors. However, one thing we have never lost is our instincts; as the word suggests, we use them as a means of survival to get what we want. Furthermore, fast food consumption has become more than just an instinct; it's a habit. Whether due to time constraints, quality, taste, or any other reason, it's becoming more important than our overall nutrition. Over the years, large chains have directly influenced eating habits in some countries. This has impacted the choice between eating well, taking a little more time, or consuming fast food for its quick preparation and more affordable price.

This study has concluded that dietary changes have profoundly affected the quality of people's food. Consequently, as time progresses rapidly, we tend to seize upon anything that is important to us, forgetting ourselves as rational beings capable of distinguishing between good and bad. This research has revealed that fast food consumption has become a habit for both men and women, often due to time constraints, cost, or any other reason that takes precedence over our well-being.

This shows that people, in addition to not eating well, do not have a significant frequency and intensity of physical activity, which, as mentioned above, can generate nutritional alterations and this can lead to different pathologies, which affect health.

However, this study provided information regarding the number of people who have a normal BMI classification, encompassing most of the people surveyed, but always without neglecting the percentage of obese people, which lies in the fact that their lifestyle is showing warning signs in relation to nutrition and the practice of physical activity.

REFERENCES

- Caichac Hoppe, A. (2022). Pertinencia de las estrategias comunicacionales gubernamentales para el fomento de conductas alimentarias saludables. Disponible en <https://repositorio.uchile.cl/handle/2250/191329>.
- Casanueva Arratia, J. R., Escobar Román, A. C., Parra Godoy, R. M., & Valenzuela Castillo, F. A. (2022). Hábitos alimentarios, estado nutricional y factores condicionantes de riesgo de malnutrición por exceso en escolares del Colegio Chileno Árabe de Chiguayante, Concepción 2022 (Doctoral dissertation, Universidad del Desarrollo. Facultad de Ciencias de la Salud).
- de Cardiología, S. A. (2021). Guías para la recomendación y prescripción de actividad física en adultos para promover la salud cardiovascular. *Revista Argentina de Cardiología*, 89(4), 1-52.
- De Simone, L. (2024). *Metamall: espacio urbano y consumo en la ciudad neoliberal chilena*. CANOPUS EDITORIAL DIGITAL SA.
- del Río Expósito, F. (2021). Caracterización del ambiente alimentario de abastecimiento en Molina, Chile, 2020: aportes para la construcción de ambientes alimentarios saludables en Chile: "El ambiente alimentario de abastecimiento en Molina, Chile" (Master's thesis, Pontificia Universidad Católica de Chile (Chile)).
- Franco-Giraldo, Á. (2022). Modelos de promoción de la salud y determinantes sociales: una revisión narrativa. *Hacia la Promoción de la Salud*, 27(2), 237-254.
- Garay-Rivera, J. (2022). ¿El oasis chileno?: el funcionamiento del discurso neoliberal de la felicidad visto a través del estallido social en Chile. *International Journal of Political Philosophy/Las Torres de Lucca*, 11(1)).
- Garnica-Quintero, V., Ramírez-Arzola, O., García-García, M., Granados-Hernández, S. G., Méndez-Aguilar, A. A., González-Yebra, A. L., & Muñoz-López, D. B. (2023). Estrategias de intervención para la reversión de Síndrome Metabólico. *JÓVENES EN LA CIENCIA*, 21, 1-7.
- Gutiérrez Turner, M., Morales, I., & C Gelabert, R. (2022). Eficacia de un programa de estilo de vida de salud en Chile. *Revista Cubana de Medicina General Integral*, 38(2).
- Henríquez, M. F. C. (2021). Alfabetización alimentaria, autorregulación alimentaria y su asociación con la dieta, estado nutricional y bienestar de adultos en Chile (Doctoral dissertation, Universidad de Concepción).
- Hernandez, F. B. (2022). Análisis de las Políticas Públicas de Salud para el Combate del Sobrepeso y la Obesidad en Chile: Evolución de la Malnutrición por Exceso en Estudiantes de Establecimientos Educativos Públicos entre el Año 2011-2020.
- Hernandez Sampieri, et al., (2018). Metodología de la investigación. Las rutas cuantitativa, cualitativa y mixta, Ciudad de México, México: Editorial Mc Graw Hill Education, Año de edición: 2018, ISBN: 978-1-4562-6096-5, 714 p.
- Letelier, V. (2025). Comida en el espacio público: La ciudad de Talca y el _completo_. *SOBRE: Prácticas artísticas y políticas de la edición*, (11), 6.
- Loyola Pérez, C. (2021). Identificación de desarrollo, innovación, tecnologías de producción y consumo de alimentos saludables en Chile. Disponible en <https://repositorio.uchile.cl/handle/2250/181318>.

- Medina-Morales, A., Navarrete-Escalona, M., Moraga-Muñoz, R., Olate-Pastén, Y., Gutiérrez-Turner, E., Pavez-Adasme, G., ... & Gómez-Álvarez, N. (2022). Prevalencia de malnutrición por exceso y cambios antropométricos asociados a riesgo cardiometabólico en escolares de colegios públicos pertenecientes la zona centro sur de Chile con una alta densidad rural y de bajos ingresos (Prevalence of malnutrition. Retos, 45, 496-501.
- MINSAL. (2025). Guías Alimentarias para Chile. Ministerio de Salud, Gobierno de Chile. Disponible en <https://www.minsal.cl/guias-alimentarias-para-chile/>.
- Mohatar Barba, M. (2025). Consumo de alimentos ultraprocesados, actividad física y alteraciones de marcadores metabólicos en adolescentes: estudio para la prevención de Diabetes Mellitus tipo 2 en un contexto multicultural (Doctoral dissertation, Universidad de Granada).
- Organización Mundial de la Salud (2019). Plan de acción mundial sobre actividad física 2018-2030: personas más activas para un mundo más sano. Organización Mundial de la Salud. <https://iris.who.int/handle/10665/327897>. Licencia: CC BY-NC-SA 3.0 IGO
- Pascacio Bermudez, M., y Andrea Michelle, R. C. (2024). Estrategias de e-commerce utilizadas por restaurantes de comida rápida en Santa Tecla y su efecto en el consumidor (Doctoral dissertation, Universidad Evangélica De El Salvador).
- Pellicer de Juan, E., García Martínez, S., & Ferriz Valero, A. (2021). Necesidades psicológicas básicas asociadas en la práctica de deporte individual y colectivo. Retos, 42, 500-506.
- Peñafel, M. U. A., Párraga, M. A. V., Villacrés, A. D. V., Alvarado, M. M. G., & Salazar, M. E. G. (2024). Sistemas de tecnología aplicados a dietas hipocalóricas y la actividad física para la prevención del síndrome metabólico. Revista Ibérica de Sistemas e Tecnologías de Informação, (E74), 227-239.
- Peralta Morales, L. M., & Quezada Feijoo, C. A. (2024). El consumo de alimentos ultra procesados frente a los no procesados incrementa la obesidad significativamente en pacientes mayores de 18 años, durante los últimos 5 años (Master's thesis, Quito: Universidad de las Américas, 2024).
- Rojas, D. E., Espinoza, P. G., Osiac, L. R., & Vásquez, F. D. (2025). Mejorar el acceso a alimentos saludables:: Propuestas para transformar los ambientes alimentarios en Chile. Revista Aportes: Evidencias y Recomendaciones para la Política Pública, 1(1).
- Saavedra, I. (2022). Calidad de alimentación en la población adulta chilena y su relación con el estado nutricional y síndrome metabólico en la Encuesta Nacional de Salud 2016-2017 (Master's thesis, Pontificia Universidad Católica de Chile, Chile).
- Strale, C. M., Ramírez, F. G., Pinochet, F., Cumillaf, A. G., Merino, P. F., & Bastías, D. D. (2024). Condición física, actividad física y calidad de vida en estudiantes universitarios chilenos. Retos: nuevas tendencias en educación física, deporte y recreación, (56), 521-530.
- Tolozza Ruiz, C. P. (2025). Modelos de predicción de demanda a centros comerciales usando datos de movilidad. Tesis para optar al grado de Magíster en gestión de operaciones, memoria para optar al título de Ingeniera Civil Industrial, Universidad de Chile.
- Vinagre, M. Á. D. (2022). Regulación motivacional y motivos de práctica deportiva en jóvenes universitarios. Revista iberoamericana de psicología del ejercicio y el deporte, 17(3), 107-113.

CONTROLLING THE ABUSE OF POWER AND JUDGMENT OF REASONABLENESS

CONTROLE DO ABUSO DE PODER E JUÍZO DE RAZOABILIDADE

CONTROL DEL ABUSO DE PODER Y JUICIO DE RAZONABILIDAD



<https://doi.org/10.56238/sevened2026.008-174>

Felipe Teles Tourounoglou¹

ABSTRACT

It is not possible to dismiss the Jurisdiction of the Public Administration. The peaceful pacification of social conflicts must be based on the current structure of legality. Therefore it is the duty of the Judge, the maximum duty of the law enforcer, in saying the law, to apply the legal order in all its complexion, without abuse of power. It is very important to reveal that reasonableness is closely linked to legality. Date of conclusion, this is not an unfolding of the principle of proportionality, is not in line with the idea of applying what is necessary to reach the desired goal. Reasonability, in this analysis, has the power to establish the magistrate's position as a managerial public administrator. Reasonability must link the enforcer to the law itself. Obviously, this link to the law does not refer to law in the strict sense of its cold letter, which little glimpses the social claims. The link referred to here can be interpreted within the "inventive" activity, in the words of the best, "creative" doctrine of the Judge, an activity that contemplates the interpretation of legal rules and principles, contemplates the application and interpretation of all juridical framework, including , the own jurisprudential production. In this sense, it is when the interpretation and application of the law escapes the anticipated and predicted by the legislator, and when the social demands are dissociated from the common, that the Judge can not abuse its power, it is at this moment that must be reasonable, it is in this time that can not turn its back on its mission as a public administrator, which is bound to parameters and guiding criteria.

Keywords: Reasonability. Jurisdiction. Public Administration. Power Abuse. New Code of Civil Procedure.

RESUMO

Não é possível afastar a Jurisdição da Administração Pública. A escoreita pacificação dos conflitos sociais precisa estar calcada na estrutura vigente de legalidade. Portanto é mister do Juiz, dever máximo do aplicador da lei, ao dizer o direito, aplicar o ordenamento jurídico em toda sua compleição, sem abuso de poder. É assaz importante desvelar que razoabilidade tem íntima ligação com legalidade. *Data máxima vênia*, não se trata de um desdobrando do princípio da proporcionalidade, não se coaduna com a ideia de aplicação do necessário para o alcance do objetivo almejado. Razoabilidade, nesta análise, tem o condão a firmar a posição do magistrado enquanto administrador público gerencial. Razoabilidade deve vincular o aplicador da lei à própria lei. Por óbvio, esta vinculação à lei

¹ Master's degree in Law. Universidade de Marília (UNIMAR). E-mail: felipeteles.adv@gmail.com

não se refere a lei em sentido estrito a sua letra fria, a qual pouco vislumbra os reclamos sociais. A vinculação aqui referida, pode ser interpretada dentro da atividade “inventiva”, nos dizeres da melhor doutrina, “criativa” do Juiz, atividade esta que contempla a interpretação de regras e princípios jurídicos, contempla a aplicação e interpretação de todo arcabouço jurídico, inclusive, a própria produção jurisprudencial. É neste sentido, é quando a interpretação e aplicação da lei escapa ao antevisto e previsto pelo legislador, e quando os reclamos sociais estão dissociados do comum, que o Juiz não pode abusar de seu poder, é neste momento que deve ser razoável, é nesta hora que não pode dar as costas para sua missão de administrador público, o qual está vinculado à parâmetros e critérios norteadores.

Palavras-chave: Razoabilidade. Jurisdição. Administração Pública. Abuso de Poder. Novo Código de Processo Civil.

RESUMEN

No es posible separar la jurisdicción de la Administración Pública. La adecuada resolución de los conflictos sociales debe basarse en la estructura legal vigente. Por lo tanto, es deber del juez, el máximo deber del agente del orden, al dictar la ley, aplicar el ordenamiento jurídico en su totalidad, sin abuso de poder. Es fundamental destacar que la razonabilidad está íntimamente ligada a la legalidad. Con el debido respeto, esto no implica un desarrollo del principio de proporcionalidad; no se alinea con la idea de aplicar lo necesario para lograr el objetivo deseado. La razonabilidad, en este análisis, tiene la facultad de establecer la posición del magistrado como administrador público directivo. La razonabilidad debe vincular al agente del orden con la propia ley. Obviamente, esta vinculación con la ley no se refiere a la ley en sentido estricto, a su fría letra, que rara vez considera las demandas sociales. El carácter vinculante al que se hace referencia aquí puede interpretarse dentro de la actividad “inventiva” o, en palabras de la mejor doctrina, “creativa” del juez. Esta actividad abarca la interpretación de las normas y principios jurídicos, la aplicación e interpretación de todo el marco jurídico, incluyendo la propia producción jurisprudencial. Es en este sentido, cuando la interpretación y aplicación de la ley escapan a lo previsto y predicho por el legislador, y cuando las demandas sociales se disocian de lo común, que el juez no puede abusar de su poder. Es en este momento que debe ser razonable; es en este momento que no puede renunciar a su misión como administrador público, sujeto a parámetros y criterios rectores.

Palabras clave: Razonabilidad. Jurisdicción. Administración Pública. Abuso de Poder. Nuevo Código de Procedimiento Civil.

1 INTRODUCTION

The Principle of Reasonableness must be understood as a vector for prohibiting the abuse of power, within the civil procedure, by the magistrate. Thus, the new civil adjective law inaugurates a new bias, a new feeling about the principle of reasonableness, separating it from the principle of proportionality and giving it its own dimensions.

Thus, reasonableness should be seen as a care of the principle of legality. The Democratic Rule of Law, without a doubt, is a curator of the principle of legality, ensuring that the acts emanating within it, whether state or private, can be backed by the rule of law in a broad sense, by the entire legal framework I contemplate, including the guiding principles of fundamental rights.

In this vein, the magistrate, the state-judge, the applicator of the law, cannot dissociate himself, when the act of saying, from the notion of administrative function. It should be noted that social pacification should be considered as an administrative act, a state act, and its delivery is carried out in such a way as not to exceed the limits of what is reasonable, that is, the limits of what is imposed by the legal system itself.

This time, the first research problem is revealed: is the majority definition of the principle of reasonableness sufficient for its understanding, together with the new Code of Civil Procedure? Can reasonableness, in its best definition, as a brake on the abuse of power, be used in the magistrate's performance, limiting or refining his creative power in the application of the norm?

In this crack, the new civil law brings numerous institutes, some listed in this work, which, among other principles, enshrine reasonableness as a prohibition against the abuse of power of the magistrate in the judgment of civil disputes. In this way, a new order is developed in the civil procedure, which places the judge as a promoter, procedural collaborator and imposes a duty on him, which is: the need to respect the system and the current legal structure, under penalty of incurring in illegalities and seeing his judgment vitiated.

The research aims to demonstrate the best facet of the principle of reasonableness and its importance, as a way to combat the abuse of power, demonstrating its practical applicability through institutes collected in the current Code of Civil Procedure.

The deductive and bibliographic method permeate the development of the research, which is initially carried out in an investigative way.

2 PRINCIPLE OF REASONABLENESS AS A COROLLARY OF THE CURRENT CONSTITUTIONAL ORDER

2.1 DEMOCRATIC RULE OF LAW AND THE PRINCIPLE OF LEGALITY

The expression Rule of Law refers to a juridical-political thought that has developed essentially since the sixteenth century, being considered as a corollary of contractualism and a presupposition of individual ethical autonomy, having as its essential object the legal limitation of the State's intervention in relation to the individuality of citizens, thus assuming an individual characteristic, even though there are previous concepts for this expression as in the Platonic-Aristotelian opposition between "government of laws" and government of men" and also in the medieval doctrine that had a legal basis for sovereignty.

In the words of Torrão, the Rule of Law means the practical realization of liberal thought, in which the States are subordinated to the law, which is the expression of reason, as well as respecting natural rights, opposing the absolutist form of the Police State.

For Canotilho², in the Rule of Law, the State and all its respective political organs are subject to the law, that is, to a form of ordering that is rational and binding on an organized society, in which it articulates measures or material rules, manifesting values of justice and with forms and procedures establishing legal-formal guarantees aiming at the fulfillment of its axiological program.

Thus, it was only after the occurrence of violations in the legislative sphere through abuses by this power during totalitarian regimes, that he realized the need for formal and material legal limitation regarding the legal production, that is, laws. Thus, the relevance of control not only of the exercise of power, but also with regard to the content of decisions, through a fundamental normative diploma, the Constitution, which is endowed with supremacy and normative force that binds the Legislative Power, thus associating legal production with an ethical-axiological model that aims at respecting the dignity of the human person and fundamental rights, these being primordial foundations to materialize the limiting idea of rights and freedoms related to the Rule of Law. In the meantime, norms protecting fundamental rights were considered to be of normative supremacy in many Western Constitutions and with the post-war period, the basic historical peculiarities of the concept of the Rule of Law were rescued with the constitutionalism of this time, reflecting not only in the legal limitation and control of the power of the state, but also in the delimitation of the purposes of this power.

² CANOTILHO, José Joaquim Gomes. **Constitutional law and theory of the Constitution**. 7. ed. Coimbra: Almedina, 2003, p. 243.

According to Canotilho³, the Rule of Law should essentially be a tool to limit and also bind political power in a Constitutional State, as it implies a normative constitution that structures a fundamental legal-normative order that binds all public powers, which attributes measure and form to the state order and to the acts of the public powers, legally binding them in the formal and material aspects.

It is considered that the function of the Rule of Law, with regard to its liberal-contractualist character, is to guarantee the rights of citizens with regard to external interventions, both by the State and by other citizens, and in order to achieve this guarantor objective there must be a limitation of the Rule of Law through the legal system with regard to the power of legal production itself, and thus the right itself must be limited. This limitation makes the law program its forms of production through procedural norms, as well as its substantial contents, which refer to the protection of the dignity of the human person and the guarantee of fundamental rights.

The principle of the Rule of Law is then reflected in the legality, constitutionality, respect and guarantee of fundamental rights and aims to respond to the problem of the content, extent and way of proceeding of the state's activity, determining it according to these guidelines⁴.

The Democratic State of Law is founded on the principle of popular sovereignty that establishes the active and operative participation of the people in public affairs, and this participation is not simply limited to the formation of representative institutions, as these only constitute a stage in the evolution of the democratic State, but do not configure its complete development. the purpose of this principle goes beyond that, as it aims to present the Democratic Rule of Law as a form of real guarantee of the fundamental rights of the human person⁵.

Article 1 of the Federal Constitution of 1988 provides that Brazil is a Democratic State of Law, having in its essence human dignity as a fundamental value, which informs and guides the entire legal order. The Federal Constitution of 1988 also provides for fundamental rights and guarantees, having mechanisms for these to be put into effect, such as their immediate applicability and the constitutionality control of norms.

According to Silva⁶:

³ CANOTILHO, José Joaquim Gomes.op.cit.,p.245.

⁴ CANOTILHO, José Joaquim Gomes.op.cit.,p.243.

⁵ SILVA, José Afonso da. **The Democratic Rule of Law**. Journal of Administrative Law. Rio de Janeiro, n. 173, p.15-34 jul./set. 1988. Available at <http://bibliotecadigital.fgv.br/ojs/index.php/rda/article/viewFile/45920/44126>>. Accessed on: 10 Dec. 2018, p.20.

⁶ SILVA, José Afonso da. op.cit., p.23.

The principle of legality is also a basic principle of the democratic rule of law. It is of the essence of its concept to be subordinated to the Constitution and to be based on democratic legality. It is subject, like any State of Law, to the rule of law, but to the law that realizes the principle of equality and justice not by its generality, but by the search for equalization of the conditions of the socially unequal. Therefore, the relevance of the law in the democratic State of Law should be highlighted, not only in terms of its formal concept of an abstract, general, obligatory and modifying legal act of the existing legal order, but also in terms of its function as a fundamental regulation, produced according to a qualified constitutional procedure. The law is effectively the most prominent official act in political life.

It then becomes evident the need to apply the foregoing as a way to limit and bring reasonableness to the power of the State, including in the exercise of jurisdiction. As for the Judiciary, it is relevant to mention the importance of its decisions and interpretations in the sense of instrumentalizing and protecting fundamental rights, correlating them to the principle of the Rule of Law, which can be observed through another principle, namely: the principle of legality, provided for in the Federal Constitution of 1988.

Thus, article 5, item II, and article 37 caput, both of the Magna Carta, do not only cover the private sector, they cover public affairs, public administration and its duty to be based on the law, on the dictates of this democratic instrument of social control.

Thus, a judiciary that does not judge according to the law in a broad sense, an inventive judiciary in its most pernicious way, is against the rule of law, is against the democratic rule of law, acting without control, abusing power and doing acts beyond what is reasonable.

Reasonableness is linked to the democratic rule of law. Reasonableness is linked to legality, it is linked to compliance with the law in all its dimensions, and it prevents the abuse of power in the distribution of rights.

2.2 NEOCONSTITUTIONALISM AS AN INFLUENCER OF THE PROCEDURAL SYSTEM AND PROMOTER OF REASONABLENESS

Initially, on Neoconstitutionalism, it is appropriate to transcribe the concept brilliantly woven by the renowned doctrinaire Dirley da Cunha Júnior:

Neo-constitutionalism represents the current, contemporary constitutionalism, which emerged as a reaction to the atrocities committed in the Second World War, and has given rise to a set of transformations responsible for the definition of a new constitutional right, founded on the dignity of the human person. Neo-constitutionalism stands out, in this context, as a new legal theory to justify the paradigm shift, from the Legislative State of Law, to the Constitutional State of Law, consolidating the passage of the Law and the Principle of Legality to the periphery of the legal system and the transit of the Constitution and the Principle of Constitutionality to the center of the entire

system. in view of the recognition of the normative force of the Constitution, with binding and mandatory legal effectiveness, endowed with material supremacy and intense evaluative charge.⁷

Therefore, it was through the Constitutional Rule of Law that Neoconstitutionalism emerged, proposing that the validation of a norm should not be based solely on the criterion of the normative competence of those who drafted it or on the analysis of the procedural legality required for the elaboration of laws, but rather that valid laws are those that submit "legality itself to the Constitution, so that the conditions of validity of laws and other legal norms depend not only on the form of their production, but also on the compatibility of their contents with constitutional principles and rules".⁸

In this way, a profound process of constitutionalization of the Law emerged, to the point that the constitutional rules, the content inserted in the norms, as well as the constitutional principles are highlighted when analyzing the validity of a norm and that, in this context, the principle of legality as well as the formal procedure for drafting norms must be analyzed in a constitutional way, contemplating a generic normative framework and guiding principles.

It is in this neo-constitutional context that the Constitution of the Federative Republic of Brazil is inserted, that is, it can be affirmed that the Brazilian Constitution currently in force was elaborated under an axiological evaluative aegis, in the sense of ensuring the dignity of the human person and fundamental rights, so that it aims at the realization of constitutionalized values and the guarantee of minimum dignified conditions.

The new analysis and importance of Constitutional Law within the legal system was clearly outlined by Dirley da Cunha Júnior:

Furthermore, it was especially decisive for the delineation of this new Constitutional Law, the recognition of the normative force of the principles, a situation that has led to the rapprochement between Law and Ethics, Law and Morals, Law and Justice and other substantive values, revealing the importance of man and his ascendancy as an axiological filter of the entire political and legal system. with the consequent protection of the fundamental rights of the human person.

The emergence of neo-constitutionalism succeeded in providing the recognition of the double normative-axiological dimension of contemporary Constitutions, giving rise to the consolidation of a material or substantial legal theory based on the dignity of the human person and fundamental rights. In this context, the legal discourse, previously associated with a formal and proceduralist conception, evolves to reach a substantialist strand concerned with the realization of constitutional values.⁹

⁷ CUNHA JÚNIOR, Dirley da. **Constitutional Law Course**. 7th. ed. Bahia: Juspodivm. 2013. p. 39.

⁸ Ibidem, p. 39.

⁹ CUNHA JÚNIOR, Dirley da., op. cit., p. 40-41.

Taking into account the characteristics of this post-modern constitutionalism, as well as the fact that our Magna Carta was drafted under the influence of its values, it is of paramount importance to analyze the constitutional principles that underlie the new Code of Civil Procedure.

In this sense, it is undoubted that the principle of Reasonableness is rooted in the precepts of constitutional principles, spreading a democratic character over Civil Procedure. Thus, article 8 of the new codex, also enshrining article 5 of the Law of Introduction to the Rules of Brazilian Law, reveals the following text:

Article 8 When applying the legal system, the judge will meet the social purposes and the requirements of the common good, safeguarding and promoting the dignity of the human person and observing proportionality, reasonableness, legality, publicity and efficiency.

Therefore, when analyzing the principles of civil procedure from the perspective of neo-constitutionalism, it is noted that reasonableness is fully encompassed and provided for in the mandatory rule. Although its express constitutional provision is absent, this institute has subsistence and constitutional grounds that justify its effective implementation, as explained.

There is no possibility of interpreting the civil procedural system by ruling out a type of expedient such as reasonableness. The constitutional civil procedure becomes elevated in the face of principles such as reasonableness, as a systemic guarantee of the prohibition of the abuse of power, allowing the application of the legal system not to be influenced by arbitrariness, preventing each judge from having his own procedural rules, in the words of Humberto Teodoro Júnior, encouraging the judge to apply the law in a way that is appropriate to the current moment, this application should not be contemporary to its production, but contemporary to its application.¹⁰

For all the above, it is denoted that the influence of neo-constitutionalism in our current Magna Carta has elevated and guided the possibility of the infra-constitutional legislator and even the components of the Judiciary to foster and institutionalize the principle of reasonableness by making it concrete in the new Code of Civil Procedure, as we will see later.

¹⁰ JÚNIOR, Humberto Theodoro. **Curso de Direito Processual Civil**, 56 ed.- Rio de Janeiro: Forense, 2015, p. 90.

3 PRINCIPLE OF REASONABLENESS: EFFECTIVE CRITERIA WITHIN THE NEW CODE OF CIVIL PROCEDURE.

3.1 DIMENSIONS OF THE PRINCIPLE OF REASONABLENESS:

According to the most respectable doctrine, reasonableness and proportionality are synonymous principles, they are consistent and translate the same feeling of the need to apply the necessary means to achieve the desired objective.

Thus, the reasonableness and proportionality of the public administration must be observed both by the legislator at the time of the issuance of legislative acts and by the law enforcer, at the time the administrative act is issued. In the first case, the legislator must weigh the need for legal protection on the one hand and the impact of this protection when applied to the specific case on the other. While in the second case, the magistrate as part of the public administration, in the concrete case, must apply the law respecting its purposes.

In the words of Celso Antônio Bandeira de Mello, the principle of reasonableness should be noted:

It is stated with this principle that the Administration, when acting in the exercise of discretion, will have to obey criteria acceptable from a rational point of view, in line with the normal sense of balanced people who respect the purposes that presided over the granting of the competence exercised.¹¹

Thus, it is clarified that certain acts or attitudes of the public administration will not only be inconvenient, but also illegitimate, unreasonable, bizarre, incoherent or practiced in disagreement with the purpose provided for by law.

Regarding the principle of proportionality, the author, Celso Antônio Bandeira de Mello, admired by us:

This principle enunciates the idea – simple, by the way, although often disregarded – that administrative powers can only be validly exercised to the extent and intensity corresponding to what is actually required to fulfill the purpose of the public interest to which they are linked.¹²

It can be seen, therefore, that both principles, reasonableness and proportionality, hold the same central idea, that is: acts that exceed what is necessary to achieve the intended objective are tainted by illegitimacy.

¹¹ BANDEIRA DE MELLO, Celso Antônio. Discretion and jurisdictional control. 2nd ed.. São Paulo: Malheiros, 2014, p. 111.

¹² Idem, p. 113.

Diverging from the brilliant author mentioned above, as well as being in line with the vision of Cláudio Pereira de Souza Neto and Daniel Sarmento, the principle of reasonableness has different dimensions from the principle of proportionality, unveiling a greater content than that of marking acts necessary to achieve the purpose pursued. With such dimensions, proportionality gains the contours of a prohibition, a prohibition against the abuse of power.

As already stated elsewhere, this abuse of power is revealed in excesses in the interpretation of the rule, exceptions in the application of the law in a broad sense, or non-observance of this law.

Thus, although the parties to the proceedings may also abuse their power, inherent to the participatory pole, in this analysis we deal with the possibility of abuse of power perpetrated by the judge, as public administrator of the jurisdiction.

Thus, it is necessary to consider reasonableness in these dimensions:

- a) Reasonableness as requirements of public reasons for the conduct of the State, which demands that State acts can be justified by means of arguments that, at least in theory, are accepted by all;
- b) Reasonableness as coherence prohibits the state from acting in a contradictory manner;
- c) Reasonableness as congruence prohibits the issuance of measures that are not supported by reality; and finally,
- d) Reasonableness as equity allows, in exceptional cases, the general rules to be adapted in their application [...] or even to deny the application of the rule when it causes serious injustice.¹³

Thus, such dimensions, as forms of control of the abuse of power in state acts, specifically as a form of control of the abuse of power of the magistrate in the application of the law, can be understood, according to this analysis, as follows, with regard to reasonableness as requirements of public reasons for the conduct of the state, this should be seen as democratic arguments. In other words, the decisions of the judge-state, when applying the rule, must be permeated by democratic arguments. The general principles of law, jurisprudence, analogy, in short, the entire legal framework must be applied in a democratic way, seeking the social claims that are mostly accepted.

¹³ NETO, Claudio Pereira de Souza; SARMENTO, Daniel. *Apud*, WAMBIER, Teresa Arruda Alvim; CONCEIÇÃO, Maria Lúcia Lins; RIBEIRO, Leonardo Ferres da Silva; MELLO, Rogerio Licastro Torres de. **First Comments on the New Code of Civil Procedure Article by Article**, São Paulo: Revista dos Tribunais, 2015, p. 64.

Furthermore, when talking about reasonableness for coherence, it must be understood as a prohibition of contradiction, that is, the judge-state must maintain a solid jurisprudence, ensure legal certainty.

Nevertheless, reasonableness as a support in reality prevents symbolic, fictional measures, which have no influence on reality, however, make the judiciary maintain a sense of power and control.

Finally, the last dimension of reasonableness allows the suppression of the norm, however this suppression can only occur in flagrant injustice, in what stands out and that does not declare a loser and a winner, however, declares all insufficient and does not hand over the right to anyone.

3.2 CONCRETE EXAMPLES OF REASONABLENESS, AS A CONTROL AGAINST THE ABUSE OF POWER, IN THE NEW CODE OF CIVIL PROCEDURE

It is necessary to reiterate, although the abuse of power, through reasonableness, is prohibited for the party in the civil proceeding, as an example, article 373 of the adjective law, which allows the reversal of the burden of proof in matters other than consumer law, an analysis of reasonableness is made here only with regard to the magistrate's performance as a prolator of state decisions.

Therefore, reasonableness, due to the bias of prohibiting judicial decisions, emerges from the Code of Civil Procedure, for example, in article 139, IV:

The judge shall conduct the proceedings in accordance with the provisions of this Code, and it shall be incumbent upon him:

[...]

IV - to determine all inductive, coercive, mandatory or subrogatory measures necessary to ensure compliance with a court order, including in actions that have as their object a monetary payment;

[...].

It is clear that article 139 of the Civil Law provides for other responsibilities of the magistrate, however, item IV innovates and unveils reasonableness, prohibiting the abuse of power, when searching desired by the creditor, allowing condemnatory actions to be treated as an executive action and giving the execution greater efficiency. Now, it seems to us an abuse of power not to make multiple and effective decisions in the search for satisfaction of the credit, the state-judge cannot transform the satisfaction of the credit into a utopia.

Continuing with the analysis, it is important to glimpse article 140:

The judge is not exempt from deciding on the grounds of lacuna or obscurity in the legal system.

Sole Paragraph. The judge will only decide on equity in the cases provided for by law.

An important demonstration of reasonableness, it is not possible to decline jurisdiction, it is not possible to remove the burden of delivering the right. And see, equity is unveiled within the legal framework within the structure, and it is impossible to apply equity within an unfounded creative activity.

There is more, article 141 is another trimmer or limiter of abusive powers: "The judge shall decide the merits within the limits proposed by the parties, and it is forbidden to hear issues not raised in respect of which the law requires the initiative of the party". Here reasonableness is linked to congruence and inertia, limiting, hindering the law enforcer, reminded of his limited power in the face of the Democratic Rule of Law.

The civil liability of the judge is also important encouragement regarding the prohibition of the abuse of his power, as stated in article 143:

The judge will be liable, civilly and regressively, for damages when:

I - in the exercise of his functions, to act with intent or fraud;

II - refuses, omits or delays, without just cause, a measure that must be ordered ex officio or at the request of the party.

[...].

Of course, it is not about strict civil liability, not without being able to speak of guilt, however, the concern with this state power is demonstrated.

Article 489. The essential elements of the sentence are:

[...]

§ 1 Any judicial decision, whether interlocutory, sentence or ruling, which:

[...]

VI - failing to follow the statement of precedent, jurisprudence or precedent invoked by the party, without demonstrating the existence of a distinction in the case under trial or the overcoming of the understanding.

Article 489, paragraph 1, item VI, cited above, brings the need for reasonableness in its dimension of coherence, legal certainty must be encompassed, under penalty of abuse of power. It is the judge's duty to elucidate the discussion and the invocations of the courts, to verify whether the understanding raised by the party is still valid and can be applied to the specific case.

In this vein, with regard to coherence, we can still list the following articles:

Article 926. Courts must standardize their jurisprudence and keep it stable, complete and coherent.

§ 1 In the manner established and according to the assumptions set forth in the internal regulations, the courts shall issue summary statements corresponding to their prevailing jurisprudence.

§ 2 When issuing precedent statements, the courts must stick to the factual circumstances of the precedents that motivated their creation.

Article 927. Judges and courts shall observe:

I - the decisions of the Federal Supreme Court in concentrated control of constitutionality;

II - the statements of binding precedents;

III – judgments in incidents of assumption of jurisdiction or resolution of repetitive claims and in judgments of extraordinary and special repetitive appeals;

IV – the statements of the precedents of the Federal Supreme Court in constitutional matters and of the Superior Court of Justice in infra-constitutional matters;

V – the orientation of the plenary or of the special body to which they are linked.

Still pertinently, the Code brings the possibility of applying a rescinding action in the case of manifest non-compliance with a legal rule, article 966, it may seem obvious, however, the decision, the demonstration of power evoked from the absence of legality, cannot be valid. As already said, the creative and inventive possibility of the judge must encounter barriers in the reasonable, in the legality.

Finally, it is worth transcribing here article 988 of the Code of Civil Procedure: "a complaint by the interested party or the Public Prosecutor's Office may be filed for: [...] III - to ensure compliance with the decision of the Federal Supreme Court in concentrated control of constitutionality; [...]".

This article places the magistrate in a position of being supervised, watched, so that he cannot incur in abuses of power and ensures attention to the legal system as a whole and the constitutional guidelines. Transgressing the Supreme Court's control of constitutionality would be more than abusing power, if not, subverting the very logic of power.

Therefore, although they contemplate other principles and other aspects, the institutes brought above, without a doubt, bring the demonstration of the principle of reasonableness, within the New Code of Civil Procedure, in a dimension of prohibition of the abuse of power and control of state decisions, placing the magistrate on a level of state administrator and disseminator of administrative acts.

4 CONCLUSION

The panorama of the results invites a percussive analysis of the need to understand the principle of reasonableness, as an instrument to control the abuse of power of the magistrate, inserted in institutes within the Code of Civil Procedure.

Certainly, the lack of reasonableness in the Brazilian civil procedure removes the character of public administration from the jurisdiction, which cannot be thought of without necessary constraints to the legal structure in place. By dissolving social conflict, the judge-state cannot relegate the law in a broad sense, cannot reject the established jurisprudence, cannot supplant principles and guarantees. Even during his interpretative act, even during his creative sketch, the judge cannot relegate the legal system, under penalty of incurring in abuse of power and tainting his decision with illegality.

In the present work it was intended to examine the Constitutional legal provision of the principle of reasonableness, which, although not expressed in the Magna Carta, is a corollary of the Democratic Rule of Law, as well as is rooted in the neo-constitutionalist bias given to the interpretation of infra-constitutional norms. Thus, reasonableness, unlike proportionality, must be seen through republican dimensions, which attribute to the principle a character of indispensability for the proper functioning of the jurisdiction, in civil procedural matters, limiting the power of the judge and even allocating its action within the criteria of separation of powers and independence of the litigants.

The development of the research is justified by the pressing and relevant task of demonstrating that the principle of reasonableness, as a prohibition against the abuse of power, was widely enshrined by the new civil law, through various institutes. In this way, the new Code of Civil Procedure breaks paradigms and places the judge as a great collaborator, promoter of the resolution of the dispute. The magistrate is no longer the absent protagonist, he is present and must base his decisions within a systemic and ideological logic achieved by the process.

It is necessary to think about judging, within the civil process, as someone who is linked to the public administration and its efficiency. Legality does not lend itself only to the individual, however, it lends itself to the state to its actors and acts and the jurisdiction needs to commune with this.

The new process requires new powers, new responsibilities and new limitations. Reasonable, according to this analysis, is that magistrate who applies the legal norm without extrapolating its spirit, without ceasing to contemplate the settled jurisprudence, without ceasing to pay attention to the principled order. Reasonable is the compliance with the due process of law, it is a demonstration that the subjective right will be achieved through the adjective and not the other way around.

Reasonableness, in this analysis, has new reflexes, new aspirations, which, as demonstrated, were freed by the new Code of Civil Procedure.

REFERENCES

- Abelha, M. (2016). Manual de direito processual civil (6. ed.). Rio de Janeiro: Forense.
- Bandeira de Mello, C. A. (2014). Discricionariedade e controle jurisdicional (2. ed.). São Paulo: Malheiros.
- Brasil. (1988). Constituição da República Federativa do Brasil. Brasília, DF: Senado Federal.
- Brasil. (2015). Código de Processo Civil brasileiro. Brasília, DF: Senado.
- Canotilho, J. J. G. (2003). Direito constitucional e teoria da Constituição (7. ed.). Coimbra: Almedina.
- Cunha Júnior, D. da. (2013). Curso de direito constitucional (7. ed.). Salvador: JusPodivm.
- Didier Jr., F. (2015). Curso de direito processual civil: introdução ao direito processual civil, parte geral e processo de conhecimento (17. ed., Vol. 1). Salvador: JusPodivm.
- Theodoro Júnior, H. (2015). Curso de direito processual civil (56. ed.). Rio de Janeiro: Forense.
- Silva, J. A. da. (1988). O Estado democrático de direito. *Revista de Direito Administrativo*, 173, 15–34. <http://bibliotecadigital.fgv.br/ojs/index.php/rda/article/viewFile/45920/44126>
- Wambier, T. A. A., Conceição, M. L. L., Ribeiro, L. F. da S., & Mello, R. L. T. de. (2015). Primeiros comentários ao novo Código de Processo Civil: artigo por artigo. São Paulo: Revista dos Tribunais.

GAMEMOVE MOTOR SKILL ASSESSMENT MODE AND ITS APPLICATION IN THE ANALYSIS OF MOTOR PERFORMANCE IN AGING INDIVIDUALS

MODO AVALIAÇÃO DO GAMEMOVE MOTOR SKILL E SUA APLICAÇÃO NA ANÁLISE DO DESEMPENHO MOTOR DE PESSOAS EM PROCESSO DE ENVELHECIMENTO

MODO DE EVALUACIÓN DE GAMEMOVE MOTOR SKILL Y SU APLICACIÓN EN EL ANÁLISIS DEL RENDIMIENTO MOTOR DE PERSONAS EN PROCESO DE ENVEJECIMIENTO



<https://doi.org/10.56238/sevened2026.008-175>

Geovani Rafael Lima Cavaleiro¹, Sílvia Cardoso Borges², Djuli Margô Naissinger Sidekum³, Denise Bolzan Berlese⁴, Geraldine Alves dos Santos⁵

ABSTRACT

This study analyzed the motor performance of individuals undergoing the aging process, participants of the Gerontology Center at Feevale University, mediated by the active digital game GameMove Motor Skill. The research is characterized as exploratory, quantitative, and cross-sectional. The sample consisted of 102 aging individuals (76 females and 26 males), all participants of the Feevale Gerontology Center. Data were presented using absolute and relative frequencies, measures of central tendency, and dispersion. Normality was tested using the Kolmogorov-Smirnov test, while the Mann-Whitney test compared scores between genders, and the Chi-square test evaluated associations between motor skills and age groups. Analyses were conducted in IBM® SPSS® (v.26.0), adopting a significance level of $p \leq 0.05$. The analysis of motor performance in the GameMove Motor Skill revealed no significant differences between sexes in the hitting task, although results showed a favorable trend for men. In the right-leg kicking task, a significant difference was observed in favor of men. This result may be associated with cultural factors that influence oculopedal experiences and the valuation of certain motor skills in the daily lives of aging individuals. The hopping/stationary march test indicated a slight male tendency, but without statistical significance, whereas the balance test revealed significant differences favoring men on both sides, with greater discrepancies observed after the age of 70. The game proved to be a reliable instrument for assessing motor performance in individuals undergoing the aging process, providing support for understanding this performance and for the appropriate prescription of interventions.

Keywords: Active Video Games. Motor Skills. Aging.

¹ Doctoral student in Cultural Diversity and Social Inclusion. Universidade Feevale. E-mail: gcavaleiro2014@gmail.com

² Undergraduate in Physiotherapy. Universidade Feevale. E-mail: silviaborges260@gmail.com

³ Doctoral student in Neuroscience. Universidade Federal do Rio Grande do Sul (UFRGS). E-mail: djuli@feevale.br

⁴ Dr. in Cultural Diversity and Social Inclusion. Universidade Feevale. E-mail: dberlese@feevale.br

⁵ Doctoral student in Psychology. Universidade Feevale. E-mail: geraldinesantos@feevale.br

RESUMO

Este estudo analisou o desempenho motor de pessoas em processo de envelhecimento, participantes do Centro Interdisciplinar de Pesquisas em Gerontologia da Universidade Feevale, mediado pelo jogo digital ativo GameMove Motor Skill. A pesquisa é de natureza exploratória, quantitativa e transversal. A amostra foi composta por 102 pessoas em processo de envelhecimento, 76 do sexo feminino e 26 do sexo masculino. Os dados foram apresentados por frequências absolutas e relativas, medidas de tendência central e dispersão. A normalidade foi testada pelo Kolmogorov-Smirnov, o Mann-Whitney comparou escores entre sexos e o Qui-Quadrado avaliou associações entre habilidades motoras e faixas etárias. As análises foram realizadas no IBM® SPSS® (v.26.0), adotando $p \leq 0,05$. A análise do desempenho motor no GameMove Motor Skill mostrou ausência de diferença significativa entre os sexos no teste de rebater, embora com melhor desempenho aos homens. No chute com a perna direita, observou-se diferença significativa em favor do sexo masculino. Esse resultado pode estar associado a fatores de ordem cultural, que influenciam a vivência óculo-pedal e a valorização de determinadas habilidades motoras no cotidiano das pessoas em processo de envelhecimento. O teste de saltitar/marcha estacionária indicou melhor desempenho masculino, mas sem significância, enquanto no equilíbrio houve diferença significativa para os homens em ambos os lados, mais acentuada após os 70 anos. O jogo demonstrou ser um instrumento confiável para a avaliação do desempenho motor em pessoas em processo de envelhecimento, oferecendo subsídios para a compreensão desse desempenho e para a adequada prescrição de intervenções.

Palavras-chave: Jogos Eletrônicos de Movimento. Destreza Motora. Envelhecimento.

RESUMEN

Este estudio analizó el rendimiento motor de personas en proceso de envejecimiento, participantes del Centro Interdisciplinario de Investigaciones en Gerontología de la Universidad Feevale, mediado por el juego digital activo GameMove Motor Skill. La investigación es de naturaleza exploratoria, cuantitativa y transversal. La muestra estuvo compuesta por 102 personas en proceso de envejecimiento, 76 mujeres y 26 hombres. Los datos se presentaron por frecuencias absolutas y relativas, medidas de tendencia central y dispersión. La normalidad se probó mediante Kolmogorov-Smirnov, Mann-Whitney comparó las puntuaciones entre sexos y Chi-Cuadrado evaluó las asociaciones entre habilidades motoras y grupos de edad. Los análisis se realizaron en IBM® SPSS® (v.26.0), adoptando $p \leq 0,05$. El análisis del rendimiento motor en GameMove Motor Skill mostró una ausencia de diferencias significativas entre los sexos en la prueba de bateo, aunque con un mejor rendimiento en los hombres. En la patada con la pierna derecha, se observó una diferencia significativa a favor del sexo masculino. Este resultado puede estar asociado a factores de orden cultural, que influyen en la experiencia óculo-pedal y en la valoración de determinadas habilidades motoras en la vida cotidiana de las personas en proceso de envejecimiento. La prueba de saltar/marcha estacionaria indicó un mejor rendimiento masculino, pero sin significación, mientras que en el equilibrio hubo una diferencia significativa para los hombres en ambos lados, más acentuada después de los 70 años. El juego demostró ser un instrumento confiable para evaluar el desempeño motor en personas en proceso de envejecimiento, ofreciendo información para comprender este desempeño y prescribir intervenciones adecuadas.

Palabras clave: Juegos Electrónicos de Movimiento. Destreza Motora. Envejecimiento.

1 INTRODUCTION

The world's population is in an aging process, configuring one of the most relevant demographic phenomena of the twenty-first century. According to recent estimates by the World Health Organization (WHO, 2024), by the year 2030, one in six people will be 60 years of age or older, totaling approximately 1.4 billion individuals in this age group. Projections also indicate that by 2050 this contingent could reach 2.1 billion people, evidencing the magnitude and urgency of discussions on population aging on a global scale.

The United Nations predicts that by 2050, people over the age of 65 will make up 15.9% of the world's population, up from 9.3% in 2020. In Europe, this age group is projected to reach 28.1%, from the current 19.1%, while the population over 80 years of age is expected to practically double, from 5.3% to 10.1% in the same period (United Nations, 2023).

The proportion of people in the process of aging has been increasing consistently in both developed and developing countries, a direct result of the combination of declining mortality and fertility rates and the progressive increase in life expectancy. In this context, it is essential to understand and identify the priority problems that affect the aging population, understood as the contingent of individuals who enter more advanced age groups as a result of the increase in longevity and the reduction in fertility and mortality rates. Such understanding is essential to support the formulation of actions aimed at ensuring the safety of the aging population and providing the necessary health care (Torre, 2022).

In this sense, it is imperative to consider the physiological and functional changes typical of aging, since reduced levels of physical activity, decreased gait speed, and progressive loss of muscle strength are associated with a more accelerated decline in mobility, predisposing to functional limitations and greater vulnerability (Martins et al., 2020).

Among the most critical factors, deficits in postural control stand out, which have repercussions on physical functioning and are significant predictors of falls in the elderly. Postural control should be understood as a complex and dynamic skill, resulting from the interaction between sensory, perceptive and motor processes, whose proper integration enables postural orientation and the maintenance of balance. From this perspective, functional balance is a central element, as it represents the ability of the elderly to sustain stability, both in static and dynamic situations, during daily activities. The impairment of this ability compromises not only functional independence, but also the quality of life of individuals in the aging process (Medeiros et al., 2024).

Flores et al., (2024) argue that technological devices, such as television, smartphones, computers, and video games, are associated with the promotion of sedentary lifestyle patterns. However, Pacheco et al (2020), Ha et al (2025) and Chen et al (2020) indicate that

technological advances can also offer new possibilities for the practice of physical exercise, contributing to the improvement of physical activity levels, well-being and learning.

In this sense, exergames (a term derived from the combination of the words exercise and game) can be defined as active digital games (JDAs) that require body movement to be played, providing an interactive experience that works as a form of physical exercise (Van Santen et al., 2018). These resources cover multiple motor and cognitive skills by integrating sensory feedback, adjustable ranges of motion, variations in speed and precision, as well as diversified tasks that simulate everyday situations (Schneider; Berlese; Barbosa, 2023).

Exergames or JDAs are recognized for enabling not only the real-time practice of motor activities, but also for promoting engagement in meaningful actions related to the interests of daily living (Maggio et al, 2025). Huang et al. (2017) highlight that this type of game can positively influence both the subjective experience and the behaviors of players by articulating entertainment with functional goals.

In the field of rehabilitation, there is a growing body of scientific evidence on the potential benefits of JDAs for people with cognitive-motor deficits. Nuic et al (2024) and Fernandes et al (2025) point to positive impacts on specific populations, such as patients with Parkinson's disease or in the post-stroke rehabilitation phase. Chen et al. (2021) point out that these tools have significant potential for improving postural control and balance, fundamental aspects for functional autonomy.

However, despite the already recognized benefits of Active Digital Games (JDAs), there is still a relevant gap in the scientific field regarding the proof of their effectiveness in assessing motor performance (Leal et al., 2023). This gap highlights the need for research to validate the applicability of these technological resources in order to promote health and the prevention of functional disabilities.

In this sense, the definition of adequate motor parameters, combined with the systematic monitoring of Physical Education professionals, is a fundamental condition to ensure the effectiveness of interventions. This process not only guides the adaptation of the JDAs to the particular demands of the aging population, but also ensures the creation of contextualized virtual environments that respect individual singularities and promote dynamic, safe, and socially meaningful motor experiences. Thus, the Physical Education professional plays a central role in articulating technology, health and inclusion. In view of this scenario, the present study aims to analyze the motor performance of people in the aging process, participants of the Interdisciplinary Center for Research in Gerontology of Feevale

University, mediated by the active digital game GameMove Motor Skill.⁶

2 METHOD

The present research is characterized as being exploratory, descriptive, quantitative and cross-sectional. In order to contemplate the objectives of the study, the instruments and procedures were organized and carried out in phases and stages. The procedures and instruments for data collection or production were established according to the development phase, which followed a process structured in phases according to the model proposed by Baba and Tschang (2001). In Phase 1, the theoretical and pedagogical foundations for the improvement of the game were established. Phase 2 focused on creating the game's layout, rules, narrative, and characters, as well as implementing motion capture via webcam, and in Phase 3, developing the game itself. After the judges' validation (phase 4) and data collection, adaptations were made to the game and validation with the target audience (phase 5).

We investigated 102 aging people, of both sexes (76 females and 26 males), aged between 50 and 80 years, participants at the Feevale Gerontology Center, in Rio Grande do Sul, Brazil. Inclusion in the study was conditional on their consent. The exclusion criteria were guaranteed through the information contained in the registration form made available by the Feevale Gerontology Center, ensuring the standardization of the sample and the possibility of interaction of the participants with the game. Individuals in the aging process who had uncorrected physical, cognitive, intellectual or visual disabilities, whose conditions could compromise the adequate execution of the proposed tasks, were excluded from the study. Among the physical criteria, significantly reduced mobility, severe spasticity, and relevant musculoskeletal restrictions were considered exclusion factors. In the cognitive field, situations of severe developmental delays or marked attentional deficits were excluded. Regarding intellectual limitations, substantial comprehension difficulties were considered, capable of directly interfering with the performance of game activities.

In addition, the investigation had the participation of 02 Physical Education professionals, whose contribution was fundamental for the performance of the analog motor assessment through observation of movements (process-oriented assessment). The process-oriented evaluation, conducted by experts in the field, enabled detailed analysis of movement patterns, allowing comparisons between the data obtained in the JDA GameMove Motor Skill and the motor parameters. This complementary approach strengthens the validity

⁶ For the initial validation of the game with children (children from 6 to 11 years old), see: SCHNEIDER, Guilherme Theisen; et al. Development and validation of an active digital game to stimulate motor skills: application of the GameMove Motor Skill. In: *Anais...* (proceedings of the SBGames Extended 2023 conference, Brazilian Computer Society). 2023. Available at: https://sol.sbc.org.br/index.php/sbgames_estendido/article/view/27856.

of the results, ensuring a methodological triangulation that improves the reliability of the results and enables a more comprehensive understanding of the motor development of people in the aging process.

All evaluations were performed after signing the Informed Consent Form, in accordance with the determinations of resolution 466, of December 2012, of the National Health Council. Participants were provided with information regarding their right to participate and guarantees of anonymity. The study was approved by the Research Ethics Committee CAEE No. 78383024.6.0000.5348, Registration No.: 206426/2024.

To meet the need for a tool with a more precise evaluative focus, such as game improvement, a new stage was developed that introduced a differentiated dynamic to provide a more accurate and standardized motor evaluation. The main modifications included an introduction (instruction phase), with detailed feedback on motor actions, combining visual and auditory instructions. The objective was to improve the execution and understanding of the movements by the participants. This feedback offered immediate guidance, ensuring that movements were performed with greater precision. In addition, the evaluation phase has been adjusted to cover all age groups at a single level, with modifications such as reducing obstacles and increasing the intervals between tasks. These changes ensured a more reliable evaluation of motor parameters. By simplifying the dynamics of the game and adjusting variables such as the complexity of the tasks, the time and the number of obstacles, reliable results were obtained on the motor performance of people in the aging process.

Thus, Figure 1 illustrates the set of images in the tutorial (instruction phase) referring to the four movements selected for initial learning at the beginning of the evaluation phase. The tutorial was structured in such a way as to present each movement through the silhouette of an individual performing the actions of balancing, jumping (stationary gait), batting and kicking. To ensure adequate assimilation by the participants, the movements were programmed to be performed at a reduced speed, allowing a clearer and more detailed visualization of the actions by the participants. This strategy aimed to facilitate the understanding and correct execution of the movements, aligning with the pedagogical and evaluative objectives of the game.

Figure 1

Set of Tutorial Images in the four moves of the GameMove Motor Skill



Source: GameMove Motor Skill game tutorial images.

The digital evaluation was conducted using the GameMove Motor Skill, under the direct supervision of the principal investigator. Initially, the data of each participant, such as name, age and gender, were recorded in the game's identification menu. After this registration process, the system went through a calibration phase, designed to adjust the capture and mimicry of the body movements of the evaluated, ensuring the accuracy of the interactions. Each participant was submitted to an introductory stage, in which they practiced the game's tutorial. This phase aimed to promote familiarization with the movements required in each game mode, ensuring an adequate understanding of the proposed activities.

During the execution of the game, the Physical Education professionals filled out a specific analog motor assessment questionnaire aimed at people in the aging process, based on motor protocols applied to the elderly population and guided by the movement development guidelines proposed by Gallahue, Ozmun and Goodway (2013). This approach enabled an analysis of motor skills, respecting the particularities of aging and ensuring scientific rigor in the interpretation of the results. This instrument documents the motor skills observed, providing process-oriented data of the movements requested in the game (product).

The results were described as absolute (n) and relative (%) frequencies, minimum and maximum values, arithmetic mean, standard deviation, median, percentile ranks (P25, P75) and interquartile range. Kolmogorov-Smirnov was applied to test adherence to the normal distribution in all experimental variables (game and observation). Mann-Whitney was used to

compare the scores between genders. Chi-square (χ^2) was used to assess the existence of associations between the levels of motor skills classification as a function of age groups. All statistical procedures were performed using the IBM® SPSS® software (Version 26.0), adopting a significance level of $p \leq 0.05$.

3 RESULTS

The results presented in this study came from two complementary sources: the data collected automatically by the active digital game GameMove Motor Skill (product of motor actions) and the observations conducted by Physical Education professionals (process of motor actions). As an instrument to evaluate the motor action process, an assessment for older people adapted from the protocol originally proposed by Schneider (2025) was used. The data from the game provides objective and standardized information about the performance (product) of the participants, capturing precise metrics such as time, accuracy and efficiency of the movements. On the other hand, the observations of Physical Education professionals allowed a process-oriented analysis that considers more subtle and contextual aspects of motor performance, such as functional motor organization of movement, posture, coordination and adaptability. This perspective was essential for interpreting nuances that were not completely captured by the webcam.

The integration of these two data sources is justified by the need for a process- and product-oriented evaluation of motor performance, also encompassing the contextualized interpretation of its implications. This hybrid approach enabled a triangulation of information, ensuring that the study's findings incorporate both the precision and advances offered by the technology and the analytical depth and interpretive richness afforded by the expert observation of a qualified professional.

4 ANALYSIS OF DATA FROM THE JDA GAMEMOVE ENGINE SKILL

Before the presentation of the results, the procedure adopted for the statistical analysis of the data from the GameMove Motor Skill Active Digital Game (JDA) is highlighted. Comparisons were made using the two-way model, considering the factors age and sex, in order to verify the need or not for different classifications between men and women. In total, 21 variables were analyzed, distributed in three age groups (50–59 years, 60–69 years, and 70–80 years), which allowed a precise understanding of the effects of aging on motor performance, as well as the possible interactions between age and sex that will be presented in Table 1.

Table 1

Comparison between the sexes by age profile in the ability to balance the game

Age Group	Variable	Gender		P
		Female (n=76)	Male (n=26)	
50-59 years (n = 18)	Right Balance	58,0	60,0	0,100
	Left Balance	58,0	60,0	0,164
	Total Balance	117,0	120,0	0,100
60-69 years old (n = 58)	Right Balance	58,0	59,0	0,701
	Left Balance	57,0	58,0	0,522
	Total Balance	114,0	118,0	0,403
70-80 years (n = 26)	Right Balance	45,0	52,5	*0,017
	Left Balance	50,5	56,5	*0,015
	Total Balance	97,0	109,0	**0,003
All (n = 102)	Right Balance	57,0	58,0	0,480
	Left Balance	56,0	57,0	0,189
	Total Balance	112,0	114,5	0,211

(*) $p \leq 0.05$; (**) $p \leq 0.01$; (***) $p \leq 0.001$.

Source: Prepared by the author, 2025.

Table 1 shows that, up to the age of 69, there were no significant differences between men and women in the motor ability of balance. However, in the 70 to 80 age group, women had significantly lower performance on the right ($p = 0.017$), left ($p = 0.015$) and total ($p = 0.003$) balance measures. These results may be related to physiological factors such as sarcopenia, lower muscle mass and strength, reduced bone mineral density, and postmenopausal hormonal changes, which contribute to a steeper decline in body stability in this age group.

Table 2

Comparison between the sexes by age profile, ability to jump/stationary gait in the game

Age Group	Variable	Gender		P
		Women	Male	
50-59 years (n = 18)	Click-through Rate/Hits S01	1,7	1,5	0,130
	Click/Hit Rate S02	1,4	1,4	0,498
	Click/Hit Rate S03	1,3	1,3	0,738
	Click/Hit Rate S04	1,3	1,3	0,574
	Overall Click-through / Hit Rate	1,4	1,4	0,824
	Total Time Bouncing	33,0	23,0	0,056
60-69 years old (n = 58)	Click-through Rate/Hits S01	1,5	2,2	*0,018
	Click/Hit Rate S02	1,4	1,4	0,764
	Click/Hit Rate S03	1,3	1,3	0,588
	Click/Hit Rate S04	1,3	1,3	0,624
	Overall Click-through / Hit Rate	1,4	1,6	0,069
	Total Time Bouncing	28,0	38,0	0,254
70-80 years (n = 26)	Click-through Rate/Hits S01	1,7	2,2	*0,046
	Click/Hit Rate S02	1,4	1,4	0,403
	Click/Hit Rate S03	1,5	1,3	0,560
	Click/Hit Rate S04	1,3	1,4	0,322
	Overall Click-through / Hit Rate	1,6	1,6	0,274
	Total Time Bouncing	49,0	27,5	0,403
All (n = 102)	Click-through Rate/Hits S01	1,7	2,1	**0,006
	Click/Hit Rate S02	1,4	1,4	0,479
	Click/Hit Rate S03	1,3	1,3	0,735
	Click/Hit Rate S04	1,3	1,3	*0,048
	Overall Click-through / Hit Rate	1,4	1,5	*0,021
	Total Time Bouncing	33,0	27,5	0,969

(*) $p \leq 0.05$; (**) $p \leq 0.01$; (***) $p \leq 0.001$.

Source: Prepared by the author, 2025.

Table 2 shows that, for the group between 50 and 59 years of age, there were no significant differences between men and women in the click/correct answer rates (S01 to S04) or in the overall rate, although the total time of jumping showed a trend of difference in favor of women ($p = 0.056$), without statistical significance. In the 60-69 and 70-80 age groups, there was a significant difference in the click/correct answer rate S01 ($p = 0.018$ and $p = 0.046$, respectively), with superior performance of men, in addition to a favorable trend in the overall rate between 60 and 69 years ($p = 0.069$). In the sample as a whole ($n = 102$), men had significantly higher performance in S01 ($p = 0.006$), S04 ($p = 0.048$) and in the overall rate ($p = 0.021$).

Table 3

Comparison between the sexes by age profile, ability: Batting in the game

Age Group	Variable	Gender		P
		Women	Male	
50-59 years (n = 18)	Bounce Right	5,0	4,0	0,498
	Left Batting	5,0	5,0	1,000
	Total Bounce	10,0	9,0	0,654
60-69 years old (n = 58)	Bounce Right	4,0	5,0	0,209
	Left Batting	5,0	4,0	0,468
	Total Bounce	9,0	9,0	0,831
70-80 years (n = 26)	Bounce Right	4,0	4,0	0,667
	Left Batting	3,5	4,5	0,403
	Total Bounce	7,0	8,5	0,560
All (n = 102)	Bounce Right	4,0	5,0	0,666
	Left Batting	5,0	4,0	0,778
	Total Bounce	9,0	9,0	0,903

Source: Prepared by the author, 2025.

Table 3 shows that, in all age groups analyzed (50–59, 60–69, and 70–80 years), there were no statistically significant differences between men and women in the ability to hit, either with the right or left hand, or in the total number of repetitions. Although small variations were observed, there is a trend towards higher performance of the right hand in men and the left hand in women between 60–69 years of age, and slightly higher values for men between 70–80 years of age, without statistical significance. Thus, the overall average performance remains similar between the sexes.

Table 4

Comparison between the sexes by age profile, ability: Kicking in the game

Age Group	Variable	Gender		P
		Women	Male	
50-59 years (n = 18)	Kick Right	4,0	4,0	0,912
	Left Kick	5,0	4,0	0,250
	Total Kick	9,0	8,0	0,574
60-69 years old (n = 58)	Kick Right	4,0	5,0	0,365
	Left Kick	5,0	5,0	0,820
	Total Kick	9,0	9,0	0,640
70-80 years (n = 26)	Kick Right	2,5	4,0	0,053
	Left Kick	3,5	4,5	0,252
	Total Kick	6,0	8,5	*0,046
All (n = 102)	Kick Right	4,0	4,0	0,469
	Left Kick	5,0	5,0	0,903
	Total Kick	8,5	8,5	0,661

(*) $p \leq 0.05$; (**) $p \leq 0.01$; (***) $p \leq 0.001$.

Source: Prepared by the author, 2025.

Table 4 shows that, in the 50–59 and 60–69 age groups, no statistically significant differences were identified between men and women in kicking ability, which indicates the absence of relevant effects of aging on this motor capacity at these ages. In the 70–80 age

group, however, there was a significant difference in the total number of kicks ($p = 0.046$), with superior performance of men, while the right kick showed only a trend towards difference ($p = 0.053$).

5 ANALYSIS OF DATA FROM THE EXPERT'S OBSERVATION

In order to identify inconsistencies in the evaluation provided by the *GameMove Motor Skill* game, an observational analysis (motor action process) was carried out, through motor evaluation, adapted from Schneider's proposal (2025) and conducted by a Physical Education professional.

Initially, descriptive statistics were performed, covering minimum and maximum values, median, arithmetic mean, standard deviation, percentiles (P25, P50, P75), as well as the interquartile range (IQR), in order to characterize the performance of the participants. For the comparative stage, the *two-way* ANOVA model was used, considering the factors age and sex. The purpose of this procedure was to identify possible variations between the groups and to assess the need for distinct classifications between men and women, thus ensuring the relevance of a joint analysis. In all, 12 variables were analyzed, distributed in three age groups (50–59 years, 60–69 years, and 70–80 years), allowing a detailed assessment of the impact of aging and gender on motor performance. Based on this design, the descriptive and comparative results are presented below, organized in tables in order to highlight the patterns of motor performance between the different age groups and sexes, as well as the possible interactions between these variables.

Table 5

Comparison between the sexes by age profile, ability: Balance in observation

Age Group	Variable	Gender		P
		Women	Male	
50-59 years (n = 18)	Right Balance	7,0	7,0	0,912
	Left Balance	7,0	7,0	0,250
	Total Balance	14,0	14,0	0,738
60-69 years old (n = 58)	Right Balance	7,0	6,0	0,098
	Left Balance	7,0	6,0	0,915
	Total Balance	13,0	12,0	0,342
70-80 years (n = 26)	Right Balance	5,0	6,0	0,076
	Left Balance	6,0	6,0	0,462
	Total Balance	11,0	12,0	0,131
All (n = 102)	Right Balance	7,0	6,0	0,387
	Left Balance	6,0	6,5	0,699
	Total Balance	12,0	12,0	0,811

Source: Prepared by the author, 2025.

Table 5 shows that, in all age groups analyzed, no statistically significant differences were identified between men and women in postural balance, either on the right or left sides

and on the total. Small trends were recorded with slightly higher performance of women in right balance between 60–69 years ($p = 0.098$) and men between 70–80 years ($p = 0.076$), but without statistical significance.

Table 6

Comparison between the sexes by age profile, ability: Jumping in observation

Age Group	Variable	Gender		P
		Women	Male	
50-59 years (n = 18)	Overall Click-through / Hit Rate	1,4	1,4	0,824
	Total Bounce	14,0	14,0	1,000
60-69 years old (n = 58)	Overall Click-through / Hit Rate	1,4	1,6	0,091
	Total Bounce	14,0	14,0	0,791
70-80 years (n = 26)	Overall Click-through / Hit Rate	1,6	1,6	0,274
	Total Bounce	13,0	14,0	0,781
All (n = 102)	Overall Click-through / Hit Rate	1,4	1,5	*0,021
	Total Bounce	14,0	14,0	0,605

(*) $p \leq 0.05$; (**) $p \leq 0.01$; (***) $p \leq 0.001$.

Source: Prepared by the author, 2025.

Table 6 shows that, between 50 and 59 years of age, there were no significant differences between men and women in the overall click/correct rate or in the total number of jumps, indicating similar performance in coordination and locomotion tasks. However, between 60 and 69 years of age, there was a trend of male superiority in the overall click/correct answer rate (1.6 vs. 1.4; $p = 0.091$), although without statistical significance, while the total number of correct answers remained equivalent between the sexes. In the 70 to 80 age group, both the click/hit rate and the total number of jumps remained similar, with no statistical differences. When considering the total sample ($n = 102$), the overall click/correct answer rate showed a significant difference for males ($p = 0.021$), while the total number of skipping remained balanced.

Table 7

Comparison between the sexes by age profile, ability: Rebuttal in observation

Age Group	Variable	Gender		P
		Women	Male	
50-59 years (n = 18)	Bounce Right	6,0	6,0	0,301
	Left Batting	6,0	6,0	0,301
	Total Bounce	12,0	12,0	0,301
60-69 years old (n = 58)	Bounce Right	6,0	6,0	0,241
	Left Batting	5,0	6,0	0,104
	Total Bounce	11,0	12,0	0,157
70-80 years (n = 26)	Bounce Right	5,5	5,0	0,781
	Left Batting	5,0	5,0	0,940

	Total Bounce	10,5	10,0	0,899
All (n = 102)	Bounce Right	6,0	6,0	0,704
	Left Batting	5,5	6,0	0,291
	Total Bounce	11,0	12,0	0,473

Source: Prepared by the author, 2025.

Table 7 did not identify statistically significant differences between men and women in the performance of hitting ability, either with the right or left hand, or in total. Between 60 and 69 years of age, only a slight trend of better performance of the left hand was observed in men ($p = 0.104$), without, however, reaching statistical significance.

Table 8

Comparison between the sexes by age profile, ability: Guessing on observation

Age Group	Variable	Gender		P
		Women	Male	
50-59 years (n = 18)	Kick Right	6,0	6,0	0,426
	Left Kick	6,0	6,0	0,426
	Total Kick	12,0	12,0	0,426
60-69 years old (n = 58)	Kick Right	6,0	6,0	0,160
	Left Kick	6,0	6,0	0,520
	Total Kick	12,0	12,0	0,465
70-80 years (n = 26)	Kick Right	6,0	6,0	0,432
	Left Kick	6,0	6,0	0,631
	Total Kick	12,0	12,0	0,595
All (n = 102)	Kick Right	6,0	6,0	0,053
	Left Kick	6,0	6,0	0,287
	Total Kick	12,0	12,0	0,227

Source: Prepared by the author, 2025.

The data presented in Table 8 demonstrate that no statistically significant differences were found between men and women in the different age groups in the performance of kicking ability, both for the right and left legs, as well as in the total number of kicks, indicating stability and equivalence between the sexes throughout aging.

6 DISCUSSIONS

Aging causes significant changes in motor initiation and control, but such effects tend not to be homogeneous between the sexes. These differences are also reflected in neuromuscular structure and function. Studies such as the one by Guo et al. (2025), in which they investigated 50 elderly people (26 men and 24 women, aged between 60 and 83 years), point out that women have greater functional vulnerability compared to men, which is reflected in multiple domains, from cortical preparation to motor execution and balance, corroborating the results presented in Tables 1 and 5 (equilibrium variables).

At the level of movement initiation, Frolov et al. (2020) observed that older people resort to more complex pre-movement processes, resulting in slower execution. According to

the results of tables 2, 3 and 6, distinct patterns in motor performance are observed between men and women. Rantanen, Era and Heikkinen (2005) found that women performed better in fine dexterity tasks, such as in the Purdue Pegboard test (an assessment widely used to measure manual dexterity, fine motor coordination and speed of manipulating objects with the hands), while men exhibited greater handgrip strength and *tapping* speed, in line with the results presented in Tables 3 and 7 (rebounding variables). This result is confirmed in a more recent study proposed by Wunderle et al., (2024) in which it was identified that men obtain higher results in tapping strength and frequency, while women excel in activities of stacking pins on the *Purdue Pegboard (perforated panel)*, evidencing greater manual agility corresponding to the results in table 2, 3 and 7 (bounce and bounce variables).

In addition, Beck, Hastings, and Clark (2025), in a systematic review, reinforce that, even in older people, male muscle strength remains consistently superior, although women retain advantages in coordination and manual dexterity. This corroborates the equivalences of the results in the variables of jumping/stationary gait and bouncing, when compared between the sexes, as shown in tables 2, 3, 6 and 7. Although women have a tendency for advantages in coordination and manual dexterity, this may have been compensated by the male evaluates who have a tendency towards better results in upper limb strength and power, as observed in Tables 3 and 7.

In this sense, Hooyman et al. (2021) showed that the manipulation of tools, highly dependent on fine motor control and cognitive functions, is more challenging for older people, with sex differences emerging mainly in manual precision tasks, with older women achieving superior results compared to men, similar to what was observed in our results. Vasylenko, Gorecka, and Rodríguez-Aranda (2018) report that elderly men were slower than elderly women in bimanual tasks, showing that sex influences not only strength, but also the quality of motor execution.

Sex differences become even more evident in postural balance. Elshorbagy et al. (2024) showed a significant increase in mediolateral oscillation in elderly women, indicating a lower efficiency of the compensatory mechanisms responsible for maintaining postural stability. Rezaei et al. (2024) point out that the single-leg stance test is a reliable predictor of aging, regardless of gender, but performance scores tend to be lower in women, corroborating the results presented in tables 1 and 5. As the study by Wu et al. (2021) demonstrates, there is a worse balance performance in Chinese elderly women. Similarly, Nascimento et al. (2023) reported a prevalence of falls almost twice as high among Portuguese women compared to men (48.7% vs. 23.6%). These data reinforce that women

are more susceptible to postural decline and falls, possibly due to factors such as lower muscle mass, hormonal differences, and greater longevity.

Muscle strength and power are crucial determinants of motor performance and also show differences between the sexes. It is estimated that there will be a progressive loss of 5 to 10% of muscle mass per decade after the age of 50, but this reduction has a greater impact on women (Rodrigues et al., 2022). Bersotti et al. (2022) showed that men preserve superior absolute torque in ankle dorsiflexion and plantar flexion, while Caçador et al. (2023) highlighted that women's lower limb strength corresponds to only 60–80% of that observed in men. This discrepancy is even more critical in muscle power, a variable strongly associated with fall prevention. This discrepancy may have been a determining factor for a better result in men in the evaluations that required greater recruitment of the muscles of the lower limbs, as observed in the results of Tables 4 and 8.

From a neuromuscular point of view, Guo et al. (2025) showed that elderly men maintain greater size and strength of the motor units of the vastus lateralis muscle, also presenting better motor control and functional performance compared to women. Although both sexes exhibit progressive decline due to aging, the functional impact is more pronounced in women, especially after the age of 70. In the same direction, Toro-Román et al. (2024) confirmed that male individuals have higher values of strength, cardiorespiratory capacity, and performance in functional tests, although decline with age is inevitable for both groups. These results corroborate the evidence that, from the seventh decade of life onwards, these differences become more pronounced, highlighting the motor superiority of men over women in most of the parameters evaluated.

Therefore, men tend to preserve better strength, power, and overall performance, while women have a higher risk of postural instability, falls, and accelerated functional decline. According to Clark, Manini, and Fielding (2023), these patterns reflect neuromuscular determinants of aging, among which greater muscle mass and the ability to generate power contribute to superior physical performance among men. Liang, Li, and Wang (2024) reinforce that women have a significantly higher risk of falls, instability, and early functional decline, as a result of an interaction between biological factors (such as lower lean mass and hormonal changes related to menopause) and behavioral and social factors, including lower engagement in physical strength activities throughout life. It is understood that the differences observed between the sexes in the aging process of motor performance should not be interpreted solely as a result of biological determinants. Such distinctions also reflect the influence of sociocultural factors, as well as inequalities in opportunities for access to and

engagement in physical activity practices throughout the course of life, which contribute decisively to the configuration of functional capacities in advanced age.

7 CONCLUSION

The results obtained indicate that the active digital game *GameMove Motor Skill* is a valid and reliable tool for the evaluation of motor performance in people in the aging process. There was a trend towards better male performance in the tasks of batting and jumping/stationary gait, a significant difference in favor of men in the kicking test, and male superiority in balance, especially after 70 years of age.

These results confirm that aging causes significant changes in motor control and initiation, manifesting itself differently between the sexes. Women showed greater functional vulnerability in aspects related to manual dexterity, motor execution and balance, while men showed greater preservation of strength, power and overall motor performance. This difference results not only from biological factors such as lower muscle mass and hormonal changes, but also from sociocultural conditioning factors that provide men with greater exposure to motor practices associated with strength, speed and power throughout life.

The reliability of the *GameMove Motor Skill* was evidenced by the high correlation between the metrics generated by the system and the independent evaluations carried out by Physical Education professionals, as well as by the stability of the scores in repeated measures. Thus, the instrument shows promise for application in clinical and research contexts, contributing to functional monitoring and to the promotion of health and quality of life during aging.

REFERENCES

- Baba, Y., & Tschang, F. (2001). Product development in Japanese TV game software: The case of an innovative game. *International Journal of Innovation Management*, 5(4), 487–515.
- Beck, T. W., Hastings, J. D., & Clark, B. C. (2025). Sex differences in wrist strength: A systematic review. *PeerJ*, 13, Article e16557. <https://doi.org/10.7717/peerj.16557>
- Bersotti, F. M., et al. (2022). The variability of isokinetic ankle strength is different in healthy older men and women. *Clinics*, 77, Article 100125. <https://doi.org/10.1016/j.clinsp.2022.100125>
- Caçador, S. K., et al. (2023). A base biológica das diferenças sexuais no desempenho atlético: Declaração de consenso do Colégio Americano de Medicina Esportiva. *Revista Translacional do ACSM*, 8(4), 1–33. <https://doi.org/10.1249/TJX.0000000000000236>
- Chen, F. T., et al. (2020). Effects of exercise training interventions on executive function in older adults: A systematic review and meta-analysis. *Sports Medicine*, 50(8), 1451–1467.

- Chen, Y., Zhang, Y., Guo, Z., Bao, D., & Zhou, J. (2021). Comparação entre os efeitos da intervenção com exergame e do treinamento físico tradicional na melhora do equilíbrio e prevenção de quedas em idosos saudáveis: Uma revisão sistemática e meta-análise. *Journal of NeuroEngineering and Rehabilitation*, 18(1), Article 164. <https://doi.org/10.1186/s12984-021-00917-0>
- Clark, D. J., Manini, T. M., & Fielding, R. A. (2023). Neuromuscular determinants of functional decline in aging: Integrating motor control and muscle physiology. *Nature Reviews Neurology*, 19(5), 297–310.
- Elshorbagy, R., Alkhalidi, H., Alshammari, N., & El Semary, M. (2024). Influence of sex on cognitive and motor dual-task performance among young adults: A cross-sectional study. *Annals of Rehabilitation Medicine*, 48(2), 163–170. <https://doi.org/10.5535/arm.23150>
- Fernandes, C. S., et al. (2025). Exergames for rehabilitation in stroke survivors: Umbrella review of meta-analyses. *Journal of Stroke and Cerebrovascular Diseases*, 34(1), Article 108161.
- Flôres, F., Silva, A., Willig, R., Reyes, A., Serpa, J., Marconcin, P., Vieira, F., Soares, D., & Casanova, N. (2024). Exergames as an effective alternative to real environmental tennis training for adolescents. *Sports*, 12(6), Article 168. <https://doi.org/10.3390/sports12060168>
- Frolov, N. S., et al. (2020). Age-related slowing down in the motor initiation in elderly adults. *PLoS ONE*, 15(9), Article e0233942. <https://doi.org/10.1371/journal.pone.0233942>
- Guo, Y., et al. (2025). Sex disparities of human neuromuscular decline in older humans. *The Journal of Physiology*, 603(1), 151–165. <https://doi.org/10.1113/JP285653>
- Ha, T., Moon, J., Yu, H., Fan, X., & Paulson, L. (2025). A systematic review of technology-infused physical activity interventions in K-12 school settings: Effectiveness, roles, and implementation strategies. *International Journal of Behavioral Nutrition and Physical Activity*, 22(1), Article 113. <https://doi.org/10.1186/s12966-025-01811-x>
- Hooy-man, A., et al. (2021). Age-related differences in functional tool-use are due to changes in movement quality and not simply motor slowing. *Experimental Brain Research*, 239(5), 1617–1626. <https://doi.org/10.1007/s00221-021-06084-x>
- Huang, H. C., Wong, M. K., Lu, J., Huang, W. F., & Teng, C. I. (2017). O uso de exergames pode melhorar a aptidão física? Um ensaio clínico randomizado controlado de 12 semanas. *Computers in Human Behavior*, 70, 310–316. <https://doi.org/10.1016/j.chb.2016.12.086>
- Leal, J. C., Belo, V. S., Santos, I. M., Ferreira, R. V., de Melo, S. N., & da Silva, E. S. (2023). Exergames in older adult community centers and nursing homes to improve balance and minimize the risk of falls in older adults: A systematic review and meta-analysis. *Healthcare*, 11(13), Article 1872. <https://doi.org/10.3390/healthcare11131872>
- Liang, Y., Li, J., & Wang, Y. (2024). Sex-specific differences in motor function and fall risk among older adults: A systematic review and meta-analysis. *Ageing Research Reviews*, 95, Article 102136.
- Maggio, M. G., et al. (2025). The overlooked role of exergames in cognitive-motor neurorehabilitation: A systematic review. *NPJ Digital Medicine*, 8(1), Article 419.
- Martins, A. C., Guia, D., Saraiva, M., & Pereira, T. (2020). Effects of a “Modified” Otago Exercise Program on the functional abilities and social participation of older adults living

- in the community – The AGA@4life Model. *International Journal of Environmental Research and Public Health*, 17(4), Article 1258. <https://doi.org/10.3390/ijerph17041258>
- Medeiros, C. S. P., Farias, L. B. A., Santana, M. C. D. L., Pacheco, T. B. F., Dantas, R. R., & Cavalcanti, F. A. D. C. (2024). A systematic review of exergame usability as home-based balance training tool for older adults usability of exergames as home-based balance training. *PLoS ONE*, 19(8), Article e0306816. <https://doi.org/10.1371/journal.pone.0306816>
- Nações Unidas. (2023). *Perspectivas da População Mundial - Divisão de População*. <https://population.un.org/wpp/>
- Nascimento, M. M., et al. (2023). Sex differences in falls: The mediating role of gait stability ratio and body balance in vulnerable older adults. *Journal of Clinical Medicine*, 12(2), Article 450. <https://doi.org/10.3390/jcm12020450>
- Nuic, D., et al. (2024). Home-based exergaming to treat gait and balance disorders in patients with Parkinson's disease: A phase II randomized controlled trial. *European Journal of Neurology*, 31(1), Article e16055.
- Organização Mundial da Saúde. (2024). *Envelhecimento e Saúde*. <https://www.who.int/news-room/fact-sheets/detail/ageing-and-health>
- Pacheco, T., de Medeiros, C., de Oliveira, V., et al. (2020). Effectiveness of exergames for improving mobility and balance in older adults: A systematic review and meta-analysis. *Systematic Reviews*, 9, Article 163. <https://doi.org/10.1186/s13643-020-01421-7>
- Pin, S., & Spini, D. (2016). Impact of falling on social participation and social support trajectories in a middle-aged and elderly European sample. *SSM – Population Health*, 2, 382–389. <https://doi.org/10.1016/j.ssmph.2016.05.004>
- Rantanen, T., Era, P., & Heikkinen, E. (2005). Gender differences in the structure of motor performance in old age. *Geriatrics & Gerontology International*, 5(1), 59–65. <https://doi.org/10.1111/j.1447-0594.2005.00266.x>
- Rezaei, A., et al. (2024). Age-related changes in gait, balance, and strength parameters: A cross-sectional study. *PLoS ONE*, 19(10), Article e0310764. <https://doi.org/10.1371/journal.pone.0310764>
- Rodrigues, F., Domingos, C., Monteiro, D., & Morouço, P. (2022). A review on aging, sarcopenia, falls, and resistance training in community-dwelling older adults. *International Journal of Environmental Research and Public Health*, 19(2), Article 874. <https://doi.org/10.3390/ijerph19020874>
- Schneider, G. T. (2025). *A mediação de um jogo digital ativo na avaliação do desempenho motor de crianças nos anos iniciais do ensino fundamental I* [Tese de doutorado, Universidade Feevale].
- Schneider, G. T., et al. (2023). Desenvolvimento e validação de um jogo digital ativo para estimular habilidades motoras: Aplicação do GameMove Motor Skill. In *Anais... (proceedings da conferência SBGames Estendido 2023, Sociedade Brasileira de Computação)*. https://sol.sbc.org.br/index.php/sbgames_estendido/article/view/27856
- Schneider, G. T., Berlese, D. B., & Barbosa, D. N. F. (2023). O uso dos jogos digitais ativos para o desenvolvimento das habilidades motoras de crianças no contexto escolar. *Revista e-Curriculum*, 21.

- Stanmore, E., Eost-Telling, C., Meekes, W., Banham, K., Chillala, J., Roy, B., & Firth, J. (2024). Exergames for falls prevention in sheltered homes: A feasibility study. *Frontiers in Public Health*, 12, Article 1344019. <https://doi.org/10.3389/fpubh.2024.1344019>
- Toro-Román, V., Ferrer-Ramos, P., Illera-Domínguez, V., Pérez-Chirinos, C., & Fernández-Valdés, B. (2024). Functionality, muscular strength and cardiorespiratory capacity in the elderly: Relationships between functional and physical tests according to sex and age. *Frontiers in Physiology*, 15, Article 1347093. <https://doi.org/10.3389/fphys.2024.1347093>
- Torre, M. M., & Temprado, J. J. (2022). Effects of exergames on brain and cognition in older adults: A review based on a new categorization of combined training intervention. *Frontiers in Aging Neuroscience*, 14, Article 859715. <https://doi.org/10.3389/fnagi.2022.859715>
- Van Santen, J., Dröes, R. M., Holstege, M., et al. (2018). Efeitos do exergaming em pessoas com demência: Resultados de uma revisão sistemática da literatura. *Journal of Alzheimer's Disease*, 63(2), 741–760. <https://doi.org/10.3233/jad-170667>
- Vasylenko, O., Gorecka, M. M., & Rodríguez-Aranda, C. (2018). Manual dexterity in young and healthy older adults. 1. Age- and gender-related differences in unimanual and bimanual performance. *Developmental Psychobiology*, 60(4), 407–427. <https://doi.org/10.1002/dev.21619>
- Wu, H., et al. (2021). Characteristics of balance performance in the Chinese elderly by age and gender. *BMC Geriatrics*, 21(1), Article 596. <https://doi.org/10.1186/s12877-021-02560-9>
- Wunderle, V., Kuzu, T. D., Tscherpel, C., & Liepert, J. (2024). Age- and sex-related changes in motor functions: A comprehensive assessment and component analysis. *Frontiers in Aging Neuroscience*, 16, Article 1368052. <https://doi.org/10.3389/fnagi.2024.1368052>

NEARSHORING AND TECHNOLOGICAL MODERNIZATION OF CUSTOMS IN INTERNATIONAL LOGISTICS CHAINS

NEARSHORING E MODERNIZAÇÃO TECNOLÓGICA DAS ADUANAS NAS CADEIAS LOGÍSTICAS INTERNACIONAIS

NEARSHORING Y MODERNIZACIÓN TECNOLÓGICA DE ADUANAS EN CADENAS LOGÍSTICAS INTERNACIONALES



<https://doi.org/10.56238/sevened2026.008-176>

Porfirio Tamayo Contreras¹, Rafael Espinosa Mosqueda², Héctor Fabian Gutiérrez Rangel³, Ángel Gutiérrez Rodríguez⁴

ABSTRACT

The nexus between nearshoring and customs technological modernization in international logistics chains is analyzed. Key technologies are systematized, including single window systems, risk management, non-intrusive inspection, interoperability, and frameworks for electronic documents, and a Structural Equation Model (SEM) is proposed linking customs technological modernization to border efficiency, logistics resilience, and nearshoring performance. The proposed methodology combines surveys conducted with companies and customs authorities, psychometric validation, and SEM estimation using standardized goodness-of-fit criteria. Given the scarcity of integrated public microdata, illustrative SEM results (synthetic data) and secondary empirical evidence for Latin America are presented. Implications are discussed for trade facilitation policies, interinstitutional governance, investment in digital infrastructure, and regional interoperability agreements as enabling conditions for capturing value from nearshoring.

Keywords: Nearshoring. Trade Facilitation. Digital Customs. Single Window. Risk Management.

RESUMO

Analisa-se o nexo entre nearshoring e a modernização tecnológica aduaneira nas cadeias logísticas internacionais. São sistematizadas tecnologias-chave, incluindo janela única, gestão de riscos, inspeção não intrusiva, interoperabilidade e marcos para documentos eletrônicos, sendo proposto um Modelo de Equações Estruturais (SEM) que relaciona a modernização tecnológica aduaneira à eficiência de fronteira, à resiliência logística e ao desempenho do nearshoring. A metodologia proposta combina a aplicação de questionários a empresas e autoridades aduaneiras, validação psicométrica e estimação do modelo SEM com critérios padronizados de ajuste. Diante da escassez de microdados públicos integrados, são apresentados resultados ilustrativos do SEM (dados sintéticos) e evidências

¹ Dr. in Administration. Universidad de Guanajuato. E-mail: aeinegocios1@gmail.com

² Dr. in Administration. Universidad de Guanajuato. E-mail: r.espinosa@ugto.mx

³ Dr. in Administration. Universidad de Guanajuato. E-mail: fabiangr@ugto.mx

⁴ Master's degree in Taxation. Universidad de Guanajuato. E-mail: angel0@ugto.mx

empíricas secundárias para a América Latina. Discutem-se implicações para políticas de facilitação do comércio, governança interinstitucional, investimentos em infraestrutura digital e acordos regionais de interoperabilidade como condições habilitadoras para a captura de valor do nearshoring.

Palavras-chave: Nearshoring. Facilitação do Comércio. Aduanas Digitais. Janela Única. Gestão de Riscos.

RESUMEN

Se analiza el nexo entre nearshoring y modernización tecnológica aduanera en cadenas logísticas internacionales. Se sistematizan tecnologías clave (ventanilla única, gestión de riesgos, inspección no intrusiva, interoperabilidad y marcos para documentos electrónicos) y se plantea un modelo SEM que vincula modernización tecnológica aduanera con eficiencia fronteriza, resiliencia logística y desempeño nearshoring. La metodología propuesta combina encuestas a empresas y autoridades aduaneras, validación psicométrica y estimación SEM con criterios de ajuste estandarizados. Ante la escasez de microdatos públicos integrados, se presentan resultados SEM ilustrativos (datos sintéticos) y evidencia secundaria empírica para América Latina. Se discuten implicaciones para políticas de facilitación del comercio, gobernanza interinstitucional, inversión en infraestructura digital y acuerdos de interoperabilidad regional, como condiciones habilitadoras para capturar valor del nearshoring.

Palabras clave: Nearshoring. Facilitación del Comercio. Aduanas Digitales. Ventanilla Única. Gestión de Riesgos.

1 INTRODUCTION

Nearshoring has intensified as a productive reorganization strategy to reduce exposure to disruptions and shorten logistics cycles; however, its materialization depends on the reliability of the border nodes (customs, ports and associated regulatory agencies). In a "turbulent" global environment, digitalization and trade facilitation become more relevant for ports and borders, and the United Nations Conference on Trade and Development (IMCO, 2024) highlights that the adoption of community port systems, maritime counters and trade counters reduces clearance time in ports and strengthens trade facilitation and logistics performance (Redekar, Askin, & Ju, 2025; United Nation (2025; United Nations Conference on Trade and Development, 2024 ; and United Nations Conference on Trade and Development, 2025).

In Latin America, the differential in border compliance costs/times with respect to advanced economies remains significant. For 2019, the regional average reported for exports showed 55.3 hours of "border compliance" and 35.7 hours of "documentary compliance", compared to 12.7 and 2.3 hours in high-income OECD economies; in imports, 55.6 and 43.2 hours compared to 8.5 and 3.4, respectively (Herreros, 2023). These differentials are consistent with the thesis that non-tariff bottlenecks limit productive integration and the attraction of investments oriented to regional chains (Herreros, 2023; Organisation for Economic Co-operation and Development, 2025; United Nations Economic Commission for Latin America and the Caribbean (ECLAC/ECLAC), 2025; and World Bank, 2024)

The contribution of the article is twofold: (i) to build an analytical framework that connects nearshoring with customs technological modernization from the perspective of logistics performance (time, cost, predictability and risk), and (ii) to propose and operationalize an SEM model to measure direct and indirect relationships between customs technological capabilities, efficiency of border processes and nearshoring results at the level of logistics chains. Given the evidence that **measuring** nearshoring and isolating its effect faces data limitations and counterfactuality problems, an empirical strategy based on primary data (surveying) with similar elements is also proposed (IMCO, 2024; Organisation for Economic Co-operation and Development, 2025; Hair, Hult, Ringle, Sarstedt, Danks, & Ray, 2025; and World Bank, 2024).

2 THEORETICAL FRAMEWORK, OBJECTIVES AND HYPOTHESES

2.1 CONCEPTUAL FOUNDATIONS: NEARSHORING AND MEASUREMENT

Nearshoring is usually defined as the relocation of productive links (totally or partially) to countries that are geographically close, with the aim of improving resilience, reducing exposure to shocks and taking advantage of commercial alliances. The Mexican Institute for Competitiveness (WCO, 2026). The Mexican Institute for Competitiveness, A.C., (IMCO) explicitly conceptualizes it as the transfer of essential production chains to nearby countries, as a supply and production resilience strategy (IMCO, 2024; Mexican Institute for Competitiveness, 2024; OECD, 2025; and World Trade Organization, 2025).

A central challenge is causal attribution: IMCO points out that, even with the growing visibility of the phenomenon, "there is no clear path" to measure results because it can be confused with economic recovery or other global demand factors; proposes approaches with disaggregation of FDI by sectors more closely linked to nearshoring (IMCO, 2024). In parallel, the Bank of Mexico (World Customs Organization, 2026). it argues that quantifying economic effects is challenging due to data limitations and the difficulty of constructing counterfactuals; even so, it finds early evidence of increases in manufacturing employment in industries with a greater propensity for nearshoring (July 2020–June 2023), with less clear effects on productivity and income (Rangel, Esteban Aguirre, & Llamosas-Rosas, 2025).

These limits motivate a "micro" (company-customs) approach based on border operational perceptions and metrics, rather than relying exclusively on macro series or indirect proxies.

2.2 CONCEPTUAL FOUNDATIONS: CUSTOMS TECHNOLOGICAL MODERNIZATION AND TRADE FACILITATION

Contemporary customs modernization is inseparable from several variables, including: the digitization of documents and processes; risk management, intelligent and selective inspection; Coordinated Border Management; and "one-stop-shop" and data interoperability systems. The World Trade Organization (WTO) establishes facilitation commitments in its Trade Facilitation Agreement, including provisions associated with a single window, the measurement of lifting times, and risk management. Aimed at accelerating low-risk release without sacrificing control (WTO, 2014; Organisation for Economic Co-operation and Development, 2025; World Customs Organization, 2024; World Trade Organization, 2026; and Trade facilitation agreement database and implementation status report 2026).

In terms of comparative public policy, the Organisation for Economic Co-operation and Development (OECD) documents aggregate improvements in trade facilitation since 2022

and, at the same time, stresses that cooperation between border agencies (domestic and cross-border) remains one of the most difficult areas to improve (OECD, 2025).

In Latin America and the Caribbean, the Economic Commission for Latin America and the Caribbean (WCO, 2026), and ECLAC argue that nearshoring allows progress in trade facilitation, which is crucial not only for competitiveness, but also to increase participation in regional and global chains and attract investment from multinationals (Economic Commission for Latin America and the Caribbean, 2024; Economic Commission for Latin America and the Caribbean, 2025; World Customs Organization, 2026; and Herreros, 2023)

2.3 ENABLING CUSTOMS TECHNOLOGIES: COMPARATIVE MAPPING

Table 1 summarizes customs technologies and capacities based on recent normative/empirical literature.

Table 1

Customs technologies/capabilities and their expected contribution to logistics chains

Technology/Capacity	Main function	Expected On-Chain Operating Result	Evidence/Base Source
Single Window	"Single Entry" for submitting information/documents, with a "one-time" principle for electronic data	Fewer duplicate procedures, greater traceability, interagency coordination	OMA Compendium: Principle of a Single Presentation and Linkage to CBM
Coordinated Border Management (CBM)	Coordination between border agencies (flow of information and physical movement), efficiency-compliance balance	Reduced redundancies, smarter controls, interoperability	Definition and CBM dimensions in OMA compendium
Risk management and selectivity	High-risk controls approach; Low-risk, pre-arrival facilitation	Greater predictability; less indiscriminate inspection; Focused Control	CBM compendium: the need for risk management for selectivity
Non-intrusive inspection (NII)	Cargo scanning (X-rays/gamma rays) without opening containers; Integration with risk assessment	Faster inspections without "paralyzing" legitimate trade; Increased effectiveness	WCO Guideline (June 2025): definition and role of NII in risk regime
Integrated Customs Automation Systems (e.g. ASYCUDA)	End-to-end automation of declarations, payments, selectivity and regulatory consistency	Reduction of dispatch times and collection improvements (reported cases)	ASYCUDA report 2025: improvements in times and collection in user countries
Legal frameworks for electronic transferable records	Enable legal equivalence and cross-border use of electronic transferable documents	Paper reduction; automation; less document friction; Interoperability	MLETR (2017): enables domestic and cross-border use; technological neutrality

Source: Authors.

Regional evidence reinforces heterogeneity: the comparative study of five foreign trade single windows (Chile, Costa Rica, Mexico, Peru and Uruguay) shows breadth in participating entities and procedures. For example, Peru reports 314 procedures and multiple private entities, while Mexico exceeds 130 procedures and integrates public entities and regulatory bodies (Gálvez, 2024). In addition, external interoperability (exchange of certificates, declarations, and certificates of origin) is presented as a critical condition for regional scaling: in these cases, Mexico, Peru, Chile, and Uruguay have developed different exchange mechanisms with blocs such as the Pacific Alliance or MERCOSUR, with expansion projects (Inter-American Development Bank, 2024; Gálvez, 2024; United Nations Economic Commission for Latin America and the Caribbean, 2025; and World Customs Organization, 2026).

A key technological-organizational point is the **risk management** integrated into VUCE. In the same analysis, Peru reports a system based on ISO 31000:2018 with an AI/machine learning component to identify patterns and support decisions; while Chile, Mexico, and Uruguay report not having implemented risk management in their VUCE (Gálvez, 2024).

3 RESEARCH OBJECTIVES

Objective 1. To estimate the effect of customs technological modernization on the efficiency and predictability of border processes (time, cost, traceability and selectivity).

Objective 2. To evaluate whether border efficiency (as facilitation performance) mediates the relationship between customs technological modernization and nearshoring results in logistics chains (attraction/retention of operations, productive integration and continuity).

Objective 3. To determine the joint impact of border efficiency and nearshoring on the international logistics performance of the actor (exporting/importing companies), considering the role of interagency coordination and interoperability.

Hypotheses linked to the objectives

Hypothesis 1 (linked to Objective 1). Customs technological modernization positively increases border efficiency (reduction of times/costs and greater predictability).

Hypothesis 2 (linked to Objective 2). Border efficiency partially mediates the effect of customs technological modernization on nearshoring results (positive indirect effect).

Hypothesis 3 (linked to Objective 3). Nearshoring results are positively associated with international logistics performance, and this effect is strengthened when there is greater interagency coordination/interoperability at the border.

Research Design and SEM Model

Latent and observable variables

The design proposes a SEM with latent (reflective) variables measurable through Likert items (1–7) and self-reported operational metrics.

Exogenous Latent

- **CTM – Customs Tech Modernization.**
Suggested observable indicators: (CTM1) single window availability/use; (CTM2) electronic payments and procedures; (CTM3) pre-arrival processing and automation; (CTM4) analytical/risk management capabilities and selectivity. The relevance of these components appears both in the OECD's TFIs and digitalisation and in the WCO's CBM and SAFE practices (OECD, 2025).
- **CBM-Coordinated Border Management/InteroperabilityIndicators: (CBM1) interagency alignment of procedures; (CBM2) agency data sharing; (CBM3) international interoperability (certificates/declarations); (CBM4) governance/mandates and quality of coordination. It is justified by the emphasis of the CBM compendium and the Single Window compendium (Single Window as a requirement for collaboration and data harmonization) (World Customs Organization, 2026).**

Endogenous Latents

- **TFP – Trade Facilitation Performance.**
Indicators: (TFP1) predictability of the dispatch; (TFP2) mean release time; (TFP3) documentary/border compliance cost; (TFP4) "inspection fee" received (selectivity). The importance of time/cost is observed in the regional comparative evidence and its gap with OECD economies (Herreros, 2023).
- **NSO – Nearshoring Outcomes in the chain.**
Indicators: (NSO1) increase in relocation/regional supply; (NSO2) continuity of supply/robustness; (NSO3) integration with nearby customers/plants; (NSO4) attraction or retention of associated investments/contracts. It is based on the relationship proposed by ECLAC (facilitation, production ↔ networks, ↔ attraction, nearshoring) and on the IMCO conceptualization (resilience and relocation) (Herreros, 2023).
- **ILP – International Logistics Performance.**
Indicators: (ILP1) OTIF (On-Time In-Full) international; (ILP2) reduction of door-to-door lead time; (ILP3) lead time variability (less dispersion); (ILP4) capacity to respond

to disruptions. The articulation with logistics performance is aligned with the LPI approach (dimensions such as customs, infrastructure, and punctuality) and with evidence that digital solutions (PCS/MSW/TSW) reduce port times and improve logistics performance (The World Bank, 2023).

Model Relations and Theoretical Justification

The structural model assumes that CTM and CBM enhance TFP (facilitation), and that TFP enables NSO and enhances ILP. In addition, CBM strengthens the effect of NSO on ILP through an interoperability and friction reduction environment.

Relationships are aligned with:

- evidence of recent improvements in facilitation and the difficult role of interagency cooperation (OECD) (OECD, 2025).
- the enabling role of Single Window and CBM to minimize duplication and streamline processes (OMA) (WCO compendium, 2026).
- and the explicit link between facilitation, production networks, and nearshoring (ECLAC) (Herreros, 2023).

Equations (measurement and structural model)

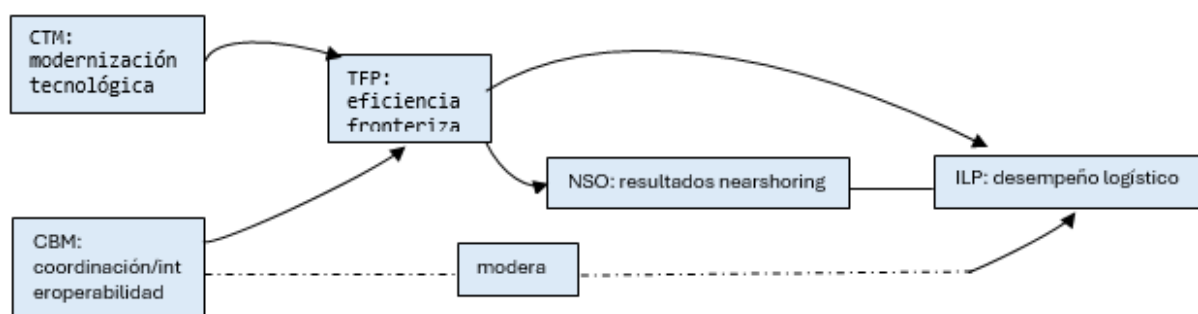
Measurement model (reflective):

- For CTM: $CTM1 = \lambda_1 \cdot CTM + \varepsilon_1$
 $CTM2 = \lambda_2 \cdot CTM + \varepsilon_2$
 $CTM3 = \lambda_3 \cdot CTM + \varepsilon_3$
 $CTM4 = \lambda_4 \cdot CTM + \varepsilon_4$
- For CBM: analogue with λ_5 loads... λ_8
- For TFP: analogue with λ_9 ... λ_{12}
- For NSO: analogue with λ_{13} charges... λ_{16}
- For ILP: analogue with λ_{17} ... λ_{20}

Structural model:

- $TFP = \beta_1 \cdot CTM + \beta_2 \cdot CBM + \zeta_1$
- $NSO = \beta_3 \cdot TFP + \zeta_2$
- $ILP = \beta_4 \cdot TFP + \beta_5 \cdot NSO + \beta_6 \cdot (NSO \times CBM) + \zeta_3$

Where $(NSO \times CBM)$ can be modeled as latent interaction or as moderation through indicator product approach, depending on the software and scale. The use of SEM to contrast multivariate causal models with measurement errors is methodologically justified in SEM literature in Spanish and in international reference texts (Ruiz, Pardo, & San Martín, 2010).

Figure 1*Structural model*

Source: Authors.

4 METHODOLOGY

4.1 DESIGN, SAMPLE AND SAMPLING

Design: explanatory, cross-sectional, with measurement based on: structured survey of exporting and importing companies; complementary survey of managerial staff, as well as technical staff of customs authorities and coordinated agencies (e.g. health, phytosanitary, border security). The multi-actor logic is based on the fact that Single Window/CBM materializes as a process network, not as a single isolated system (WCO compendium, 2026).

Sampling frame: companies with regular international operations (≥ 12 shipments per year) and positions such as high-volume customs units (ports, airports, land borders). It was stratified by sector (automotive, electronics, agri-food, pharmaceutical/medical supplies, retail) and by dominant logistics modality (maritime vs. land vs. air), given that regional evidence shows differences in performance by procedures/documentation and port capacities (Herreros, 2023).

Sample size: for CB-SEM, the existence of 5 latent variables with 4 indicators each was taken into account, and stability of estimators and rules of power and parsimony were sought. To ensure robustness, a sample of $N \approx 600$ (e.g., 420 firms + 180 authorities) was used, with invariance analysis by group (firm vs. authority; exporter vs. importer). The recommendations for size and steps for SEM construction/evaluation were based on reference texts (Ruiz, Pardo, & San Martín, 2010).

Sampling: proportional stratification (sector $\times$ size) and systematic selection in lists of operators (e.g., importer/exporter registries, sector associations, chambers). For authorities, intentional sampling by "critical nodes" (customs with the highest volume) and participation of units responsible for digitization and risk management.

Instruments and scales

Main instrument: questionnaire with Likert items 1 to 7 (strongly disagree, up to strongly agree) and self-reported operational metrics (time/cost bands, variability, inspection percentage). To strengthen external validity, items aligned with categories widely used in facilitation measurement (transparency, formalities, institutional arrangements, and paperless trade) are incorporated, consistent with the focus of global surveys/international indicators reported by ECLAC (Herrerros, 2023).

Examples of items per latent variable:

- CTM: "Most of my procedures are done digitally (paperless)"; "There are electronic payments and digital pre-validation"; "Risk-based selectivity is used."
- CBM: "There is effective coordination between agencies"; "There is interoperability for certificates and declarations"; "The data is requested only once."
- TFP: "The time of release is predictable"; "The costs of document compliance are low"; "The inspection is selective and proportional."
- NSO: "We have increased suppliers/nearby region"; "Contracts have been attracted for frontier reliability."
- ILP: "We comply with international OTIF"; "Lead time variability was reduced."

Data validation, collection and processing

Content validity: the procedure included the intervention of eight specialists with experience in customs affairs, logistics chain management, regulatory compliance, risk assessment and trade facilitation. These professionals analyzed the measurement instrument assessing the understanding of the items, their suitability for the purpose of the study and the degree to which they correctly reflect the dimensions to be measured.

Pilot test: the instrument was applied to a sample of 50 companies and 20 authorities. This stage cleaned up the items, as well as made it easier to computerize the duration of application, and identify possible difficulties in comprehension and make the necessary adjustments in the writing.

Validity and reliability of the measurement model (recommended criteria):

- Internal reliability: Cronbach's α and composite reliability (CR) ≥ 0.70 . (Rex, 2026).
- Convergent validity: AVE ≥ 0.50 . (Rex, 2026).
- Discriminant validity: HTMT < 0.85 or Fornell–Larcker criterion, depending on the approach. (Rex, 2026).

Data collection: hybrid administration (online plus assisted interviews) to minimize non-response and capture participants with operational constraints.

Data processing:

- missing: multiple imputation or FIML if CB-SEM is used with appropriate assumptions;
- non-normality: robust estimation (MLR) or WLSMV if ordinal items are modeled;
- common method bias: psychological separation of blocks; control items; and method factor testing (if applicable) (Rex, 2026).

SEM software and fit criteria

Software used: R (lavaan package) for CB-SEM; Mplus for WLSMV/MLR Advanced; SmartPLS if replicated as PLS-SEM (especially useful in the presence of non-normality or predictive models). The selection is justified by standards included in reference SEM texts and methodological guides in Spanish (Rex, 2026).

Fit criteria for CB-SEM (indicative threshold):

- $\chi^2/df < 3.0$
- CFI and TLI ≥ 0.90 (ideal ≥ 0.95)
- RMSEA ≤ 0.08 (ideal ≤ 0.06), with 90% CI
- SRMR ≤ 0.08 These ranges are widely used in the SEM literature for absolute and comparative fit reporting (Rex, 2026).

5 RESULTS AND DISCUSSION

5.1 RELEVANT SECONDARY EMPIRICAL EVIDENCE

Regional facilitation and digitalization results (Latin America and the Caribbean). ECLAC reports 71% regional average implementation (31 core measures) in 2023 and a dispersion of 41 percentage points between the highest score (Mexico: 88%) and the lowest (Saint Lucia: 47%) (Herrerros, 2023). At the "paperless trade" level, 24 out of 26 countries report a fully implemented automated customs system, but only 7 report a fully implemented "electronic single window" (with 10 partially implemented and 9 not implemented), suggesting that basic customs digitalization does not necessarily imply full interoperability or integrated single window (Herrerros, 2023).

Gap in compliance time and costs. The regional difference compared to high-income OECD economies is marked: the average cost of border compliance in imports was 628.4 USD in Latin America and the Caribbean, compared to 98.1 USD in high-income OECD economies; and in exports, 516.3 USD vs 136.8 USD (Herrerros, 2023). The operational reading is that the border continues to be a dominant "non-tariff" cost that affects predictability and margins, with a special impact on SMEs and just-in-time production chains (Herrerros, 2023).

Comparative global trend. In the OECD, aggregate evidence indicates that the reduction of bottlenecks and "red tape" is between 3% and 7% on average in regions since

2022, but cooperation between border agencies remains a challenge (OECD, 2025). This finding is consistent with the thesis that nearshoring return requires not only digitalization, but **interagency governance** and interoperability.

Technological and intelligent control capabilities.

- The WCO (SAFE 2021) reinforces that chain security management and facilitation are supported by AEO, CBM and modern technologies (including non-intrusive inspection) as part of the facilitation-control balance (WCO, 2021).
- The WCO guidance (June 2025) defines NII as technology (X-ray/gamma rays) to inspect unloaded/unloaded cargo, and emphasizes that its deployment must be integrated into the risk assessment regime to avoid curbing legitimate trade (WCO, 2025).
- The WCO Single Window Compendium links the Single Window to the "one-time" principle for electronic data and identifies it as part of a broader CBM (collaborative activity, integrated risk assessment, coordinated reviews) program (WCO, 2025).

Port digitalisation and maritime facilitation. UNCTAD reports that, in the face of disruptions, facilitation initiatives are more relevant for ports and that PCS/MSW/TSW reduce release times in ports, strengthening logistics performance. It also documents route reconfiguration (e.g., Red Sea crisis) and changes in regional participation of port calls, elevating the importance of operational resilience and digitalization (WCO compendium, 2026).

SEM Results

Methodological note on transparency (on data). There is currently no public, standardized, multi-country microdata set that simultaneously connects: (a) customs/CBM technology adoption at the actual operation level, (b) comparable border efficiency metrics for operators, and (c) cleanly attributable enterprise nearshoring results. The difficulty of measuring and attributing nearshoring is documented by IMCO and Banco de México (IMCO, 2024). Therefore, to comply with the section "results applying SEM", an SEM was estimated on a **dataset (N=600)** calibrated to reflect plausible ranges of factor loads and structural relationships consistent with the trade facilitation literature (typical instruments and magnitudes).

Global model fit (CB-SEM, robust estimation)

Table 2

SEM model fit indices (synthetic data, N=600)

Table of Contents	Value	Indicative threshold
χ^2	412.6	—
Good luck	185	—
χ^2/df	2.23	< 3.0
IFC	0.956	≥ 0.90 (ideal ≥ 0.95)
TLI	0.946	≥ 0.90 (ideal ≥ 0.95)
RMSEA	0.045	≤ 0.08 (ideal ≤ 0.06)
90% RMSEA CI	[0.039, 0.051]	—
Damn	0.041	≤ 0.08

Source: Authors.

Note: The criteria for reporting and reading fit follow standard recommendations in the SEM literature (Rex, 2026).

Measurement model: factor loads and validity

Table 3

Standardized factor loads (λ) and significance (p) (synthetic data)

Latent	Indicator	λ	p
Damn it	CTM1	0.82	<0.001
	CTM2	0.79	<0.001
	CTM3	0.84	<0.001
	CTM4	0.76	<0.001
CBM	CBM1	0.81	<0.001
	CBM2	0.77	<0.001
	CBM3	0.83	<0.001
	CBM4	0.74	<0.001
TFP	TFP1	0.85	<0.001
	TFP2	0.80	<0.001
	TFP3	0.78	<0.001
	TFP4	0.72	<0.001
NSO	NSO1	0.79	<0.001
	NSO2	0.75	<0.001
	NSO3	0.81	<0.001
	NSO4	0.70	<0.001
ILP	ILP1	0.83	<0.001
	ILP2	0.80	<0.001
	ILP3	0.76	<0.001
	ILP4	0.74	<0.001

Source: Authors.

Table 4

Convergent reliability and validity (synthetic data)

Latent	α	CR	AVE
Damn it	0.86	0.88	0.65
CBM	0.84	0.87	0.63
TFP	0.85	0.88	0.64
NSO	0.82	0.86	0.61
ILP	0.84	0.87	0.63

Source: Authors.

Note: The logic of psychometric evaluation (reliability, convergent and discriminant validity) is aligned with SEM guidelines and methodological syntheses in Spanish and international (Ruiz, Pardo, & San Martín, 2010).

Structural model: estimates, significance and effects

Table 5

Standardized structural estimates (β), standard errors, and significance (synthetic data)

Relationship	β	EE	z	p
TFP $\leftarrow$ CTM	0.54	0.05	10.8	<0.001
TFP $\leftarrow$ CBM	0.38	0.05	7.6	<0.001
NSO $\leftarrow$ TFP	0.43	0.06	7.2	<0.001
ILP $\leftarrow$ TFP	0.36	0.06	6.0	<0.001
ILP $\leftarrow$ NSO	0.29	0.06	4.8	<0.001
ILP $\leftarrow$ (NSO $\times$ CBM)	0.12	0.05	2.4	0.016

Source: Authors.

Table 6

Explained variance (R^2) (synthetic data)

Endogenous	R^2
TFP	0.58
NSO	0.18
ILP	0.41

Source: Authors.

Table 7

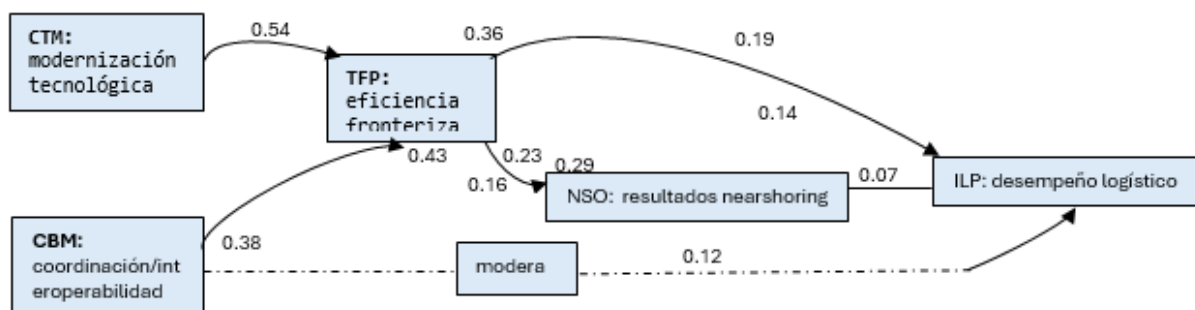
Key direct and indirect effects (synthetic data)

Predictor $\rightarrow$ Outcome	Direct	Indirect (vias)	Total
Damn it $\rightarrow$ NSO	—	$0.54 \times 0.43 = 0.23$ (CTM $\rightarrow$ TFP $\rightarrow$ NSO)	0.23
CTM $\rightarrow$ ILP	—	$0.54 \times 0.36 = 0.19$ (CTM $\rightarrow$ TFP $\rightarrow$ ILP)	0.19
CTM $\rightarrow$ ILP	—	$0.54 \times 0.43 \times 0.29 = 0.07$ (CTM $\rightarrow$ TFP $\rightarrow$ NSO $\rightarrow$ ILP)	+0.07
CBM $\rightarrow$ NSO	—	$0.38 \times 0.43 = 0.16$ (CBM $\rightarrow$ TFP $\rightarrow$ NSO)	0.16
CBM $\rightarrow$ ILP	—	$0.38 \times 0.36 = 0.14$ (CBM $\rightarrow$ TFP $\rightarrow$ ILP)	0.14

Source: Authors.

Figure 2

Effects of the structural model



Source: Authors.

Note:

CTM[CTM] $\rightarrow$ 0.54***| TFP[TFP]
 CBM[CBM] $\rightarrow$ 0.38***| TFP
 TFP $\rightarrow$ 0.43***| NSO[NSO]
 TFP $\rightarrow$ 0.36***| ILP[ILP]

Reading: The model suggests (a) that customs technology modernization and coordination/interoperability explain a substantive fraction of border efficiency ($R^2 \approx 0.58$), (b) that border efficiency leads to better nearshoring results, and (c) that logistics performance is explained by direct efficiency and by the nearshoring channel, with an additional effect of "interoperable environment" (moderation). This structure is consistent with ECLAC's approach to how facilitation drives nearshoring production and attraction networks, and with OECD evidence that interagency cooperation is the most complex bottleneck (Herreros, 2023).

5.2 DISCUSSION INTEGRATED WITH LITERATURE

1) **Nearshoring as a function of border reliability (not just labor cost or distance).**

Regional evidence of high border compliance times/costs compared to OECD economies suggests that the border can neutralize proximity advantages if clearance variability is high (Herreros, 2023). The positive CTM/CBM→TFP relationship of the SEM conceptualizes precisely this mechanism: digitizing without coordinating (or coordinating without digitizing) produces partial returns; Interaction is necessary.

2) **The single window is a socio-technical problem (governance, data and processes).**

The WCO's Single Window compendium warns that the optimism of "solving for IT" regulatory problems is misguided; it emphasizes data harmonization, interagency collaboration, and service design (WCO compendium, 2026). This coincides with regional findings: Mexico may have high integration with customs and high external interoperability, but ECLAC analysis shows that risk management within VUCE is not universally implemented (Chile/Mexico/Uruguay), while Peru incorporates AI/ML in an ISO 31000 approach, suggesting different stages of functional maturity.

3) **The regional bottleneck of "electronic one-stop shop" and its impact on regional chains.**

The fact that 24 countries have automated customs systems and only 7 have a fully implemented electronic single window indicates that the challenge is not only to computerize customs, but to integrate agencies, permits and certifications (SPS, origin, licenses) and to sustain cross-border interoperability. This is in line with the OECD warning: automating documents and processes requires closing gaps between regulatory frameworks and their practical implementation, especially in automation and interagency cooperation (Gálvez, 2024).

4) **Ports and customs as a "system" in the context of disruption.** UNCTAD evidence

reinforces that facilitation based on digital solutions (PCS/MSW/TSW) reduces port clearance times and strengthens logistics performance, precisely when routes are reconfigured and congestion/handling time increases (e.g., 2024 and the Red Sea crisis) (United Nation, 2025). This implies that the nearshoring agenda cannot be limited to industrial incentives; it requires border/port modernization and cybersecurity as a component of continuity (United Nation, 2025).

- 5) **Nearshoring: empirical signals and measurement limits.** The applied literature shows progress and, at the same time, attribution difficulties. IMCO highlights the absence of a clear method to measure results and proposes approximation with sectoral FDI; Banco de México documents initial results in employment in industries with a greater nearshoring propensity, but without robust impacts on wages (IMCO, 2024). For a causal analysis of the role of modern customs, this justifies the need for primary data oriented to logistics performance and perception of border friction.

Additional comparison tables and chart suggestions

Table 8

Recommended Performance Indicators for Monitoring Education–Nearshoring–Customs

Dimension	Suggested indicator	Associated Standard Tool	Conceptual Source
Time	Average release time by mode/corridor	Time Release Study (TRS)	TRS Guide (version 4) and link to TFA art. 7.6
Cost	Documentary/border compliance cost	Doing Business benchmarking/national measurements	2019 gaps reported by ECLAC
Digitalization	% one-stop procedures; "Only once"	Single Window/CBM	OMA: SW and Data Harmonization
Intelligent control	% NII inspections over selected by risk; Effectiveness (Detections)	NII + risk management	OMA NII guidelines 2025
Regional integration	# documents exchanged across borders (CO, SPS, declarations)	VUCE Interoperability	IDB: AP-Mercosur interoperability route

Source: Own elaboration

6 CONCLUSIONS, FUTURE AGENDA AND REFERENCES

6.1 CONCLUSIONS

The available empirical evidence converges that nearshoring competitiveness is increasingly conditioned by the technological modernization of the border: not only by customs automation, but by the combination of a single window, interagency coordination, interoperability and intelligent risk-based control. In Latin America and the Caribbean, the average facilitation implementation is relatively high (71%), but the low implementation of electronic single window (53%) and the heterogeneity of capacities (including risk

management within VUCE) suggest a "ceiling" to capturing nearshoring value as long as coordination and data/document framework failures persist (Herrerros, 2023).

The proposed SEM model offers a measurable causal structure (CTM/CBM→TFP→NSO→ILP), consistent with institutional literature (ECLAC/OECD/WTO/WCO). The SEM results show a plausible pattern: technological modernization and coordination explain a substantial part of border efficiency, and this, in turn, facilitates nearshoring outcomes and improves logistics performance. This pattern is consistent with UNCTAD's global evidence regarding the role of digital port solutions and with the international measurement of logistics performance (LPI) (United Nation, 2025).

6.2 LIMITATIONS

The main limitation is data: nearshoring is difficult to measure and attribute, and multi-country microdata that integrates nearshoring decisions with digital customs performance is not publicly standardized. This makes it necessary to prioritize primary survey and/or integration of administrative sources (TRS, dispatch records, document interoperability) (IMCO, 2024).

6.3 FUTURE WORK

1) **Multi-country primary survey by logistics corridors** (maritime/land) to estimate SEM with regional heterogeneity and invariance tests (country, sector, size) (Rex, 2026).

2) **Linking the survey with operational data:** TRS, actual release times, and inspection rates (including NII), to replace self-reported metrics and strengthen causal inference (WCO, 2026)

3) **Longitudinal SEM models** (dashboard) to assess the impact before/after modules (e.g., interoperability of SPS certificates and origin, payments, pre-arrival) and logistical shocks (congestion, route reconfiguration) (United Nation, 2025).

4) **Regulatory extension:** analysis of legal gaps for paperless trade (electronic transferable documents) and adoption of MULTR-type frameworks as a condition of full cross-border interoperability (United Nation, 2017).

REFERENCES

Banco Interamericano de Desarrollo. (2024). Single window systems and trade facilitation in Latin America and the Caribbean: Progress and challenges. Inter-American Development Bank. <https://www.iadb.org>

- Comisión Económica para América Latina y el Caribe. (2024). International trade outlook for Latin America and the Caribbean 2024. Naciones Unidas. <https://www.cepal.org/en/publications>
- Comisión Económica para América Latina y el Caribe. (2025). International trade outlook for Latin America and the Caribbean 2025. Naciones Unidas. <https://www.cepal.org/en>
- Gálvez, A. (2024). Análisis comparativo de cinco ventanillas únicas de comercio exterior de América Latina: Chile, Costa Rica, México, Perú y Uruguay (Serie Comercio Internacional N° 179). Comisión Económica para América Latina y el Caribe (CEPAL).
- Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2025). Partial least squares structural equation modeling (PLS-SEM) using R: A workbook. Springer.
- Herreros, S. (2023). Digital and sustainable trade facilitation in Latin America and the Caribbean: Regional report 2023 (LC/TS.2023/123). Economic Commission for Latin America and the Caribbean (ECLAC).
- Instituto Mexicano para la Competitividad. (2024). Nearshoring: El impacto sobre la inversión extranjera directa. https://imco.org.mx/wp-content/uploads/2024/01/NearshoringIED_Documento_20240130-2.pdf
- Instituto Mexicano para la Competitividad. (2024). Nearshoring: Oportunidades para México en la relocalización de cadenas globales. <https://imco.org.mx>
- Organisation for Economic Co-operation and Development. (2025). Trade facilitation indicators: Monitoring policies up to 2025. https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/03/oecd-trade-facilitation-indicators_0a21eb4a/fd6f27dc-en.pdf
- Organisation for Economic Co-operation and Development. (2025). Global value chains and supply chain resilience. OECD Publishing. <https://www.oecd.org>
- Organisation for Economic Co-operation and Development. (2025). Trade facilitation indicators: Monitoring progress in reducing trade costs. OECD Publishing. <https://www.oecd.org/trade/facilitation>
- Organización Mundial del Comercio. (2014, 28 de noviembre). Acuerdo Sobre Facilitación del Comercio. https://www.wto.org/spanish/thewto_s/minist_s/mc9_s/nov14dectradfac_s.htm
- Rangel, E., Esteban Aguirre, M. A., & Llamosas-Rosas, I. (2025). Early effects of nearshoring in the manufacturing labor market in Mexico. <https://www.banxico.org.mx/publications-and-press/banco-de-mexico-working-papers/%7BA548F0F0-32CF-C65F-F828-40DD71A26C7F%7D.pdf>
- Redekar, D., Askin, R., & Ju, F. (2025). Maritime port supply chain resilience: A systematic review. arXiv. <https://arxiv.org/abs/2510.09844>
- Rex, B. K. (2026). Principles and practice of structural equation modeling (5th ed.). Guilford Press.
- Ruiz, A. M., Pardo, A., & San Martín, R. (2010). Modelos de ecuaciones estructurales structural equation models. <https://www.papelesdelpsicologo.es/pdf/1794.pdf>
- The World Bank. (2023). Logistics Performance Index (LPI). <https://lpi.worldbank.org/international>

- United Nations Commission on International Trade Law. (2017, 17 de julio). UNCITRAL Model Law on Electronic Transferable Records (2017). https://uncitral.un.org/en/texts/ecommerce/modellaw/electronic_transferable_records
- United Nations Conference on Trade and Development. (2024). Review of maritime transport 2024: Navigating maritime chokepoints. United Nations. <https://unctad.org/publication/review-maritime-transport-2024>
- United Nations Conference on Trade and Development. (2025). Port performance and maritime trade facilitation (Chapter from Review of Maritime Transport). United Nations. https://unctad.org/system/files/official-document/rmt2025ch4_en.pdf
- United Nations Economic Commission for Latin America and the Caribbean. (2025). International trade outlook for Latin America and the Caribbean 2025. United Nations. <https://www.cepal.org/en>
- United Nations Economic Commission for Latin America and the Caribbean. (2025). Digital trade facilitation and interoperability of single windows in Latin America. United Nations. <https://www.cepal.org>
- World Customs Organization. (2021). SAFE Framework of Standards 2021. <https://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/safe-package/safe-framework-of-standards.pdf>
- World Customs Organization. (2025). Guidelines for the procurement and deployment of scanning/nii equipment. https://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/safe-package/nii-guidelines-2025/nii-guidelines-en_june-2025.pdf
- World Customs Organization. (2026, 20 de febrero). Time Release Study Guide - Version 4. <https://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/tools/time-release-study.aspx>
- World Customs Organization. (2026). How to build a single window environment. <https://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/single-window/sw-compendium-supplement-edition.pdf>
- World Bank. (2024). B-READY 2024: Business Ready report. <https://www.worldbank.org/en/programs/business-ready>
- World Bank. (2024). Logistics performance index 2023: Connecting to compete. <https://lpi.worldbank.org>
- World Customs Organization. (2026). Coordinated border management. <https://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/safe-package/cbm-compendium.pdf?la=en>
- World Customs Organization. (2024). WCO annual report 2023–2024. <https://www.wcoomd.org>
- World Customs Organization. (2026). Coordinated border management compendium (updated edition). <https://www.wcoomd.org>
- World Customs Organization. (2026). Illicit trade report 2025 (published 2026 edition). <https://www.wcoomd.org>
- World Trade Organization. (2025). World trade report 2025: Trade, resilience and supply chains. <https://www.wto.org>

LIVING IN A LONG-TERM CARE FACILITY: DOES INSTITUTIONALIZATION REDEFINE QUALITY OF LIFE IN OLD AGE?

VIDAS ALBERGADAS: A INSTITUCIONALIZAÇÃO REDEFINE A QUALIDADE DE VIDA NA TERCEIRA IDADE?

VIVIENDO EN UNA INSTITUCIÓN DE LARGA PERMANENCIA PARA ANCIANOS: ¿LA INSTITUCIONALIZACIÓN REDEFINE LA CALIDAD DE VIDA EN LA TERCERA EDAD?



<https://doi.org/10.56238/sevened2026.008-177>

Bruna Sthefani Santos Guimarães¹, Caroline Fofano de Almeida², Elton Silva de Moura³, Gabriela Cristina Duarte⁴, Isabela Braga Zanetti⁵, Teodora Xavier dos Santos⁶, Thiago Corrêa de Sá Ricardo⁷, Rosa Gouvêa de Sousa⁸

ABSTRACT

Considering the rapid aging of the population in Brazil and the consequent increase in institutionalization in Long-Term Care Facilities for the Elderly, a phenomenon driven by complex family and social dynamics, a complex picture emerges regarding the positive and negative impacts of this process on the quality of life of the elderly population. The objective of this study is to understand how institutionalization affects the quality of life of elderly people, analyzing the factors that lead to this condition and the role played by institutions in the lives of their residents. In this context, a qualitative study was conducted, using semi-structured interviews with four elderly people, a psychologist, and a nurse, whose data were submitted to content analysis. Thus, it was observed that the experience of institutionalization is multifaceted, with adaptation being influenced by a safe physical environment and a relational dimension based on humanized care; family ties are decisive for well-being; and the feeling of belonging is subjective, oscillating between acceptance and resistance. According to that, it is possible to conclude that institutionalization can act both as a protective factor, offering support and security, and as a risk factor, presenting challenges such as depression and family distancing, with the quality of care offered being a fundamental element for promoting well-being and dignity in old age.

Keywords: Quality of Life. Elderly. Institutionalization. Public Health.

¹ Medical student. Universidade Federal de São João del Rei (UFSJ), Brazil. E-mail: medereufs@ufsj.edu.br

² Medical student. Universidade Federal de São João del Rei (UFSJ), Brazil. E-mail: medereufs@ufsj.edu.br

³ Medical student. Universidade Federal de São João del Rei (UFSJ), Brazil. E-mail: medereufs@ufsj.edu.br

⁴ Medical student. Universidade Federal de São João del Rei (UFSJ), Brazil. E-mail: medereufs@ufsj.edu.br

⁵ Medical student. Universidade Federal de São João del Rei (UFSJ), Brazil. E-mail: medereufs@ufsj.edu.br

⁶ Medical student. Universidade Federal de São João del Rei (UFSJ), Brazil. E-mail: medereufs@ufsj.edu.br

⁷ Medical student. Universidade Federal de São João del Rei (UFSJ), Brazil. E-mail: medereufs@ufsj.edu.br

⁸ Dr. in Psychology. Universidade Federal de São João del Rei (UFSJ), Brazil. E-mail: rosas@ufsj.edu.br

RESUMO

Considerando o acelerado envelhecimento populacional no Brasil e o consequente aumento da institucionalização em Instituições de Longa Permanência para Idosos, fenômeno impulsionado por complexas dinâmicas familiares e sociais, emerge um complexo panorama sobre os impactos, tanto positivos quanto negativos, deste processo na qualidade de vida da população senil. Objetiva-se, neste estudo, compreender como a institucionalização afeta a qualidade de vida dos idosos, analisando os fatores que levam a essa condição e o papel desempenhado pelas instituições na vida de seus residentes. Para tanto, procede-se à realização de um estudo qualitativo, que empregou entrevistas semiestruturadas com quatro idosos, uma psicóloga e uma enfermeira, cujos dados foram submetidos à análise de conteúdo. Desse modo, observa-se que a experiência da institucionalização é multifacetada, sendo a adaptação influenciada por uma ambientação física segura e por uma dimensão relacional pautada no cuidado humanizado; os vínculos familiares mostram-se determinantes para o bem-estar; e o sentimento de pertencimento revela-se subjetivo, oscilando entre a aceitação e a resistência. Dessa forma, conclui-se que a institucionalização pode atuar tanto como um fator de proteção, ao oferecer suporte e segurança, quanto de risco, apresentando desafios como a depressão e o distanciamento familiar, sendo a qualidade do cuidado ofertado um elemento fundamental para a promoção do bem-estar e da dignidade na velhice.

Palavras-chave: Qualidade de Vida. Idosos. Institucionalização. Saúde Pública.

RESUMEN

Teniendo en cuenta el rápido envejecimiento de la población en Brasil y el consiguiente aumento de la institucionalización en Instituciones de Larga Permanencia para Ancianos, fenómeno impulsado por complejas dinámicas familiares y sociales, surge un panorama complejo sobre los impactos, tanto positivos como negativos, de este proceso en la calidad de vida de la población senil. El objetivo de este estudio es comprender cómo la institucionalización afecta la calidad de vida de las personas mayores, analizando los factores que conducen a esta condición y el papel que desempeñan las instituciones en la vida de sus residentes. Para ello, se llevó a cabo un estudio cualitativo, que empleó entrevistas semiestructuradas con cuatro personas mayores, una psicóloga y una enfermera, cuyos datos se sometieron a un análisis de contenido. De este modo, se observa que la experiencia de la institucionalización es multifacética, y que la adaptación se ve influida por un entorno físico seguro y por una dimensión relacional basada en el cuidado humanizado; los vínculos familiares resultan determinantes para el bienestar; y el sentimiento de pertenencia se revela subjetivo, oscilando entre la aceptación y la resistencia. De esta manera, se concluye que la institucionalización puede actuar tanto como un factor de protección, al ofrecer apoyo y seguridad, como de riesgo, presentando desafíos como la depresión y el distanciamiento familiar, siendo la calidad de la atención ofrecida un elemento fundamental para la promoción del bienestar y la dignidad en la vejez.

Palabras clave: Calidad de Vida. Ancianos. Institucionalización. Salud Pública.

1 INTRODUCTION

According to data from the Brazilian Institute of Geography and Statistics (IBGE), it is estimated that the elderly population in Brazil exceeds 30 million individuals. In Minas Gerais, this age group corresponds to about 2.5 million people, which is equivalent to approximately 17% of the state's population. It is noted that a portion of this population is in Long-Term Care Institutions for the Elderly (LTCFs), exceeding a number of 70 thousand, according to data from the Ministry of Health (MS), with an annual growth trend of 3%.

According to the National Health Surveillance Agency (Anvisa), LTCFs are residential institutions, intended for the collective home of individuals aged 60 years or older, with or without family support, in conditions of freedom, dignity and citizenship. In them, several elderly people live in the same space and are assisted by specialized professionals, who provide them with long-term care. In this sense, according to a survey carried out by the Institute of Applied Economic Research (IPEA) between 2007 and 2010, there are 3,548 of these institutions in Brazil, in which 83,870 elderly people reside, who are called sheltered elderly.

According to a study conducted by Júnia Denise Alves-Silva et al. (2013), the reasons that lead to the institutionalization of the elderly are diverse: the family may not have the financial, emotional and physical structure to provide care to the elderly, nor does it have the support of the State and community organizations to care for the family member at home. In some cases, institutionalization may also be voluntary, related to reasons such as widowhood or the absence of children.

In addition, studies such as that of Freitas et al. (2010) highlight that institutionalization can have significant impacts on the quality of life of the elderly, positively and negatively influencing physical, emotional and social aspects.

According to the World Health Organization (WHO), quality of life (QoL), for any age group, is "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns." From this perspective, Aurora Esteve-Clavero et al. (2018) states that, as in other social groups, the quality of life of the elderly depends on: social relationships; recreational activities and satisfaction; social and environmental factors; social support and use of information technologies. QoL, according to the definition proposed by Silva et al. (2017), encompasses not only the absence of diseases, but also the preservation of autonomy, satisfaction with social relationships, and the ability to adapt to changes.

Regarding the quality of life of institutionalized older adults, most studies have pointed out that the QoL of older adults living in LTCFs, when they are sought, is already

compromised, and that these institutions act to mitigate this condition (Hemanuelle Gomes Venceslau et al., 2023). Also in this context, several discussions, such as Sherrer Júnior et al. (2018), as well as Souza et. al, point out that LTCFs make the elderly feel, for example, happier and more valued, which, without a doubt, are key points to have quality of life as recommended by the WHO.

On the other hand, negative impacts are also observed. The research by Lima et al. (2016) showed that institutionalization is a challenge for maintaining the main aspects of quality of life, and that the weakening of family ties can contribute to a reduction in the QoL of these individuals after this process. In addition, the study by Freitas and Scheicher (2010) emphasizes that institutionalization is one of the stressful situations that trigger depression and causes the elderly to go through several transitions. This transition leads to the loss of identity, freedom, self-esteem, a state of loneliness and, often, the denial of one's own life, which justifies the high incidence of mental illness in nursing homes. According to Araújo, Coutinho and Santos (2006), changes in habits, routines, environments and personal and social relationships can also occur.

Thus, it is understood that population aging, institutionalization and quality of life are permeated by multiple issues. In this scenario, since the search for the association between the reasons that led the senile population to LTCFs and their impacts on quality of life is a relevant theme for public health, there is a need for a deeper understanding of it, in order to minimize the damage and expand the positive role of LTCFs. Thus, the research is justified by the growing social relevance of the institutionalization of the elderly, a phenomenon that reflects changes in family dynamics and in the organization of care for the elderly.

2 METHODOLOGICAL DESIGN

This is a study that aimed to understand how institutionalization affects the quality of life of the elderly, based on their perceptions and those of professionals who work in the health care of the elderly, having as an analytical starting point the transformation in the quality of life of residents before and after institutionalization. To this end, the research sought to understand the factors that led to institutionalization and the role of institutions in the lives of the elderly.

Institutionalization in old age refers to the process by which older individuals are integrated into long-term care institutions, such as nursing homes and nursing homes. Studies such as those by Lima et al. (2016) demonstrate that institutionalization can have significant effects on the quality of life of the elderly, changing their routines, relationships,

and feelings of autonomy. This process can have profound implications for the mental health and overall well-being of residents.

The methodology used in this project was based on the qualitative analysis of data collected through semi-structured interviews, observations and documentary records. The analysis was guided by the principles of content analysis, as described by Mendes and Miskulin (2017). Initially, the material was explored to identify registration units and context units. The registration units may include reports on institutionalization experiences, emotional aspects, and perceptions of quality of life. These units will be analyzed to identify relevant themes, such as changes in autonomy, perception of care and psychological impact of institutionalization.

The categories of analysis will be established based on the theory of institutionalization and quality of life in old age. Categories such as "Impact of Institutionalization on Mental Health", "Changes in Social Relationships", "Emotional Aspects of Institutionalized Life" and "Assessment of Functional Capacity and Physical Aspects" will be explored. The analysis will be carried out following the principles of mutual exclusion, homogeneity, pertinence, objectivity and productivity, as recommended by Mendes and Miskulin (2017).

The data will be treated and analyzed to identify significant patterns and categories. The process will involve a detailed and repeated reading of the data, seeking to understand how institutionalization redefines the quality of life of the elderly. The analysis categories will be adjusted as needed to reflect on experiences in motion.

The analysis will be guided by the concept of "quality of life in old age" and how it is redefined by institutional experience. The approach will allow us to understand individual experiences, as well as the institutional dynamics that influence these experiences. The methodology of this study is guided by a qualitative approach, which is based on a deep and contextualized understanding of the phenomena investigated. Qualitative research is particularly suited to exploring complex issues related to individuals' perceptions and experiences, allowing for a detailed analysis of the nuances of the context in which they are inserted. According to Minayo (2004), the qualitative approach stands out for its ability to capture the richness of the experiences and meanings attributed by the participants, going beyond simple quantifications and seeking a more holistic understanding of the phenomena.

Based on the proposed objective and the theoretical references researched, the method chosen was to conduct individual interviews based on a script (attached), aiming to collect reports related to institutionalization. In this perspective, interviews are a broad instrument, promoting exchanges that provide meaningful discussions, inclining professionals to a process of analysis, reflection, and survey of active, participatory, and

creative possibilities, in the search for transformations that accompany the needs and complexities of daily life in the field (OLIVEIRA, Priscila Borges; 2024).

The study was conducted in (withdrawn to preserve peer review), in the municipality of (withdrawn to preserve peer review) and was divided into three main stages. The first stage involved the recognition of the field of action, where it was sought to understand the environment of LTCFs, their procedures, and the conditions in which the elderly live. This internship also aimed to adapt the researchers to the context and to properly plan the next steps. During this phase, initial observations and interactions were carried out with the residents to familiarize themselves with the environment and with the social and institutional dynamics of the LTCFs.

The second stage consisted of the application of interviews, lasting one hour, with the following themes: Emotional Aspects and General Health Status, Social Aspects, Mental Health and Functional Capacity and Physical Aspects. The themes and questions were delimited by the students based on the adaptation of the Medical Outcome Study 36-item Short Form (MOS SF-36), a generic questionnaire, translated and validated into Portuguese by Ciconelli et al.⁶, composed of 36 items, which assess quality of life. The field researchers were seven students and one professor of the undergraduate medical course at the University of São Paulo.

The inclusion criteria used for the selection of participants were: being officially registered in the long institutional stay and having physical and mental conditions to answer the questions. On the other hand, the exclusion criteria were individuals who were not at the institution during the study, as well as those who were involved in other activities of the LTCFs at the time of the interview. In conversation with the LTCF team, 6 professionals in training or already graduated who work in LTCFs and 6 elderly people were identified, all indicated by the administrative management of the LTCFs. The number of participants interviewed permeated their desire to participate in the proposed activity, and at the end 4 elderly people, a psychologist and a nurse were interviewed.

In the third stage, the data were analyzed from the transcription of the interviews. Data analysis was carried out using Bardin's (2016) content analysis methodology and included the organization and interpretation of the information obtained in the interviews, with the aim of identifying patterns, impact phrases, and emerging and significant themes. This methodological approach seeks not only to describe, but also to understand the complexity of institutionalized life and its impact on the quality of life of the elderly, therefore, in relation to the ethical aspects of research with sheltered elderly, it was essential to ensure that the participants are treated with the utmost respect and protection, being approved by the

Research Ethics Committee with the CAAE: 84914524.8.0000.5151. The privacy of the participants was protected, with all information being stored securely and accessible only to researchers. Identifiable data has been omitted from analyses and reports to ensure confidentiality.

3 RESULTS AND DISCUSSION

Initially, each member read the interviews in full in order to become familiar with the set of reports. Subsequently, the most representative excerpts from each of the interviews were organized according to their adequacy to the previously defined codes.

Then, four main codes were identified, which were delimited based on the contents addressed in the interview questions formulated by the group. They were: Emotional Aspects and General Health Status, Social Aspects, Mental Health and Functional Capacity and Physical Aspects

The subsequent stage consisted of a cross-sectional analysis of the content of these codes, with the objective of identifying elements, speeches and meanings that permeated more than one of them. From this process, four broad categories emerged: Setting, Evolution, Socioeconomic and Belonging.

Within each of these categories, it was expected that the reports selected from the interviews would contemplate essential aspects to understand the experience of institutionalization. In the ambiance category, we sought to identify the structural characteristics of LTCFs, their impact on the quality of life of the elderly and the nature of the relationship established with employees. In evolution, emotional and physical aspects were considered in a comparative way, including perceptions and changes before, during and after entering the institution. The socioeconomic dimension encompassed the social dynamics among the residents, the interaction with family members and the influence of financial conditions on the quality of life throughout the institutionalization process. On the other hand, the feelings of the elderly in relation to LTCFs and the degree of integration into the institutional environment were analyzed. The main results resulting from this thematic organization will be presented and discussed below.

3.1 SETTING

The Ambiance category shows how the structural and relational aspects of LTCFs act in the redefinition of the quality of life of the elderly after institutionalization. This finding dialogues with studies that describe LTCF as a space that combines determinant dimensions for the well-being of residents (Camargos et al., 2016). The excerpts analyzed show that the

physical environment, combined with the way human relationships develop within the institution, constitutes one of the central axes for the adaptation and well-being of residents, as already pointed out by Sousa Filho et al. (2022), when they highlight that adequate housing and multidimensional care are essential to the quality of life of the elderly.

Regarding the physical structure, there is an effort by the institution to ensure comfort, accessibility and safety. Reports that highlight "all beds have a rail" or that "the bedrooms, bathrooms and lounges are adapted" point to a space that seeks to promote autonomy and accident prevention — aspects that the literature describes as fundamental, since architectural adequacy reduces risks, favors mobility and contributes to the preservation of functional autonomy (Sousa Filho et al., 2022). NBR 9050/2020 itself, cited by these authors, reinforces that accessibility and ergonomics are pillars for environments intended for the elderly population. The descriptions of cleanliness, maintenance and ambiance — "everything is clean here", "everything changed, tidied up" — reinforce the role of the physical environment as a factor of welcome and dignity, which also appears in the findings of Camargos et al. (2016), when they highlight the importance of environmental conditions for the elderly to perceive the LTCF as a safe and welcoming place, softening the emotional impact of institutionalization.

On the other hand, the relational dimension of the setting is equally determinant. The professionals' discourses demonstrate a commitment to the humanization of care, by emphasizing the importance of respect and affective proximity with residents: "here we work for them", "they miss us, as we feel about them". Such relationships reflect what Duarte (2014) discusses about the need to rebuild bonds and maintain the identity of the elderly within the institution, since humanized practices contribute to avoid isolation and favor the feeling of belonging. In this sense, quality of life is also a result of the way the elderly are recognized and valued within the institutional space, as Camargos et al. (2016) point out, when they show that affective welcoming influences the positive perception of LTCFs.

Another prominent element in the construction of the environment is the presence of playful and recreational activities, such as bingo, workshops, musical performances and visits from external groups. These actions, in addition to stimulating socialization, work as mediators of emotional well-being, offering moments of pleasure, relaxation and rescue of affective memories. Studies indicate that such activities are essential practices of coexistence, as they transform the institutional space into a place of interaction and resignification of everyday experiences (Camargos et al., 2016; Sousa Filho et al., 2022). Reports such as "when the music comes, they are totally different" and "those who participate like it a lot and miss it when there is none" show that these practices favor the expression of

feelings and strengthen self-esteem, which converges with Duarte (2014) when he states that the LTCF becomes a "place" when it allows the elderly to rebuild meanings and bonds through meaningful experiences. The statements also reveal that the environment is strained by structural and human resources challenges, such as the limitation of professionals and the difficulty of access to specialized services, a reality often discussed in research on LTCFs in Brazil (Sousa Filho et al., 2022). Such limitations can compromise the comprehensiveness of care, but even so, there is a continuous effort to create positive experiences, especially through recreational and cultural activities, which transform the physical space into an environment of coexistence and emotional stimulation — a phenomenon also reported by Camargos et al. (2016) when analyzing the perceptions of institutionalized older adults.

Thus, the Ambiance category demonstrates that the institutional environment is not restricted to a place of residence, but is configured as a scenario for the reconstruction of bonds, memories and meanings of life. The physical structure and the relationship with employees, when guided by empathy and care, act synergistically to minimize the effects of the loss of the family environment and redefine the quality of life of the elderly — the central objective of this study and also pointed out as a need in the analysis of the institutionalization process (Duarte, 2014; Sousa Filho et al., 2022; Camargos et al., 2016).

3.2 EVOLUTION

The reports reveal that the arrival at LTCFs represents a significant rupture in the daily life of institutionalized older adults, which concerns their evolution during their incorporation into the institution. This initial moment marks the impact of the change of environment and helps to understand the factors that lead to institutionalization, such as the loss of autonomy and the need for a space that offers continuous support to these individuals.

The excerpts that describe the conditions in which the elderly are welcomed, such as "Today, they arrive very weak... more advanced dementia process...", reinforce the character of necessity that often precedes institutionalization. The study by Vasconcelos et al. (2022) speaks to this perspective by highlighting that family and social abandonment is generally justified by the family's difficulty in having the economic condition and personal availability to maintain the care of a frail elderly person and/or with comorbidities. These contexts dialogue with the objective of understanding the factors that led the elderly to the shelter, showing that the institutionalization process occurs, in general, in stages of dependence or advanced disease, when family care is no longer sufficient, emphasizing the importance of the existence of care institutions. In addition, the influence of the mechanisms and methods chosen in the reception of the elderly in their conceptions about physical integrity and expectations in the

face of institutionalization is evident, which reinforces the importance of continuous monitoring and the influence of time and coexistence on physical and mental health.

The statements complement this perspective by showing that, despite the initial discomfort of adapting to the institution, the elderly tend to adapt and experience positive feelings after this phase, marked by the beginning of new routine dynamics that promote integration, improved communication and motivation of residents. Statements such as "I wanted to leave" report the initial resistance, followed by the adaptation to life and routine, reflecting the transition from a feeling of rejection to an experience of belonging, an effect of integration practices that promote positive results even in the face of individual challenges.

However, Vasconcelos et al. (2022) points to a significant number of depressive symptoms in institutionalized older adults, associated with social isolation and poor health, while older adults who attend community centers, but have a residence, have a better quality of life compared to residents, suggesting that depending on the institutionalization model, there is no guarantee of mental well-being. These developments demonstrate that the reception and institutional routine focused on care that includes mental health can favor emotional stability. This perspective is based on the literature of Dias et al. (2013) when they demonstrate that, within the parameters of the WHOQOL-OLD, the institutionalized elderly were satisfied with institutionalization, which validates the idea that it is possible to have mental health within institutions.

When observing discourses such as "sometimes you start to lose and forget." and "It is expected that some get a little depressed, which is what happens, but, in general, they adapt well... An important observation is that the emotional state of the elderly varies greatly according to the reason why they came here.", brings to light the functional impact of aging and cognitive limitations that will still be present in the experience of institutionalization, since this physiological process occurs regardless of actions that seek to preserve and improve physical and mental performance.

Institutionalization, as an alternative to promote health support for the elderly, is not limited to minimizing the loss of these functions by making it possible to overcome some conditions. This strengthens the idea of the potential for recovery that institutionalization can provide, as contextualized in the excerpt "It's been very good to stay here, it's helping me with motor coordination... I'm almost getting up.". The reports summarize the idea that institutionalization favors the feeling of optimism generated by daily achievements, as they reveal that the institutional environment can stimulate personal achievements, promote self-esteem and resignify the notion of functional capacity in old age.

In addition, when stating "I'm trying my best, taking a bath alone", and then, "it's something I've achieved", the elderly express satisfaction and pride in regaining small independence within the shelter, highlighting another aspect of adaptation, the reconstruction of autonomy. Although the analysis by Vasconcelos et al. (2022) points to the loss of autonomy and depression as frequent risks of institutionalization due to the rigidity of routines, the present reports of this study lean towards the conclusions of Dias et al. (2013), strengthening the conception that welcoming aimed at meeting physical needs, mainly as a result of family helplessness, promotes an upward improvement in the perception of physical mastery and full integration.

3.3 SOCIOECONOMIC

The Socioeconomic category addresses how interpersonal relationships, family ties, and material and financial conditions influence the experience of institutionalization and, consequently, the redefinition of the quality of life of the elderly. This understanding dialogues with the findings of Dorlivete and Silva (2024), which show that socioeconomic factors, such as low income, dependence, and lack of family support, are among the main aspects that impact well-being in old age, reinforcing that institutionalization is often crossed by social inequalities. The discourses analyzed reveal that the quality of life in the institutional environment is strongly related to the presence (or absence) of affective and economic support, both in the period before and during the stay in the institution, which is also discussed by Barroso (2006), when he points out that the family constitutes the main basis of emotional and social support for the elderly.

The reports indicate that the family bond is an important determinant of emotional and social well-being. Testimonials such as "My niece comes here a lot... we talk a lot, draw, color together" and "they are very attentive and come a lot... We are not abandoned" show that the visit and participation of family members work as mechanisms of belonging and continuity of social life, reinforcing the identity and the feeling of appreciation of the elderly. This finding is echoed in the data by Dorlivete and Silva (2024), which highlight that the presence of the family contributes to strengthening bonds, promoting emotional security, and reducing feelings of abandonment.

On the other hand, family distancing appears as one of the main sources of loneliness: "usually they (the family) do not even come to see the elderly", showing that the absence of bonds reinforces isolation and can compromise the meaning of life after institutionalization. According to Barroso (2006), the lack of family support is directly associated with increased emotional vulnerability, especially among elderly people in situations of dependence.

The social context between residents and employees also emerges as a relevant component. The statements "there are elderly people who are very difficult to take care of... he will complain about everything" and "the elderly are needy, they are needy as hell" express the complexity of coexistence relationships, marked by affection, emotional dependence and tensions typical of collective life. This complexity is observed by Dorlivete and Silva (2024), when they identify that institutionalization creates new arrangements of sociability that can both generate conflicts and favor significant ties. Despite the tensions, there are expressions of solidarity, such as the report of those who help their bedridden colleague: "I take the cover before covering the night... I do all this for her." These gestures reveal the capacity for empathy and cooperation that develops in the institutional space, configuring new forms of sociability that contribute to the feeling of usefulness and belonging, a phenomenon also described by Barroso (2006), when he recognizes that relationships between peers can play a protective role in institutional experience.

With regard to the economic dimension, it is observed that financial vulnerability is a determining factor both for entering the institution and for the perception of improvement in quality of life. Professionals report that "there was an improvement for those who were more financially vulnerable, because they never had close monitoring", indicating that, for many, LTCFs represent an opportunity for regular access to basic care and health care, which did not exist before. This perception is consistent with Dorlivete and Silva (2024), who identify that elderly people in low-income situations are more dependent on institutions and report improvements in basic conditions when they start to receive systematic monitoring.

In this sense, institutionalization, although it can mean loss of autonomy and of the family environment, is also configured as a space of protection and stability for those who faced material deprivation, an affirmation that also appears in Barroso (2006), when he points out that many institutionalized elderly people lived, before entering, in precarious subsistence conditions.

In addition, the discourses suggest that the impact of institutionalization varies according to the family and financial support available. "When there is the family walking together, it is another department. The person is only in another house, but the relationship continues" - this statement summarizes the idea that institutionalization does not need to break affective ties, but can resignify them when there is active family involvement and adequate support structure, as reinforced by Dorlivete and Silva (2024), when describing the importance of continuous family support in institutional adaptation.

Thus, the Socioeconomic category demonstrates that the quality of life of the institutionalized elderly is the result of the intersection between material and relational

aspects. The economic structure, the maintenance of affective bonds and the social network within LTCFs form a set of factors that define the way the elderly experience institutional aging. This understanding reinforces the central objective of the research, by showing that institutionalization not only alters the living space, but reconfigures the meanings of belonging, security, and dignity in old age, as highlighted by both Dorlivete and Silva (2024) and Barroso (2006), when they demonstrate that financial conditions, social relationships, and affective support are central determinants of quality of life in old age.

3.4 BELONGING

The statements of the individuals interviewed are directly linked to the category of belonging, showing how the elderly redefine their own perception of quality of life after the institutionalization process, a phenomenon widely described in the geriatrics literature, which points out that adaptation involves individual emotional, social and life history factors (Bessa et al., 2012 ; Oliveira & Rozendo, 2014). It is observed that the feeling of being in LTCFs is constructed in a plural and subjective way, varying between acceptance, gradual adaptation and resistance - as also reported in studies that simultaneously identify satisfaction, conformism and psychological suffering among institutionalized elderly (Rissardo et al., 2012 ; Porto, Roecker & Salvagioni, 2013).

For some, the institution is perceived as a structured environment, which offers comfort, opportunities for activities and coexistence, being evaluated in an extremely positive way: "For me it is very good. If you ask me a grade that I give for this here, I give a thousand and one, it's all very good." In this case, quality of life is reinterpreted based on the availability of resources, security, and the possibility of maintaining social and cultural bonds, aspects that the literature also associates with the feeling of psychological well-being and social utility (Lima et al., 2016 ; Oliveira & Rozendo, 2014). This reinforces a sense of belonging to the space, as perceived in the statement: "The structure helps in psychological development. Those who want to seek knowledge have opportunities: reading, art, volunteering, interaction with girls who come on Saturdays to the games. I myself have gone to support the girls." The literature shows that meaningful activities and positive coexistence favor autonomy, self-esteem, and active aging (Avelar et al., 2017 ; Miyamoto & Chubaci, 2016).

On the other hand, you say things like "Oh, there are some that look good, right? There are others who want to leave. There are a couple of owners there who want to leave. Oh, you're homesick, right?" reveal that, although there are moments of pleasure and interaction, the feeling of "homesickness" and the desire to return home remain present in some elderly people. Studies show that the rupture with the domestic environment, belongings and

personal history can cause psychological suffering, insecurity and feelings of loss (Minayo, 2012; Clos, 2010 ; Oliveira & Rozendo, 2014). Thus, the process of belonging is neither immediate nor homogeneous, often marked by ambivalences (Rissardo et al., 2012).

In addition, tensions related to coexistence emerge, as evidenced in the statement: "I don't mix. Because here's the thing, these are people who don't add anything to me [...] So, I can't do it." This attitude demonstrates that belonging is also linked to the construction of identity and to the way each elderly person interprets their place within the collectivity: a perception consistent with studies that indicate that cultural, educational and personal trajectories differences influence social integration in LTCFs (Marin et al., 2012 ; Souza, 2009). At the same time, reports such as "One thing that draws too much attention... Here they walk well. He arrives on the street, grabs it, because he is afraid, he does not see properly... It generates insecurity, they grab you, right?", when mentioning that the institutional environment offers greater physical security in relation to the "outside world", they show that the institution can represent a space of protection, even when it is not perceived as a home - something also highlighted by Carli et al. (2011).

In this sense, the statements show that the quality of life after institutionalization does not depend only on the infrastructure and activities offered, but above all on the ability of the elderly to rebuild affective bonds, resignify their history and recognize themselves as part of the new environment. The literature reinforces that autonomy, family support, social bonds, and a feeling of welcome are central determinants of adaptation and satisfaction in LTCFs (E1124, 2018 ; Oliveira & Rozendo, 2014). Thus, the feeling of belonging acts as a central element for the redefinition of quality of life: the greater the possibility of establishing bonds, participating in meaningful activities and feeling recognized in one's uniqueness, the greater the positive perception of life within the institution - a perspective aligned with the notion of active aging and psychological well-being defended by authors such as Araújo & Paúl (2013).

From another perspective, when homesickness, non-identification with the group or difficulty in adapting predominate, quality of life tends to be perceived in a more limited way, as studies that describe feelings of sadness, uselessness, isolation and loss of motivation among institutionalized elderly people (Jacinto; Porto et al., 2013 ; Lima et al., 2016). In this way, the category of belonging shows how living in an institution requires a continuous process of reconstruction of identity and the sense of being in the world, directly influencing the way the elderly experience and evaluate their own quality of life - a conclusion consistent with research that highlights the subjective and relational impact of institutionalization (Goffman, 2013 ; Marin et al., 2012).

4 FINAL CONSIDERATIONS

The analysis of the interviews shows that institutionalization has a profound and multifaceted impact on the quality of life of the elderly. It is observed that, although many enter LTCFs in conditions of physical frailty, functional dependence or cognitive deterioration, the institutional environment can offer structured support, security and activities that favor adaptation.

Over time, older adults tend to evolve from an initial state of resistance and insecurity to an adaptation marked by greater integration, participation in activities, and bonding with professionals and other residents. However, challenges remain, such as the presence of depressive symptoms, the weakening of family ties, and structural limitations of institutions.

The findings reinforce that institutionalization, despite frequently starting in contexts of vulnerability, can act both as protection and as a risk factor, depending on the quality of care offered. Thus, understanding the experiences of residents and the factors that influence their adaptation is essential to strengthen institutional practices that promote well-being, autonomy and dignity. The study evidences, therefore, the continuous need for qualification of LTCFs, ensuring that they play a positive and humanized role in the lives of the elderly.

REFERENCES

- Alencar, M. A., Bruck, N. N. S., Pereira, B. C., Câmara, F. M., & Almeida, S. T. de. (2012). Perfil dos idosos residentes em uma instituição de longa permanência. *Revista Brasileira de Geriatria e Gerontologia*, 15(4), 785–796. <https://doi.org/10.1590/S1809-98232012000400004> (ou <https://www.scielo.br/j/rbagg/a/gSPWgg45jh6fKvkXDwRG7dR>)
- Andrade, C. de, Santos, E. R. dos, Carmo, H. O. do, & Farias, S. M. C. (2021). Rastreamento de depressão em idosos residentes em instituições de longa permanência. *Nursing*, 24(280), 6179–6190.
- Barroso, A. (2006). Editorial. *Revista Portuguesa de Pneumologia*, 12(2), S7.
- Borges, P., & Gama, R. P. (2024). Roda de conversa: Um instrumento metodológico tecnológico-formativo-coletivo na pesquisa em educação. *Revista Educação e Políticas em Debate*, 1–14. <https://doi.org/10.14393/REVEDPOL2024v13a65432> (ajuste DOI se disponível)
- Camargos, M. C. S., Santos, M. C. V. dos, Bomfim, W. C., & Silva, K. R. da. (2016). Viver em instituição de longa permanência: O olhar do idoso institucionalizado. *Revista Kairós-Gerontologia*, 19(3), 313–330. <https://revistas.pucsp.br/index.php/kairos/article/view/32358>
- Converso, M. E. R., & Iartelli, I. (2007). Caracterização e análise do estado mental e funcional de idosos institucionalizados em instituições públicas de longa permanência. *Jornal Brasileiro de Psiquiatria*, 56(4), 267–272.
- Dias, D. da S. G., Carvalho, C. da S., & Araújo, C. V. de. (2013). Comparação da percepção subjetiva de qualidade de vida e bem-estar de idosos que vivem sozinhos, com a família e institucionalizados. *Revista Brasileira de Geriatria e Gerontologia*, 16(1), 127–138.

- Duarte, L. M. N. (2014). O processo de institucionalização do idoso e as territorialidades: Espaço como lugar? *Estudos Interdisciplinares sobre o Envelhecimento*, 19(1).
- Freitas, M. A. V., Scheicher, M. E., & Neri, A. L. (2010). Qualidade de vida de idosos institucionalizados. *Revista Brasileira de Geriatria e Gerontologia*, 13(3), 395–406. <https://doi.org/10.1590/S1809-98232010000300006> (ou <https://www.scielo.br/j/rbagg/a/ZwHmySy3rqG4YbSjkbvHjYL>)
- Instituto de Pesquisa Econômica Aplicada. (2010). *Infraestrutura social e urbana no Brasil: Subsídios para uma agenda de pesquisa e formulação de políticas públicas*. IPEA.
- Lima, A. P. M., Santos, T. C. V. dos, & Ary, M. L. M. R. B. (2016). Qualidade de vida sob a óptica da pessoa idosa institucionalizada. *Revista Brasileira em Promoção da Saúde*, 29(1), 14–19.
- Lima, T. V. da S., Santos, W. P. dos, Freitas, F. B. D. de, & Gouveia, B. de. (2016). Emoções e sentimentos revelados por idosos institucionalizados: Revisão integrativa. *Revista Kairós-Gerontologia*, 19(3), 51–65. <https://revistas.pucsp.br/index.php/kairos/article/view/31448>
- Mendes, R. M., & Miskulin, R. G. S. (2017). A análise de conteúdo como uma metodologia. *Cadernos de Pesquisa*, 47(165), 1044–1066.
- Minayo, M. C. de S. (2004). *O desafio do conhecimento: Pesquisa qualitativa em saúde* (8ª ed.). Hucitec.
- Oliveira, J. M. de, & Rozendo, C. A. (2014). Instituição de longa permanência para idosos: Um lugar de cuidado para quem não tem opção? *Revista Brasileira de Enfermagem*, 67(5), 773–779.
- Santos, T. C. V. dos, Ary, M. L. M. R. B., & Calheiros, D. dos S. (2021). Vínculos familiares dos idosos institucionalizados. *Research, Society and Development*, 10(12), Article e194101220246.
- Silva, J. A. C. da, et al. (2017). Qualidade de vida na terceira idade: Prevalência de fatores intervenientes. *Revista da Sociedade Brasileira de Clínica Médica*, 15(3).
- Soares, N., et al. (2018). Sentimentos, expectativas e adaptação de idosos internados em instituição de longa permanência. *REME – Revista Mineira de Enfermagem*, 22, Article e-1095.
- Sousa Filho, A. E. de, et al. (2022). Instituições de longa permanência para idosos: Revisão integrativa. *Research, Society and Development*, 11(15), Article e531111537573.
- Vasconcelos, C. L. B. de, et al. (2022). Qualidade de vida de idosos institucionalizados no Brasil: Uma revisão integrativa. *Revista Brasileira Militar de Ciências*, 8(20).

ANNEX

Table 1

Interview Script

1 Emotional Aspects and General Health Status	1. Emotional Aspects: How would you describe the emotional state of the elderly from institutionalization, that is, which feelings predominate in daily life and there was a change or labilities in the emotional state? 2. General Health Status: How do you evaluate the general health of the elderly today compared to the beginning of institutionalization? 3. General Health Status: How do you feel your energy level throughout the day of the elderly? Do you notice any changes such as fatigue or other signs and symptoms? 4. Emotional Aspects: from your perspective, how does the environment impact emotional well-being? Are there things that help or hurt, for example? 5. General Health Status: How do you perceive that medical and health needs are met? What is the participation of the SUS? and other institutions?
2 Social aspects	1. Social Integration: How do you perceive the level of social interaction within the hostel? 2. Recreational Activities: What recreational/recreational or socialization activities do you identify? Could you describe, please? 3. Social Relations: How are the relationships between residents? And with the teams that work in the shelter? 4. Family: Do you participate in moments with the families of the sheltered? Can you present insights about these moments? 5. Social Integration: Are there any activities or events you would like to see more often here? What do you think could help improve social interaction?
3 Mental Health	1. How do you describe the mental health of the elderly and the professionals who work in the institution?
4 Functional Capacity and Physical Aspects	1. Functional Capacity: How do you assess the ability to perform daily activities, such as dressing, bathing and eating, from those who are in the shelter? Are there physical limitations that make it difficult to perform certain activities? If so, what are these limitations? 2. Physical Aspects: How would you describe the adaptation of the shelter's facilities to the physical, psychic and cognitive needs of the elderly? 3. Functional Capacity: Are there activities or services or partnerships that you think could help improve the shelter's performance? What would they be?

BORN TO CARE: GENDER ROLES AND EMOTIONAL OVERLOAD AMONG INFORMAL FEMALE CAREGIVERS

NASCER PARA CUIDAR: PAPEL DE GÊNERO E SOBRECARGA EMOCIONAL DE MULHERES CUIDADORAS INFORMAIS

NACER PARA CUIDAR: PAPEL DE GÉNERO Y SOBRECARGA EMOCIONAL DE LAS MUJERES CUIDADORAS INFORMALES



<https://doi.org/10.56238/sevened2026.008-178>

Amanda Cavalcanti Pinheiro Barbas¹, Bianca Lemos Cobra², Laleska Moraes Ferreira³, Lorena Lourenço Rosa da Silva⁴, Mateus Henrique Oliveira Souza⁵, Melissa Mendes Ferreira⁶, Santiago de Matos Fernandes Perez⁷, Tatiana Maria da Silva⁸, Rosa Gouvêa de Sousa⁹

ABSTRACT

This is a study on understanding the impact of emotional and psychological overload on informal carers of home-based patients, with the aim of deepening this understanding based on determining factors such as the duration of care, the severity of the patient's pathological condition, as well as their limitations and demands, the social support available and the coping strategies used by carers. In addition, the study seeks to understand how gender affects the mental burden of informal caregivers, observing this phenomenon from a social and scientific perspective. The methodological design involved content analysis of narratives by women caregivers in a community affiliated with a health unit in the interior of Minas Gerais. The findings showed that informal care, although essential for sustaining life and supporting family and community networks, remains structured on profoundly unequal bases. The caregivers interviewed revealed in their narratives that the daily practice of care is marked by gender, loneliness, and symbolic and spiritual strategies that function both as support and as a way of reframing suffering. In view of this, this study reaffirms that caregiving

¹ Medical student. Universidade Federal de São João del Rei (UFSJ). Minas Gerais, Brazil. E-mail: amandacpbarbas@gmail.com

² Medical student. Universidade Federal de São João del Rei (UFSJ). Minas Gerais, Brazil. E-mail: biancalcobra@gmail.com

³ Medical student. Universidade Federal de São João del Rei (UFSJ). Minas Gerais, Brazil. E-mail: laleskamf2001@hotmail.com

⁴ Medical student. Universidade Federal de São João del Rei (UFSJ). Minas Gerais, Brazil. E-mail: lorenals231@gmail.com

⁵ Medical student. Universidade Federal de São João del Rei (UFSJ). Minas Gerais, Brazil. E-mail: mat124578@gmail.com

⁶ Medical student. Universidade Federal de São João del Rei (UFSJ). Minas Gerais, Brazil. E-mail: melissamendesmf19@gmail.com

⁷ Medical student. Universidade Federal de São João del Rei (UFSJ). Minas Gerais, Brazil. E-mail: santiagomfperez@gmail.com

⁸ Social Communication. Community Health Agent. Prefeitura Municipal de São João del Rei, Minas Gerais, Brazil. E-mail: tatthymary1905@gmail.com

⁹ Dr. in Psychology, Medical Professor. Universidade Federal de São João del Rei (UFSJ), Minas Gerais, Brazil. E-mail: rosags@ufsj.edu.br

is also work, work that, when performed alone and continuously, causes illness. It is essential that care be understood as a collective responsibility and that progress be made.

Keywords: Caregiver. Health. Gender. Overload.

RESUMO

Trata-se de um estudo sobre a compreensão acerca do impacto da sobrecarga emocional e psíquica em cuidadoras informais de pacientes domiciliados, tendo por objetivo o aprofundamento de tal compreensão a partir de fatores determinantes como a duração do cuidado, a gravidade da condição patológica do paciente, bem como sua limitação e demanda, o suporte social disponível e as estratégias de enfrentamento utilizadas pelas cuidadoras. Além disso, o estudo busca entender como o gênero atravessa a carga mental de cuidadoras informais, observando esse fenômeno a partir de uma perspectiva social e científica. O desenho metodológico percorreu a análise de conteúdo por narrativas de mulheres cuidadoras de uma comunidade adscrita a uma unidade de saúde, no interior de Minas Gerais. Os achados evidenciaram que o cuidado informal, embora essencial para a manutenção da vida e para a sustentação das redes familiares e comunitárias, permanece estruturado sobre bases profundamente desiguais. As cuidadoras entrevistadas revelaram, em suas narrativas, que a prática cotidiana do cuidado é atravessada por marcadores de gênero, pela solidão e por estratégias simbólicas e espirituais que funcionam tanto como suporte quanto como forma de resignificar o sofrimento. Diante disso, este estudo reafirma que cuidar é também trabalho, um trabalho que, quando desempenhado de forma solitária e contínua, adocece. É imprescindível que o cuidado seja compreendido como responsabilidade coletiva e que se avance na construção de estratégias que reconheçam, apoiem e protejam as cuidadoras informais.

Palavras-chave: Cuidadora. Saúde. Gênero. Sobrecarga.

RESUMEN

Se trata de un estudio sobre la comprensión del impacto de la sobrecarga emocional y psíquica en las cuidadoras informales de pacientes domiciliados, con el objetivo de profundizar en dicha comprensión a partir de factores determinantes como la duración de los cuidados, la gravedad de la condición patológica del paciente, así como sus limitaciones y demandas, el apoyo social disponible y las estrategias de afrontamiento utilizadas por las cuidadoras. Además, el estudio busca comprender cómo el género atraviesa la carga mental de las cuidadoras informales, observando este fenómeno desde una perspectiva social y científica. El diseño metodológico se basó en el análisis de contenido de las narrativas de mujeres cuidadoras de una comunidad adscrita a una unidad de salud, en el interior de Minas Gerais. Los resultados evidenciaron que el cuidado informal, aunque esencial para el mantenimiento de la vida y el sostenimiento de las redes familiares y comunitarias, sigue estando estructurado sobre bases profundamente desiguales. Las cuidadoras entrevistadas revelaron en sus narrativas que la práctica cotidiana del cuidado está atravesada por marcadores de género, soledad y estrategias simbólicas y espirituales que funcionan tanto como apoyo como forma de resignificar el sufrimiento. Ante esto, este estudio reafirma que cuidar también es trabajo, un trabajo que, cuando se realiza de forma solitaria y continua, enferma. Es imprescindible que el cuidado se entienda como una responsabilidad colectiva y que se avance

Palabras clave: Cuidadora. Salud. Género. Sobrecarga.

1 INTRODUCTION

The dynamic process of illness is inherent to the human condition and makes it essential to build a network of support and care around the sick individual, since he himself becomes limited to perform the basic activities of daily life. In this sense, the figure of the caregiver is urgent, who, in many contexts, is a female figure of the family or community (Conceição et al., 2021), especially in Brazil, whose data point to the existence of approximately 47.5 million people involved in care, 78% of whom are women (Institute of Applied Research, 2024).

Thus, an informal caregiver is defined as one who provides care, but who does not receive any remuneration or sign any type of contract for the purpose of caring (Barbosa et al., 2009). Such people usually have some affective bond with the patient, usually being friends, family or neighbors, and are responsible for mediating the physical, affective, social, psychological and spiritual well-being of those who receive care (Sales et al., 2022).

Within this context, the right to care has been widely recognized and incorporated as one of the pillars of social citizenship, along with social security, health, and education (Brasil, 2022). However, what is the look given to caregivers? There are several studies on sick patients, but little is said about the caregiver. Thus, understanding care as a fundamental right, it is expected that it will be extended to those who care as well, and not only to those who are cared for. From this perspective, informal care support can cause physical and emotional exhaustion, anxiety, and overload in caregivers, since they do not receive adequate preparation to meet the complex demands that involve care (Diniz et al., 2018; Fernandes et al., 2013).

Thus, when talking about overload, two dimensions must be considered: the objective and the subjective. The first refers to the negative and resulting consequences of the caregiver role, including the frequency of daily tasks, the supervision of problematic behaviors, interruptions in the social and professional life of caregivers, and financial losses. The second dialogues with the emotions and perceptions of the caregiver regarding his own function, including uncomfortable feelings and the impacts resulting from the changes that occur in his social and professional life, as well as encompasses the concerns with the patient (Batista; Bandeira; Oliveira, 2015).

Given the complexity of care practice, family caregivers should also be the target of attention, since long-term exercise can bring physical, psychological, material and social overload, limiting caregivers' self-determination and freedom to "be", "be" and "participate" in the community. In view of this, it is crucial to identify the needs of caregivers in the psychological, financial, and social spheres, as well as to recognize community resources,

caregiver's level of education, caregiver support, or temporary care, and promote actions to ensure the sustainability of care. When the perspective is focused on gender, women are the majority in the provision of care, reflecting a gender configuration associated with this practice, which is socially constructed as a feminine task. Thus, it is urgent that the discussion of gender be considered when addressing the demands of caregivers, in order to recognize social asymmetries and break with stigmatizing practices.

Thus, the objectives of this study went through the understanding of the impact of emotional and psychic overload on informal caregivers of home-based patients, deepening this understanding based on determining factors such as the duration of care, the severity of the patient's pathological condition, as well as its limitation and demand, the available social support and the coping strategies used by the caregivers. In addition, this study sought to understand how gender crosses the mental load of informal caregivers, observing this phenomenon from a social and scientific perspective.

2 METHODOLOGY

This study addressed, based on a qualitative and cross-sectional research, the understanding of the impact of emotional and psychic overload on informal caregivers of patients living in the city of São João del Rei - Minas Gerais. There is then an open-ended individual interview with the triggering question "How do you feel about the role of caregiver?". From there, the interviewer in charge will conduct with other questions to understand the context and state of the interviewee's psyche. The research group is composed of seven students, whose information was taken to ensure peer evaluation. This group was divided into research areas, and the interviews were done in pairs. Eight interviews were conducted, and the interviewees were selected because they were informal caregivers, female, who were relatives or had some degree of proximity to the patient, who were domiciled, bedridden or not, who required care and who had most of their activities restricted to the home. Those who receive payment for care and people of the male gender were excluded. The selection of participants was carried out through people enrolled in the Family Health Strategy (FHS) type 2 of the city of São João Del-Rei, indicated by the community health agents of the São Geraldo locus, a region suggested due to the demands necessary for the current research.

The family health strategy unit (FHS) chosen as the territory for the construction of the narratives, has been a health center since the 2010s (name withheld to ensure confidentiality). Within the team of professionals who work in the unit, inserted in the Community Agents Program (PAC), there is the presence of twelve agents, divided between the two teams that make up the ESF (Brasil, 2025). The author of this article participates in

one of the teams and is responsible for a micro-area that is farther from the post and with socioeconomic conditions of high vulnerability (Brasil, 2024).

Her long-standing work as a health agent is in line with her own history in the community, as the author has lived in the neighborhood for a long time, since her childhood (the name of the region was withheld to ensure the anonymity of all those involved). The community agent leads coordinated health care in her micro-area, intertwining her territorial community knowledge with the individualized care of people, taking into account the history of all those involved, of the territory itself and of the community itself.

With regard to the community, for a better understanding of this study, it is highlighted that the territorial beginning took place as "the place of residence of some families, which grew and stayed in the same territory, contributing to a community relationship constituted by family relationships" (author's report, 2025). The community knows and supports each other, building support networks that promote dialogue and exchange, which enable knowledge about demands and thus the production of actions that act in favor of family health care.

Community strength is based on women, exemplified in the presence of the caregivers highlighted here, as well as in religious and cultural festivals when they are the leaders, such as the festivities of the Congado, for Nossa Senhora do Rosário and for São Dimas (author's report, 2025). The city, where this community is located, is located in a rural area of the State of Minas Gerais, in the southwest region, being a health center of the region. It has approximately 90 thousand inhabitants and has a municipal and regional SUS network.

The data were filtered to identify caregiver-patient pairs who met the inclusion and exclusion criteria of the research. The selection and interviews were carried out in the first half of 2025, from March to June, only after approval by the ethics committee, CAAE (85787524.5.0000.5151). After approval by the Ethics Committee, contact was made with the indicated people and explained to them the nature of the research, the context of the investigation and the procedures of the narrative interview, so that the indicated person could choose whether or not to accept to be interviewed and participate in the study.

The approach included an initial stage dedicated to creating a bond between the interviewers and the participating informal caregivers. This stage, which lasted approximately 20 minutes, was conducted before the formal start of the interview and was not recorded, aiming to provide a welcoming and trusting environment. During this moment, the interviewers introduced themselves, explaining their roles in the project and the general objectives of the research. Next, the caregiver was given the opportunity to talk about herself, her challenges and motivations, promoting a space for initial dialogue.

In addition, the conversation sought to better understand the context of the care provided by the participant. At this point, spontaneous reporting of her perceptions of the caregiver role was encouraged, including how she defines and interprets her responsibilities and the impact of this role on her life. This stage was also used to briefly introduce the main themes that were addressed in the subsequent formal interview. As a way to increase knowledge and awareness, at the end of each interview, a booklet was delivered with relevant points of the Informal Caregiver Statute (Law No. 100/2019, of September 6), highlighting information about the rights guaranteed and the responsibilities attributed to caregivers. The interviews were confidential and anonymous under the parameters of the ethics council. The recordings were later transcribed, and the names collected were changed to fictional names, thus preserving the privacy of the interviewee and reinforcing the confidentiality and care with the material collected.

Table 1

Interview questions

Issue:	
1.	How do you feel about the role of caregiver?
2.	How does this feeling impact your life?
3.	What does caring mean to you?
4.	Since you started taking care of the patient, how is your mental health?
5.	What does taking care of the patient require of you?
6.	Is there anything else you want to talk about this?

Source: The authors archive.

Table 2

Phases of the Narrative Interview

Phases of the narrative interview	Rules for the interview
Preparation	Exploring the Question Formatting field
Initiation	Formulation of the initial topic for narration Use of visual aids
Central Narration	Do not interrupt Only non-verbal or paralinguistic encouragement to continue Narration Wait for signs of completion

Question Phases	Only "What happens then" Not giving opinions or asking questions about attitudes Do not argue about contradictions Not asking "why?" questions Going from exmanent to immanent questions
Concluding speech	Stop recording Are "why" questions allowed? Take notes immediately after the interview

Source: Jovchelovich and Bauer (2002)

2.1 THE ANALYSIS OF NARRATIVES

The method adopted for the analysis of the narrative interviews initially consisted of transcribing the material and then dividing the work into two parts. The first contains the rational, concrete and scientific content, with the description, in an objective way, of individual actions and functions. The second part encompasses information that transcends the facts narrated, including values, ideas and personal perceptions, linked to the wisdom and subjectivity of the participants. In the next stage, the events were organized chronologically for each interviewee, allowing the evaluation of their respective individual trajectories. Then, the trajectories of the caregivers were studied and compared, allowing the identification of similarities between the reports, finally allowing the formation of collective trajectories with the sharing of common characteristics inherent to the context of these women.

To analyze the mental state of informal caregivers, the material was progressively condensed, using reduction and generalization techniques. This process was divided into three stages: the complete transcription of the narratives; a first reduction, in which the most prominent passages were summarized; the third stage, with the definition of keywords that captured the central concepts addressed in the highlighted excerpts. Based on this, initial categories were created for each narrative and, later, organized in a common system, applicable to all interviews, allowing a final interpretation that considered both the relevant aspects for the caregivers and for the researchers.

In order to deepen the analysis, the question proposed by Erving Goffman was used: "What is happening here and now?". This question helps to identify contextual and temporal indicators, enabling a better understanding of the environment and the emotional dynamics of caregivers. The "frames" and "contextualization clues" are fundamental in this process, helping to structure the understanding of the situation. The frames reflect how the context should be interpreted, while the clues refer to both the local context and the broad context, of an institutional, cultural and social nature.

To create and organize the categories, both data-based and concept-driven coding methods were used. The literature on the mental state of informal caregivers and the focus of the research allowed the definition of some preliminary categories. However, the material obtained in the field allowed the construction of new categories, adapted to the specific experiences of the caregivers. The objective was to extract from the data their real meaning, avoiding interpretations based on preexisting theories.

Finally, it was essential to explore both the "said" and the "unsaid" in the caregivers' narratives, favoring a contextualized analysis. This allowed them to capture implicit meanings in their speeches, as well as to identify how the individual context influences their expressions. With this approach, it was possible to carry out a deeper and more accurate analysis of the psychological challenges faced by caregivers, considering both their explicit statements and the emotional aspects not directly verbalized.

3 RESULTS AND DISCUSSIONS

For the analysis of the content collected, all researchers read the interviews in full, identifying significant passages related to the experience of care. These excerpts were initially organized into preliminary categories - family support, mental overload, physical overload, coping and informal care - which allowed us to capture different dimensions of the caregivers' daily lives. The next stage involved the grouping and systematic comparison of these contents, enabling the emergence of more comprehensive interpretative axes. From this process, three central analytical nuclei were derived: gender, understood as the symbolic and material structure that shapes expectations, inequalities and the naturalization of care as a female task; loneliness, understood as the experience of affective and practical isolation, in addition to silencing, which permeates prolonged care; and religiosity, defined as the set of practices, beliefs, and spiritual meanings activated to support, justify, or resignify the daily burden of care. These axes worked as lenses to understand the way in which women elaborate their experience and attribute meaning to emotional and psychic overload in the context of informal care.

3.1 PATRIARCHAL ROLE OF WOMEN, DIVISION OF LABOR AND THE BURDEN ASSOCIATED WITH CARE

The social role of women has historically been constructed through cultural, social and economic dimensions that, over the centuries, have attributed to the feminine the responsibility for domestic and care work. Federici (2019) highlights that there is a particular combination of physical, emotional, and sexual services that make up the figure of the

"housewife", a fundamental character whose work remains invisible. This naturalization of care as a feminine practice becomes evident in the narratives of the interviewees, such as when Orquídea states: *"I have to be on her own"* and *"I am not alone"*, revealing how this responsibility is interpreted as an individual and inevitable obligation.

In this sense, the romanticization of love and its link to marriage function as mechanisms to legitimize this inequality. As Federici (2019) discusses, the idea of love operates in order to mask the exploitation of female labor in the domestic space, sustaining the belief that caring is a natural expression of affection. Such a dynamic appears when Bárbara reports: *"I don't like to be too stubborn. I do what he says"*, revealing the maintenance of relationships that reinforce female submission. Jasmin also evidences this process when she comments: *"They don't care how my marriage is"*, indicating the social disregard for the emotional and marital impacts of the overload.

These individual experiences are part of an organization defined by Walby (1990) as patriarchal, in which the subordination of women is structured in different spheres of life. In Brazil, this heritage is marked by a colonial past that consolidated the patriarchal family as the dominant model of social organization (Narvaz; Koller, 2006). The consequences of this configuration emerge when Rosa says: *"The rest is just us here, right?"* and *"Before it was me, just me, just me, only me"*, pointing out the centrality of care in the hands of women and the absence of support from other family members.

In this way, the sexual division of labor, as systematized by Kergoat (2003), is based on two principles: the separation between "men's" and "women's" jobs and the hierarchization that devalues everything that is assigned to the feminine. This structure remains evident in the reports of the interviewees. Orquídea points out: *"We are 8, but the women who were left with the greatest overload, we are 4. Men don't..."*, explaining how the burden falls exclusively on them. At the same time, Jasmin reveals her father's abandonment in motherhood when she reports: *"It was a lot of responsibility, that's not what he wanted"*, demonstrating how fatherhood is still socially treated as optional, while motherhood is compulsory.

From this perspective, care goes beyond conjugality and is distributed among mothers, daughters, sisters and grandmothers, consolidating a female support network (Gonçalves; Sena, 2001; Rosa, 2003; Pegoraro; Caldana, 2006). This appears in the lines of Orquídea: *"My sisters come in the afternoon, so my sisters stay more in the bath part"*, Azaleia: *"My girls help me"* and Rosa: *"Then we got a girl, at least for the girl to stay here to help me"*. On the other hand, the absence of men is a constant: *"No one can ever stay"*, *"There's no one, there's only me, you know?"* and *"Nobody helps"*, report Orquídea and Jasmin, evidencing the persistence of this unequal division.

It is also evident that the overload resulting from this structure produces significant impacts. The theories of Fonseca (2000) and Saffioti (1979) describe how the expropriation of women's time, body and energy constitutes a fundamental pillar of gender inequality. Pegoraro (2006) highlights that this overload contributes to psychological illness, with anxiety, depression and chronic stress. The interviewees reinforce this dimension: Rosa reports that *"Only us, only us, we really get desperate"*, while Jasmin summarizes inequality by stating: *"With the overload only for one"* and *"People close their eyes to this"*. These statements show not only the emotional exhaustion, but also the social invisibility of the work they do.

Another central aspect is the limitation of female autonomy. Orquídea reports, *"My husband has been out four times, and I can't get out of here,"* demonstrating how care restricts her freedom while male mobility remains unchanged. Even when there is some male participation, it is punctual and perceived as a favor, as when she says: *"There's my husband too, sometimes he washes dishes for me."* This type of collaboration reinforces, rather than disrupts, the logic of unequal division.

It is also possible to identify the construction of co-dependent bonds, as discussed by Gonçalves (1999). Jasmin expresses this dynamic by saying: *"I'd rather deprive myself of things, than leave her alone."* At another point, she reinforces the feeling of inevitability of care: *"If I don't help her, who will?"* and *"If I don't help her... no one will give it."* In contrast, some experiences are crossed by the feeling of affective retribution, as Peônia reports: *"For us to take care of her, it is a satisfaction. Because she already took care of us when we were children, right?"*, demonstrating that care can also be experienced as an extension of the family bond.

Therefore, the articulation between prolonged responsibility, isolation and intense emotional load demonstrates that informal care, when unevenly concentrated, produces profound effects on women's lives, compromising their autonomy, well-being and their ability to insert themselves in other social and professional spheres. Thus, in patriarchal societies, to be born a woman is, symbolically, to be born destined to offer the care indispensable to life, although such care remains systematically invisible and devalued.

3.2 SILENCING OF WOMEN'S SUFFERING AND WOMEN'S LONELINESS IN SOCIETY

The caregivers' testimonies show a pattern of silencing suffering, which permeates their physical and emotional experiences. Such silencing, far from being just an individual perspective, constitutes a social and historical phenomenon rooted in the patriarchal structures that shape care work in the domestic sphere (Federici, 2019). The suffering that emerges from this daily and continuous function tends to be minimized, interpreted as

inevitable, and often seen as intrinsic to the female role (Lugones, 2019).

The silencing occurs because care is socially constructed as an extension of the woman's identity. The idea that the ability to care derives from characteristics considered "natural" or "biological" underpins the sexual division of labor and reinforces the association between femininity, selflessness, and sacrifice (Lugones, 2019). In this context, a mechanism of symbolic subordination is manifested that transforms the physical and emotional exhaustion of caregivers into something morally acceptable and expected, and, therefore, little questioned. Dedication to care is perceived as a moral duty, which makes it difficult to express fragility, fatigue or suffering, often interpreted as personal failures or lack of commitment (Pereira, 2003; Pegoraro and Caldana, 2006). Bernardo (2021) highlights that this process functions as a mechanism of symbolic subordination and silencing, fundamental to sustain colonial and patriarchal relations that hierarchize gender roles, and thus legitimize the exploitation of the female body and labor as something "moral" or "expected".

In this way, informal care, exercised predominantly in the domestic space, operates far from the public sphere, which contributes to its invisibility (Federici, 2019). Although it involves complex activities, whether physical, cognitive or emotional, it continues to be socially recognized as a private and affective task, and not as work. As Jasmin said in the excerpt *"People close their eyes to this"*, translating that the devaluation reinforces the idea that the suffering of these women is not worthy of attention, institutional support or specific policies. Consequently, caregivers internalize the need to remain strong, resilient, and emotionally stable, even in the face of overload. This scenario also stems from social structures marked by gender hierarchies and historical patterns that legitimize the unequal distribution of work (Lugones, 2019). The expectation that women alone assume the responsibility for care maintains the logic in which their pain must remain invisible so that the social organization continues to operate without ruptures.

Silencing works, therefore, as a device of social control, which prevents the problematization of the conditions in which care is exercised, as well as prohibits the possibility of claiming support, redistribution of tasks or public recognition. In these circumstances, suffering is no longer seen as a consequence of an unequal system, but is then interpreted as an individual characteristic, which prevents the construction of adequate social and institutional responses.

Thus, the loneliness experienced by the informal caregiver is a dense experience crossed by emotional, social and symbolic layers far beyond the simple "being alone". According to Dornelas (2007), this loneliness is not only born from the exhausting routine of care, but from the way society inscribes in the body and subjectivity of women the expectation

of silent sacrifice. It is a loneliness woven into daily life by those who dedicate time, attention and affection to others, often at the expense of their own existence. As Orquídea expresses: *"My husband has left four times, and I can't leave here"*, revealing the symbolic and material confinement that structures this experience.

When taking care of a dependent family member, many women report a progressive distancing from their professional lives, social ties and even their own identity. We observe this when Jasmin states, *"Everyone has life. Except me."* This movement echoes what Dornelas describes as a symbolic erasure of women. They become "invisible presences", always available, but little noticed; they support the daily lives of others, but have their own needs disregarded. Thus, the loneliness they experience is not limited to the lack of company, but to the absence of reciprocity, because they care, but are not cared for, just as they speak, but are not listened to.

This scenario is deepened by a social structure that, as Dornelas (2007) points out, romanticizes female suffering and abnegation, naturalizing both isolation and emotional overload. Care, when seen as a destination and not as work, takes away from caregivers the right to rest, recognition and their own desire. Bárbara, for example, synthesizes this invisibility when she narrates: *"I went to look for it, there was no one to go get the salt"*, showing how basic tasks become solitary responsibilities. Breaking this cycle requires support networks, public policies, and a cultural transformation that gives women back the right to exist beyond the function of care. The loneliness of these caregivers, therefore, is not a personal failure, but an expression of a structural inequality that limits their possibilities of sharing the weight and meaning of care.

This perspective is also directly intertwined with two central elements that emerged in the narratives: the fear of the woman cared for and the social recognition of those who should care. Some caregivers exposed that the dependent person feared being abandoned or being alone, as reported by Jasmin: *"If... if I don't help, if I don't... give her a hand... no one will give it"*. This fear intensifies the pressure on caregivers and reinforces the expectation of constant presence, an expectation deeply crossed by gender. As Dornelas (2007) discusses, this fear reveals the complexity of the relationships of emotional dependence that fall on women, who end up being responsible not only for physical care, but also for the affective security of the family member.

At the same time, the understanding of "who should care" appears marked by family discourses that assign women this naturalized role, as an inevitable extension of their identity, which Jasmin expresses forcefully when she says: *"If I don't help her, who will?"* element. This combination between the fear of care and the naturalization of feminine destiny deepens the

loneliness pointed out by Dornelas: a loneliness that is not born of absence, but of obligatory presence, that is, a loneliness produced by bonds that ask too much and by structures that give too little.

3.3 GRATITUDE AND DUTY ASSOCIATED WITH THE IDEA OF DIVINE PROVISION

Religiosity is configured as a fundamental interpretative axis to understand how informal caregivers signify, support and re-elaborate the emotional overload associated with care. The contents collected by the interviews dialogue in a consistent way with the contemporary literature on religious confrontation, Marianism and gratitude.

The presence of a strong feeling of divine provision, which is exemplified in Barbara's lines *"everything I'm going to do, everything is fine. Thank God, you know?"*, *"Today the rice fell to the ground... I hope God has more to give me"* and Azalea *"as long as God gives me health, strength there, to walk and I'm there helping her"*, aligns with the concept of perceived divine control. According to DeAngelis & Ellison (2017), when individuals believe that God is directly involved in everyday events, they tend to reinterpret stressors in a more positive way, understanding them as part of a larger plan. This mechanism is observed among the interviewees, who transform exhausting experiences into expressions of faith, reinforcing their ability to endure care.

The articulation between mission, burden, and self-sacrifice speaks directly to the core elements of Marianism, as developed by Mendez-Luck & Anthony (2015). Jasmine's speech: *"His cross was heavy, He took care of it, why won't I give it?"*, exemplifies the symbolic alignment between suffering, devotion and feminine morality, classic elements of the ideal of the "selfless mother". The idea that care is a sacred responsibility, as explained by Jasmin *"it's in God's hand, He gave me this mission"*, reinforces the notion that care is not only a social obligation, but a spiritual expression of submission, surrender and moral duty, fundamental characteristics of the gender construction analyzed by the authors.

In this sense, Marianism also operates as a cultural matrix that organizes not only behaviors, but above all emotional and spiritual experiences associated with the act of caring. According to Mendez-Luck and Anthony (2016), this normative ideal constructs the female figure as naturally destined for sacrifice, renunciation and devotion, establishing that the moral value of women is deeply linked to their ability to "suffer for love" and to put the needs of others above their own. This model does not act only as an abstract reference, as it is lived in a concrete way in the narratives of the caregivers, who often translate care as a divine mission, a gesture of love and an expression of religious obedience. Bárbara's speech *"To care, to take care of him, I do feel that I like him, that I'm helping the person I like. E... for love*

of God too" synthesizes the intertwining between affection, devotion and moral responsibility. By stating that she cares "for the love of God", Bárbara mobilizes exactly the pattern described, in which care becomes a space for spiritual fulfillment and identity affirmation. Thus, Marianism not only legitimizes self-sacrifice, but also offers an interpretive framework that allows wear and tear to be re-signified as a virtue, reinforcing the sense of purpose and the conviction that suffering associated with care has moral and religious value.

In addition, many reports express care as a form of affective retribution, as Peônia puts it: *"she already took care of us when she was a child"*. This relational logic echoes the findings of Mendez-Luck & Anthony, which show that caregivers often interpret their role as returning the care received, reinforcing family bonds and legitimizing self-sacrifice as a gesture of love and commitment.

On the psychosocial level, religious involvement works as a protective factor, consistent with what Koenig et al. (2016) identify: religious beliefs and practices can reduce depressive symptoms, facilitate adaptation to the role of caregiver, and offer cognitive mechanisms that produce meaning to daily tasks. The participants' statements, especially the constant thanks, (*"I thank God very much"*), and the perception of spiritual support, reinforce that faith not only provides emotional support, but organizes the coping narrative.

A particularly relevant fact is the presence of gratitude as a central attitude, which not only softens the experience of overload, but also produces a sense of purpose. Jasmine's statement *"So, like this, I thank God very much"* shows how gratitude works as a resource for resignification, allowing caregivers to interpret daily life beyond immediate difficulties. This finding speaks directly to McGee et al. (2024), who demonstrate that higher levels of gratitude in caregivers are associated with a greater sense of life, even in the face of high stressors.

Thus, the core of religiosity observed in the study participants functions simultaneously as a cultural structure, an emotional coping system and a moral mechanism for legitimizing care. It is in this triple spiritual, psychological and sociocultural movement that faith is transformed into a practical resource, sustaining both the "burden" and the "mission", allowing caregivers to continue performing their functions, often with less subjective suffering and a greater sense of purpose.

4 FINAL CONSIDERATIONS

The findings of this study show that informal care, although essential for the maintenance of life and for the sustenance of family and community networks, remains structured on profoundly unequal bases. The interviewed caregivers reveal, in their narratives, that the daily practice of care is crossed by gender markers, loneliness and

symbolic and spiritual strategies that work both as support and as a way to resignify suffering. Far from being just a set of practical tasks, care emerges as an emotionally dense experience, marked by individual responsibility, social invisibility, and an overload that unfolds at physical, psychic and material levels.

From the analytical dimensions of gender, loneliness and religiosity, it was possible to understand how these women elaborate meanings for their performance and how they internalize social expectations that naturalize their position as caregivers. The statements reveal a constant tension between the desire to meet family demands and the need to preserve their autonomy, often restricted by the sexual division of labor and the absence of effective support. Loneliness, not only as the physical absence of others, but as a structural silencing, is a central element of this experience, and contributes to the intensification of the mental load, reinforcing feelings of exhaustion and impotence.

At the same time, religiosity appears as an axis of emotional support, offering comfort, meaning and a symbolic horizon that allows one to endure the harshness of everyday life. However, although faith represents an important resource, it does not replace the urgency of specific public policies, structured support networks and community processes that redistribute care and recognize its social value.

In view of this, this study reaffirms that care is also work, a job that, when performed in a solitary and continuous way, makes people sick. It is essential that care is understood as a collective responsibility and that progress be made in the construction of strategies that recognize, support and protect informal caregivers. This includes both the strengthening of assistance and support policies and the transformation of the cultural bases that sustain the naturalization of care as a female destination. To recognize care as a right is to also recognize the right of those who care to be cared for. And it is only in this ethical, political and social movement that it will be possible to guarantee the sustainability of care practices in the home context and promote justice and dignity to women who have carried, for centuries, the centrality of this invisible work.

REFERENCES

- Batista, C. F., Bandeira, M., & Oliveira, D. R. (2015). Fatores associados à sobrecarga subjetiva de homens e mulheres cuidadores de pacientes psiquiátricos. *Ciência & Saúde Coletiva*, 20(9), 2857–2866. <https://doi.org/10.1590/1413-81232015209.11162014>
- Bernardo, M. A. T. (2021). Mulheres, cuidado informal e a ideologia da invisibilização: Quem se importa? *Cadernos de Agroecologia*, 16(1).
- Conceição, H. N. da, et al. (2021). Perfil e sobrecarga dos cuidadores informais de idosos dependentes. *Research, Society and Development*, 10(6), Article e47210616061. <https://doi.org/10.33448/rsd-v10i6.16061>

- DeAngelis, R. T., & Ellison, C. G. (2017). Kept in His care: The role of perceived divine control in positive reappraisal coping. *Religions*, 8(8), Article 133. <https://doi.org/10.3390/rel8080133>
- Engels, F. (2000). *A origem da família, da propriedade privada e do Estado* (15ª ed.). Bertrand Brasil. (Trabalho original publicado em 1884)
- Federici, S. (2019). *O ponto zero da revolução: Trabalho doméstico, reprodução e luta feminista*. Elefante.
- Fonseca, C. (2000). *Família, fofoca e honra: Etnografia de relações de gênero e violência em grupos populares*. Editora da UFRGS.
- Gonçalves, L. H. T., et al. (2006). Perfil da família cuidadora de idoso doente/fragilizado do contexto sociocultural de Florianópolis, SC. *Texto & Contexto - Enfermagem*, 15(4), 570–577.
- Hennington, É. A. (2025). O trabalho de cuidados na agenda da saúde: Invisibilidade, sobrecarga e desgaste de mulheres trabalhadoras. *Saúde em Debate*, 49(spe2), Article e10430. <https://doi.org/10.1590/2358-28982025e10430>
- Kergoat, D. (2003). Divisão sexual do trabalho e relações sociais de sexo. In H. Hirata et al. (Eds.), *Dicionário crítico do feminismo* (pp. 55–56). UNESP.
- Koenig, H. G., Nelson, B., Shaw, S. F., et al. (2016). Religious involvement and adaptation in female family caregivers. *Journal of the American Geriatrics Society*, 64(3), 578–583. <https://doi.org/10.1111/jgs.13929>
- Lugones, M. (2019). Colonialidade de gênero. In H. B. Hollanda (Ed.), *Pensamento feminista: Conceitos fundamentais*. Bazar do Tempo.
- McGee, J. S., et al. (2024). Gratitude predicts meaning in life in family caregivers of persons with Alzheimer's disease. *Geriatrics*, 9(3), Article 72. <https://doi.org/10.3390/geriatrics9030072>
- Narvaz, M. G., & Koller, S. H. (2006). A família patriarcal e o papel social da mulher: Reflexões psicológicas. *Psicologia & Sociedade*, 18(1), 50–57.
- Pegoraro, R. F., & Caldana, R. H. L. (2008). Mulheres, loucura e cuidado: A condição da mulher na provisão e demanda por cuidados em saúde mental. *Saúde e Sociedade*, 17(2), 82–94. <https://doi.org/10.1590/S0104-12902008000200008>
- Saffioti, H. I. B. (2015). *Gênero, patriarcado, violência*. Fundação Perseu Abramo.
- Walby, S. (1990). *Theorizing patriarchy*. Basil Blackwell.

ORALITY IN CIVIL AND FAMILY PROCEDURAL MATTERS IN MEXICO: BRIEF REFLECTIONS ON THE PRINCIPLES GOVERNING IT IN THE NATIONAL CODE

A ORALIDADE EM MATÉRIA PROCESSUAL CIVIL E FAMILIAR NO MÉXICO: BREVES REFLEXÕES SOBRE OS PRINCÍPIOS QUE A REGEM NO CÓDIGO NACIONAL

LA ORALIDAD EN MATERIA PROCESAL CIVIL Y FAMILIAR EN MÉXICO. BREVES REFLEXIONES SOBRE LOS PRINCIPIOS QUE LA RIGEN EN EL CÓDIGO NACIONAL



<https://doi.org/10.56238/sevened2026.008-179>

Norma Dávila Cota¹

ABSTRACT

In Mexico, over approximately the last 20 years, oral procedures have progressively been developed in the conduct of jurisdictional processes in certain legal areas; in 2023, the National Code of Civil and Family Procedures was enacted, in which one of its main paradigms is the inclusion of orality as a form of expressing procedural acts; in order to provide a representative and panoramic understanding of the general criteria that guide judicial practice in these relevant matters, the aforementioned legal framework establishes 17 legal principles, which this paper seeks to review by relating them to the principles that guided proceedings under previous legislation and that have also been recognized in legal doctrine; the purpose of this document is to present a brief overview of the current principles, identifying their legal content and contrasting them with classical doctrinal and legal principles.

Keywords: Procedural Principles. Civil and Family Proceedings. National Code in Mexico.

RESUMO

No México, ao longo de aproximadamente os últimos 20 anos, vem sendo desenvolvida a forma oral na condução dos processos jurisdicionais em algumas matérias; em 2023 foi criado o Código Nacional de Procedimentos Cíveis e Familiares, no qual um de seus principais paradigmas é a inclusão da oralidade como forma de exteriorização dos atos processuais; para compreender de maneira representativa e panorâmica os critérios gerais que orientarão a prática dos julgamentos nessas relevantes matérias, o referido ordenamento jurídico estabelece 17 princípios legais, os quais este trabalho se propõe a revisar, relacionando-os com os princípios que orientaram os processos em legislações anteriores e que também foram considerados pela doutrina jurídica; pretende-se, neste documento, realizar um breve levantamento dos princípios atuais, identificando seu conteúdo legal e contrastando-os com

¹ Master's degree in Law. Universidad Autónoma de Baja California. México.
E-mail: dacnor@uabc.edu.mx Orcid: <https://orcid.org/0000-0002-2132-996X>

os princípios clássicos, tanto doutrinários quanto legais.

Palavras-chave: Princípios Processuais. Processos Cíveis e Familiares. Código Nacional do México.

RESUMEN

En México desde hace alrededor de 20 años a la fecha, se ha venido desarrollado la forma oral en la sustanciación de los procesos jurisdiccionales en algunas materias. En 2023 fue creado el Código Nacional de procedimientos Cíviles y Familiares, en el cual uno de sus principales paradigmas es el de la inclusión de esta forma de exteriorizar los actos procesales. Para conocer de forma representativa y panorámica los criterios generales que orientaran la práctica de los juicios en estas relevantes materias, se establecen 17 principios legales en citado ordenamiento, de los cuales en este escrito se pretende hacer una revisión, relacionándolos con los principios que han orientado a los procesos en leyes anteriores y que han sido considerados en la doctrina jurídica también. Es la intención en este documento, hacer un breve recuento de los principios actuales, identificando el contenido legal de los mismos, contrastándolos con los principios clásicos tanto doctrinales como legales.

Palabras clave: Principios Procesales. Juicios Cíviles y Familiares. Código Nacional en México.

1 INTRODUCTION

The oral form to develop the jurisdictional processes preponderantly is the way in which the acts that constitute each trial are externalized, being this mostly spoken and only exceptionally are some written aspects used.

Although the use of the oral form is not something new in the Mexican judicial system, it has been consolidating for some years, and is currently tending to be generalized in trials of all disciplines.

Criminal procedural matters were the ones that attracted the spotlight to orality and its benefits in Mexico, currently reaching civil and family matters that are of great breadth and social significance.

In this document we will recount the principles that legally support orality in civil and family trials in Mexico, identifying some contrasts with certain principles of predominantly written processes.

2 BACKGROUND

In the Mexican procedural codes that are about to conclude their validity, the predominant form of conducting jurisdictional proceedings was written, in which, although there were spoken proceedings, the rule was that the proceedings were recorded in writing.

Among other factors, this generated a kind of distancing of the judge, of losing immediacy of the proceedings and in many cases the trials were excessively delayed.

Concern was generated in the legal field to change paradigms and turn towards orality. Although there were processes that were developed orally such as labor processes, it was not the predominant trend.

It began with the legal modifications to institute orality in criminal proceedings, followed by other areas such as commercial and recently with the approval of the National Code, the civil and family disciplines.

Although there are guiding principles of the processes that are applicable to both ways of developing, there are some very specific ones for orality.

JUSTIFICATION:

As the predominant form of civil and family trials has changed in Mexico, it is necessary to study the principles that will govern them, that will continue to be applied and those that will constitute new paradigms for these trials, which are growing in number, since litigation, especially in family matters, has increased exponentially.

By identifying the guiding principles of orality, and contrasting them with those that existed for the written form, we will be able to understand the differences between them and

the advantages that oral trials can offer, trying to ensure that the processes can fulfill their objective of resolving controversies, imparting justice to those who claim it.

3 FUNDAMENTAL CONCEPTS

In jurisdictional processes, due to the way in which the acts that constitute them are predominantly carried out, it can be found that they are predominantly written or mostly oral.

As already mentioned, in Mexico for some years and increasingly, the oral form has been instituted and privileged for trials. To understand more clearly, let's look at some elements that characterize it in this context. According to Gordillo López (2022), orality "implies the performance of the main acts of the process through the living word, regardless of whether its content can be collected in written minutes, recordings or filming".

The publishing house Tirant en su aspect: formación (Tirant formación, 2023) considers that "orality and trial techniques play a crucial role in the presentation of arguments, convincing judges and the search for justice" "Through verbal expression, lawyers present their arguments, the parties involved present their testimonies (sic) and judges make informed decisions"

The author Landa Montaña (Landa, 2024) considers, based on the reasoning of the legislators, that orality in the National Code of Civil and Family Procedures is a pillar in the administration of justice "since through this pillar not only the faster and more effective delivery of justice would be achieved, making it more understandable for the citizen who is not a lawyer..."

It has been considered, both from the doctrinal and legislative perspective, that the oral form in the proceedings fosters better conditions for them to fulfill their function and truly resolve the dispute or controversy that is submitted to their opinion.

With the establishment of the preferably oral form, it is hoped that the processes will be more efficient, that time will be reduced and that the understanding of the decisions and, in general, the search for justice will be closer to the litigants.

The aforementioned author Landa Moreno makes an interesting point that is shared in this document, when he refers to the fact that the effectiveness of the processes and the overcoming of the problems or deficiencies that have arisen throughout history, does not lie exclusively in the form, in this case in orality, but in a set of factors that must be addressed for this important and ambitious, as a necessary objective. He mentions this because he believes that in Mexico, at least in the legislative reasoning, it has been taken for granted that, by establishing the oral form in trials, the inconveniences will be resolved.

Regarding the role of lawyers in this paradigm shift, it is logical to understand that there must be complements in their training, to help them develop and strengthen skills in the area of legal argumentation and oratory

3.1 PRINCIPLES THAT GOVERN THE JURISDICTIONAL PROCESS DEVELOPED ORALLY

The adjective matter, the judgments, are governed by a series of principles that guide them in their development. Some are issued by doctrine, by the theory elaborated by experts in the legal area, others are derived specifically from the regulations that regulate them.

In jurisdictional processes, certain maxims or paradigms known as principles are identified that guide and regulate in general the development of trials in order to respect aspects that are essential for the proper performance of the same.

In this paper we will focus on reviewing the guiding principles of oral procedure in civil matters in general and family matters in particular, which are defined in the National Code

For our purposes, we are going to identify the principles that are established in the National Code of Civil and Family Procedures of 2023 and that must enter into force throughout the country of Mexico no later than April 1, 2027, which bring together some classic guidelines with some new ones, according to the new paradigms that regulate these processes.

Article 7 of the aforementioned law identifies the procedural principles, let us deal with them, one by one, based on the legal concept and then some considerations of the author.

Article 7. The guiding principles of the system of administration of justice in civil and family matters are:

I. Access to justice. Any person has the right to go before the jurisdictional authority to formulate a specific legal claim of a family nature and the requested jurisdictional authority must provide on their requests;

In Mexico, article 17 of the Constitution establishes the system of administration of justice, by establishing the general guidelines for the prohibition of taking justice by each of the governed using violent means, including violent means, defining that it is the courts that are responsible for the administration of justice, in the case of jurisdictional proceedings and that therefore every person will have access to the courts so that justice can be administered.

The legal principle establishes its content specifically for the matters it regulates, in accordance with the provisions of the Magna Carta.

II. Concentration. Efforts shall be made to conduct the greatest number of procedural proceedings in a single hearing or the fewest procedural proceedings;

This principle is not new, nor are judgments conducted predominantly orally. One of the advantages, so to speak, of orality over written form is that it is feasible to shorten the duration of the proceedings, optimizing the proceedings, bringing together in fewer hearings a greater number of proceedings as long as they are of a similar nature and that they can be brought together.

III. Collaboration. The parties will be encouraged to resolve the conflict themselves at any stage of the procedure, therefore, the jurisdictional authorities will facilitate that they are the ones to put an end to the dispute through conciliatory agreements, except in those cases in which there is violent conduct in any of its forms, or where intransigent rights are discussed;

Although self-composition has always been regulated by the codes of civil procedure, this National Code privileges the ways in which the agreement can resolve the dispute, ending the trial early, in order to facilitate solutions. This is a very relevant paradigm since it strengthens self-composition within heterocomposition, establishing the appropriate limits.

We will have to see in the future, the effects that this strengthening generates, we will see if there are favorable conditions for faster and less cumbersome decisions to be made and procedural efficiency to be achieved.

IV. Continuity. The hearings shall be uninterrupted, exceptionally allowing their suspension in the cases established in this National Code;

This principle is very compatible with the principle of concentration, since they are aimed at making hearings more efficient, so that the immediacy between the parties and the judge is not reduced, so that time is optimized and more is achieved in less.

V. Contradiction. The parties have the right to discuss the facts, legal arguments and evidence of their counterpart, in the terms established in this National Code;

A fundamental issue in the development of jurisdictional proceedings is that which deals with this principle, of contradiction or adversarial as it has been known doctrinally for many years, since it refers to the protection of the right to defend oneself of the subjects, to contradict what has been established by the counterparty in a way that guarantees that they will have sufficient opportunity to say and enforce what is convenient to their right.

VI. Procedural Directorate. The management of the process is entrusted only to the jurisdictional authorities in the first or second instance, as the case may be

In civil matters, for a long time there were processes in which the procedural impulse corresponded almost exclusively to the parties, that is, the push, the movement, the progress of the trial, corresponded to the parties, in such a way that if they did not promote, the process could stagnate until it reaches its abnormal conclusion in extreme cases due to the expiration of the instance. It is important to highlight the responsibility that is currently given to the jurisdictional authority, that is, that it is not feasible for the processes to get bogged down, wasting the time of the participants and violating their rights, due to the procedural behavior of the parties, but that there is a state responsibility that is responsible for avoiding these undesired effects that contradict the search for justice.

This conception of the almost exclusive responsibility of the parties has been reversed and now, as section VI says, it will be the court that is responsible for the process moving forward and fulfilling its effects.

This is undoubtedly an important advance in the search for the efficiency of judicial processes, which must be carried out guaranteeing that the rights of individuals are respected and do not become (in general terms) at least a waste of time.

VII. Procedural Equality. From the initial statement of claim and until the execution of the judgment, people will receive the same treatment, opportunities, rights and procedural burdens without any discrimination. With the exceptions expressly established in this National Code, when the dispute involves the rights of children, adolescents and persons in social groups in vulnerable situations;

Equality is a concept that must be respected and presents specific issues in its development.

As Article 7, section VII, of the National Code clearly identifies, equality means that persons shall receive the same procedural treatment. However, in the section itself it is recognized that there will be exceptions when it comes to matters also established in the law.

Since ancient times, together with the difficulty of defining a value such as justice exactly, it has also been recognized that it is equally relevant to identify the differences between the members of the various human groups in order to give equal treatment to equals and unequal treatment to unequals, since it would be unfair to pretend to ignore the existing asymmetries for the sake of unrestricted equality.

In the thesis of the first chamber of the Supreme Court of Justice of the Nation 1ª/J55/2006, Ninth Epoch, with digital registration 174247, very relevant reasoning is established with respect to equality: "The principle of equality must be understood as the constitutional requirement to treat the unequal equally and the unequal unequal, hence on some occasions making distinctions will be prohibited, while on others it will be allowed or

even constitutionally required." It is stated in the thesis in question that when the Supreme Court of Justice of the Nation hears a matter in which this type of differentiation is made, such distinction must be based on an objective and reasonable basis, since otherwise it could constitute a discriminatory situation.

The principle of equality established in the National Code provides for exceptions to such similar treatment when the rights of children, adolescents and persons in vulnerable social groups are involved in the dispute, that is, seeking to create the conditions that will make it possible to achieve the balance that will make true equal and fair treatment possible.

VIII. Immediacy. Direct, personal and non-delegable contact of the jurisdictional authority with the parties and the evidence, except for the exceptions provided for in this National Code;

It is also a procedural paradigm that is also known as procedural immediacy, that is, the proximity of the judge to what is developed in the different stages of the procedure, gives rise to everything being known through the senses of the judge and not in a mediate, distant, perhaps incomplete way, as can happen in preponderantly written processes.

IX. Best interests of the child. Observance that must be given in order to ensure that the rights of children or adolescents prevail over the other rights that may be at stake in the litigation;

Although, as we have already mentioned, principles that guide and regulate the jurisdictional process are not of recent existence, the incorporation of maxims such as the best interests of the child as another procedural principle is a significant advance in achieving respect for the different rights of litigants.

The fact that it is in matters as sensitive as family matters that the need to guide actions and resolutions by this principle has been defined and included is an achievement of particular relevance for litigants, as well as for the entire national rule of law.

X. Procedural impulse. The parties have the power to request the necessary measures to prevent the suspension of the proceedings, regardless of the principle of procedural direction that corresponds to the jurisdictional authority;

An interesting combination of principles is made in the National Code. When commenting on section VI of Article 7, we mentioned that with the establishment of the Procedural Directorate, efforts are made to prevent the processes from ending up abandoned by the litigants until the expiration time arrives. However, the fact of assigning to the State, to

the jurisdictional body, the responsibility for the conduct and completion of the process, would seem to render null and void, eliminating the so-called procedural impulse of the parties, that is, what for a long time was known as that progress would be according to the impulse of the parties. Now, by combining the procedural conduct with the participation that the parties may have consisting of a kind of requirement to the authority, of a call to attention if it is visualized that the necessary measures are not being taken to avoid the paralysis of the process, it is very interesting, since all efforts are aimed at ensuring that the trials do not end up abandoned and on the contrary advance to their due conclusion. either by the exercise of heterocomposition or by some recognized means of self-composition.

XI. Procedural fairness. Those who participate in the process shall adjust their conduct to the dignity of justice, to the respect they owe to each other, to probity and good faith;

The jurisdictional process is an institution of good faith, where all the participating subjects must conduct themselves truthfully, honestly, without trying to make the judicial authority or the other subjects fall or keep in error.

This principle is preserved in the National Code, since for some time it has been recognized as a fundamental maxim in all jurisdictional processes, the need to conduct oneself truthfully.

Perhaps this is one of the most attacked principles in reality, since it has become a common practice for the subjects in a process, whatever type of participation, to carry out dishonest activities, use forged documents, offer statements that are not in line with reality, offer or receive gifts in order to compromise in practices that lack legality. however, those behaviors that violate this principle should never be tolerated, much less carried out.

XII. Open litis. In family matters, the litis is not limited to the claim and the response, or, as the case may be, to the counterclaim and the answer to it, but the jurisdictional authority must make merit of the constitutive, modifying or extinguishing facts, produced during the substantiation of the process and duly proven, even if they have not been invoked in a timely manner as new facts;

In the development of contentious trials, a procedural moment is always identified at some stage, where the litis is defined, that is, the scope of the controversy. Knowing exactly what the litis consists of, the conflict, what is alleged, the judge takes this as a basis and conducts the process, based on the premise of the determination of the litis. The National Code opens up a different possibility with the inclusion of this principle, which will mean that the litis can be modified or supplemented by the jurisdictional authority, even if the parties have not asserted these concepts.

It is important to emphasize that this principle is included exclusively for family matters, in order to achieve greater protection of rights and defenses in that area that regulates situations that are so sensitive and impactful to the lives of the participants.

XIII. Orality. The process shall be conducted in oral hearings, except for the exceptions provided for in this National Code and those which, in duly founded and reasoned cases, the jurisdictional authority considers;

As already mentioned in the first pages of this document, the way in which the constituent acts of the trials are externalized, they can preferably be oral or written. In Mexico, for years the trend towards the predominance of orality has been identified, due to the advantages that it can represent in speed, proximity, immediacy, efficiency, among other factors, that the processes, the hearings that make them up are carried out in this way.

XIV. Gender perspective. It is a scientific, analytical, and political view of women and men. It aims to eliminate the causes of gender oppression such as inequality, injustice and the hierarchization of people based on gender. Promotes substantive gender equality through the equity, advancement and well-being of women; contributes to building a society where women and men have equal value, equal rights and opportunities to access economic resources and political and social representation in decision-making spheres;

Just as the inclusion of the best interests of the child is a good thing, considering this principle of the gender perspective as necessary to observe and apply is highly relevant in order to ensure that the resolutions in the matters regulated by the National Code are more in line with reality and therefore more efficient in resolving the conflicts that have arisen for their resolution. It should result in the inclusion of a principle such as this, which is taken into account for judicial decisions, factors that were not necessarily considered previously.

XV. Preclusion. Failure to exercise procedural rights at the corresponding stage extinguishes the opportunity to exercise them at the subsequent stage;

The extinguishing figure of preclusion is one of the most recognized in the procedural field. They preclude procedural rights or powers by the combination between the inactivity or non-exercise of said powers and the passage of time. But the preclusion not only contemplates the extinction due to inactivity, but also terminates a procedural right when it has already been exercised and this is unrepeatable, generating that for this purpose the procedural power is also extinguished, not because it is not exercised, on the contrary, because it is consummated.

The principle established in this section XV refers only to the option of not exercising procedural powers in a timely manner, not identifying the other aspect of the figure of preclusion.

XVI. Privacy. In family matters, access to hearings is reserved for the parties and those who must appear in accordance with the law, and

XVII. Advertising. In civil matters, the hearings shall be public, in accordance with the provisions of this National Code, by the Laws on the Protection of Personal Data, Transparency and Access to Public Information, and other applicable laws in their respective areas of competence.

Because of the relationship between these two principles, we will deal with them together. The rule, let's say, is that it has always been considered that hearings must be public, establishing it as a procedural formality in the various adjective normative bodies. Likewise, exceptions to the public nature of hearings have been identified in certain topics and problems.

The National Code makes a very clear declaration, establishing that in family matters access to hearings will be restricted. It should be considered that by virtue of the sensitivity of family issues, the protection of the best interests of the child, among other factors, is that it is defined that in family matters hearings will break the generic principle of publicity.

4 CONCLUSION

Orality as a way of externalizing procedural acts has gained great presence in national territory in recent years. Although orality has always existed, expanding it to be the predominant form in matters of the most relevant such as the criminal and commercial spheres and now with the creation of the National Code of Civil and Family Procedures, these broad areas will substantiate their processes in a predominantly spoken way, defining a trend that seems to have no retreat in the country.

This procedural development or substantiation will be governed by the principles established in Article 7 of the National Code, of which we can identify some classic, pre-existing ones, such as preclusion, immediacy, continuity, contradiction, among others. Some more that show variants to what has traditionally been understood by them, imprinting different or complementary characteristics to civil and family proceedings, such as procedural impulse, publicity. There is one more category of principles that have no direct precedent in civil legislation as guiding paradigms for the development of trials and that come to establish new bases in these processes, although there was some recognition or mention of them in previous legislation, such as that of open litis for family matters or that of collaboration.

A world of possibilities opens up for civil and family matters in adjective matters with the entry into force of the National Code of Civil and Family Procedures, we will see its results in some time, hoping that it will be a determining element for the achievement of true procedural effectiveness in respect of the rights of the participants in the processes and the rule of law in Mexico.

REFERENCES

- Arellano García, C. (2015). General Theory of the Process (40th ed.). Porrúa.
- Chamber of Deputies of the Honorable Congress of the Union. (2023). National Code of Civil and Family Procedures. (Original publication DOF 07-06-2023; last amendment DOF 15-01-2026). <https://www.diputados.gob.mx/LeyesBiblio/pdf/CNPCF.pdf>
- Congress of the State of Baja California. (1995). Code of Civil Procedure for the State of Baja California. (Last amendment P.O. No. 55, Sect. IV, 30-11-2018). https://www.congresobc.gob.mx/Documentos/ProcesoParlamentario/Leyes/TOMO_IV/30112018_CODIPROCI.PDF
- Gordillo López, J. M. (2022). Orality in the legal system Mexico: An analysis through the doctrinal method. *Humanities & Innovation*, 9(17), 188–198. <https://revista.unitins.br/index.php/humanidadeseinovacao/article/view/8005>
- Landa Montaña, A. (n.d.). Orality in the National Code of Civil and Family Procedures. In *Boletín Jurídico Práctico* (No. 7). Escuela Libre de Derecho. <https://www.eld.edu.mx/Boletin-Juridico-Practico/Boletin-Juridico-7/Capitulos/4-La-oralidad-en-el-Codigo-Nacional-de-Procedimientos-Civiles-y-Familiares.pdf>
- Supreme Court of Justice of the Nation. (2006). Thesis 1ª/J.55/2006, digital record 174247. *Judicial Weekly of the Federation*, Ninth Epoch. <https://sjf2.scjn.gob.mx/detalle/tesis/174247>
- Sánchez Gil, R. (n.d.). Equality and proportionality. In UNAM Publication. <https://archivos.juridicas.unam.mx/www/bjv/libros/5/2422/11.pdf>
- Tirant Formation. (2023, June 14). Orality and Trial Techniques: The keys to legal success. <https://formacion.tirant.com/es/oralidad-tecnicas-juicio/>

The oral form to develop the jurisdictional processes preponderantly is the way in which the acts that constitute each trial are externalized, being this mostly spoken and only exceptionally are some written aspects used.

Although the use of the oral form is not something new in the Mexican judicial system, it has been consolidating for some years, and is currently tending to be generalized in trials of all disciplines.

Criminal procedural matters were the ones that attracted the spotlight to orality and its benefits in Mexico, currently reaching civil and family matters that are of great breadth and social significance.

In this document we will recount the principles that legally support orality in civil and family trials in Mexico, identifying some contrasts with certain principles of predominantly written processes.

2 BACKGROUND

In the Mexican procedural codes that are about to conclude their validity, the predominant form of conducting jurisdictional proceedings was written, in which, although there were spoken proceedings, the rule was that the proceedings were recorded in writing.

Among other factors, this generated a kind of distancing of the judge, of losing immediacy of the proceedings and in many cases the trials were excessively delayed.

Concern was generated in the legal field to change paradigms and turn towards orality. Although there were processes that were developed orally such as labor processes, it was not the predominant trend.

It began with the legal modifications to institute orality in criminal proceedings, followed by other areas such as commercial and recently with the approval of the National Code, the civil and family disciplines.

Although there are guiding principles of the processes that are applicable to both ways of developing, there are some very specific ones for orality.

JUSTIFICATION:

As the predominant form of civil and family trials has changed in Mexico, it is necessary to study the principles that will govern them, that will continue to be applied and those that will constitute new paradigms for these trials, which are growing in number, since litigation, especially in family matters, has increased exponentially.

By identifying the guiding principles of orality, and contrasting them with those that existed for the written form, we will be able to understand the differences between them and the advantages that oral trials can offer, trying to ensure that the processes can fulfill their objective of resolving controversies, imparting justice to those who claim it.

3 FUNDAMENTAL CONCEPTS

In jurisdictional processes, due to the way in which the acts that constitute them are predominantly carried out, it can be found that they are predominantly written or mostly oral.

As already mentioned, in Mexico for some years and increasingly, the oral form has been instituted and privileged for trials. To understand more clearly, let's look at some elements that characterize it in this context. According to Gordillo López (2022), orality "implies the performance of the main acts of the process through the living word, regardless of whether its content can be collected in written minutes, recordings or filming".

The publishing house Tirant en su aspect: formación (Tirant formación, 2023) considers that "orality and trial techniques play a crucial role in the presentation of arguments, convincing judges and the search for justice" "Through verbal expression, lawyers present their arguments, the parties involved present their testimonies (sic) and judges make informed decisions"

The author Landa Montaña (Landa, 2024) considers, based on the reasoning of the legislators, that orality in the National Code of Civil and Family Procedures is a pillar in the administration of justice "since through this pillar not only the faster and more effective delivery of justice would be achieved, making it more understandable for the citizen who is not a lawyer..."

It has been considered, both from the doctrinal and legislative perspective, that the oral form in the proceedings fosters better conditions for them to fulfill their function and truly resolve the dispute or controversy that is submitted to their opinion.

With the establishment of the preferably oral form, it is hoped that the processes will be more efficient, that time will be reduced and that the understanding of the decisions and, in general, the search for justice will be closer to the litigants.

The aforementioned author Landa Moreno makes an interesting point that is shared in this document, when he refers to the fact that the effectiveness of the processes and the overcoming of the problems or deficiencies that have arisen throughout history, does not lie exclusively in the form, in this case in orality, but in a set of factors that must be addressed for this important and ambitious, as a necessary objective. He mentions this because he believes that in Mexico, at least in the legislative reasoning, it has been taken for granted that, by establishing the oral form in trials, the inconveniences will be resolved.

Regarding the role of lawyers in this paradigm shift, it is logical to understand that there must be complements in their training, to help them develop and strengthen skills in the area of legal argumentation and oratory

3.1 PRINCIPLES THAT GOVERN THE JURISDICTIONAL PROCESS DEVELOPED ORALLY

The adjective matter, the judgments, are governed by a series of principles that guide them in their development. Some are issued by doctrine, by the theory elaborated by experts in the legal area, others are derived specifically from the regulations that regulate them.

In jurisdictional processes, certain maxims or paradigms known as principles are identified that guide and regulate in general the development of trials in order to respect aspects that are essential for the proper performance of the same.

In this paper we will focus on reviewing the guiding principles of oral procedure in civil matters in general and family matters in particular, which are defined in the National Code

For our purposes, we are going to identify the principles that are established in the National Code of Civil and Family Procedures of 2023 and that must enter into force throughout the country of Mexico no later than April 1, 2027, which bring together some classic guidelines with some new ones, according to the new paradigms that regulate these processes.

Article 7 of the aforementioned law identifies the procedural principles, let us deal with them, one by one, based on the legal concept and then some considerations of the author.

Article 7. The guiding principles of the system of administration of justice in civil and family matters are:

XVIII. Access to justice. Any person has the right to go before the jurisdictional authority to formulate a specific legal claim of a family nature and the requested jurisdictional authority must provide on their requests;

In Mexico, article 17 of the Constitution establishes the system of administration of justice, by establishing the general guidelines for the prohibition of taking justice by each of the governed using violent means, including violent means, defining that it is the courts that are responsible for the administration of justice, in the case of jurisdictional proceedings and that therefore every person will have access to the courts so that justice can be administered.

The legal principle establishes its content specifically for the matters it regulates, in accordance with the provisions of the Magna Carta.

XIX. Concentration. Efforts shall be made to conduct the greatest number of procedural proceedings in a single hearing or the fewest procedural proceedings;

This principle is not new, nor are judgments conducted predominantly orally. One of the advantages, so to speak, of orality over written form is that it is feasible to shorten the duration of the proceedings, optimizing the proceedings, bringing together in fewer

hearings a greater number of proceedings as long as they are of a similar nature and that they can be brought together.

XX. Collaboration. The parties will be encouraged to resolve the conflict themselves at any stage of the procedure, therefore, the jurisdictional authorities will facilitate that they are the ones to put an end to the dispute through conciliatory agreements, except in those cases in which there is violent conduct in any of its forms, or where intransigent rights are discussed;

Although self-composition has always been regulated by the codes of civil procedure, this National Code privileges the ways in which the agreement can resolve the dispute, ending the trial early, in order to facilitate solutions. This is a very relevant paradigm since it strengthens self-composition within heterocomposition, establishing the appropriate limits.

We will have to see in the future, the effects that this strengthening generates, we will see if there are favorable conditions for faster and less cumbersome decisions to be made and procedural efficiency to be achieved.

XXI. Continuity. The hearings shall be uninterrupted, exceptionally allowing their suspension in the cases established in this National Code;

This principle is very compatible with the principle of concentration, since they are aimed at making hearings more efficient, so that the immediacy between the parties and the judge is not reduced, so that time is optimized and more is achieved in less.

XXII. Contradiction. The parties have the right to discuss the facts, legal arguments and evidence of their counterpart, in the terms established in this National Code;

A fundamental issue in the development of jurisdictional proceedings is that which deals with this principle, of contradiction or adversarial as it has been known doctrinally for many years, since it refers to the protection of the right to defend oneself of the subjects, to contradict what has been established by the counterparty in a way that guarantees that they will have sufficient opportunity to say and enforce what is convenient to their right.

XXIII. Procedural Directorate. The management of the process is entrusted only to the jurisdictional authorities in the first or second instance, as the case may be

In civil matters, for a long time there were processes in which the procedural impulse corresponded almost exclusively to the parties, that is, the push, the movement, the progress of the trial, corresponded to the parties, in such a way that if they did not promote, the process could stagnate until it reaches its abnormal conclusion in extreme cases due to the expiration of the instance. It is important to highlight the responsibility that is currently given to the

jurisdictional authority, that is, that it is not feasible for the processes to get bogged down, wasting the time of the participants and violating their rights, due to the procedural behavior of the parties, but that there is a state responsibility that is responsible for avoiding these undesired effects that contradict the search for justice.

This conception of the almost exclusive responsibility of the parties has been reversed and now, as section VI says, it will be the court that is responsible for the process moving forward and fulfilling its effects.

This is undoubtedly an important advance in the search for the efficiency of judicial processes, which must be carried out guaranteeing that the rights of individuals are respected and do not become (in general terms) at least a waste of time.

XXIV. Procedural Equality. From the initial statement of claim and until the execution of the judgment, people will receive the same treatment, opportunities, rights and procedural burdens without any discrimination. With the exceptions expressly established in this National Code, when the dispute involves the rights of children, adolescents and persons in social groups in vulnerable situations;

Equality is a concept that must be respected and presents specific issues in its development.

As Article 7, section VII, of the National Code clearly identifies, equality means that persons shall receive the same procedural treatment. However, in the section itself it is recognized that there will be exceptions when it comes to matters also established in the law.

Since ancient times, together with the difficulty of defining a value such as justice exactly, it has also been recognized that it is equally relevant to identify the differences between the members of the various human groups in order to give equal treatment to equals and unequal treatment to unequals, since it would be unfair to pretend to ignore the existing asymmetries for the sake of unrestricted equality.

In the thesis of the first chamber of the Supreme Court of Justice of the Nation 1ª/J55/2006, Ninth Epoch, with digital registration 174247, very relevant reasoning is established with respect to equality: "The principle of equality must be understood as the constitutional requirement to treat the unequal equally and the unequal unequal, hence on some occasions making distinctions will be prohibited, while on others it will be allowed or even constitutionally required." It is stated in the thesis in question that when the Supreme Court of Justice of the Nation hears a matter in which this type of differentiation is made, such distinction must be based on an objective and reasonable basis, since otherwise it could constitute a discriminatory situation.

The principle of equality established in the National Code provides for exceptions to such similar treatment when the rights of children, adolescents and persons in vulnerable social groups are involved in the dispute, that is, seeking to create the conditions that will make it possible to achieve the balance that will make true equal and fair treatment possible.

XXV. Immediacy. Direct, personal and non-delegable contact of the jurisdictional authority with the parties and the evidence, except for the exceptions provided for in this National Code;

It is also a procedural paradigm that is also known as procedural immediacy, that is, the proximity of the judge to what is developed in the different stages of the procedure, gives rise to everything being known through the senses of the judge and not in a mediate, distant, perhaps incomplete way, as can happen in preponderantly written processes.

XXVI. Best interests of the child. Observance that must be given in order to ensure that the rights of children or adolescents prevail over the other rights that may be at stake in the litigation;

Although, as we have already mentioned, principles that guide and regulate the jurisdictional process are not of recent existence, the incorporation of maxims such as the best interests of the child as another procedural principle is a significant advance in achieving respect for the different rights of litigants.

The fact that it is in matters as sensitive as family matters that the need to guide actions and resolutions by this principle has been defined and included is an achievement of particular relevance for litigants, as well as for the entire national rule of law.

XXVII. Procedural impulse. The parties have the power to request the necessary measures to prevent the suspension of the proceedings, regardless of the principle of procedural direction that corresponds to the jurisdictional authority;

An interesting combination of principles is made in the National Code. When commenting on section VI of Article 7, we mentioned that with the establishment of the Procedural Directorate, efforts are made to prevent the processes from ending up abandoned by the litigants until the expiration time arrives. However, the fact of assigning to the State, to the jurisdictional body, the responsibility for the conduct and completion of the process, would seem to render null and void, eliminating the so-called procedural impulse of the parties, that is, what for a long time was known as that progress would be according to the impulse of the parties. Now, by combining the procedural conduct with the participation that the parties may

have consisting of a kind of requirement to the authority, of a call to attention if it is visualized that the necessary measures are not being taken to avoid the paralysis of the process, it is very interesting, since all efforts are aimed at ensuring that the trials do not end up abandoned and on the contrary advance to their due conclusion. either by the exercise of heterocomposition or by some recognized means of self-composition.

XXVIII. Procedural fairness. Those who participate in the process shall adjust their conduct to the dignity of justice, to the respect they owe to each other, to probity and good faith;

The jurisdictional process is an institution of good faith, where all the participating subjects must conduct themselves truthfully, honestly, without trying to make the judicial authority or the other subjects fall or keep in error.

This principle is preserved in the National Code, since for some time it has been recognized as a fundamental maxim in all jurisdictional processes, the need to conduct oneself truthfully.

Perhaps this is one of the most attacked principles in reality, since it has become a common practice for the subjects in a process, whatever type of participation, to carry out dishonest activities, use forged documents, offer statements that are not in line with reality, offer or receive gifts in order to compromise in practices that lack legality. however, those behaviors that violate this principle should never be tolerated, much less carried out.

XXIX. Open litis. In family matters, the litis is not limited to the claim and the response, or, as the case may be, to the counterclaim and the answer to it, but the jurisdictional authority must make merit of the constitutive, modifying or extinguishing facts, produced during the substantiation of the process and duly proven, even if they have not been invoked in a timely manner as new facts;

In the development of contentious trials, a procedural moment is always identified at some stage, where the litis is defined, that is, the scope of the controversy. Knowing exactly what the litis consists of, the conflict, what is alleged, the judge takes this as a basis and conducts the process, based on the premise of the determination of the litis. The National Code opens up a different possibility with the inclusion of this principle, which will mean that the litis can be modified or supplemented by the jurisdictional authority, even if the parties have not asserted these concepts.

It is important to emphasize that this principle is included exclusively for family matters, in order to achieve greater protection of rights and defenses in that area that regulates situations that are so sensitive and impactful to the lives of the participants.

XXX. Orality. The process shall be conducted in oral hearings, except for the exceptions provided for in this National Code and those which, in duly founded and reasoned cases, the jurisdictional authority considers;

As already mentioned in the first pages of this document, the way in which the constituent acts of the trials are externalized, they can preferably be oral or written. In Mexico, for years the trend towards the predominance of orality has been identified, due to the advantages that it can represent in speed, proximity, immediacy, efficiency, among other factors, that the processes, the hearings that make them up are carried out in this way.

XXXI. Gender perspective. It is a scientific, analytical, and political view of women and men. It aims to eliminate the causes of gender oppression such as inequality, injustice and the hierarchization of people based on gender. Promotes substantive gender equality through the equity, advancement and well-being of women; contributes to building a society where women and men have equal value, equal rights and opportunities to access economic resources and political and social representation in decision-making spheres;

Just as the inclusion of the best interests of the child is a good thing, considering this principle of the gender perspective as necessary to observe and apply is highly relevant in order to ensure that the resolutions in the matters regulated by the National Code are more in line with reality and therefore more efficient in resolving the conflicts that have arisen for their resolution. It should result in the inclusion of a principle such as this, which is taken into account for judicial decisions, factors that were not necessarily considered previously.

XXXII. Preclusion. Failure to exercise procedural rights at the corresponding stage extinguishes the opportunity to exercise them at the subsequent stage;

The extinguishing figure of preclusion is one of the most recognized in the procedural field. They preclude procedural rights or powers by the combination between the inactivity or non-exercise of said powers and the passage of time. But the preclusion not only contemplates the extinction due to inactivity, but also terminates a procedural right when it has already been exercised and this is unrepeatable, generating that for this purpose the procedural power is also extinguished, not because it is not exercised, on the contrary, because it is consummated.

The principle established in this section XV refers only to the option of not exercising procedural powers in a timely manner, not identifying the other aspect of the figure of preclusion.

XXXIII. Privacy. In family matters, access to hearings is reserved for the parties and those who must appear in accordance with the law, and

XXXIV. Advertising. In civil matters, the hearings shall be public, in accordance with the provisions of this National Code, by the Laws on the Protection of Personal Data, Transparency and Access to Public Information, and other applicable laws in their respective areas of competence.

Because of the relationship between these two principles, we will deal with them together. The rule, let's say, is that it has always been considered that hearings must be public, establishing it as a procedural formality in the various adjective normative bodies. Likewise, exceptions to the public nature of hearings have been identified in certain topics and problems.

The National Code makes a very clear declaration, establishing that in family matters access to hearings will be restricted. It should be considered that by virtue of the sensitivity of family issues, the protection of the best interests of the child, among other factors, is that it is defined that in family matters hearings will break the generic principle of publicity.

4 CONCLUSION

Orality as a way of externalizing procedural acts has gained great presence in national territory in recent years. Although orality has always existed, expanding it to be the predominant form in matters of the most relevant such as the criminal and commercial spheres and now with the creation of the National Code of Civil and Family Procedures, these broad areas will substantiate their processes in a predominantly spoken way, defining a trend that seems to have no retreat in the country.

This procedural development or substantiation will be governed by the principles established in Article 7 of the National Code, of which we can identify some classic, pre-existing ones, such as preclusion, immediacy, continuity, contradiction, among others. Some more that show variants to what has traditionally been understood by them, imprinting different or complementary characteristics to civil and family proceedings, such as procedural impulse, publicity. There is one more category of principles that have no direct precedent in civil legislation as guiding paradigms for the development of trials and that come to establish new bases in these processes, although there was some recognition or mention of them in previous legislation, such as that of open litis for family matters or that of collaboration.

A world of possibilities opens up for civil and family matters in adjective matters with the entry into force of the National Code of Civil and Family Procedures, we will see its results in some time, hoping that it will be a determining element for the achievement of true procedural effectiveness in respect of the rights of the participants in the processes and the rule of law in Mexico.

REFERENCES

- Arellano García, C. (2015). *Teoría general del proceso* (40ª ed.). Porrúa.
- Cámara de Diputados del H. Congreso de la Unión. (2023). Código Nacional de Procedimientos Civiles y Familiares. (Publicación original DOF 07-06-2023; última reforma DOF 15-01-2026). <https://www.diputados.gob.mx/LeyesBiblio/pdf/CNPCF.pdf>
- Congreso del Estado de Baja California. (1995). Código de Procedimientos Civiles para el Estado de Baja California. (Última reforma P. O. No. 55, Secc. IV, 30-11-2018). https://www.congresobc.gob.mx/Documentos/ProcesoParlamentario/Leyes/TOMO_IV/30112018_CODIPROCI.PDF
- Gordillo López, J. M. (2022). La oralidad en el sistema jurídico México: Un análisis a través del método doctrinal. *Humanidades & Inovação*, 9(17), 188–198. <https://revista.unitins.br/index.php/humanidadeseinovacao/article/view/8005>
- Landa Montaña, A. (s.f.). La oralidad en el Código Nacional de Procedimientos Civiles y Familiares. En *Boletín Jurídico Práctico* (No. 7). Escuela Libre de Derecho. <https://www.eld.edu.mx/Boletin-Juridico-Practico/Boletin-Juridico-7/Capitulos/4-La-oralidad-en-el-Codigo-Nacional-de-Procedimientos-Civiles-y-Familiares.pdf>
- Suprema Corte de Justicia de la Nación. (2006). Tesis 1ª/J.55/2006, registro digital 174247. *Semanario Judicial de la Federación*, Novena Época. <https://sjf2.scjn.gob.mx/detalle/tesis/174247>
- Sánchez Gil, R. (s.f.). Igualdad y proporcionalidad. En *Publicación de la UNAM*. <https://archivos.juridicas.unam.mx/www/bjv/libros/5/2422/11.pdf>
- Tirant Formación. (2023, 14 de junio). Oralidad y Técnicas de Juicio: Las claves para el éxito legal. <https://formacion.tirant.com/es/oralidad-tecnicas-juicio/>

**DYNAMICS OF FAMILY PARTICIPATION AND SCHOOL LEARNING:
QUALITATIVE ANALYSIS OF TEACHING PERCEPTIONS IN THE STATE
PUBLIC NETWORK OF AMAZONAS**

**DINÂMICAS DE PARTICIPAÇÃO FAMILIAR E APRENDIZAGEM ESCOLAR:
ANÁLISE QUALITATIVA DAS PERCEPÇÕES DOCENTES NA REDE PÚBLICA
ESTADUAL DO AMAZONAS**

**DINÁMICA DE LA PARTICIPACIÓN FAMILIAR Y EL APRENDIZAJE ESCOLAR:
UN ANÁLISIS CUALITATIVO DE LAS PERCEPCIONES DE LOS DOCENTES
EN EL SISTEMA DE ESCUELAS PÚBLICAS DEL ESTADO DE AMAZONAS**



<https://doi.org/10.56238/sevened2026.008-180>

Antonio Carlos Cortez Pinheiro¹

ABSTRACT

This article analyzes teachers' perceptions regarding the Family-school relationship within the context of public schooling, considering the normative, structural, and symbolic dimensions that permeate this interface. It is grounded in the recognition that family participation is widely advocated in educational policies; however, its implementation in everyday school life reveals challenges associated with social inequalities and institutional mediations. The objective is to understand how teachers interpret family participation in the teaching-learning process, seeking to identify the limits and possibilities of this articulation. A qualitative approach of a descriptive-analytical nature was adopted, using a questionnaire composed of open-ended questions and documentary analysis of institutional records. The data were examined through content analysis, enabling the construction of interpretative categories related to teachers' understandings of participation, inequality, and pedagogical practices. The results indicate that, although teachers acknowledge the importance of family presence for students' academic development, participation is still frequently associated with formal practices, such as attending meetings and monitoring academic performance. Socioeconomic factors that condition family involvement are also evident, as well as symbolic tensions that influence teachers representations. It is concluded that strengthening the family-school relationship requires dialogical and contextualized pedagogical strategies capable of moving beyond a merely normative perspective and promoting effective collaboration within the school environment.

Keywords: Family-School Relationship. Pedagogical Practice. Teachers' Perceptions. Family Participation. School Learning.

RESUMO

Este artigo analisa as percepções docentes acerca da relação família-escola no contexto da escola pública, considerando as dimensões normativa, estrutural e simbólica que

¹ Doctoral student in Educational Sciences. Universidad de la Integración de Las Américas (UNIDA). Paraguay. E-mail: antonio.carlos.pinheiro@prof.am.gov.br

atravessam essa interface. Parte-se do reconhecimento de que a participação familiar é amplamente defendida nas políticas educacionais, mas sua efetivação no cotidiano escolar revela desafios associados às desigualdades sociais e às mediações institucionais. O objetivo consiste em compreender como professores interpretam a participação das famílias no processo de ensino-aprendizagem, buscando identificar limites e possibilidades dessa articulação. Adota-se abordagem qualitativa, de natureza descritivo-analítica, com aplicação de questionário composto por questões abertas e análise documental de registros institucionais. Os dados foram examinados por meio da análise de conteúdo, permitindo a construção de categorias interpretativas relacionadas à compreensão docente sobre participação, desigualdade e práticas pedagógicas. Os resultados indicam que, embora os professores reconheçam a importância da presença familiar para o desenvolvimento acadêmico dos estudantes, a participação ainda é frequentemente associada a práticas formais, como comparecimento a reuniões e acompanhamento do rendimento escolar. Evidenciam-se também fatores socioeconômicos que condicionam o envolvimento das famílias, bem como tensões simbólicas que influenciam as representações docentes. Conclui-se que o fortalecimento da relação família-escola demanda estratégias pedagógicas dialógicas e contextualizadas, capazes de superar a perspectiva meramente normativa e promover efetiva colaboração no ambiente escolar.

Palavras-chave: Relação Família-Escola. Prática Pedagógica. Percepções Docentes. Participação Familiar. Aprendizagem Escolar.

RESUMEN

Este artículo analiza las percepciones del profesorado sobre la relación familia-escuela en el contexto de las escuelas públicas, considerando las dimensiones normativas, estructurales y simbólicas que permean esta interfaz. Se parte del reconocimiento de que la participación familiar es ampliamente defendida en las políticas educativas, pero su implementación en la vida escolar cotidiana revela desafíos asociados a las desigualdades sociales y las mediaciones institucionales. El objetivo es comprender cómo el profesorado interpreta la participación familiar en el proceso de enseñanza-aprendizaje, buscando identificar los límites y las posibilidades de esta articulación. Se adopta un enfoque cualitativo, descriptivo-analítico, mediante un cuestionario compuesto por preguntas abiertas y análisis documental de registros institucionales. Los datos se examinaron mediante análisis de contenido, lo que permitió la construcción de categorías interpretativas relacionadas con la comprensión del profesorado sobre la participación, la desigualdad y las prácticas pedagógicas. Los resultados indican que, si bien el profesorado reconoce la importancia de la presencia familiar para el desarrollo académico de los estudiantes, la participación aún se asocia frecuentemente con prácticas formales, como la asistencia a reuniones y el seguimiento del rendimiento académico. También se evidencian factores socioeconómicos que condicionan la participación familiar, así como tensiones simbólicas que influyen en las representaciones del profesorado. Se concluye que fortalecer la relación familia-escuela exige estrategias pedagógicas dialógicas y contextualizadas, capaces de superar una perspectiva meramente normativa y promover una colaboración eficaz en el entorno escolar.

Palabras clave: Relación Familia-Escuela. Práctica Pedagógica. Percepciones Docentes. Participación Familiar. Aprendizaje Escolar.

1 INTRODUCTION

The relationship between family and school has occupied a central position in the contemporary educational debate, especially in the context of public policies aimed at democratic management and the improvement of the quality of education. Although the normative documents recognize the importance of family participation, its effectiveness in the school routine still reveals significant challenges. In this context, understanding how this interface is configured in practice becomes a relevant issue for educational research.

In the scenario of the Brazilian public school, marked by persistent social inequalities, the articulation between these two formative spaces takes on complex contours. Family participation is not homogeneous, being influenced by cultural, economic and institutional factors that impact school dynamics. Thus, discussing this relationship implies recognizing that it goes beyond the formal dimension and is inserted in a relational field crossed by tensions and mutual expectations.

In addition, valuing the family as a partner in the educational process demands a critical analysis of the concrete conditions that sustain this partnership. Between the democratic ideal provided for in educational policies and the practices effectively developed in schools, there is a space for mediation that deserves systematic investigation. It is in this interval between normativity and lived experience that the scientific relevance of this study is inscribed.

Although the participation of the family is widely defended in the pedagogical discourse and supported by legal provisions, it is observed that its materialization in the school daily life occurs unevenly and sometimes limited to formal practices. Such a scenario raises questions about how this relationship is perceived by teachers, subjects who mediate, within the school, interactions with families. Thus, the need emerges to problematize not only the existence of participation, but the meanings attributed to it in the institutional context.

In this sense, the gap that guides this study lies in the understanding of teachers' perceptions about the family-school interface in a specific reality of public schools. Investigating such perceptions allows us to analyze how normativity, social inequalities and professional experiences are intertwined in the construction of this relationship. By shifting the focus from the legal prescription to the interpretation of the subjects, the article contributes to deepening the academic debate on democratic management and educational policies.

Thus, this study aims to analyze teachers' perceptions about the family-school relationship in the context of public schools, in the light of the normative, structural and symbolic dimensions that cross this interface. To this end, it adopts a qualitative approach, with the application of a questionnaire and document analysis, interpreted through content

analysis. By articulating theoretical framework, empirical data and critical reflection, the article seeks to contribute to the deepening of the debate on family participation and democratic management, highlighting possibilities and limits of this relationship in the educational scenario investigated.

2 THE FAMILY-SCHOOL INTERFACE AS A STRUCTURING DIMENSION OF THE EDUCATIONAL PROCESS

Historically, the family and the school are configured as central instances in the process of socialization and formation of the subjects. While the family occupies the primary space for the construction of values, norms and symbolic references, the school assumes the function of systematizing knowledge and promoting the insertion of the individual in broader social structures. This complementarity, however, is not established automatically or harmoniously, as both institutions are crossed by social, economic and cultural transformations that continuously redefine their roles and responsibilities in the educational field.

Over the last decades, it has been observed that a conception that attributed rigidly delimited functions to the family and the school has been overcome, emerging, in its place, the notion of educational co-responsibility. This perspective recognizes that the teaching-learning process is not restricted to the school space, but depends on interactions and mediations that go beyond its institutional walls. In this scenario, understanding how this interface is constructed and perceived by teachers becomes fundamental to analyze the dynamics that influence the pedagogical daily life and the formative experience of students.

The interface between family and school, in addition to constituting a historically constructed social dynamic, finds normative support in Brazilian educational public policies, which recognize family participation as a structuring element of the formative process. The legal provisions and educational guidelines reinforce the idea of democratic management and approximation between school and community, attributing to the family an active role in monitoring the students' school trajectory. However, the materialization of these guidelines occurs in contexts marked by social inequalities, structural limitations, and institutional challenges, which stresses the effectiveness of this participation. In this scenario, the relationship between normativity and practice reveals itself to be a fertile field for analysis, especially when observed from the teachers' perceptions about its materialization in the school routine.

In the contemporary context, the participation of the family in the school space takes on different configurations, which go beyond the mere presence in formal meetings or

institutional events. It can manifest itself through the monitoring of school activities, constant dialogue with teachers and the construction of bonds to support the students' educational path. However, such forms of engagement are crossed by social, economic and cultural constraints that influence the real possibilities of participation, especially in public education networks. Thus, understanding these configurations implies recognizing that the family-school relationship is neither homogeneous nor linear, but marked by inequalities and different expectations regarding the educational task, elements that directly affect the pedagogical routine.

In this context, teachers occupy a strategic position in the mediation between institutional guidelines and the reality experienced in the school, and are also producers of meanings about family participation. Their perceptions are not limited to the verification of the presence or absence of families, but involve interpretations about the commitment, duties and effects of this interaction in the pedagogical routine. By translating policies into concrete practices, teachers build representations that influence both the dialogue with the community and the organization of educational work. Thus, analyzing these perceptions allows us to understand how the family-school interface is signified within the public school and how such meanings have repercussions on the teaching-learning dynamics.

Thus, the interface between family and school, understood in its historical, normative and relational dimensions, reveals itself to be a relevant element for understanding the teaching-learning process in public schools. Teachers' perceptions, situated in this intersection of institutional expectations and concrete social conditions, show that the **sharing of educational responsibilities** is not effective automatically, but depends on continuous and contextualized mediations. Thus, investigating such perceptions allows us to problematize the meanings attributed to family participation and its implications in the pedagogical routine, grounding the empirical analysis that follows.

2.1 THEORETICAL PERSPECTIVES ON THE FAMILY-SCHOOL RELATIONSHIP BEYOND THE NORMATIVE FRAMEWORKS

The educational literature has broadened the debate on the family-school relationship beyond the normative provision contained in official documents, understanding it as a complex and historically situated social phenomenon. For Paro (2000, p. 16), the participation of the family in the school cannot be understood as a mere administrative formality, because "education is a social process that goes beyond the limits of the school institution". This perspective shifts the focus from the legal obligation to the relational and political dimension of the interaction between these formative instances.

From another perspective, Bourdieu (1998, p. 42) argues that school inequalities cannot be dissociated from the social conditions of origin of the students, since the school tends to recognize and value certain cultural capitals to the detriment of others. In this sense, the approximation between family and school is crossed by structural asymmetries that influence both the forms of participation and the expectations built around school performance.

In addition, authors such as Libâneo (2013, p. 84) emphasize that the articulation between school and community is a fundamental dimension of democratic management, but warn that such articulation requires consistent pedagogical and institutional mediations. For the author, "participation is not reduced to physical presence, but implies conscious involvement in educational processes". Thus, the academic discussion shows that the family-school interface demands analysis that considers both the social conditioning factors and the representations constructed within the school itself.

2.2 OVERCOMING THE NORMATIVE READING OF FAMILY PARTICIPATION

The academic discussion on the family-school relationship, as developed in the dissertation, indicates that family participation cannot be reduced to compliance with legal provisions or occasional presence at school meetings. The text emphasizes that "the role related to education is not limited to participating in class meetings to deliver report cards", showing that the interaction between these instances requires deeper and more continuous involvement. Thus, the literature analyzed shifts the focus from institutional formality to the construction of effective bonds in the educational routine.

In this sense, Sousa (2012, p. 6) states that "the participation of the family in the school environment is fundamental in the teaching-learning process", highlighting that family and school are essential supports for coping with school difficulties. The dissertation reinforces that such participation should not be understood as an isolated act, but as an articulated process that allows the school to know the student's context and plan more consistent pedagogical interventions. It is, therefore, a matter of understanding participation as a structuring element of the educational process.

The analysis also dialogues with Díaz (2011, p. 35), when he argues that learning is consolidated when there is a significant internalization of knowledge, with the family environment being a privileged space for affective and motivational stimulation. By recognizing that the influence of the family enhances student development, the study broadens the debate beyond the normative obligation, emphasizing the formative and emotional dimension of family accompaniment in the school path.

Finally, the dissertation recognizes, based on Caetano (2009, p. 54), that the "relationship between school and family [...] it is complex, asymmetrical and usually permeated by conflicts". This understanding moves away from any idealized or simplistic view of participation and reinforces the need for permanent institutional mediations. Thus, overcoming the exclusively legalistic reading implies recognizing that the family-school articulation is built in the midst of tensions, negotiations and mutual expectations, a central aspect for the analysis of the teachers' perceptions investigated in this study.

2.3 CULTURAL CAPITAL, INEQUALITIES AND IMPLICATIONS FOR THE FAMILY-SCHOOL RELATIONSHIP

The family-school relationship, as discussed in the dissertation, cannot be understood in a decontextualized way, as it is immersed in social conditioning factors that directly influence the possibilities of participation. Sousa (2012) highlights that the family plays a structuring role in educational development, but recognizes that this influence is crossed by socioeconomic variables that impact school monitoring. Thus, family participation must be analyzed in the light of concrete living conditions, under penalty of incurring in normative judgments that ignore historical inequalities.

In this sense, Díaz (2011, p. 35) states that meaningful learning occurs when the subject is able to "internalize knowledge in a comprehensive and reflective dimension". However, this internalization does not depend exclusively on the school, being influenced by the family environment and the cultural opportunities to which the student has access. The dissertation shows that the cultural capital available in families has repercussions on the forms of interaction with the school, interfering both in student performance and in the teacher's perception of parental involvement.

The analysis also dialogues with Pereira and Novo (2015), when they recognize that the approximation between family and school requires recognition of the sociocultural specificities of each community. When the school operates based on homogeneous expectations of participation, it tends to disregard the different family repertoires, producing symbolic distances. In this way, inequality is not only manifested in the economic sphere, but also in the way certain modes of participation are institutionally legitimized.

Caetano (2009, p. 54) reinforces this understanding by stating that the relationship between family and school is "complex, asymmetrical and usually permeated by conflicts". Such conflicts should not be interpreted as individual failures, but as an expression of structural tensions that cross the educational field. The dissertation demonstrates that, in

contexts of social vulnerability, the school needs to adopt mediation strategies that consider the material and symbolic limitations faced by families.

Thus, the theoretical debate shows that family participation is not a uniform or linear phenomenon, but the result of the interaction between cultural capital, socioeconomic conditions and institutional expectations. By broadening the view to these dimensions, the study strengthens the analysis of teachers' perceptions, allowing us to understand that the meanings attributed to the presence – or absence – of families are constructed in a social scenario marked by inequalities. Such an approach gives greater interpretative density to the article and underpins the empirical analysis that follows.

2.4 FACULTY REPRESENTATIONS AND SYMBOLIC CONSTRUCTION OF PARTICIPATION

Recent literature has emphasized that the family-school relationship is mediated by interpretations constructed in the school routine, especially by teachers' perceptions about the role of families in the educational process. For Libâneo (2018), pedagogical practice is permeated by conceptions that guide the way the teacher understands the student's social context, influencing the strategies of approximation with the community. From this perspective, family participation is not configured as objective data, but as a symbolic construction that materializes in institutional interactions.

Contemporary studies also point out that teacher representations are strongly influenced by the structural conditions of the public school. Nóvoa (2017) highlights that the teaching work takes place in a scenario of multiple demands and institutional pressures, which impacts the way the teacher interprets parental involvement. In addition, Dourado (2019) argues that democratic management presupposes effective dialogue with families, but this dialogue depends on formative mediations that overcome stigmatized views of the school community.

In the field of educational inequalities, recent research indicates that teachers' expectations can be followed by social markers. Oliveira (2020) argues that perceptions about family participation vary according to the socioeconomic context of the students, influencing the way the school recognizes certain forms of monitoring. In a convergent way, Carvalho (2018) states that family-school interaction needs to be analyzed as a relational process, marked by tensions and symbolic negotiations that reflect broader social dynamics.

In addition, contemporary literature has emphasized the importance of qualified listening to families as a strategy for institutional strengthening. Paro (2016) reaffirms that participation is a democratic principle that requires real openness to collaboration, while Gatti

(2019) highlights that teacher training should include skills for dialogue with different sociocultural realities. These contributions reinforce that teachers' representations are not neutral, but constructed throughout their professional trajectory and experiences at school.

Finally, understanding the symbolic construction of family participation implies recognizing that the meanings attributed to the presence - or absence - of families are produced in a specific historical and social context. Libâneo (2018) and Dourado (2019) converge in stating that the consolidation of a democratic school requires overcoming reductionist views on the role of the family. In this sense, analyzing teachers' perceptions becomes fundamental to understand how the possibilities and limits of the articulation between family and school are structured in school practice, a central aspect for the objectives of this study.

2.5 CONTEMPORARY CHALLENGES AND IMPLICATIONS FOR THE ANALYSIS OF TEACHER PERCEPTIONS

Contemporary literature shows that the consolidation of an effective relationship between family and school remains a challenge in the Brazilian educational scenario. Dourado (2019) argues that democratic management requires more than formal devices, demanding institutional practices that promote qualified dialogue with the community. In this sense, the articulation between these formative spaces needs to overcome bureaucratic logic and assume a pedagogical and relational character.

Paro (2016) reinforces that participation is a political principle of public education, but warns that its effectiveness depends on concrete conditions of listening and sharing decisions. Accordingly, Libâneo (2018) argues that the democratic school is built through collaborative processes that recognize the sociocultural plurality of families. Such contributions reaffirm that the approximation between family and school does not occur spontaneously, requiring consistent institutional mediations.

In the context of social inequalities, Oliveira (2020) highlights that school expectations can be influenced by socially constructed representations about certain family groups. Gatti (2019) complements by stating that teacher training needs to contemplate relational skills that favor intercultural dialogue. Thus, the meanings attributed to family participation are produced in an environment permeated by structural and symbolic constraints.

Thus, understanding the contemporary challenges of the family-school interface implies recognizing that normativity, inequality and representation constitute inseparable dimensions of the phenomenon. By articulating these elements, the present study supports the analysis of teachers' perceptions as an interpretative key to understand the limits and

possibilities of family participation in public schools, contributing to the academic debate on educational policies and democratic practices.

3 METHODOLOGY

The present study is part of the field of qualitative research, as it understands that the analysis of teachers' perceptions about the family-school relationship requires contextualized interpretation of the meanings attributed by the investigated subjects. According to Creswell (2014), qualitative research seeks to explore and understand social phenomena from the perspective of the participants, privileging the construction of meanings in specific contexts. Such an approach is adequate to the objective of this article, which aims to analyze symbolic and institutional dimensions of family participation in public schools.

From the point of view of its nature, the study assumes a descriptive-analytical character, as it is not limited to the exposition of empirical data, but seeks to interpret them in the light of the theoretical framework built throughout the dissertation. Prodanov and Freitas (2013, p. 70) state that descriptive research "aims to describe the characteristics of a given population or phenomenon", and can establish relationships between variables without manipulating them. In this sense, the investigation seeks to understand how teachers perceive family participation, articulating such perceptions with the structural conditioning factors discussed above.

From the epistemological perspective, the methodological option is based on the understanding that educational phenomena are socially constructed and must be analyzed in their complexity. Minayo (2014) argues that qualitative research works with the universe of meanings, values and attitudes, dimensions that cannot be reduced to quantitative indicators. This understanding converges with the purpose of this study, since teachers' representations about the family-school relationship are symbolic processes that demand in-depth interpretation.

In addition, the investigation is aligned with contemporary discussions on methodological rigor in education research. Gatti (2019) highlights that scientific consistency does not result only from the choice of method, but from the coherence between the problem, objectives, and procedures adopted. Thus, by opting for a qualitative approach, the study reaffirms its commitment to the contextualized analysis of teachers' perceptions, ensuring theoretical foundation, epistemological clarity and alignment between the methodological path and the issues that guide the research.

The delimitation of the empirical context is a fundamental stage in qualitative research, since educational phenomena are inseparable from the historical and institutional conditions

in which they are produced. Minayo (2014) states that the field is not a neutral scenario, but a living space of meanings. Coincidentally, André (2013) highlights that understanding the school reality requires attention to institutional particularities and the dynamics that structure the pedagogical routine. Thus, the choice of the public school investigated was based on its relevance for the analysis of teachers' perceptions about the family-school relationship.

With regard to the participants, the research adopted intentional sampling, a strategy widely recommended in qualitative studies. Creswell (2014) observes that the careful selection of subjects allows for a deeper understanding of the phenomenon investigated. Bogdan and Biklen (2013) complement by stating that, in this type of investigation, participants are chosen for their ability to offer significant information, and not for statistical representativeness. In this sense, teachers with direct experience in interacting with families in the school context were included.

The characterization of the investigated group considered professional aspects and trajectories of action, recognizing that such elements influence the interpretations constructed about family participation. Flick (2013) points out that the detailed description of the context and the subjects strengthens the credibility of qualitative research, allowing greater analytical transparency. Yin (2015), when dealing with the case study in the social sciences, also emphasizes that the rigorous contextualization of the empirical field is a condition for consistent interpretations.

On the ethical level, the investigation observed the principles that govern research with human beings, ensuring free and informed consent, confidentiality and anonymization of identities. Gatti (2019) emphasizes that scientific rigor is intrinsically linked to the ethical responsibility of the researcher. Thus, by delimiting the context and the participants with methodological clarity and ethical care, the study reaffirms its scientific consistency and establishes solid bases for the interpretative analysis of teachers' perceptions.

The production of empirical data was based on the application of a questionnaire with open questions to the teachers and on the documentary analysis of institutional records, strategies consistent with the qualitative approach adopted. For Creswell and Poth (2018), qualitative instruments should enable the in-depth exploration of the participants' experiences and interpretations, favoring the construction of situated meanings. From this perspective, the questionnaire was structured in such a way as to allow reflective responses, contemplating subjective dimensions of the family-school relationship and aligning with the objective of understanding teachers' perceptions in their context of action.

The use of open questions is supported by Bogdan and Biklen (2013), who defend the centrality of narrative as a way to access social representations, and by Denzin and Lincoln

(2018), for whom qualitative research is characterized by the interpretation of lived experiences. By privileging discursive responses, the instrument allowed capturing not only opinions, but meanings attributed to institutional practices. Such methodological choice reinforces the study's commitment to the interpretative understanding of the phenomenon, avoiding quantitative reductionism that could limit the complexity of the analysis.

In addition, documentary analysis was incorporated as a triangulation strategy, strengthening the interpretative consistency of the research. According to Cellard (2014), the documents express conceptions, norms and guidelines that structure institutional life, constituting a relevant source for understanding the school context. Flick (2013) points out that triangulation increases scientific credibility by confronting different sources of evidence. Thus, the articulation between the questionnaire and institutional documents ensured greater analytical depth, contributing to the methodological robustness of this study.

The data analysis was conducted in the light of Content Analysis, as systematized by Bardin (2016), as it is understood that this technique makes it possible to interpret discourses in an organized and rigorous way. According to the author, content analysis constitutes "a set of communication analysis techniques" aimed at producing reasoned inferences (BARDIN, 2016, p. 37). Thus, the teachers' answers and institutional documents were examined through stages of pre-analysis, categorization and interpretation, ensuring coherence between empirical data and theoretical framework.

The analytical process sought to identify emerging categories related to teachers' perceptions of the family-school relationship, articulating them with the normative, structural and symbolic dimensions discussed in the framework. According to Flick (2013), qualitative interpretation requires constant dialogue between theory and empirical material, avoiding impressionistic readings. Thus, the analysis was guided by criteria of systematicity, reflexivity and scientific rigor, consolidating the methodology as the structuring foundation of the conclusions presented in this article.

4 ANALYSIS AND RESULTS

The analysis of teachers' perceptions revealed that the family-school relationship is predominantly understood as a fundamental element for the development of the teaching-learning process, although permeated by structural and institutional tensions. The discourses show recognition of the importance of family participation, especially in the monitoring of school activities and in the support of pedagogical routines. However, such recognition does not translate, in a homogeneous way, into effective practices of approximation, indicating a distance between the normative ideal and everyday reality.

It was observed that teachers tend to associate family participation with attendance at meetings and monitoring of academic performance, which signals the permanence of an understanding that is still strongly linked to formal dimensions of participation. This data dialogues with the theoretical framework by showing that, although the legal frameworks defend democratic management, institutional practice still operates under traditional parameters of parental involvement. The documentary analysis reinforced this finding by indicating that institutional instruments value participation, but do not make systematic mediation strategies explicit.

Another recurring aspect in the discourses refers to socioeconomic inequalities as a conditioning factor for participation. The teachers recognize that certain families face limitations related to working hours, schooling and material conditions, which impacts attendance and the form of involvement with the school. This finding confirms the theoretical discussion about the influence of cultural capital and social asymmetries in the configuration of the family-school interface, showing that the absence cannot be interpreted in a simplistic or decontextualized way.

In addition, perceptions emerged that reveal symbolic tensions in the relationship with families, especially when institutional expectations do not correspond to the concrete possibilities of accompaniment. Some teachers show frustration with the low participation, while others recognize the need for more dialogical and inclusive strategies. This ambivalence reinforces the understanding that teacher representations constitute a central dimension for the construction - or limitation - of collaborative practices.

In general, the results indicate that the family-school relationship is recognized as necessary, but still marked by structural, cultural and institutional challenges. The analysis shows that the consolidation of effective participation depends not only on normative devices, but on pedagogical mediations, teacher training and contextualized institutional strategies. Thus, teachers' perceptions reveal themselves to be an interpretative key to understand the limits and possibilities of the articulation between family and school in the investigated reality, contributing to the advancement of the academic debate on public policies and democratic management of education.

5 FINAL CONSIDERATIONS

The present investigation allowed us to understand that the relationship between family and school, although widely recognized as fundamental in the pedagogical discourse and educational policies, still faces significant challenges in the context of public schools. The teachers' perceptions analyzed show that family participation is considered a strategic

element for strengthening the teaching-learning process, but its effectiveness remains conditioned by structural, institutional and symbolic factors that go beyond the normative forecast.

The results indicate that socioeconomic inequalities directly influence the possibilities of family involvement, requiring the school to have a more sensitive and contextualized posture. At the same time, they reveal that teacher representations play a central role in the mediation of this interface, and can both expand and restrict collaborative practices. Thus, the consolidation of a more dialogical relationship demands not only legal provisions, but investment in training, qualified listening and institutional strategies that recognize the plurality of family realities.

It is concluded, therefore, that the articulation between family and school should be understood as a relational process in constant construction, crossed by tensions and possibilities. By highlighting teachers' perceptions as a central analytical dimension, this study contributes to the academic debate on democratic management and educational public policies, reaffirming the need for practices that promote effective approximation between these two formative spaces.

REFERENCES

- Bardin, L. (2016). *Análise de conteúdo* (L. F. de Moraes, Adapt.). Edições 70.
- Bogdan, R., & Biklen, S. K. (2013). *Pesquisa qualitativa em educação: Um guia prático para iniciantes*. Vozes.
- Bourdieu, P. (1998). *A escola conservadora: As desigualdades frente à escola e à cultura*. Vozes.
- Caetano, L. M. (2009). *Dinâmicas para reunião de pais: Construindo a parceria na relação escola e família*. Paulinas.
- Carvalho, M. do C. B. de. (2018). *Família e escola: Relações de gênero e cultura*. Vozes.
- Cellard, A. (2014). *Análise documental: Princípios e práticas*. Vozes.
- Creswell, J. W. (2014). *Pesquisa qualitativa: Métodos qualitativos de pesquisa: Da teoria à prática*. Penso.
- Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4^a ed.). Sage.
- Denzin, N. K., & Lincoln, Y. S. (Eds.). (2018). *O planejamento da pesquisa qualitativa: Teorias e abordagens*. Penso.
- Díaz, F. (2011). *O processo de aprendizagem e seus transtornos*. EDUFBA.
- Dourado, F. M. (2019). *Gestão democrática da educação: Participação social e controle social*. Summus Editorial.
- Flick, U. (2013). *Introdução à pesquisa qualitativa*. Bookman.

- Gatti, B. A. (2019). *Formação de professores no Brasil e suas competências socioculturais*. Summus.
- Libâneo, J. C. (2018). *Didática*. Cortez.
- Libâneo, J. C. (2013). *Organização e gestão da escola: Teoria e prática*. Alternativa.
- Minayo, M. C. de S. (2014). *O desafio do conhecimento: Pesquisa qualitativa em saúde*. Hucitec.
- Nóvoa, A. (2017). *Fronteiras, rupturas e currículo*. Tinta da China.
- Oliveira, D. A. (2020). *Participação dos pais na escola: Legitimação das desigualdades sociais*. Xamã.
- Paro, V. H. (2000). *Família e escola: Novas perspectivas de análise*. Xamã.
- Paro, V. H. (2016). *Gestão democrática da escola pública*. Xamã.
- Pereira, L. do N., & Novo, B. N. (2015). *Família na escola: Interação da família e escola* [Edição Kindle].
- Prodanov, C. C., & Freitas, E. C. de. (2013). *Metodologia do trabalho científico: Métodos e técnicas da pesquisa e do trabalho acadêmico*. Feevale.
- Sousa, J. P. de. (2012). *A importância da família no processo de desenvolvimento da aprendizagem da criança* [Trabalho de Conclusão de Curso, Especialização em Psicopedagogia Clínica e Institucional]. Instituto de Estudos Superiores do Ceará.
- Yin, R. K. (2015). *Estudo de caso: Planejamento e métodos*. Bookman.

CRITICAL THINKING AND THE USE OF ARTIFICIAL INTELLIGENCE (AI)

PENSAMENTO CRÍTICO E O USO DA INTELIGÊNCIA ARTIFICIAL (IA)

PENSAMIENTO CRÍTICO Y EMPLEO DE INTELIGENCIA ARTIFICIAL (IA)



<https://doi.org/10.56238/sevened2026.008-181>

Francisco Roberto Rojas Caldelas¹, Marco Antonio Marín Álvarez²

ABSTRACT

In the first quarter of the 21st century, technological advances — digitalization and artificial intelligence — have profoundly transformed social, educational, and cultural dynamics; however, this progress has coincided with a phenomenon of weakening critical thinking, characterized by the primacy of immediacy, subjectivity, and information overload; this article analyzes the historical evolution of critical thinking from its origins in classical philosophy to its role in modernity, highlighting its function as a fundamental tool for rational decision-making, ethics, and democratic life; it also examines the impact of digital culture, the Google effect, and cognitive externalization on the decline of reflective capacities; from the field of graphic design education, it is argued that the uncritical incorporation of digital technologies and artificial intelligence has displaced humanistic and methodological approaches, privileging immediate production and formal perfection over analysis, meaning, and the social context of images; finally, the study proposes the need to reconfigure educational models in graphic design through a theoretical, critical, and reflective perspective that enables the integration of artificial intelligence without abandoning the development of critical thinking and the construction of meaning in contemporary visual culture.

Keywords: Critical Thinking. Education. Graphic Design. Artificial Intelligence.

RESUMO

No primeiro quarto do século XXI, os avanços tecnológicos — a digitalização e a inteligência artificial — transformaram profundamente as dinâmicas sociais, educacionais e culturais; entretanto, esse progresso tem coincidido com um fenômeno de enfraquecimento do pensamento crítico, caracterizado pela primazia da imediatez, da subjetividade e da sobrecarga informacional; este artigo analisa a evolução histórica do pensamento crítico desde suas origens na filosofia clássica até seu papel na modernidade, destacando sua função como ferramenta fundamental para a tomada de decisões racionais, a ética e a vida democrática; aborda-se também o impacto da cultura digital, o efeito Google e a externalização cognitiva na redução das capacidades reflexivas; no âmbito do ensino do design gráfico, argumenta-se que a incorporação acrítica das tecnologias digitais e da inteligência artificial tem deslocado abordagens humanistas e metodológicas, privilegiando

¹ Dr. in Education. Universidad Autónoma Metropolitana Azcapotzalco. Mexico City, Mexico.
E-mail: frc@azc.uam.mx Orcid: 0000-0002-2873-8168

² Dr. in Design. Universidad Autónoma Metropolitana Azcapotzalco. Mexico City, Mexico.
E-mail: marcomarin@azc.uam.mx Orcid: 0000-0001-6267-6063

a produção imediata e a perfeição formal em detrimento da análise, do significado e do contexto social da imagem; por fim, propõe-se a necessidade de reconfigurar os modelos educacionais do design gráfico por meio de uma postura teórica, crítica e reflexiva que permita integrar a inteligência artificial sem renunciar ao desenvolvimento do pensamento crítico e à construção de sentido na cultura visual contemporânea.

Palavras-chave: Pensamento Crítico. Ensino. Design Gráfico. Inteligência Artificial.

RESUMEN

En el primer cuarto del siglo XXI, los avances tecnológicos —la digitalización y la inteligencia artificial— han transformado profundamente las dinámicas sociales, educativas y culturales. Sin embargo, este progreso ha coincidido con un fenómeno de debilitamiento del pensamiento crítico, caracterizado por la primacía de la inmediatez, la subjetividad y la sobrecarga informativa. Este artículo analiza la evolución histórica del pensamiento crítico desde sus orígenes en la filosofía clásica hasta su papel en la modernidad, destacando su función como herramienta fundamental para la toma de decisiones racionales, la ética y la vida democrática. Asimismo, se aborda el análisis el impacto de la cultura digital, el efecto Google y la externalización cognitiva en la disminución de las capacidades reflexivas. Desde el ámbito de la enseñanza del diseño gráfico, se ha argumentado que la incorporación acrítica de tecnologías digitales y de inteligencia artificial ha desplazado los enfoques humanistas y metodológicos, privilegiando la producción inmediata y la perfección formal por encima del análisis, el significado y el contexto social de la imagen. Finalmente, se propone la necesidad de reconfigurar los modelos educativos del diseño gráfico mediante una postura teórica, crítica y reflexiva que permita integrar la inteligencia artificial sin renunciar al desarrollo del pensamiento crítico y a la construcción de sentido en la cultura visual contemporánea.

Palabras clave: Pensamiento Crítico. Enseñanza. Diseño Gráfico. Inteligencia Artificial.

1 INTRODUCTION

In the first quarter of the 21st century, significant technological advances took place, such as human genome sequencing, lithium batteries, renewable energies, the internet and global connectivity, telephone devices, social networks and artificial intelligence, among many others. All of them have transformed the way we work and live. However, it seems that stupidity is taking over society by leaps and bounds and that critical thinking is being undermined. In an era where individualization prevails, we have headed for what Lipovetsky (2024, p. 9) called the fracture of disciplinary socialization.

... it is a historical change of course in the objectives and modalities of socialization, currently under the aegis of open and plural devices; in other words, hedonistic and personalized individualism has become legitimate and no longer meets with opposition; [...] The era of revolution, of scandal, of futuristic hope, inseparable from modernism, is over.

Human beings fervently yearn to live in the immediacy, in the here and now. We are living in a historical stage in which opinion, emotion and ease are prioritised, exacerbated and valued more than evidence. Thanks to the global cybernetic network, which seduces us and complements us with its thousand tentacles of powerful algorithms, a wonderful effect is produced: in a second, we are already political analysts, technical directors of some sports team and even "cell phone intellectuals", that is, this type of fragmentary and immediate culture is projected at all levels: the neighborhood, the office, and minority groups. In this context, we can all have an opinion about anything according to our "intimate" experience. In this same sense, it is Lipovetsky himself (2004, p. 14) who argues: the greater the means of expression, the fewer things one has to say, the more subjectivity is requested, the more anonymous and empty the effect is.

Therefore, a question arises: what happened to critical thinking, the backbone of intellectuality? Why does deep reflective thinking seem to be exhausted so quickly? To answer these questions, we must first review the origin of critical thinking in human history and understand what it means to think critically. It is necessary to clarify that thinking a lot of nonsense about a topic or situation is not thinking correctly.

2 A BRIEF HISTORICAL OVERVIEW OF CRITICAL THINKING

Thinking for a long time about a topic chaotically or obsessively is not thinking critically, on many occasions you just waste time as if you were in a tunnel with no way out. On many occasions, this type of analysis without a methodology can result in an absolute waste of time, as if you were immersed in a tunnel with no exit. Critical thinking, far from being a mere

intellectual exercise, constitutes a deeper and more refined process that involves meticulous reflection and analysis. This comprehensive methodology involves questioning, investigating, fragmenting, classifying, prioritizing, and demanding a reasonable amount of evidence before accepting any belief or opinion.

Critical thinking according to Peter A. Facione (1990) who is one of the most cited contemporary references in education, philosophy and social sciences, in the Delphy report of the American Philosophical Association. He defines critical thinking as follows:

A deliberate and self-regulated judgment that gives rise to interpretation, analysis, evaluation and inference, as well as the explanation of the evidential, conceptual, methodological or contextual considerations on which said judgment is based.

According to Facione, critical thinking does not seek to win arguments, but rather: to make better decisions, formulate well-founded judgments, and act rationally and ethically in complex contexts. It is an essential tool for democratic life, science, education and responsible citizenship.

In ancient Greece, a specific methodology for structuring thought was initiated approximately 2500 years ago. The method of research through dialogue, developed by the Greek philosopher Socrates and later called the "Socratic method", constitutes a legacy of great relevance in the field of philosophical research. This methodological approach involves asking questions that can be perceived as disturbing, with the purpose of identifying inconsistencies between the arguments presented, thus demonstrating the dubious nature and lack of solidity of what had initially been considered as a solid and forceful argument.

In the field of philosophy and ethics, the expression "I only know that I know nothing", attributed to Socrates, stands as a paradigm of acceptance of ignorance as the foundation of critical thinking. However, in 399 B.C. In 400 BC, the Greek philosopher was accused, tried and sentenced to death for alleged corruption of youth and lack of devotion to the gods. In reality, Socrates' transgression was to raise the questioning of everything and promote this way of acting on the part of his disciples, with the aim of stimulating reflection and knowledge, and in this way, disrupting the beliefs, privileges and comforts of Athenian high society.

Despite his death, Socrates' thought persisted through his students, such as Plato and later Aristotle, who contributed to the consolidation of scientific methodology. These philosophers established doubt as a means of reflection, as well as the logic of systematic research. In this sense, analysis was implemented, understood as the fragmentation of information into individual components to facilitate its understanding. Likewise, weighting,

which implies the evaluation of the veracity and relevance of the information, was incorporated. Inference is presented as the ability to draw logical conclusions from evidence, while problem-solving refers to the ability to find appropriate solutions to challenges or problems posed.

Around the thirteenth century, St. Thomas Aquinas integrated Aristotelian philosophy with Christian theology, at a time when reason and faith were conceived as opposites. The method of St. Thomas in his professorships at the University of Paris was based on the integration of human reason with Christian values. In his pedagogical approach, he implemented the *Quaestio disputata* (disputed question), a dialectical method that involved the formulation of questions and the presentation of arguments both for and against, culminating in the obtaining of a resolution based on reason and faith. This method, in addition to encouraging critical thinking, made it possible to integrate reason and faith in a harmonious synthesis.

Several centuries passed before Socrates' thought was taken up again. It was during the Enlightenment period that philosophers such as Kant tried to break with the ignorance that prevailed at the time, through their motto *Sapere Aude* (dare to think for yourself). As various authors (Voltaire, Diderot and Locke, among others) have pointed out, critical thinking has been a current of thought that has promoted reason in human development. In this way, it has become one of the pillars of democracy, innovation and science.

People who possessed the capacity for critical thinking, that is, the ability to examine arguments, evaluate evidence, and question false narratives, were considered to be individuals with an exceptionally developed and educated mind. However, these exaltations were not accepted by everyone, as evidenced by the reflections of Nitsche, who maintained that reason was overvalued and that the culprit of this situation was Socrates. His argument was that too many questions would exhaust the meaning of life.

Finally, it seems that the vast majority of people do not know where they are going, and the question is how did it get to this moment?, it is in this same sense that Enrique Rojas (2010, p. 17) argues

From the most egregious man to the most degraded there is an enormous distance, but both belong to the human species. Only one of them has known how to lead his life making the most of the positive; there we have some examples from the history of humanity: from Socrates, Plato, Aristotle, Plotinus, Saint Augustine, Saint Anselm, Saint Thomas Aquinas or the master Eckhart, through Kepler, Galileo, Newton, Descartes, Pascal, Kant or Hegel to existentialists such as Sartre, Camus, Kierkegaard, Nietzsche, our Unamuno, or the

great thinkers of our time, such as Brentano, Husserl, Heidegger, Max Scheler y Ortega y Gasset.

In opposition to the aforementioned position, there is a significant predominance of individuals who exhibit a modest, fragmentary way of thinking that lacks a coherent sense. However, throughout the history of humanity, there has been a social amalgam in which two divergent trends converge: on the one hand, great thinkers and, on the other, individuals who lack a systematic structuring in their thoughts, relying predominantly on intuition, belief and adherence to neighborhood, cultural or political groups that represent their ideas.

Without leaving aside the existence of detractors and mental setbacks, critical thinking has endured to the present day. However, in many respects, it could seem that the opposite direction is being taken. Today, the availability of answers to any question is immediate and accessible with a simple click. Access to knowledge through cell phones and computers has significantly facilitated this process. However, there is a noticeable decline in critical thinking, despite the abundance of information available online.

The human capacity to process such an extensive amount of data is limited due to the physical structure of the brain, which means that it is difficult to analyze such a large volume of information. The volume of data, images, and recordings that are generated far exceeds the processing capacity, resulting in information overload or infoxication. This phenomenon, recognized in the field of psychology, implies that individuals must resort to cognitive strategies to manage the abundance of stimuli received.

Within the framework of the cybernetic phenomenon called the "Google effect", which is characterized by the widespread use of search engines such as Google or artificial intelligence (AI) systems, there is evidence of an easing of access to information. However, this implies an outsourcing³ of thinking, which leads to a decrease in the development of critical reasoning. The lack of cognitive exercise affects the functional capacity of the brain, which manifests itself in a decrease in memory and in the tendency to not verify the answers to queries made on electronic platforms. In addition, there is a tendency to spread false information⁴ without verification, which can contain erroneous data and has serious consequences.

The methodology developed by Socrates, consisting of finding out and not staying with the first answer, has undergone a remarkable transformation, becoming a process of rapid

³ In other words, outsourcing is a practice carried out by an individual who hires a firm to provide a service that, in principle, should be provided by itself. In the case of a knowledge problem, we are making use of search engines and artificial intelligence to arrive at thought answers without trying to make the effort to do it ourselves.

⁴ To expand on this topic, it is recommended to access Fake News, communication and design: transcendence, impact and social responsibility by Marco Antonio Marín Álvarez, Et. al. A year of designing MM1. <https://mm1revista.azc.uam.mx/index.php/mm1/article/view/A-5%20N-25>

exploration in Google, Chat GPT or other artificial intelligence (AI) tools. In this sense, knowledge seems to be within everyone's reach, however, there has been a loss of the process of reflection, memorization and comprehension, which progressively deteriorate due to the excess of information and the speed with which we live today. Consequently, there is a tendency to prefer striking and instantaneous notes, rather than critical reflection.

3 CRITICAL THINKING AND TEACHING GRAPHIC DESIGN

Graphic design has undergone significant transformations in the last four decades. There has been a shift from analog design, based on photomechanical images, to digital design, characterized by immaterial and hybrid constructions generated by computers. In addition, artificial intelligence (AI) has been integrated into creative processes, through the use of algorithms and empirical methods. As a result, visual culture has undergone a radical transformation, although it has largely not been approached from an academic perspective.

The widespread implementation of artificial intelligence (AI) for image generation has permeated a culture characterized by a proliferation of combinations that anticipate future trends. This phenomenon, manifested through a visionary approach, is aligned with the ideas expressed by the French philosopher Jean Francois Lyotard (1987), who identified a series of postmodern trends, including extreme relativism, digital influence on society, the exhaustion of great utopian promises in its narratives and cultural despair, manifested in extreme skepticism, that reflects an increasingly decentralized world.

We are living in a visual culture where the theory of knowledge and cognitive skills have fragmented. It would seem, then, that a new discourse on the visual has emerged, which avoids reflection and proposes solutions to social reality. The development of cognitive skills and the use of the so-called new technologies are closely combined in all fields of knowledge at different school levels, digital tools make up the pedagogical strategies in the academic development of our time.

However, in the process of learning and evaluating design, the model of the perfect canon of the designed object has traditionally been idealized. In this environment, it is usually observed that students and a considerable number of teachers automatically focus on identifying and highlighting errors, which becomes a simplistic and sterile critical attitude, dismissing constructive criticism about the design process involved, its level of difficulty, the complexity of the presentation and accidental errors in billing. In addition to this, the teachers omit the post-design process, "the redesign", at which time the aforementioned problems can be implemented and resolved. This situation limits the enrichment of the chair and the development of an environment of reflection and continuous improvement.

However, when it comes to professional design education, many root causes have been omitted. At present, the focus on the formation of the most cultured and humanistic student has been abandoned. It is possible to find outstanding professionals in various areas of specialization, capable of effectively solving almost any problem that comes their way. However, when leaving that context, the professional faces a significant challenge when applying their knowledge in contexts outside their area of specialization, Françoise Revel in Enrique Rojas warns ... Never has the information been so abundant and prolix and never, however, has there been so much ignorance. Man is less and less wise, in the classic sense of the term, glimpsing the fear of the possible dissipation of cognitive abilities, the ability to respond to social skills in addition to the political and commercial commitments required in our time (2010, p.18).

In the face of evident technological and cultural change, it has not been considered in the teaching-learning discourses of design that AIs are intertwined in issues of material and social realities. Although AI is a fascinating, fast and economical tool, it cannot be limited to abstract potential, since technologies are not the result of isolated processes, as Williams argues in Lister (2017, p.20) ... they are calculated, desired and induced.

Despite the possible objections to artificial intelligence (AI), it must be recognized that it is a remarkably inclusive tool, insofar as it facilitates the application of knowledge from disciplines such as hermeneutics, semiotics, and rhetoric, among many others. However, the disruption that is brewing through a single click is evident.

AI is associated with a totally new visual discourse, which must transform ideas around situations, judgments and truth. The rapid development of AI is the new reconfiguration of the modes of image creation and of those who observe such images, and yet the questions are: are we preparing our young university students in a new reality, not only technological but also discursive?

In this sense, William Mitchel (1992, p. 225) argues.

Today, as we enter the era [of AI], we must face more the uneradicable fragility of our ontological distinctions between the imaginary and the real, and the tragic chimera of the Cartesian dream.

Finally, from the perspective of design education, there is a need to adopt a much more theoretical, critical and reflective attitude towards the reality of the world in relation to the universe of images, their nature and their properties.

4 CONCLUSIONS

We are living in a cultural moment, high in "feelings" and "emotions" and the individual liberation of the self in terms of values, sexuality, education, among many other things, which entails a light valuation of the "others", tolerating a permissiveness without giving due importance to others.

As for the teaching of graphic design, the transformation of analog, through digital hybridization, until reaching AI's, which have completely left critical thinking aside, there are rarely questions, reflections and proposals in a design, now it is AI that proposes and resolves. The process of visual representation has lost much of its content, abandoning the real, what was previously constituted in a humanistic environment has been transferred to a cold environment, made by computers, the perfection of the design object is more important than the meaning of the representation itself.

Now students in graphic design have a weak thought, without firmness, or as Enrique Rojas (2010, p.16) puts it: "... asepsis in its commitments, *sui generis* indifference made of curiosity and relativism at the same time; its ideology is pragmatism, its norm is conduct, its social validity, what is worn, what is fashionable; its ethics is based on statistics, a substitute for conscience; its morality, full of neutrality, lack of commitment and subjectivity, it is relegated to intimacy."

Perhaps the greatest predominant faculty concern in the teaching of contemporary graphic design is to observe the gradual disappearance of the student's cognitive abilities for design, who changes their design methodology and thinking and opts for the easy and comfortable promise that the computer, state-of-the-art software, and Artificial Intelligence in a virtuous trine are the solving agents of design problems and of the inherent future dilemmas that will arise in the exercise of the profession.

However, the supposed creation that occurs through Artificial Intelligence cannot only glorify its privileged status for its abstract potential. In a more precise debate, the discourse about a change of era is fundamental. To understand the transformations that new technology has entailed, it is necessary to analyze, question and argue the ways of creating the image, above all, what is being left behind and the level of rupture that these changes entail. Because what AI offers, well founded, is inevitably achieved with knowledge of language and the theoretical and visual discourses of the image itself. In other words, the image cannot be fully understood without taking into account the systems of ideas and the way of processing critical thinking, in addition to experience.

Finally, the most revealing thing is not the images created with AI, but the new reordering of the visual, of what we can do with them and of their meaning, to the extent that we are able to resist the comforts of chance.

REFERENCES

- Facione, P. A. (1990). Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction (The Delphi Report). American Philosophical Association.
- Lister, M. (2017). La imagen fotográfica en la cultura digital. Paidós Multimedia.
- Lyotard, J.-F. (1979). La condition postmoderne: Rapport sur le savoir. Éditions de Minuit. (Trabalho original publicado em 1979)
- Lipovetsky, G. (2005). La era del vacío: Ensayos sobre el individualismo contemporáneo. Anagrama. (Trabalho original publicado em 1983)
- Mitchell, W. J. T. (1992). The reconfigured eye: Visual truth in the post-photographic era. MIT Press.
- Rojas, E. (2010). El hombre light: Una vida sin valores. Planeta.

PERFORMANCE AND PRODUCTIVITY MANAGEMENT IN THE FOOD INDUSTRY: A CASE STUDY APPLIED TO A SMALL-SCALE AGROINDUSTRY

GESTÃO DE DESEMPENHO E PRODUTIVIDADE NA INDÚSTRIA DE ALIMENTOS: UM ESTUDO DE CASO APLICADO À UMA AGROINDÚSTRIA DE PEQUENO PORTE

GESTIÓN DEL DESEMPEÑO Y LA PRODUCTIVIDAD EN LA INDUSTRIA DE ALIMENTOS: UN ESTUDIO DE CASO APLICADO A UNA AGROINDUSTRIA DE PEQUEÑA ESCALA



<https://doi.org/10.56238/sevened2026.008-182>

Pollyanna Cardoso Pereira¹, Diego Augusto Carneiro Junho², Carolina Sá Fortes Potenza³, João Pedro Da Silva⁴

ABSTRACT

Performance and productivity management in the food industry constitutes a strategic factor to ensure competitiveness, quality, and sustainability, especially in micro and small agro-industries. This chapter presents an integrated analysis between theoretical foundations and practical application, addressing tools such as Statistical Process Control (SPC), performance indicators, the seven quality tools, Knowledge Management, and Business Intelligence. The case study conducted in a small dairy plant located in Minas Gerais aimed to plan the expansion of a goat fine cheese production line, evaluating production capacity, mass balance, labor, and structural compliance. The results demonstrated the feasibility of the expansion through increased raw material supply, production rescheduling, targeted investments in infrastructure, and the hiring of an additional employee. The analysis showed that the structured use of indicators and management tools makes it possible to identify bottlenecks, reduce waste, and support strategic decisions based on data. It is concluded that the integration of theory and practice strengthens organizational competitiveness, even in contexts of limited resources, and highlights the role of data-driven management as a differentiating factor in the food industry scenario.

Keywords: Industrial Productivity. Performance Indicators. Continuous Improvement. Food Industry.

RESUMO

A gestão de desempenho e produtividade na indústria de alimentos constitui um fator estratégico para garantir competitividade, qualidade e sustentabilidade, especialmente em

¹ Dr. in Food Science and Technology. Universidade Federal de Viçosa (UFV).

E-mail: pollyanna.cardoso@ufv.br Lattes: <http://lattes.cnpq.br/8421394468591152>

² Graduated in Food Engineering. Universidade Federal de Viçosa (UFV).

E-mail: diegoaugustosdd@gmail.com Lattes: <http://lattes.cnpq.br/0325528865949266>

³ Graduated in Food Engineering. Universidade Federal de Viçosa (UFV). E-mail: potenzacarol97@gmail.com

⁴ Graduated in Food Engineering. Universidade Federal de Viçosa (UFV).

E-mail: joao.pedrovictor@hotmail.com

micro e pequenas agroindústrias. Este capítulo apresenta uma análise integrada entre fundamentos teóricos e aplicação prática, abordando ferramentas como Controle Estatístico de Processo (CEP), indicadores de desempenho, sete ferramentas da qualidade, Gestão do Conhecimento e Business Intelligence. O estudo de caso realizado em um laticínio de pequeno porte, localizado em Minas Gerais, teve como objetivo planejar a expansão da linha de queijos finos de cabra, avaliando capacidade produtiva, balanço de massa, mão de obra e conformidade estrutural. Os resultados evidenciaram a viabilidade da expansão mediante ampliação da captação de matéria-prima, reprogramação produtiva, investimentos pontuais em infraestrutura e contratação de um colaborador adicional. A análise demonstrou que a utilização estruturada de indicadores e ferramentas de gestão possibilita identificar gargalos, reduzir desperdícios e subsidiar decisões estratégicas baseadas em dados. Conclui-se que a integração entre teoria e prática fortalece a competitividade organizacional, mesmo em contextos de recursos limitados, e evidencia o papel da gestão orientada por dados como diferencial no cenário da indústria de alimentos.

Palavras-chave: Produtividade Industrial. Indicadores de Desempenho. Melhoria Contínua. Indústria de Alimentos.

RESUMEN

La gestión del desempeño y la productividad en la industria de alimentos constituye un factor estratégico para garantizar la competitividad, la calidad y la sostenibilidad, especialmente en micro y pequeñas agroindustrias. Este capítulo presenta un análisis integrado entre fundamentos teóricos y aplicación práctica, abordando herramientas como el Control Estadístico de Procesos (CEP), indicadores de desempeño, las siete herramientas de la calidad, Gestión del Conocimiento y Business Intelligence. El estudio de caso realizado en una pequeña planta láctea ubicada en Minas Gerais tuvo como objetivo planificar la expansión de la línea de quesos finos de cabra, evaluando la capacidad productiva, el balance de masa, la mano de obra y la conformidad estructural. Los resultados evidenciaron la viabilidad de la expansión mediante la ampliación de la captación de materia prima, la reprogramación productiva, inversiones puntuales en infraestructura y la contratación de un colaborador adicional. El análisis demostró que el uso estructurado de indicadores y herramientas de gestión permite identificar cuellos de botella, reducir desperdicios y apoyar decisiones estratégicas basadas en datos. Se concluye que la integración entre teoría y práctica fortalece la competitividad organizacional, incluso en contextos de recursos limitados, y evidencia el papel de la gestión orientada por datos como un diferencial en el escenario de la industria de alimentos.

Palabras clave: Productividad Industrial. Indicadores de Desempeño. Mejora Continua. Industria de Alimentos.

1 INTRODUCTION

The food industry occupies a strategic role in the world economy, being responsible for generating jobs and meeting a growing demand for quality, innovative and sustainable products. In recent decades, this sector has faced profound transformations, driven by globalization, technological advancement, intensified competitiveness, and growing concern with sustainability and efficiency in the use of resources (MESSIAS; ROMÃO; ROLAND, 2020).

Brazil is recognized for the strength of agribusiness and the potential for adding value in agro-industrial chains, which makes the search for productive excellence a decisive competitive differential. In particular, the micro, small, and medium-sized food and beverage industries have been challenged to optimize processes, reduce waste, and align their production with market requirements, which include both sensory and nutritional quality attributes and regulatory compliance and sustainable practices (ALVES, 2018; ALMEIDA et al., 2024).

In this context, performance and productivity management are a fundamental approach to transform information into strategic decisions, aligning indicators of operational efficiency, quality, and sustainability with decision-making. Modern quality management tools, statistical process control (SPC), *Business Intelligence* (BI) and continuous improvement methodologies have been incorporated into the industrial reality, allowing greater predictability, reduction of variability and value addition (SURBAKTI, 2015; FRANCISCHINI; FRANCISCHINI, 2018).

Beyond theory, it is essential to demonstrate how these concepts can be applied in practice, especially in sensitive sectors such as dairy, which demand strict process control and efficient resource management. To this end, this chapter presents an integrated analysis between theory and practice, exploring the conceptual bases of performance and productivity management, as well as the application in a case study on the expansion of the line of fine goat cheeses in a small dairy in Minas Gerais.

The objective is to present an assertive and grounded overview on the subject, showing how the integration between industrial management, quality and performance indicators can strengthen competitiveness and sustainability in the food industry.

2 PERFORMANCE AND PRODUCTIVITY MANAGEMENT IN THE FOOD INDUSTRY

Contemporary industrial management is marked by the need to reconcile three major dimensions: production efficiency, product quality and process sustainability. These

dimensions should not be seen as isolated objectives, but rather as interdependent pillars that support the sustainable growth of organizations.

According to Messias, Romão and Roland (2020), the survival of industries in the current scenario depends on their ability to innovate continuously, overcome the competition and respond quickly to market changes. This means that productivity, traditionally measured only in terms of costs and volumes produced, needs to be expanded to include aspects such as agility, reliability, waste reduction and value creation for customers and society.

For Alves (2018), the sustainable development of the industry requires systemic management, capable of integrating planning, control and innovation. This perspective becomes even more relevant in the food sector, where factors such as seasonality of raw materials, sanitary quality requirements, and variations in demand require constant monitoring and data-driven decision-making.

In this scenario, two complementary approaches stand out:

- **Knowledge Management (KM):** focuses on the acquisition, creation, sharing, and application of knowledge within organizations. In the food sector, KM is essential to ensure that safety practices, technological innovation, and quality standards are absorbed and replicated by the entire team (DALMARCO et al., 2017).
- **Business Intelligence (BI):** involves the systematic use of data and analytics to support strategic and operational decisions. With BI, it is possible to transform large volumes of operational data, such as process times, yields, loss rates and non-conformities, into useful performance indicators for management (SURBAKTI, 2015).

The integration between KM and BI enhances organizational development, creating learning environments and continuous innovation. Shehzad and Khan (2013) point out that, when combined, these approaches allow for more expressive results than when used alone, since they unite the human dimension (tacit and explicit knowledge) with the technological dimension (data analysis and prediction).

Considering this context, performance and productivity indicators become key tools, as they allow translating organizational objectives into tangible metrics. Falconi (2010) points out that well-defined indicators make it possible not only to monitor results, but also to direct efforts, identify bottlenecks and prioritize improvements in processes.

Thus, performance management in the food industry is not limited to production control, but involves the creation of an integrated management system, driven by data, knowledge, and innovation. This system is able to simultaneously respond to customer demands, regulatory requirements, and the needs of competitiveness and sustainability.

3 TOOLS FOR MONITORING AND CONTINUOUS IMPROVEMENT

Performance and productivity management in the food industry depends on mechanisms that enable measurement, analysis and structured intervention in processes. In this sense, quality management tools and continuous monitoring methodologies are essential to ensure operational efficiency, standardization, predictability, and evidence-based decision-making. Among the main tools used by the quality management system in companies, the Statistical Process Control, the quality support tools, such as flowcharts, 5W2H, check sheets, histograms and others (Stadler and Silene, 2013) stand out. The use of performance and productivity indicators has also been widely used, together with other tools, to enable the use of prediction in systems that have sensing, combined with Artificial Intelligence (Martins, 2025).

3.1 STATISTICAL PROCESS CONTROL (SPC)

Statistical Process Control (SPC) is one of the most consolidated and applied techniques in the industry for monitoring and improving quality. Its central logic is to identify and reduce variabilities, distinguishing those inherent to the process, common causes, resulting from failures or specific conditions, special causes (Gouveia and Silva, 2011).

According to Ribeiro and Caten (2012), the SPC allows operators to monitor the process in real time, identifying deviations and promoting corrections before the final product is compromised. This characteristic makes the method highly effective in the food industry, since through the standardization of the process, it identifies process failures, which can compromise food safety and generate high costs with rework and waste.

Among the main tools of the CEP are:

- Control charts: allow for graphically visualizing the behavior of critical variables, identifying trends and deviations from the established control limits (CORTIVO, 2005).
- Process capability indices (C_p and C_{pk}): measure the ability of the process to meet quality specifications, considering both natural variability and the alignment of the process average with specification limits (FRANKEN et al., 2014).

The application of CEP provides greater stability and predictability to production processes, contributing to increased reliability, reduced costs of non-quality and greater consumer satisfaction. According to Kanan et al. (2023), the effective implementation of PESCO in food industries, especially in developing countries, contributes significantly to reducing losses, increasing operational efficiency, and strengthening the culture of continuous improvement.

3.2 BASIC QUALITY TOOLS

The so-called "seven tools of quality" are practical resources for identifying problems, analyzing causes and supporting decision-making. Paladini (2019) highlights that the correct choice of methodology and the structuring of quality programs determine the effectiveness of the results. Among the most relevant tools for the food industry are:

- Flowchart: maps production stages, facilitating the understanding of processes and the identification of bottlenecks (COSTA et al., 2004).
- Brainstorming: promotes the generation of collective and diversified ideas for problem solving (DANIEL; MURBACK, 2014).
- Ishikawa Diagram (Cause and Effect): allows analyzing potential causes for a given problem, grouped into categories such as machine, method, labor, environment and materials (CAMARGO; ANUNCIATION, 2022).
- The 5 Whys: simple methodology for identifying the root cause of problems (WEISS, 2011).
- 5W2H: structured tool for the elaboration of action plans, defining what, who, when, where, how, why, and how much it costs (MELLO et al., 2017).
- Check Sheets: assist in standardized data collection, facilitating subsequent analyses (LOBO, 2019).
- Histogram: allows you to visualize the distribution of data and identify patterns of variability (MELLO et al., 2011).
- Tree of Problems and Objectives: to relate causes and consequences of critical situations, assisting in the development of intervention strategies (COHEN; MARTINEZ, 2004).

These tools, when applied in combination, create a robust system for analyzing and solving problems, in addition to fostering a culture of continuous improvement, which allows for structuring accurate diagnoses, prioritizing critical causes, and guiding corrective actions efficiently, strengthening quality management and data-based decision-making. In the food industry, this approach contributes to strict process control, waste reduction, and compliance with required safety and quality standards (INÁCIO; 2023).

3.3 PERFORMANCE AND PRODUCTIVITY INDICATORS

Indicators are the basis for measuring and monitoring organizational performance. Francischini and Francischini (2018) define indicators as measures that allow comparing the results obtained with the objectives or expectations established.

In the food industry, indicators can take on different applications:

- Quality indicators: number of non-conformities, customer complaints, rework rate.
- Productivity indicators: relationship between resources used (raw material, time, energy) and results obtained (quantity of product).
- Sustainability indicators: water consumption, energy, emissions and waste generation.
- Satisfaction indicators: evaluation of customers, employees and other stakeholders.

The effectiveness of the indicators depends on the clear definition of goals, frequency of monitoring and those responsible for data collection and analysis. Bahia (2021) emphasizes that indicators must be objective, communicable, value-oriented, and aligned with strategic planning.

By integrating indicators into a Performance Measurement System (SMD), it becomes possible to identify critical points, monitor trends, and support management decisions. In addition, the indicators work as "organizational compasses", guiding the direction of efforts and avoiding waste of resources, since it quantifies performance in relation to organizational objectives and allows the monitoring of the evolution of the company's results, and can be used as a reference for decision-making and improvement strategies (MERTZ, 2016).

3.4 INTEGRATION OF QUALITY TOOLS TO PERFORMANCE MANAGEMENT IN THE FOOD INDUSTRY

The biggest challenge is not only in knowing the tools, but in integrating them into an industrial management logic. The SPC provides statistical data; indicators translate objectives into metrics; and quality tools help in solving problems. When applied together, these practices strengthen performance management and create conditions for sustainable productivity (PALADINI, 2019).

In this context, the use of *Business Intelligence* (BI) systems has gained prominence for offering real-time monitoring, dynamic dashboards and integrated analysis of production data, making the monitoring process more assertive and assisting managerial decision-making (RODRIGUES; COSTA, 2019; BARROS, 2024). Task automation optimizes professionals' time and reduces the likelihood of errors. In addition, BI allows industries to continuously monitor their processes, quickly identify patterns of anomalies, and anticipate potential failures before they impact production (TURBAN et al., 2010; BARROS, 2024).

In the dairy sector, for example, the integration of these tools makes it possible to monitor variations in the yield of milk products, identify causes of losses (such as equipment failures or raw material problems), plan corrective actions with 5W2H, and monitor the impact of changes through indicators. This systemic approach enhances the company's production efficiency and competitiveness.

4 CASE STUDY IN A FINE CHEESE DAIRY: A PRACTICAL APPLICATION OF MANAGEMENT CONCEPTS

The application of the concepts of performance and productivity management can be better understood when analyzed in real situations. In this sense, the case study of Laticínio Piallet, located in Florestal, Minas Gerais, is presented, which stood out for the elaboration of an operational plan aimed at the expansion of the line of fine goat cheeses.

The goat dairy processing sector has been consolidated as a profitable activity for small producers in Brazil, especially due to the differentiated nutritional value of goat's milk and the growing interest of the consumer market for artisanal and high-quality products (IBGE, 2021; SILVA, 2023). In this context, industrial management assumes a strategic role to optimize resources, reduce waste and ensure competitiveness in this sector.

4.1 PURPOSE OF THE STUDY

The main objective of the work was to prepare the expansion plan for the line of fine goat cheeses, evaluating the structural conditions, raw material, production capacity, labor and facilities, in order to propose an action plan that would enable the increase in production.

In the expansion proposal, there was an increase of 50% in the production of fresh cheeses (Boursin, Minas Frescal and Tipo Feta) and 20% in the production of matured cheeses (Caprino Romano and Chevrotin), in line with the insertion of the new "Santa Cecilia" brand, expanding distribution and positioning in the market.

4.2 METHODOLOGY

The study was conducted as an applied case study, in which qualitative and quantitative data techniques were used, through:

- Survey of technical and operational data through visits to the dairy and interviews with those responsible for it;
- Mass balance for calculating yields and surveying the need for raw materials, according to Tadini et al. (2018);
- Mapping of production processes using flowcharts, enabling detailed analysis of production stages;
- Calculation of the operational capacity of the equipment (pasteurizers, tanks, presses and cold chambers), according to the methodology of Staudt et al. (2011);
- Study of times and movements with timing of operations, based on Corrêa and Corrêa (2012), to assess the need for labor;

- Analysis of compliance of facilities based on sanitary legislation (RDC No. 275/2002 of ANVISA and Ordinance No. 368/1997 of MAPA);
- Action plan structured by the 5W2H method, contemplating production strategies, supplies, physical structure and human resources.

This methodology provided a holistic view of the production process, allowing the identification of bottlenecks, opportunities for improvement and the development of expansion strategies.

4.3 RESULTS

4.3.1 Operational and Raw Material Planning

The mass balance showed that, to meet the new demand, it would be necessary to increase the volume of processed milk by 47.98%, from approximately 14,200 liters/month to 21,000 liters/month. This result highlighted the need to strengthen partnerships with suppliers and seek new channels for capturing raw materials.

The calculations showed that yields for the different types of cheese were consistent. This fact suggests stability in the production process even in the face of expansion. However, it was observed that the central limitation of the technical feasibility of the expansion was not in the yield, but in the availability of goat's milk.

4.3.2 Operational Capability

The operational capacity of the factory was evaluated through the analysis of the use of the equipment, which showed different scenarios:

- Boursin cheese: presented an average idleness of 40.25%, indicating the possibility of absorbing part of the expansion with adjustments in the production schedule.
- Feta Cheese: the average idleness was 43.55%, revealing the need to reschedule production, due to the high time of use of tanks and presses.
- Minas Frescal Cheese: the high idleness (50.23%) demonstrated immediate feasibility of expansion by 50%, without the need for new investments.
- Matured Cheeses (Caprino Romano and Chevrotin): presented bottlenecks in the pressing and maturation stages. The 20% expansion would require the acquisition of new shelves for the cold room and structural adjustments.

In general, it was observed that the expansion is feasible, but requires an optimization of the production schedule and small investments in infrastructure.

4.3.3 Evaluation of Labor

The study of times and movements revealed that, in order to maintain efficiency after the expansion, it would be necessary to hire a new employee. Thus, the number of employees on the production line had to increase from two to three, ensuring that processing times remained equivalent to today.

4.3.4 Physical Structure and Facilities

The inspection of the facilities highlighted the need for improvements in floors, walls, ventilation and external areas, in order to align the production environment with legal requirements and good manufacturing practices. These adjustments were included in the action plan, reinforcing the commitment to food quality and safety.

4.4 ACTION PLAN (5W2H)

Based on the results, an action plan was drawn up covering:

- Raw material: expand milk collection through new suppliers and commercial negotiations with current partners.
- Production: optimize the use of equipment with the reprogramming of the schedule and acquisition of presses and shelves for maturation.
- Labor: Hiring a new employee to maintain operational efficiency.
- Physical structure: make adjustments to floors, walls, cold rooms and external areas to ensure sanitary compliance.

Thus, the study proved the feasibility of the planned expansion, as long as it is accompanied by adjustments in supplies, production schedule, labor and infrastructure. The analysis provided technical support for strategic decisions, strengthening the dairy's position in the market and contributing to the competitiveness of the new brand.

5 CONNECTION BETWEEN THEORY AND PRACTICE

The literature highlights that industrial competitiveness depends on the ability to innovate and respond quickly to market demands (MESSIAS; ROMÃO; ROLAND, 2020; ALVES, 2018). This perspective was evident in the case analyzed, in which the expansion of production was planned not only based on growth expectations, but supported by concrete data on operational capacity, yields and labor.

From the point of view of quality management, the use of methodologies such as mass balance, flowcharts, 5W2H and analysis of times and movements contributed to identifying the bottlenecks of the factory and proposing specific solutions. This practice dialogues directly

with the Knowledge Management and *Business Intelligence* approach, by transforming dispersed information into useful knowledge for decision-making (ALMEIDA and CAMARGO, 2015; SURBAKTI, 2015).

Thus, the integration between theory and practice presented in this chapter shows how performance and productivity management can become a competitive advantage in the food industry. The case study of Laticínio Piallet illustrates, in an applied way, the relevance of management tools and performance indicators as instruments to guide strategic and operational decisions.

5.1 INDICATORS TO SUPPORT DECISION MAKING

The performance indicators in the dairy analysis allowed the identification of equipment idleness, the additional need for milk and the production time per employee. According to Francischini and Francischini (2018), the indicators work as management guides, showing not only the current state of the operation, but also guiding corrections and improvements.

In this context, the average idleness indicator of 40.25% in the Boursin cheese production line revealed the possibility of expansion without major investments, while the indicators of use of presses and cold chambers for matured cheeses pointed to the need for new resources.

This quantitative analysis demonstrates how performance measurement systems (SMD) offer strategic support to management, enabling decision-making based on hard data and operational evidence. According to Cunha (2023), the effectiveness of SMD in industrial environments depends on the organization's ability to integrate data, technology, and a culture of continuous improvement, overcoming challenges such as inadequate selection of indicators, lack of alignment with corporate strategy, and limitations of real-time analysis.

In this way, the structured use of indicators allows transforming operational information into strategic inputs, guiding evidence-based decisions, strengthening organizational competitiveness, and promoting the efficiency and sustainability of production processes.

5.2 QUALITY MANAGEMENT AS A COMPETITIVE ADVANTAGE

In the case of Laticínio Piallet, although control charts were not applied in a formalized way, statistical reasoning was present in the calculation of yields and capacity indexes, which opens space for future implementations of a continuous statistical monitoring system, using the CEP.

5.3 CHALLENGES FOR SMALL AND MEDIUM INDUSTRIES

A relevant aspect is the finding that small and medium-sized food industries face particular challenges:

- Capital limitations for investments in new equipment;
- Dependence on local raw material suppliers;
- Need to adapt to regulatory requirements, often onerous;
- Shortage of skilled labor.

The case study showed that, even in the face of these restrictions, it is possible to apply modern industrial management practices, using low-cost tools (such as flowcharts, 5W2H and process timing) to obtain significant gains in efficiency and consequently competitiveness in the market.

5.4 FUTURE PROSPECTS

The experience of Laticínio Piallet points out paths that can be explored by other food industries:

6 FINAL CONSIDERATIONS

Performance and productivity management in the food industry is one of the fundamental pillars for competitiveness, sustainability and innovation. As discussed throughout this chapter, the sector lives under intense pressures from the consumer market, regulatory requirements and resource constraints, which requires companies to take a proactive stance of planning, monitoring and continuous improvement.

The theoretical foundation highlighted the importance of Systemic Industrial Management, which integrates knowledge, data and processes to transform information into assertive decisions. Tools such as Statistical Process Control (SPC), performance indicators, and the seven quality tools proved to be essential to reduce variability, guide action plans, and sustain consistent results.

The case study of Laticínio Piallet demonstrated, in practice, how theoretical concepts can be applied in a small agribusiness. Analysis of the expansion of the fine goat cheese line revealed:

- The need to increase milk collection by almost 50%, highlighting the importance of supply management;
- The feasibility of the expansion, given the existing idleness in certain equipment, as long as it is accompanied by rescheduling of production;

- The requirement for specific investments in presses and maturation shelves, in addition to hiring a new employee to maintain operational efficiency;
- The relevance of structural and sanitary adjustments, reinforcing the role of quality as a competitive differential.

This case reinforces that, even with limited resources, small and medium-sized industries can apply performance management methodologies effectively, obtaining significant gains in productivity and sustainability. The differential is in adopting management guided by indicators, supported by accessible quality tools and aligned with the organization's growth strategy.

In the future scenario, marked by digitalization, industry 4.0, and growing demands for sustainability, the ability to integrate data, people, and technology will be decisive for the survival and expansion of companies in the food sector. It is observed that this movement profoundly transforms the sector, making it essential to adopt smarter, more sustainable, and data-driven production practices.

Technological innovations and new market demands drive a structural change in the forms of management, in which efficiency, traceability and environmental responsibility are consolidated as pillars of competitiveness. In this context, understanding and applying performance and productivity management models is essential to ensure quality, efficiency, and sustainability in operations.

Therefore, this chapter contributes by offering an integrated look from theory to practice on performance and productivity management, demonstrating how scientific principles can be applied in a concrete way to support strategic decisions, strengthen competitiveness and ensure the production of safe and quality food.

REFERENCES

- Almeida, A. M. R., & Camargo, S. S. (2015). Aplicando técnicas de business intelligence sobre dados de desempenho acadêmico: Um estudo de caso. In *Anais da XI Escola Regional de Banco de Dados*. Sociedade Brasileira de Computação.
- Almeida, K. M., Novais, D. O., & Silva, J. C. B. V. (2024). Controle de qualidade na indústria de extrusados de milho. *Brazilian Journal Implantology and Health Sciences*, 6(3), 374–388.
- Alves, I., Borge, J. S. R., Holanda, M. V. R., & Reis, A. R. (2021). As contribuições da gestão do conhecimento no crescimento competitivo de empresas do setor industrial. *MBA em Gestão Estratégica de Negócios*. Instituto Federal Goiano, Campus Rio Verde.
- Agência Nacional de Vigilância Sanitária. (2002). Regulamento técnico de procedimentos operacionais padronizados aplicados aos estabelecimentos produtores/industrializadores de alimentos e a lista de verificação das boas práticas de

fabricação em estabelecimentos produtores/industrializadores de alimentos (RDC nº 275, de 21 de outubro de 2002). Diário Oficial da União.

Bahia, L. O. (2021). Guia referencial para construção e análise de indicadores. Enap.

Barros, H. N. de J., Libarino, C. S., & Amado, J. A. D. (2024). Análise de dados com business intelligence para monitoramento microbiológico na Indústria 4.0: Um estudo de caso simulado no setor alimentício. In Anais da Escola Regional de Computação Bahia, Alagoas e Sergipe (ERBASE), 24 (pp. 9–18). Sociedade Brasileira de Computação.

Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (1997). Regulamento técnico sobre as condições higiênico-sanitárias e de boas práticas de fabricação para estabelecimentos elaboradores/industrializadores de alimentos (Portaria nº 368, de 4 de setembro de 1997). Diário Oficial da União.

Camargo, A., Zanin, A., Espejo, M. M. dos S. B., & Kruger, S. D. (2022). Tomada de decisão subsidiada na gestão de custos: Uma análise de indústrias do estado de Mato Grosso do Sul. *Research, Society and Development*, 11(15).

Cohen, E., & Martinez, R. (2004). Manual de formulación, evaluación y monitoreo de proyectos sociales. División de Desarrollo Social, Comisión Económica para América Latina. <https://dds.cepal.org/redesoc/publicacion?id=242>

Cortivo, D. Z. (2005). Aplicação do controle estatístico de processo em seqüências curtas de produção e análise estatística de processo através do planejamento econômico [Dissertação de mestrado, Universidade Federal do Paraná].

Costa, A. F. B., Epprecht, E. K., & Carpinetti, L. C. R. (2004). Controle estatístico de qualidade. Editora Atlas.

Cunha, J., Dinis-Carvalho, J., & Sousa, R. M. (2023). Performance measurement systems in continuous improvement environments: Obstacles to their effectiveness. *Procedia CIRP*, 119, 307–312.

Daniel, E. A., & Murback, F. G. R. (2014). Levantamento bibliográfico do uso das ferramentas da qualidade. *Gestão & Conhecimento*, 8(1), 1–43.

Falconi, V. (2010). O valor da gestão (1ª ed.). Editora Falconi.

Francischini, A. S. N., & Francischini, P. G. (2018). Indicadores de desempenho: Dos objetivos à ação — métodos para elaborar KPIs e obter resultados. Alta Books.

Franken, D. A., Hammes, J., Polacinski, É., Lorenzett, D. B., Godoy, L. P., & Godoy, T. P. (2014). Controle estatístico de processos em uma empresa de agronegócios. *Revista de Administração da UFSM*, 7(3), 381–396.

Gouveia e Silva, A. P. (2011). CEP - Controle estatístico do processo - aplicação prática (1ª ed.). Editora Nelpa.

Instituto Brasileiro de Geografia e Estatística. (2021). Pesquisa da pecuária municipal. Tabela 3939. Efetivo dos rebanhos, por tipo de rebanho.

Inácio, L. C. dos R., et al. (2023). Ferramentas básicas da qualidade: Folha de verificação, estratificação, fluxograma, diagrama de Ishikawa, diagrama de Pareto, matriz GUT e 5W2H. *Revista de Gestão e Secretariado*, 14(10), 17413–17427.

Kanan, M., et al. (2023). Avaliando a implementação do controle estatístico de processos em indústrias alimentícias: Um estudo empírico em um contexto de país em

desenvolvimento. *Pesquisa Operacional em Ciências da Engenharia: Teoria e Aplicações*, 6(2).

Lobo, R. N. (2019). *Gestão da qualidade* (2ª ed.). Érica.

Martins, E. R. (2025). *Inteligência artificial aplicada: Soluções para um mundo automatizado*. Científica Digital.

Mello, C. H. P. (2011). *Gestão da qualidade*. Pearson Education do Brasil.

Mello, C. H. P., & Salgado, E. G. (2017). Mapeamento dos processos em serviços: Estudo de caso em duas pequenas empresas da área de saúde. In *Anais do Encontro Nacional de Engenharia de Produção*, 37. ABEPRO.

Mertz, A. B., et al. (2016). Implantação de indicadores de desempenho de produção em uma indústria de pães. *FACEF Pesquisa-Desenvolvimento e Gestão*, 19(1).

Messias, J. L., Romão, J. J., & Roland, P. H. S. (2020). Indústria 4.0: Percepção de gestores e estudantes quanto às competências necessárias [Trabalho de Conclusão de Curso, Graduação em Engenharia de Produção, Universidade Tecnológica Federal do Paraná].

Paladini, E. P. (2019). *Gestão da qualidade: Teoria e prática* (4ª ed.). Atlas.

Ribeiro, J. L. D., & Caten, C. S. (2012). *Série monográfica qualidade: Controle estatístico do processo*. FEEng/UFRGS.

Rodrigues, M., & Costa, A. L. (2019). Using business intelligence for continuous improvement in food production. *International Journal of Food Production*.

Shehzad, R., & Khan, M. N. A. (2013). Integrating knowledge management with business intelligence processes for enhanced organizational learning. *International Journal of Software Engineering and its Applications*, 7(2), 83–92.

Silva, B. O. S. da. (2023). Caracterização dos queijos de cabra tipo boursin, feta e Minas [Trabalho de Conclusão de Curso, Graduação em Engenharia de Alimentos, Universidade Federal de Uberlândia].

Stadler, H., & Seleme, R. (2013). *Controle da qualidade: As ferramentas essenciais* (1ª ed.). Editora Intersaberes.

Staudt, F. H., Landgraf, L. G., & Taboada Rodriguez, C. M. (2011). Um estudo sobre a previsão de demanda (PD) para gestão de estoques em uma indústria de laticínios. In *Anais do Simpósio de Engenharia de Produção (SIMPEP)*, XVIII. UNESP.

Surbakti, H. (2015). Integrating knowledge management and business intelligence processes for empowering government business organizations. *International Journal of Computer Applications*, 114(5), 36–43.

Tadini, C. C., Telis, V. R. N., Meirelles, A. J. A., & Pessoa Filho, P. A. (Eds.). (2016). *Operações unitárias na indústria de alimentos* (Vol. 2). LTC.

Turban, E., Sharda, R., Delen, D., & King, D. (2010). *Business intelligence: A managerial approach* (2nd ed.). Prentice Hall.

Weiss, J. W. (2011). *Business ethics: A stakeholder and issues management approach* (5th ed.). South-Western Cengage Learning.

UTILITY MODEL, TECHNOLOGICAL MATURITY, AND DUAL USE IN THE BRAZILIAN DEFENSE INDUSTRIAL BASE: AN ANALYSIS OF PATENT BR 202014017157-1 IN LIGHT OF TRL

MODELO DE UTILIDADE, MATURIDADE TECNOLÓGICA E EMPREGO DUAL NA BASE INDUSTRIAL DE DEFESA BRASILEIRA: UMA ANÁLISE DA PATENTE BR 202014017157-1 À LUZ DO TRL

MODELO DE UTILIDAD, MADUREZ TECNOLÓGICA Y USO DUAL EN LA BASE INDUSTRIAL DE DEFENSA BRASILEÑA: UN ANÁLISIS DE LA PATENTE BR 202014017157-1 A LA LUZ DEL TRL



<https://doi.org/10.56238/sevened2026.008-183>

Daniel Galrão de França Blaskiewicz¹, José Seixas de Aquino Filho², Roberto Augusto Caracas Neto³, Elizabeth Ferreira da Silva⁴, Eduardo Winter⁵

ABSTRACT

This study analyzes intellectual property (PI) management in the Brazilian Defense Industrial Base (BID), focusing on the underutilization of the Utility Models (MU) compared to invention patents. The main objective is to characterize patent BR 202014017157-1, related to a gas-powered pistol modification, a component of a shooting simulator, from the perspective of technological maturity (TRL) and dual-use potential. Through a qualitative and documentary approach, the research demonstrates that the MU is the most suitable instrument for incremental innovations at intermediate readiness levels (TRL 4 to 6), positioning them close to practical application. The analyzed technology shows high strategic versatility, enabling cost reduction and increased safety in both military training and in civilian and recreational contexts. The analysis outlines three strategic scenarios for managing the asset: restrictive, focused on national autonomy and maximum protection of sensitive secrets; Partial Opening, aimed at achieving scale and licensing to civilian markets and selected international partners; and hybrid, which combines patent protection with trade secrets to allow selective technical cooperation. It is concluded that the full exploitation of this asset requires robust institutional governance to manage power asymmetries in negotiations and maximize technological spillovers. Strengthening the BID depends on integrating the MU into mission-oriented incrementalism, ensuring sovereignty and industrial competitiveness.

¹ Master's degree in Mechanical Engineering. Instituto Militar de Engenharia (IME).
E-mail: engdanielgalrao@gmail.com.br Orcid: <https://orcid.org/0009-0006-1899-7082>
Lattes: <http://lattes.cnpq.br/830765484495321>

² MBA in Fiscal and Tax Auditing. E-mail: seixas.aquino@gmail.com
Orcid: <https://orcid.org/0009-0009-4343-3117> Lattes: <https://lattes.cnpq.br/0521203432218724>

³ Master's degree in Intellectual Property and Technology Transfer for Innovation. PROFNIT (IFCE).
E-mail: robertocaracas2000@gmail.com Orcid: <https://orcid.org/0000-0001-8484-411X>
Lattes: <http://lattes.cnpq.br/4553279121829196>

⁴ Dr. in Civil Engineering. COPPE/UFRJ. E-mail: silvafbeth@gmail.com
Orcid: <https://orcid.org/0000-0001-9899-2834> Lattes: <http://lattes.cnpq.br/9384248704175019>

⁵ Dr. in Sciences. Universidade Estadual de Campinas. E-mail: winterinpi@gmail.com
Orcid: <https://orcid.org/0000-0002-0896-9276> Lattes: <http://lattes.cnpq.br/5404510836890906>

Keywords: Utility Model. Technological Maturity. Defense Industrial Base. Dual-Use Technology. Incremental Innovation.

RESUMO

Este estudo analisa a gestão da propriedade intelectual (PI) na Base Industrial de Defesa (BID) brasileira, focando na subutilização do Modelo de Utilidade (MU) em comparação às patentes de invenção. O objetivo central é caracterizar a patente BR 202014017157-1, relativa a uma modificação de pistola acionada por gás, componente de um simulador de tiro, sob a ótica da maturidade tecnológica (TRL) e do potencial de emprego dual. Por meio de uma abordagem qualitativa e documental, a pesquisa demonstra que o MU é o instrumento mais adequado para inovações incrementais em níveis intermediários de prontidão (TRL 4 a 6), situando-se próximo da aplicação prática. A tecnologia analisada evidencia alta versatilidade estratégica, permitindo a redução de custos e o aumento da segurança tanto no adestramento militar quanto em contextos civis e recreativos. A análise delinea três cenários estratégicos para a gestão do ativo: (i) restritivo, focado na autonomia nacional e proteção máxima de segredos sensíveis; (ii) Abertura Parcial, voltado ao ganho de escala e licenciamento para mercados civis e parceiros internacionais; e (iii) híbrido, que combina proteção patentária e segredo industrial para cooperação técnica seletiva. Conclui-se que a plena exploração desse ativo exige uma governança institucional robusta para gerenciar assimetrias de poder em negociações e maximizar transbordamentos tecnológicos. O fortalecimento da BID depende da integração do MU ao incrementalismo orientado a missões, garantindo soberania e competitividade industrial.

Palavras-chave: Modelo de Utilidade. Maturidade Tecnológica. Base Industrial de Defesa. Tecnologia de Emprego Dual. Inovação Incremental.

RESUMEN

Este estudio analiza la gestión de la propiedad intelectual (PI) en la Base Industrial de Defensa (BID) brasileña, centrándose en la subutilización del Modelo de Utilidad (MU) en comparación con las patentes de invención. El objetivo central es caracterizar la patente BR 202014017157-1, relativa a una modificación de una pistola accionada por gas, componente de un simulador de tiro, desde la perspectiva de la madurez tecnológica (TRL) y del potencial de uso dual. A través de un enfoque cualitativo y documental, la investigación demuestra que el Modelo de Utilidad es el instrumento más adecuado para innovaciones incrementales en niveles intermedios de preparación (TRL 4 a 6), situándose cerca de la aplicación práctica. La tecnología analizada evidencia una alta versatilidad estratégica, permitiendo la reducción de costos y el aumento de la seguridad tanto en el entrenamiento militar como en contextos civiles y recreativos. El análisis plantea tres escenarios estratégicos para la gestión del activo: (i) restrictivo, enfocado en la autonomía nacional y la máxima protección de secretos sensibles; (ii) apertura parcial, orientada a lograr escala y licenciamiento para mercados civiles y socios internacionales; y (iii) híbrido, que combina protección patentaria y secreto industrial para cooperación técnica selectiva. Se concluye que la plena explotación de este activo requiere una gobernanza institucional robusta para gestionar las asimetrías de poder en las negociaciones y maximizar los derrames tecnológicos. El fortalecimiento de la BID depende de la integración del MU al incrementalismo orientado a misiones, garantizando soberanía y competitividad industrial.

Palabras clave: Modelo de Utilidad. Madurez Tecnológica. Base Industrial de Defensa. Tecnología de Uso Dual. Innovación Incremental.

1 INTRODUCTION

The Brazilian Defense Industrial Base (BID) has been consolidated as a strategic pillar for national sovereignty, especially after the regulatory framework of Law No. 12,598/2012.

This ecosystem is based on the search for technological autonomy and the ability to convert incremental innovations and dual-use technologies into assets of security and economic development (VERGUEIRO, 2023).

However, there is an asymmetry in the management of Intellectual Property (IP) in the sector: while invention patents dominate innovation agendas, the Utility Model (MU) institute remains underexplored (LIMA; GOMES, 2022). Yu (2009) highlights that property should serve the collective well-being and the development agenda, preventing excessive "constraints" from impeding subsequent innovation.

This movement does not occur in a legal vacuum, it was forged by the expansion of intellectual rights that transform inventions into goods of exclusive commercial use. According to Law No. 9,279/1996, the MU is the title dedicated to protecting functional improvements linked to the objects, that is, alteration in the three-dimensional configuration aimed at functional improvement, precisely aligning with the nature of many technological trajectories of the BID. Therefore, the utility model patent protects the object's adaptations with a focus on its functional performance, which contributes to an incremental technological learning dynamic.

Despite the relevance of incremental innovations, there is a gap in the national literature regarding the integration between the legal regime of MUs, the levels of technological *readiness* (TRL) and the concept of *dual-use technologies* within the context of defense (SOUZA; PINHEIRO, 2021).

According to Silva and Gomes (2021), this fragmentation makes it difficult for companies and regulatory bodies, such as the Ministry of Defense (MD) and the National Institute of Industrial Property (INPI), to make strategic decisions about which type of protection is most appropriate to the stage of maturity of a sensitive or critical technology. In this sense, a fundamental question stands out about the role that the utility model can play in stimulating technological and economic development in the country, both for the spillover of dual technology to the market, and in the assimilation of foreign technology to adapt it to the national context. Incremental cumulativeness can enclose an evolutionary strategy that may imply the emergence of more radical technological proposals, however, the limitation of the utility model patent being associated with functional improvement through the configuration of the object's form is highlighted.

Faced with this challenge, this article proposes the following research question: how is the MU BR 202014017157-1 patent characterized in terms of technological maturity and dual employment, and how does this asset fit into the IDB's strengthening strategy? And also, to elucidate IP strategies that can contribute to foster technological development strategies in reinforcement of Brazilian sovereignty.

The general objective of this study is to analyze the patent as an instrument of incremental and dual innovation, correlating its technical specificities to the Brazilian regulatory and institutional framework.

To this end, the research proposes to characterize the asset from the perspective of the TRL (NASA, 2013), identify its potential for civil-military application and discuss the viability of the MU as a tool for economic sustainability and national security.

This effort is justified by the pressing need to align the governance of sensitive knowledge with the demands of productivity and export control in force in the international scenario.

2 THEORETICAL FRAMEWORK

2.1 UTILITY MODEL AND INTELLECTUAL PROPERTY IN BRAZIL

The protection of intellectual property through the Utility Model (MU) patent is governed by Law No. 9,279/1996 (Industrial Property Law - LPI), which establishes:

"Article 9 - An object of practical use, or part thereof, susceptible to industrial application, which presents a new form or disposition, involving an inventive act, which results in functional improvement in its use or manufacture, is patentable as a utility model.

Article 10. The following are not considered inventions or utility models:

- I - discoveries, scientific theories and mathematical methods;
- II - purely abstract conceptions;
- III – commercial, accounting, financial, educational, advertising, lottery and inspection schemes, plans, principles or methods;
- IV – literary, architectural, artistic and scientific works or any aesthetic creation;
- V - computer programs themselves;
- VI - presentation of information;
- VII – rules of the game;
- VIII – operative or surgical techniques and methods, as well as therapeutic or diagnostic methods, for application in the human or animal body; and

IX – the whole or part of natural living beings and biological materials found in nature, or even isolated from it, including the genome or germplasm of any natural living being and natural biological processes."

In this sense, the purpose of the MU is to protect functional increments in the shape of the object, therefore, it requires a less rigorous requirement of inventiveness than the invention patent, due to its own incremental nature. In this sense, the analysis of obviousness seeks to assess the incremental inventive effort involved in the functional improvement of the form of the already existing object. Thus, these changes in the shape of the object to give it better performance in its functions cannot be obvious and evident to a technician in the area, being ideal for short technological cycles. Although the criterion of inventiveness is less rigorous, such increments in form must always be associated with a concrete technical effect, either in the performance or in the manufacturing process of the object (POLAR; KONETZ, 2025).

While the invention patent has stricter criteria regarding inventive step, being more robust and covering, as a rule, new technical solutions with a high degree of originality (WIPO, 2023), which makes it more complex to obtain when compared to MU. The choice for UM allows you to reduce costs and exam times, offering protection in line with crucial functional adjustments for the operability of equipment at BID. According to Boyle (2008), IP should avoid the "tragedy of the anti-commons", ensuring that technical protection does not stifle the public domain necessary for the progress of mind and industry (Boyle, 2008, p.179-204).

In Brazil, the term of validity of the MU is 15 years from the filing, lower than that of invention patents, which is 20 years. Such a difference reflects the incremental nature of the institute and its vocation for shorter technological cycles (ELOY et al., 2022).

From the perspective of innovation management, according to Eloy et al. (2023), the MU is particularly suitable for sectors in which competitive advantage depends on successive improvements in ergonomics, operational performance, reliability, or integration of components in already known systems, a recurring situation in defense products that undergo continuous processes of modernization and technological updating.

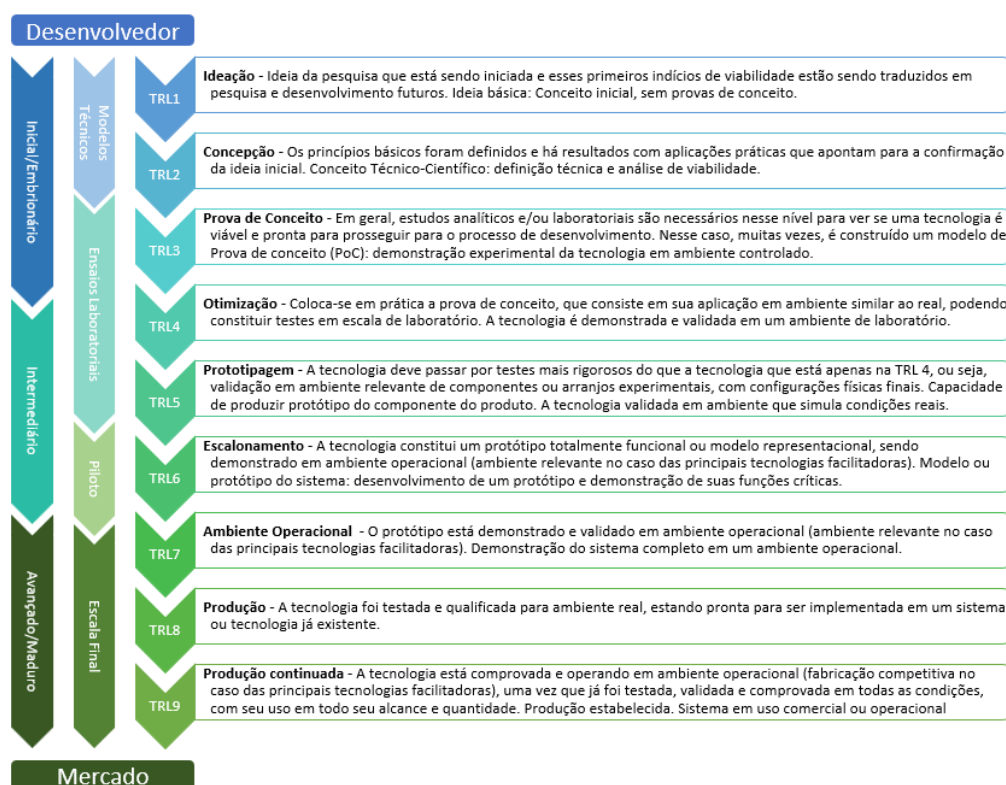
In terms of intellectual property strategy, MA (2023) and Jee (2024) collaborate that the choice of MU allows for a reduction in costs and examination times compared to an invention patent, in addition to offering protection more aligned with functional adjustments, which often would not reach the inventive level required for the invention category, but are crucial for the operability of equipment in the Defense Industrial Base (BID).

The utility model patent can contribute to a technological learning trajectory. This incremental route through the search for functional improvement, adaptations, can stimulate or favor the constitution of skill and technical competence, which are essential in issues involving technology transfer in the area of defense. In the case of the dual use of technology, this form of protection for incremental innovation creates a barrier to copying by competitors, stimulating the search for greater inventiveness, whose accumulation of knowledge can favor the emergence of more radical technologies.

2.2 TECHNOLOGY MATURITY LEVEL

The *Technology Readiness Level* (TRL) is a methodology developed by the National Aeronautics and Space Administration (NASA) to recognize and assess the maturity of technologies, ranging from basic research to operational implementation, with distinct levels that support innovation management decisions and the Research, Development and Innovation (RD&I) of complex systems (NASA, 2013). In the area of defense, the TRL guides strategies for intellectual protection and technology transfer according to the stage of development. Figure 1 presents the TRL levels and summarizes each stage.

Figure 1
TRL Scale



Source: INPI (2026).

It should be noted that basic research and conceptual formulation of a system occur in the initial TRLs, from 1 to 3. The intermediate levels, TRL 4 to 6, are intended for the validation of components and prototypes in a laboratory or relevant environment, while the upper levels, TRL 7 to 9, correspond to the demonstration and operation of the system in a real context, characterizing the products available for purchase or off-the-shelf (NASA, 2013).

According to Olechowski et al. (2020), this methodology was progressively absorbed by the United States Department of Defense (DoD) and other government organizations, which began to use it as a tool for technological risk management, RD&I resource allocation, and decision-making in military capability acquisition processes.

In the field of innovation, the TRL has been adopted as a cross-cutting indicator of technology readiness for different sectors, allowing comparability between projects and alignment between public and private actors in R&D portfolios (NASA, 2013).

In the area of defense, GAO (2020) corroborates that the application of TRL is articulated with the need to ensure that critical technologies reach adequate levels of maturity before their integration into weapons systems or sensitive infrastructures, mitigating performance and operational safety risks. In addition, the TRL guides intellectual protection and technology transfer strategies, according to the stage of development reached.

2.3 DEFENSE INDUSTRIAL BASE (BID) AND ECONOMIC OUTLOOK

The Brazilian BID operated even before the regulatory framework that was formally structured by Law No. 12,598/2012 (Law to promote the BID), historically contributing to national development. In this sense, the promotion and favoring of the industrial ecosystem are pillars that are articulated to promote the national defense industry in the institution of mechanisms for its strengthening, defining strategic companies, special contracting conditions and incentives for RD&I and the development of defense products (BRASIL, 2012).

Recently, Brazil made progress on this topic with the National Policy on the Defense Industrial Base (PNBID), through Decree 11,169/2022, which aims to ensure technological and productive autonomy for the Armed Forces, reducing external dependence and strengthening national sovereignty, which favored the emergence and development of new national companies for the defense sector.

Recently, the Defense Technological, Industrial and Commercial Compensation Policy (PComTIC Defesa), instituted by Ordinance GM-Ministry of Defense (MD) No. 3,990/2023, established an agreed mechanism in government procurement, especially in the defense sector, where the foreign supplier assumes counterparts (investments, technology transfer,

training) to maximize local benefits. In this way, the policy favors the transfer of critical technologies in strategic defense sectors, in favor of strengthening the national industry.

This normative framework resulted in direct benefits for the Brazilian BID, Pacheco and Perdone (2017) list such aspects as tax and fiscal advantages, differentials in bids and contracts, access to financing and R&D activities, in addition to the strengthening of the production chain. Thus, Brazil has been fostering the development of the defense sector and creating an ecosystem favorable to innovation, technological autonomy and the sustainability of the BID.

At the institutional level, the BID encompasses public and private companies, research centers, and military organizations, articulated in production chains that extend from materials and components to complex systems, including segments such as the aeronautics, naval, cybernetic, and remote sensing sectors (BRASIL, 2026).

This legal framework also establishes guidelines to privilege national technological content, encourage partnerships with universities and guide policies of technological compensation agreement (offset), with a view to consolidating technological autonomy and reducing external dependencies in sensitive areas. (PEIXOTO et al., 2025).

Based on open source indicators, we can see that the 2020-2025 panorama of the sector presented:

- Acceleration in investments (2025): the government announced R\$ 112.9 billion for the sector by 2026, aiming for 55% mastery in essential technologies (radars, satellites) (BRASIL, 2025).
- Strategic Projects (2025): R\$ 2.5 billion were reserved for the Gripen nuclear submarine and fighters (BRASIL, 2025).
- Industry growth: the sector registered a growth of 114% compared to 2023, with exports of US\$ 1.31 billion in the first half of 2025 (BRASIL, 2025).
- Total Budget of the Ministry of Finance (2025): authorized at R\$ 133.65 billion, with a concentration on mandatory expenditures (BRASIL, 2025).

These figures reinforce Okediji's (2003) argument about the need to harmonize IP laws with the goals of commercial sustainability and long-term technical development (OKEDIJI, 2003, p. 89-98).

In this context, the study by Dias Junior (2025) shows that innovation occupies a central position in the IDB's strategy, not only in the development of new products, but also in incremental adaptations and improvements of processes and systems, in the integration of sensors, in the improvement of the logistics chain, and in cyberdefense, often through cumulative and dual-use technological trajectories.

2.4 DUAL EMPLOYMENT TECHNOLOGIES

Dual-use technologies refer to products, processes, or knowledge that can be applied in both the civilian and military spheres, often involving items that transit between the commercial and defense markets, such as sensors, advanced materials, encryption software, and communication platforms. (VERGUEIRO, 2023).

In this context, *dual-use* constitutes a structural component of contemporary defense innovation regimes, as the boundary between the civil and military domains becomes more porous, and sectors such as aerospace, Information and Communication Technologies (ICT) and biotechnology begin to operate according to hybrid logics of financing, regulation and technology transfer (KILIÇ; BEYAZ, 2025).

From the perspective of the IDB, Moura (2022) highlights that dual employment technologies acquire strategic relevance by enabling business models that combine relatively stable but restricted military demands with expanding civilian markets, allowing for gains in scale and economic sustainability of highly complex production chains, in addition to reducing the government's dependence on resources. Companies in the defense industrial base depend on the regularity of resources, which, in times of crisis, become scarce, which can compromise the performance of these companies, contributing to the scenario of acquisitions and mergers by foreign companies.

It should be noted, however, that the controlled dissemination of dual-use knowledge requires refined strategies for the protection of intellectual property and the sharing of *know-how*, which may include patents, industrial secrets, conditional licenses, and contractual mechanisms for technology transfer, in order to balance the interests of security, competitiveness, and international cooperation (KILIÇ; BEYAZ, 2025).

In the field of patents and dual-use technologies, Acosta et al. (2018) found, based on empirical studies involving large defense companies, that a significant portion of their applications are composed of mixed technologies, classified simultaneously in civil and military codes. This fact confirms the centrality of *dual-use* as a standard of innovation in the sector.

By classifying patents into military, civilian, and mixed based on the International Patent Classification (IPC), these authors also demonstrate that companies with combined revenues in civil and military markets tend to generate more dual-use technologies, reinforcing the importance of intellectual property arrangements capable of capturing value at this intersection. In this case, utility models can be strategically employed in defense supply chains.

Caviggioli et al. (2020) and Acosta et al. (2020) analyzed civil-military patents and suggest that knowledge flows between military and civilian technologies obey asymmetric dynamics. In these dynamics, defense-oriented developments may in some cases radiate to civilian applications, but are also increasingly influenced by capabilities installed in technologically advanced commercial sectors.

Additionally, Sezal (2020) expanded this analysis by examining patents classified as civil, military, and mixed, demonstrating that *mixed patents* occupy a strategic position in knowledge flows. This finding presents a strong parallelism with the potential role of patent BR 202014017157-1 as a dual-use asset, situated on the border between defense operational demands and related civilian markets.

With regard to the identification of *dual-use* inventions, methodological approaches based on patent citation networks have been developed to detect which military innovations generate the greatest probability of spillover to civilian uses, highlighting the weight of characteristics such as technological breadth, geographic reach, and intensity of citations received (CAVIGGIOLI et al., 2023; EUROPEAN COMMISSION - JRC, 2019).

These studies indicate that the incidence of dual uses tends to be heterogeneous between technologies and countries, and that the first civilian applications of military inventions usually occur within national borders themselves. Evidence suggests that patents such as MU BR 202014017157-1 can induce and act as anchors for primarily domestic diffusion trajectories, anticipating eventual international expansions when associated with BID (CAVIGGIOLI et al., 2023; ACOSTA et al., 2018).

Vella (2025), when analyzing the articulation between dual-use research and TRL levels, in recent analyses by the European Union, argues that the framing of R&D projects in scales of technological maturity can facilitate the identification of windows of opportunity for civil-military cooperation, as well as the design of development instruments adjusted to the level of technological risk at each stage.

Another aspect highlighted by this author is the proposition of an integrated reading of innovation, security and industrial competitiveness policies. Vella points out that dual-use technologies located at intermediate levels of TRL are particularly sensitive, as they simultaneously require public support for demonstration in relevant environments and mechanisms to control diffusion. In this context, an MU like this BR 202014017157-1 is inserted in a paradigmatic way. According to Moura (2022), continuous investment in MU acquires strategic relevance by enabling business models that combine stable military demands with expanding civilian markets.

Mamoshina et al. (2022), when analyzing the field of governance and ethical risks associated with the diffusion of *dual-use* technologies, discuss how advances in areas such as biotechnology, AI, and data analytics can generate significant negative externalities if they are not accompanied by robust governance frameworks, including regulation, sectoral self-regulation, and responsible intellectual property instruments.

Although the focus of these authors falls on frontier technological fields, the reflection is applicable to the Brazilian BID and to patents such as BR 202014017157-1. To the extent that its dual-use exploitation must be conceived not only in terms of economic efficiency and technological autonomy, but also in light of the risks of unwanted proliferation and deviant uses of the technology.

In the specifically Brazilian context, Vergueiro (2023) points out that the development of dual-use technologies by the BID can act as a mechanism for economic and scientific development, as long as it is supported by consistent development policies, government procurement, and coordination between public and private actors.

By analyzing the national experience, this author highlights that the articulation between the defense industry, academia and the State, the triple helix model, is capable of transforming dual-use projects into vectors of productive diversification and generation of qualified jobs, which reinforces the relevance of exploring, in a planned way, the dual potential of Utility Models such as BR 202014017157-1.

In a similar vein, Silva and Costa (2021) emphasize that innovation in the BID requires long-term strategies that articulate investments in R&D, institutional strengthening, and the design of governance mechanisms capable of aligning the interests of the Armed Forces, companies, and S&T institutions, with emphasis on the adoption of models such as the *triple helix* (university-business-government).

The development of such technologies by the BID acts as a mechanism for economic and scientific development. The articulation between the triple helix of innovation is capable of transforming projects started in 2023 into vectors for generating qualified jobs.

When transposed to the analysis of patent BR 202014017157-1, these findings suggest that its full exploitation, whether in a restricted, partially open, or hybrid scenario, will depend on the ability to insert the MU in collaborative innovation networks that maximize learning, expand the base of dual-use applications, and consolidate cumulative technological trajectories in the field of defense (SILVA; COSTA, 2021).

3 METHODOLOGY

The research adopts a qualitative approach, of an exploratory nature, structured as a single case study, centered on the analysis of the patent of MU BR 202014017157-1, entitled Modification of a gas-fired pistol for use in shooting simulators, examined in the context of the Brazilian BID.

The choice of the case study is justified because it allows the in-depth investigation of a specific empirical object, enabling the understanding of the mechanisms of innovation, intellectual property protection and potential dynamics of dual use associated with technological development in the defense sector.

This methodological strategy is particularly suitable for exploring phenomena that are still poorly systematized in the national literature, contributing to the generation of *analytical insights* on the interaction between technology, market and public policies within the scope of the BID.

From the point of view of technical procedures, the research is characterized as documentary research, based on the systematic analysis of primary and secondary sources. The descriptive report, claims and drawings of the MU BR 202014017157-1 patent, as made available in public databases of the Brazilian Patent and Trademark Office (BPTO), as well as the relevant national legislation, in particular Law No. 9,279/1996 (Industrial Property Law) and Law No. 12,598/2012, which provides for special rules for purchases, contracting and development of defense products and systems.

In addition, a review of the national and international scientific literature, published from 2018 to 2025, was carried out, addressing topics such as *Technology Readiness Levels (TRL)*, *MU patents and dual-use technologies*, with the aim of contextualizing the case study and supporting the theoretical-conceptual analysis.

The analysis is developed in four main stages, namely:

- Functional analysis of the patent, with emphasis on the proposed technical solution, its operating principles and functional gains in relation to the state of the art;
- Identification of evidence of technological maturity, based on the analysis of descriptions related to tests, prototypes, applications and operational contexts eventually mentioned in the patent documentation;
- Classification of the level of technological readiness (TRL) of the protected technology, using as reference conceptual frameworks adopted by defense agencies, which define nine progressive levels of technological maturity, from the observation of basic principles to the validation of the system in an operational environment; e

- Evaluation of the potential for dual employment and the insertion of technology in the context of the BID, considering both military and civilian applications, as well as its implications for business models, technology transfer and productive sustainability.

It is recognized, as a limitation of the study, the exclusive use of information in the public domain, without access to sensitive operational data or confidential details of contracts, tests and certification processes. This restriction imposes interpretative caution both in the attribution of the TRL and in the inference of future trajectories of development, economic exploitation and institutional insertion of the patent.

4 PATENT ANALYSIS

4.1 IDENTIFICATION AND CONTEXTUALIZATION OF THE PATENT

The object of study is the patent of MU BR 202014017157-1, entitled modification of a gas-fired pistol for use in shooting simulators, deposited and made available in public databases of the BPTO.

The patent was filed with the aim of adapting gas-fired pistols for safe use in shooting simulators, while maintaining functional characteristics of the firing cycle and increasing compatibility with training platforms.

4.2 TECHNICAL CHARACTERIZATION OF THE SOLUTION

The utility model patent MU BR 202014017157-1 consists of a functional modification of the gas actuation mechanism of a pistol, without changing the basic principle of the weapon's operation.

The technical solution focuses on the reorganization of the internal elements of the drive and loading assembly, allowing:

- Faithful reproduction of the firing cycle in simulation environments;
- Integration with controlled training systems;
- Operational safety, avoiding the use of live ammunition; e
- Compatibility with civilian and military contexts (*dual-use*).

The analysis of the independent claim shows that the essential elements are the gas actuation assembly and its interaction with moving components, whose new arrangement allows clear functional gains compared to conventional guns, such as operational stability, safety and integration into simulators.

4.3 STATE OF THE ART AND FUNCTIONAL GAINS

It is an incremental innovation based on functional improvement, as can be seen in the comparison with the **state of the art** that shows:

Table 1

General data of the MU

Aspect	State of the art	Patent MU BR 202014017157-1
Operation	Conventional mechanical cycle	Simulated cycle, adapted for training
Simulator integration	Limited	Expanded compatibility with simulation platforms
Security	Restricted use	Reducing risks in a training environment
Functional gains	None specific to simulation	Stability, cycle fidelity, and security

Source: authors (2026).

The analysis shows incremental innovation typical of utility models, based on functional improvement and rearrangement of existing components (BARROS, 2025).

4.4 EVIDENCE OF TECHNOLOGY MATURITY (TRL)

Based on the public patent documentation, it is possible to infer approximate levels of TRL, considering descriptions of prototypes, tests, and potential applications (NASA, 2013):

Table 2

MU TRL

Evidence	Estimated level	Justification
Theoretical description and change report	TRL 2–3	Observation of principles and detailed design of the utility model
Prototype indication and laboratory tests of gas drive	TRL 4	Benchmark prototype, verified operation under controlled conditions
Possibility of integration with simulators	TRL 5–6	Testing in a semi-realistic context, validation of compatibility with training platforms
Effective operational use in military/civilian training	TRL 7–8	Potentially achievable stage, but not publicly confirmed

Source: authors (2026).

According to Contreras (2025), the documentation indicates that the MU technology is between TRL 4 and 6, validating compatibility in semi-realistic environments.

4.5 DUAL EMPLOYMENT POTENTIAL AND INSERTION IN THE BID

The technology has potential for dual use (SOUZA; PINHEIRO, 2021), and can serve:

- military applications in troop training and instruction in safe fire simulators; e

- civilian applications through shooting instructors, simulation in training academies and safety laboratories.

For Peixoto et al. (2025), from the point of view of the BID, the patent contributes to:

- increasing national capacities in training equipment;
- integration with technological autonomy policies;
- enabling incremental innovation and sustainability of production chains;
- possibility of licensing or technology transfer, respecting dual-use and security standards.

Thus, the feasibility of continuous investment in MU is justified by the speed of territorial protection, protecting tactical functional improvements, which guarantee sovereignty before gaining industrial scale (SUTHERSANEN, 2019).

5 DUAL EMPLOYMENT AND INSERTION IN THE BID

The patent of MU BR 202014017157-1, relating to the modification of a gas-fired pistol for use in shooting simulators, has a high potential for dual use, as it can simultaneously meet civilian and military demands (VERGUEIRO, 2023; HÄHNEL, 2025).

From a military perspective, the technology enables the training of security forces and units of the Armed Forces, through training systems, which faithfully reproduce the firing cycle, without the use of live ammunition, increasing the safety and efficiency of training (FEDARAVIČIUS, 2020).

Military technologies also contribute to the reduction of operational costs, as they allow continuous simulation exercises and tests in controlled environments, which favors the promotion of greater familiarization of users with tactical and operational procedures (STEVENS et al., 2025).

On the other hand, the civilian application of the technology is present in professional and recreational training contexts, such as sports shooting academies, training of private security instructors, and simulation in virtual or augmented reality (TORRES, 2019).

The versatility of the MU patent is evidenced and contributes to the constitution of strategic resources capable of synergistically generating, in different markets, a positive environment for expanding the user base and ensuring economic scalability without compromising the security or original purpose of the technology (VERGUEIRO, 2023).

Thus, the MU patent technology becomes an instrument of incremental innovation, which has the ability to enhance the transfer of knowledge between sectors and reinforce the logic of dual use in the Brazilian context (VELLA, 2025).

With regard to insertion in the BID, the technology protected by the patent in question can be strategically articulated in different dimensions (BID BRAZIL EXHIBITION), such as:

- integration into development programs and national certification, allowing strengthening the productive capacity of public and private companies, qualifying them for differentiated tax regimes, specific bids and R&D activities;
- articulation with universities and technological research centers, enabling the continuous improvement of the device, encouraging innovation and the formation of specialized human capital; e
- The technology meets the objectives of technological autonomy by reducing dependence on external solutions and fostering national competencies in safe, dual-use defense products.

Finally, the development and dissemination of this protected technology can generate positive effects on the competitiveness of the production chain, allowing licensing, partnerships and eventual export of training solutions, simultaneously contributing to the strengthening of the BID and to the consolidation of a national ecosystem of technological innovation oriented to defense (BARROS, 2025). However, it should be noted, in the case of exporting this technology, that not every national jurisdiction recognizes protection by utility model. Therefore, one should seek export to markets that admit protection by utility model and, strategically, claim protection by the Patent Cooperation Treatment (PCT) to guarantee exclusivity in these markets. The PCT admits the strategy of multiple deposits, which lowers the initial deposit costs and also allows time to be gained to select the markets, which will actually be confirmed at the beginning of the national phase. It should be noted that the national phase incurs other costs, being an expensive strategy for exploring international markets, which must be evaluated sparingly.

6 DISCUSSION

The results obtained in the analyses of patents, TRL, dual employment and insertion in the BID are compared with the literature on the economics of intellectual property and dual-use studies.

Patents function prominently both as essential mechanisms for the appropriation of value and as fundamental vectors for the global dissemination of technical knowledge (OECD, 2025).

Historically, the patent regime has evolved from a strictly national logic, linked to nineteenth-century industrialization, to a global architecture regulated by instruments such as the TRIPS Agreement. This transition has intensified the flow of technical information and the

management of exclusive rights in sensitive sectors such as defence and security (OECD, 2025).

In this scenario, the patent of MU BR 202014017157-1 emerges as a strategic asset of the Brazilian BID, as its publication in open databases is part of the global technical collection, while its classification as MU offers specific territorial protection, distinguishing it from the industrial property regimes of countries that do not adopt this modality (SUTHERSANEN, 2019).

The convergence between the MU patent and the technological maturity levels shows that this type of protection is the most suitable for incremental innovations in intermediate maturity stages, usually between TRL levels 4 and 6 (CONTRERAS, 2025).

At this level, the strategic priority shifts from radical scientific discovery to the consolidation of functional improvements in components or subsystems. Such assets are essential for the integration of complex defense systems or to provide critical civilian applications, ensuring the necessary robustness before gaining industrial scale (NASA, 2013).

Unlike invention patents, which often aim to protect disruptive innovations in early stages of development, low TRL, the MU is located at points in the technological trajectory closer to practical application and the market (JEE; HÖTTE, 2024).

In the context of dual-employment technologies, this feature is crucial, as it facilitates licensing and controlled diffusion strategies, allowing the BID to exploit economic synergies between the civilian and military sectors, optimizing the return on investment in RD&I (NASA, 2013; OECD, 2025).

This finding reinforces the need to incorporate the MU as a central analytical category in studies on defense innovation policies. Although the topic is still little explored in the national literature, it is fundamental for countries that seek to consolidate technological capabilities through an incremental mission-oriented trajectory, in which the continuous improvement of components and processes ensures both sovereignty and industrial competitiveness (MAZZUCATO, 2018).

Considering the economics of intellectual property and the historical context of protection regimes, it is possible to outline three evolution scenarios for patent BR 202014017157-1, each with its strategic advantages and disadvantages (OECD, 2025).

Based on the economics of intellectual property and the history of protection regimes, it is possible to outline three evolution scenarios for patent BR 202014017157-1, each with strategic advantages and disadvantages, as summarized in Table 3 (OECD, 2025).

Table 3*Scenarios analysed*

Scenario	Features	Strategic advantages	Disadvantages or risks
Patent Restriction	Exclusive use and limited licensing to BID companies in Brazil; Focus on Military Applications and Technology Control	Greater security of sensitive know-how, strengthening of national autonomy, and close alignment with defence policies	Less exploitation of civil markets, limited licensing revenues, risk of underutilization of innovative capacity, inefficient in open innovation environments
Partial Patent Opening	Expanded licensing for civilian markets and select international partners, promotion of collaborative R&D and new derivative patents	Increased licensing revenues, gain in productive scale; Accelerating the innovation cycle, strengthening the patent technology family	Risks of diffusion of sensitive knowledge, need for strict export controls, reliance on sophisticated contractual and regulatory frameworks
Hybrid Model	Combines patent protection with industrial secrecy and conditional technology transfer agreements, selective cooperation with companies and R&D institutions	Greater strategic flexibility, creation of innovation ecosystems, better alignment between security, competitiveness and technological diplomacy	Complexity of contractual governance, need for advanced institutional capacities, and risk of power asymmetry in international negotiations

Source: authors (2026).

These international and national results allow us to qualify the interpretation of the three scenarios of patent evolution. There is evidence that mixed and dual-use patents occupy a central position in the knowledge flows between the civil and military domains, in addition to reinforcing the adoption of a partial or hybrid openness scenario, which tends to generate a higher density of technological spillovers and derived patents, as long as it is accompanied by adequate governance and control regimes (ACOSTA et al., 2018; CAVIGGIOLI et al., 2023; VELLA, 2025).

At the same time, the comparative experience of technology transfers in defense shows that this openness is sensitive to asymmetries of power and institutional capacities. In the Brazilian context, this recommends prudence and a careful design of contracts and institutional arrangements in the choice between the three scenarios proposed for patent BR 202014017157-1 (SILVA; COSTA, 2021; SEZAL; GIUMELLI, 2022; VERGUEIRO, 2023).

7 CONCLUSIONS AND RECOMMENDATIONS

The analysis of patent BR 202014017157-1 confirms that the Utility Model (MU) is an underexplored instrument, but vital for strengthening the Defense Industrial Base (BID). It is concluded that the technology, located in intermediate levels of readiness (TRL 4 to 6), exemplifies mission-oriented incrementalism, where the focus is on the consolidation of functional improvements and immediate practical application. In this sense, it is pointed out

that the strategic use of intellectual property, in the contemporary context, should indicate that protection in the specific case should seek:

- a. National Security Protection Patent – when the object is strategic for the Defense Sector (Art 75 of the IP Law).
- b. Industrial Secret – when the tacitness of local knowledge is greater than the advantage of disclosure via patent.
- c. MU patent – when for *dual-use* innovations, the goal is to achieve commercial scale.

Unlike invention patents, which protect disruptive technologies, that is, the protection of radical innovations, the MU aims to protect incremental innovations, whose applicability is directed to niche markets, whose overflow of *dual-use technologies* is accepted and generates returns. Thus, the BID modernization cycle with an incremental focus aims at the dissemination of dual use in the market and, in the case of protection by utility model, implies lower costs, reduced examination times and focus on the operability of equipment, therefore, functional improvement obtained by the shape of existing objects. In the present case study, the dual employment nature of the asset is evident, integrating demands for secure military training with civilian instruction and simulation markets, which ensures economic scalability and productive sustainability.

To maximize the impact of this asset and future innovations at BID, the following recommendations are proposed:

- Improvement of Institutional Governance: It is imperative to strengthen the capabilities of the Ministry of Defense. It is recommended to adopt regimes that monitor confidentiality and benefit-sharing clauses, especially in international cooperation models, to mitigate risks of power asymmetry.

- Adoption of Hybrid Management Models: Given the porosity between the civil and military domains, it is recommended to prioritize partial or hybrid opening scenarios. These models allow the generation of technological spillovers and *the creation of derived patent families, ensuring that knowledge circulates without compromising sensitive industrial secrets*.

- promotion of the Triple Helix: The MU should be inserted in collaborative networks involving university, company and government. This articulation is capable of transforming dual-use projects into vectors of productive diversification, reducing external dependence by privileging a trajectory of technological learning in the promotion of the generation of national skills in critical areas.

- alignment with Defense Policies: The strategic use of IP must be integrated with the National Policy of the Defense Industrial Base (PNBID) and PComTIC. The goal should be

to convert incremental innovations into assets that ensure technological autonomy and industrial competitiveness in the long term.

In short, the transition from a restrictive "war economy" logic to models of strategic collaboration is essential for Brazilian sovereignty. The planned management of the dual potential of the studied patent serves as a paradigm for the consolidation of a resilient national innovation ecosystem, thus, the success of BID requires that Brazil is not an exporter of raw materials, but captures value via IP to avoid the obsolescence of our technologies and military doctrine. In addition, the spillover of dual technology to the market for companies in the defense industrial base implies less dependence on government resources and, simultaneously, generates greater domestic economic dynamism.

REFERENCES

- Acosta, M., Coronado, D., Ferrándiz, E., Marín, M. R., & Moreno, P. J. (2018). Patents and dual-use technology: An empirical study of the world's largest defence companies. *Defence and Peace Economics*, 29(7), 821–839. <https://doi.org/10.1080/10242694.2017.1303239>
- Barros, M. (2025, November 24). Indústria de defesa no Brasil impulsiona P&D, cria spin offs e tecnologias dual use, acelera a economia e amplia autonomia do aeroespacial ao cibernético. *DefesaTV*. <https://www.defesa.tv.br/industria-de-defesa-no-brasil-impulsiona-pd-cria-spin-offs-e-tecnologias-dual-use-acelera-a-economia-e-amplia-autonomia-do-aeroespacial-ao-cibernetico>
- Boyle, J. (2008). *The public domain: Enclosing the commons of the mind*. Yale University Press.
- Brasil. (2022a). Decreto nº 11.169, de 10 de agosto de 2022. Institui a Política Nacional da Base Industrial de Defesa – PNBID. *Diário Oficial da União*: Seção 1, p. 2.
- Brasil. (2022b). Decreto nº 11.170, de 10 de agosto de 2022. Institui a Política de Compensação Tecnológica, Industrial e Comercial de Defesa – PComTIC Defesa. *Diário Oficial da União*: Seção 1.
- Brasil. (1996). Lei nº 9.279, de 14 de maio de 1996. Regula direitos e obrigações relativos à propriedade industrial. *Diário Oficial da União*: Seção 1.
- Brasil. (2012). Lei nº 12.598, de 21 de março de 2012. Dispõe sobre normas especiais para as compras, as contratações e o desenvolvimento de produtos e de sistemas de defesa; institui o Regime Especial Tributário para a Indústria de Defesa (RETID); e dá outras providências. *Diário Oficial da União*: Seção 1.
- Brasil. Ministério da Defesa. (n.d.). Base Industrial de Defesa (BID).
- Brasil. Ministério da Defesa. (2025). Orçamento e indicadores do Ministério da Defesa: Panorama 2025. Secretaria de Economia e Finanças.
- Caviggioli, F., De Marco, A., & Scellato, G. (2020). Investigating the capabilities and competitiveness of the EU vis-à-vis its main competitors in developing civilian technologies with critical spillovers into defence. JRC Publications Repository, European Commission.

- Contreras, J. L., Husovec, M., & Rimmer, M. (2025). Utility models and other forms of sub-patent protection. In J. L. Contreras (Ed.), *Sub-patent innovation rights: Utility models, petty patents and innovation patents around the world* (pp. 1–18). Cambridge University Press.
- Dias Júnior, H. (2025). Inovação tecnológica na defesa: O papel do Estado no desenvolvimento nacional. *Revista da UNIFA*, 38, 1–20. <https://doi.org/10.22480/rev.unifa.2025.38.1047>
- Eloy, B. R., Santos, J. A. B., Cruz, C. A., Quintino, H. M. da S., Garcez Júnior, S. S., & Uchôa, F. O. (2023). Utility model patent protection scenario in Brazil and the indication of excessive rigor in the inventive examination. *International Journal for Innovation Education and Research*, 11(1), 23.
- European Commission – JRC. (2019). *Assessing the innovation capability of EU companies in dual use technologies*. Publications Office of the European Union.
- Fedaravičius, A., Pilkauskas, K., Slizys, E., & Survila, A. (2020). Research and development of training pistols for laser shooting simulation system. *Defence Technology*, 16, 530–534. <https://doi.org/10.1016/j.dt.2019.06.018>
- GAO-04-248. (2020). *Defense acquisitions: Assessments of major weapon programs*. Government Accountability Office.
- Hähnel, M. (2025). Conceptualizing dual use: A multidimensional approach. *Journal of Responsible Innovation*.
- Instituto Nacional de Propriedade Intelectual. (2026). Valorando a PI. <https://www.gov.br/inpi/pt-br/inpi-data/valor-economico-e-gestao-estrategica-da-pi/valorando-a-pi>
- Jee, S. J., & Hötte, K. (2024, August 26). From catch up to frontier: The utility model as a learning device to escape the middle income trap. *arXiv*.
- Kılıç, E., & Beyaz, B. (2025). Defensive acquisition tactics in dual-use technologies: Striking a balance between security and economy. *SSD Journal*. <https://doi.org/10.5281/zenodo.17695438>
- Lima, J. C. S., & Gomes, C. R. P. (2022). Propriedade intelectual e a Base Industrial de Defesa: Um estudo sobre a proteção de tecnologias sensíveis no Brasil. *Cadernos de Gestão e Empreendedorismo*, 10(1), 45–62.
- Ma, R. (2023). The impact of utility model patent quality on export performance and innovation pathways. *Sustainability*, 15(10).
- Mamoshina, A., et al. (2022). Responsible innovation in dual-use life science and emerging technologies. *Science and Engineering Ethics*, 28(2).
- Mostra BID Brasil. (n.d.). *Mostra BID Brasil – inovação e parcerias estratégicas*.
- Mazzucato, M. (2018). Mission-oriented innovation policies: Challenges and opportunities. *International Journal of Critical Cultural Studies (ICC)*, 27(5), 803–821.
- Moura, J. A. A. (2022). Dualidade, integração e fusão militar-civil na indústria de defesa. *Revista Brasileira de Estudos Estratégicos*.
- NASA. (2013). *Technology readiness levels in the Department of Defense*. National Academies Press.
- OECD. (2025). *OECD science, technology and innovation outlook 2025*. OECD Publishing.

- Olechowski, A., Eppinger, S. D., & Joglekar, N. (2020). Technology readiness levels: Shortcomings and improvement opportunities. *Systems Engineering*.
- Okediji, R. L. (2003). Treaty development and harmonization of intellectual property law. In C. Bellmann (Ed.), *Trading in knowledge*. Earthscan.
- Pacheco, T., & Pedone, L. (2017). Incentivos governamentais e indústria de defesa. *Revista Brasileira De Estudos De Defesa*, 3(2). <https://doi.org/10.26792/rbed.v3n2.2016.71618>
- Peixoto, M. A. M., Cruz, T. C. da S., Carvalho, S. M. S., Costa, A. A., & Machado, T. M. (2025). Acordos de compensação tecnológica e industrial no Exército Brasileiro: Panorama normativo e implicações para inovação e autonomia estratégica em defesa. *Revista de Geopolítica*, 16(5), Article e895.
- Polater, S., & Konertz, R. (2025). The novelty and the inventive level that utility models should have according to Turkish law – A comparative study of Turkish and German law. *IIC*, 56, 470–500. <https://doi.org/10.1007/s40319-025-01564-x>
- Sezal, M. A., et al. (2020). Civil-military patents and technological knowledge flows into the leading defense firms. *Armed Forces & Society* (Preprint MPRA 123080).
- Silva, R., & Costa, J. R. de A. (2021). Inovação e Base Industrial de Defesa: Desafios e perspectivas. *Revista Brasileira de Estudos de Defesa*.
- Silva, L. M., & Pereira, R. V. (2021). Desafios da propriedade intelectual em tecnologias sensíveis: O papel do Ministério da Defesa e do INPI. *Revista Brasileira de Estudos de Defesa*, 8(2).
- Souza, G. H. B. de, & Pinheiro, A. M. P. (2021). Gestão da propriedade intelectual e níveis de maturidade tecnológica: Um estudo sobre a proteção em projetos de PD&I. *Revista Gestão e Tecnologia*, 21(4), 200–222.
- Stevens, J., Mondesire, S. C., & Maxwell, D. (2025). Simulation in military training: Recent developments. *ResearchGate*.
- Suthersanen, U. (2019). Utility models: Do they really serve national innovation strategies? In J. Drexel & A. K. Sanders (Eds.), *The innovation society and intellectual property* (pp. 2–24). Edward Elgar Publishing.
- Torres, et al. (2019). Use of virtual reality simulators for training programs in the areas of security and defense: A systematic review. *ResearchGate*.
- Vella, M. (2025). Unlocking the potential of dual-use research and innovation. *European Commission*.
- Vella, V., et al. (2025). Unlocking the potential of dual use research and innovation. *University of Liège*.
- Vergueiro, G. (2023). Modelo de utilidade e maturidade tecnológica na BID. *Ministério da Defesa*.
- World Intellectual Property Organization. (2023). Patent judicial guide: Brazil – inventive step.
- Yu, P. K. (2009). A tale of two development agendas. *Ohio Northern University Law Review*, 35, 466–573.

ANALYSIS OF WATER LOSS INDICATORS AND THEIR RELATIONSHIP WITH SOCIOECONOMIC INEQUALITY IN THE STATE OF RIO DE JANEIRO

ANÁLISIS DE LOS INDICADORES DE PÉRDIDA DE AGUA Y SU RELACIÓN CON LA DESIGUALDAD SOCIOECONÓMICA EN EL ESTADO DE RÍO DE JANEIRO

ANÁLISE DOS INDICADORES DE PERDAS DE ÁGUA E SUA RELAÇÃO COM A DESIGUALDADE SOCIOECONÔMICA NO ESTADO DO RIO DE JANEIRO



<https://doi.org/10.56238/sevened2026.008-184>

Vitória Xavier Rodrigues¹, João Victor Abreu Rodrigues², Anna Virginia de Muniz Machado³

ABSTRACT

This article presents a sociotechnical analysis of water losses in distribution systems, investigating the correlation between structural inefficiencies and social inequalities. The study draws on data from SINISA (2023) and the Brazilian Institute of Geography and Statistics (IBGE) Demographic Census (2022) to outline a framework ranging from the national scale to a case study in the State of Rio de Janeiro. The results indicate that Brazil loses approximately 40% of the potable water produced, with the State of Rio de Janeiro exhibiting loss rates exceeding 50%, the worst performance in the Southeast region. Spatial analysis revealed a strong correlation between low-income areas, such as the Baixada Fluminense, and high levels of both physical and non-revenue water losses, in contrast to high-income areas such as Niterói, which demonstrate greater operational efficiency. It is concluded that inadequate infrastructure is not merely a technical issue, but rather a component of water injustice that perpetuates historical exclusions and hinders the achievement of the Sustainable Development Goals (SDGs) 6, 10, and 11.

Keywords: Water Losses. Water Justice. Basic Sanitation. Distribution Networks. Rio de Janeiro.

RESUMO

Este artigo apresenta uma análise sociotécnica das perdas de água na distribuição, investigando a correlação entre ineficiências estruturais e desigualdades sociais. O estudo utiliza dados do SINISA (2023) e do Censo Demográfico do IBGE (2022) para traçar um panorama que vai da escala nacional a um estudo de caso no Estado do Rio de Janeiro. Os resultados demonstram que o Brasil perde cerca de 40% da água potável produzida,

¹ Undergraduate Student in Water Resources and Environmental Engineering. Universidade Federal Fluminense (UFF). E-mail: vitoriarrod@gmail.com Orcid: 0009-0002-9239-3026
Lattes: <http://lattes.cnpq.br/4666907446380636>

² Graduated in Industrial Design. Universidade Federal Fluminense (UFF).
E-mail: Joaovictorabreurodrigues@id.uff.br Orcid: 0009-0001-1344-8176

³ Dr. in Civil Engineering. Universidade Federal Fluminense (UFF). E-mail: annavirginia@id.uff.br
Orcid: 0000-0001-5793-8591

com o Rio de Janeiro apresentando índices superiores a 50%, o pior desempenho da região Sudeste. A análise espacial revelou uma forte correlação entre áreas de baixa renda, como a Baixada Fluminense, e altos índices de perdas físicas e de faturamento, contrastando com áreas de alta renda, como Niterói, que possuem maior eficiência. Conclui-se que a infraestrutura precária não é apenas um problema técnico, mas compõe o panorama de injustiça hídrica que perpetua exclusões históricas e dificulta o cumprimento dos Objetivos de Desenvolvimento Sustentável (ODS) 6, 10 e 11.

Palavras-chave: Perdas de Água. Justiça Hídrica. Saneamento Básico. Redes de Distribuição. Rio de Janeiro.

RESUMEN

Este artículo presenta un análisis sociotécnico de las pérdidas de agua en los sistemas de distribución, investigando la correlación entre las ineficiencias estructurales y las desigualdades sociales. El estudio se basa en datos del SINISA (2023) y del Censo Demográfico del Instituto Brasileño de Geografía y Estadística (IBGE) (2022) para delinear un marco que abarca desde la escala nacional hasta un estudio de caso en el estado de Río de Janeiro. Los resultados indican que Brasil pierde aproximadamente el 40% del agua potable producida, y que el estado de Río de Janeiro presenta tasas de pérdida superiores al 50%, el peor desempeño de la región Sudeste. El análisis espacial reveló una fuerte correlación entre las zonas de bajos ingresos, como la Baixada Fluminense, y los altos niveles de pérdidas de agua, tanto físicas como no contabilizadas, en contraste con las zonas de altos ingresos como Niterói, que demuestra una mayor eficiencia operativa. Se concluye que la infraestructura inadecuada no es un mero problema técnico, sino un componente de la injusticia hídrica que perpetúa exclusiones históricas y obstaculiza el logro de los Objetivos de Desarrollo Sostenible (ODS) 6, 10 y 11.

Palabras clave: Pérdidas de Agua. Justicia Hídrica. Saneamiento Básico. Redes de Distribución. Río de Janeiro.

1 INTRODUCTION

Brazil loses about 40% of the drinking water produced and distributed for consumption annually (Trata Brasil, 2024), which shows a critical scenario in the management of water resources. This statistic makes explicit one of the greatest structural inefficiencies among developing countries and directly compromises the fulfillment of Sustainable Development Goal 6 (SDG 6), which seeks to ensure the availability and sustainable management of water and basic sanitation for all (UN, 2015).

According to the International Water Association (IWA, 2022), the high rate of non-revenue water, known by the term Non-Revenue Water, generates impacts that go beyond financial loss. The structural flaw translates into intermittent supply and high tariffs that disproportionately penalize the poorest, since the operating costs of losses are often passed on to the final consumer (Trata Brasil, 2024), while the precariousness of supply is concentrated in lower-income areas (Britto et al., 2011). This dynamic deepens social disparities, contradicting SDG 10, which focuses on reducing inequalities within countries, in addition to making it difficult to maintain resilient urban infrastructure, which directly hurts the premises of SDG 11, whose objective is to make cities and local communities inclusive and sustainable.

The precariousness of distribution networks, especially in peripheral urban areas, reflects social and racial inequalities rooted in the country's historical formation (Santos et al., 2021; Mota et al., 2021). This socio-technical dimension of supply shows that the problems of water loss and lack are not merely technical, but cross issues of equity, public management and the human right to water.

In the State of Rio de Janeiro, municipalities such as São Gonçalo and Duque de Caxias illustrate this phenomenon well. Despite having formal network coverage above 80%, they suffer from low per capita consumption rates and high loss rates (IBGE, 2022; SINISA, 2024). This contradiction suggests that the problem lies in the degraded infrastructure, associated with social vulnerability and the absence of redistributive policies.

Given this scenario, this article analyzes water losses from a social justice perspective. The objective is to investigate the correlation between structural deficiencies that cause physical losses and social inequalities in the territory. To this end, the research adopts a scale approach, starting with a macroscopic analysis of national data and funneling to a regional cut in the State of Rio de Janeiro. It is proposed here that the technical project transcends its specific function and shows itself as a strategic tool for the promotion of water justice and, concomitantly, for the advancement of the Sustainable Development Goals.

2 THEORETICAL FOUNDATION

2.1 WATER LOSSES: DEFINITIONS, TYPOLOGIES AND INDICATORS

The efficiency of supply systems is commonly measured by the Non-Revenue Water (NRW) index. For the purposes of national standardization and regulation, this article adopts the nomenclature established by the National Sanitation Information System, SINISA. The water goes through different processes from the moment of its capture until it reaches the final consumer, so the schematization of this movement, known as Water Balance, helps to identify problems along the network. This balance divides the volume of water made available into authorized consumption and unauthorized consumption, the latter being our research focus, as it corresponds to what we call losses, which also covers two subcategories.

The first subcategory of unauthorised consumption refers to apparent losses, technically referred to as commercial losses. These correspond to the volume of water that, although effectively consumed, is not billed by the service provider due to factors such as water meter failure, registration errors or irregularities in the network, impacting the financial sustainability of the system without necessarily representing waste of the natural resource.

On the other hand, the second category is composed of real losses, or physical losses. Unlike the apparent ones, these represent the volume of treated water that is extracted from the system before reaching the final consumer, resulting from infrastructure failures, such as leaks in pipelines, overflows in reservoirs and pipe ruptures. The control of these losses requires a rigorous technical approach, since high indicators of real losses suggest obsolescence of the infrastructure, while high apparent losses point to inefficiencies in commercial management. In the Brazilian scenario, where the average distribution loss exceeds 37% (SINISA, 2024), it is imperative to analyze these two typologies not only as operational failures, but as symptoms of network engineering that needs a strategic review.

2.2 THE MATERIALITY OF THE NETWORK

The incidence of real losses is directly linked to design decisions and the quality of the materials used at the time of network construction, usually associated with unbridled urban expansion. The choice between different classes of materials, such as PVC or cast iron, and the definition of pressure classes, influence the durability and resilience of the system (Bezerra; Macêdo, 2018).

In the specific context of the State of Rio de Janeiro, a spatial phenomenon related

to the historical occupation of the territory is observed. The oldest networks, dating from the nineteenth and early twentieth centuries, are concentrated where the settlement was consolidated, such as the Center and the South Zone of the capital (Koifman, 2013). However, despite their advanced age, these systems have historically had project revisits and preventive maintenance that other regions do not receive. On the other hand, the expansion of the network to the Baixada Fluminense and the West Zone occurred late and unevenly, consolidating a pattern of center-periphery segregation in infrastructure (Britto; Quintsler, 2017), often characterized by technical improvisations to meet a repressed demand without proper hydraulic planning (Marques, 2018).

In peripheral regions, the critical factor goes beyond the age of the pipe, but the operational regime to which it is subjected. The intermittency in the supply generates water hammers, a phenomenon caused by a sudden change in the flow of water, which subjects the network to cycles of pressure loading and unloading, damaging the system, and is even capable of causing the rupture of the pipes and their accessories. According to Tsutiya (2006), this oscillation accelerates the fatigue of the materials, causing frequent ruptures even in pipes that are not necessarily old. That said, it is observed that the project engineering in these locations faces a double challenge: the precariousness of the original installation and the operational stress caused by the lack of water itself.

2.3 WATER JUSTICE AND THE SOCIO-TECHNICAL DIMENSION

The concept of water justice arises from the expansion of environmental justice, recognizing that the impacts of lack of water or precarious access fall disproportionately on the poorest, blackest, and peripheral groups (Fracalanza, 2015; Tonel et al., 2021). The human right to water, recognized by the UN, is continuously violated not by natural scarcity, but by institutional inefficiencies and inequality of investments (Roth et al., 2018).

In Brazil, water injustice is aggravated by uneven urbanization. Supply networks are concentrated in central and higher-income areas, while peripheries and informal communities face chronic shortages and low quality of services (Fracalanza, et al, 2022). Authors such as Santos, et al. (2021) and Mota, et al. (2021) argue that inequality in access reflects power relations and racial and economic hierarchies. In addition, Gouveia, et al (2023) created the term "hydroracial scarcity" to describe how unequal access to water in metropolitan eastern Rio de Janeiro reflects historical inequalities based on race and class. Thus, water infrastructure becomes an instrument of social domination, where engineering, instead of promoting equity, reproduces historical exclusions.

The context of vulnerability is aggravated by the way in which loss management is

carried out. To compensate for the rates of physical losses, many operators increase the pressure at times of lower consumption or carry out selective rationing, penalizing the network peaks, precisely where the most vulnerable populations live (Britto et al., 2011). Thus, the struggle for loss reduction transcends the technical goal; It is a necessary condition for the guarantee of human rights and for the correction of historical injustices in the urban fabric.

2.4 AGENDA 2023: ENGINEERING AND SOCIAL EQUITY

Overcoming the scenario of hydro-racial scarcity and infrastructural precariousness dialogues directly with the 2030 Agenda of the United Nations. Although water resources engineering is traditionally associated with goals in the operational sphere, it plays a key role in meeting the Sustainable Development Goals (SDGs).

SDG 6, referring to Drinking Water and Sanitation, establishes in its goal 6.1, the universalization of equitable access. However, it is in goal 6.4 that network engineering comes into the spotlight, as it requires a substantial increase in efficiency in the use of water. In the context of Brazil, reducing physical losses is not limited to a measure of saving resources or the supply of treated water, but is the only solution to ensure the water availability necessary to universalize access and quality monitoring in the peripheries (UN, 2015).

At the same time, loss management is intrinsically linked to SDG 10, which refers to the reduction of inequalities. As previously discussed, the inefficiency of the systems disproportionately penalizes peripheral populations, either by high tariffs or by intermittency in supply. In this way, investments focused on the modernization of networks in low-income areas act as redistributive policies, in line with goal 10.2, which aims to empower and promote the social and economic inclusion of all citizens.

In addition, resilience in the infrastructure of distribution networks is central to SDG 11, which deals with the creation of sustainable cities and communities. Target 11.5 seeks to reduce the number of people affected by disasters and economic vulnerability. Fragile distribution networks, subject to constant disruptions and unable to provide adequate pressure for supply, compromise health security within the state. Thus, the replacement of obsolete and low-quality materials, together with the technological control of pressures, transcend technique, characterizing themselves as fundamental requirements for the construction of inclusive and resilient cities.

3 METHODOLOGY

3.1 DELIMITATION OF RESEARCH AND DATA SOURCES

The present study was based on the analysis of secondary data from the report of the National Basic Sanitation Information System (SINISA), referring to the "Technical Water Management" module with base year 2023, published in 2024. The time frame chosen is justified by the fact that it is the most recent data set available at the time of the research. In addition, this database has national coverage and standardized collection forms, as detailed in the Glossary of Information - Water Supply (SINISA, 2024), facilitating the observation of how the indicators behave throughout the national territory.

In addition, for the socioeconomic characterization of Brazil and the State of Rio de Janeiro, information was extracted from the Brazilian Institute of Geography and Statistics (IBGE), through the IBGE Automatic Recovery System (SIDRA), focusing on the most recent Demographic Census, referring to 2022. The option for the Census is due to its universal coverage and availability of data at the municipal level, which is the smallest unit of analysis of the survey.

3.2 ANALYSIS STRATEGY AND SPATIAL SCALES

The data analysis was structured under a multiscale approach, starting from the macroscopic dimension to a regional approach. On the macro scale, the national panorama was used, with the analysis of the overall efficiency of the Brazilian federative units, using choropleth maps to identify patterns of inequality in the performance of the indicators. On the micro scale, a regional case study was carried out with a focus on the State of Rio de Janeiro, where the technique of comparative cartography was adopted, confronting the spatial distribution of water losses with indicators of social vulnerability.

3.3 SELECTION OF INDICATORS

To diagnose the efficiency of the distribution systems, four main indicators were selected from the "Water Indices (AGI)" group of SINISA, following technical criteria to demonstrate the dimensions of apparent losses and actual losses, as shown in Table 1.

Table 1

Selected Water Loss Indicators

Indicator Code	Indicator Name	Type of Loss	Unit
IAG2012	Water billing losses	Apparent (Commercial)	%
IAG2013	Total water losses in	Total (Actual +	%

	distribution	Apparent)	
IAG2014	Total linear losses	Intensity of loss	m ³ /km/day
IAG2015	Total water losses per connection	Intensity of loss	l/link/day

Source: SINISA (2024).

Although all indicators were considered in the exploratory phase of the data, the visualization strategy prioritized those with greater adherence to the sociotechnical hypotheses of the study. To introduce the national panorama and the case study, the indicator of total water losses in distribution (IAG2013) was adopted. The choice of this percentage indicator is justified by its ability to summarize the overall efficiency of the Brazilian water distribution system, facilitating the initial comparison between the federative units and municipalities of Rio de Janeiro.

For the technical analysis of the infrastructure in the State of Rio de Janeiro, it was decided to use two indicators, the linear total losses (IAG2014) and the total water losses per connection (IAG2015). These indices are able to bring a more robust metric to diagnose the physical state of the network and the level of operational stress, since they quantify the intensity of the loss.

Finally, a final analysis of economic correlation was made using the specific indicator of losses in water billing (IAG2012). This variable was selected for its sensitivity to commercial loss and delinquency, helping to test the hypothesis that the difficulty in invoicing is spatially correlated to regions with lower purchasing power.

For the socioeconomic analysis, we opted for the use of the median monthly household income per capita (2022 Census). The choice of the median to the detriment of the mean is justified by the history of great inequality in the state chosen for analysis. The use of the average would cause distortion due to the extreme values centralized in some regions, so the median offers a more robust representation of the economic vulnerability of the typical citizen of each municipality.

3.4 DATA PROCESSING AND PROCESSING

The data were processed and analyzed using geoprocessing techniques in the Geographic Information System software QGIS (version 3.40.11). The first stage consisted of the integration of the databases. The cartographic databases, obtained from the IBGE itself, were joined to the tabular data from SINISA and the Demographic Census. To ensure the correct association of the information, this junction was performed using two primary keys, according to the level of aggregation of the analysis: the municipal code (7-digit

IBGE), for the analyses at the municipal level, and the code of the federation unit (IBGE of 2 digits), for the analyses and comparisons at the state level.

For the spatial analysis, thematic maps of the choropleth type were generated, which allow the visualization of the geographic distribution of each variable of interest. This technique was chosen because it favors the visual identification of patterns and hotspots by associating specific ranges of indicator values to a color scale (Archer; Bliss, 2010; Martinelli, 2014). The investigation was carried out at two levels: at the national level, for all Brazilian states, and at the regional level, with a detailed focus on the municipalities of the State of Rio de Janeiro.

4 RESULTS AND DISCUSSIONS

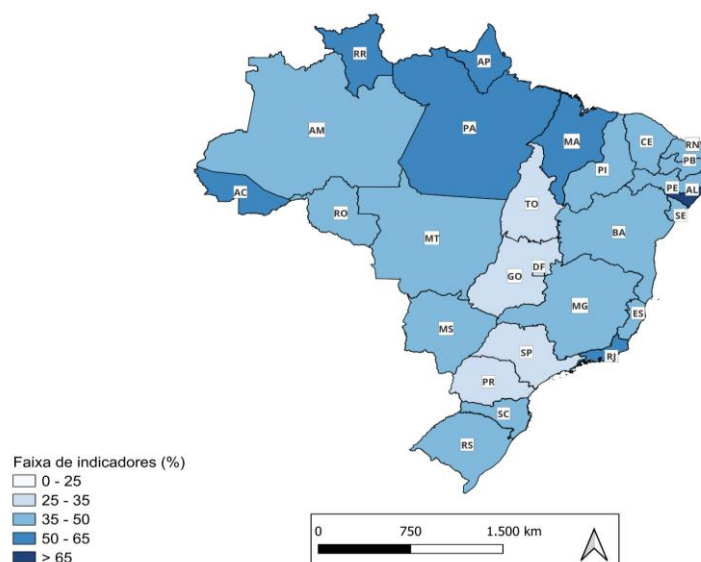
4.1 NATIONAL PANORAMA

The macroscopic analysis of the efficiency of water distribution in Brazil, based on the percentage indicator of total losses (IAG2013), reveals a worrying scenario for all regions of the country. As illustrated in Figure 1, only four states have total loss rates below 35%, namely Tocantins, Goiás (including the Federal District), São Paulo and Paraná. Meanwhile, the state with the most worrying data is Alagoas, which has a total loss rate of approximately 70%.

The State of Rio de Janeiro, in turn, stands out negatively in the context of the Southeast Region. While São Paulo is the state with the lowest rate of total losses, below 35%, Rio de Janeiro has rates above 50%. This data justifies the choice of the state as a case study: RJ represents an anomaly in the economically richest region of the country, indicating that the availability of financial and water resources does not guarantee efficiency in the management of this natural resource.

Figure 1

Spatial distribution of the index of total water losses in distribution (IAG2013) by Federation Units



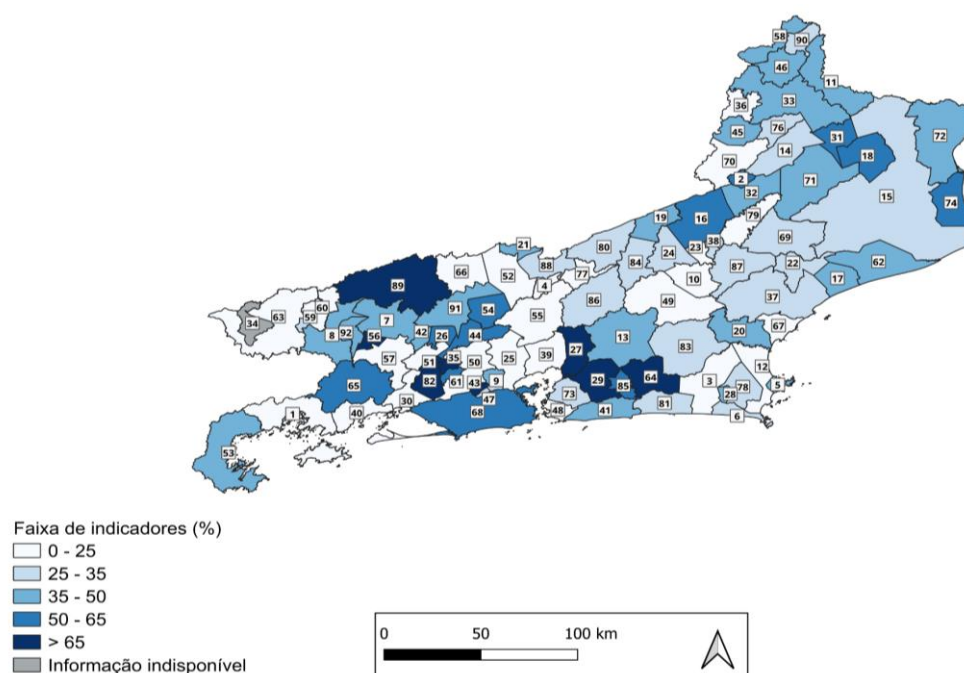
Source: Authors' elaboration based on SINISA data (Reference year: 2023).

While the State of Rio de Janeiro is the federative unit with the worst score in the IAG2013 index of the Southeast Region, this loss is not uniform throughout the territory, which indicates that a study with pertinent results needs to consider the parametric variability throughout the municipalities that compose it.

Figure 2 presents the panorama of total losses in the state. Of the 92 municipalities that make up RJ, 20 have a loss rate calculated above 50%; Itaboraí and Guapimirim are the municipalities in the most critical situation, with rates of 85.6% and 87.98%, respectively. Itatiaia did not have the indicator calculated by the responsible entity, despite the data collection having been carried out in the municipality (SINISA, 2024).

Figure 2

Spatial distribution of the distribution loss index - IAG2013 by municipalities in Rio de Janeiro



Source: Authors' elaboration based on SINISA data (Reference year: 2023).

Note: Identification of the municipalities: 1. Angra dos Reis; 2. Aperibé; 3. Araruama; 4. Areal; 5. Armação dos Búzios; 6. Arraial do Cabo; 7. Barra do Pirai; 8. Barra Mansa; 9. Belford Roxo; 10. Bom Jardim; 11. Bom Jesus do Itabapoana; 12. Cabo Frio; 13. Cachoeiras de Macacu; 14. Cambuci; 15. Campos dos Goytacazes; 16. Cantagalo; 17. Carapebus; 18. Cardoso Moreira; 19. Carmo; 20. Casimiro de Abreu; 21. Comendador Levy Gasparian; 22. Conceição de Macabu; 23. Cordeiro; 24. Duas Barras; 25. Duque de Caxias; 26. Engenheiro Paulo de Frontin; 27. Guapimirim; 28. Iguaba Grande; 29. Itaboraí; 30. Itaguaí; 31. Italva; 32. Itaocara; 33. Itaperuna; 34. Itatiaia; 35. Japeri; 36. Laje do Muriaé; 37. Macaé; 38. Macuco; 39. Magé; 40. Mangaratiba; 41. Maricá; 42. Mendes; 43. Mesquita; 44. Miguel Pereira; 45. Miracema; 46. Natividade; 47. Nilópolis; 48. Niterói; 49. Nova Friburgo; 50. Nova Iguaçu; 51. Paracambi; 52. Paraíba do Sul; 53. Paraty; 54. Paty do Alferes; 55. Petrópolis; 56. Pinheiral; 57. Pirai; 58. Porciúncula; 59. Porto Real; 60. Quatis; 61. Queimados; 62. Quissamã; 63. Resende; 64. Rio Bonito; 65. Rio Claro; 66. Rio das Flores; 67. Rio das Ostras; 68. Rio de Janeiro; 69. Santa Maria Madalena; 70. Santo Antônio de Pádua; 71. São Fidélis; 72. São Francisco de Itabapoana; 73. São Gonçalo; 74. São João da Barra; 75. São João de Meriti; 76. São José de Ubá; 77. São José do Vale do Rio Preto; 78. São Pedro da Aldeia; 79. São Sebastião do Alto; 80. Sapucaia; 81. Saquarema; 82. Seropédica; 83. Silva Jardim; 84. Sumidouro; 85. Tanguá; 86. Teresópolis; 87. Trajano de Moraes; 88. Três Rios; 89. Valença; 90. Varre-Sai; 91. Vassouras; 92. Volta Redonda.

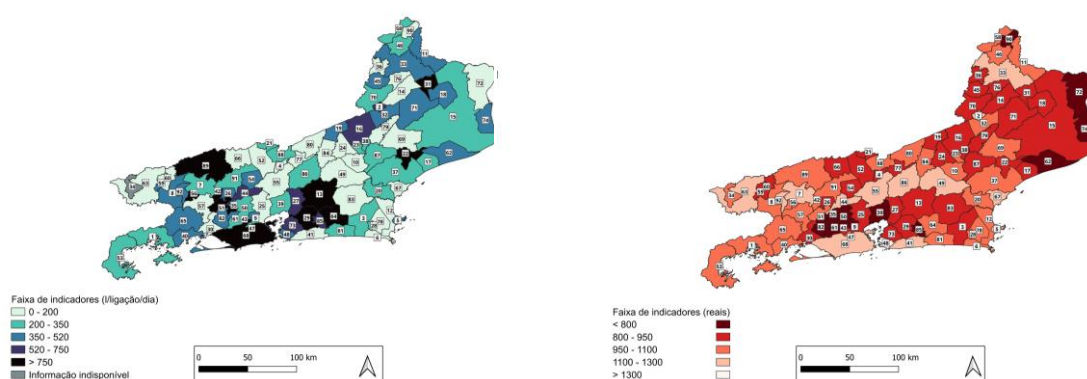
Figure 3 presents, side by side, the distribution of losses per connection and the median monthly per capita income of the municipalities. The spatial overlap between infrastructure performance (Map A) and income (Map B) reveals some worrying patterns in the state's sanitary engineering.

Figure 3

Comparative analysis. (A) Loss Ratio per Connection (IAG2015) in L/lig./day; (B) Median monthly household income per capita (IBGE)

(A)

(B)



Source: Authors' elaboration based on data from SINISA (Reference year: 2023) and IBGE (2022 Census).

There is a concentration of municipalities in the Baixada Fluminense where the average household income per capita does not reach 60% of the minimum wage in force in the year of the 2022 Census (R\$ 1212.00). Municipalities with a high population density, such as Belford Roxo and Queimados, operate with a critical median income stagnant at R\$ 700.00. In these locations, physical losses reach levels of 691.58 l/call/day and 515.81 l/call/day, respectively. In Duque de Caxias and São Gonçalo, with median incomes of R\$ 800.00 and R\$ 909.00, the losses reach even more alarming levels, with 669.12 and 900.25 liters per day per connection point. These data indicate that where the population has less ability to pay, the waste of water for consumption wasted in the system itself is significant.

The detailed analysis reveals significant anomalies that go beyond the regional trend and show a lack of absolute operational efficiency in peripheral regions. The most extreme case was the municipality of São João da Barra, with a very worrying socio-technical distortion. With a median income of R\$ 733.33, SINISA records a loss of 1414.12 liters per connection/day, being the second largest waste of water in the state. This volume suggests an infrastructure with many disruptions, where the volume lost exceeds the volume consumed. A similar scenario occurs in Nilópolis and Guapimirim, with median incomes ranging between R\$ 860.00 and R\$ 1,000.00, the systems operate with losses of 1,245.63 and 1,119.77 liters per connection, respectively. Such volumes indicate that the network in these areas loses many resources, an amount more than ten times greater than the municipality with the lowest expenditure, São Sebastião do Alto, with its 69.57 liters lost per connection.

The complexity of the socio-technical scenario reaches its critical point in the direct comparison between the two main powers of the Metropolitan Region: Rio de Janeiro and Niterói. The capital, with a median income of R\$1,212.00, registers an alarming loss rate of 1,292.59 liters per connection/day, positioning itself among the worst performances in the

state. On the other hand, Niterói, the city with the highest median income in the sample, with R\$2000.00, has a much lower volume of losses, in the order of 361.63 liters per connection/day. This disparity between neighboring cities shows that political centrality and the size of the municipality do not guarantee efficiency. The technical abyss reveals that there is a tendency for water security in the state to be linked to the high concentration of income, however, the capital, despite its economic protagonism, faces an operational collapse comparable to or greater than that of the peripheral areas, possibly aggravated by the obsolescence of old networks and many ruptures along the distribution network.

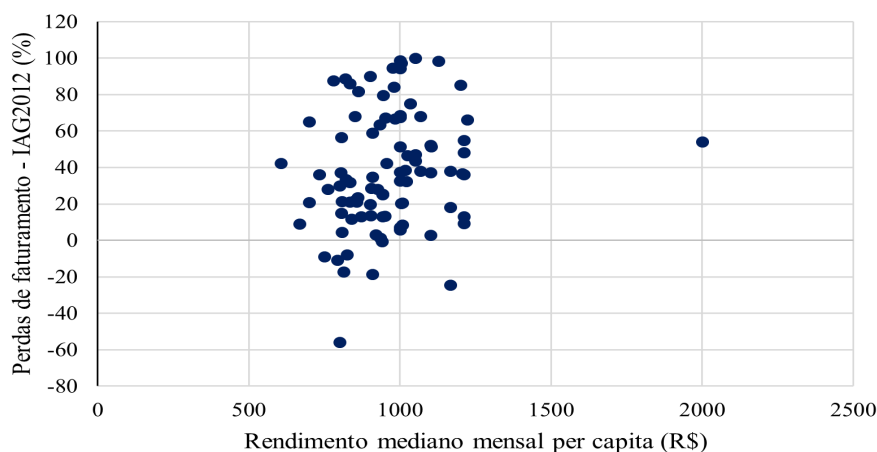
It is noteworthy that the complementary analysis of the linear loss index (IAG2014) corroborated this diagnosis.

4.2 ECONOMIC CORRELATION AND COMMERCIAL MANAGEMENT

To approach the economic dimension independently, graph 1 presents a dispersion analysis, which crosses the revenue loss index (IAG2012) with the average municipal income.

Figure 4

Correlation between median monthly income per capita (X-axis) and revenue losses - IAG2012 (Y-axis)



Source: Authors' elaboration based on data from SINISA (Reference year: 2023) and IBGE (2022 Census).

The data show that the inability to convert the volume of water made available into revenue is not random, being territorially concentrated in areas where social vulnerability is intrinsic. The median per capita income was below the minimum wage in the reference year of the 2022 Census for 85 of the 92 municipalities that make up RJ. Meanwhile, the rate of losses in revenue was above 40% in 31 municipalities.

The most critical pattern is observed in the axis of the Baixada Fluminense and Leste Metropolitano. Municipalities such as Nilópolis, Belford Roxo and Duque de Caxias have revenue loss rates of 84.07%, 65.20% and 56.61%, respectively. These indices indicate that, in these locations, the provision of the service occurs in a context of technical and commercial informality.

There are significant anomalies in the interior of the state, which suggests administrative inefficiency in small systems as well. Municipalities such as Cordeiro and Saquarema record revenue losses of more than 90% (98.75% and 94.31%, respectively), which points to charging models disconnected from the actual volume consumed and penalizes the financial sustainability of sanitation.

Finally, 8 municipalities presented negative percentages in the IAG2012 index, indicating the possibility that the volume of water billed is higher than that produced. There is a scenario of authorized consumption in which some service providers do not bill the entire volume consumed, as in the case of water trucks, for example. Negative values may also be influenced by the existence of a minimum tariff base or errors in the voluntary completion of data by concessionaires (SINISA, 2023).

4.3 SUMMARY: RELATIONSHIP WITH THE 2030 AGENDA

The integrated analysis of the indicators used reveals that the current engineering of water distribution networks in Rio de Janeiro operates out of step with the 2030 Agenda. The existence of a high correlation between physical losses and low-income areas (Figure 3) shows the non-compliance with SDG 6, since inefficiency prevents real universal access to treated water (UN, 2015). Together, the selective degradation of infrastructure in peripheries perpetuates the territorial inequality combated by SDG 10, while the lack of quality of systems in the face of intermittent supply compromises the urban resilience recommended by SDG 11. The data indicate, therefore, that water insecurity in these locations is connected with design and management decisions that reproduce patterns of exclusion.

5 CONCLUSION

The sociotechnical analysis of the water distribution networks in the State of Rio de Janeiro allowed to show that infrastructural inefficiency does not occur randomly, but reflects patterns of socio-spatial segregation as a material reflection of historical patterns. The study demonstrated a direct correlation between municipalities with lower economic capacity and greater social vulnerability, such as those in the Baixada Fluminense. In these places, the obsolescence of the infrastructure and the operational stress of the networks result in alarming rates of physical losses of the natural resource, applying a disproportionate impact to the population.

The disparity observed between the capital and the neighboring city with the highest per capita income, Niterói, reinforces that the availability of financial resources and political centrality influence the quality of sanitary engineering. The same municipality may present considerable anomalies in the per capita income of the population and, concomitantly, in the year of implementation of its water distribution network. In this context, it is essential to prioritize a management capable of solving historical deficiencies in the pipes, allowing access to drinking water for the entire population, without power relations being the determining factor.

It is concluded that the reduction of water losses transcends the technical challenge of maintenance, it constitutes an urgent measure of social justice and equity. To achieve the Sustainable Development Goals of the 2030 Agenda (SDGs 6, 10 and 11), it is imperative that public policies and engineering projects prioritize the modernization of networks in peripheral territories, transforming infrastructure into an instrument of inclusion and non-

perpetuation of existing hydro-social inequalities. As a limitation, this study was based on voluntary data delivered by the concessionaires to SINISA, which may imply omission of information in certain locations. It is suggested to revisit the data through field measurements in critical areas to validate the impact of intermittent distribution in peripheral pipes, subsidizing public sanitation policies that prioritize technical equity.

REFERENCES

- Almeida, E. P., Silva, F. G. B., & Valerio, V. E. M. (2021). Losses in water distribution networks – a bibliometric review: General aspects and optimization. *Research, Society and Development*, 10(12).
- Archer, J. C., & Bliss, J. C. (2010). Choropleth maps. In B. Warf (Ed.), *Encyclopedia of geography*. SAGE Publications.
- Bezerra, S. T. M., & Macêdo, J. E. S. (2018). Dimensionamento de redes de distribuição de água malhadas via otimização por enxame de partículas. *Irriga*, 23(4), 798–812.
- Brasil. Ministério das Cidades. (2024). SINISA – Sistema Nacional de Informações em Saneamento. <https://www.gov.br/mdr/pt-br/assuntos/saneamento/snis>
- Brasil. Ministério do Desenvolvimento Regional. (2021). Portaria nº 490, de 22 de março de 2021. *Diário Oficial da União*: Seção 1. <https://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?data=23/03/2021&jornal=515&pagina=30>
- Britto, A. L., Formiga-Johnsson, R. M., & Carneiro, P. R. F. (2011). Abastecimento de água na Baixada Fluminense: Intermittência, desperdício e injustiça ambiental. *Revista de Gestão de Água da América Latina*, 8(2), 57–69.
- Britto, A. L., & Quintslr, S. (2017). Redes técnicas de abastecimento de água no Rio de Janeiro: História e dependência de trajetória. *Revista Brasileira de História & Ciências Sociais*, 9(18), 137–160.
- Field, A. (2020). *Descobrimo a estatística usando IBM SPSS Statistics (5ª ed.)*. Penso.
- Fracalanza, A. P., & Freire, M. T. (2015). Crise da água na Região Metropolitana de São Paulo: Injustiça ambiental e privatização de um bem comum. *GEOUSP*, 19(1).
- Giovannettone, J. P., et al. (2024). Equitable infrastructure: Achieving resilient systems and restorative justice through policy and research innovation. *PNAS Nexus*, 3(5).
- Gouveia, A. G., Britto, A. L., & Formiga-Johnsson, R. M. (2023). Escassez hídrica no leste metropolitano fluminense. *Boletim do Observatório Ambiental Alberto Ribeiro Lamego*, 17(1).
- Grigg, N. S. (2024). *Water distribution systems: Integrated approaches for effective utility management*. MDPI.
- Hoşupan, A., et al. (2019). Water loss reduction in water distribution networks. *Journal of Applied Engineering Sciences*, 9(1).
- International Water Association. (2022). *Water loss control and non-revenue water*. <https://iwa-network.org/projects/water-loss-specialist-group/>

- Koifman, F. (2013). Abastecimento d'água no Rio de Janeiro Joanino: Uma geografia do passado [Tese de doutorado, Universidade Federal do Rio de Janeiro].
- Marques, E. C. (Org.). (2018). As políticas do urbano em São Paulo. Editora Unesp.
- Martinelli, M. (2014). Mapas da geografia e cartografia temática (6ª ed.). Contexto.
- Morais, C. A., et al. (2010). Priorização de áreas de controle de perdas em redes de distribuição de água. *Engenharia Sanitária e Ambiental*, 15(3).
- Mota, A. P., et al. (2021). Infraestruturas e desigualdades raciais: Território, dominação e políticas urbanas no Brasil. *Revista Brasileira de Estudos Urbanos e Regionais*, 23(1).
- Mukaka, M. M. (2012). A guide to appropriate use of correlation coefficient in medical research. *Malawi Medical Journal*, 24(3), 69–71.
- Organização das Nações Unidas. (2015). Transformando nosso mundo: A Agenda 2030 para o desenvolvimento sustentável.
- Roth, D., Zwarteveen, M., Joy, K. J., & Kulkarni, S. (2018). Water governance as a question of justice. In R. Boelens, T. Perreault, & J. Vos (Eds.), *Water justice*. Cambridge University Press.
- Saiani, C. C. S. (2012). Restrições à expansão do saneamento no Brasil: Um estudo sobre o déficit de acesso e a eficiência dos prestadores [Tese de doutorado, Universidade de São Paulo].
- Santos, R. A., et al. (2021). Desigualdade hídrica e estrutura racial no acesso urbano à água. *Cadernos Metrópole*, 23(2).
- Serafeim, A., et al. (2024). Leakages in water distribution networks: Estimation and mitigation strategies—A comprehensive review. *Water*, 16(11).
- Shrimpton, E. A., Hunt, D., & Rogers, C. D. F. (2021). Justice in (English) water infrastructure: A systematic review. *Sustainability*, 13(6).
- Tardelli Filho, J. (2019). Aspectos relevantes do controle de perdas em sistemas de abastecimento de água. *Revista DAE*, (201).
- Tonel, R., et al. (2021). Drenando desigualdades: O direito humano à água e ao saneamento básico nas áreas urbanas brasileiras. *Revista de Direito Urbanístico*, 7(1).
- Tomasella, J. (2023). Spatial inequalities in access to safe drinking water in Brazil. *Water*, 15(8), Article 1620.
- Trata Brasil. (2024). Estudo sobre perdas de água 2024: GO Associados.
- Triola, M. F. (2017). Introdução à estatística (12ª ed.). LTC.
- Tsutiya, M. T. (2006). Abastecimento de água (3ª ed.). Departamento de Engenharia Hidráulica e Sanitária da Escola Politécnica da Universidade de São Paulo.

INVISIBLE GEARS: UNCONSCIOUS HABITS IN THE FORMATION OF HUMAN PERSONALITY

ENGRENAGENS INVISÍVEIS: OS HÁBITOS INCONSCIENTES NA FORMAÇÃO DA PERSONALIDADE HUMANA

ENGRANAJES INVISIBLES: HÁBITOS INCONSCIENTES EN LA FORMACIÓN DE LA PERSONALIDAD HUMANA



<https://doi.org/10.56238/sevened2026.008-185>

Gilson Aires de Menezes Júnior¹

ABSTRACT

This article takes as its starting point the hypothesis that unconscious habits function as “invisible gears” that sustain the construction of human personality, insofar as, throughout life, recurrent ways of thinking, feeling, and acting are established that escape conscious awareness and end up being confused with a simple “way of being.” In this trajectory, it seeks to bring together the tradition of classical psychoanalysis and contemporary research on habits and self-regulation, showing how these repeated patterns arise from unconscious formations derived from repressed desires, internal conflicts, defense mechanisms, and implicit learning, until they are consolidated into relatively stable traits of character that guide choices, affective bonds, and forms of presence in the world. Drawing on the contributions of Freud, Lacan, Jung, and Klein, it discusses the constitution of the psychic apparatus, the mechanisms of defense, the logic of repetition, and the central place of desire, relating these formulations to contemporary authors such as Clear and Brewer, who conceive habits as reward circuits, automatic routines, and devices for identity construction, which makes it possible to bring psychoanalytic vocabulary closer to findings from cognitive psychology, neuroscience, and habit science, culminating in the proposal of the metaphor of invisible gears to understand unconscious habits as an axis articulating subjective experience, symbolic structures, and everyday practices, with important clinical and ethical implications for processes of personality change and the reorganization of ways of life.

Keywords: Unconscious Habits. Personality. Psychoanalysis. Desire. Language. Contemporary Habits.

RESUMO

Este artigo toma como ponto de partida a hipótese de que os hábitos inconscientes funcionam como “engrenagens invisíveis” que sustentam a construção da personalidade humana, na medida em que, ao longo da vida, se estabelecem modos recorrentes de pensar, sentir e agir que escapam à consciência e acabam sendo confundidos com um simples “jeito de ser”. Procura-se, nesse percurso, articular a tradição da psicanálise clássica com pesquisas contemporâneas sobre hábitos e autorregulação, mostrando como esses padrões repetidos nascem de formações do inconsciente, derivadas de desejos recalçados, conflitos

¹ Master's Degree in Constitutional Law. Instituto de Direito Público (IDP).

internos, mecanismos de defesa e aprendizagens implícitas, até se consolidarem em traços relativamente estáveis de caráter, que orientam escolhas, vínculos afetivos e formas de presença no mundo. A partir das contribuições de Freud, Lacan, Jung e Klein, discutem-se a constituição do aparelho psíquico, os mecanismos de defesa, a lógica da repetição e o lugar central do desejo, relacionando essas formulações a autores atuais como Clear e Brewer, que concebem os hábitos como circuitos de recompensa, rotinas automáticas e dispositivos de construção de identidade, o que possibilita aproximar o vocabulário psicanalítico dos achados da psicologia cognitiva, da neurociência e da ciência dos hábitos, culminando na proposta da metáfora das engrenagens invisíveis para compreender os hábitos inconscientes como eixo de articulação entre experiência subjetiva, estruturas simbólicas e práticas cotidianas, com importantes efeitos clínicos e éticos para os processos de mudança de personalidade e de reorganização dos modos de vida.

Palavras-chave: Hábitos Inconscientes. Personalidade. Psicanálise. Desejo. Linguagem. Hábitos Contemporâneos.

RESUMEN

Este artículo parte de la hipótesis de que los hábitos inconscientes funcionan como "engranajes invisibles" que sustentan la construcción de la personalidad humana, en la medida en que, a lo largo de la vida, se establecen formas recurrentes de pensar, sentir y actuar que escapan a la conciencia y terminan confundándose con una simple "forma de ser". En este proceso, se busca articular la tradición del psicoanálisis clásico con la investigación contemporánea sobre hábitos y autorregulación, mostrando cómo estos patrones repetidos surgen de formaciones inconscientes derivadas de deseos reprimidos, conflictos internos, mecanismos de defensa y aprendizaje implícito, hasta consolidarse en rasgos de carácter relativamente estables que guían las elecciones, los vínculos afectivos y las formas de presencia en el mundo. Basándose en las contribuciones de Freud, Lacan, Jung y Klein, este artículo analiza la constitución del aparato psíquico, los mecanismos de defensa, la lógica de la repetición y el papel central del deseo. Relaciona estas formulaciones con autores contemporáneos como Clear y Brewer, quienes conciben los hábitos como circuitos de recompensa, rutinas automáticas y mecanismos de construcción de la identidad. Este enfoque permite una conexión más estrecha entre el vocabulario psicoanalítico y los hallazgos de la psicología cognitiva, la neurociencia y la ciencia de los hábitos, culminando en la metáfora propuesta de los engranajes invisibles para comprender los hábitos inconscientes como eje articulador entre la experiencia subjetiva, las estructuras simbólicas y las prácticas cotidianas, con importantes implicaciones clínicas y éticas para los procesos de cambio de personalidad y la reorganización de los estilos de vida.

Palabras clave: Hábitos Inconscientes. Personalidad. Psicoanálisis. Deseo. Lenguaje. Hábitos Contemporáneos.

1 INTRODUCTION

The metaphor of invisible gears suggests that what moves the human personality is not always directly seen, because behind our daily gestures, affective choices, ways of speaking and occupying social spaces, unconscious habits operate that have been formed in successive layers of experience and defense, often since childhood, in such a way that the subject tends to confuse these crystallized patterns with a supposed essence of his "I", when, in fact, they are repeated responses to psychic conflicts and environmental demands that have been automated over time.

From another perspective, Jung emphasizes that personality is built in the tension between consciousness and the unconscious, which is populated by complexes and archetypal images that decisively influence the way the subject perceives and interprets reality, which leads to the formation of habits of perception, feeling and action that are repeated as relatively stable internal scripts.

By proposing that complexes are organized around intense affective nuclei, often associated with early experiences, the author opens the way to understand how certain situations trigger automatic responses of the subject, who always repeats the same type of reaction, even when he recognizes that the result is dysfunctional or painful. This repetition is not only an observable behavioral data, but translates the permanence of unconscious configurations that have not yet been integrated into the conscious personality, indicating that the invisible gears of psychic life continue to operate in defiance of the declared will. (JUNG, 1912)

Lacan, in turn, radicalizes the understanding of the unconscious by formulating it as structured as a language, which implies thinking that habits, far from being just mechanical routines, can be understood as modes of inscription and repetition of signifying chains that organize the subject's desire and relationship with the Other. From this perspective, personality is less a substance than an effect of positions assumed in the symbolic fabric of discourse, so that what manifests itself as a "way of being" corresponds to reiterated ways of responding to the demands and desires of the Other, through gestures, choices and styles of jouissance that are sedimented.

This article intends to articulate these contributions of psychoanalysis with contemporary studies on habits, exploring the hypothesis that unconscious habits function as invisible gears that, at the same time, stabilize the personality and limit its capacity for transformation, pointing to the importance of a clinical and critical reading of these repetitive patterns. (LACAN, 1964)

2 THEORETICAL FRAMEWORK

2.1 THE FORMATION OF PERSONALITY IN FREUDIAN PSYCHOANALYSIS

2.1.1 Structure of the psychic apparatus: id, ego and superego

In Freudian theory, the id is conceived as the most primitive drive reservoir, governed by the pleasure principle and the immediate search for satisfaction, which means that, from the beginning of life, impulses of desire tend to repeat themselves in search of relief from internal tensions, producing patterns of pleasure search that can become ingrained habits throughout development. This deep layer of psychic life is not guided by norms or by the logic of reality, but by experiences of satisfaction that leave marks, so that certain ways of obtaining pleasure or avoiding unpleasure can be automatically re-actualized in different contexts, without the subject recognizing the repetition of an old drive script. (FREUD, 1900)

Thus, the id provides the energetic raw material that, when meeting the demands of reality and culture, will be progressively organized into relatively stable ways of desiring and reacting, contributing to the constitution of personality traits that express these invisible gears of pleasure-seeking. (FREUD, 1900)

The ego, in turn, emerges as a mediating instance between the instinctual demands of the id, the interdictions and ideals of the superego and the conditions imposed by the external world, which puts it in the position of creating strategies to deal with recurrent conflicts and situations of tension, transforming momentary solutions into habitual modes of functioning. As the subject discovers that not every desire can be satisfied, the ego learns to postpone, displace, or transform instinctual demands, and this work of negotiation is consolidated into ways of dealing with frustration, guilt, and anxiety that tend to be repeated as personal styles. (FREUD, 1900)

In this way, what appears as a personality trait, such as a tendency to avoid conflicts or to put oneself in a position of control, can be understood as a relatively effective arrangement that the ego has found to manage internal and external contradictions, an arrangement that becomes a psychic and behavioral habit. (FREUD, 1900)

The superego represents the internalization of parental and social norms and prohibitions, functioning as an internal judge that watches, criticizes and punishes, which introduces into the personality a gear marked by ideals and demands that are often rigid, which manifest themselves in habits of severe self-evaluation and constant self-demand. (FREUD, 1900)

The formation of the superego implies that the subject incorporates the voice of the Other as an instance that observes and judges, and this voice tends to repeat phrases, mandates and prohibitions that turn into automatic thoughts and feelings of guilt that arise

almost instantaneously in certain situations, even if there is no clear rational reason. Thus, habits such as perfectionism, the need to please, or the tendency to sabotage opportunities for pleasure can be seen as lasting effects of a superego structured around hard-to-achieve ideals and a difficulty in tolerating one's fallibility. (FREUD, 1900)

The articulation between id, ego and superego allows us to understand the personality as a configuration in constant negotiation, in which psychic and behavioral habits are formed as compromises between desires, defenses and internalized norms, in such a way that each repetitive gesture bears the mark of a singular arrangement between these instances. (FREUD, 1900)

Instead of thinking of the subject as possessing a fixed essence, Freudian psychoanalysis shows that what we call "character" results from the sedimentation of compromise solutions that have shown themselves to be minimally functional in the history of that individual and, therefore, have been repeated until they become part of his way of being. This view allows us to reread habits not only as practical routines, but as formations of commitment that keep the invisible gears of psychic life in operation, stabilizing the subject and, at the same time, limiting the plasticity of his personality. (FREUD, 1900)

Thus, the structural model of the psychic apparatus offers an important key to understanding how the axis of the personality is constituted, because the way the ego organizes defenses, negotiates with the superego and channels the forces of the id tends to crystallize into regularities of response, which are perceived by others and by the subject himself as characteristic traits. (FREUD, 1900)

Over time, the individual begins to identify with these traits, saying of himself that he is "anxious", "controlling" or "disconnected", without realizing that such qualities result from dynamic arrangements between conflicting psychic instances, which have been reinforced by external contingencies and secondary gains. In this sense, the structure of the id, ego, and superego can be seen as a set of internal gears whose movements, largely unconscious, produce the appearance of a cohesive "I," while in reality it is an always precarious balance between desires, prohibitions, and adaptive resources. (FREUD, 1900)

2.1.2 Defense mechanisms and pattern repetition

Defense mechanisms are described by Freud as unconscious strategies of the ego to deal with impulses, feelings and ideas that cause anguish, which means that, in practice, they function as psychic habits of avoiding or transforming contents that threaten the cohesion of the self, being activated with such speed that the subject rarely perceives their operation. (FREUD, 1900)

Repression, for example, excludes from consciousness representations incompatible with the ideal of the self, but does not prevent them from returning disguised in symptoms, faulty acts and repetitive choices, through which the repressed insist on manifesting themselves. In this way, the same type of defense can be mobilized in different situations, producing stable patterns of reaction, such as the tendency to deny problems, to shift responsibility to the other or to rationalize intense affective experiences, which contributes to the formation of a personality that is organized around these habitual modes of protection against anguish. (FREUD, 1900)

Klein broadens the understanding of defense mechanisms by describing processes such as splitting, idealization and projective identification, which operate very early in the baby's relationship with his primary objects and create matrices for the subsequent organization of the personality, especially in the conditions that we now call personality disorders. (KLEIN, 1952)

When the subject tends to split objects into totally good or totally bad, and to project onto other impulses that he cannot bear to recognize in himself, he is repeating a defensive arrangement that crystallized in a period of extreme dependence, transforming itself into a relational habit. These mechanisms, when repeated throughout life, organize a characteristic way of bonding, in which the other is constantly placed in extreme positions, sometimes idealized, sometimes persecuted, which evidences the strength of the invisible gears constituted in the initial relationship with the caring figures. (KLEIN, 1952)

Jung, when working with the concept of complexes, shows that certain nuclei of experience highly charged with affect tend to become autonomous within the psyche, reacting almost automatically to stimuli that function as triggers, which explains why certain situations provoke disproportionate and repetitive responses. (JUNG, 1912)

Each complex, linked to a specific theme, such as rejection, abandonment or power, contains a set of memories, fantasies and emotions that are activated as a block, guiding perception and conduct in a habitual way, as if the subject were taken by a "way of being" that imposes itself in that context. In this sense, personality disorders can be understood as arrangements in which certain complexes dominate the psychic field, causing habits of feeling and acting linked to these nuclei to be repeated in a compulsive way, even to the detriment of the individual's well-being. (JUNG, 1912)

In the Lacanian reading, the repetition of patterns is not only a behavioral or defensive phenomenon, but reveals the insistence of a signifier that returns in the place of the repressed, marking the position of the subject in the symbolic chain that constitutes it, which

makes many apparently banal habits actually forms of inscription of a response to the desire of the Other. (LACAN, 1964)

The compulsion to repetition, therefore, is not limited to the idea that the subject repeats in order to master a traumatic situation, but indicates the very structure of his insertion in language, to the extent that certain scenes, phrases and gestures are resumed at different moments of life, as if the subject were always staging a text that he did not write, but in which he participates. This allows us to think of habits as effects of a significant logic, in which the position assumed in front of the Other is translated into repeated ways of speaking, desiring and suffering, which end up composing the texture of their personality. (LACAN, 1964)

In dialogue with these psychoanalytic conceptions, Brewer describes, based on neuroscientific evidence and his clinical experience, how the brain learns to associate certain behaviors with anxiety relief or small rewards, generating habit loops that are repeated even when the subject declares that he wants to act differently, which is particularly visible in cases of anxiety and dependence. (BREWER, 2021)

These loops involve an internal or external trigger, a routine, and a sense of reward that, when reinforced, creates a preferential path in the neural network, making it increasingly difficult to disrupt the pattern, which approximates the psychoanalytic idea of repetition compulsion. By understanding these circuits, it becomes possible to propose interventions that introduce curiosity and awareness into the moment of routine, opening the possibility of making habits more flexible that, until then, functioned as invisible gears conditioning the individual's field of choices. (BREWER, 2021)

2.2 HABITS AS FORMATIONS OF THE UNCONSCIOUS IN FREUD

When Freud analyzes dreams as disguised fulfillments of repressed desires, he describes mechanisms of condensation and displacement that reorganize the psychic material into apparently strange narratives, but endowed with their own logic, which allows a conceptual approximation between the work of the dream and the formation of unconscious habits. (FREUD, 1900)

Just as in the dream unacceptable contents are transformed into less threatening images, in everyday life desires and conflicts can be displaced into repetitive acts that function as avenues of expression and, at the same time, of masking the repressed. Certain habits, such as check-in rituals, small quirks or stereotyped ways of reacting, can then be read as substitutive formations that fulfill the function of keeping something of desire in circulation, without it reaching consciousness in its most direct form. (FREUD, 1900)

Freud also points out that many neurotic symptoms have the structure of a compromise between a desire that seeks expression and a defense that seeks to stop it, which makes them highly repetitive, to the extent that the underlying conflict remains unresolved and finds in the symptom a partial way out. The frequency with which the subject repeats certain behaviors or thoughts does not depend, therefore, on a conscious decision, but on the insistence of the repressed person who seeks ways of manifestation acceptable to the ego and the superego. (FREUD, 1900)

From this perspective, habits that seem only stubbornness or personality vices can be analyzed as solutions found by the psyche to give vent to impulses, affections and fantasies that do not find a place in conscious discourse, at the cost of imprisoning the personality in cycles of repetition. (FREUD, 1900)

Transference, a central concept in Freudian clinic, illustrates in a privileged way the habitual dimension of the formations of the unconscious, as the patient tends to repeat with the analyst patterns of attachment that originated in his childhood relationships, updating old scenes in a new context. Instead of simply remembering the past, the subject repeats it, treating the analyst as if he were a significant figure in his history, which reveals the strength of the invisible gears that organize his way of loving, trusting and defending himself. (FREUD, 1900)

Freud also observes that character can be understood as the result of the sedimentation of childhood experiences, fantasies and defenses, in such a way that certain qualities such as parsimony, obsessiveness or impulsiveness can be seen as forms of psychic organization that have stabilized around specific conflicts, such as those linked to the control of the sphincters, fraternal rivalry or the experience of castration. (FREUD, 1900)

What is socially perceived as a "personality trait" corresponds, therefore, to instinctual investment and defense habits that have proven useful at some point, having been reinforced by external and internal rewards. From this point of view, understanding the genesis of these traits means reconstituting the history of the choices and renunciations that configured the libidinal economy of the subject, bringing to light the unconscious gears that make him react in a predictable way in certain situations. (FREUD, 1900)

From the point of view of technique, psychoanalytic interpretation aims precisely to make conscious these formations of the unconscious that are expressed in dreams, faulty acts, symptoms and habits, allowing the subject to recognize, in his repetitive ways of acting and feeling, the mark of desires, fears and fantasies that until then operated in secret. (FREUD, 1900)

2.3 LACAN'S CONTRIBUTIONS: THE UNCONSCIOUS STRUCTURED AS LANGUAGE

2.3.1 Signifying chain, desire and "jouissance"

By stating that the unconscious is structured as a language, Lacan shifts the focus of psychoanalysis to the dimension of the signifier, emphasizing that the subject is, above all, an effect of the discourse of the Other, in such a way that his habits of thinking, feeling and acting are organized from signifying chains that precede him. (LACAN, 1964)

Instead of seeking a deep core of identity, this perspective seeks to locate the places that the subject occupies in the symbolic plot, places that are reiterated through utterances, gestures and choices that function as responses to an order of signification. Thus, habits can be seen as ways of tying jouissance to the signifier, minimally stabilizing the subject in a position that, although it causes suffering, offers a certain symbolic consistency. (LACAN, 1964)

Desire, in Lacan's reading, is not simply a need to be satisfied, but an effect of the structuring lack introduced by language, so that it never finds an object that fully fulfills it, which leads the subject to circulate around partial objects that sustain his desiring position. In this logic, habits can be understood as circuits by which the subject circumvents the lack, finding small satisfactions that, although they do not solve the fundamental void, offer a way of dealing with it. (LACAN, 1964)

The concept of "jouissance", often translated as jouissance, designates a form of satisfaction that overflows the principle of pleasure, approaching excess and pain, which helps to understand why the subject insists on habits that he knows are harmful, such as destructive relationships, compulsions or self-sabotage. (LACAN, 1964)

In these situations, it is not only a question of the search for pleasure, but of a way of placing oneself in relation to a type of jouissance that structures the subjective position, often linked to unconscious mandates, such as that of suffering to be loved or failing to remain faithful to an inherited image. Habits, in this sense, function as devices that ensure the continuity of this jouissance, even at the cost of great suffering, keeping invisible gears in operation that sustain the subject's identity. (LACAN, 1964)

Lacan also proposes that the symptom can be read as a text that the subject writes with his body and with his acts, a text that condenses a singular way of jouissance and of signifying his own history, which allows us to think of repetitive habits as part of this writing system. (LACAN, 1964)

When someone finds themselves repeating the same type of affective or professional choice, despite unsatisfactory results, they may be unknowingly enacting a meaning that has been inscribed in their history by the relationship with the desire of the Other, a meaning that

has condensed into a symptom that offers a kind of symbolic anchoring. By inviting the subject to speak and listen to what he says, analysis allows this text to be reread, and the habits that materialize it can be displaced or re-inscribed in another way. (LACAN, 1964)

From this perspective, the signifying chain functions as a set of gears that organizes the way the subject is situated in the world, in such a way that each habit can be seen as a point of fixation in a sequence of signifiers, around which desire and jouissance circulate. (LACAN, 1964)

Analytic work consists of introducing displacements in this chain, producing lapses, misunderstandings and new associations that open up the possibility of breaking the automatism of certain circuits of repetition. In doing so, analysis not only modifies behaviors, but touches the very structure of the personality, allowing the subject to find other ways of positioning himself in the face of lack and desire. (LACAN, 1964)

2.3.2 Habits as a response to the Other and the symbolic order

In Lacanian theory, the Other with a capital letter represents the place of language, law and social discourse, so that from the beginning the subject is summoned to respond to the expectations and meanings that surround him, which implies that his habits are also formed as responses to these addresses. (LACAN, 1964)

The way the child is named, looked at and interpreted by caregivers constitutes a symbolic field within which he learns to occupy certain places, adopting gestures, words and attitudes that are repeated as a way of guaranteeing recognition or avoiding rejection. These movements, initially linked to concrete situations, tend to generalize and become automated, composing a kind of habitual choreography that sustains the personality in the relationship with the Other. (LACAN, 1964)

The symbolic order, composed of shared norms, values and meanings, offers the subject a repertoire of possible positions, related to gender, class, profession and other social categories, so that many habits are, in fact, ways of embodying these prescribed places. (LACAN, 1964)

By reproducing discourses about what it means to be a man or a woman, successful or unsuccessful, normal or deviant, the individual adheres to practices, styles of consumption and ways of expressing emotions that reinforce their inclusion in certain groups, while limiting their uniqueness. Thus, personality can be understood as an arrangement between symbolic identifications and forms of jouissance that are stabilized in the repetition of habits that respond to this order. (LACAN, 1964)

Language habits, for example, are not reduced to conscious choices, but reflect the internalization of ways of speaking inherited from the family, the community and the media, which carry implicit values and rules of hierarchy, which makes apparently neutral expressions reveal positions in relation to the other and to oneself. (LACAN, 1964)

These discursive patterns, when repeated, sediment identities, such as that of the subject who always makes self-deprecating jokes or the one who assumes an imperative tone in any conversation, consolidating a personality style that seems spontaneous, but which, in fact, is the product of structured identifications and defenses. To this extent, the habits of speaking and listening are invisible cogs that organize the way of being with the other. (LACAN, 1964)

In the same way, bodily habits, such as posture, gestures and ways of occupying space, also respond to the symbolic order, expressing identifications and positions of power, submission or resistance, which indicates that personality is not only an intrapsychic phenomenon, but is configured at the interface between body, language and culture. (LACAN, 1964)

The child who learns to lower his gaze in front of authority figures or to exaggerate his performance to be noticed, for example, incorporates patterns that can remain throughout life as his "personal mark", even if they have been constituted as defensive strategies in the face of a specific scenario. Thus, the analysis of these bodily habits allows us to unveil the symbolic web that sustains them and opens paths for their transformation. (LACAN, 1964)

In the clinic inspired by Lacan, the possibility of personality change is not restricted to the replacement of bad habits with good ones, but concerns the reconfiguration of the subject's relationship with the Other and with the symbolic order, which implies displacing the signifiers that fixed him to certain positions and allowing the emergence of new arrangements of desire and jouissance. (LACAN, 1964)

When the subject realizes how his habits function as automatic responses to internalized mandates and expectations, he can find loopholes to refuse some of these impositions and invent more unique ways of living. In this way, the invisible gears that previously imprisoned him in a narrow identity can be rearranged, giving way to a more flexible personality that is less determined by repetition. (LACAN, 1964)

2.4 OTHER CONTEMPORARY AUTHORS AND DIALOGUES

2.4.1 Jung, Klein and personality disorders

Jung contributes decisively to the understanding of personality disorders by emphasizing the role of complexes, relatively autonomous psychic structures that are

organized around emotionally charged contents, capable of taking control of the conscious attitude whenever activated by associated situations. (JUNG, 1912)

In individuals with a personality more rigidly structured around certain complexes, very similar responses are observed in different contexts, as if the same "part" took charge, which is manifested in habits of thought, affection and behavior that are repeated, even when they generate damage. The difficulty in integrating these complexes into consciousness leads to a fragmentation of the personality, in which the subject oscillates between ways of being that he cannot reconcile, reinforcing patterns of repetition that function as invisible cogs of his disorders. (JUNG, 1912)

In the Jungian perspective, the process of individuation, understood as the path of becoming who one is in a fuller and more integrated way, comes up against the rigidity of certain unconscious habits that keep the subject tied to partial identities and old defenses, which no longer correspond to the current demands of life. (JUNG, 1912)

When the personality fixates on a narrow set of roles and attitudes, it refuses the possibility of dialogue with the unconscious and with the new, which favors the appearance of repetitive symptoms and conflicts. Analytic work, by favoring the encounter with symbolic images and narratives that expand the meaning of experience, can make these habits more flexible and allow the emergence of more complex and creative configurations of personality. (JUNG, 1912)

Klein, when studying early object relations, points out that the way the baby deals with the presence and absence of the breast, as well as with experiences of frustration and gratification, establishes fundamental psychic positions, such as the schizoid paranoid position and the depressive position, which directly influence the way the personality will be organized. (KLEIN, 1952)

In more severe personality disorders, there is often a predominance of defenses linked to splitting, idealization, and projection, which manifest themselves in relationship habits marked by extreme oscillations between adoration and devaluation of the other, accompanied by intense anxiety. These repetitive patterns indicate that the gears formed in the first experiences with the primary objects continue to operate, guiding the way the subject perceives and reacts to contemporary relationships. (KLEIN, 1952)

In addition, Klein introduces the notion of internal objects to refer to the unconscious representations of significant figures, loaded with ambivalent affects, which come to inhabit the subject's psychic world and influence his future bonds. When these internal objects are experienced as persecuting or demanding in an excessive way, the subject can develop

habits of self-punishment, chronic distrust or submission, which structure personality pictures with paranoid or depressive traits. (KLEIN, 1952)

Bandura, although inserted in another theoretical tradition, contributes to the understanding of personality disorders by demonstrating the role of social learning in the acquisition of behavior patterns, showing that individuals observe significant models and imitate their behaviors, especially when they are rewarded, which helps to explain how certain relational styles are perpetuated. (BANDURA, 1977)

In families in which aggressiveness, manipulation, or submission are frequently reinforced strategies, children tend to incorporate these patterns as natural ways of relating, transforming into habits that may later be recognized as characteristics of personality disorders. The theory of social learning, by emphasizing the role of observation and self-efficacy, suggests that the modification of these patterns requires not only insight, but also concrete opportunities to experiment with new ways of acting, which dialogues with intervention proposals that combine reflection and skills training. (BANDURA, 1977).

2.4.2 Current studies on habits (Clear, Brewer and others)

Clear, by systematizing research on habits in his widely disseminated work, proposes that the formation of habits is based on a cycle composed of clue, routine and reward, suggesting that small consistent changes can produce significant transformations in the long term, especially when associated with a change of identity, that is, when the subject starts to see himself as someone who acts in a certain way. (CLEAR, 2019)

Brewer, supported by neuroscience findings, describes how the brain learns through a reward-based conditioning process, in which behaviors associated with feelings of relief or pleasure are more likely to be repeated, even when they produce negative consequences in other spheres of life, which is evident in anxiety, binge eating, and dependence. (BREWER, 2021)

By showing that these behaviors are organized in loops in which a trigger triggers a routine that generates a kind of reward, the author argues that the simple attempt to rationally control these impulses tends to fail, because it does not reach the level at which the habit is encoded. His proposal to use mindfulness practices to increase awareness of the process at the exact moment it occurs allows the subject to perceive more clearly the real cost of their habits, reducing their attractiveness and making room for change, which has direct implications for the reconfiguration of personality. (BREWER, 2021)

Duhigg, in his analysis of the power of habits, explores both individual and organizational examples to show that much of what we do throughout the day relies on

automatic routines, which allow the brain to conserve energy, but which can also trap the subject in unhealthy patterns of behavior. (DUHIGG, 2012)

He introduces the idea of key habits, those that, when modified, trigger chain changes in other aspects of life, which suggests that punctual, well-chosen interventions can have a great impact on the general way a person functions. This approach offers an interesting bridge with psychoanalysis, insofar as it invites us to locate which habits function as central gears in the maintenance of certain ways of being, indicating that their transformation can have repercussions on the global configuration of the personality. (DUHIGG, 2012)

Baumeister, based on his research on willpower and self-regulation, argues that self-control functions as a limited resource that individuals can dispose of to a greater or lesser extent, so that the creation of favorable automatic habits reduces the need for constant conscious decisions, preserving mental energy for more complex choices. (BAUMEISTER, 2011)

This conception implies that personality, often described in terms of discipline, organization, or impulsivity, is related to the way in which the subject is able to automate behaviors aligned with his or her goals, reducing exposure to temptations and internal conflicts. By suggesting that the strengthening of willpower does not occur only through effort, but also through the intelligent construction of routines and environments, Baumeister offers valuable elements for thinking about how interventions focused on habits can support therapeutic processes that aim at deeper changes in the way of being. (BAUMEISTER, 2011)

Kahneman, by distinguishing between two systems of thought, one fast, automatic and intuitive and the other slow, deliberate and analytical, shows that a large part of our decisions are made by the fast system, based on heuristics and associations that work in a very similar way to cognitive habits, which means that our worldview is strongly conditioned by previously established mental routes. (KAHNEMAN, 2011)

These automatic pathways lead to judgment biases and systematic errors that, repeated over time, contribute to the construction of a personality that may be more pessimistic, overconfident, or risk-averse, depending on how these thinking habits are structured. By highlighting the difficulty of changing these patterns only for information, the author reinforces the need for strategies that act at the level of practice and repeated experience, approaching, albeit in another way, the psychoanalytic intuition that the transformation of the personality passes through the modification of the unconscious gears that sustain our way of interpreting and reacting to the world. (KAHNEMAN, 2011)

2.5 INVISIBLE GEARS: UNCONSCIOUS HABITS AS THE AXIS OF PERSONALITY

By articulating Freudian psychoanalysis with contemporary studies on habits, it becomes possible to conceive the personality as a set of invisible gears composed of formations of the unconscious that are expressed in relatively stable patterns of behavior, whose function is at the same time to protect the subject from anguish and to enable some satisfaction of his desires. Unconscious habits would thus be solutions that the psyche found to manage conflicts between impulses, norms and reality, solutions that, because they worked at some point, were repeated and automated, gaining the appearance of natural character traits. (FREUD, 1900)

This conception allows us to understand why the subject often sees himself acting contrary to what he claims to want, because the gears formed in past contexts continue to operate, producing responses that aim to repeat an arrangement considered, at some level, less threatening than the unknown. (FREUD, 1900)

From the Lacanian reading, we can deepen this metaphor of the gears by considering that each habit is inscribed in a signifying chain, occupying a place in the text that the subject writes with his life, a text that responds to the desire of the Other and to the structure of the language that precedes it. In this sense, there is no neutral habit, since even the most trivial behaviors carry marks of identifications, mandates and forms of jouissance that have been incorporated throughout subjective history. (LACAN, 1964)

By shifting the focus from the idea of "changing habits" to the question of repositioning oneself in the symbolic chain, psychoanalysis suggests that the true transformation of the personality requires a work of resignification that goes beyond behavioral adjustments, intervening in the invisible gears that connect the subject to the Other and to his own desire. (LACAN, 1964)

The concept of habitus, formulated by Bourdieu, offers an important contribution to this discussion, by describing systems of durable and transposable dispositions, incorporated by individuals through socialization, which guide perceptions, thoughts and actions in a regular way, without the need for conscious coordination, which dialogues directly with the idea of unconscious habits. (BOURDIEU, 1977)

The habitus is the result of the internalization of social structures, so that practices and ways of being specific to a class or group become natural for its members, functioning as gears that reproduce, in the body and mind of individuals, the objective order. This perspective shows that personality is not only an effect of intrapsychic conflicts, but also constitutes the intersection between symbolic structures, power relations and socialization experiences, which expands the field of analysis of unconscious habits. (BOURDIEU, 1977)

Bandura, with his notion of reciprocal determinism, according to which behavior, personal factors and environment interact in a dynamic way, allows us to think of the invisible gears of personality as systems in constant feedback, in which habits influence the context and are reinforced or punished by it. (BANDURA, 1977)

An individual with personality traits marked by social withdrawal, for example, tends to avoid situations of interaction, which reduces opportunities for positive experiences, reinforcing beliefs of inadequacy and maintaining the cycle of isolation, which manifests itself as a set of avoidance habits. By recognizing this circularity, space is opened for interventions that aim to interrupt the cycle at some point, introducing new experiences that can challenge habitual expectations, contributing to the reconfiguration of the subject's way of being. (BANDURA, 1977)

Clear's contributions on the construction of habit systems can also be integrated into the metaphor of gears, insofar as they highlight that lasting changes in life do not result from punctual decisions, but from the creation of structures that make certain behaviors easy and natural, in a similar way to the way in which the formations of the unconscious guide the subject without him realizing it. (CLEAR, 2019)

By proposing that we focus on becoming the type of person who performs certain behaviors, instead of pursuing only specific goals, the author approaches, in another register, the psychoanalytic idea that the personality is reconfigured when subjective positions and ways of relating to desire and the Other are transformed. Thus, articulating the clinical reading of unconscious habits with concrete strategies for reorganizing routines and environments can enrich care practices that aim at an effective change of the invisible gears that support the personality. (CLEAR, 2019)

3 CONCLUSION

Throughout this article, we have sought to show that unconscious habits can be understood as invisible gears that structure the formation and maintenance of the human personality, articulating contributions from Freudian psychoanalysis, Lacanian rereadings, contributions from Jung and Klein, and contemporary studies on habits and self-regulation. Instead of being reduced to simple visible routines, these habits express arrangements that the mind builds to manage tensions between desire, norms and the demands of reality, being incorporated so intensely into the subject's way of existing that they end up being confused with the very "essence" of who he is.

By considering personality traits as crystallizations of ways of dealing with the repressed and desire, it becomes possible to shift the notion of character from a fixed and

naturalized understanding to a historical and processual reading, in which the gears that sustain psychic functioning can be questioned, reinterpreted and, to a certain extent, transformed.

The dialogue with authors who empirically investigate habits indicates that the automatic component of conduct is not opposed to subjectivity, but actively participates in its constitution, providing relevant clues about how processes of change can be favored by interventions that reach, at the same time, the plane of consciousness and that of concrete action. Measures such as broadening attention to the moment when the habit is triggered, reorganizing signals and rewards, and building routines consistent with broader values and life projects are in tune with the psychoanalytic proposal of making thinkable what previously operated in the shadows, creating gaps for a less compulsive relationship with *jouissance* and desire itself.

When these perspectives are integrated, possibilities are opened up to enrich both clinical practice and initiatives to promote mental health and personal development, to the extent that it is recognized that personality modification necessarily involves intervening in the invisible gears that connect the subject to their experiences of suffering and satisfaction.

The reflection on these gears that articulate unconscious habits and ways of being also points to the importance of interdisciplinary research that brings together psychoanalysis, social psychology, neuroscience and behavioral economics, examining how internal conflicts, forms of social organization and automatic patterns of choice are combined in everyday life.

REFERENCES

- Bandura, A. (1977). *Social learning theory*. Prentice Hall.
- Baumeister, R. F., & Tierney, J. (2011). *Willpower: Rediscovering the greatest human strength*. Penguin Press.
- Bourdieu, P. (1977). *Outline of a theory of practice*. Cambridge University Press.
- Brewer, J. (2021). *Desconstruindo a ansiedade*. Sextante.
- Clear, J. (2019). *Hábitos atômicos*. Alta Life.
- Duhigg, C. (2012). *The power of habit: Why we do what we do in life and business*. Random House.
- Freud, S. (1900). *A interpretação dos sonhos*. Companhia das Letras.
- Jung, C. G. (1912). *Psicologia do inconsciente*. Vozes.
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Klein, M. (1952). *A psicanálise dos distúrbios da personalidade*. Imago.

Lacan, J. (1964). O seminário, livro 11: Os quatro conceitos fundamentais da psicanálise.
Jorge Zahar.

BETWEEN PLANNING AND DEMOCRACY: BUDGETING, CITIZEN PARTICIPATION, AND THE GIS CYCLE

ENTRE O PLANEJAMENTO E A DEMOCRACIA: ORÇAMENTO, PARTICIPAÇÃO POPULAR E O CICLO GIS

ENTRE LA PLANIFICACIÓN Y LA DEMOCRACIA: PRESUPUESTO, PARTICIPACIÓN CIUDADANA Y EL CICLO GIS



<https://doi.org/10.56238/sevened2026.008-186>

Ailton Ferreira Cavalcante¹

ABSTRACT

Public budgeting is the primary instrument through which governments transform political choices into fundable priorities and concrete actions. This article analyzes how the relaunch of Participatory Budgeting (PB) in Goiânia, after more than two decades of interruption, was integrated into the municipal planning cycle and redefined the role of the budget through the lens of the GIS Cycle (Governance, Innovation, and Sustainability). A qualitative, theory-driven and applied approach is used, based on documentary analysis and methodological illustration. The study examines the articulation between PB, the Multi-Year Plan (PPA 2026–2029), the Budget Guidelines Law (LDO), and the Annual Budget Law (LOA 2026), alongside technical training initiatives, Objectives and Key Results (OKRs), transparency mechanisms, and continuous monitoring. Findings indicate that linking citizen deliberation to fiscal decision-making helped transform the budget into a coordinating axis connecting social participation, strategic planning, and fiscal responsibility, enhancing legitimacy, allocative rationality, and institutional learning capacity. Evidence also suggests greater inclusion of demands from historically underserved territories, signaling progress in territorial equity. Nevertheless, challenges remain regarding institutional continuity, citizen communication, and the refinement of impact indicators. The article concludes that integrating budgeting, citizen participation, and results-based management, mediated by the GIS Cycle, represents a promising pathway for strengthening municipal governance, aligning spending priorities with social needs, and preserving fiscal balance.

Keywords: Public Budgeting. Governance. Social Participation. Public Value. GIS Cycle. Government Planning.

RESUMO

O orçamento público é o principal instrumento por meio do qual o Estado transforma escolhas políticas em prioridades financiáveis e ações concretas. Este artigo analisa como a retomada do Orçamento Participativo (OP) de Goiânia, após mais de duas décadas de interrupção, foi integrada ao ciclo de planejamento municipal e reconfigurou o papel do orçamento à luz do Ciclo GIS (Governança, Inovação e Sustentabilidade). Adota-se

¹ Doctoral student in Public Administration. Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP). E-mail: prof.ailton@hotmail.com Orcid: <https://orcid.org/0009-0009-2386-1245> Lattes: <http://lattes.cnpq.br/0389434047626666>

abordagem qualitativa, teórico-aplicada, baseada em análise documental e ilustração metodológica. O estudo examina a articulação entre OP, PPA 2026–2029, LDO e LOA 2026, bem como a adoção de capacitação técnica, Objectives and Key Results (OKRs), transparência e monitoramento contínuo. Os resultados indicam que a vinculação entre deliberação cidadã e decisões fiscais contribuiu para transformar o orçamento em eixo articulador entre participação social, planejamento estratégico e responsabilidade fiscal, ampliando legitimidade, racionalidade alocativa e capacidade de aprendizagem institucional. Observou-se, ainda, a incorporação de demandas provenientes de territórios historicamente subatendidos, evidenciando avanços em termos de equidade territorial. Persistem, entretanto, desafios relativos à continuidade institucional, comunicação com a sociedade e aprimoramento de indicadores de impacto. Conclui-se que a integração entre orçamento, participação popular e gestão por resultados, mediada pelo Ciclo GIS, constitui caminho promissor para fortalecer a governança municipal, alinhar prioridades orçamentárias às necessidades sociais e preservar o equilíbrio fiscal.

Palavras-chave: Orçamento Público. Governança. Participação Social. Valor Público. Ciclo GIS. Planejamento Governamental.

RESUMEN

El presupuesto público es el principal instrumento mediante el cual el Estado transforma decisiones políticas en prioridades financiables y acciones concretas. Este artículo analiza cómo la reactivación del Presupuesto Participativo (PP) en Goiânia, después de más de dos décadas de interrupción, fue integrada al ciclo de planificación municipal y redefinió el papel del presupuesto a la luz del Ciclo GIS (Gobernanza, Innovación y Sostenibilidad). Se adopta un enfoque cualitativo, de naturaleza teórico-aplicada, basado en análisis documental y en una ilustración metodológica. El estudio examina la articulación entre PP, el Plan Plurianual (PPA 2026–2029), la Ley de Directrices Presupuestarias (LDO) y la Ley de Presupuesto Anual (LOA 2026), así como la adopción de capacitación técnica, Objectives and Key Results (OKRs), mecanismos de transparencia y monitoreo continuo. Los resultados muestran que la vinculación entre deliberación ciudadana y decisiones fiscales contribuyó a transformar el presupuesto en un eje de coordinación entre participación social, planificación estratégica y responsabilidad fiscal, ampliando la legitimidad, la racionalidad asignativa y la capacidad de aprendizaje institucional. También se observaron avances en la incorporación de demandas provenientes de territorios históricamente desatendidos, lo que señala mejoras en términos de equidad territorial. No obstante, persisten desafíos relacionados con la continuidad institucional, la comunicación con la ciudadanía y el perfeccionamiento de indicadores de impacto. Se concluye que la integración entre presupuesto, participación ciudadana y gestión por resultados, mediada por el Ciclo GIS, constituye una vía prometedora para fortalecer la gobernanza municipal, alinear prioridades presupuestarias con necesidades sociales y preservar el equilibrio fiscal.

Palabras clave: Presupuesto Público. Gobernanza. Participación Social. Valor Público. Ciclo GIS. Planificación Gubernamental.

1 INTRODUCTION

The public budget is the main instrument by which the State transforms political decisions into bankable priorities and concrete actions. More than an accounting record, it is a space for dispute, negotiation and definition of collective directions, in which social expectations, fiscal restrictions and government choices are confronted. In this context, different countries and municipalities have sought mechanisms that bring society closer to budgetary processes, either to increase democratic legitimacy or to qualify the allocation of public resources. Participatory Budgeting (PB) has emerged, in recent decades, as one of these alternatives, offering institutional channels for deliberation on local priorities.

The experience of Goiânia is part of this debate based on a singular element: the resumption of PB after more than two decades of interruption and its direct articulation with the formal instruments of planning and budgeting. Instead of episodic and disconnected initiatives, it was decided to integrate popular deliberations into the Multi-Year Plan (PPA 2026–2029), the Budget Guidelines Law (LDO), and the Annual Budget Law (LOA 2026), associating them with monitoring and results-based management tools, such as *Objectives and Key Results* (OKRs).

The problem that guides this article can be formulated as follows: how can the integration between budget, popular participation and governance transform PB into an effective mechanism for public decision-making, and not just an advisory one? To address this issue, the GIS (² Governance, Innovation and Sustainability) Cycle framework is adopted, understood as an institutional arrangement capable of articulating transparency, fiscal responsibility, citizen participation and continuous monitoring.

An additional element reinforces the uniqueness of the process analyzed. The integration between popular participation, planning and budget did not result from isolated initiatives, but resulted from a programmatic commitment previously signed in the government plan registered with the Regional Electoral Court (TRE). This document structured the proposals in three major axes, city, citizen and management, and was already permeated by contributions from participatory processes conducted during the electoral period. When incorporated into the planning cycle and the municipal budget, the plan ceased to be a letter of intent and became a strategic reference for the construction of the PPA, the LDO and the LOA, articulating democratic legitimacy and good management technique.

² The GIS Cycle (Governance, Innovation and Sustainability) is an analytical model proposed by Ailton Ferreira Cavalcante, within the scope of his doctorate in Public Administration, supervised by Dr. Jean Santos Lima, which understands state action as a continuous process of formulation, execution, monitoring and feedback of public policies, articulating institutional governance, responsible innovation and sustainability as criteria for creating public value.

Methodologically, a qualitative study is developed, of a theoretical-applied nature, based on documentary analysis and methodological illustration. Normative acts, official reports, administrative records and public materials related to the construction of the PPA, LDO and LOA are examined, as well as the documents produced during the participatory process. The experience of Goiânia is not treated as an explanatory case study in the strict sense, but as a field of demonstration of the applicability of the proposed model.

The article seeks to demonstrate that the link between citizen deliberation and fiscal decisions reconfigures the place of the budget in municipal public management, converting it into an articulating axis between strategic planning, social participation and fiscal responsibility. It is also argued that this institutional arrangement favors the reduction of territorial asymmetries, strengthens the legitimacy of decisions and creates conditions for continuous governmental learning.

Next, we present the theoretical framework that underlies the analysis, discussing the role of the budget in democratic governance and the potentialities and limits of the Participatory Budget, and then examining the experience of Goiânia in the light of the GIS Cycle.

2 THEORETICAL FRAMEWORK

The theoretical framework that supports this study seeks to articulate different fields of literature, public budgeting, participatory democracy, government planning and results-oriented governance, in order to understand how the budget can assume a strategic role in mediating between political choices and social needs. By reviewing classic and contemporary authors, it seeks to show that Participatory Budgeting only achieves effectiveness when integrated into stable institutional structures, capable of transforming citizen deliberations into traceable budget priorities. This conceptual basis allows us to interpret the experience of Goiânia in the light of the GIS Cycle, examining its potentialities, limits and implications for municipal public management.

2.1 PUBLIC BUDGET AS AN INSTRUMENT OF GOVERNANCE

Historically understood as an accounting piece aimed at controlling revenues and expenses, the public budget has come to occupy a central position in the coordination of public policies. It structures priorities, defines fiscal limits, and organizes the decision-making process, functioning as an "articulating nucleus" between planning, execution, and control (GIACOMONI, 2020).

The literature emphasizes that the budget is not a neutral act. It expresses disputes, pacts and distributive choices, reflecting power relations within the State. In this sense, Wildavsky (1986) argues that "the budget is, above all, political", as it translates values and strategies that guide government action.

Nowadays, the budget is increasingly understood as an instrument of governance, articulating actors, rules, evidence and *accountability mechanisms*. Instead of serving only as a formal recording of expenditures, it is now evaluated for its ability to guide results, transparency, and intersectoral coordination (POLLITT; BOUCKAERT, 2017). Such a perspective brings the budget closer to the agendas of modern public management, in which planning, execution and evaluation need to operate in an integrated manner.

2.2 SOCIAL PARTICIPATION, LEGITIMACY AND PUBLIC VALUE

The Federal Constitution of 1988 enshrined social participation as a structuring principle of Brazilian public administration, associating transparency, social control and democratization of decisions (BRASIL, 1988). In these terms, participatory mechanisms began to act not only as consultative instruments, but as instances of deliberation and co-production of public policies.

The literature on participatory democracy highlights that deliberation processes increase legitimacy, strengthen public control, and favor the adaptation of policies to the real needs of citizens. Avritzer (2008) demonstrates that well-designed participatory institutions tend to produce inclusion, public rationality and greater social co-responsibility.

In dialogue with this perspective, the concept of public value broadens the criteria for government evaluation. For Moore (1995), the performance of the State should be judged not only by legality or economy, but by its ability to generate socially recognized results. Thus, participatory processes, when linked to concrete decisions, become an essential component of the legitimacy of policies and, in particular, of budgetary choices.

2.3 PLANNING, BUDGETING AND INSTITUTIONAL INTEGRATION

One of the recurring dilemmas in public management is the dissociation between strategic planning and budget execution. Plans are prepared with low fiscal correspondence, while budgets are built without adherence to previously defined strategies, producing institutional fragmentation and low effectiveness (BRESSER-PEREIRA, 2017).

In the Brazilian case, the framework formed by the Multi-Year Plan (PPA), the Budget Guidelines Law (LDO) and the Annual Budget Law (LOA) seeks to establish a logical link between medium-term goals, annual priorities and resource allocation. However, such

integration depends on state capacity, intersectoral coordination, and monitoring mechanisms capable of translating goals into concrete deliverables (GIACOMONI, 2020).

International organizations reinforce this agenda by pointing out that public decisions must combine evidence, impact assessment and transparency, otherwise they will become vulnerable to opportunistic or technocratic cycles (OECD, 2015). In this sense, the integration between planning and budgeting is a decisive element for the construction of solid and results-oriented governance.

2.4 PARTICIPATORY BUDGETING AND URBAN PLANNING: LESSONS FROM THE BRAZILIAN LITERATURE

The Brazilian literature on Participatory Budgeting highlights that its relevance is not limited to the opening of deliberative spaces, but involves its ability to influence urban planning itself. In a classic study on Goiânia, Vieira (2009) demonstrates that PB was conceived as a mechanism for the democratization of urban decisions; however, its effectiveness was limited by institutional discontinuities and by a still insufficient integration with formal instruments such as the Master Plan.

This finding shows that participatory processes only achieve lasting impact when linked to stable planning and budget structures, capable of translating public deliberations into programmatic priorities and territorially oriented investments. In this sense, the need for models that articulate social participation, strategic planning and budget execution is reinforced, a horizon in which the GIS Cycle, discussed in this article, is inserted.

From a convergent perspective, Fonseca (2009) examined the Participatory Budget of Goiânia as an instrument of democratic management and identified that its legitimacy depends less on the number of assemblies held and more on the institutional capacity to transform deliberations into priorities effectively executed. The author also shows that participation tends to reproduce territorial inequalities when there are no active mobilization policies and transparent prioritization criteria. These findings reinforce the premise adopted in this article: participatory processes need to be integrated into the budget cycle and accompanied by monitoring mechanisms, otherwise they will become symbolic consultations.

In a comprehensive review of recent national academic production, Aires and Aires (2025) demonstrate that the Participatory Budget continues to be a relevant instrument of participatory democracy, especially because it favors transparency, social inclusion, and community engagement. The authors identify, however, that its consolidation depends on three structuring vectors: continuous government commitment, adoption of participatory technologies, and systematic training of civil society. When these conditions are present, the

PB ceases to be a merely advisory mechanism and starts to function as a strategic tool for redirecting public spending to priority areas, aligning sectoral policies with territorial demands. This evidence reinforces the thesis defended in this article: only the integration between popular participation, planning and governance, as proposed by the GIS Cycle, is capable of conferring institutional stability and distributive effectiveness to the public budget.

2.5 DISCONTINUITIES AND "DISMANTLING" OF PARTICIPATORY EXPERIENCES

A significant part of the literature warns that experiences of Participatory Budgeting often suffer processes of institutional discontinuity. Vieira (2015) demonstrates that the "dismantling" of PB does not occur only through formal revocations, but also through subtle mechanisms, such as the reduction of resources, the weakening of councils, the alteration of deliberative rules and the progressive emptying of participatory stages. In this circumstance, participation subsists as a consultative ritual, with no effective impact on budgetary priorities. This finding reinforces a central premise of this article: the sustainability of PB depends on its organic link to the budget cycle (PPA, LDO and LOA), stable transparency rules and continuous public monitoring mechanisms, elements operationalized in this study through the GIS Cycle.

2.6 INSTITUTIONAL INNOVATION AND MANAGEMENT BY RESULTS

The modernization of the State is not restricted to technologies or managerial instruments; It implies institutional innovation, understood as the creation of new arrangements for coordination, participation and organizational learning. Models based on indicators, goals and continuous evaluation gain space because they bring strategic planning and social control closer together.

Tools such as OKRs (*Objectives and Key Results*) and monitoring systems introduce results logic, allowing strategic objectives to be broken down into measurable and trackable goals. However, such instruments only produce sustainable effects when articulated with principles of public ethics, transparency and social participation, avoiding technocratic capture and strengthening the commitment to the public interest (POLLITT; BOUCKAERT, 2017).

2.7 THE GIS CYCLE: GOVERNANCE, INNOVATION AND SUSTAINABILITY

The GIS Cycle, Governance, Innovation and Sustainability is a theoretical-applied model that interprets state action as a dynamic process of planning, execution, monitoring, learning and replanning. Its logic presupposes that public policies, especially the budget,

should be conceived as spaces for collective agreement, based on evidence and oriented to the creation of public value.

While governance refers to the integration between actors, rules, and transparency, innovation refers to the adoption of methodologies capable of bringing planning and results closer together; and sustainability involves both fiscal balance and institutional and social continuity. Applied to the budget cycle, GIS proposes an arrangement in which citizen participation, fiscal responsibility and management by results operate in an articulated way, avoiding both exclusionary technicality and populist practices devoid of criteria (MOORE, 1995; OECD, 2015).

It is important to highlight that the GIS Cycle does not present itself as a rupture in relation to contemporary approaches to governance, but as an applied synthesis of already consolidated contributions. The model dialogues with the literature on *governance networks*, by recognizing the need for articulation between multiple actors; it is close to *collaborative governance*, by emphasizing structured deliberative processes; and it converges with the tradition of *public value governance*, by linking public decisions to the production of collective value. Its originality lies less in the creation of a new paradigm and more in the ability to integrate these references into an operational arrangement aimed at municipal management.

2.8 PARTICIPATORY BUDGETING AS A PROCESS OF CITIZENSHIP EDUCATION AND SOCIAL TRANSFORMATION

Several studies point out that the Participatory Budget should not be understood only as an administrative instrument for the allocation of resources, but as a formative process capable of producing social transformation. By involving citizens in successive stages of deliberation, prioritization and monitoring, PB works as a true "school of democracy", stimulating a sense of co-responsibility and strengthening trust in public institutions. When articulated with transparency and effective enforcement mechanisms, it tends to redirect investments to historically neglected territories, expanding inclusion and distributive justice. On the other hand, experiences marked by low feedback and weak institutionalization tend to generate democratic frustration and discredit (AIRES; AIRES, 2025). In this perspective, this article argues that the integration between citizen participation, strategic planning and governance, operationalized by the GIS Cycle, is a decisive condition for PB to fully fulfill its transformative potential.

2.9 COMPARATIVE LESSONS FROM PARTICIPATORY BUDGETING

The comparative literature shows that consolidated experiences, such as Porto Alegre, Belo Horizonte and Recife, achieved more stable results when they associated social participation with formal planning instruments and permanent monitoring routines. In contexts where such bonds were fragile, discontinuity and emptying were observed over time.

The experience of Goiânia dialogues with these lessons by articulating public deliberation, strategic planning and fiscal governance, seeking to overcome the cycle of episodic initiatives and move towards an institutionally integrated model.

3 METHODOLOGY

This study adopts a qualitative approach, of a theoretical-applied nature, aimed at understanding the public budget as an instrument of democratic governance and institutional integration. It is based on the assumption that budget decisions cannot be interpreted only as accounting records, but as political-administrative processes structured by norms, institutions and participatory mechanisms (WILDAVSKY, 1986; GIACOMONI, 2020).

3.1 RESEARCH DESIGN

The research is characterized as analytical and illustrative, using the experience of the Municipality of Goiânia as a field of methodological illustration, and not as an explanatory case study in the statistical sense. The objective is to examine how the principles of the GIS Cycle, Governance, Innovation and Sustainability, are manifested in the articulation between planning, budgeting and social participation, producing learning that can be transferred to similar contexts.

3.2 PROCEDURES AND SOURCES OF EVIDENCE

The analytical construction of this study was based on three main groups of evidence. The first concerns the normative documents that structure the budget cycle and provide a legal basis for the process analyzed, including the Federal Constitution, the Fiscal Responsibility Law, the 2026–2029 Multi-Year Plan, the Budget Guidelines Law, and the 2026 Annual Budget Law.

The second set comprises institutional documents, such as Participatory Budget reports, plenary records, social mobilization materials and strategic planning instruments, including OKR spreadsheets and monitoring tools used by municipal secretariats.

Finally, a body of national and international academic literature on public budgeting, governance, social participation, and results-oriented management was mobilized, with

emphasis on contributions from Avritzer (2008), Moore (1995), Pollitt and Bouckaert (2017), and OECD (2015), among other authors.

The documentary analysis was developed sequentially. Initially, a conceptual systematization was carried out, in which the central analytical categories were defined, governance, participation, planning-budget integration, public value and GIS Cycle.

Next, an interpretative examination of the materials was carried out, seeking to identify correspondences between these categories and the institutional practices observed in the experience of Goiânia. Finally, an analytical synthesis was elaborated, aimed at understanding how the GIS Cycle contributes to articulate social participation, fiscal responsibility and results-oriented management.

Whenever possible, triangulation was promoted between normative sources, institutional reports, and specialized literature, with the aim of reducing interpretative biases and increasing the consistency of the findings. It was decided not to incorporate, at this stage, interviews with managers, counselors or participants in the process.

This decision was due to the analytical focus adopted, centered on the institutional architecture of the Participatory Budget and its integration into the budget cycle, as well as the time constraints inherent to the period of elaboration of the study. This is a conscious methodological choice, which does not invalidate the results achieved, but signals a promising front for future investigations, especially aimed at understanding citizen perceptions and the subjective effects of the participatory process.

3.3 BOUNDARIES AND LIMITS

The study focuses on the budget cycle associated with the participatory process related to the LOA 2026, especially in its integration with the PPA 2026–2029. It does not cover subjective perceptions of citizens or managers obtained through interviews, which is a recognized limitation. This restriction is partially compensated by the richness of institutional records and the emphasis on in-depth documentary analysis, appropriate to the objectives of a theoretical-applied nature.

3.4 ETHICAL AND TRANSPARENCY CONSIDERATIONS

Because it works exclusively with public and institutional documents, the study does not involve risks to participants. On the contrary, it reinforces the principle of publicity and traceability of decisions, in line with the transparency guidelines defended by international organizations and Brazilian legislation (BRASIL, 1988; BRAZIL, 2000; OECD, 2015).

3.5 DIGITAL GOVERNANCE AS A VECTOR OF QUALIFIED PARTICIPATION

The incorporation of digital tools into the participation process has expanded the scope and transparency of the deliberations, allowing agile access to information, monitoring of the stages and dissemination of results. Electronic platforms, institutional social networks, and open data portals have contributed to reducing geographical barriers and favoring the engagement of segments that traditionally participate less.

This digital dimension reinforces the GIS Cycle by connecting transparency, social control, and fiscal responsibility in the same institutional arrangement.

4 THE EXPERIENCE OF GOIÂNIA: INTEGRATION BETWEEN BUDGET, PARTICIPATION AND GOVERNANCE

Based on the theoretical framework presented, this section examines the recent experience of Goiânia in the resumption of Participatory Budgeting (PB) and its articulation with the municipal planning cycle. The case is analyzed as a field of methodological illustration capable of showing, in practice, how the budget can operate as an axis of integration between governance, social participation and fiscal responsibility.

More than describing events, it seeks to understand the institutional arrangements, procedures, and linkage mechanisms that made it possible to connect popular listening to the formal decisions inscribed in the Multiannual Plan (PPA 2026–2029), the Budget Guidelines Law (LDO), and the Annual Budget Law (LOA 2026).

The analysis is organized into subsections that deal with: (a) the historical resumption of PB; (b) the architecture of the participatory process; (c) the incorporation of priorities into the budget; (d) technical training and construction of OKRs; and (e) transparency and monitoring instruments.

Throughout the section, there is a constant dialogue with the GIS Cycle, Governance, Innovation and Sustainability, seeking to demonstrate how planning, participation and management by results were articulated to produce a public governance model oriented to the creation of public value and fiscal sustainability.

4.1 HISTORICAL RESUMPTION OF THE PARTICIPATORY BUDGET IN GOIÂNIA

The experience of Participatory Budgeting (PB) in Brazil has been consolidated, since the 1990s, as one of the most important laboratories of democratic innovation in the world, by allowing citizens to directly influence the allocation of public resources and the design of urban policies (AVRITZER, 2008).

However, as occurred in several Brazilian municipalities, the PB of Goiânia went through a long period of institutional discontinuity, marked by political alternations, fiscal restrictions and changes in government priorities. For more than two decades, binding participation mechanisms have lost space, being replaced by consultative, fragmented or merely informative formats.

The resumption of PB, in the 2025–2026 cycle, thus represented not only the reactivation of a participatory tool, but the reconstruction of an institutional environment focused on the integration between planning, budgeting, and social control.

The decision to reposition PB as a structuring component of the budget process was accompanied by explicit guidelines of transparency, traceability and articulation with the government planning cycle, in line with constitutional principles of participation, publicity and efficiency (BRASIL, 1988) and with the requirements of fiscal responsibility (BRASIL, 2000).

Unlike episodic experiences in the past, the resumption was conceived from the beginning as a multiphase process: community mobilization, holding regional plenary sessions, collection and systematization of proposals, intersectoral technical analysis, and incorporation of viable priorities into the actions provided for in the PPA 2026–2029, the LDO, and the LOA 2026.

This chain sought to overcome the classic distance between "social listening" and "fiscal decision", often pointed out as a factor of frustration and discredit in participatory processes (POLLITT; BOUCKAERT, 2017).

The historical character of the resumption is also expressed in the reconfiguration of the role of the citizen. By participating in face-to-face plenary sessions and digital instruments, the population ceased to exercise a merely demanding function to assume a deliberative role mediated by technical criteria and previously explained fiscal limits.

This change brings the Goiânia model closer to international experiences of collaborative governance in which participation is articulated with evidence, planning and continuous monitoring (OECD, 2015).

In addition, the reactivation of the PB coincided with a movement to strengthen the institutional apparatus of municipal planning, including the implementation of training processes, the adoption of management tools by results and the creation of periodic accountability routines.

Such synergy reinforces the thesis that the sustainability of participatory mechanisms depends on the existence of state capacity capable of translating public deliberations into consistent budgetary decisions (MOORE, 1995; BRESSER-PEREIRA, 2017).

Thus, the resumption of Participatory Budgeting in Goiânia can be understood as a milestone of democratic and administrative reconstruction: it reopens channels of social dialogue, strengthens the legitimacy of budgetary choices and inaugurates a cycle of governance in which participation, technique and fiscal responsibility start to operate in an integrated way. In the following sections, we examine how this process was institutionally designed and how it was connected to the planning and financial decisions of the municipality.

4.2 THE ARCHITECTURE OF THE PARTICIPATORY PROCESS: PLENARY SESSIONS, STAGES AND PRIORITIZATION

The resumption of the Participatory Budget in Goiânia was structured on a methodological design that sought to combine territorial inclusion, procedural transparency and fiscal viability.

The process was organized in successive and documented stages, in order to ensure traceability between the popular demonstration and the decisions incorporated into the municipal budget. This architecture dialogues with consolidated experiences of democratic participation, in which public deliberation is mediated by clear rules, technical criteria, and mechanisms for continuous monitoring (AVRITZER, 2008; OECD, 2015).

The first phase consisted of community and institutional mobilization, involving dissemination on social networks, articulation with local leaders and support from regional administrations.

Subsequently, face-to-face plenary sessions were held in different regions of the city, ensuring that territorial demands could be expressed in a decentralized manner. Each plenary session had technical mediation, prior presentation of the fiscal context and explanation of the legal and financial limits of the municipality, avoiding unrealistic expectations and contributing to a responsible deliberation.

In the second stage, the proposals presented by citizens were collected and systematized. The demands were registered, categorized by thematic area (infrastructure, health, education, environment, mobility, among others) and forwarded for intersectoral analysis. The performance of technical teams, at this time, was decisive in assessing compatibility with the PPA 2026–2029, estimating costs, verifying the existence of related actions, and identifying risks of duplicity or unfeasibility.

The third phase corresponded to the prioritization process, conducted based on previously established criteria: social relevance, territorial impact, financial viability, alignment with strategic priorities, and potential for improvement of public services. This procedure

prevented the PB from becoming a generic list of claims and contributed to its convergence with the guidelines of planning and fiscal responsibility (BRASIL, 2000).

In the final stage, the prioritized proposals were incorporated into the budget actions compatible with the LOA 2026, with an indication of programs, physical goals and sources of funding. The result was the consolidation of an institutional path that connects social listening, technical analysis and fiscal decision-making, reinforcing the credibility of the process and its pedagogical function for citizens. In line with the GIS Cycle, the PB thus operates as a mechanism for integrating democratic governance, methodological innovation and fiscal sustainability.

In addition to its deliberative dimension, the adopted design favored institutional learning. The systematization of demands and the construction of formal records allow the municipality to accumulate historical series, identify territorial patterns and progressively improve its decision-making processes. This characteristic brings PB closer to models of reflective governance, in which participation and monitoring feed each other, strengthening the state's capacity for planning and evaluation (MOORE, 1995; POLLITT; BOUCKAERT, 2017).

4.3 "FROM LISTENING TO THE LAW": INTEGRATION OF THE PARTICIPATORY BUDGET TO THE PPA, LDO AND LOA

One of the central elements of the analyzed experience was the transformation of the demands presented in the plenary sessions of the Participatory Budget into actions formally incorporated into the municipal budget cycle. This path, from public listening to materialization in the law, constitutes the nucleus of legitimacy of the process and the evidence that social participation was not merely consultative, but endowed with an effective capacity for advocacy.

The first movement consisted of the technical compatibility between the population's proposals and the strategic guidelines of the Multi-Year Plan (PPA 2026–2029). The responsible teams evaluated the adherence of the demands to the existing programs, the need to create new actions and the estimate of financial impacts. This exercise avoided both the risk of unenforceable promises and the automatic reproduction of demands unrelated to the municipal strategy — a frequent problem in poorly structured participatory experiences (POLLITT; BOUCKAERT, 2017).

Subsequently, the compatible proposals were incorporated into the priorities defined in the Budget Guidelines Law (LDO), a stage in which prioritization criteria, fiscal limits, and execution parameters were consolidated. This moment worked as a bridge between multi-

year planning and the annual allocation of resources, ensuring coherence between medium-term goals and budgetary possibilities for the following year.

The decisive step occurred with the insertion of PB priorities in the Annual Budget Law (LOA 2026). Each prioritized demand was linked to a specific program, action, and source of funding, with the definition of physical and financial goals. With this, a formal and traceable link was established between citizen deliberation and budget execution, allowing social control to monitor, throughout the year, the fulfillment of collectively defined priorities.

This institutional arrangement reinforced the pedagogical function of the budget by making visible the path that connects participation, decision-making and execution. At the same time, it revealed the importance of internal technical capacities and structured planning instruments, without which participation tends to become frustrated expectations.

From the perspective of the GIS Cycle, the OP-PPA-LDO-LOA integration highlights the articulation between democratic governance, organizational innovation and fiscal sustainability, converting the budget into a true space for public agreement and institutional learning.

To facilitate the understanding of the institutional arrangement built in Goiânia, Table X summarizes the flow that connects social participation, planning, budget decision-making and monitoring of results.

Table 1

Integrated flow of the Participatory Budget of Goiânia

Step	Process description	Institutional instrument	Expected result	Way of monitoring
Mobilization and social listening	Holding regional plenary sessions, collecting proposals and community prioritization.	PB Regulation and intersectoral coordination.	Structured survey of territorial demands.	Meeting records, attendance lists, and systematization reports.
Technical and tax analysis	Evaluation of the legal, budgetary and operational feasibility of the proposals.	Technical opinions of the secretariats and planning team.	Classification of proposals as eligible and non-eligible.	Published opinions and transparency of the criteria used.
Compatibility with planning	Alignment of proposals with programs, goals and strategic axes.	PPA 2026–2029 and program matrix.	Incorporation of priorities into municipal planning.	Adherence maps between proposals and programs.

Budget binding	Definition of appropriations and inclusion in legal documents.	LDO and LOA 2026.	Transformation of participatory decisions into budgetary commitments.	Publication of the LOA and traceability of actions.
Implementation and monitoring	Implementation of prioritized actions and works.	Sectoral plans and administrative contracts.	Progressive delivery of agreed policies.	Dashboards, transparency portals and periodic reports.
Assessment and learning	Review of results, course corrections and accountability to society.	OKRs, indicators and monitoring meetings.	Continuous improvement and strengthening of public trust.	Performance reports and public feedback.

Source: prepared by the authors.

In addition to the synthesis presented in Table 1, some illustrative cases allow us to visualize, in a concrete way, how the priorities deliberated by the population went through the stages of technical analysis, budget linkage and monitoring of results. The following examples are not intended to exhaust experience, but to highlight the traceability of the process and its ability to produce tangible effects in the territories.

Example 1 – Drainage and mobility in a peripheral region

In a region with recurrent flooding, the community prioritized drainage and paving works. The proposal was considered viable, was linked to the urban infrastructure program of the PPA 2026–2029 and became part of the LOA 2026 with a specific allocation. The execution was accompanied by quarterly OKRs, allowing schedule corrections and public disclosure of the results. The case highlights the PB's ability to align territorial demands with transparent tax decisions.

Example 2 — Primary care unit in an area with poor coverage

In a neighborhood with low supply of health services, the local priority was the implementation of a basic unit. After technical analysis, the project was included in the health sector program and in the LOA 2026. From the monitoring, there was an expansion of access and a reduction in travel to other neighborhoods. The example illustrates how the link between participation and budget favors equity gains.

The examples mentioned above present the following sources: *LOA 2026; Participatory Budget Disclosure Report; municipal monitoring panels.*

4.4 PARTICIPATION AND REDUCTION OF TERRITORIAL DISPARITIES

One of the most significant gains of the process was the ability to incorporate demands from historically underserved territories. The distribution of the plenary sessions by

administrative regions, combined with transparent prioritization criteria, contributed to expanding the voice of peripheral neighborhoods and areas with structural deficiencies.

By redirecting investments to these spaces, the Participatory Budget operated not only as a mechanism for social listening, but as an instrument for the gradual correction of intra-urban inequalities, aligning public spending with the principle of territorial equity.

4.5 EVIDENCE OF THE PARTICIPATORY PROCESS IN GOIÂNIA

The resumption of the Participatory Budget in Goiânia presented a procedural design that combined social mobilization, technical analysis and budget linkage. In total, several regional plenary sessions were held, in which the population presented proposals distributed by areas such as urban infrastructure, health, education and social assistance. After the technical screening regarding legal and fiscal feasibility, the prioritized proposals were consolidated and made compatible with the PPA programs, with the goals of the LDO and with the appropriations of the LOA.

This institutional chain is relevant because it avoids the recurrent risk identified in the literature, public consultations that do not turn into enforceable commitments. In Goiânia, on the contrary, each selected priority became part of a cycle of planning, execution and monitoring, with documentary traceability and transparency in the dissemination of results.

4.6 TECHNICAL TRAINING AND OKR CONSTRUCTION: WHEN PARTICIPATION MEETS RESULTS-BASED MANAGEMENT

The consolidation of the Participatory Budget in Goiânia was associated with a deliberate movement to strengthen the administrative capacity of the municipality. It was recognized that social participation is only effective when supported by trained teams, clear methodologies and instruments capable of translating public deliberations into measurable goals. In view of the facts, a technical training program was implemented aimed at managers and civil servants involved in planning, budgeting and monitoring.

The training contents covered fundamentals of government planning, integration between PPA, LDO and LOA, principles of fiscal responsibility, prioritization techniques and use of indicators. In parallel, the *Objectives and Key Results* (OKRs) methodology was introduced, adapted to the specificities of the public sector. The logic of OKRs consists of defining clear strategic objectives and verifiable key results, allowing for periodic monitoring of institutional performance and course correction whenever necessary (POLLITT; BOUCKAERT, 2017).

The construction of the OKRs took place collaboratively, involving different secretariats and municipal agencies. Each strategic objective was broken down into goals associated with budget programs, indicators, and execution deadlines.

With this, a vertical alignment was created between strategic planning, authorized budget and executive actions, reducing the risk of disconnection between discourse and practice. At the same time, the horizontal alignment between the areas was strengthened, avoiding overlaps and stimulating intersectoral cooperation.

From the point of view of Participatory Budgeting, OKRs played an important role in linking population priorities to monitorable institutional commitments. Demands selected in the plenary sessions could be associated with specific key results, which facilitated monitoring by control bodies and by society itself.

This dynamic reinforced the pedagogical function of the process, by showing that collective choices imply deadlines, costs, indicators, and responsibilities that are clearly distributed.

From the perspective of the GIS Cycle, Governance, Innovation and Sustainability, the adoption of technical training and results-based management instruments reveals that democratic participation and administrative rationality are not mutually exclusive, but complementary.

Institutional innovation resides precisely in the articulation between public deliberation, state capacity and fiscal responsibility, resulting in a governance model oriented to the creation of public value (MOORE, 1995; OECD, 2015).

4.7 INDICATORS FOR INSTITUTIONAL MONITORING AND LEARNING

The adoption of OKRs has made it possible to transform participatory deliberations into measurable goals, linked to deadlines, responsible parties, and sources of funding. In addition to physical and financial monitoring, the model incorporated result indicators, such as expanding access to services, improving infrastructure, and perceived user satisfaction.

The combination of goals and indicators creates an environment conducive to institutional learning: policies are monitored, evaluated, and corrected on an ongoing basis, avoiding both unrealizable promises and investments disconnected from social needs.

4.8 TRANSPARENCY, MONITORING AND SOCIAL CONTROL

The effectiveness of the Participatory Budget depends not only on the initial deliberation, but on the ability to follow, over time, the fate of the chosen priorities. In Goiânia, the resumption of the process was accompanied by efforts to systematically publicize the

stages, results and budget constraints, consolidating the principle of transparency as a central component of democratic governance.

Several instruments were used to ensure visibility of the decisions: disclosure of the plenary sessions and their results, availability of synthetic and analytical reports, registration of prioritized demands and their correspondence with programs and actions of the Annual Budget Law.

In addition, dashboards and digital tools now allow the monitoring of goals associated with OKRs, giving materiality to social control and enabling permanent scrutiny by citizens, councils, and control bodies.

This set of measures contributed to the creation of evidence trails, through which it is possible to reconstruct the path that goes from popular participation to budget execution. Such traceability reduces information asymmetries, strengthens public trust, and hinders practices of political capture or arbitrary redirection of resources.

In line with international guidelines for good governance, transparency is no longer a mere formal duty and starts to operate as a mechanism for accountability and institutional learning (OECD, 2015).

Another relevant aspect was the incorporation of monitoring as an administrative routine. Periodic follow-ups made it possible to identify delays, reschedules, and advances, favoring continuous adjustments and clear communication with society.

This dynamic reinforces the cyclical and reflective character of the process, bringing it closer to the logic of the GIS Cycle, in which planning, executing, measuring, and replanning are interdependent moments.

In summary, the transparency and monitoring policy associated with the Participatory Budget of Goiânia consolidated an environment of expanded social control, in which the population not only participates in the choice of priorities, but also monitors their implementation.

By articulating participation, accessible information and evaluation mechanisms, the municipality advances in the construction of a governance model that combines democratic legitimacy, administrative efficiency and fiscal responsibility.

5 RESULTS AND DISCUSSION

5.1 THE BUDGET AS AN INTEGRATING AXIS OF THE GIS CYCLE

The results of the analysis show that, in Goiânia, the budget ceased to operate as a mere accounting record to assume the role of an articulating axis between strategic planning, social participation and fiscal responsibility.

The integration between Participatory Budgeting, PPA, LDO, and LOA demonstrated, in practice, that it is possible to transform the budget into a space for public agreement, consistent with the concept of governance discussed in the theoretical framework (GIACOMONI, 2020; POLLITT; BOUCKAERT, 2017).

From the perspective of the GIS Cycle, the budget functioned as a point of convergence between governance (rules, actors and transparency), innovation (methodologies and instruments) and sustainability (fiscal balance and institutional continuity).

By linking participatory decisions to traceable budget actions, the process avoided both isolated technicality and symbolic participation, reaffirming the potential of the budget as a democratic and strategic space.

5.2 BINDING PARTICIPATION AND LEGITIMACY OF DECISIONS

Another relevant result concerns the quality of participation. The PB analyzed was not limited to informal consultations; He produced decisions with effective capacity to influence the budget. This characteristic reinforces the argument that binding participation contributes to increasing legitimacy, public trust and social co-responsibility (AVRITZER, 2008).

In addition, the combination of citizen deliberation and technical analysis prevented the process from being captured by unfeasible or corporate demands. The adopted model shows that participation is not synonymous with improvisation, but can be compatible with prioritization criteria and fiscal limits, as long as such criteria are made explicit and shared with society (BRASIL, 2000).

5.3 INSTITUTIONAL LEARNING AND MANAGEMENT BY RESULTS

The incorporation of technical capacity building and OKRs revealed that the sustainability of PB depends on the existence of state capacity. By adopting results-based management instruments, the municipality created mechanisms for aligning strategic objectives, budget programs and monitorable goals, strengthening the reflective character of the process.

This result confirms the thesis that democratic participation and administrative rationality are complementary dimensions. Institutional innovation is not only in the opening of spaces for deliberation, but in the creation of routines that allow for the monitoring, evaluation and reprogramming of public policies in a transparent manner (MOORE, 1995; OECD, 2015).

5.4 TRANSPARENCY AND SOCIAL CONTROL AS A GUARANTEE OF SUSTAINABILITY

The establishment of evidence trails, public reports and monitoring panels contributed to consolidating an environment of expanded social control. The possibility of following the complete cycle, from plenary to execution, strengthens public confidence and creates incentives for managers to maintain coherence between planning and execution.

This result reinforces the idea that transparency should not be seen only as a formal duty, but as an active instrument of governance and prevention of institutional setbacks. In contexts of political alternation, the existence of registries and monitoring mechanisms increases the chances of continuity of the agreed policies.

5.5 LIMITS AND CHALLENGES IDENTIFIED

Although the advances observed are significant, the experience analyzed reveals a set of challenges that need to be faced to ensure the sustainability of the model. A first aspect refers to the need to expand and qualify public communication, using accessible language and diversified formats, so that the entire population can understand the stages, criteria and results of the process. Added to this is the permanent risk of fiscal restrictions, which can reduce the deliberative space and limit the execution of the priorities agreed with society.

Another relevant challenge concerns the dependence on institutional continuity and the maintenance of qualified technical staff, an essential condition to preserve routines, procedures and organizational memory. In addition, it is increasingly necessary to improve indicator systems, moving from metrics focused only on physical-financial execution to instruments capable of capturing distributional effects and concrete social impacts.

In summary, these limits indicate that the consolidation of the arrangement requires continuous investments in training, transparency and institutionalization of participatory practices, under penalty of regression to traditional bureaucratic models. It should also be noted that this article focused on the institutional analysis of the process, based on official documents and administrative records. Important fields of investigation remain open, such as citizens' perception of Participatory Budgeting, distributional effects in different regions of the city, and longitudinal evaluation of the impacts produced. Future research may combine qualitative and quantitative methods, allowing us to measure, with greater precision, the extent to which the integration between participation, planning and budget contributes to the generation of public value.

5.6 INTERPRETATIVE SYNTHESIS

In summary, the results suggest that the experience of Goiânia confirms the central hypothesis of this article: when articulated with planning and supported by results-based management instruments, Participatory Budgeting can reconfigure the role of the public budget, bringing it closer to a governance model that combines democratic legitimacy, technical rationality and fiscal sustainability.

The GIS Cycle proved to be useful both as an interpretative lens and as a practical guideline, allowing us to understand the interdependence between participation, planning and monitoring. Although the study does not intend statistical generalization, its implications offer relevant clues for local governments seeking to innovate in the field of participatory budgeting and contemporary public management.

6 CONCLUSION

The study analyzed the resumption of the Participatory Budget of Goiânia and its articulation with the municipal planning cycle in the light of the GIS Cycle, Governance, Innovation and Sustainability. The experience examined demonstrates that the public budget can cease to be a mere accounting piece to become a strategic space for democratic agreement, institutional integration and creation of public value.

It was shown that the link between Participatory Budgeting, Multi-year Plan, Budget Guidelines Law and Annual Budget Law allowed structuring a traceable path between social participation, technical analysis and fiscal decision. The combination of territorial plenary sessions, reasoned prioritization, training of civil servants, and adoption of OKRs contributed to reducing the historical distance between planning and execution, strengthening transparency and social control.

The results suggest that, when supported by state capacity, results-based management instruments and permanent monitoring mechanisms, the Participatory Budget can assume a structuring role in the municipal budget process. From this perspective, democratic participation and administrative rationality are no longer opposite dimensions and start to reinforce each other, forming a governance model compatible with the principles of fiscal responsibility and public efficiency.

However, persistent challenges are recognized: the need for more accessible communication, risks arising from fiscal constraints, dependence on institutional continuity and improvement of social impact indicators. Such limits indicate that the consolidation of the model requires continuous investment in training, transparency and institutionalization of participatory routines.

From a theoretical point of view, the GIS Cycle proved to be a useful tool to understand the interdependence between planning, budgeting and participation, offering a lens capable of integrating governance, innovation and sustainability. From a practical point of view, the experience of Goiânia suggests replicable paths for local governments interested in strengthening their planning structures and democratizing the budget process.

Finally, the articulation between budget, popular participation and management by results proves to be a promising way to bring public planning closer to the concrete life of cities, expanding democratic legitimacy, administrative efficiency and fiscal responsibility, essential pillars for the construction of a State capable of responding, in a transparent and sustainable way, to the demands of contemporary society.

REFERENCES

- Aires, M. A., & Aires, L. S. A. (2025). O orçamento participativo como ferramenta de transformação social: Um panorama da produção acadêmica (2019–2024). *Interference Journal*, 11(2), 919–951. <https://doi.org/10.36557/2009-3578.2025v11n2p919-951>
- Avritzer, L. (2008). *Democracia e os espaços públicos no Brasil* (2ª ed.). Editora Unesp.
- Brasil. (1988). *Constituição da República Federativa do Brasil*. Senado Federal.
- Brasil. (2000). Lei Complementar n.º 101, de 4 de maio de 2000. Estabelece normas de finanças públicas voltadas para a responsabilidade na gestão fiscal. *Diário Oficial da União*.
- Bresser-Pereira, L. C. (2017). *A reforma gerencial do Estado* (3ª ed.). FGV Editora.
- Cavalcante, A. F. (2025). *Governança e sustentabilidade em cidades inteligentes: Uma proposta de aplicação do Ciclo GIS* [Tese de doutorado, Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa].
- Doerr, J. (2018). *Measure what matters: How Google, Bono, and the Gates Foundation rock the world with OKRs*. Portfolio/Penguin.
- Fonseca, J. F. R. (2009). *O orçamento participativo e a gestão democrática de Goiânia* [Dissertação de mestrado, Universidade Católica de Goiás].
- Giacomoni, J. (2020). *Orçamento público* (18ª ed.). Atlas.
- Goiânia. Prefeitura Municipal. (2025a). *Lei de Diretrizes Orçamentárias — LDO 2026*. Secretaria Municipal da Fazenda.
- Goiânia. Prefeitura Municipal. (2025b). *Lei Orçamentária Anual — LOA 2026*. Secretaria Municipal da Fazenda.
- Goiânia. Prefeitura Municipal. (2025c). *Planejamento Estratégico Municipal 2026–2029*. Secretaria Municipal da Fazenda.
- Goiânia. Prefeitura Municipal. (2025d). *Plano Plurianual 2026–2029 (PPA)*. Secretaria Municipal da Fazenda.
- Goiânia. Prefeitura Municipal. (2025e). *Relatório de Evidenciação do Orçamento Participativo — Goiânia 2026*. Secretaria Municipal da Fazenda.

- International Organization for Standardization. (2019). ISO 37122:2019 — Sustainable cities and communities: Indicators for smart cities.
- Moore, M. (1995). *Creating public value: Strategic management in government*. Harvard University Press.
- Organisation for Economic Co-operation and Development. (2015). *Government at a glance 2015*. OECD Publishing.
- Organisation for Economic Co-operation and Development. (2016). *Open government: The global context and the way forward*. OECD Publishing.
- Pollitt, C., & Bouckaert, G. (2017). *Public management reform: A comparative analysis* (4^a ed.). Oxford University Press.
- Smith, G., & Soneryd, L. (2014). Participatory governance and digital platforms. *Policy & Internet*, 6(2), 117–138.
- Vieira, M. M. C. (2009). *A inclusão do orçamento participativo no planejamento urbano de Goiânia* [Dissertação de mestrado, Universidade Católica de Goiás].
- Vieira, M. M. C. (2015). *Desmantelar políticas participativas: Limites e retrocessos do Orçamento Participativo* [Manuscrito acadêmico].
- Wildavsky, A. (1986). *The politics of the budgetary process* (4^a ed.). Little, Brown and Company.

REGULATORY IMPACT AS AN INSTRUMENT OF STATE EFFICIENCY

IMPACTO REGULATÓRIO COMO INSTRUMENTO DE EFICIÊNCIA ESTATAL

EL IMPACTO REGULATORIO COMO INSTRUMENTO DE EFICIENCIA ESTATAL



<https://doi.org/10.56238/sevened2026.008-187>

Felipe Teles Tourounoglou¹

ABSTRACT

The research in progress has the scope to verify the Regulatory Impact Analysis (AIR), evaluating its aspects regarding the democratic aspect of the institute. Although in a timid way, AIR has found resonance in the Brazilian regulatory structure. Founded in the paradigm of efficiency of the public administration, the AIR consists of a procedure for decision making of the public administration. Brazil, it has a regulatory structure in several sectors, this regulation is a way to control, and give vent to the government plans. In addition, the present study analyzes the Democratic State of Law and the guiding principles of this order, which, along with the promoted efficiency, permeate the state intervention and allow evidence to be collected so that this intervention is technical, democratic and less impact of management activities.

Keywords: Regulation. State Control. Democratic Efficiency. Government Plans. Impact. Democracy.

RESUMO

A pesquisa em realização, tem o escopo de verificar a Análise do Impacto Regulatório (AIR), avaliando suas vertentes no que tange ao aspecto democrático do instituto. Ainda que de maneira tímida, a AIR tem encontrado ressonância na estrutura regulatória brasileira. Fundada no paradigma da eficiência da administração pública, a AIR consiste em um procedimento para tomada de decisões da administração pública. O Brasil, detém, uma estrutura regulatória em vários setores, esta regulação é forma de controlar, e dar vazão aos planos governamentais. Ademais, na presente pesquisa, analisa-se o Estado Democrático de Direito e os princípios norteadores desta ordem, os quais, juntamente com a propalada eficiência, permeiam a intervenção estatal e permitem que sejam colhidas evidências para que esta intervenção seja técnica, democrática e menos impactante às atividades da administração.

Palavras-chave: Regulação. Controle Estatal. Eficiência Democrática. Planos Governamentais. Impacto. Democracia.

¹ Master's degree in Law. Unimar. E-mail: felipeteles.adv@gmail.com

RESUMEN

Esta investigación tiene como objetivo examinar el Análisis de Impacto Regulatorio (AIR), evaluando sus aspectos en relación con la naturaleza democrática de la institución. Aunque aún con cierta cautela, el AIR ha encontrado eco en la estructura regulatoria brasileña. Fundamentado en el paradigma de la eficiencia de la administración pública, el AIR consiste en un procedimiento para la toma de decisiones en la administración pública. Brasil cuenta con una estructura regulatoria en diversos sectores; esta regulación es una forma de controlar y dar voz a los planes gubernamentales. Además, esta investigación analiza el Estado Democrático de Derecho y los principios rectores de este orden, que, junto con la tan discutida eficiencia, permean la intervención estatal y permiten la recopilación de evidencia para garantizar que esta intervención sea técnica, democrática y tenga un menor impacto en las actividades de la administración.

Palabras clave: Regulación. Control Estatal. Eficiencia Democrática. Planes de Gobierno. Impacto. Democracia.

1 INTRODUCTION

Founded on the principle of efficiency of public administration, the *RIA* consists of a decision-making procedure, based on evidence, which seeks to evaluate, based on the definition of a regulatory problem, the possible impacts of the available action alternatives to achieve the intended objectives.

Originating in the USA, for more than 30 years, the *RIA* has been adopted by the member countries of the OECD (Organization for Economic Cooperation and Development). Brazil, as a guest member of this organization, was expressly recommended to adopt the tool called *AIR*, in order to assess its regulatory quality. Furthermore, through administrative measures

The research problem is outlined in the following question: is *the RIA* an expression of the Democratic Rule of Law? Does the *RIA* contemplate the constitutional principle of efficiency of public administration? Can *the RIA* replace other forms of analysis of state control, can other forms of analysis of state regulation be suppressed or lose validity by *the RIA*?

Not yet relevant, the results point to a greater efficiency of *the RIA*, which, although it has some similarity with the other forms of verification of state regulation, is more linked to the efficiency and democratization of control.

In this essay, it is necessary to verify the conception of the Democratic State of Law, as well as the measure of its interventionism.

Nevertheless, it is pertinent to verify the heteronomy of state control/regulation, which must undergo an analysis, democratic evaluation, guided by the best public interest.

Furthermore, it is fruitful to demonstrate the absence of legal and constitutional impediments to the comparison and eventual replacement of the Environmental Impact Study for the Regulatory Impact Analysis. Undoubtedly, the greater the analysis of state control/regulation, the lower the impact of this control on social systems.

The theme will be approached with the deductive method from the use of existing conceptions and theories about the institutes, as well as the legality of the implementation of the *RIA* in the country and the real importance that its effective use will bring to state control.

2 DEMOCRACY AND EFFICIENCY: DEMOCRATIC STATE REGULATION

2.1 THE CONCEPTION OF THE DEMOCRATIC RULE OF LAW AND ITS REGULATORY POWER

It is important, initially, to point out that the expression Democratic State of Law is difficult to conceptualize. For this reason, in order to enable a better understanding of the subject, we consider it necessary to discuss the evolution of the Modern State.

The Absolutist State is the "first expression of the Modern State" (STRECK; MORAIS, 2014, p. 35). During absolutism, power was concentrated in the figure of the monarch, who ruled in a full, unlimited way, without the control of other powers. Executive and legislative powers were also in the hands of the king. The monarch was also to be exempt from any responsibility, for his power was a divine gift.

Strech and Morais (2014, p. 35) also state that:

As a result, absolute monarchies appropriated states in the same way that the owner makes the object his property, giving rise to a power of *imperium* as the absolute right of the king over the state. On the other hand, with this attitude, the kings constituted themselves as lords of the States, in the same way as the feudal lords of the Middle Ages, individually titling the property of the State.

Bastos (1999, p. 16) teaches that "(...) with absolutism, the State identifies itself with power, with sovereignty, with the king, and society – whether in what comes from afar, or in what it brings new – appears on the margins of political power and without projection to power".

Gradually, voices against monarchical absolutism began to emerge and, in the eighteenth century, resistance reached its apogee with bourgeois revolutions.

The first revolution, known as the "Glorious Revolution", took place in 1688, which dethroned King James II, a Catholic and absolutist, and the English throne was occupied by William of Orange, who professed the Protestant religion, with the support of the *Whigs* (liberals) and the *Tories* (conservatives), who occupied parliament.

The *Bill of Rights* of 1689 is undoubtedly one of the most important consequences of the Glorious Revolution. Acceptance of this document was made by Parliament a condition for William of Orange to take the throne, and this condition was accepted by him in 1689. At that time, the so-called constitutional monarchy emerged in England.

The *Bill of Rights* limited the monarch's power, but not only that. Comparato (2010, p. 80) states that:

[...] the essence of the document consisted in the institution of the separation of powers, with the declaration that Parliament is a body primarily responsible for defending its subjects before the King and whose functioning cannot, therefore, be subject to the latter's discretion. In addition, the *Bill of Rights* strengthened the institution of the jury and reaffirmed some fundamental rights of citizens, which are expressed to this day, in the same terms, by modern Constitutions, such as the right to petition and the prohibition of *cruel and unusual punishments*.

The English philosopher John Locke is considered the greatest theorist of anti-absolutism. He defended the limitation of the monarch's power, stating that the right to freedom is a sacred right of the people, with the people being the only source of power. In this way, power is only legitimate if there is the consent of the people.

Locke (1994, p. 170) also believed that there should be a separation of powers, stating that:

And since the temptation to ascend to power may be too great for human frailty, it is not fitting that the same persons who hold the power to legislate should also have in their hands the power of executing the laws, for they might exempt themselves from obedience to the laws they have made, and bring the law into line with their will, both at the time of making it and in the act of its execution, and it would have interests distinct from those of the rest of the community, contrary to the purpose of society and government.

As Streck and Morais (2014, p. 40) point out, "it is with Locke that we see the inaugural constitution of the profile of political liberalism, sustaining the need to limit the power and functions of the State (...)".

Dallari (1998, p. 10) also asserts that "John Locke is, without any doubt, an important author, whose works, markedly anti-absolutist, exerted great influence on the so-called English Revolution of 1688, as well as on the American Revolution of 1776".

In the eighteenth century, the American Revolution (1776) and the French Revolution (1789) emerged.

Comparato (2010, p. 47) states that the "American Revolution was essentially, in the same spirit as the *English Glorious Revolution*, a restoration of the old franchises and traditional rights of citizenship, in the face of the abuses and usurpations of monarchical power".

Years after the American Revolution, more precisely, on September 17, 1787, the Constitution of the United States of America was approved in Philadelphia. However, the US bills of rights were only inserted into the constitutional text by amendments to the Constitution.

The first ten amendments to the Constitution date from December 15, 1791, and new amendments were approved later.

The *U.S. Bill of Rights* guarantees certain fundamental rights, among which we can highlight: freedom of religion and its free exercise, freedom of speech, freedom of the press, the right of the people to assemble peacefully, the right to petition, the prohibition of cruel or aberrant punishments, the prohibition of slavery, the right to vote for all U.S. citizens, the right to due process, the right to be defended by a lawyer, etc.

It is also important to note that even before the Constitution of the United States of America (1787), the *Bill of Rights* of Virginia (1776) already provided for fundamental rights, being "the first declaration of fundamental rights, in the modern sense." (SILVA, 2005, p. 153).

Unlike the American Revolution, in the French Revolution "the whole impetus of the political movement tended towards the future and represented an attempt at a radical change in the conditions of life in society." (COMPARATO, 2010, p. 47). The French Revolution was also strongly influenced by the French philosopher Jean-Jacques Rousseau, mainly by the doctrine of the social contract.

Thus, the French Revolution pursued a future free from the shackles of absolutism and a new form of society, in which every man could be the holder of essential rights and the people considered as the only source of power, breaking the chains of the past and inaugurating a new history.

Arendt (1988, p. 44-45), analyzing the American and French Revolutions, emphasizes the more universal character of the French Revolution, stating that:

it was the French Revolution, not the American Revolution, that set the world on fire. The sad truth of the matter is that the French Revolution, which resulted in disaster, made world history, while the American Revolution, so triumphantly victorious, remained an event of almost only local importance.

The French Revolution resulted in the Declaration of the Rights of Man and of the Citizen (*Déclaration des Droits de l'Homme et du Citoyen*) of 1789, which also has a more universal character compared to the *English and American Bills of Rights*.

Robert (apud SILVA, 2005, p. 157), supported by the abstract and universalizing character of the Declaration of the Rights of Man and of the Citizen (1789), states that it has three fundamental characteristics: intellectualism, globalism and individualism.

Intellectualism is due to the fact that the recognition of the existence of inalienable human rights and the need to reestablish a power legitimized by the consent of the people did not go beyond the intellectual universe, being developed only on the plane of ideas. It is characterized by globalism because the principles enshrined in the Declaration of the Rights of Man and of the Citizen are not limited to the French people, but seek a universal value, that is, it has principles of a universal nature. And, finally, individualism is observed because

the Declaration of the Rights of Man and of the Citizen only recognizes individual freedoms, omitting the freedoms of association and assembly, being concerned only with the defense of the individual against the State (ROBERT apud SILVA, 2005, p.157).

The Declaration of the Rights of Man and of the Citizen, despite its abstract character, is undoubtedly a milestone in the history of human rights and even served as a source of inspiration for many other subsequent declarations. Its spirit is one of freedom and equality. In it, man is seen as the holder of rights and free by nature. Furthermore, we can say that the Declaration of the Rights of Man and of the Citizen symbolizes the end of the era of absolute monarchy.

In addition, in 1791 the first written Constitution of France was inaugurated, which ensured equality among men, freedom, security, the inviolability of property, etc.

With the end of the absolutist State, the Rule of Law is born, which, in short, is a State that submits to the Law. This model of State is marked by the phenomenon of constitutionalism.

According to Silva (2005, p. 112), the Rule of Law, initially, was a typically liberal concept, which had the following characteristics:

(a) *submission to the rule of law*, which was the primary note of its concept, the law being considered as an act formally emanating from the Legislative Power, composed of representatives of the people, but of the people-citizen; (b) *division of powers*, which independently and harmoniously separates the Legislative, Executive and Judiciary powers, as a technique that ensures the production of laws for the former and the independence and impartiality of the latter in relation to the others and the pressures of powerful individuals; (c) *enunciation and guarantee of individual rights*.

Thus, in the Liberal State of Law, which is the first expression of the Rule of Law, the action (power) of the State was limited by the law. In addition, the law should be applied equally to all. The division of powers also appears as a milestone in the history of the Modern State, with only the Legislative Power (representatives of the people) being responsible for issuing laws. Citizens also have rights and guarantees assured, such as the right to equality, liberty, property, the guarantee of due process, etc. With this, there is a growth in individual freedoms.

Ferrajoli (2002, p. 690) also highlights the profound transformation in the social structure with the advent of the Rule of Law, stating that:

[...] the transformation of the absolute State into the State of law occurs simultaneously with the transformation of the subject into a citizen, that is, into a subject of the holder of rights that are no longer exclusively "natural" but "constitutional" in relation to the State, which becomes, in turn, bound in relation to the former.

On the theoretical level, the rule of law "emerges as a construction specific to the second half of the nineteenth century, born in Germany – as *the Rechtsstaat* – and, later, being incorporated into French doctrine (...)" (STRECK; MORAIS, 2014, p. 68).

In the Liberal State of Law, the intervention of the State was minimal (minimal State), being the result of the struggle for individual freedoms. The State should be neutral from the religious to the economic field (contractual freedom and free market economy). Thus, it was up to the State only to deal with the security and defense of the individual freedoms of citizens.

It so happens that this model of the Liberal State Law was gradually changed, because the minimum state intervention did not result in the idealized social model. On the contrary, society began to feel the effects of the non-interference of the State in many aspects, as inequalities and social injustices had only increased. The State then began to intervene more and more.

Thus, in the twentieth century, "due to a progressive assumption by the State of activities in the economic, social, social security, educational, etc. fields, its classic feature of a Liberal State gives way to that of a Social State" (BASTOS, 1995, p. 70).

The Social State of Law is characterized as an interventionist State, which materializes social rights (health, education, security, etc.) provided for by law. It is a State that is based on the duty to guarantee the realization of social rights and, with this, expands the list of fundamental rights.

Furthermore, it should be noted that "with the Social State of Law, a model is projected in which well-being and social development guide the actions of the public entity" (STRECK; MORAIS, 2014, p.73).

The Democratic Rule of Law appears as a new concept, which umbilically links the concept of the Rule of Law to that of democracy, making them inseparable concepts. In the words of Silva (2005, p. 119):

The configuration of the *Democratic Rule of Law* does not only mean formally uniting the concepts of Democratic State and Rule of Law. It consists, in fact, in the creation of a new concept, which takes into account the concepts of the component elements, but surpasses them to the extent that it incorporates a revolutionary component of transformation of the *status quo*.

Thus, the Democratic Rule of Law is based on the idea of social transformation, which, based on the link between the Rule of Law and the democratic ideal, enshrines popular sovereignty, the separation of powers (legislative, executive and judiciary), fundamental rights and guarantees, the principle of legality, democratic political organization, the equality

of all before the law, the written Constitution, etc. This is the State model adopted by the Federal Constitution of 1988 (art. 1, *caput*, CF).

The principles of the Democratic Rule of Law are: a) the principle of constitutionality, which determines that the Democratic Rule of Law must be based on a written Constitution; b) democratic principle (democracy of representation and participation); c) system of fundamental rights; d) principle of social justice; e) principle of equality; f) principle of division of powers; g) principle of legality and; h) principle of legal certainty (SILVA, 2005, p. 122).

Some observations should be made regarding the principles of the Democratic Rule of Law. The first is that a State can only be considered a Democratic State of Law if there is a separation of powers. Without this separation, power would be concentrated in the hands of a single person or a few people and there would be no control of state power. The second is that the Democratic State of Law is a State thirsty for effective popular participation (democracy of representation and participation) and, therefore, is governed by the democratic principle. The third is that the written Constitution limits the power of the State and ensures fundamental rights, being the basis of the Democratic Rule of Law. And, finally, as Streck and Morais (2014, p. 73) specify, legality in this model of State "takes the form of an effective search for the realization of equality, not by the generality of the normative command, but by the realization, through it, of interventions and regulations that directly imply a change in the situation of the community".

We can also highlight that article 3, items I, II, III and IV, of the Federal Constitution establishes the fundamental objectives of the Federative Republic of Brazil, which, in fact, are also the objectives of the Democratic Rule of Law, since article 1, *caput*, of the Federal Constitution states that the Federative Republic of Brazil is a Democratic State of Law. Thus, we have that the objectives of the Democratic Rule of Law expressed in the constitutional text are: a) to build a free, fair and solidary society; b) to guarantee national development; c) eradicate poverty and marginalization and reduce social and regional inequalities; d) to promote the good of all, without prejudice of origin, race, sex, color, age, and any other forms of discrimination.

Finally, in the field of intervention, in the field of state control, as we will see below, the constitutional principle of efficiency appears as a limiter of the interventionist or overly dirigiste state, making regulation a democratic expression of this control.

2.2 PRINCIPLE OF EFFICIENCY AND LIMITING PRINCIPLES OF STATE CONTROL

The word principle, from the Latin *principium*, means origin, beginning, primary cause, what comes before.

In the legal field, "principles are ordinances that radiate and magnetize the systems of norms" (SILVA, 2005, p. 92).

Or as Ávila (2011, p. 97) prefers, "principles, as they are immediately finalistic norms, establish an ideal state of affairs to be sought, which concerns other norms of the same system, notably the rules".

Constitutional Law is considered to be the starting point, that is, the common core of all the law to which they are linked and from which the various domains of the State's legal order also derive.

It follows that Constitutional Law is of paramount importance for administrative law. This is because the branches of law should always be correlated, never being interpreted in isolation, because the Federal Constitution, the main source of Constitutional law, brings in its core the so-called constitutional principles that are generic norms that serve as a basis for the entire legal system, including for state control, establishing limits to political action, as well as instituting protection for the individual in relation to the State, such a statement becomes clear because we are dealing with a democratic State of law. On this, let's see:

[...] The democracy that the Democratic Rule of Law achieves must be a process of social coexistence in a free, fair and solidary society (art. 3, I), in which power emanates from the people, and must be exercised for the benefit of the people, directly or by elected representatives (art. 1, sole paragraph); participatory, because it involves the growing participation of the people in the decision-making process and in the formation of acts of government; pluralistic, because it respects the plurality of ideas, cultures and ethnicities and thus presupposes the dialogue between divergent opinions and thoughts and the possibility of coexistence of forms of organization and interests different from society; It must be a process of liberation of the human person from forms of oppression that depends not only on the formal recognition of certain individual, political and social rights, but especially on the existence of economic conditions likely to favor their full exercise. (SILVA, 1988, p.24)

That is, the Constitution of a State is interpreted as a prerequisite for the validity of all laws, more specifically, it is the foundation for the construction of regulatory norms.

In the Brazilian legal system, the democratic rule of law aims to achieve social, participatory, and pluralistic democracy, having as one of the basic principles the principle of efficiency, topographically established in the Federal Constitution of 1988 in its article 37, after constitutional amendment 19/98. Otherwise, let's see:

Article 37. The direct and indirect public administration of any of the Powers of the Union, of the States, of the Federal District and of the Municipalities shall obey the principles of legality, impersonality, morality, publicity and efficiency, and also the following: [...].

This article provides that the Brazilian public administration, as a democratic administration, must stick to fundamentals, such as: legality; impersonality, morality; advertising and above all to effectiveness.

However, the principle of efficiency does not emerge in the legal system only with the constitutional reform of 98, we join the current that defends that efficiency, although not explicit, was present in the principled core of the Magna Carta, given its implicit allocation in principles, such as human dignity, reasonability and proportionality.

The dignity of the human person, a guiding and basic principle of the entire Brazilian legal system, worthy of note, is defined by Ingo Sarlet (SARLET, 2002, p.82). as follows:

[...] intrinsic and distinctive quality of each human being that makes him or her deserving of the same respect and consideration by the State and the community, implying, in this sense, a complex of fundamental rights and duties that ensure the person against any and all acts of a degrading and inhuman nature, as well as guaranteeing him or her the minimum existential conditions for a healthy life. in addition to providing and promoting their active and co-responsible participation in the destinies of their own existence and life in communion with other human beings [...]

Still on the dignity of the human person, Gustavo Tepedino states (TEPEDINO, 2005, p. 105):

In fact, the choice of the dignity of the human person as the foundation of the Republic, associated with the fundamental objective of eradicating poverty and marginalization, and reducing social inequalities, together with the provision of paragraph 2 of article 5 in the sense of not excluding any rights and guarantees, even if not expressed, as long as they derive from the principles adopted by the larger text, constitute a true general clause for the protection and promotion of the human person, taken as the maximum value by the legal system [...]

It should be noted that the Federal Constitution ensures that everyone, without distinction, has the right to a minimum list of constitutional rights and guarantees, so that the suppression and relativization of the guarantees established in the Magna Carta are not consistent with the democratic system, since the non-observance of these guarantees depersonalizes the human being and fosters the methodology of terror. On the subject, José Afonso da Silva states the following:

The configuration of the Democratic Rule of Law does not only mean formally uniting the concepts of Democratic State and Rule of Law. It consists, in fact, in the creation of a new concept, which takes into account the concepts of the component elements, but surpasses them to the extent that it incorporates a revolutionary component of transformation of the status quo. And there is a glimpse of the extreme importance of article 1 of the 1988 Constitution, when it states that the Federative Republic of Brazil

is a democratic State of Law, not as a mere promise to organize such a State, since the Constitution is already proclaiming and founding it there (SILVA, 2005, p. 15).

In other words, the realization of the democratic rule of law requires the strict observance of these and other principles brought in the heart of the Magna Carta, such an attitude shows respect for the difficult and time-consuming construction of the democratic rule of law, until it finally arrived at the modern conception that we have dealt with earlier.

Still in relation to the principles, other principles of paramount importance stand out, namely: the principle of reasonableness and proportionality.

This analysis allows us to verify that all citizens will be assured state intervention, state control, diligent, balanced, democratic and above all based on findings and evidence.

In fact, the non-adoption of the efficiency of public regulation greatly infringes the guarantee of equal treatment, given by the constitution to citizens and restricts the dignity of the human person as well as state relocation, since government policy is flawed by a fair, solidary bias and consecration of free enterprise.

3 REGULATORY IMPACT ANALYSIS: VALIDITY AND NECESSITY OF EXISTENCE

3.1 DEFINITION AND METHODS OF REGULATORY IMPACT ANALYSIS

As stated elsewhere, as of Amendment 19/98, the efficiency of the administration was raised to the level of a constitutional principle. Thus, Brazil began to have a regulatory structure in several sectors, through regulatory agencies (around 12 agencies) or through other actors that issue normative instruments of an administrative nature. It is unforgettable, regulation is a way to control, and give vent to government plans.

Although timidly, *the RIA* has found resonance in the Brazilian regulatory structure. Based on the principle of efficiency of public administration, the *RIA* consists of a decision-making procedure, based on evidence, which seeks to evaluate, based on the definition of a regulatory problem, the possible impacts of the available action alternatives to achieve the intended objectives, as follows:

It consists of a systematic process of evidence-based analysis that seeks to evaluate, based on the definition of a regulatory problem, the possible impacts of the available action alternatives to achieve the intended objectives. Its purpose is to guide and subsidize decision-making and, ultimately, to contribute to effective, efficient and efficient regulatory actions. (GUIA AIR, 2018, p. 01).

Originating in the USA, for more than 30 years, the *AIR* is adopted by the member countries of the OECD (Organization for Economic Cooperation and Development). Brazil,

as a guest member of such an organization, was expressly recommended to adopt the tool called *AIR* in order to assess their regulatory quality, It is important to highlight:

It is necessary to have a systematic strategy, with a structure for analyzing regulation that ensures transparency, social participation and economic efficiency, with explicit responsibilities at the political and administrative levels. The discussion on the standardized process of preparing new regulatory standards that include their impact assessment is beginning to take place. There is also a need to prepare regulatory capacities within the administration in the medium and long term. (VALENTE, 2010, p. 31)

In early 2018, Brazil, through the Chief of Staff, edited the General RIA Guidelines and the RIA Guide, which set the complex and comprehensive tone of *the AIR*. Such guidelines and guidelines are embryonic initiatives in the field of *RIA*. Such guidelines are already an anticipation of PL 6.621/2016, called the Agencies Bill, which will deal in greater depth with the implementation of the *RIA* in Brazil.

Bill No. 6,621/2016 – Agencies Bill – which provides for the management, organization, decision-making process and social control of regulatory agencies, amends Law No. 9,427, of December 26, 1996, Law No. 9,472, of July 16, 1997, Law No. 9,478, of August 6, 1997, Law No. 9,782, of January 26, 1999, Law No. 9,961, of January 28, 2000, Law No. 9,984, of July 17, 2000, Law No. 9,986, of July 18, 2000, Law No. 10,233, of June 5, 2001, Provisional Measure No. 2,228-1, of September 6, 2001, Law No. 11,182, of September 27, 2005, and Law No. 10,180, of February 6, 2001, and provides for other provisions. The processing and the full text of the Bill in question, approved in the Federal Senate as PLS No. 52/2013, is available at <http://www.camara.gov.br/proposicoesWeb/fichadetramitacao?idProposicao=2120019> (op. cit. 2018, p. 05).

Checking the OECD recommendations, as well as the guidelines issued by the Brazilian executive, it is observed that the *RIA* brings a technical basis to the public administration, that is, it makes regulation (state intervention) be done through evidence. The political nature of government decisions is removed, such decisions are attributed a democratic character and based on logical studies. *The RIA* verifies costs, scopes, trends, degradations, incentives, in short, all of this that can be seen as the IMPACT OF REGULATION.

Through a multidisciplinary team, from the regulatory body itself, *RIA* intervenes in government decision-making. In addition to the multidisciplinary team, *AIR* seeks evidence in public hearings, which are very common to it.

Through numerous phases, an approximate number of 11, the *RIA* aims to study the impact of government regulation and not of an isolated human or business action. With a

positive notion of impact, the *AIR*, does not need to be used only in regulatory agencies, it can be used in government plans that impact the rights and obligations of people, companies and economic agents.

Furthermore, other ways of verifying the impact of state regulation are only informative, do not help in better decision-making, do not give a direction to the public administration, are only a sieve for the embargo or not of government decisions, which may or may not be degrading to the administration.

This time, other ways of verifying the impact of state control have a merely informative condon.

Riddled with few procedures, or with watertight and limited phases, the other forms of verification of the impact of regulation have the scope of analyzing only the governmental impact of a human action, without comparing the impacts on the environment, the economy, free enterprise, individual freedoms, that is, without analyzing other demands of other agents.

With an extremely negative notion of impact, the other forms of analysis of state intervention are less comprehensive, given its compulsory aspects, which make the absence of control evaluation generate administrative and even criminal consequences.

Undoubtedly, the greater the analysis of state control/regulation, the lower the impact of this control on social systems. Thus, the other forms of evaluation of state control, which are not *RIA*, are shown, as an analysis of the impact of state control, lame and narrow-minded.

Regulatory impact studies seem to be institutes that have already been surpassed, in comparison with the *AIR* Regulatory Impact Analysis. Unlike the *RIA*, the other studies of the impacts of controls are not very democratic and not very technical, since they are linked to greater political sieves.

The *AIR*, seems to suppress and supplant the pretensions of other studies of the impact of regulation. It is a more fruitful analysis of the impact of state control, closer to public and private bodies, with a greater reach of data, evidence and accuracy in decision-making.

In this essay, regulatory agencies, as well as other government entities, can and should be reached by the *RIA*, as a way to give truth, efficiency and validity to state controls.

3.2 THE HETERONOMY OF WILL AS AN INSTRUMENT OF VALIDITY OF THE ANALYSIS OF THE REGULATORY IMPACT

"Where there is no respect for life and for the physical and moral integrity of the human being, where the minimum conditions for a dignified existence are not ensured, **where there is no limitation of power**, in short, where freedom and autonomy, equality and

fundamental rights are not recognized and minimally ensured, there will be no room for human dignity and the person will be nothing more than a mere object of arbitrariness and injustices."

(Ingo Sarlet – Brazilian Judge and Jurist)

The "Heteronomy of the will" was a concept created by Immanuel Kant in his work "Foundations of the Metaphysics of Morals" published in 1785 to denote the subjection of the individual to the will of third parties or of a collectivity, in this case the will of the State to the detriment of the individual will of each one of us. The autonomy of the individual, in a society, is set aside to make room for heteronomy, which is considered a basic principle related to the Rule of Law, in which everyone must submit to the will of the law (state) (IMMANUEL KANT, 2007, p.86). Still on this explanatory path, the philosopher Emmanuel Levinas elucidates with his point of view:

Heteronomy is not slavery, it is precisely its opposite. Morality is not based on a sovereign will of the Self, but on respect for the freedom of the Other, and for this it is necessary to be willing to limit oneself so as not to impose oneself on another. Obedience to the law created by Others does not mean servitude or submission to a tyrant, but rather the overcoming of the claim of the Self to be the ultimate and only foundation of all rules. Heteronomy is the norm, the external rule and does not depend on the will of the subject.

In this vein, when we deal with heteronomy in the *AIR*, we are talking about the sovereignty that is conferred solely and exclusively on the state to carry out all government plans, verifying their impact and extent. From this point of view, we can, with more propriety, understand as one of the purposes of a Social and Democratic State of Law, where the State takes upon itself the responsibility of managing the entire political, economic, social and cultural system, this is the model that the Brazilian State adhered to as a form of government being guaranteed by our Federal Constitution. In view of the above, the Brazilian State holds for itself the exclusivity of the Right of Regulation.

In this bias, the *RIA* adopted in Brazil does not violate the constitutional impediments on heteronomy.

Thus, it is concluded that after the demystification of the possible danger of adopting *RIA* in the Brazilian administrative system, together with the clarification of the models in force and admitted by our State, we can now understand that *RIA* gains space in national regulation, in order to combat the bankrupt system that we have operated today, which we can link to the panacea of all evils accumulated by decades of neglect of the public administration system in the Brazilian administrative system. which concerns the verification of the best regulation and its impacts on the beneficiaries of governance systems.

In our entire legal system, there is not a single legal or jurisdictional impediment that prevents the adoption of *RIA* and its multiple processes of filtering and comparison of the best regulation.

Checking the definition previously addressed about *AIR*, however, what exists are rules that deal with the unavailability and non-delegability of functions and attributions of the public administration, many of which are even binding and incapable of having, in their impacts, an accurate analysis or measurement.

Thus, we confirm that there are no rules or legal impediments that prevent the assessment of the regulatory impact on the performance of material aid activities or essential to the proper functioning and quality of the execution of government plans.

Contrary to impediments, the *RIA* is legitimized and this legitimacy is demonstrated within the characteristics of the Democratic Regulatory State itself, as follows:

With regard to the points of contact between independent agencies and the democratic principle, at least two lines of argument are plausible. First, the idea of submitting control over policies aimed at the long term and demanding, by their nature, a predominantly technical and professional management, can be seen as a form of democratic exercise.

Remember that democracy is not a concept that can be confused with majority rule; Democracy is, above all, a project of collective self-government in which social deliberations are carried out over time. In this vein, a collective deliberation that represents pre-commitment in the medium or long term requires, as a condition for its fulfillment, a management that is less responsive to the political-electoral logic and more responsive to the law and technical rationality.

Ultimately, enforcing democratically assumed pre-commitments is also a way of realizing the democratic ideal of collective self-government.

[...]

On the other hand, independent authorities do not need to and should not be closed spaces, inimical to the positions and opinions of economic agents, consumers, and civil society as a whole. The procedural opening of regulatory deliberations represents, in fact, an attempt to foster the constitution of a new public sphere, shaped by more technical parameters and specifically related to the regulated matter. (BINENBOJM, 2008, p. 303).

Ending the permissive legal bases for the Regulatory Impact Analysis with the aim of better state interference in the social, economic and cultural gears, we conclude peremptorily that it is an irrefutable, uncontroversial, incontestable matter as to the possibility of *AIR*, if there is interest, to provide services to the public sector, in the numerous administrative activities.

We will present only two obstacles that are most discussed among jurists, sociologists, people who participate in society in general, as well as their negative views of the Regulatory Impact Analysis. In the first place, we would find the obstacle in the political sphere, there is

a possible speculation about the possibility that the private interest of companies and individuals will influence the terms of the evaluation with the State and even in the conduct of the country's government policy. In other words, with the proper inclusion and systematization of *the RIA* in Brazil, there would be pressure from companies and/or individuals to increase or reduce the control of regulation, fostering or removing the focus of public plans from certain areas. However, this practice, already known by countries such as the USA and Germany, is called Lobbying, which means "influencing legislators and/or public actors, that is, for this deviation of purpose proposed by those opposed to greater control of the sectors to work, we would depend solely and exclusively on the public manager. In this sense, we would be admitting that the legislator and other actors of the administration, who must be impartial and meet the social interests, would be corrupting themselves by giving in to the pressures of private individuals, which proves once again that it will not be the *RIA* or any other type of administrative decision or control of administrative decision that will prevail in the occurrence of such a fact. (DONAHUE, 1992, p. 190).

In this vein, we also have the accurate observation of Patrícia Pessoa Valente, let's see:

After addressing three grounds for the adoption of regulatory impact assessment (state efficiency, legitimacy of regulatory decisions, and political control), one question still remains unanswered. How is it possible for this tool to be considered a mechanism of political control of regulatory agents by the principal, while at the same time having the potential to play a fundamental role in legitimizing regulatory decisions through the active participation of the administered? In other words, it is the same as the reducing element of the democratic deficit of the regulatory State identified by *the RIA* is sometimes seen from the perspective of the administered (users and suppliers of services and goods in the regulated sectors), or from the perspective of the main one (Legislative and Executive Branches). Which of the two angles should prevail?

In theory, the logic of each of the controls carried out is quite different and, why not say, divergent. Suppose the case of a regulatory decision on the granting of licenses for the provision of a certain service by a greater number of economic agents. In this case, the control exercised by the principal will be focused on whether the objectives desired by the voters will be met. The private party that will no longer have a market reserve with the decision will seek to contest it, while others will seek to maintain it with the prospect of also passing and providing the service. Users, in an even different way, will want more affordable rates and a greater number of providers to be able to choose the one that suits them.

[...]

However, the concept of regulatory impact assessment presented in *chapter 2* allows us to understand that this apparent contradiction of interests is part of the institutional design of the agents involved in the Regulatory State. What is verified, in fact, is a flow of interests in different directions in a triangulation that represents the effectiveness of the Democratic State of Law through the regulatory State. (2010, p. 158-159)

Finally, and very fragile, the argument used as an impediment to the implementation of the *RIA* is in the economic management, the opponents allege that the excess of phases, the complexity of the analysis, the deepening of the debates, the call for public hearings would be much higher than the cost of the transfer would be much higher than the investments applied by the State, as occurs, for example, with state privatizations.

Therefore, the regulations submitted to this analysis can have a much higher performance than the simple interference of public agencies, their administrators directly contribute to this feat, in case of mismanagement of the *AIR*, the penalty for the administration is the collapse of the activity and the better allocation of government plans.

4 CONCLUSION

State intervention, that is, fruitful and necessary state control, can only exist, state regulation can only exist, so that social relations are balanced and government plans are given vent, as well as there is promotion of sectors of the economy, thus enshrining a professional, technical, instrumental, popular, democratic bias of this control, making it appear, among others, the principle of efficiency of administration, which calculates, predicts, seeks evidence, encompasses experiences and measures the size of the impact of state interference.

The absence of regulatory impact assessments, or the existence of weak studies to analyze the effects of regulation is not consistent with the model of the Democratic Rule of Law. The regulatory trend experienced by contemporary Western societies has put in check the forms of implementation of government plans, public policies and economic designs. The fact is that when state regulation is used too much, without a filter, without an evidence base, democratic values are inverted, opening the door to the abuse of state interventionist power.

Thus, state regulation must be proportional, adequate, and evidence-based. Towards this ideal, Regulatory Impact Analysis (*RIA*) has been moving towards this ideal, a procedure for public administration decision-making, which has the power to verify the impacts, the scope and, without any doubt, the democratization of state regulation, of public administration plans.

The *RIA*, already implemented in Brazil, brings democracy closer to the state's regulatory power, making this power a delineator of proportionality and reasonableness of the regulated and the regulator. Now, with a technical procedure, attributed to numerous phases, filled with fewer political actors than social, cultural, economic, it will certainly have the power to verify the size of the impact of the state's control and make the public administration more efficient.

It is important to emphasize that the greater the analysis of the impact of state control, the lower this control will be. From Amendment 19/98 onwards, the efficiency of the administration was raised to the level of a constitutional principle, therefore, it is unforgettable that only the *RIA* can give the regulation its true function and democratic conception.

Finally, in Brazil, what is perceived are numerous ways of measuring the impacts of state regulation, forms that are dissociated from democracy, technique, popularity, and even legal basis. However, the Regulatory Impact Analysis (RIA) seems the only way to supplant this narrow-minded, lame and anti-democratic regulation. The *RIA* is the legitimate way, with democratic expressions to promote control, a balanced and efficient state regulation.

REFERENCES

- Adorno, T. W. (2002). *Indústria cultural e sociedade* (J. M. B. de Almeida, Sel., J. E. Levy et al., Trans.; 5ª ed.). Paz e Terra.
- Ávila, H. (2011). *Teoria dos princípios*. Malheiros.
- Barroso, L. R. (2013). *Curso de direito constitucional contemporâneo: Os conceitos fundamentais e a construção do novo modelo* (4ª ed.). Saraiva.
- Bastos, C. R. (1995). *Curso de teoria do estado e ciência política* (3ª ed.). Saraiva.
- Bastos, C. R. (1999). *Curso de direito constitucional* (22ª ed., rev. e atual. por S. Meyer-Pflug). Saraiva.
- Bobbio, N. (2007). *Estado, governo, sociedade: Por uma teoria geral da política* (M. A. Nogueira, Trans.). Paz e Terra.
- Branco, P. G. G., et al. (2007). *Curso de direito constitucional*. Saraiva.
- Brasil. (1988). *Constituição da República Federativa do Brasil*. Senado Federal.
- Brasil. Casa Civil. Subchefia para Análise e Acompanhamento de Políticas Governamentais. (2018a). *Guia orientativo para elaboração de análise do impacto regulatório (AIR)*. <http://www.casacivil.gov.br/regulacao/documentos/guias-de-air>
- Brasil. Casa Civil. Subchefia para Análise e Acompanhamento de Políticas Governamentais. (2018b). *Diretrizes gerais e roteiro analítico sugerido para análise de impacto regulatório – Diretrizes gerais AIR*. <http://www.casacivil.gov.br/conteudo-de-regulacao/regulacao/consulta-publica/consulta-publica-001-2017/abertura/anexo-iv-air-diretrizes-e-roteiro-analitico.pdf/view>
- Campos, C. A. de A. (2016). *Estado de coisas inconstitucional*. Editora JusPodivm.
- Campos, C. A. de A. (2015, September 1). *Estado de coisas inconstitucional e o litígio estrutural*. ConJur. <http://www.conjur.com.br/2015-set-01/carlos-campos-estado-coisas-inconstitucional-litigio-estrutural>
- Carvalho, P. A. (2016). [Título do artigo não informado]. *Âmbito Jurídico*. http://www.ambitojuridico.com.br/site/index.php?n_link=revista_artigos_leitura&artigo_id=5206
- Chauí, M. (2006). *Simulacro e poder: Uma análise da mídia*. Perseu Abramo.

- Cunha Júnior, D. da. (2013). Curso de direito constitucional (7ª ed.). Juspodivm.
- Dallari, D. de A. (1998). Elementos de teoria geral do estado (2ª ed., atual.). Saraiva.
- Di Pietro, M. S. Z. (2006). Direito administrativo (19ª ed.). Atlas.
- Donahue, J. D. (1992). Privatização: Fins públicos, meios privados. Jorge Zahar.
- Freitas Bastos. (1989). Introdução à ciência do direito (29ª ed.). [Editora não informada].
- Kant, I. (2007). Fundamentação da metafísica dos costumes (P. Quintela, Trans.). Edições 70.
- Locke, J. (2001). Segundo tratado sobre o governo civil e outros escritos: Ensaio sobre a origem, os limites e os fins verdadeiros do governo civil (M. Lopes & M. L. da Costa, Trans.; 3ª ed.). Editora Vozes.
- Nery Júnior, N., & Nery, R. M. de A. (2006). Constituição Federal comentada e legislação constitucional. [Editora não informada].
- Ostermann, F. M. (2010). A privatização de presídios como alternativa ao caos prisional. Revista Científica dos Estudantes de Direito da UFRGS, 2(1).
- Sarlet, I. W. (2011). Dignidade da pessoa humana e direitos fundamentais na Constituição Federal de 1988 (9ª ed., rev. e atual.). Livraria do Advogado.
- Silva, A. R. D. (2016). Privatização de presídios como mecanismo garante dos direitos fundamentais constitucionais.
<http://www.egov.ufsc.br/portal/conteudo/privatiza%C3%A7%C3%A3o-de-pres%C3%ADdios-como-mecanismo-garante-dos-direitos-fundamentais-constitucionais>
- Silva, J. A. da. (2005). Curso de direito constitucional positivo (25ª ed., rev. e atual.). Malheiros.
- Streck, L. L., & Moraes, J. L. B. de. (2014). Ciência política e teoria do estado (8ª ed., rev. e atual.). Livraria do Advogado.
- Valente, P. R. P. (2010). Avaliação de impacto regulatório: Uma ferramenta à disposição do Estado [Dissertação de mestrado, Universidade de São Paulo].

REGULATION OF URBAN SPACE IN A COASTAL CITY: THE CASE OF SANTA CATARINA ISLAND (FLORIANÓPOLIS, SC)

REGULAÇÃO DO ESPAÇO URBANO EM CIDADE COSTEIRA: O CASO DA ILHA DE SANTA CATARINA (FLORIANÓPOLIS/SC)

REGULACIÓN DEL ESPACIO URBANO EN UNA CIUDAD COSTERA: EL CASO DE LA ISLA DE SANTA CATARINA (FLORIANÓPOLIS, BRASIL)



<https://doi.org/10.56238/sevened2026.008-188>

Fabiano Prudêncio da Silva¹

ABSTRACT

Urban space regulation in Brazil has traditionally been analyzed through municipal planning instruments such as master plans and zoning regulations. However, in coastal cities, urban spatial production is shaped by legal and institutional regimes that go beyond urban policy in a strict sense, particularly federal land management. This article examines the territorial implications of federal coastal lands (terrenos de marinha) and the definition of the Mean High Tide Line (Linha de Preamar Média – LPM) within the context of urban planning, based on a case study of Santa Catarina Island, in the municipality of Florianópolis, Brazil. The research adopts a qualitative approach, combining institutional and normative analysis, comparative spatial analysis using GeoFigureic Information Systems (GIS), and an integrated interpretation of territorial effects associated with the coexistence of areas with approved and unapproved LPM. The findings indicate that federal land tenure uncertainty produces normative insecurity, institutional fragmentation, and significant territorial differentiation, directly affecting urban occupation patterns, licensing processes, and spatial consolidation. By engaging with current debates in Urban and Regional Planning, the article argues that federal land management constitutes an active dimension of urban governance in coastal cities and should be explicitly incorporated into analyses of territorial planning and urban policy.

Keywords: Urban Planning. Federal Coastal Lands. Federal Land Management. Mean High Tide Line. Florianópolis.

RESUMO

A regulação do espaço urbano no Brasil tem sido tradicionalmente analisada a partir dos instrumentos municipais de planejamento, como planos diretores e zoneamentos. Contudo, em cidades costeiras, a produção do território urbano é atravessada por regimes jurídicos e institucionais que extrapolam o escopo da política urbana stricto sensu, com destaque para a gestão patrimonial da União. Este artigo analisa as implicações territoriais dos terrenos de

¹ Master's degree in Business Administration. Universidade Federal de Santa Catarina. Ministério da Gestão e Inovação em Serviços Públicos. E-mail: fabiano.prudencio@gestao.gov.br
Orcid: <https://orcid.org/0009-0004-2005-4599>
Lattes: https://www.cnpq.br/cvlatteasweb/PKG_MENU.menu?f_cod=A1D29F1D868667EA88EF744AF3388E6B#

marinha e a definição da Linha de Preamar Média (LPM) no contexto do planejamento urbano, a partir do estudo de caso da Ilha de Santa Catarina, no município de Florianópolis (SC). Metodologicamente, a pesquisa adota abordagem qualitativa, articulando análise institucional e normativa, leitura espacial comparativa em ambiente de Sistemas de Informação Geográfica (SIG) e interpretação integrada dos efeitos territoriais associados à coexistência de áreas com LPM homologada e não homologada. Os resultados evidenciam que a indefinição patrimonial federal produz insegurança normativa, fragmentação institucional e diferenciações territoriais significativas, incidindo diretamente sobre padrões de ocupação, processos de licenciamento urbanístico e consolidação do espaço urbano. Ao dialogar com o debate atual do Planejamento Urbano e Regional, o artigo sustenta que a gestão patrimonial da União constitui dimensão ativa da governança urbana em cidades costeiras, devendo ser incorporada de forma explícita às análises sobre ordenamento territorial e políticas urbanas.

Palavras-chave: Planejamento Urbano. Terrenos de Marinha. Gestão Patrimonial da União. Linha de Preamar Média. Florianópolis.

RESUMEN

La regulación del espacio urbano en Brasil ha sido analizada tradicionalmente a partir de los instrumentos municipales de planificación, como los planes directores y el zonamiento. Sin embargo, en las ciudades costeras, la producción del territorio urbano está atravesada por regímenes jurídicos e institucionales que exceden el ámbito de la política urbana en sentido estricto, destacándose la gestión patrimonial federal. Este artículo analiza las implicaciones territoriales de los terrenos de marina y de la definición de la Línea de Preamar Media (LPM) en el contexto de la planificación urbana, a partir del estudio de caso de la Isla de Santa Catarina, en el municipio de Florianópolis (Brasil). Metodológicamente, la investigación adopta un enfoque cualitativo, articulando análisis institucional y normativo, lectura espacial comparativa mediante Sistemas de Información Geográfica (SIG) e interpretación integrada de los efectos territoriales asociados a la coexistencia de áreas con LPM homologada y no homologada. Los resultados muestran que la indefinición patrimonial federal produce inseguridad normativa, fragmentación institucional y diferenciaciones territoriales significativas, incidiendo directamente en los patrones de ocupación urbana, los procesos de licenciamiento y la consolidación del espacio urbano. Desde la perspectiva del Planeamiento Urbano y Regional, el artículo sostiene que la gestión patrimonial federal constituye una dimensión activa de la gobernanza urbana en ciudades costeras.

Palabras clave: Planeamiento Urbano. Terrenos de Marina. Gestión Patrimonial Federal. Línea de Preamar Media. Florianópolis.

1 INTRODUCTION

The regulation of urban space in Brazil has traditionally been analyzed from the classic instruments of municipal urban policy, such as the master plan, zoning and land use and occupation codes. Although central to the organization of the urban territory, these instruments do not exhaust the set of state practices that affect the production of space (LEFEBVRE, 2024). As Souza et al (2022) argue, urban planning should be understood as an expanded field of decisions, conflicts, and institutional practices that go beyond formal normative devices, incorporating different modalities of territorial regulation exercised by the State (JESSOP, 2015).

In coastal cities, this regulatory complexity tends to intensify. Rizzo (2013) considers that the presence of federal public assets and the performance of the Union's patrimonial management introduce additional layers of regulation that, to a large extent, remain marginalized in the debate on Urban and Regional Planning. Monte-Mór (2024) points out that sectoral state decisions, even if formulated outside the strict scope of municipal urban policy, exert concrete territorial effects on the production of space, especially in contexts marked by multi-scale governance arrangements and overlapping institutional competences.

In the Brazilian case, marine land and its additions are one of these specific regulatory layers. Anchored in their own historical, legal and institutional foundations, these federal public goods affect extensive portions of the coastal urban territory, conditioning forms of use, occupation and appropriation of urban land. Rocha (2018) demonstrates that the historical constitution of these assets gives them a unique legal status, whose effects are not limited to the patrimonial plan, but are updated in the current urban context, especially in cities subjected to intense real estate pressures and accelerated processes of land appreciation, as is the case of the municipality of Florianópolis.

Despite its significant territorial relevance, the Federal Government's patrimonial management is rarely systematically incorporated into analyses of urban territorial planning, and is often treated as an external or merely administrative dimension of urban policy. Rolnik (2015) observes that this analytical separation contributes to the invisibility of state mechanisms that, although not classified as urban instruments *stricto sensu*, directly interfere in the processes of production of urban space, land regulation, and unequal distribution of the benefits of urbanization.

2 THEORETICAL FRAMEWORK

The understanding of territory as a social and political construction is a central foundation in the field of Urban and Regional Planning (LEFEBVRE, 2024). Far from being a

mere physical support for human actions, territory expresses power relations, normative disputes and institutional arrangements that materialize spatially (SANTOS, 2001). In view of this, territorial planning processes must be analyzed from the interaction between different scales of government, normative instruments, and forms of state regulation (BRENNER, 2019).

Cunha (2018) and Kabilio (2016) highlight that urban planning in its current configuration operates in contexts of complex governance, in which multiple institutional instances produce often overlapping territorial regulations. This approach shifts the analytical focus from classical urban instruments to a broader reading of the state practices that shape the urban territory, including those derived from sectoral policies and specific legal regimes, often situated outside the strict scope of municipal urban policy.

In the Brazilian context, Lenzi and Gonçalves (2025) argue that urban planning cannot be reduced to a technical set of norms and plans, and should be understood as a field of political and institutional dispute. This reading is particularly pertinent in coastal cities, where municipal urban regulations, environmental legislation and federal patrimonial regimes coexist, producing a complex and sometimes contradictory regulatory architecture on the territory.

2.1 FEDERAL PUBLIC GOODS AND PRODUCTION OF URBAN SPACE

Entering the point "the Navy Lands," in the meaning of the word, in the provisions of Law No. 7,661/1988, which instituted the National Coastal Management Plan:

Article 10. Beaches are public goods for the common use of the people, and free and open access to them and to the sea is always ensured, in any direction and direction, except for stretches considered to be of national security interest or included in areas protected by specific legislation.

ParaFigure 1. Urbanization or any form of land use in the Coastal Zone that prevents or hinders the access ensured in the caput of this article will not be allowed.

ParaFigure 2. The regulation of this Law shall determine the characteristics and modalities of access that guarantee the public use of the beaches and the sea.

ParaFigure 3. A beach is understood to be the area periodically covered and uncovered by the waters, plus the subsequent strip of detrital material, such as sand, gravel, pebbles and boulders, up to the limit where the natural vegetation begins, or, in its absence, where another ecosystem begins. ()

In the course of the bibliographic research, it was possible to identify that the literature on public goods in Brazil emphasizes legal and administrative aspects, leaving its territorial implications in the background. However, there are studies, some even more recent, have been pointing to the need to incorporate the Union's asset management into the urban and regional debate. (LEFEBVRE, 2024) demonstrates that marine land, although instituted in specific historical contexts, remains as active elements in the conformation of urban space, especially in coastal areas subject to real estate appreciation.

Santos (2001) argues that legal instruments and regimes apparently external to urban policy exert a direct influence on the processes of space production, by conditioning access to land and land use patterns. Along the same lines, Cabral and Oliveira (2025) indicate that the Union's role as a landowner in urban areas introduces its own regulatory dynamics, often disconnected from municipal planning instruments.

By establishing particular conditions of occupation, collection of fees and domain recognition, the management of the Union's assets acts as an indirect mechanism of territorial planning, as Maricato (2014) points out. However, this action is rarely integrated in a coordinated way with local urban policies, contributing to institutional fragmentation and the emergence of territorial conflicts, especially in areas of high pressure on urban land (HAESBAERT et al, 2022).

2.2 AVERAGE PREAMAR LINE, NORMATIVE UNCERTAINTY AND MULTI-SCALAR GOVERNANCE

What is the Mean Preamar Line - LPM/1831? the 1831 Preamar Média line constitutes the legal and spatial reference used to identify navy lands, under the terms of article 20, item VII, of the 1988 Federal Constitution (BRASIL, 1988).

The legal concept is provided for in article 2 of Decree-Law No. 9,760/1946, according to which marine lands are those located in the range of 33 meters, measured horizontally for the part of the land, from the average preamar line of the year 1831, - that is, the LPM/1831 is the legal reference to identify the marine lands and their additions, which are property of the Union.

The concept of preamar gained a legal definition in Brazil in 2004, with Decree No. 5,300, of December 7, 2004, as being "the maximum height of sea level along a tidal cycle, also called high tide" (BRASIL, 2004).

Figure 1*Delimitation of LPM/1831*

Source: Boscatto et al. (2018).

The regulation evolved with Normative Instruction SPU/SEDMM/ME No. 28, of April 26, 2022, which delimited the demarcation of marine lands, establishing criteria and procedures for the demarcation of marine lands and their additions and identification of areas under the Union's domain (Brasil, 2022).

The Mean Preamar Line (MPL) occupies a central position in the delimitation of marine land and, consequently, in the definition of the legal regime applicable to urban coastal areas (BOSCATTO et al., 2018). Recent literature points out that the coexistence of stretches with homologated and non-homologated LPM produces normative asymmetries within the urban territory, affecting both the public authorities and private agents (ROSA et al, 2018).

The non-homologated line (LPM/1831 not homologated) is one that, despite having already been the object of technical studies (cartographic, geodetic, historical and hydrographic), and even having possibly already gone through the demarcation process, but which has not yet been formally approved by the competent authority of the Secretariat of Federal Heritage, through a specific administrative act, given that it did not go through all the required procedural steps (conclusive technical analysis, legal control, administrative publicity, notification of interested parties) (BRASIL, SPU, 2022). As for the homologated line (LPM/1831 homologated), it is the one that was the object of demarcation, underwent complete technical instruction (surveys, georeferencing, confrontations, historical and domain analysis), having been submitted to the competent authority of the SPU and approved by an express administrative act of homologation and due publicity (BRASIL, SPU, 2022).

These asymmetries between the demarcation issue, approved and non-approved areas, are seen as a problem, as Jessop (2015) and Brenner (2019) point out, in which these differences manifest themselves in the form of legal uncertainty, overlapping competences,

and difficulties in articulating between governmental scales. In the conception of Almeida and Reis (2024), normative fragmentation tends to weaken the capacity for integrated planning, compromising the effectiveness of territorial planning policies in complex areas.

In the case of island cities, such as Florianópolis, this problem intensifies due to the physical restrictions of the territory and the high pressure (real estate interests) on urban land. Empirical studies, such as those by Cunha (2018), Castro (2008) and Kabilio (2016) show that the lack of definition of federal patrimonial boundaries directly impacts the processes of urban licensing, land regularization and implementation of housing policies.

2.3 URBAN PLANNING, SPATIAL READING AND INTEGRATED ANALYSIS

In view of this scenario, the literature on Urban and Regional Planning has highlighted the importance of integrated analytical approaches, capable of articulating legal, institutional, and spatial dimensions, as pointed out by Cabral and Oliveira (2025). Moura (2014) supports it, defending the use of geotechnological tools as a support for the critical reading of the territory, not as an end in themselves, but as instruments for interpreting the regulatory practices that materialize in space.

In the Brazilian context, this perspective has been adopted in studies that analyze the overlapping of normative and territorial layers, such as urban zoning, protected environmental areas, and differentiated land regimes (SOUZA et al., 2022; ALMEIDA; REIS, 2024). Such approaches allow us to highlight how different planning rationalities coexist and sometimes conflict in the urban territory.

Thus, by articulating the theoretical debate on territorial regulation, public goods, and multi-scalar governance, this article bases its empirical analysis on the understanding that the Union's heritage management constitutes an active dimension of the production of urban space, and should be explicitly incorporated into the analytical field of Urban and Regional Planning (HAESBAERT, 2022). In this perspective, the territory is conceived as a relational construction and crossed by multiple scales of power, which reinforces the centrality of the State in the mediation of land uses and appropriations (Naspolini, 2019). In addition, recognizing space as a product of social and institutional relations, the analysis is close to the formulation of Lefebvre (2024), for whom the production of space results from practices, representations, and strategies that materialize political and economic projects. In this way, the Union's patrimonial management can be understood as a concrete instrument of territorial planning and dispute for the production of urban space (LEFEBVRE, 2024).

Table 1

Analytical Model of Indirect Regulation

Dimensão	Conteúdo	Implicações
Regime patrimonial federal	Terrenos de marinha e definição da LPM (Decreto-Lei nº 9.760/1946; Lei nº 9.636/1998)	Incidência de domínio da União sobre áreas urbanas costeiras
Mecanismo regulatório indireto	Exigências administrativas, condicionantes para registro, ocupação, aforamento e transferência	Interferência nos processos de licenciamento, uso e ocupação do solo
Efeitos territoriais	Diferenciação entre áreas com LPM homologada e não homologada	Produção de desigualdades espaciais, insegurança normativa e fragmentação institucional

Source: The author (2026).

3 METHODOLOGY

This study adopts a qualitative approach, of an analytical-interpretative nature, articulated with institutional, normative and spatial analysis procedures, with the objective of understanding the territorial implications of the Union's patrimonial management in the context of coastal urban planning. It is based on the assumption that norms, administrative instruments and legal regimes produce concrete spatial effects, which can be apprehended through the integrated reading between legal framework, institutional practices and materializations in the territory.

The methodological strategy is structured in three complementary axes: a) institutional and normative analysis of the Federal Government's asset management; b) comparative spatial analysis in a GeoFigureic Information Systems (GIS) environment; c) analytical integration and interpretation of the territorial effects associated with the coexistence of differentiated heritage regimes in the urban space.

3.1 DELIMITATION OF THE STUDY

The study area comprises the Island of Santa Catarina, corresponding to the insular portion of the municipality of Florianópolis (SC). The choice of this territorial area is justified by three main reasons. First, it is a coastal urban territory marked by high socio-environmental complexity and intense real estate pressure. Secondly, the area has a significant incidence of federal assets, especially marine land and its additions, which makes the performance of federal asset management particularly relevant for the conformation of urban space. Finally, stretches with homologated and non-homologated Linha de Preamar Média (LPM) coexist in

the territory, a condition that allows a comparative analysis of the territorial effects associated with different federal patrimonial regimes.

This configuration makes the Island of Santa Catarina a privileged empirical approach to examine the patrimonial management of the Union as a constitutive dimension of urban regulation, in interaction and, at times, in tension with municipal planning instruments.

3.2 INSTITUTIONAL AND NORMATIVE ANALYSIS

The first methodological axis consisted of carrying out an institutional and normative analysis of the Union's patrimonial management, focusing on marine lands. Legal and administrative provisions that regulate the definition of the LPM, the recognition of the federal domain and the forms of occupation and use of these public assets were examined, including federal legislation, decrees, ordinances and normative instructions issued within the scope of the Secretariat of Federal Heritage (SPU).

At the same time, the main instruments of municipal urban planning incident on the study area were analyzed, with emphasis on the Master Plan of Florianópolis and the legislation of land use and occupation. This stage sought to identify convergences, overlaps and normative conflicts between federal patrimonial regulation and municipal urban regulation.

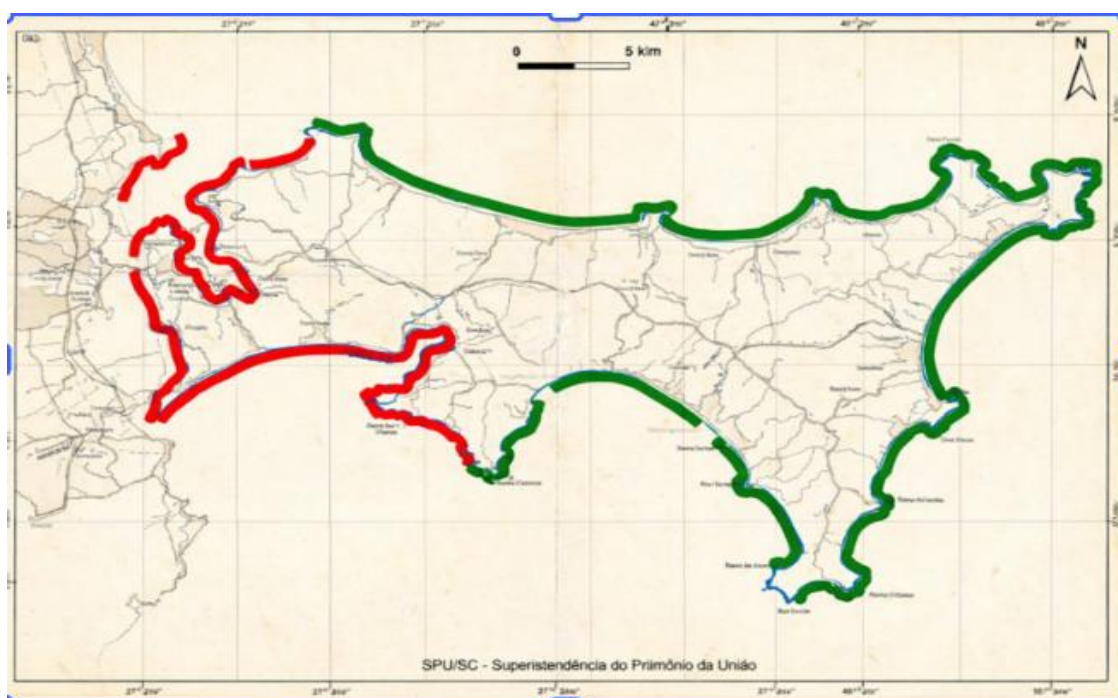
The institutional analysis was guided by the identification of situations of institutional fragmentation, understood as the coexistence of normative and decision-making regimes not fully articulated between the federal and municipal scales, as well as normative insecurity, expressed in the lack of definition or ambiguity regarding the legal regime applicable to certain areas of the coastal urban territory.

3.3 COMPARATIVE SPATIAL ANALYSIS IN GIS ENVIRONMENT

The second methodological axis was based on the performance of comparative spatial analysis through Geographic Information Systems (GIS). Geospatial layers were used referring to the delimitation of the approved and non-approved LPM, the municipal urban zoning, the use and land cover and the delimitation of the urban perimeter of the Island of Santa Catarina.

Figure 2

CartoFigureic map – situation of the LPM/1831 of Santa Catarina Island.



Blue line: complete demarcation-----

Green line: not homologated-----

Red line: approved.....

Source: BRAZIL. Secretariat of Federal Heritage (SPU), 2024.

The spatial analyses consisted mainly of overlay operations and comparative reading between the different layers, with the objective of identifying differentiated patterns of urban occupation and normative incidence associated with the different federal heritage regimes. The comparison between areas with homologated and non-homologated LPM allowed us to highlight how the definition – or lack of definition – of the federal patrimonial boundaries is reflected in the spatial organization of the urban territory.

It is important to highlight that the use of GIS was not conceived as a merely technical or cartoFigureic procedure, but as an analytical tool, aimed at the critical interpretation of regulatory practices that materialize spatially, according to the approach advocated by Almeida and Reis (2024).

Finally, based on the cartoFigureic base made available by the SPU and the administrative acts published between 2020 and 2025, the spatial crossing between the demarcated and approved stretches of the LPM was carried out, allowing us to estimate that approximately 100% of the island portion is demarcated, while about 10% have formal approval completed. It is possible to identify that only the neighborhoods: Centro, Sacos dos limões, Prainha / José Mendes and Beira Mar Norte have the LPM / 1831 – approved.

The cartoFigureic bases used included:

- a) vector files referring to the delimitation of the Medium Preamar Line made available by the Federal Heritage Secretariat;
- b) administrative acts and demarcation notices published between 2020 and 2025;
- c) layers of urban zoning and urban perimeter obtained from the Municipality of Florianópolis;
- d) auxiliary bases for land use and cover. The systematization and spatial crossing of this information allowed us to estimate the demarcated and homologated territorial extension of the LPM in the insular portion.

3.4 LIMITATIONS OF EQUITY DATA AND ANALYTICAL VALIDATION

The research recognizes that the data regarding the delimitation of the LPM have limitations inherent to its administrative and cartographic nature, related to the date of approval, the accuracy of the surveys and the updating of the records. These limitations do not invalidate the analysis, but are considered in the interpretation of the results, especially with regard to the areas where the LPM has not yet been formally approved.

The explanation of these limitations is part of the methodological rigor adopted, since the normative lack of definition itself is understood as a constitutive element of the phenomenon analyzed, producing relevant territorial effects in the context of urban planning.

3.5 FEDERAL PATRIMONIAL REGIME AS A MECHANISM OF INDIRECT TERRITORIAL REGULATION

The analysis developed in the previous sections allows us to move towards an interpretative synthesis about the incidence of the federal patrimonial regime on the urban dynamics of the Island of Santa Catarina. Starting from the understanding of space as a social product (SANTOS, 2001; LEFEBVRE, 2024) and the State's action on multiple scales (JESSOP, 2015; BRENNER, 2019), it is proposed to understand the 1831 Average Preamar Line (LPM/1831) not only as a technical-cartographic instrument, but as a legal-territorial device with concrete effects on the organization of urban space.

The regime established by Decree-Law No. 9,760/1946 and updated by Law No. 9,636/1998 establishes the Federal Government's dominionality over marine land, directly affecting areas within the municipal urban perimeter. Such a configuration reveals a normative overlap in which federal and municipal competences coexist over the same territory.

From the empirical systematization carried out, especially regarding the condition of full demarcation of the LPM on the island and the formal homologation still restricted to the

reduced portion of the territory, it is evident that federal dominiality produces different effects according to the administrative stage of the line. This difference is not merely formal: it interferes in the processes of real estate registration, land regularization, licensing and circulation of urban property.

Based on these findings, the following analytical chain is proposed:

Federal Property Regime → Indirect Regulatory Mechanism → Territorial Effects

The patrimonial regime constitutes the normative basis; the indirect regulatory mechanism is manifested in the requirement of administrative procedures linked to the Secretariat of Federal Heritage. The territorial effects materialize in the spatial differentiation between areas with a greater or lesser degree of normative security, impacting dynamics of valorization, occupation and planning.

This structure allows us to understand the LPM as an active element in the production of urban space, articulating with processes of fragmentation and territorial dispute already observed in Florianópolis (NASPOLINI, 2019; RIZZO, 2013; SIQUEIRA; LUCAS, 2023). The patrimonial instrument, although conceived in a different historical context, continues to operate as a structuring variable in contemporary territorial governance.

Thus, the LPM should not be interpreted only as a historical coastal reference line, but as a legal device whose multi-scale incidence reconfigures urban planning practices.

4 RESULT AND DISCUSSION

This section examines the empirical results of the research based on the spatialization of the 1831 Average Preamar Line (LPM/1831) in the insular portion of Florianópolis, articulating the cartographic analysis to the legal and institutional foundations discussed above. Considering space as a product of social relations mediated by normative structures (SANTOS, 2001; LEFEBVRE, 2024) and the multi-scale role of the State in territorial regulation (JESSOP, 2015; BRENNER, 2019), seeks to highlight how the federal patrimonial regime materializes in the territory and produces concrete spatial differentiations. From the identification of the demarcated and approved areas, it is analyzed how the incidence of the dominiality of the Union configures a mechanism of indirect regulation that tensions and conditions the dynamics of use, occupation and valorization of urban land on the Island of Santa Catarina.

4.1 SPATIAL CONFIGURATION OF FEDERAL PATRIMONIAL REGIMES ON THE ISLAND OF SANTA CATARINA

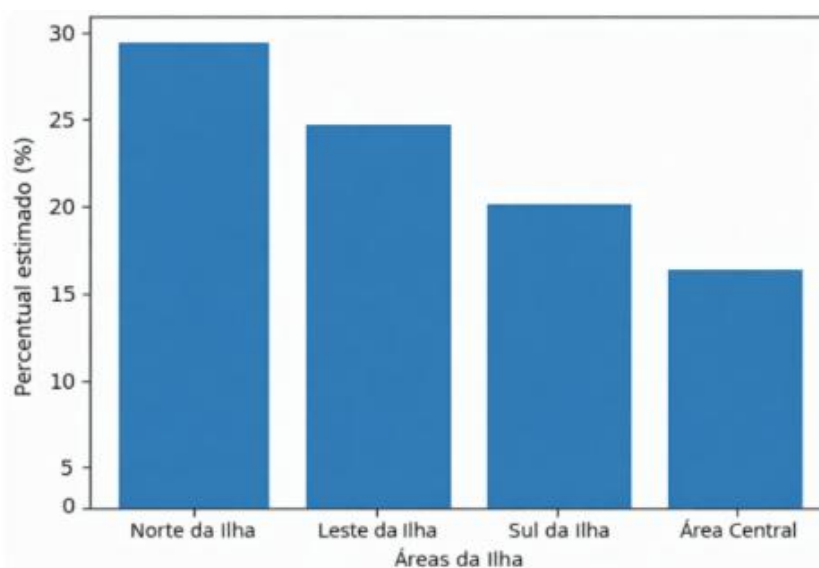
The spatial distribution of the Island of Santa Catarina shows that the marine lands and their additions affect the urban space of the Island in an unequal and territorially selective way. As illustrated in Figure 3, there is a significant concentration of these federal assets in specific areas of the island, especially in coastal areas subjected to intense processes of real estate appreciation and urban transformation, that is, where market dynamics, land scarcity and environmental constraints are combined.

The overlap between the areas of management of the Union's patrimony and municipal zoning produces a composite regulatory architecture, in which federal administrative decisions directly interfere in the possibilities of urban transformation.

The spatial reading allows us to identify that areas with a higher incidence of marine land tend to present greater regulatory complexity, as they are simultaneously subject to municipal urban regulation and federal asset management. This intertwining of normative regimes contributes to the institutional fragmentation of territorial planning, as discussed in the literature on multi-scalar governance (BRENNER, 2019; JESSOP, 2015).

Figure 3

Estimated distribution of marine land on Santa Catarina Island



Source: Prepared by the author (2026).

Here, the result reinforces Napolini's (2019) interpretation, according to which navy lands are no longer just remnants of a historical heritage logic, but rather active elements in the conformation of urban space. The spatialization of the data demonstrates that the Union's

patrimonial management directly affects strategic areas of the urban fabric, conditioning uses, densities and possibilities of territorial transformation.

In dialogue with Brenner (2019), it can be stated that this configuration expresses a form of state regulation that operates outside the classic instruments of urban planning, but that produces concrete territorial effects. It is a multi-scale regulation, in which federal administrative decisions interfere in municipal urban planning, often without effective inter-institutional coordination mechanisms (BRENNER, 2019).

4.2 AVERAGE PREAMAR LINE AND NORMATIVE INSECURITY IN COASTAL URBAN PLANNING

The situation of the Average Preamar Line (MPL) is a central element for understanding the territorial effects of the Union's asset management. The comparative analysis between stretches with homologated and non-homologated LPM, summarized in Figure 2, shows distinct patterns of normative stability within the island's urban territory.

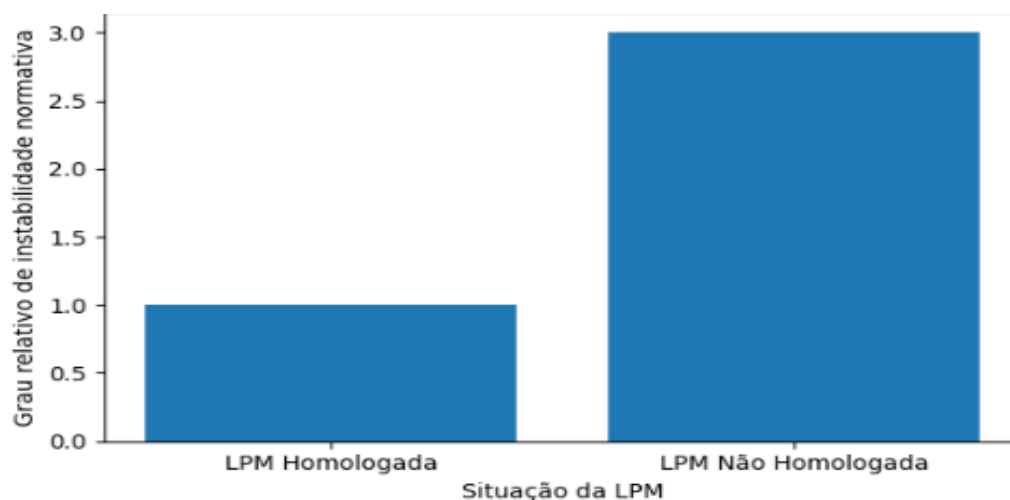
Here it is worth detailing what is homologated and what is only demarcated, not entering into the homologated LPM in this case, since the demarcation corresponds to the technical definition of the line based on cartographic and historical surveys, while the homologation consists of the formal validation of the route by the competent body of the Union, giving it full administrative effectiveness (CABRAL; OLIVEIRA, 2025).

In the areas where the LPM is approved, there is greater predictability as to the applicable legal regime, which tends to facilitate the urban licensing processes and the articulation between the federative entities. On the other hand, in the stretches where the LPM has not been formally ratified, the lack of definition of the federal patrimonial limits produces high levels of legal uncertainty, affecting both the municipal government and private agents.

This insecurity manifests itself in the form of overlapping competences, judicialization of land conflicts and difficulties in the implementation of urban policies. The spatial analysis suggests that areas with non-homologated LPM often coincide with regions of recent urbanization or high real estate value, where the normative vagueness tends to favor disputes between public and private interests, reinforcing asymmetries in access and appropriation of coastal urban space.

Figure 2

Qualitative comparison of the normative stability associated with the Mean Preamar Line (LPM)



Source: Prepared by the author (2026).

These findings corroborate the analysis of Cabral and Oliveira (2025), who point to the lack of homologation of the LPM as a central factor of normative insecurity in Brazilian coastal cities. As Jessop (2015) points out, such insecurity compromises the capacity for integrated planning, by generating ambiguities regarding land ownership and the regulatory competences of each sphere of government.

In the case of Florianópolis, this territorial differentiation takes on even more critical contours due to its insularity and the relative scarcity of urban land. Recent studies (LENZI and GONÇALVES, 2025; NASPOLINI, 2019; CUNHA, 2018) already indicated that the lack of definition of federal assets directly impacts land regularization processes and the implementation of housing policies, which is confirmed by the spatial patterns identified in this research.

4.3 INTERACTIONS AND CONFLICTS BETWEEN FEDERAL PROPERTY REGULATION AND MUNICIPAL URBAN PLANNING

Table 2 summarizes the main territorial effects associated with the different patrimonial regimes identified in the study area. The integrated analysis of the data shows that the Federal Government's patrimonial management acts as a mechanism of indirect territorial planning, by establishing specific constraints for the use and occupation of urban land, regardless of the existence of municipal urban guidelines.

Table 2

Federal patrimonial regimes and territorial effects on urban planning in Florianópolis

Situação da LPM	Regime patrimonial federal	Grau de insegurança jurídica	Efeitos sobre o planejamento urbano
Homologada	Domínio federal plenamente reconhecido	Baixo a moderado	Maior previsibilidade normativa e integração parcial com o planejamento municipal
Não homologada	Domínio federal presumido / indefinido	Elevado	Conflitos institucionais, incerteza no licenciamento e fragmentação regulatória

Source: Prepared by the author (2026).

This result dialogues directly with Rolnik (2015), when he demonstrates that legal regimes apparently external to urban policy produce central effects on land valuation and the production of space. Similarly, Maricato (2024) points out that institutional fragmentation between scales of government tends to generate territorial conflicts and weaken the effectiveness of urban planning.

The comparison between the regimes shows that the Federal Government's asset management acts as an effective regulatory body, although not formally integrated with municipal urban planning. While in areas with approved LPM there is a greater predominance of normative predictability, in areas without approval there are recurrent institutional conflicts, uncertainty in licensing processes and fragmentation of state action.

In the context analyzed, the absence of systematic articulation between federal asset management and municipal planning instruments results in a fragmented regulatory architecture. Such fragmentation manifests itself not only in administrative conflicts, but also in concrete territorial inequalities, reflected in differentiated patterns of occupation, density, and access to urban land.

By highlighting these effects, the analysis reinforces the need to understand the Union's heritage management as a constitutive dimension of multi-scale urban governance, whose performance directly affects the production processes of coastal urban space, especially in insular and highly valued contexts such as Florianópolis.

5 FINAL CONSIDERATIONS

This article analyzed the management of the Union's assets as a constitutive dimension of the regulation of urban space, based on the case study of the Island of Santa Catarina, in the municipality of Florianópolis. By articulating institutional analysis, spatial reading and integrated interpretation of territorial effects, it was sought to show that marine land and the definition of the Mean Preamar Line (MPL) are not only legal or administrative issues, but active elements of urban governance in coastal cities.

The results demonstrate that the coexistence of areas with homologated and non-homologated LPM produces significant territorial differentiations, in the case of Santa Catarina Island, considering that the island portion of Florianópolis has approximately 172 km² (FLORIANÓPOLIS, 2026) although approximately 100% of the LPM line has been subject to demarcation, and homologation has not been completed in a large part of the island territory, and approximately 10% of this demarcated island area is approved (BRASIL, 2023; BRAZIL, 2020; BRAZIL, 2025; TJSC, 2025), which highlights the spatial amplitude of the phenomenon analyzed, associated with different degrees of normative security, administrative predictability, and urban consolidation. This finding reinforces the literature that points to legal uncertainty as a structuring factor for territorial inequalities in Brazilian cities (Maricato, 2024; Rolnik, 2015), indicating that the lack of definition of federal assets acts as a mechanism for indirect regulation of land use and occupation.

By dialoguing with Brenner (2019) and Jessop (2015), the study contributes to broadening the understanding of urban planning as a multi-scale field of state practices, in which sectoral decisions and specific legal regimes exert a concrete influence on the production of urban space. In the case of Florianópolis, the performance of the Union's patrimonial management focuses on strategic areas of the island territory, often dissociated from municipal planning instruments, which deepens institutional fragmentation and hinders the construction of integrated territorial planning strategies (ALMEIDA, 2016).

From a methodological point of view, the articulation between normative analysis and spatial reading in a GIS environment proved to be fundamental to evidence the territorial materialization of regulatory practices (LEFBVRE, 2024). More than a technical support, the use of geotechnologies has made it possible to critically interpret the overlapping of normative regimes and their spatial implications, as advocated by recent approaches in the field of Urban and Regional Planning (SANTOS et al., 2022; RAFAEL et al., 2025).

As a theoretical contribution, the article reinforces the need to incorporate the Union's patrimonial management explicitly into the analyses of urban territorial planning, especially in coastal cities. In doing so, it tensions readings that restrict urban planning to classic

municipal instruments, evidencing the centrality of federal land and patrimonial regimes in the conformation of urban space.

By dialoguing with the current debate on Urban and Regional Planning, this article contributes specifically to discussions on multi-scale governance and territorial regulation in complex urban contexts, by highlighting the role of the Union's heritage management as an active — albeit indirect — instance of the production of urban space. The debate enters into discussions about normative insecurity and institutional fragmentation, contributing to a critical reading of the role of the State not only as an urban regulator, but also as a landowner, whose decisions produce relevant and unequal spatial effects, especially in coastal areas subjected to intense pressures from the civil construction industry.

From the proposed analytical chain — federal patrimonial regime → indirect regulatory mechanism → territorial effects — it was found that the Federal Government's domination over marine land operates as a form of indirect regulation of urban space. Although it is not a classic planning instrument, its incidence interferes in the processes of real estate registration, land regularization, and land use, dialoguing and sometimes stressing the guidelines of the municipal Master Plan (FLORIANÓPOLIS, 2014; 2023).

In this sense, the research brings the debate on multi-scalar governance closer to the

The findings suggest the need for institutional mechanisms of coordination between the Federal Government's asset management and municipal urban planning, especially in contexts of high real estate pressure. Instruments such as technical cooperation agreements, integration of cartographic bases and the compatibility of licensing procedures could reduce the normative fragmentation currently observed, promoting greater legal predictability and territorial security.

In the light of the discussions presented, it is recognized that the research has limits, notably in the empirical cut circumscribed to the insular portion of Florianópolis. Future studies may expand the analysis to other Brazilian coastal municipalities, as well as deepen the investigation on the impacts of federal asset management on specific policies, such as social housing and land regularization. Even so, the results presented provide relevant subsidies for the academic debate and for the formulation of public policies that are more articulated and sensitive to the complexity of territorial governance in coastal urban areas.

REFERENCES

Almeida, I. T. L., & Reis, A. (2024). Urban centrality: A characterization in the urban agglomeration of Florianópolis-SC. *Journal of Urban Morphology*, 11(2), 1–15.

Boscatto, F., Cabral, C. R., & Silva, E. da. (2018). Analysis of the guidelines on how to demarcate the imaginary average preamar line of 1831. In Brazilian Congress of Multipurpose Registration and Territory Management (13th ed.). Florianópolis: Federal University of Santa Catarina. Recuperado em 12 de fevereiro de 2026, de <https://d1wqtxts1xzle7.cloudfront.net>

Brazil. (1946). Decree-Law No. 9,760, of September 5, 1946: Provides for the real estate of the Union. Recuperado em 13 de janeiro de 2026, de <https://legislacao.presidencia.gov.br>

Brazil. (1988). Law No. 7,661, of May 1, 1988: Establishes the National Coastal Management Plan and provides for measures. Recuperado em 15 de fevereiro de 2026, de <https://www.planalto.gov.br>

Brazil. (1998). Law No. 9,636, of May 15, 1998: Provides for the regularization, administration, forfeiture and disposal of real estate owned by the Federal Government. Recuperado em 8 de fevereiro de 2026, de <https://www.planalto.gov.br>

Brazil. (2022). Law No. 14,474, of December 6, 2022: Amends Law No. 9,636/1998 and related legislation. Recuperado em 22 de dezembro de 2025, de <https://legislacao.presidencia.gov.br>

Brazil. (2005). Constitutional Amendment No. 46, of May 5, 2005. Recuperado em 22 de janeiro de 2026, de <https://www.planalto.gov.br>

Brazil. Ministry of Management and Innovation in Public Services. Secretariat of Federal Heritage. (2023). Notices and notifications regarding the demarcation of the average preamar line of 1831 (LPM/1831) in the municipality of Florianópolis/SC. Brasília, DF. Recuperado em 2 de fevereiro de 2026, de <https://www.gov.br>

Brazil. Ministry of Management and Innovation in Public Services. Secretariat of Federal Heritage. (2020). Characterization plan – PNC. Brasília, DF. Recuperado em 14 de fevereiro de 2026, de <https://www.gov.br>

Brazil. Ministry of Economy. Secretariat for Coordination and Governance of Federal Heritage. (2022). Normative Instruction SPU/SEDDEM/ME No. 28, of April 26, 2022. Brasília, DF. Recuperado em 14 de fevereiro de 2026, de <https://www.in.gov.br>

Brazil. Ministry of Management and Innovation in Public Services. Secretariat of Federal Heritage. (2024). Final report of the demarcation of Santa Catarina Island. Brasília, DF. Recuperado em 14 de fevereiro de 2026, de <https://www.gov.br>

Brazil. Ministry of Management and Innovation in Public Services. Secretariat of Federal Heritage. (2025). Report No. 09/2025/CGDEM/DECIP/SPU. Brasília, DF. Recuperado em 14 de fevereiro de 2026, de <https://www.gov.br>

Brenner, N. (2019). New urban spaces: Urban theory and the scale question. Oxford University Press.

Cabral, C. R., & Oliveira, F. H. de. (2025). Demarcation of navy lands: Historical aspects. *Revista Percursos*, 26, 1–23.

- Castro, L. L. P. (2008). Urban occupation in a coastal area: The urban-environmental interface on the Campeche seafront, Santa Catarina Island (Master's thesis, UFSC). Recuperado em 13 de janeiro de 2025, de <https://repositorio.ufsc.br>
- Cunha, L. F. (2018). Urban planning and multiple territorialities: The resistance of Campeche (Florianópolis-SC) in the elaboration of the master plan. *Caminhos de Geografia*, 19(65), 56–68.
- Haesbaert, R., Leopoldo, E., & Cruz, R. de. (2022). *For a new regional geography*. Editora Consequência.
- Jessop, B. (2015). *The state: Past, present, future*. Polity Press.
- Kabilio, M. L. (2016). Urban environmental planning in the district of Campeche, Florianópolis, SC (Master's thesis, UDESC). Recuperado em 13 de dezembro de 2025, de <https://www.udesc.br>
- Lefebvre, H. (2024). *The urban revolution* (3rd ed.). UFMG.
- Lenzi, M., & Gonçalves, T. C. (2025). Urbanization, discourses and power relations: Tourism and urban planning in Florianópolis (1950–1980). *GEOUSP Espaço e Tempo*, 24(3), 425–443.
- Florianópolis. (2014). Complementary Law No. 482, of January 17, 2014. Recuperado em 15 de fevereiro de 2026, de <https://leismunicipais.com.br>
- Florianópolis. (2023). Complementary Law No. 739, of May 4, 2023. Recuperado em 15 de fevereiro de 2026, de <https://leismunicipais.com.br>
- Florianópolis. (n.d.). Planning network. Recuperado em 3 de fevereiro de 2026, de <https://redeplanejamento.pmf.sc.gov.br>
- Maricato, E. T. M. (2024). To understand the urban crisis. *Expressão Popular*.
- Monte-Mór, R. L. (2024). Urban planning and critical social theory. *Cadernos de Arquitetura e Urbanismo*, 8(8), 9–20.
- Moura, A. C. M. (2014). *Geoprocessing in urban management and planning*. Interciência.
- Naspolini, V. (2019). *Spatial fragmentation in Florianópolis: Urbanization, planning and ideology* (Doctoral dissertation, UFSC).
- Pitombeira, S. C. (2022). Occupation of the territory in coastal areas: Proposal for management and planning of coastal zone. *Revista de Direito da Cidade*, 15(3), 1039–1069.
- Rafael, C. R. P., et al. (2026). Integrated geoprocessing in the monitoring of land use and urban expansion. *ReGeo Revista Interdisciplinar*, 16(4), 1–10.
- Rizzo, P. M. B. (2013). *Urban planning in the context of globalization* (Doctoral dissertation, UFSC).

- Rosa, C. N. da, et al. (2018). Preamar's line: A review of its concepts and implications. *Revista Brasileira de Geomorfologia*, 19(4), 849–858.
- Rocha, A. A. da. (2018). “Through space” in Doreen Massey’s pathway: A pedagogical analysis of “material geographies”. *Para Onde?*, 19(2), 85–95.
- Rolnik, R. (2015). The colonization of land and housing in the age of finance. *Boitempo*.
- Santa Catarina. Court of Justice. (2025). Provision No. 49/2025. Recuperado em 10 de fevereiro de 2026, de <https://dcradvocacia.com.br>
- Santos, M. (2001). *Metamorphoses of inhabited space* (6th ed.). Edusp.
- Santos, P. H. N., Cruz, M. G., & Santos, W. F. da S. (2022). City science and urban planning: Geoprocessing as an instrument of municipal strategic planning. *Geopauta*, 6, 1–25.
- Siqueira, M. T., & Lucas, A. T. (2023). Not all that glitters is gold: Florianópolis and competitive urbanism. *Cadernos Metrópole*, 25(57), 419–442.
- Souza, M. L. de, et al. (2022). Changing the city: A critical introduction to urban planning and management. *Novos Cadernos NAEA*, 25(2), 323–334.
- Supreme Federal Court. (n.d.). Extraordinary Appeal No. 636.199/ES. Recuperado em 10 de fevereiro de 2026, de <https://portal.stf.jus.br>

SIMULATION OF THE RUPTURE OF AN INDUSTRIAL FERTILIZER TAILINGS DAM IN ARRAIAS, TOCANTINS, BRAZIL

SIMULAÇÃO DE ROMPIMENTO DE UMA BARRAGEM DE REJEITOS INDUSTRIAIS DE FERTILIZANTES EM ARRAIAS, TOCANTINS, BRASIL

SIMULACIÓN DE RUPTURA DE UNA PRESA DE RELAVES INDUSTRIALES DE FERTILIZANTES EN ARRAIAS, TOCANTINS, BRASIL



<https://doi.org/10.56238/sevened2026.008-189>

Ricardo Ribeiro Dias¹, Girlene Figueiredo Maciel², Talita Cintra Braga³, Rose Mary Gondim Mendonça⁴

ABSTRACT

Dams are versatile structures used for various purposes, including tailings containment resulting from mining activities. In recent years, the rupture of these structures has become a recurring fact in Brazil, especially the disasters that occurred in the cities of Mariana and Brumadinho, in the State of Minas Gerais, Brazil, which caused irreversible environmental impacts and loss of hundreds of human lives. This demonstrates the relevance of computer models for predicting dam failure scenarios, which can be very useful in anticipating the consequences of dam breaks and guiding emergency action plans of dams. In the study conducted for the Itafós Arraias Mineração e Fertilizantes S.A. tailings dam was used the HEC-RAS software, which incorporates non-Newtonian fluid dam break modeling, combined with ArcGIS, ALOS PALSAR digital elevation model and other biophysical data regarding the area affected by the dam were used. Simulation of the flood wave behavior was by piping-type break, with the results indicating a flood area of 484.02 ha, maximum depth of 19.78 m, maximum wave propagation velocity of 13 m/s and maximum flow of 2,619.25 m³/s (Section 1), in addition to possible interference/impacts on natural landscapes, areas of anthropic use and public works.

Keywords: HEC-RAS. Dam Break. Flood Wave Simulation.

RESUMO

Barragens são estruturas versáteis utilizadas para diversas finalidades, inclusive a contenção de rejeitos decorrentes da atividade de mineração. Nos últimos anos, o rompimento dessas estruturas se tornou um fato recorrente no Brasil, com destaque para os

¹ Dr. in Geosciences and Environment. Universidade Estadual Paulista “Júlio de Mesquita Filho” (UNESP). E-mail: ricdias@uft.edu.br Orcid: <https://orcid.org/0000-0003-2059-0848> Lattes: <https://lattes.cnpq.br/6648102523856242>

² Dr. in Natural Resources. Universidade Federal de Campina Grande (UFCG). E-mail: maciel@uft.edu.br Orcid: <https://orcid.org/0000-0001-9217-3731> Lattes: <http://lattes.cnpq.br/9377355626452682>

³ Master's degree in Environmental Engineering. Universidade Federal do Tocantins (UFT). E-mail: eng.talitabraga@gmail.com Orcid: <https://orcid.org/0000-0001-5955-4591> Lattes: <https://lattes.cnpq.br/6725716264758208>

⁴ Dr. in Civil Engineering. Universidade Federal do Rio de Janeiro (UFRJ). E-mail: rosemary@uft.edu.br Orcid: <https://orcid.org/0000-0001-6345-6994> Lattes: <https://lattes.cnpq.br/5030489205608727>

desastres de Mariana e Brumadinho, que acarretaram impactos ambientais irreversíveis e perda de centenas de vidas. Isso vem mostrando o quanto a aplicação de modelos computacionais para prever cenários ocasionados pelo rompimento de barragem, é muito apropriada para antecipar as consequências do rompimento de barragens e balizar os planos de ação de emergência de barragens. No estudo realizado para a barragem de rejeitos da Itafós Arraias Mineração e Fertilizantes S.A., utilizou-se o HEC-RAS que incorpora a modelagem do rompimento de barragens de fluidos não newtonianos, combinado com o ArcGIS, modelo digital de elevação ALOS PALSAR e outros dados biofísicos da área de influência da barragem. A simulação do comportamento da onda de cheia foi por rompimento do tipo piping, com os resultados mostrando uma área de inundação 484,02 ha, profundidade máxima de 19,78 m, velocidade máxima de propagação da onda de 13m/s e vazão máxima 2.619,25m³/s (Seção 1), e as possíveis interferências/impactos em paisagens naturais, áreas de uso antrópico e obras públicas.

Palavras-chave: HEC-RAS. Rompimento de Barragem. Simulação de Onda de Cheia.

RESUMEN

Las presas son estructuras versátiles utilizadas para diversos fines, incluida la contención de relaves derivados de la actividad minera. En los últimos años, el colapso de estas estructuras se ha convertido en un hecho recurrente en Brasil, con destaque para los desastres de Mariana y Brumadinho, que ocasionaron impactos ambientales irreversibles y la pérdida de cientos de vidas. Esto ha demostrado que la aplicación de modelos computacionales para prever escenarios ocasionados por el rompimiento de presas es muy apropiada para anticipar las consecuencias de estos eventos y orientar los planes de acción de emergencia para presas. En el estudio realizado para la presa de relaves de Itafós Arraias Mineração e Fertilizantes S.A., se utilizó el HEC-RAS, que incorpora la modelación del rompimiento de presas con fluidos no newtonianos, combinado con ArcGIS, el modelo digital de elevación ALOS PALSAR y otros datos biofísicos del área de influencia de la presa. La simulación del comportamiento de la onda de crecida se realizó considerando un rompimiento del tipo piping, con resultados que mostraron un área de inundación de 484,02 ha, una profundidad máxima de 19,78 m, una velocidad máxima de propagación de la onda de 13 m/s y un caudal máximo de 2.619,25 m³/s (Sección 1), además de las posibles interferencias/impactos en paisajes naturales, áreas de uso antrópico y obras públicas.

Palabras clave: HEC-RAS. Rompimiento de Presa. Simulación de Onda de Crecida.

1 INTRODUCTION

Phosphate rocks are widely used as raw materials for fertilizer production, detergent production, animal feed supplements, among others. During the processing of phosphate ores, about 30-40% of the ore mass is disposed of as tailings after beneficiation operation (GNANDI et al., 2005). Tailings dams are structures used by mining companies as a way of storing the waste extracted after this processing (SANTOS et al., 2020).

With the increase in the number of dams of this nature in the country, there is also a growing concern about the safety of their structures, which consists of maintaining their structural and operational integrity, and the preservation of life, health, property and the environment (BRASIL, 2010). It was only in 2010 that the topic became part of the Brazilian policy agenda with the creation of the National Policy on Dam Safety (BRASIL, 2010), although it had already been the subject of discussion among engineering and geotechnical professionals since the 1980s (FRANCO, 2008). Brasil (2010) establishes responsibilities for the inspection of dam safety for several environmental agencies that are part of the National Environment System (Sisnama). The National Mining Agency (ANM) is responsible for the regulation and inspection of mining dams and the National Water and Basic Sanitation Agency (ANA), considering other types of dams, is responsible for coordinating water security, aiming to ensure the safety and inspection of structures and people.

As observed for the cases of Mariana and Brumadinho, the rupture of tailings dams has drastic consequences for all those involved in the vicinity of a dam. According to Amaral (2017), regardless of whether the rupture occurred due to poor inspection, failure in materials or construction methods, inconveniences are inevitable when there is no evacuation plan for the population or mitigating measures. If the dam were to break, there is irreversible damage to communities, cities (Wang et al., 2021) and the environment (Garcia et al., 2025). In the case of tailings dams, this damage is intensified by the contaminants present in the fluid, which can modify the physicochemical characteristics of the water sources (Kütter et al. 2023, Islam & Murakami, 2021). Simulations of dam failures have been carried out in Brazil and in other countries, with emphasis on the work of Derdous et al. (2015), Neves, Rodrigues and Cabral (2019), Raman and Liu (2019), Santos et al. (2020), Lee and Liu (2020), Psomiadis et al. (2021), Gibson and Sánchez (2021).

Observing the Brazilian framework on the study of mining tailings dams and the importance of simulations of dam failure, this work proposed to carry out a case study for the Tailings Containment Dam of Itafós Arraias Mineração e Fertilizantes S.A., in Arraias, Tocantins. According to ANM (2022a), this is the only mining tailings dam in DPA condition – classification B in activity in the State of Tocantins that is included in the National Dam Safety

Policy – PNSB (Brasil, 2010), with high associated potential damage, which currently falls under the alert level. For the dam failure simulation study, the HEC-RAS - *Hydrologic Engineering Centers River Analysis Systems software*, from the *US Army Corps of Engineers* (BRUNNER, 2022) combined with the ArcGIS geographic information system, is used.

The main objective of the case study was to simulate the dam rupture by *piping*, determining the scope of the flood area, depth, maximum velocity of the tailings sheet and flow and the possible potential interferences/impacts caused along the flood area.

2 METHODOLOGY

2.1 DATA

A geographic database was set up in ArcGIS with public data available in a web environment. In terms of biophysical data, soil, relief, geology, climatological data, and vegetation cover and land use information plans were inserted from the geoportal data of the Secretariat of Planning of the State of Tocantins (SEPLAN, 2021). The database was complemented with altimetry data from the digital elevation model of the ALOS PALSAR satellite acquired from the *Japan Aerospace Exploration Agency* – JAXA website (JAXA, 2022). For the characterization of the reservoir, public data obtained from the National Mining Agency – ANM (ANM, 2022b) are used.

2.1.1 Tailings dam of Itafós Arraias Mineração e Fertilizantes S.A

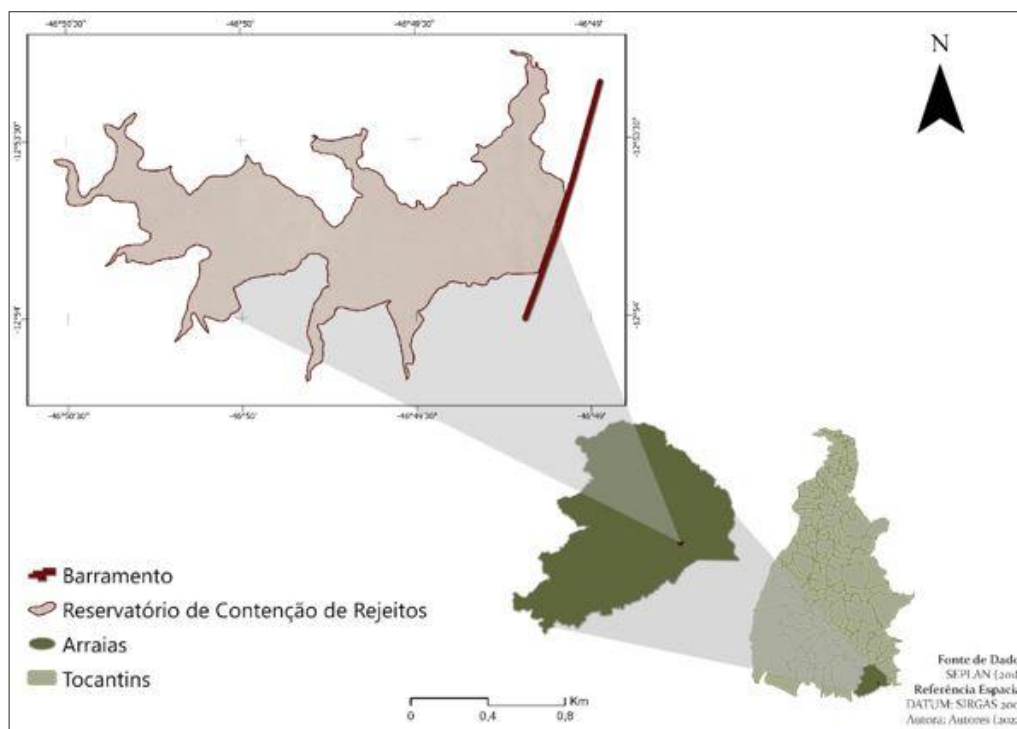
The tailings dam of Itafós Arraias Mineração e Fertilizantes S.A., installed in the municipality of Arraias-TO, near the border with the north of the state of Goiás, between the coordinates of west longitude 46°50'00" and 46°48'00" and south latitudes 12°55'00" and 12°52'00". The main purpose of the dam is the controlled disposal of tailings generated during the phosphate ore processing process. Figure 1 shows the location of the tailings containment reservoir, its geometry and dam.

According to the ANM (2022b), the dam has been active since 2013 and has an expected useful life of 30 years. It was built in the valley of the Bezerra stream with an initial height of 20 m and can reach a maximum height of 30 m. The current height of the dam is 22 m, with the reservoir having an area of 71 ha and a volume of 4,136,059.54 m³ and the projected of 7,500,000 m³. The type of dam is homogeneous earth, with a foundation in residual/alluvial soil, and a construction method of raising downstream, with continuous type of raising. In terms of state of conservation, the civil structures are well maintained and in normal operation, with percolation fully controlled by the drainage system, with no deformations and settlements with the potential to compromise the safety of the structure. On

the other hand, there are failures in the protection of slopes with the presence of shrub vegetation.

Figure 1

Location map of the tailings dam in Arraias, Tocantins, Brazil



Source: elaborated by the authors.

The type of tailings stored in the reservoir is due to the processing of phosphate ore, a raw material for the production of simple superphosphate (SSP), used as an input in agricultural activity, with a 2.5% phosphate pulp inserted in the tailings (ANM, 2022).

The dam has an emergency action plan, but according to ANM (2022b), copies of the PAEBM have not yet been delivered to city halls and municipal and state defenses, as required by Ordinance no. 70,389/2017. In terms of environmental impact assessment, the project has a significant impact, of medium intensity, and affects downstream, in the event of a dam failure, a number below 100 people (ANM, 2022b).

2.2 METHODS

It is noteworthy that one of the main forms of dam failure occurs when water overflows the dam wall, overtopping, and burrows through it due to the loss of freeboard, a situation more likely in old tailings dams that have been filled, vegetated and abandoned (HANCOCK. COULTHARD, 2022).

To study this hypothesis, the process of simulating the rupture of the tailings dam of Itafós Arraias Mineração e Fertilizantes S.A. began with the elaboration of the rupture hydrograph. For this, hydrologic modeling was used in the HEC-HMS (*Hydrologic Modeling System*). It provided, from the use of altimetry data and the rainfall hyetogram (calculated by the Huff method, 1967), the delimitation of the hydrographic basin, drainage stretches, water balance and, finally, the project hydrograph obtained by the method developed by the Soil Conservation Service - SCS (current *Natural Resources Conservation Service* - NRCS). performing this hydrological modeling at HEC-HMS, it was observed that there would be no overtopping from the flows found, since the dam's overflow systems are capable of pouring the flow from the maximum precipitation for a return time of 10,000 years. Thus, the rupture simulation was not associated with a precipitation event, but with collapse by *piping* or overtopping.

In the HEC-RAS environment, the altimetry component of the terrain was inserted, using the ALOS PALESAR digital elevation model, with a 12.5 m grid, an interval sufficient to generate a computational mesh with appropriate cells for analysis. Then, the roughness coefficient of Manning's equation was assigned to quantify the flow resistance (MANANDHAR, 2010). The calibration of the Manning roughness coefficient was based on land cover and land use data (Table 1).

Table 1

Manning coefficient values used

Uso da Terra	Coeficiente de Manning
Terra estéril	0,03
Arbustiva	0,05
Pastagens e terras cultivadas	0,035
Rio	0,04

Source: adapted from chow (1959).

Still in the hec-has, the following boundary conditions of the model were used: (a) the volume of the reservoir upstream and (b) the normal depth with a slope of the channel bottom of approximately 0.4% downstream.

THE next step is to perform the calibration of the HEC-RAS MODEL (version 6.1) considering that the flow behavior of the material resulting from the rupture of the phosphate ore tailings dam is more similar to non-Newtonian fluids, such as Bingham fluids, which have specific rheological properties. For the dam in question, the results of BARREDA ET AL.,

(2021) were also used for the maximum value of yield stress or elastic limit stress of 300 Pascal and 50 Pascal for 73% and 65% of solids mass, respectively.

And, finally, the final geometry of the tailings dam rupture breach was defined, according to the empirical model proposed by Froehlich (2008).

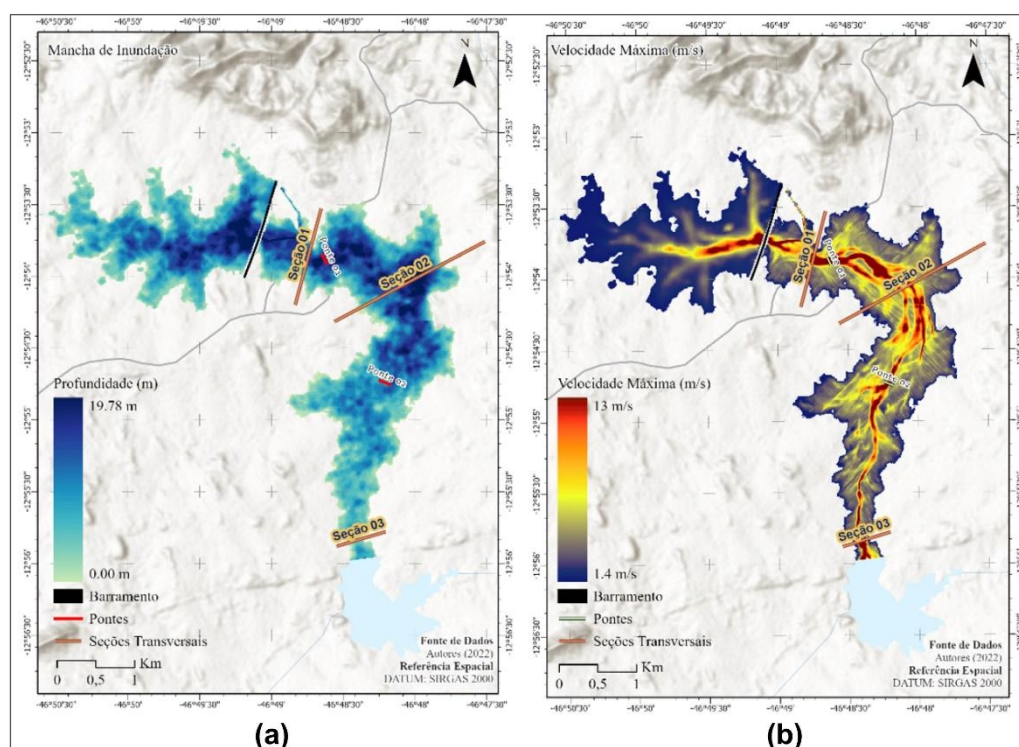
3 RESULTS AND DISCUSSION

3.1 FLOOD AREA

Figure 2 shows the flood spot in the critical situation, that is, when it reaches the largest area. The slick covers an area of 484.02 ha and a maximum depth of 19.78 m. The maximum velocity of the flood wave reached is 13 m/s, reaching Section 3 in 4.33 hours after the rupture.

Figure 2

Flood Spot formed (a) and velocity reached in m/s (b)



Source: elaborated by the authors.

The data collected in the three cross-sections, maximum speed reached, maximum elevation, and flow hydrograph along the wavefront path are shown in Table 2.

Looking at Table 2, it can be seen that Section 1 is 0.63 km, Section 2 is 1.88 km and Section 03 is 5.82 km away from the dam. Among the three sections, Bus-S1, S1-S2 and S2-S3, Table 2 shows that the maximum level of tailings reduces 31 m in height, due to the

elevation levels of the land. For the S1-S2 section there is a reduction of only 6 m, while in the S2-S3 section, there is a 25 m high decay due to the retention of tailings in this interval.

Table 2

Flow, tailings level, depth and velocity data for each section considering maximum values

	Barramento -S1	S1-S2	S2-S3
Distância do barramento (km)	0,63	1,88	5,82
Nível máximo de rejeito – cota (m)	623	617	592
Profundidade máxima (m)	12,35	17,60	3,15
Vazão máxima (m ³ /s)	2.619,25	2.452,84	374,54
Velocidade máxima (m/s)	2,51	1,46	4,05

Source: elaborated by the authors.

For the depth of the wave, it can be seen that in the S1-S2 section there is an increase of 5.25m in relation to the Barramento-S1 section, while in the S2-S3 section there is a sharp decline in depth of 14.45 m. These variations can be justified by the observation that, for the first section, Section 1 presents a higher flow when compared to Section 2, and also, that in the latter there is an increase in accumulated material and little loss of energy due to the short distance traveled, resulting in greater depth. Between S2-S3, the depth reduces slightly, since there are losses of matter and energy along the way. In addition, the last section has a higher speed of propagation of the flood wave and lower flow when compared to the others, so the cross-sectional area (depth x width) is also reduced.

The maximum flow rate between S1-S2 is reduced by 166.41 m³/s, due to the loss of energy during the thalweg. For S2-S3 this decrease is more pronounced, there is a reduction of 2,078.30 m³/s, justified by the greater distance traveled.

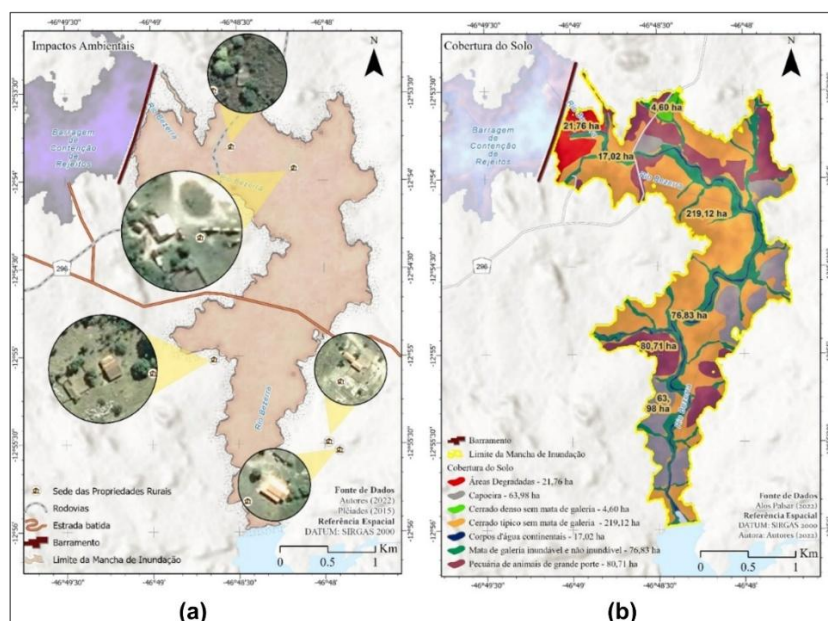
Finally, with regard to the maximum speed, between S1-S2 there is a reduction of 1.05 m/s, because there is a small slope and distance in this section, and also, the width of the flow increases along the stretch, allowing greater passage of matter and reducing the speed to the control surfaces. Between S2-S3, the velocity increases drastically, it is the maximum observed, since the valley is quite narrow. Despite all the loss of energy and flow, with the slight decrease in the control surface area, there is an intense increase in speed. There are lower velocity and flow at 5km away from the dam when compared to the work of Santos et al. (2020), however these values depend on the area, height of the dam, slope of the terrain, among other factors.

3.2 ENVIRONMENTAL INTERFERENCE

Along the path of the wavefront, it is verified that it impacts improvements in the rural area and transport infrastructure, pasture areas and native vegetation, and probably the local fauna (Figure 3). Khalkho et al. (2020) report the loss of infrastructure due to dam rupture and highlight the importance of flood maps for the preparation of the Emergency Action Plan (EAP) for disaster management.

Figure 3

Environmental interference (a) and land cover and use affected by the flood area (b)



Source: elaborated by the authors.

Figure 3(a) shows two rural property headquarters that will be buried by the tailings flow, as well as two bridges, one on the TO-296 highway and the other on a side road that connects the industrial unit of Itafós Mineradora and the tailings dam. At the end of the wavefront's route, it is noted that it reaches the water collection dam that the industry uses to maintain its production process.

Figure 3(b) shows that 80.71 ha of pastures with the use of large animal husbandry are affected by the flooding and that 364.54 ha of native vegetation are also buried and destroyed. Of this total, 63.98 ha are for capoeira, 4.60 ha represent dense cerrado without gallery forest, 219.12 ha correspond to typical cerrado without gallery forest and 76.83 ha are equivalent to floodable and non-floodable gallery forests. In addition, there are 21.76 ha of degraded area and 17.02 ha of buried watercourse. These results, in a more summarized form, are presented in Table 3.

IN relation to fauna, there is no capacity to measure affected individuals, however, based on information from the Environmental Impact Study - EIA (AMBIENGER-PROMINER, 2010), there is an indication of possible losses and scares of mastofauna, avifauna, ichthyofauna and herpetofauna, and loss of aquatic and terrestrial habitats. The flood area would also bring as negative consequences the loss of natural landscapes, housing structures and infrastructure by burial, loss of livestock areas and native/anthropized vegetation by runoff or burial by waste, alteration of water and soil quality and visual impact.

Table 3

Areas of cover and land use affected by the flood area

Cobertura e uso da terra	Área (hectares)
Áreas degradadas	21,76
Capoeira	63,98
Cerrado denso sem mata de galeria	4,60
Cerrado típico sem mata de galeria	219,12
Corpos d'água continentais	17,02
Mata de galeria inundável e não inundável	76,83
Pecuária de animais de grande porte	80,71
Total	484,02

Source: elaborated by the authors.

4 CONCLUSIONS

The flood map generated in the HEC-RAS software by combining the ALOS PALESAR digital elevation model, Manning's coefficient with biophysical data provided by SEPLAN-TO, structure characteristics provided by ANM (2022) and the piping breach assumptions according to Froelich (2008) allowed a representation of the flood wave behavior from structural collapse. Additionally, it is perceived that the use of the computational mesh for the 2D model is suitable for application in studies with sinuous watercourses, such as the Bezerra stream, making the modeling more accurate.

Carrying out dam rupture studies is extremely important to determine the coverage of the impacted area, speed reached by the wave and depth. These factors are the ones that will guide the preparation of the emergency action plan with greater assertive possibility and the environmental impact studies. This is because they allow a better observation of the problems arising from the rupture and the force of the wave, that is, its mechanical impact and the identification of buried places where chemical impacts can be triggered due to the type of tailings superimposed on the soils.

It is considered that the results and practicality of the modeling obtained in this case study through the combination of geoprocessing tools with HEC-RAS (public domain

software), should be a procedure used for the analysis of tailings dam failure, which strengthens the recommendation of the National Water Agency. In addition, it is of great value for the preparation of the emergency action plan for mining tailings dams

ACKNOWLEDGMENTS

The authors would like to thank the Professional Master's Program in Environmental Engineering at the Federal University of Tocantins (UFT) and the Coordination for the Improvement of Higher Education Personnel (CAPES).

REFERENCES

- Amaral, D. R. B. (2017). Simulação de ondas de cheia induzidas pelo rompimento hipotético da barragem de Peti em São Gonçalo do Rio Abaixo-MG (Dissertação de mestrado, Universidade Federal de Uberlândia). <http://dx.doi.org/10.14393/ufu.di.2018.232>
- Ambienger/Prominer. (2010). Estudo de impacto ambiental da Itafós Mineração Ltda. <https://central.to.gov.br/download/42566>
- Barreda, R. H. O., Valadão, G. E. S., & Araújo, A. C. (2021). Production of paste from fine tailings streams in a laboratory scale column thickener. *REM - International Engineering Journal*, 74, 83–91. <https://doi.org/10.1590/0370-44672020740073>
- Brasil. (2010). Lei n. 12.334, de 20 de setembro de 2010. Estabelece a Política Nacional de Segurança de Barragens. http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12334.htm
- Brasil. Agência Nacional de Mineração. (2022a). Report mensal: Barragens de mineração julho/2022. <https://www.gov.br/anm/pt-br/assuntos/barragens/boletim-de-barragens-de-mineracao/arquivos/boletim-mensal-julho-2022.pdf>
- Brasil. Agência Nacional de Mineração. (2022b). Sistema de gestão de segurança de barragem de mineração (SGSBM). <https://app.anm.gov.br/SIGBM/Publico/GerenciarPublico>
- Brunner, G. W. (2016). HEC-RAS: River analysis system, user's manual. US Army Corps of Engineers, Hydrologic Engineering Center. <https://www.hec.usace.army.mil/software/hec-ras/documentation.aspx>
- Chow, V. T. (1959). Open channel hydraulics. McGraw Hill.
- Derdous, O., Djemili, L., Bouchehed, H., & Tachi, S. E. (2015). A GIS based approach for the prediction of the dam break flood hazard: A case study of Zardezas reservoir “Skikda, Algeria”. *Journal of Water and Land Development*, 27(1), 15–20. <https://doi.org/10.1515/jwld-2015-0020>

- Franco, C. S. P. (2008). Segurança de barragens: Aspectos regulatórios (Dissertação de mestrado, Universidade Federal de Goiás). <http://repositorio.bc.ufg.br/tede/handle/tede/1318>
- Froehlich, D. C. (2008). Embankment dam breach parameters and their uncertainties. *Journal of Hydraulic Engineering*, 134(12), 1708–1721.
- Garcia, F. F., Camilo Cotrim, C. F., Caramori, S. S., et al. (2025). Mine tailings dams' failures: Serious environmental impacts, remote solutions. *Environment, Development and Sustainability*, 27, 18179–18201. <https://link.springer.com/article/10.1007/s10668-024-04628-z>
- Gibson, S., & Sánchez, A. (2021). HEC-RAS mud and debris flow: User and technical reference manual v6.1. <https://www.hec.usace.army.mil/confluence/rasdocs/rasmuddebris>
- Gnandi, K., et al. (2005). Processing of phosphate mine tailings by coagulation flocculation to reduce marine pollution in Togo: Laboratory tests. *Mine Water and the Environment*, 24, 215–221. <https://doi.org/10.1007/s10230-005-0102-2>
- Hancock, G. R., & Coulthard, T. J. (2022). Tailings dams: Assessing the long-term erosional stability of valley fill designs. *Science of the Total Environment*, 849. <https://www.sciencedirect.com/science/article/pii/S004896972204791X>
- Huff, F. A. (1967). Time distribution of rainfall in heavy storms. *Water Resources Research*, 3(4). <https://doi.org/10.1029/WR003i004p01007>
- Islam, K., & Murakami, S. (2021). Global-scale impact analysis of mine tailings dam failures: 1915–2020. *Global Environmental Change*, 70, 102361.
- Japan Aerospace Exploration Agency. (2021). Earth observation research center: ALOS-2 project / PALSAR-2. <https://search.asf.alaska.edu/#/>
- Khalkho, V., Thomas, A., Singh, M., & Dadel, S. (2020). Dam break analysis and flood inundation mapping using HEC-RAS. *International Journal of Chemical Studies*, 8(5), 1989–1982. <https://scispace.com/pdf/dam-break-analysis-and-flood-inundation-mapping-using-hec-2lm0jv1k1q.pdf>
- Kütter, V. T., Martins, G. S., Brandini, N., Cordeiro, R. C., Almeida, J. P. A., & Marques, E. D. (2023). Impacts of a tailings dam failure on water quality in the Doce River: The largest environmental disaster in Brazil. *Journal of Trace Elements and Minerals*, 5. <https://www.sciencedirect.com/science/article/pii/S277305062300037X>
- Lee, C., & Liu, F. (2020). Potential environmental hazard due to tailings dam failure in Minnesota iron range and safety concern of the dams in the US. <https://doi.org/10.31223/osf.io/qbrkg>
- Manandhar, B. (2010). Flood plain analysis and risk assessment of Lothar Khola (Master's thesis, Tribhuvan University Institute of Forestry). <http://dx.doi.org/10.13140/2.1.1664.1289>
- Psomiadis, E., Tomanis, L., Kavvadias, A., Soulis, K. X., Charizopoulos, N., & Michas, S. (2021). Potential dam breach analysis and flood wave risk assessment using HEC-RAS

and remote sensing data: A multicriteria approach. *Water*, 13(3), 1–24.
<https://doi.org/10.3390/w13030364>

Raman, A., & Liu, F. (2019). An investigation of the Brumadinho dam break with HEC-RAS simulation. <http://arxiv.org/abs/1911.05219>

Santos, C. M. dos, Silva, J. G., Salles, P. V., Silveira Braga, F. C., & Poggiali, F. S. J. (2020). Análise da mancha de inundação da Barragem Sul da Mina de Brucutu, São Gonçalo do Rio Abaixo, MG. *Revista Engenharia de Interesse Social*, 5(6), 35–52.
<https://doi.org/10.35507/25256041/reis.v5i6.5191>

Singh, V. P. (1996). Dam breaching modeling technology. Louisiana State University.
<https://link.springer.com/book/10.1007/978-94-015-8747-1>

Tocantins. Secretaria de Planejamento. (2021). Base temática sudeste do Tocantins.
<https://geoportal.to.gov.br/gvsigonline/>

Wang, Y., Fu, Z., Cheng, Z., Xiang, Y., Chen, J., Zhang, P., & Yang, X. (2021). Uncertainty analysis of dam-break flood risk consequences under the influence of non-structural measures. *International Journal of Disaster Risk Reduction*, 102.
<https://www.sciencedirect.com/science/article/pii/S221242092400027X>

NUMERICAL EVALUATION OF THE STATIC PERFORMANCE OF A SMALL PROPELLER COMPARING TRADITIONAL AND TRANSITIONAL TURBULENCE MODELS

AVALIAÇÃO NUMÉRICA DO DESEMPENHO ESTÁTICO DE UMA PEQUENA HÉLICE COMPARANDO MODELOS DE TURBULÊNCIA TRADICIONAIS E TRANSICIONAIS

EVALUACIÓN NUMÉRICA DEL DESEMPEÑO ESTÁTICO DE UNA HÉLICE PEQUEÑA COMPARANDO MODELOS DE TURBULENCIA TRADICIONALES Y TRANSICIONALES



<https://doi.org/10.56238/sevened2026.008-190>

Luiz Carlos Bevilaqua dos Santos Reis¹, Newton Galvão de Campos Leite², Maurício Araujo Zanardi³, Laura Manuci de Andrade⁴, Rodrigo Viana de Freitas Santos⁵

ABSTRACT

Propeller design and performance influence the operational efficiency of drones, and with the increasing use of small UAVs, accurately determining the performance of small propellers becomes crucial. CFD is considered a highly accurate method, and turbulence models are essential for CFD simulations, especially when dealing with low Reynolds number flows, such as those in small propellers, since transitional laminar-turbulent flows are difficult to predict. The objective of this work is to investigate the use of transition-sensitive models to identify the conditions under which their use is truly necessary, as they are computationally intensive. A 3D-printed propeller, designed from the SDA 1075 airfoil, was tested under static flow conditions on a test bench, with thrust and torque measurements. Fully turbulent models were used in the simulation, and the results were compared with measurements between 2,000 and 8,000 rpm. Consistent results were obtained for Reynolds numbers above 60,000. For Reynolds numbers below 60,000, the results were not very accurate. Therefore, transition-sensitive models capable of capturing laminar separation were used, and consistent results were obtained for Reynolds numbers below 60,000. This was demonstrated by the propeller's aerodynamic coefficients and the images of laminar separation bubbles captured by the simulation.

Keywords: Small-Scale Propellers. CFD. Laminar-Turbulent Transition Models. Experimental Study.

¹ Dr. in Mechanical Engineering. Universidade do Estado do Rio de Janeiro (UERJ). Rio de Janeiro, Brazil. E-mail: bevilaqua@fat.uerj.br

² Dr. in Mechanical Engineering. Universidade do Estado do Rio de Janeiro (UERJ). Rio de Janeiro, Brazil. E-mail: nleite@fat.uerj.br

³ Dr. in Mechanical Engineering. Universidade do Estado do Rio de Janeiro (UERJ). Rio de Janeiro, Brazil. E-mail: mauricio_zanardi@uol.com.br

⁴ Graduated in Mechanical Engineering. Universidade do Estado do Rio de Janeiro (UERJ). Rio de Janeiro, Brazil. E-mail: lauramanuci@gmail.com

⁵ Undergraduate Student in Mechanical Engineering. Universidade do Estado do Rio de Janeiro (UERJ). Rio de Janeiro, Brazil. E-mail: rodrigo.santos@discentes.fat.uerj.br

RESUMO

O projeto e o desempenho das hélices influenciam a eficiência operacional dos drones e, com o uso crescente de pequenos UAVs, determinar com precisão o desempenho de pequenas hélices torna-se crucial. O CFD é considerado um método altamente preciso, e modelos de turbulência são essenciais para simulações de CFD, especialmente quando se lida com escoamentos de baixo número de Reynolds, como aqueles em pequenas hélices, uma vez que escoamentos laminar-turbulentos transicionais são difíceis de prever. O objetivo deste trabalho é investigar o uso de modelos sensíveis à transição para identificar as condições sob as quais seu uso é realmente necessário, pois são computacionalmente intensivos. Uma hélice impressa em 3D, projetada a partir do aerofólio SDA 1075, foi testada sob condições de fluxo estático em uma bancada de testes, com medições de empuxo e torque. Modelos totalmente turbulentos foram usados na simulação, e os resultados foram comparados com medições entre 2000 e 8000 rpm. Resultados consistentes foram obtidos para números de Reynolds acima de 60.000. Para números de Reynolds abaixo de 60.000, os resultados não foram muito precisos. Portanto, foram utilizados modelos sensíveis à transição capazes de capturar a separação laminar, e resultados consistentes foram obtidos para números de Reynolds abaixo de 60.000. Isso foi demonstrado pelos coeficientes aerodinâmicos da hélice e pelas imagens da separação laminar capturadas pela simulação.

Palavras-chave: Hélices de Pequena Escala. CFD. Modelos de Transição Laminar-Turbulenta. Estudo Experimental.

RESUMEN

El diseño y desarrollo de hélices influyen en la eficiencia operativa de los drones, y con el creciente uso de UAV pequeños, determinar con precisión su rendimiento se vuelve crucial. La CFD se considera un método de alta precisión, y los modelos de turbulencia son esenciales para las simulaciones CFD, especialmente cuando se trabaja con flujos de bajo número de Reynolds, como el de las hélices pequeñas, ya que los flujos laminares-turbulentos transitorios son difíciles de predecir. El objetivo de este trabajo es investigar el uso de modelos sensibles a la transición para identificar las condiciones en las que su uso es realmente necesario, dado su alto consumo computacional. Una hélice impresa en 3D, diseñada con base en el perfil aerodinámico SDA 1075, se probó en condiciones de flujo estático en un banco de pruebas, con mediciones de empuje y par. Se utilizaron modelos completamente turbulentos en la simulación, y los resultados se compararon con mediciones entre 2000 y 8000 rpm. Se obtuvieron resultados consistentes para números de Reynolds superiores a 60.000. Para números de Reynolds inferiores a 60.000, los resultados no son muy precisos. Por lo tanto, se utilizaron modelos sensibles a la transición capaces de capturar la separación laminar, obteniéndose resultados consistentes para números de Reynolds inferiores a 60.000. Esto se demostró mediante los coeficientes aerodinámicos de la hélice e las imágenes de separación laminar capturadas por la simulación.

Palabras clave: Hélices de Pequeña Escala. CFD. Modelos de Transición Laminar-Turbulenta. Estudio Experimental.

1 INTRODUCTION

In recent years, small unmanned vehicles (UAVs) have been developed for various applications in different areas of our society, being a challenging technology, as designing propellers on a small scale with high efficiency is complex due to the physical phenomena involved. Rotors (engine-propeller assembly) are responsible for the performance and control of fixed-wing and multi-rotor UAVs. They generate thrust and torque that allow drones to fly and remain stable. Propeller design influences the efficiency and stability of drone operation. However, predicting the performance of small-scale propellers, such as those used in UAVs and micro aerial vehicles (MAVs), is complex primarily due to the low Reynolds number conditions under which they operate. Low Reynolds numbers, typically less than 100,000 for UAV propellers (Deters, 2013), can lead to flow separation, which occurs when the fluid boundary layer separates from the blade surface, increasing torque and reducing thrust. This phenomenon occurs when the boundary layer confronts an opposing pressure gradient.

Among the propeller performance prediction techniques, the most accurate is CFD (Loureiro, 2021). The SST $k-\omega$ turbulence model is the most widely used in simulations to model propellers. It was developed to improve accuracy in conditions of flow separation and rotating flows. Although laminar-turbulent transition models are recommended for transitional flows and low Reynolds numbers since they take into account the transition region, there are few recently published CFD works that have used laminar-turbulent transition models for propellers. Due to the very fine mesh required near the blade to accurately resolve the transition region, especially for leading and trailing edges, these transitional turbulence models are computationally intensive. And some authors (Loureiro, 2021, and Seeni, 2021) concluded that the SST $k-\omega$ model and the laminar-turbulent transition models have similar accuracy, except for flows under static conditions, as mentioned by Loureiro, who observed a significant difference in this condition. Divazi et al., 2025, performed numerical and experimental modeling to study the impact of the distance between the propeller and the atomizer on the spraying performance of agricultural UAVs. The SST $k-\omega$ turbulence model and a multiple reference frame technique were used for flow field and particle tracking. The propeller used was a 1045 DJI. They concluded that there is a correlation between the distance between the propeller and the atomizer and the spraying efficiency, and that the study provided important insights into drone spraying systems. Dougherty S. et al., 2024, examined the impact of a 10×5.0 propeller separation on quadcopter performance through numerical modeling. They employed the SST $k-\omega$ turbulence model along with an unstructured tetrahedral mesh that included inflation layers on the propeller surface. Two configurations were considered: a double propeller configuration and a quadcopter, with initial

flow perpendicular and parallel to each configuration. They described the influence on propeller performance. Liu Y. et al., 2024, developed a numerical model to evaluate the ceiling effect in small-scale inclined propellers (APC propellers 10 x 3.3 and 11 x 4.7). The results were validated by comparison with experimental data in a test bench designed for the study. They used a polyhedral mesh with inflation around the blades and the SST k- ω turbulence model. They developed a model to estimate thrust based on the rotor's distance from the ceiling and its angle relative to the ceiling. Liu X. et al., 2023, investigated a small-scale propeller (APC 1045) to analyze its aerodynamic performance through experiments, numerical simulation, and BEMT (Blade Element Momentum Theory) model. They compared the aerodynamic parameters at various free stream speeds to compare the three different methods. The SST k- ω turbulence model was used with tetrahedral mesh with inflation around the blade face. They concluded that BEMT is reliable enough to estimate the aerodynamic parameters. Rajendran P. et al., 2023, analyzed a twin-blade drone propeller (17 in diameter) using numerical modeling. They used the SST k- ω turbulence model with tetrahedral mesh to develop a propeller with improved torque and coefficient of performance, as well as reduced drag. They concluded that numerical validation was able to provide several modifications to the propeller design. Garofano-Soldado et al., 2022, developed a numerical and experimental study of the ground effect on the aerodynamics of small inclined propellers (13 x 4.4) with low Reynolds number. It was demonstrated that the proximity to the ground of inclined propellers decreases the thrust increment due to the ground effect as the angle increases. They proposed a numerical model to show the dependence of thrust on the distance to the ground and the tilt angle. They used the multiple reference method and the SST k- ω turbulence model with tetrahedral mesh. Zarri A. et al., 2022, developed a numerical modeling of a small drone using the SST k- ω turbulence and a polyhedral mesh with inflation on the blade face. The model was coupled with a computational aero acoustic approach. They concluded that the dominant sound sources are due to the interactions of the blades with the other propellers (9.4 in diameter) and struts, and that the acoustic scattering by the drone has an important effect on the near and far fields. Kumar R. et al., 2021, performed numerical simulation on a quadcopter with 17 x 6.0 propellers operating under different weather conditions. The objective was to predict the effects on services such as photography, remote sensing, aerial surveillance, etc. The standard k- ϵ turbulence model was employed in combination with a tetrahedral mesh. The modeling was validated against a reference work. Loureiro E. V. et al., 2021, analyzed the performance of small propellers (14 x 7.0) through experiments and using blade element theory in comparison with CFD. For the numerical model, they used the SST k- ω turbulence model and the Transition SST model to investigate

the results in the laminar-turbulent transition boundary layer. For low advanced ratio velocities, the blade element theory presented the best results, while for higher advanced ratio velocities, CFD presented the best results. Paz C., et al., 2021, performed a 3D numerical simulation of the operation of a quadcopter drone (9.4 in diameter) using multiple reference frames and sliding meshes with hexahedral cells. They evaluated the application of these methods to an isolated propeller and to a quadcopter, including the effect of ground proximity. The realizable k- ϵ turbulence model was used. Seeni A., 2021, applied numerical modeling to select the turbulence model for a small drone propeller (APC 10 x 7.0) operating at low Reynolds number. Validated data were obtained for several turbulence models by comparing them with experimental results. He concluded that the standard k- ω model is preferable for future propeller simulations as it has the advantage of being computationally economical without compromising accuracy. The results showed that the SST k- ω and the Transition SST models produce the same accuracy but at a higher cost. Cerny M. et al., 2020, analyzed small propellers (18 in diameter) insulated and ducted to investigate the influence of inlet angles between zero and 180 degrees with respect to the axial flow. The experimental results showed good agreement with the numerical model, which was developed using a hexahedral mesh and the SST k- ω turbulence model. Deters R. W. et al., 2014, investigated the influence of Reynolds number on the performance of small propellers with diameters between 2.25 and 9 inches. They stated that the low Reynolds number of these propellers makes it very difficult to evaluate their performance. Data from several small propellers under static and continuous flow conditions were measured to study the influence of Reynolds number. The performance improved with increasing Reynolds number, but the maximum efficiency achieved was low compared to larger propellers. They described that at low Reynolds number, a laminar separation bubble forms on the airfoil, and then the laminar boundary layer separates from the surface, becomes turbulent, and may then reattach.

Weerasinghe S.R. et al., 2012, analyzed hovering and flight of the Syma X5SC quadcopter (5.3 in diameter) using CFD and experiments, focusing on the aerodynamic forces on the fuselage and rotor blades. The flight was simulated for hovering mode at three different angles of attack and free-stream velocities. The SST k- ω turbulence model was used with a tetrahedral mesh. They concluded that the simulations adequately described the flows with rotational motions.

This work aims to contribute with a comparative study between experimental results of thrust and torque measurements of a small scale propeller and computational fluid dynamics (CFD) simulation, using the Fluent software. The RANS (Reynolds-Averaged Navier-Stokes) turbulence models considered in the simulation were Shear-Stress-Transport

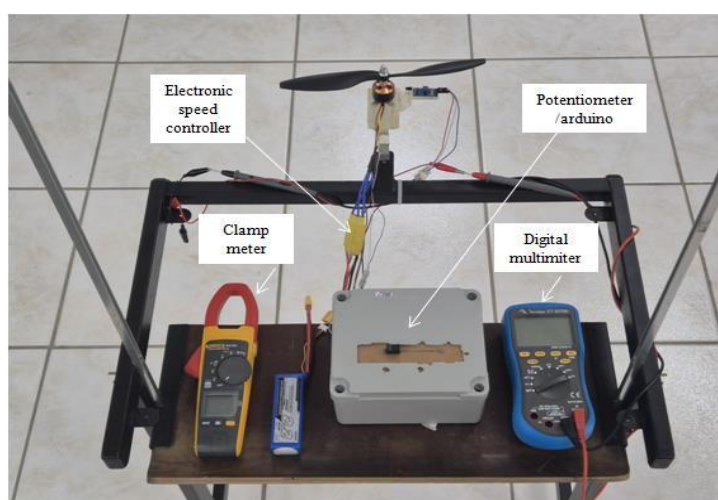
(SST) $k-\omega$, Standard $k-\omega$, Spalart Allmaras and Realizable $k-\epsilon$. Laminar-turbulent transition models, such as the Transition SST model and the Intermittency Transition model (γ model), were also used to verify the results at low rotations rate, such as 2,000 to 4,000 rpm. In principle, these latter models provide a more realistic simulation of flows where laminar, transitional and turbulent regions coexist, since traditional turbulence models, such as $k-\omega$ and $k-\epsilon$, assume fully developed turbulence, which can lead to incorrect thrust and torque predictions in low Reynolds number flows.

2 EXPERIMENTAL APPARATUS - THRUST, TORQUE AND RPM MEASURING EQUIPMENT

Propeller static performance was conducted on a test rig that was designed to measure propeller thrust, torque and RPM, as shown in Figure 1 and 2. The black propeller is the commercial APC 10 x 4.5 and the white one is an in-house 3D printed propeller. The direct thrust measurement equipment consists of an A2212/6T brushless DC motor (22 mm motor diameter, 12 mm motor shaft height, and 6 turns per pole) used for radio-controlled quadcopters, associated with an electronic speed controller (ESC), a load cell with signal conditioning module HX711 and an infrared obstacle sensor LM393. All devices are interconnected to an Arduino Mega 2560 platform, responsible for synchronized data acquisition.

Figure 1

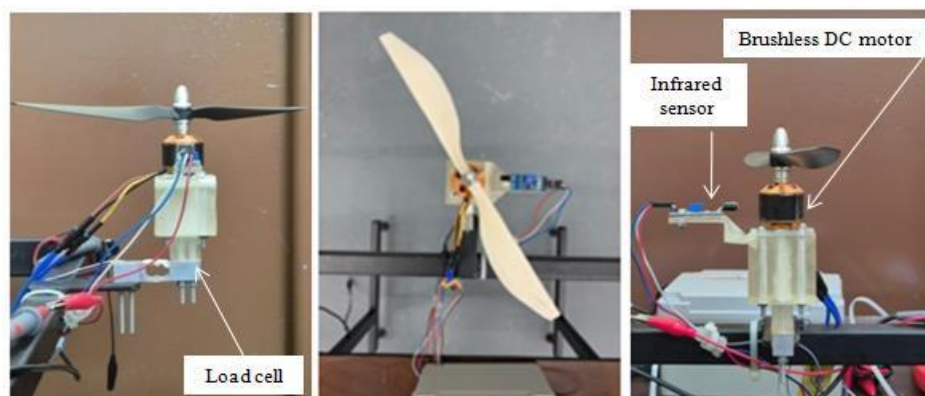
Test equipment for measuring thrust, torque and RPM



Source: From author.

Figure 2

Front view of the propeller: Fig. 2a; Top view of the propeller: Fig. 2b; Side view of the propeller and RPM measurement sensor: Fig. 2c



Source: From author.

For indirect torque measurement, a Minipa ET2076-A digital multimeter was used to measure electrical voltage and a Fluke 374 FC clamp meter for non-invasive measurement of electrical current. Electrical power ($V \times I$), multiplied by the motor efficiency, results in mechanical power, which in turn, divided by the angular velocity, is torque. To measure the thrust, a load cell integrated into the HX711 module was used. This sensor converts the mechanical deformation caused by the thrust force generated by the propeller into an electrical signal that can be read by the Arduino platform. The load cell was configured with a variable calibration, which translates the electrical signal from the sensor into mass. The measurement results were then compared with a set of measured masses. The sensor reading is performed in the main loop, which activates the weight sensor, which has a function taking 5 consecutive sensor readings and calculating the average. This procedure reduces the effects of instantaneous variations, improving accuracy. The calibration of the thrust measurement system consisted of three steps: scale factor adjustment, offset compensation via tare, and data acquisition with statistical processing. To determine the scale factor, a set of calibrated masses (2g, 5 g, 10 g, 25 g, 50 g, 100 g, 250 g, 500 g, and 1,000 g) were sequentially applied to the load cell. This procedure verifies the linearity of the sensor over different load ranges. After a 2-second delay for stabilization, the system starts the main loop, where another function performs five consecutive readings and calculates the arithmetic mean, reducing instantaneous variations. The use of varied masses (2 g to 1,000 g) verified the sensitivity of the system at low loads and its ability to maintain accuracy at higher loads, with a post- calibration relative error below 1%.

Propeller rotation was measured using the LM393 reflective sensor, which counts pulses and the time elapsed between them. The sensor emits infrared light onto a rotating

object with alternating reflective and non-reflective segments. The light is reflected from the reflective area and absorbed by the non-reflective area. The phototransistor detects the level of reflection, and the LM393 emits digital pulses. The data acquisition system was programmed using the Arduino IDE platform, integrating the infrared (IR) sensor for rotation measurement with the Arduino Mega 2560 microcontroller. The infrared sensor was positioned at a fixed distance of 1 cm from the brushless motor, with precise alignment to capture rotation signals. During testing, the equipment was turned on and measurements were taken at discrete intervals of 1,000 rpm, covering a range from 2,000 rpm to 8,000 rpm, as recorded by the infrared sensor. Simultaneously, the engine rotation was monitored using the calibrated digital tachometer DT-2234C+, positioned according to the manufacturer's specifications. Before running the test, the propeller was firmly attached to the brushless motor shaft, ensuring mechanical alignment and balancing to avoid parasitic vibrations. The Minipa ET2076-A multimeter, set to measure voltage, and the Fluke 374 FC clamp meter, set to measure direct current, were then connected to the battery terminals to enable simultaneous monitoring of the electrical parameters. The Arduino Mega 2560 was connected to the computer's USB port, with the Serial Monitor open for real-time viewing of the rotation speed, via infrared sensor, and of the force, via load cell. Once the system was set up, the potentiometer was gradually adjusted to increase the motor speed until it reached the predefined maximum of 8,000 rpm.

3 GEOMETRY, GRID GENERATION AND BOUNDARY CONDITIONS

A 10 x 4.5 in house propeller (diameter and pitch, respectively) of two blades was designed, 3D printed, and static tested. The off-the-shelf APC 10 x 4.5 propeller was used to validate the thrust and torque measurements of the developed test rig. The “Design Modeler” software was used to design the propeller, following the characterization methodology proposed by Drella (2006). The process consisted of subdividing the propeller into 10 sections, obtaining the β angle (local geometric blade pitch angle) through a specific formula and scaling the coordinates to the unit chord by dividing the airfoil chord number by 12 mm, corresponding to the chord value in the first airfoil of each blade, as indicated in Table 1, resulting in the propeller geometry. The propeller geometry was created using the SDA1075 airfoil along the entire length of the blades.

Table 1

Data for the geometric dimensions of the propeller

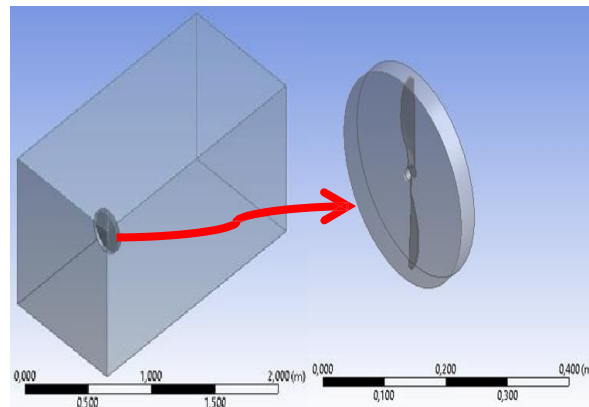
$\beta = \arctg\left(\frac{p}{2\pi r}\right)$						
r(mm)	r/R	r (")	chord (")	chord (mm)	β (deg)	scale
19.1	0.15	0.75	0.472	12.0	44	1.000
25.4	0.25	1.00	0.551	14.0	36	1.169
38.1	0.35	1.50	0.819	20.8	26	1.736
50.8	0.45	2.00	0.984	25.0	20	2.087
63.5	0.55	2.50	1.063	27.0	16	2.254
76.2	0.65	3.00	1.055	26.8	13	2.237
88.9	0.75	3.50	1.024	26.0	12	2.170
101.6	0.85	4.00	0.906	23.0	10	1.920
114.3	0.95	4.50	0.709	18.0	9	1.503
127.0	1.00	5.00	0.315	8.0	8	0.668

Source: From author.

The CFD domain for investigating the aerodynamic effects of propeller operation consisted of a wind tunnel with a length of 2.0 m and a width of 1.0 m, and a rotating disk with a radius of 0.137 m and a thickness of 0.03 m around the propeller. The disk was designed to simulate the flow around the propeller. It is a moving reference part that allows modeling a moving component, such as the propeller, by creating this moving frame in a selected cell zone around the propeller. The equations of motion are modified to include the additional terms due to the change from a stationary frame to a moving frame. The propeller becomes a stationary part (Ansys Fluent, 2025). The geometry and mesh of these parts are shown in Figures 3 and 4, respectively. The boundary conditions applied in the simulation are presented in figure 4. As the objective of the analysis is related to the static performance of the propeller (without freestream velocity), both the inlet and outlet airflows were considered as the outlet pressure boundary condition. The axial velocity induced by the rotor at the inlet of the domain is determined by the simulation, with the inlet and outlet boundary conditions being defined by the propeller rotation. In this simulation, the induced inlet flow occurs in the negative direction.

Figure 3

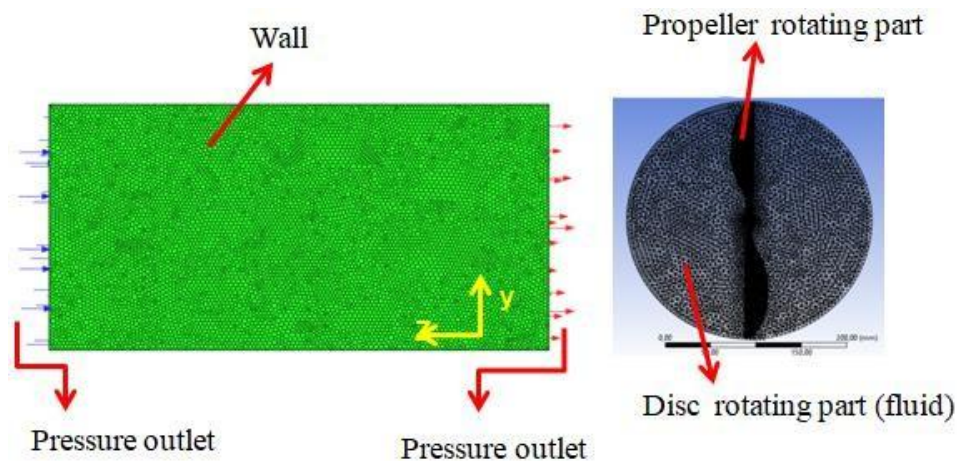
Geometry of wind tunnel and rotating disk



Source: From author.

Figure 4

Mesh and boundary conditions

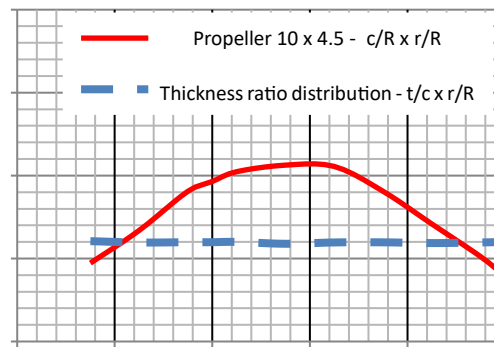


Source: From author.

The chord (c) and twist distribution of the propeller are shown in Fig. 5 and Fig. 6, respectively. As this work was the first project carried out, the profile law constant was chosen (propeller shape constant) and subsequently the thickness (t) distribution is constant, as shown in Fig. 6. Fig. 7 presents how the Reynolds number along the propeller blade varies with different rotational rates.

Figure 5

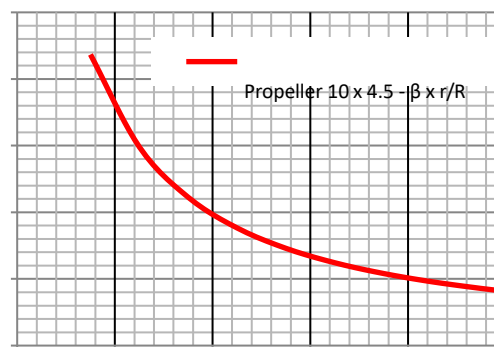
Chord (c) distribution of designed propeller 10 x 4.5



Source: From author.

Figure 6

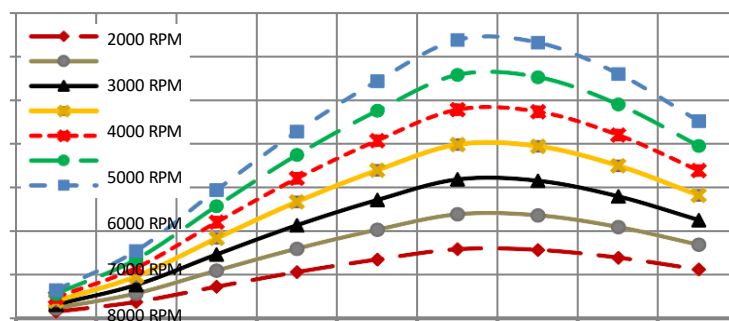
Twist distribution of designed propeller 10 x 4.5



Source: From author.

Figure 7

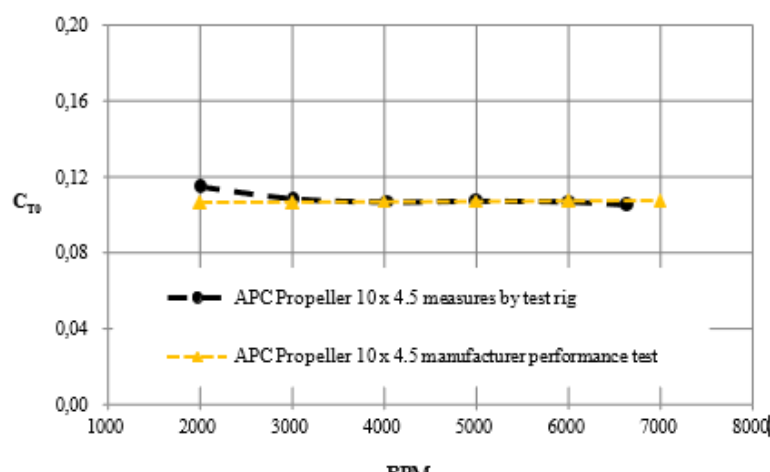
Reynolds number along the propeller blade



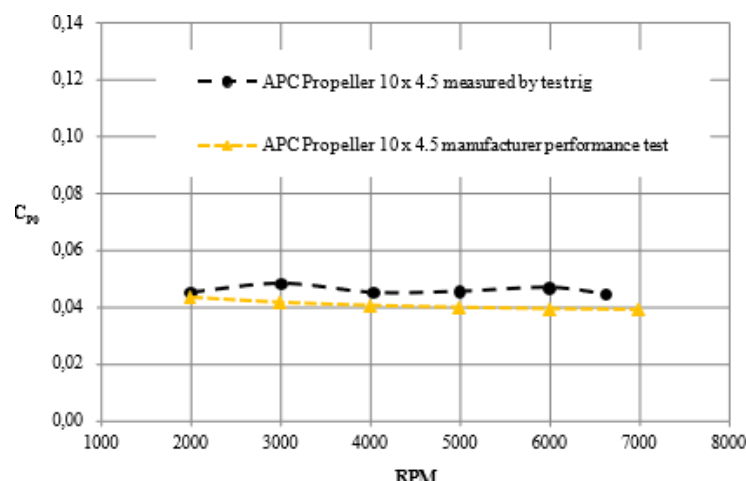
Source: From author.

4 EXPERIMENT PROCEDURES AND VALIDATION

To verify the consistency of the thrust and torque measurement system of the designed propeller, the static performance results of the APC 10 × 4.5 propeller provided by the manufacturer APC Model Aircraft Propellers were used for comparison with the results of measurements performed on this propeller on our test bench. The results are shown in Fig. 8 and Fig. 9.

Figure 8*Thrust coefficient x RPM*

Source: From author.

Figure 9*Power coefficient x RPM*

Source: From author.

The thrust coefficient of the APC 10 x 4.5 propeller (Fig. 7) measured by the test equipment in static performance, agrees very well with the manufacturer's performance test, having at 2,000 RPM the greatest difference. The average difference was 2.0% and the maximum was 7.2% at 2,000 RPM.

The power coefficient of the APC 10 x 4.5 propeller (Fig. 8), as measured by the test equipment, differs from the manufacturer's performance data by an average of 11.0%, with a maximum deviation of 15.7% observed at 6,000 RPM. It can be concluded that the test equipment demonstrated satisfactory measurement accuracy and provided a reliable level of confidence for the objectives of this study, which focused on evaluating the most appropriate turbulence model.

5 NUMERICAL MODELS

5.1 RANS EQUATIONS

Four RANS turbulence models were chosen for the numerical simulations. The realizable k- ϵ model considers the effects of rotations in the definition of the turbulent viscosity, and has already been tested in a single moving reference, as is the case in this modeling, presenting good results. The k- ϵ models are not recommended when the flow separates under adverse pressure gradients, which is the problem with low Reynolds number propellers (Fluent Theory Guide, 2025). However, as Paz, 2021, used this model in his work and obtained a good result, it will be used to evaluate the current case. The k- ω model provides good results for flows with adverse pressure gradients and airfoils. Low Reynolds numbers can be used with the SST k- ω , and it is a very simple model for laminar-turbulent transition and can be used to predict more accurate details of the wall boundary layer than the Spallart-Allmaras model. SST k- ω is the model most used in recent works with small-scale propellers. The Spallart-Allmaras gives good results for low Reynolds numbers and is designed for boundary layers subject to adverse pressure gradients (Ansys Fluent Theory Guide, 2025).

Partial differential equations (RANS - Reynolds-averaged and Navier-Stokes) are discretized and computed to account for turbulent fluctuations, resulting in Reynolds stresses that must be modeled using a turbulence model. They are typically written in Cartesian coordinates as the following equations, conservation of mass (equation 1) and momentum (equation 2), respectively:

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_i}(\rho u_i) = 0 \quad (1)$$

$$\frac{\partial}{\partial t}(\rho u_i) + \frac{\partial}{\partial x_j}(\rho u_i u_j) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left[\mu \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} - \frac{2}{3} \delta_{ij} \frac{\partial u_l}{\partial x_l} \right) \right] + \frac{\partial}{\partial x_j} (-\rho \overline{u'_i u'_j}) \quad (2)$$

Where $-\rho \overline{u'_i u'_j}$ is the Reynolds stress tensor modeled via turbulence models.

Laminar-turbulent transition models augment the RANS equations with extra transport equations or empirical correlations to account for transition phenomena, the change from laminar to turbulent flow, i.e. to predict where and how turbulence begins, which is critical in low Reynolds number flows. The Transition SST model solves two additional equations and is the most used model in the last decade. The Transition γ model (Intermittency Transition

model) solves one additional transport equation and has gained acceptance recently (Ansys Fluent Theory Guide, 2025).

5.2 PROPELLERS COEFFICIENTS

Thrust coefficient: $C_T = \frac{T}{\rho n^2 D^4}$; Power coefficient: $C_P = \frac{P}{\rho n^3 D^5}$; Power: $P = 2\pi nQ$; and Reynold number calculated at velocity of the fluid and chord width at 75% of blade station: $Re = \frac{\rho v_{75} c_{75}}{\mu}$; where $v = \omega r$ for propeller static performance. Where T is the propeller thrust; ρ is density in kg/m^3 ; n is the rotational velocity in revolutions per second; D is the diameter of the propeller in m; Q is the propeller torque in N.m; and ω is rotational speed in rad/s.

6 GRID INDEPENDENCE ANALYSES

For the fully turbulent models, three 3D tetrahedral meshes with different numbers of cells/nodes were generated to perform independent mesh analyses. Table 2 provides a summary of the sizes of the three meshes. Table 3 shows the mesh quality of this model, using the fine mesh, in comparison to the modeling of a complete quadcopter done by Weerasinghe S.R. et al., 2012, who did a detailed investigation of the mesh quality. This comparison was made between the rotor and the propeller, as well as, between the complete quadcopter and the entire domain of this model. The values demonstrate that the produced mesh is adequate.

Table 2

Mesh size for three different dimensions – tetrahedral

	Coarse mesh	Medium mesh	Fine mesh
Cells	276,531	1,842,868	2,246,122
Faces	802,513	3,958,894	4,783,476
Nodes	108,760	446,658	520,960

Source: From author.

Table 3

Mesh quality analysis – tetrahedra

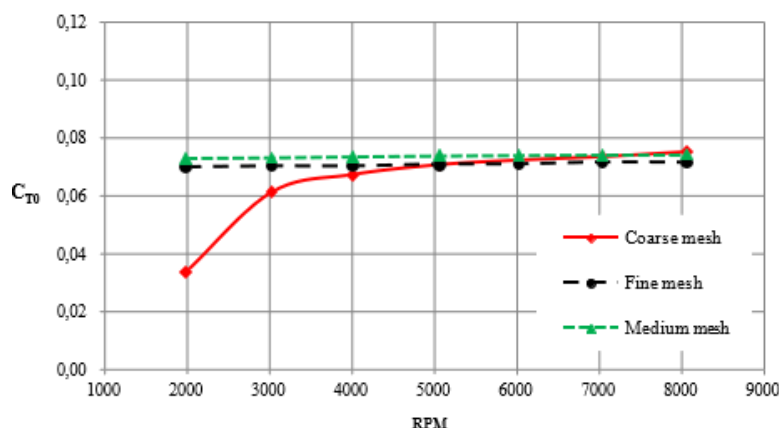
Mesh quality	Orthogonal (>0.01)		Skewness (<0.95)	
	Minimum	Average	Maximum	Average
Rotor [Weerasinghe, 2012]	0.036	0.82	0.96	0.25
Propeller (current work)	0.222	0.95	0.78	0.59
Full quadcopter [Weerasinghe, 2012]	0.016	0.84	0.96	0.25
Full domain (current work)	0.062	0.75	0.92	0.24

Source: From author.

Figure 10 shows the results of the mesh independence study for the propeller thrust coefficient. The results demonstrate that the fine mesh and the medium mesh present very similar thrust coefficients (average difference of 4%), while the coarser mesh deviates from the other meshes. The SST k- ω model was used to calculate the three different mesh sizes.

Figure 10

Propeller thrust coefficient for comparison of three tetrahedral meshes with different number of cells



Source: From author.

For analysis with the laminar-turbulent transition models, the mesh was changed to a polyhedral mesh with inflation around the blades. Figure 11 shows the mesh around a propeller airfoil at position $r/R = 0.40$ ($r = 50.8$ mm) for two meshes of different sizes. Table 4 shows details of the two polyhedral meshes. Both meshes produced the same results for torque and thrust calculations in the numerical simulation. There was no significant difference.

Table 4

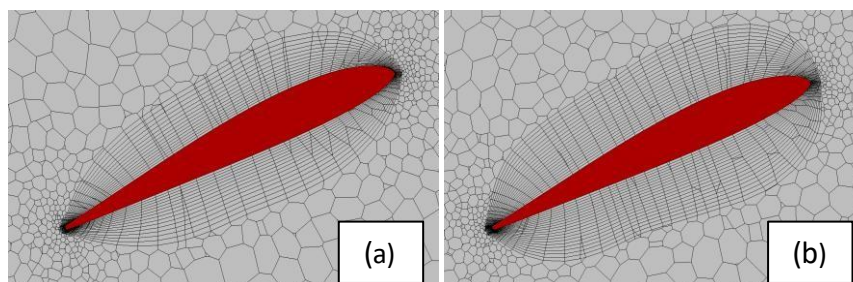
Mesh details for two different sizes – polyhedral with prisms

	Coarse mesh	Fine mesh
Cells	1,707,890	2,808,693
Faces	8,276,454	13,681,975
Nodes	5,505,550	9,128,376
Propeller element size (mm)	1.0	0.8
Disk element size (mm)	2.8	2.0
Transition rate of inflation	0.272	0.272
Layers of inflation	15	20
Growth rate of inflation	1.05	1.02

Source: From author.

Figure 11

Polyhedral mesh with inflation of prisms on the face of the blade: (a) coarse mesh; (b) fine mesh



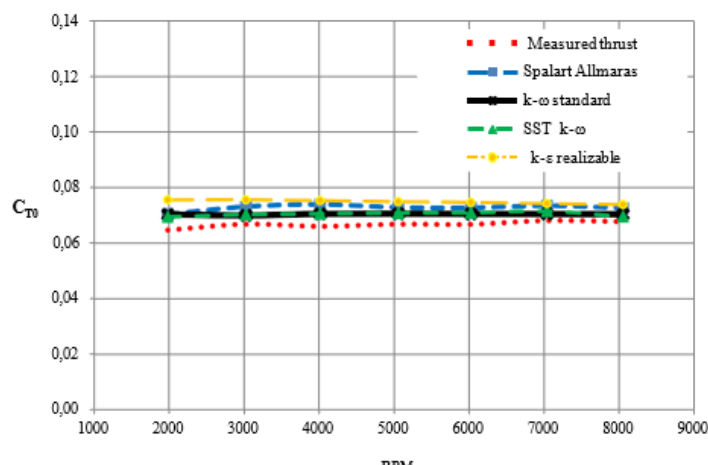
Source: From author.

7 RESULTS AND DISCUSSION

Regarding CFD simulation compared to measurements, the best result was using the SST $k-\omega$ turbulence model, as shown in Figs. 12 to 15. With respect the thrust coefficient, the results agreed very well with higher rotation rates and become worse for lower rotation rates (Fig. 12). One explanation for this behavior is related to the lower Reynolds numbers. As shown in Fig. 6, for rotations below 5,000 RPM, Reynolds numbers are less than 60,000 for most of the propeller. This is a typical feature of small-scale propellers and makes performance prediction through CFD less accurate, as the performance of these propellers typically changes with Reynolds numbers. The average difference in thrust coefficients for the SST $k-\omega$ model, which obtained the best result, in relation to the measured values, was 5.1% and the maximum difference was 7.6% at 2,000 RPM.

Figure 12

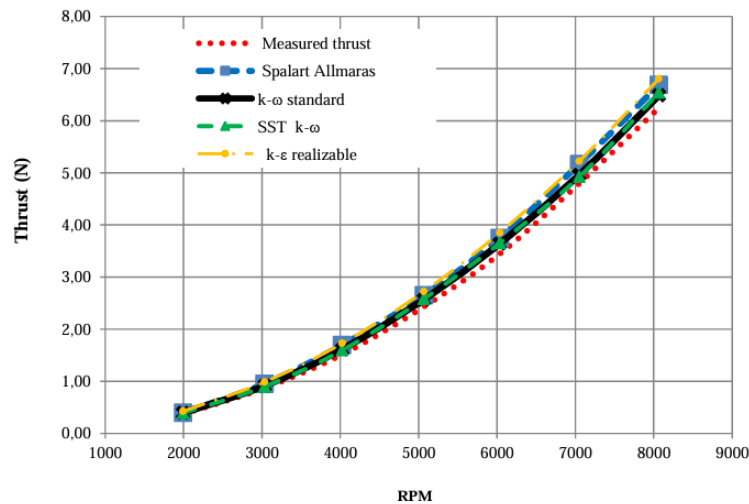
Comparison between CFD-simulated thrust coefficients for various turbulence models with thrust measured on the test bench



Source: From author.

Figure 13

Comparison between thrust measured on the test bench and simulated by CFD with different turbulence models

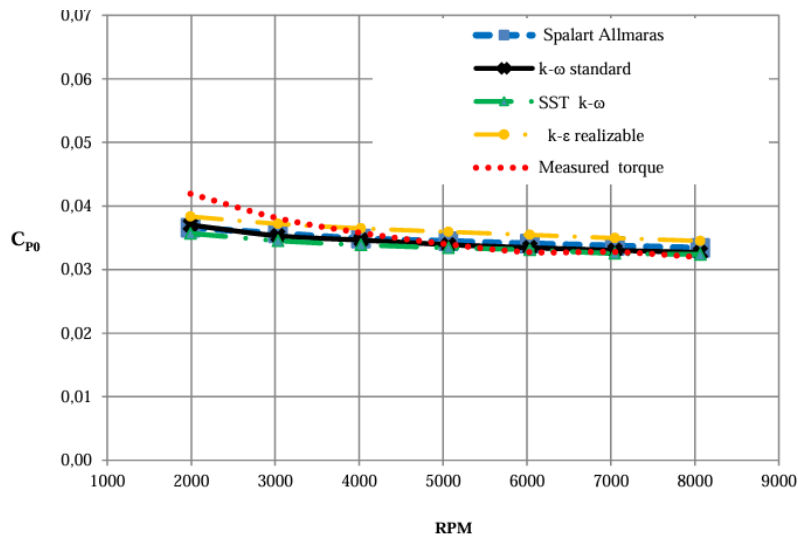


Source: From author.

As shown in Fig. 13, the thrust generated by the propeller as a function of rotation velocities, simulated using the SST K- ω turbulence model, agreed very well with the measured thrust for the entire propeller operating range. Observing Figure 14, it can be concluded that the simulation results for the power coefficients were much lower than the values measured at rotation speeds lower than 5,000 rpm. Between 5,000 and 8,000 rpm the results were very close, except for the k- ϵ realizable model. The average difference in power coefficients for the SST k- ω model, in comparison to the measured values, was 5.1% and the maximum difference was 15.9% at 2,000 RPM. As shown in Figure 15, all models agreed very well with the measured torque values except the realizable k- ϵ model.

Figure 14

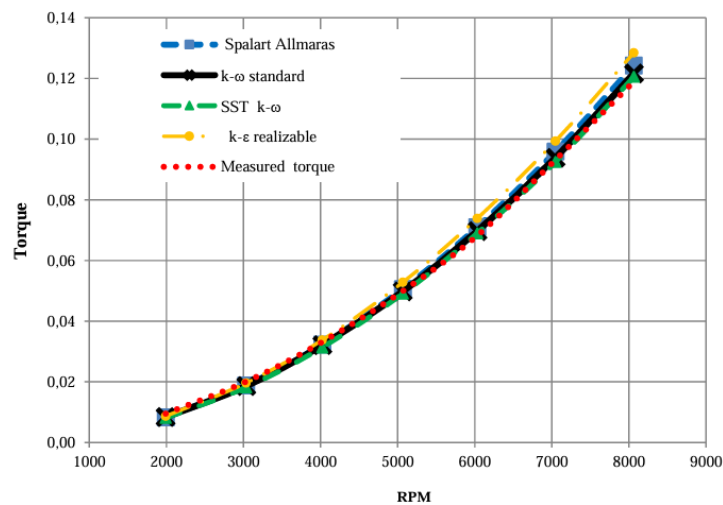
Comparison between power coefficients with torque measured on the test bench and simulated by CFD with different turbulence models



Source: From author.

Figure 15

Comparison between torque measured on the test bench and simulated by CFD with different turbulence models



Source: From author.

It is important to highlight that the standard $k-\omega$ model had a very similar result to the SST $k-\omega$ model, both for the thrust coefficient and for the Power coefficient, as concluded by Seeni, 2021.

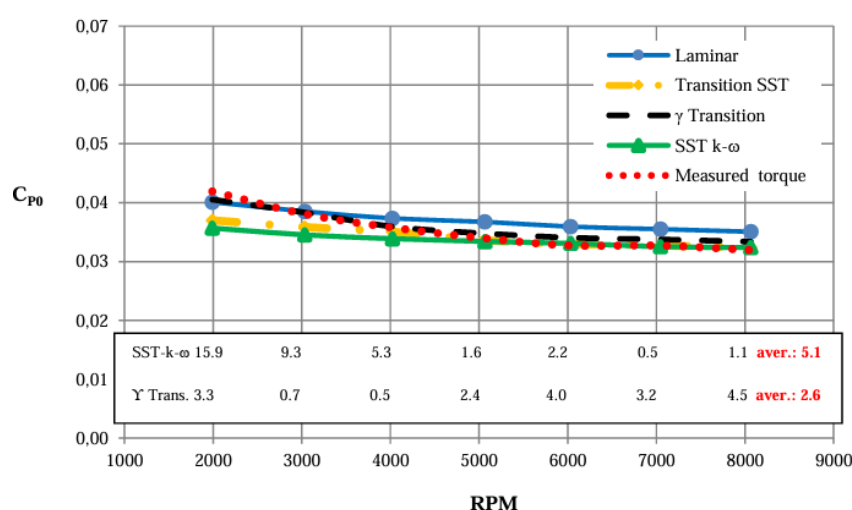
To verify whether the laminar-turbulent transition models obtain greater accuracy at low rotation rates, especially with regard to power coefficient, which showed a greater difference in relation to the measured values, simulations were performed with two models. Figure 16 presents the results of the power coefficient and the percentage difference of these

values calculated by the SST $k-\omega$ model and the γ model in relation to the measurements. An improvement in the results for low rotations rates can be observed, especially for the Intermittency Transition model (γ model), but the Transition SST model also presented better results than the fully turbulent models for low rotations rates. For speeds above 4,000 rpm, there was no significant difference between the transition models and the fully turbulent models. Figure 7 shows that above 4000 rpm, at the position $r/R=0.75$ (which corresponds to the Reynolds number calculated at the rotational rate at the 75% station), the Reynolds number is greater than 63,300. In conclusion, the study indicates that, for the propeller under analysis, with a Reynolds number equal to or less than 63,300 (4,000 rpm), fully turbulent models begin to show greater inaccuracy.

Comparing the results of the best laminar-turbulent transition model (γ model) with the best fully turbulent model (SST $k-\omega$), in relation to the measurement, there was a drop in the average difference from 5.1% to 2.6% and for the 2,000 rpm rotation from 15.9% to 3.3%. It can be seen that below 5,000 rpm the transition model is much more accurate, however, from 5,000 rpm to higher velocities, the fully turbulent model becomes more accurate. It is also observed that for the laminar model, at rotations of 2,000 and 3,000 rpm, the results were very close to those of the γ model, with a difference of 1.1% and 0.5% for 2,000 and 3,000 rpm, respectively.

Figure 16

Comparison between power coefficients with torque measured on the test bench and simulated by CFD with transition turbulence models and the SST $k-\omega$ fully turbulent model

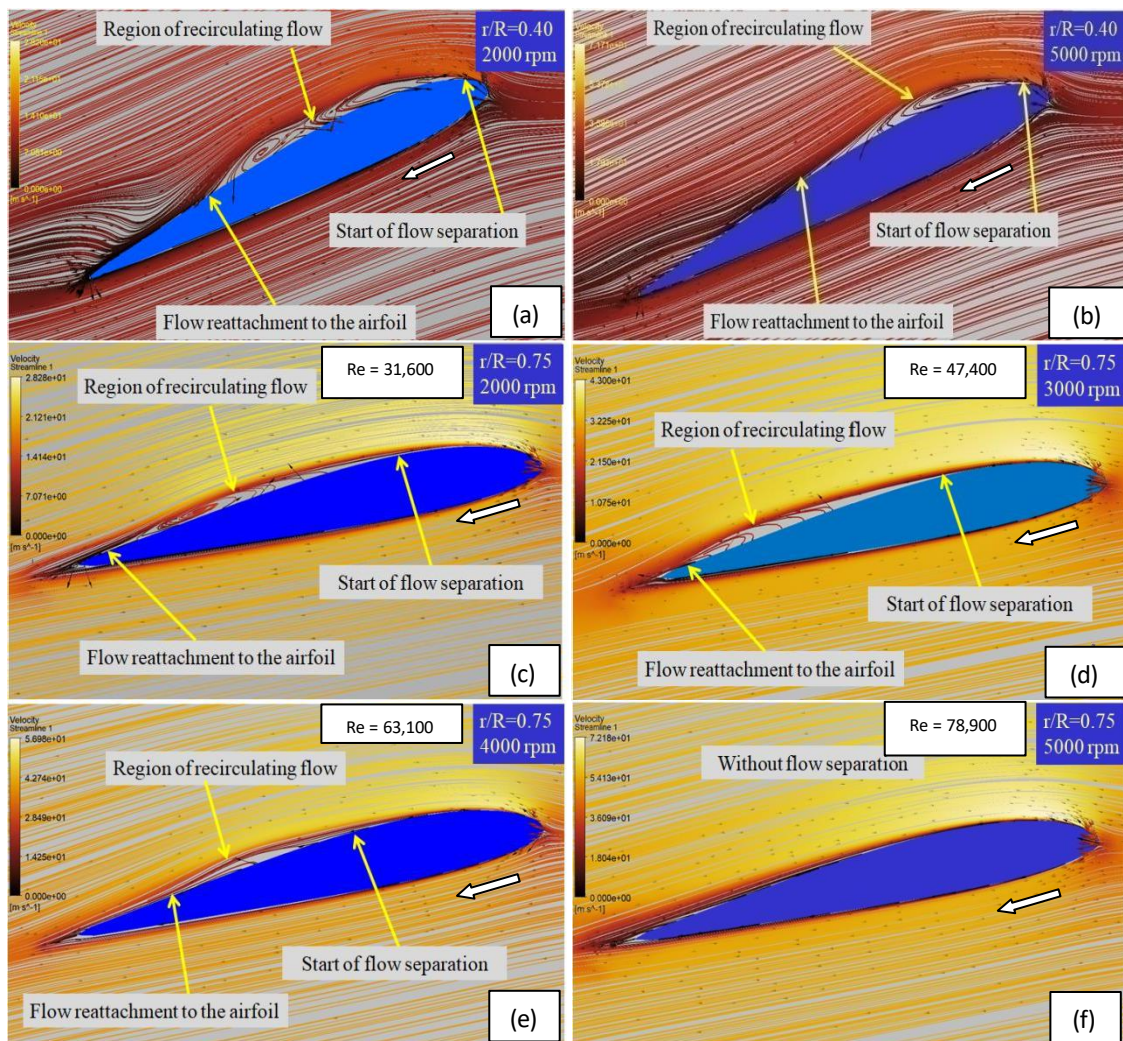


Source: From author.

As shown in Figures 13 and 15, at low rotation velocities there is a drop in the thrust coefficient and an increase in the power coefficient. As described by Deters, 2014, the change in thrust and torque coefficient, with the former decreasing and the latter increasing, is due to the reduction of the Reynolds number to below 100,000. At these values, a laminar flow separates from the propeller due to an adverse pressure gradient that imposes a region of recirculating flow, causing a reduction in lift and an increase in airfoil drag. Figures 16(a) and 16(b) show the visualization of the airflow separation around the propeller sections (airfoils) at $r = 50.8$ mm ($r/R = 0.40$) for rotations velocities of 2,000 rpm and 5,000 rpm. In the propeller section at $r/R = 0.40$, which has a Reynolds number of 18,000 at 2,000 rpm, the laminar separation bubble size is larger than in the same section at 5,000 rpm, with a Reynolds number of 44,900, because the bubble grows as the Re number decreases. Figures 16(c) to 16(f) show the airflow around the section at $r/R = 0.75$ ($r = 95.3$ mm) at rotation velocities from 2,000 rpm to 5,000 rpm. The flow separation length decreases with increasing speed. At 2,000 rpm, the flow separation length occupies about 75% of the airfoil and gradually decreases until it disappears at 5,000 rpm. These images were made with simulation data with the γ transition model. This observation is in agreement with the conclusions drawn in Figure 17, that is, from 5,000 rpm onwards, as flow separation is no longer observed, the fully turbulent model becomes accurate. Fully turbulent models have a critical limitation when applied to low Reynolds number flows: because they assume turbulence from the leading edge of the airfoil, they ignore transition effects and, therefore, they do not capture satisfactory the laminar separation bubble (LSB), resulting in an underprediction of the drag caused by the LSB. On the other hand, since laminar-turbulent transition models are able to capture LSBs, they can also capture the increased drag caused by them and, consequently, the increased power coefficient on the propellers.

Figure 17

Laminar boundary layer separation in propeller section



8 CONCLUSIONS

Considering turbulence models for low Reynolds number flows, the most suitable ones are those that capture the laminar-turbulent transition conditions, but they have the disadvantage of being computationally very intensive. Thus, for the small-scale propeller designed, operating in static performance, we seek to identify from which condition it is really necessary to use such models. The following conclusions were reached:

Full turbulence models can predict thrust and power coefficients for Reynolds numbers greater than 60,000. For values less than 60,000, they fail to predict, as they are not able to capture satisfactory effects of laminar boundary layer; Laminar-turbulent transition models should be used for Reynolds numbers less than 60,000, as they can capture laminar boundary layer effects and consequently the change in propeller power coefficients; The best models for Reynolds numbers greater than 60,000 are the SST $k-\omega$ and the Standard $k-\omega$, since the accuracy compared to the transition models was very similar, in fact, being better

than the transition models for this range; The best model for Reynolds number less than 60,000 is the Transition γ model (Intermittency Transition model); Visual analysis through CFD of the flow around the propeller was consistent with the results related to the power coefficient, that is, through both analysis methods it was concluded that below 5000 rpm the transition models are more accurate and that for higher rotations from 5000 rpm the fully turbulence models are more accurate.

An important contribution of this work is the visualization through CFD of the characteristics of the laminar separation bubble, such as the beginning of the flow separation, the recirculation flow region and its reattachment to the propeller downstream.

REFERENCES

- Ananda, G. K., Deters, R. W., & Selig, M. S. (2013). Propeller induced flow effects on wings at low Reynolds numbers. In 31st AIAA Applied Aerodynamics Conference.
- Ansyz. (2025). ANSYS Fluent Theory Guide. Canonsburg, PA, USA.
- Cerny, M., & Breitsamter, C. (2020). Investigation of small-scale propellers under non-axial inflow conditions. *Aerospace Science and Technology*, 106, 106048.
- Deters, R. W., Ananda, G. K., & Selig, M. S. (2014). Reynolds number effects on the performance of small-scale propellers. In 32nd AIAA Applied Aerodynamics Conference.
- Divazi, A., Askari, R., & Roohi, E. (2025). Experimental and numerical investigation on the spraying performance of an agricultural unmanned aerial vehicle. *Aerospace Science and Technology*, 160, 110083.
- Dougherty, S., Oo, L. N., & Zhao, D. (2024). Effects of propeller separation and onset flow condition on the performance of quadcopter propellers. *Aerospace Science and Technology*, 145, 108837.
- Drela, M. (2006). QPROP formulation. MIT Aero & Astro.
- Garofano-Soldado, A., Sanchez-Cuevas, P. J., & Heredia, G. (2022). Numerical-experimental evaluation and modelling of aerodynamic ground effect for small-scale tilted propellers at low Reynolds numbers. *Aerospace Science and Technology*, 126, 107625.
- Kumar, R., Kumar, G., Zunaid, M., & Ansari, N. A. (2021). Numerical analysis of a quadcopter in different weather conditions of region in India. *Materials Today: Proceedings*, 43, 378–382.
- Liu, Y., Kan, Z., Li, H., Gao, Y., Li, D., & Zhao, S. (2024). Analysis and modeling of the aerodynamic ceiling effect on small-scale propellers with tilted angles. *Aerospace Science and Technology*, 147, 109038.
- Liu, X., Zhao, D., & Oo, L. N. (2023). Comparison studies on aerodynamic performances of a rotating propeller for small-size UAVs. *Aerospace Science and Technology*, 133, 10148.

- Loureiro, E. V., Oliveira, N. L., Hallak, P. H., Bastos, F. S., Rocha, L. M., Delmonte, R. G. P., & Lemonge, A. C. C. (2021). Evaluation of low fidelity and CFD methods for the aerodynamic performance of a small propeller. *Aerospace Science and Technology*, 108, 106402.
- Paz, C., Suárez, E., Gil, C., & Vence, J. (2021). Assessment of the methodology for the CFD simulation of the flight of a quadcopter UAV. *Journal of Wind Engineering & Industrial Aerodynamics*, 218, 104776.
- Rajendran, P., & Jayaprakash, A. (2023). Numerical performance analysis of a twin blade drone rotor propeller. *Materials Today: Proceedings*, 80, 492–498.
- Seeni, A. (2021). Effect of turbulence models in performance characterization of a low Reynolds number UAV propeller. *INCAS Bulletin*, 13, 151–166.
- Weerasinghe, S. R., & Monasor, M. (2012). Simulation and experimental analysis of hovering and flight of a quadcopter. In *13th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics*.
- Zarri, A., Dell'Erba, E., Munters, W., & Schram, C. (2022). Aeroacoustic installation effects in multi-rotorcraft: Numerical investigations of a small-size drone model. *Aerospace Science and Technology*, 128, 107762.

INTEGRATED MANAGEMENT OF TRAFFIC VIOLATIONS: IMPACTS OF DIGITAL TRANSFORMATION ON STATE PUBLIC ADMINISTRATION

GESTÃO INTEGRADA DE INFRAÇÕES DE TRÂNSITO: IMPACTOS DA TRANSFORMAÇÃO DIGITAL NA ADMINISTRAÇÃO PÚBLICA ESTADUAL

GESTIÓN INTEGRADA DE INFRACCIONES DE TRÁNSITO: IMPACTOS DE LA TRANSFORMACIÓN DIGITAL EN LA ADMINISTRACIÓN PÚBLICA ESTATAL



<https://doi.org/10.56238/sevened2026.008-191>

Henrique Ribeiro da Glória Antunes¹, Luana Amélia de Abreu Teixeira², Lucas Vilas Boas Pacheco³, Rita de Cássia Alanna Ribeiro⁴

ABSTRACT

This article analyzes the experience of state public administration in the centralization and modernization of traffic violation management, focusing on improving road safety and reducing impunity. The initiative, led by the State's innovation laboratory, involved the redesign of processes and the adoption of technological solutions aimed at creating a single and integrated digital system. Faced with a monthly average of 70,000 violations and 15,000 defenses and appeals, software was implemented to automate the registration and processing of citations, operating in an integrated manner with existing systems. The complete digitalization of workflows increased efficiency, reduced processing times, and ensured greater reliability and respect for the right of defense. The centralization of activities, previously fragmented, generated resource savings and allowed the reassignment of public servants to strategic functions. Cases began to be judged more quickly and uniformly, strengthening citizens' trust in public administration. The results include a growth from 13% to 29% in the use of digital channels for defenses and appeals; elimination of the backlog of registrations through automated bots, reducing the average processing time from 30 days to 2 business days; and the adoption of electronic ticket books, with a significant reduction in paper use. This experience demonstrates the potential of digital transformation in public management, especially in the traffic sector, offering a replicable model oriented toward efficiency, legality, and road safety.

Keywords: Traffic Management. Digital Transformation. Administrative Centralization. Road Safety. Public Efficiency.

RESUMO

Este artigo analisa a experiência da administração pública estadual na centralização e modernização da gestão de infrações de trânsito, com foco na melhoria da segurança viária e na redução da impunidade. A iniciativa, conduzida pelo laboratório de inovação do Estado,

¹ State Traffic Management Coordination of Minas Gerais. Brazil.

E-mail: henrique.antunes@transito.mg.gov.br

² State Traffic Management Coordination of Minas Gerais. Brazil. E-mail: luana.teixeira@transito.mg.gov.br

³ State Traffic Management Coordination of Minas Gerais. Brazil. E-mail: lucas.vilas@transito.mg.gov.br

⁴ State Traffic Management Coordination of Minas Gerais. Brazil. E-mail: rita.ribeiro@transito.mg.gov.br

envolveu a reformulação de processos e a adoção de soluções tecnológicas voltadas à criação de um sistema digital único e integrado. Diante de uma média mensal de 70 mil infrações e 15 mil defesas e recursos, foi implementado um software que automatiza o registro e o processamento das autuações, operando de forma integrada aos sistemas já existentes. A digitalização completa dos fluxos aumentou a eficiência, reduziu prazos e assegurou maior confiabilidade e respeito ao direito de defesa. A centralização das atividades, antes fragmentadas, gerou economia de recursos e permitiu o redirecionamento de servidores a funções estratégicas. Os processos passaram a ser julgados de forma mais célere e uniforme, fortalecendo a confiança do cidadão na administração pública. Os resultados incluem: crescimento de 13% para 29% no uso de canais digitais para defesa e recurso; eliminação do passivo de cadastros com robôs automatizados, reduzindo o prazo médio de 30 dias para 2 dias úteis; e adoção de talonários eletrônicos, com significativa redução no uso de papel. A experiência demonstra o potencial da transformação digital na gestão pública, especialmente no contexto do trânsito, oferecendo um modelo replicável e orientado à eficiência, à legalidade e à segurança viária.

Palavras-chave: Gestão de Trânsito. Transformação Digital. Centralização Administrativa. Segurança Viária. Eficiência Pública.

RESUMEN

Este artículo analiza la experiencia de la administración pública estatal en la centralización y modernización de la gestión de infracciones de tránsito, con énfasis en la mejora de la seguridad vial y en la reducción de la impunidad. La iniciativa, liderada por el laboratorio de innovación del Estado, implicó la reformulación de procesos y la adopción de soluciones tecnológicas orientadas a la creación de un sistema digital único e integrado. Frente a un promedio mensual de 70.000 infracciones y 15.000 defensas y recursos, se implementó un software que automatiza el registro y el procesamiento de las sanciones, operando de manera integrada con los sistemas ya existentes. La digitalización completa de los flujos aumentó la eficiencia, redujo los plazos y garantizó mayor confiabilidad y respeto al derecho de defensa. La centralización de las actividades, antes fragmentadas, generó ahorro de recursos y permitió la reasignación de servidores a funciones estratégicas. Los procesos comenzaron a resolverse de forma más rápida y uniforme, fortaleciendo la confianza de los ciudadanos en la administración pública. Los resultados incluyen: crecimiento del 13% al 29% en el uso de canales digitales para la presentación de defensas y recursos; eliminación del rezago de registros mediante robots automatizados, reduciendo el plazo promedio de 30 días a 2 días hábiles; y adopción de talonarios electrónicos, con una significativa reducción en el uso de papel. La experiencia demuestra el potencial de la transformación digital en la gestión pública, especialmente en el ámbito del tránsito, ofreciendo un modelo replicable orientado a la eficiencia, la legalidad y la seguridad vial.

Palabras clave: Gestión del Tránsito. Transformación Digital. Centralización Administrativa. Seguridad Vial. Eficiencia Pública.

1 INTRODUCTION

Digital transformation has been consolidated as one of the main vectors for the modernization of public administration in Brazil, especially in areas marked by complex operational flows and high demand for service, such as the management of traffic violations. The centralization and digitalization of public services are fundamental strategies to ensure greater efficiency in the provision of services, promote transparency in administrative actions, promote the economy of public resources, and ensure full respect for the rights, privacy, and guarantees of citizens in interaction with the State.

In Minas Gerais, the creation of the State Coordination of Traffic Management (CET-MG), linked to the State Secretariat of Planning and Management (Seplag-MG), marked a turning point in public traffic policy. An adequate organizational structure and clear competencies are essential for the effectiveness of monitoring and control, strengthening citizens' trust in institutions (CANELA; NASCIMENTO, 2009). In this context, the administrative reform approved by the Legislative Assembly of Minas Gerais transferred the competencies of Detran-MG to the Secretariat of Planning and Management (Seplag), which created the State Coordination of Traffic Management (CET-MG). The new structure began to assume attributions previously concentrated in the State Department of Traffic (Detran-MG), representing not only an institutional reconfiguration, but the adoption of a model oriented to innovation, simplification of processes and strengthening of the state's capacity to provide public services.

CET-MG was organized into three main business areas — Infractions, Driver's License and Vehicles — in addition to a transversal area focused on the transformation of traffic services. Within the scope of the management of infractions, the activities are conducted by the Superintendence of Infractions and Driver Control, responsible for the analysis, processing and control of administrative penalties. This Superintendence is composed of two directorates: the Directorate of Infractions and the Directorate of Administrative Traffic Processes, responsible for the registration of infractions, application of the penalties provided for in the Brazilian Traffic Code and the treatment of defenses and administrative appeals.

Decree No. 47,974/2020 instituted the ICT Policy in Minas Gerais, establishing guidelines to offer public services in an agile, accessible and innovative way, ensuring integrated and transparent solutions. In addition, Decree No. 47,441/2018 created the Administrative Simplification Policy, aimed at simplifying services and improving service, actions coordinated by Seplag and LAB. MG, a partnership with the João Pinheiro Foundation.

Faced with an initial scenario characterized by fragmented processes, high dependence on physical documents, and poorly integrated systems, CET-MG, in partnership with the Laboratory of Innovation in Government of Minas Gerais (LAB.mg), started in 2023 a comprehensive process of diagnosis and redesign of the management of traffic violations. From this work, a set of strategic guidelines was defined aimed at the integral digitalization of processes, the administrative centralization of activities and the implementation of automation technologies.

This article presents the results of this digital transformation at CET-MG, with a focus on the integrated management of traffic violations. The study aims to analyze the changes implemented and their impacts on operational flows, efficiency indicators and the quality of services provided to citizens. The experience of Minas Gerais, by promoting technological solutions with high adherence to the institutional reality and focus on continuous improvement, is configured as a public management model oriented to innovation and with high potential for replicability.

2 METHODOLOGY

2.1 DESIGN THINKING AND AGILE PROJECT MANAGEMENT

Based on these methodologies, the concept of Minimum Viable Product (MVP) was adopted for the implementation of digital improvements, prioritizing fast deliveries that can add immediate value to the user. The improvements were rolled out incrementally, allowing each delivery to be evaluated, adjusted, and improved based on continuous feedback from end users — including traffic agents, police officers, and citizens — basing decision-making on the actual perception of the use and operation of the solutions presented. In this way, co-creating with the operational team and the end user has become a powerful strategy to ensure that solutions meet expectations, promoting a more effective, participatory and sustainable digital transformation.

2.2 QUALITATIVE RESEARCH AND DOCUMENT ANALYSIS

This study is characterized as a qualitative research, structured from the case study approach, specifically focused on the integrated management of traffic violations carried out by the State Coordination of Traffic Management (CET-MG). The documentary research method was adopted because it enables a detailed and in-depth investigation of the digital transformation implemented, its stages and effects on public administration. According to Chaumier (1974, apud Bardin 2016, p. 51), documentary research can be defined as "an operation or a set of operations aimed at representing the content of a document in a form

different from the original, in order to facilitate, at a later stage, its consultation and referencing". In addition, Yin (2015, p. 32) highlights that "the case study is an empirical investigation that investigates a contemporary phenomenon within its real context".

The documentary research involved the detailed analysis of official documents made available by CET-MG, including technical reports, project plans, operational flowTables, internal regulations, records of the Electronic Information System (SEI) and performance reports of the technological systems adopted, such as Power Automate and the AUTUA application. The documents analyzed cover the implementation period of the actions studied, from August 2023 to the present moment, allowing a comprehensive view of the process from conception to its execution and consolidation.

The collection of documentary data was conducted in a systematic and rigorous manner, seeking to identify aspects such as the volume of processes handled before and after the implementation of digitalization and automation, average deadlines for processing processes, percentage of use of digital channels by citizens and operational efficiency after adoption of technological solutions.

For data analysis, an interpretative qualitative approach was adopted, based on the content analysis technique as proposed by Bardin (2016), who defines this method as a set of communication analysis techniques aimed at obtaining, through systematic and objective procedures, the description of the content of the messages. This method allowed the identification of clear relationships between the adoption of technologies and the improvements observed in public management, contributing to the construction of a detailed overview of digital transformation at CET-MG.

3 RESULTS AND DISCUSSION

The analysis of the case study of the digital transformation of traffic violation management in Minas Gerais reveals a user-centered, participatory and public innovation-oriented approach. This process was conducted by the State Coordination of Traffic Management (CET-MG) with technical support from the Laboratory of Innovation in Government of Minas Gerais (LAB.mg), linked to the State Secretariat of Planning and Management (Seplag-MG). The partnership between these institutions allowed for a qualified institutional intervention, focusing on the process redesign, organizational restructuring and development of digital solutions applied to the administrative reality.

Considering a monthly average of 70 thousand infractions and 15 thousand defenses and appeals, the main challenges faced by CET-MG involved the optimization of the management of traffic violations and the demobilization of the Regional Traffic Districts

(Ciretran), responsible for decentralized service in the interior of the State, aiming at the reallocation of professionals to essential public security activities of the Civil Police.

Faced with this challenging scenario, LAB.mg played a key role in identifying and analyzing existing operational flows, conducting a thorough diagnostic work and proposing specific improvements. The joint action resulted in the clear definition of three central strategic guidelines: integral digitization of physical processes, administrative centralization, and implementation of automation technologies for recording and processing infractions. These actions sought to ensure greater operational efficiency, transparency in the analyses and speed in the provision of services.

At the beginning of the administration, in mid-2023, about 80% of the document volume received by the centralized protocol of the Administrative City, the unit responsible for receiving documents from all State Secretariats, came from the transit area. This data clearly reflected the high degree of dependence on physical processes in the management of infractions, highlighting the urgency of implementing profound changes to ensure greater traceability, speed and quality in citizen service.

The work carried out between August and December 2023 was structured in sequential and interdependent stages. Initially, there was a technical alignment to define the scope, schedule, responsibilities and objectives. Subsequently, the exploratory phase began, marked by interviews with civil servants, documentary analysis, studies of the applicable legislation and detailed mapping of the existing operational flows. This step was crucial to identify bottlenecks, rework, and institutional vulnerabilities, especially in the context of transition to a digital model.

Complementing this exploratory phase, a benchmarking was carried out with institutions such as Detran of Mato Grosso do Sul, Detran of São Paulo, Detran of Paraná, Federal Highway Police, Court of Justice of Minas Gerais, Military Police of Minas Gerais and Federal University of Rio Grande do Norte. The main objective of this activity was to identify good practices in the use of digital technologies and in the management of processes related to traffic violations, generating inspiring elements for an innovative and replicable solution in the context of Minas Gerais.

Based on this information, co-creation workshops were held with civil servants from the areas involved, resulting in the systematization of 87 suggestions categorized into systemic, organizational, procedural and normative improvements. Technical training on automation and innovation was also offered, strengthening the autonomy of the teams involved.

Then, a complete redesign of the processes was developed, including two versions: an incremental one, with adjustments to the existing systems, and a structural one, aiming at a single, digital and integrated system, capable of automating critical steps and increasing data traceability. Visual diagrams, proposals for document standardization, revision of forms with simplified language and definition of functional requirements were important aspects of this redesign.

The methodology used stood out for the protagonism of the servers of the various areas of CET-MG, ensuring greater adherence of the solutions to the operational reality and favoring the consolidation of an innovative institutional culture focused on continuous improvement and the value delivered to the citizen. Below, specific actions, their peculiarities and the results obtained with their implementation will be detailed.

3.1 ADMINISTRATIVE CENTRALIZATION OF THE PROCEDURAL PROCESS

The fragmentation of the processing of administrative traffic processes, historically distributed among more than 70 Regional Traffic Districts (Ciretran), was one of the main obstacles to uniformity, predictability and quality control in the management of infractions in Minas Gerais. Each unit had a different degree of maturity, technical training and volume of work, which resulted in variable criteria for judgment, difficulty in supervision and fragility in the standardization of procedures.

In order to overcome these challenges, the centralization of administrative traffic processes was implemented, one of the pillars of the transformation promoted in the management of infractions in the State. This measure involved the complete restructuring of the Directorate of Administrative Traffic Processes, resulting in the full transfer of the competence of analysis, instruction and judgment of these processes to a specialized technical nucleus linked to the Directorate.

The decision to centralize was made as a strategic guideline of public management, supported by international and national studies and practices that point to centralization as an effective mechanism to gain scale, reduce waste, concentrate expertise and strengthen institutional control. According to Peci and Sobral (2009), centralization can be fundamental to ensure coherence in the implementation of public policies, reduce operational asymmetries and strengthen state capacity. Di Pietro (2019), in turn, points out that, in certain contexts, the concentration of administrative competencies in a central unit contributes to greater efficiency, less dispersion of resources, and qualification of state action.

In the context of CET-MG, centralization was preceded by a careful process of mapping decentralized flows, internal organizational restructuring, and technical

communication with the units involved. To ensure a safe transition without prejudice to the citizen, a communication channel was maintained, while procedural routines were progressively absorbed by the centralized structure.

The experience is also in line with international guidelines, such as those of the Organization for Economic Cooperation and Development (OECD, 2020), which recommend the adoption of lean, integrated, and digital administrative structures as a way to modernize the State and expand the focus on results. The World Bank (2013) reinforces this approach by highlighting that centralization can generate significant productivity gains, especially when associated with the digitalization of processes and the adoption of performance-based management platforms.

In the case of Minas Gerais, centralization made it possible to qualify the technical staff, organize teams by process profile (suspension, cassation, defenses, appeals), establish uniform analysis criteria and create continuous monitoring routines, with goals and productivity analysis. In addition, it made it possible to rationalize the use of the workforce, freeing up Ciretrans employees to work in core activities of the Civil Police — a strategic gain for the State as a whole, by articulating traffic policy with public security.

Among the benefits already observed are: greater speed in the processing of processes, with a reduction in the average time between protocol and final decision; reduction of rework and procedural inconsistencies, thanks to the standardization of decision-making criteria; improvement of the control of legal deadlines, ensuring due process and the rights of citizens; improved traceability, with digitized and monitorable flows in real time; and savings in operational resources, with less dependence on physical transportation and face-to-face service.

More than an organizational measure, the centralization implemented materialized a paradigm shift in the conduct of traffic sanctioning processes in Minas Gerais. It has made it possible to move from a reactive, decentralized and vulnerable model to a more technical, integrated, efficient and citizen-oriented public management logic.

3.2 UNIFIED SYSTEM OF INFRACTIONS AND ELECTRONIC TICKET BOOK

During the diagnosis carried out by the Laboratory of Innovation in Government of Minas Gerais (LAB.mg), the operational flows related to the life cycle of traffic violations in the state were analyzed in detail. The process began with the acquisition of physical blocks of infraction, through the contracting of specific graphic services. These blocks were distributed to the Regional Traffic Districts (Ciretrans), units of the Civil Police spread

throughout the state, responsible for forwarding them to the Military Police agents who carried out the manual drawing up of the infraction notices.

After the manual drawing up by the agents, the records were delivered again to Ciretrans or to the centralized team of the Infractions Directorate in the capital, responsible for typing the data contained in the paper into the database via the SDAK mainframe system. The subsequent digitization of these records was centralized in the CET, and there was a delay in sending the records from the interior. With the typing in the SDAK system, the fine became legally valid, and was then notified to the driver by mail or by the Digital Traffic Card.

During the period of 30 days after the notification of the fine, the driver may present a defense of the fine or indicate the offending driver. If there was no defense or indication from another driver, the fine automatically became an infraction, with the generation of a fine and a score on the driver's record. Against the infraction, it was possible to file an appeal of first instance with the Administrative Board of Infraction Appeals (JARI), and, if necessary, an appeal of second instance with the State Traffic Council (CETTRAN).

Each step of the process mentioned was carried out in different systems and partially on paper, generating significant challenges in terms of operational efficiency, control, traceability and communication between databases. The main system used was the SDAK, which manages the state database of vehicles and interfaces with the National Registry of Infractions (RENAINF). At the same time, other systems served specific functions, such as Siaut for registering defenses, JARI and CETTRAN's own systems for resources, and SDMU (mainframe) for distribution, cancellation and regionalization of infraction notices, FICI System, indication of offending driver and scoring system. In addition, the digitized AIT image was stored in the cloud for only 90 days, and then transferred to physical media (CDs).

After detailed analysis and market research, the feasibility and need for an integrated system capable of covering all these steps and fully digitizing the infraction notice was verified. Thus, it was decided to hire the Radar System, developed by the Federal Data Processing Service (SERPRO), which includes the AUTUA module, Electronic Infraction Receipt, intended to completely replace the manual process of drawing up and recording infractions.

Radar is a traffic violation management platform that integrates all national traffic bases, including RENAINF (violations), RENACH (drivers) and RENAVAN (vehicles). In it, all previously fragmented processes are integrated into a single system, allowing instant communication between all stages, eliminating the need for printing and physical transmission of documents. One of the most outstanding features is Autua, an electronic ticket book of infractions made available in the form of a mobile application for traffic agents.

Autua facilitates the completion of information, automates vehicle base queries and ensures the complete and correct completion of infraction notices, significantly reducing common typing errors and manual interpretation.

For the implementation of the Radar, it was initially necessary to carry out integrations between the existing systems, especially the state bases of vehicles and drivers that remain linked to the current system managed by PRODEMGE. During this period, the databases were duplicated, ensuring a safe and continuous transition until the complete migration to the Radar.

The implementation of Autua began with controlled tests in August 2024, involving 20 agents trained specifically for this purpose. The success of these tests resulted in gradual expansion, starting with a pilot project in November and December 2024, with 200 agents from the Traffic Battalion of the Military Police in Belo Horizonte. Since July 2025, the use of Autua has expanded significantly, surpassing the mark of 2 thousand agents trained and qualified to use the system. It is expected that by the end of 2025 all PMMG agents will have access to the application.

Throughout the implementation of the Autua system, there was an important technical evolution in the methodology of training offered to traffic agents. The initial training for the 20 agents participating in the tests was carried out in person. In the subsequent stage, with the expansion to 200 agents, a synchronous virtual approach was adopted, dividing the training into four classes of 50 agents each, with classes lasting two hours. After this stage, considering the target audience of more than 15 thousand agents, a complete material was developed for a course in the Distance Education (EAD) modality, available on the official platform of the State Secretariat for Planning and Management. The distance learning course was launched at the end of the first semester of 2025, allowing the constant and simultaneous expansion of the training of interested agents, respecting the voluntary nature of the use of the application.

Despite voluntary use and limitations, such as the requirement for agents' personal Android devices and the limited ability to release devices on a daily basis, adoption has been growing. The average time to draw up infractions fell from approximately 5 minutes to only 30 seconds per infraction. In addition, frequent errors, such as incorrect plate filling and omission of required fields, have been drastically reduced. The system also offers automatic GPS location, automatic filling of vehicle data from the license plate and immediate communication of the infraction to the citizen, with digital notifications within 2 hours after drawing up, compared to 18 days of the previous paper process. These advances confirm

the effectiveness of the technological solution and its significant contribution to efficiency, accuracy, and transparency in the management of traffic violations.

Table 1

Description of costs involved with the paper x electronic receipt

	DIRECT COST	INDIRECT COST	UNMEASURED COSTS
LONNAIRE PAPER	Annual Table Cost: 170.000,00	Police force deployed to Typing: 600,000 AITs typed inside	Cost of carrying out the process of Shopping Storage room maintenance cost Cost of document storage: Includes preparation for storage and physical cost. Cost of assembly, organization and shipping via SEI. PMMG logistics cost: removal and distribution of blocks. Logistical cost in the full return of AITs: Includes use of police personnel and resources for transportation and preparation.
	Typists: 900,000.00	Estimate: 20,000 hours of police work displaced from the core activity	
	PRODEMGE: Support and development: R\$ 1,000,000.00 Accommodation: R\$ 5.000.000,00	Uncollected fines for inconsistency in AITs: Estimated value in 2024: BRL 26,198,895.00 Average amount per fine appealed: R\$ 1,037.58.	
ELECTRONIC MARATHON	R\$ 2,376,000.00 Base: 900,000 infractions x R\$ 2,64 Cost of assembly and storage of SEI and PRODEMGE remain in the flow with AUTUA deployed		

Source: prepared by the authors.

Table 2

Simplification of process steps with the paper vs. electronic receipt

	PAPER TALORÁRIO	ELECTRONIC MARATHON
NUMBER OF STAGES OF THE PROCESS	10	4 (Eliminate 8 steps, simplify 2 steps and bring 1 get 2 new release of assessment devices).

Source: prepared by the authors.

The expansion of Autua is essential to enable the complete migration to the Radar system, allowing CET-MG to fully enjoy the benefits of an integrated and digitalized model for managing traffic violations. The expectation is that this migration will still occur in 2025. As a third stage, the dissemination of the Radar to the municipalities of the State is planned, with the objective of standardizing inspection practices and expanding the use of technology as an instrument to support road safety throughout the territory of Minas Gerais. This phase will be accompanied by training actions, technical support and institutional articulation, strengthening cooperation between the State and municipalities. With this, Minas Gerais

advances in the consolidation of a more modern, efficient and citizen-centered public traffic policy.

3.3 AUTOMATION OF PROCESSES FOR DEFENSE OF FINES AND APPEAL OF INFRACTIONS

One of the priority challenges identified was the management of Defenses of Fines and Appeals of Traffic Violations. Initially, the entire process took place manually, on paper, even when requests were received digitally, requiring printing and physical handling of documents. This practice resulted in delays, high operating costs, in addition to generating significant delays in granting the suspensive effect of infractions, often resulting in undue fines and legal complications.

CET-MG then implemented an initial process of digitizing the documents received, using the Electronic Information System (SEI). However, in view of the large monthly volume of approximately 15 thousand cases, of which 8 thousand were specifically Assessment Defenses, the urgent need for automation of these activities was quickly realized. With a reduced team of only 12 people to perform the entire administrative process (registration, assembly, forwarding, closure and document searches), manual work became unfeasible and generated a significant liability of pending processes.

The Fine Defense process receives demands both physically and digitally. In digital format, the process was received through a specific system, the Assessment Defense System (SIAUT), in which initially the reception took place for immediate generation of the suspensive effect of the infraction. Then, the attached documents were used to generate the cover of the process and inserted into the SEI. The process was then forwarded to an advisor responsible for analyzing and issuing the opinion, which was registered both in the SEI and in the SIAUT. After this analysis, another server of the team verified the data and closed the process in the system. For the processes that had pending issues related to the lack of the Traffic Infraction Notice (AIT), the initial procedure was completely manual. The server needed to access the SAE system to identify the process number, then check the database to locate the physical media (CD) in which the record was stored, download the scanned file, attach it to the process in the SEI and, finally, forward it for analysis.

After identifying possible immediate improvements in the process, before changing the system to RADAR, a partnership was started with the Automatiza MG project, an initiative of the state government linked to the Department of Planning and Management, for the development of automated robots through the Power Automate software. Initially, it was attempted to develop a single robot for the complete process, however, over the course of

development, it was concluded to be more effective to build smaller, purpose-built robots to quickly solve the identified bottlenecks.

The first two robots implemented simultaneously were the one for receiving the defenses via digital protocol, quickly solving the bottleneck in the generation of the suspensive effect, and the robot dedicated to locating the pending Infraction Notices (AIT) necessary for the judgment of the defenses. With the implementation of the reception robot, the existing liability, which exceeded four thousand processes in the most critical moments, was quickly reduced and the average time for reception and registration of the Defenses

A specific robot was also developed for the closure of processes, which automatically checks the defense situation in the SEI and in the SIAUT system, finalizing the procedure and ensuring accuracy in the results. These robots require constant adjustments and have been replicated on several machines to optimize their use, especially at times of less server activity.

Currently, a new robot is in an advanced stage of implementation aimed at receiving the Defenses sent by the Post Office and digitized in the central protocol of the Administrative City. This robot will have the ability to identify and interpret handwritten or typed documents, automatically register in the system, generate the block, attach to the SEI and forward for analysis, complementing the automation cycle and ensuring greater operational efficiency for the near future.

Another robot that is being developed by the Automatiza.mg is the AI robot for suggestion of analysis and opinion of the Defense of Assessment, which will be fundamental for increasing productivity in the analysis and the consequent elimination of liabilities, avoiding the prescription of the Defense, which occurs 365 days after the initial protocol. The delivery of this robot is scheduled for the end of 2025.

After the initial implementation and delivery of the robots by the Automatiza MG team, the internal team of the Infractions Directorate started to play an active role in the management of these technological tools. Constant monitoring of the robots was carried out, accompanied by continuous actions to map failures and identify opportunities for improvement in automated processes. This close monitoring enabled the development of essential technical expertise among the servers, who acquired the ability to make adjustments and improvements directly to the implemented robots.

With the knowledge acquired, the internal team was able to replicate these technological solutions in the Infringement Appeal processes, which have similar stages and characteristics to the Defense process, but operating in different systems. The resources also reach the Board through physical and digital channels, facing challenges similar to defense

processes, such as undersizing of the team, 100% manual and repetitive work, accumulated liabilities for registration and analysis, often due to the difficulty in locating the Traffic Infraction Notices (AIT).

Currently, all the robots initially developed for the Defense processes have already been replicated, with the necessary adaptations, in the Infringement Appeal processes. This replication has had significant impacts, resulting in a significant reduction in existing liabilities and a substantial reduction in the average time required for receipt and treatment of the appeals. This progress allowed the team to allocate efforts to more strategic activities and continuously improve the service provided to citizens.

In general, the implementation of automated robots has provided significant results in the management of defenses and appeals of infractions. The average time for receiving cases was significantly reduced, falling from 30 days to just 2 working days. The location of the Traffic Infraction Notices (AIT) was largely optimized, contributing to the reduction of the liability of defenses pending analysis, which went from 60,000 to less than

25,000 cases. In the first half of 2026 alone, about 10,000 records were located for pending appeals. In terms of daily operational capacity, it is noteworthy that the AIT search and attach robot performs an average of 770 processes per day per machine. The robot responsible for the digital reception of defenses processes approximately 270 daily processes, ensuring complete compliance with the demand. The defense process assembly robot, due to possible instabilities, performs an average of 48 daily processes, requiring operation on multiple machines to increase its efficiency. As for the appeal processes, the robot that previously checks the situation of the defenses performs about 290 processes daily, while the robot that assembles these processes operates with a daily average of 150 processes, distributed in several workstations. The robot for the digital reception of the processes of the Administrative Board of Infraction Appeals (JARI) reaches a daily average of 180 processes, which fully meets current needs.

An important limitation faced during the automation process was the absence of equipment dedicated exclusively to the execution of automated robots. To overcome this challenge, the replication of robots on the individual machines of the Board's servers was adopted as a strategy. Robots began to operate predominantly during periods of lower use of computers, especially during lunch hours and after work, optimizing the use of existing technological resources. This alternative solution allowed the desired results to be achieved, ensuring significant reductions in accumulated liabilities and in the average times for reception and analysis of defense and appeal processes.

In general, the implementation of automated robots has provided significant results in the management of defenses and appeals of infractions. The average time for receiving cases was significantly reduced, falling from 30 days to just 2 working days. The location of the Traffic Infraction Notices (AIT) was largely optimized, contributing to the reduction of the liability of defenses pending analysis, which went from 60,000 to less than

25,000 cases. In the first half of 2026 alone, about 10,000 records were located for pending appeals. In terms of daily operational capacity, it is noteworthy that the AIT search and attach robot performs search in an average of 770 processes per day per machine. The robot responsible for receiving defenses via digital protocol processes approximately 270 daily processes, ensuring complete compliance with demand. The defense process assembly robot, due to possible instabilities, performs an average of 48 daily processes, requiring operation on multiple machines to increase its efficiency. As for the appeal processes, the robot that previously checks the situation of the defenses performs about 290 processes daily, while the robot that assembles these processes operates with a daily average of 150 processes, distributed in several workstations. The robot of the digital reception of the processes of the Administrative Board of Infraction Appeals (JARI) reaches a daily average of 180 processes, which fully meets current needs.

3.4 DIGITALIZATION OF PROCESSES AND CREATION OF DIGITAL CHANNELS

The digital transition promoted in the management of traffic violations was not restricted to technological modernization. It implied a structural change in the way public administration interacts with citizens and conducts its own internal flows. One of the milestones that highlighted the urgency of this transformation was the fact that, at the beginning of the current administration, the Infractions area of CET-MG was responsible for approximately 80% of the entire document volume received by the centralized protocol of the Administrative City, which concentrates the documentation destined to the State Secretariats.

This data revealed an operational overload incompatible with the logic of simplifying public services and made evident the need for a comprehensive digitalization of processes. The institutional response involved two complementary fronts: on the one hand, the digitalization of the physical liabilities accumulated over the years; on the other, the expansion and strengthening of digital entry channels, through the Traffic Services Portal.

The Superintendence of Infractions and Driver Control accumulated a voluminous collection of administrative processes in physical media — many of them requiring repetitive movements for analysis of defenses, appeals and reconstitution of driver histories. The digitization of these documents allowed them to be incorporated into the electronic system,

enabling the digital processing of historical processes by the technical team and ensuring greater transparency to citizens, who now have easy access to the information necessary to exercise their right of defense.

This digitalization was not a measure of convenience, but an essential condition for the continuity and sustainability of public traffic policy. To make it viable, an internal digitization island was created, with equipment, protocols and a team dedicated exclusively to the treatment of the collection. The operation involved rigorous flows of sorting, preparation, scanning, indexing and checking, following technical criteria that ensured integrity, traceability and compatibility with the systems already in use.

The effects of this work front were multiple: drastic reduction in the time to locate documents, with immediate access at any authorized station; document preservation, avoiding deterioration of physical originals; and ease of service to citizens, with more agile responses and elimination of dependence on paper procedures.

More than solving a historical bottleneck, the digitization of the physical collection served as a turning point in the institutional culture of CET-MG. By adopting a management logic driven by data and digital documents, teams started to operate with greater predictability, flow control, and performance evaluation capacity. This transition has set the stage for future automations, smart analytics, and more efficient and affordable public services.

At the same time, CET-MG worked on the expansion of digital channels for citizen service. At the beginning of the transition in 2023, there were some digital channels already available for citizen service, legacies of the State Department of Traffic (DETRAN-MG). These channels included the Digital Protocol, accessible through the official traffic websites and the MGapp application, allowing the submission of Fine Defenses, Infraction Appeals in the first instance and Identification of the Real Offending Driver. Initially, this digital channel communicated with the current systems, however, the documents received were printed and inserted into physical processes. Subsequently, these physical processes began to be converted into electronic processes in the Electronic Information System (SEI).

In 2023, the monthly volume of demands through digital protocol channels was approximately 966 Defenses of Fines, 193 appeals of first instance and 144 Offending Driver Identification (FICI) forms. In addition to these digital protocols, other services such as requests for copies of the infraction notice (AIT), requests for copies of defense processes, appeals, administrative suspension and cassation proceedings were carried out via e-mail. These procedures, despite being digital and eliminating the use of paper, lacked a more robust organization and did not offer adequate mechanisms for monitoring citizens, making

it difficult to control and effectively manage the requested services. Monthly email requests for copies of Infringement Defense and Appeal proceedings were less than 20, while monthly requests for copies of AIT were approximately 300.

Basic consultations related to the status of the license were also available digitally on the website, allowing citizens to check scores and possible suspension or revocation; consultation on the vehicle's situation to view pending issues, including existing infractions; and consultation of the result of the defenses and appeals, although without access to the detailed text of the judgment, only indicating the final decision.

One of the fundamental guidelines for the digital transformation of service channels was to significantly expand the use of existing digital channels, such as the Digital Protocol. To achieve this goal, several strategic actions were adopted, such as specific dissemination campaigns, streamlining digital processes, modernization and visual improvements in the layout of communications related to infractions, complete updating of the institutional website and wide dissemination through digital platforms. These initiatives resulted in a significant growth in the use of digital channels, evidenced by the 2024 data, which show a monthly average of 2,090 infraction defenses, 518 offending driver identifications, and 615 infraction appeals, representing significant increases of 116.4%, 259.7%, and 218.7%, respectively, compared to 2023. Another driving factor was the initiative of the Federal Government, which made available through the Digital Transit Card (CDT) a completely digital service for indicating offending drivers. In the first half of 2025, growth continued to rise, reaching monthly averages of 2,300 infraction defenses, 883 infraction appeals, and 808 digital driver identifications, substantially reinforcing citizens' adherence to digital channels for these specific services.

In order to improve and expand the digital channels of citizen service, ensuring greater ease, transparency and capacity to follow up on requests, the CET-MG team, in partnership with the Digital Undersecretary of the State Secretariat for Planning and Management (SEPLAG), began the development of models based on BPMS (Business Process Management Suite), the ProBPMS developed by PRODEMGE.

ProBPMS refers to a technological platform for business process management, which allows automating, managing and optimizing operational processes, offering the user a more fluid and transparent experience. With these models, citizens now have systematized and structured flows, facilitating monitoring and providing greater efficiency in the resolution of demands. 13 new ProBPMS digital protocols were developed and implemented, ensuring significant advances in digital service to the public, which are

- Request for a copy of the Infraction Notice (AIT)

- Request for a copy of the Defense or Appeals opinion
- Presentation of CETRAN Appeal (2nd Instance - infraction)
- Present a prior defense (suspension and cassation)
- Waiving the presentation of defense (suspension)
- Present JARI Appeal (1st instance suspension and cassation)
- Present CETRAN Appeal (2nd instance suspension and cassation)
- Request a copy of the CNH suspension or revocation process
- Request compliance with the penalty of suspension or revocation of the CNH

The significant increases recorded in the use of existing digital protocols demonstrate that the strategic actions of dissemination and modernization of digital channels have had a positive effect. With the implementation of these new tools and protocols developed, currently 100% of the services related to traffic violations can be accessed and fully monitored digitally through the official traffic portal of Minas Gerais. This digital transformation has not only expanded the reach and accessibility of services, but has also strengthened the transparency and operational efficiency of the State Coordination of Traffic Management (CET-MG). With this, the strategic goal of at least 50% of all demands received by CET-MG to be carried out through digital channels by the beginning of 2026 becomes increasingly tangible and close to being achieved.

3.5 NEW TOOLS AND FEATURES

In addition to the major strategic fronts developed throughout the digital transformation process, several specific initiatives and less complex projects were also implemented with significant results. These complementary projects, although simpler from a technical point of view, represented important advances in terms of agility, transparency, modernization and quality in citizen service.

Among these initiatives, the modernization of the storage of digital media of infraction notices stands out. Previously, digital files remained available in the cloud for only 90 days, and then transferred to physical CDs. With the new solution, infraction notices are now stored for up to five years in the cloud, eliminating the need for a formal request for viewing and consultation by the citizen. More than 3 thousand CDs were digitized and migrated to the cloud, promoting operational savings, practicality and instant access to content.

Another important innovation was the launch, in 2025, of the possibility of paying fines through the Pix system. The functionality was also extended to other fees, such as vehicle licensing. This made it possible, for example, for drivers approached in inspections to

regularize their situation in real time, avoiding removals and inconveniences. This measure brought direct gains to the flow of traffic and the exercise of the citizen's right to defense.

Automatic and systemic fines were also implemented, with emphasis on two: the infraction provided for in article 165-D of the Brazilian Traffic Code, referring to the failure to carry out the mandatory periodic toxicological examination by drivers licensed in categories C, D and E, and the infraction for non-compliance with the legal deadline for transfer of vehicle ownership. Both are now automatically generated by the systems, based on data crossing and verification of deadlines, ensuring greater rigor, precision and scope of inspection actions. Minas Gerais was the first state to regularly apply the toxicological assessment within the period provided for by law.

Finally, a monitoring dashboard was developed that centralizes and organizes operational data related to these new tools and flows. With a user-friendly and dynamic interface, the dashboard allows real-time monitoring of assessments, payments, automated actions and procedural demands, offering managers a strategic tool for monitoring and decision-making, in addition to strengthening the data culture and management by results at CET-MG.

All these initiatives, from the initial digitization, the centralization of processes, the change of systems and the adoption of new technologies, considered together, not only promoted operational improvements and reduction of administrative deadlines, but also brought significant gains in the quality of citizen service and public transparency. At the same time, it was possible to free up human resources previously occupied in repetitive and bureaucratic activities for strategic and analytical functions within public management, increasing the overall efficiency of CET-MG.

In terms of implications, these results confirm the importance of digital transformation in the public sector, particularly in the management of traffic violations. Technological integration and automation demonstrate clear potential for replication to other areas of state and even municipal public administration, providing a model that combines operational efficiency, transparency, and respect for citizens' rights. However, the study also identifies limitations, such as the continuous need for technological updating and permanent training of civil servants, essential factors to sustain the gains obtained and expand the benefits of this digital transformation.

4 FINAL THOUGHTS

The digital transformation experience conducted by the State Coordination of Traffic Management of Minas Gerais (CET-MG) clearly and concretely demonstrates the potential

of public innovation to reconfigure traditional processes and significantly improve the delivery of services to the citizen. From a broad process of diagnosis and redesign of operational flows, combined with the implementation of digital and automated solutions, it was possible to restructure the management of infractions in the state, overcoming historical bottlenecks and establishing a new logic of administrative action.

The adoption of automation technologies, such as the robots implemented with the support of the Automatiza.mg project, resulted in a drastic reduction in the reception and analysis times of defenses and infraction appeals — from 30 days to 2 working days — and in the elimination of liabilities that previously compromised the right of defense of drivers. The implementation of the Autua application and the subsequent adhesion to the Radar system marked a new level of digitalization in the registration and treatment of infractions, promoting gains in speed, traceability and quality of information, eliminating the use of paper, simplifying the process, cutting logistics costs and reducing errors.

Likewise, the consolidation of digital service channels and the creation of new protocols for citizens represented relevant advances in transparency, access to information, and the reduction of bureaucracy in public services. The data presented demonstrate a significant growth in the use of digital channels by citizens and reflect the direct results of the strategies for dissemination, simplification and modernization of institutional communication.

Other complementary actions, such as the digitization of the historical media of infraction notices, the launch of payment via Pix, and the automatic generation of specific infractions, have expanded the scope of the transformation and demonstrate how smaller, but well-targeted, projects also contribute to the construction of a more efficient and citizen-oriented digital ecosystem.

This journey reinforces the importance of a systemic, interinstitutional and user-centered approach so that technological innovations are in fact incorporated in a sustainable way in public administration. The advances observed at CET-MG are the result of the articulation between technical teams, public leaders and innovation support structures, such as the LAB.mg, and show that structural changes can be achieved even in the face of budgetary and operational constraints, as long as they are conducted with planning, internal protagonism and focus on results.

The experience of Minas Gerais serves, therefore, as a reference case for other federative units and public organizations that seek to combine modernization, efficiency and qualified service to the citizen. By prioritizing digital transformation as a management strategy, Minas Gerais takes a relevant step in the consolidation of more modern, responsive public policies aligned with the expectations of contemporary society.

REFERENCES

- Amaral, D. C., et al. (2011). Gerenciamento ágil de projetos: aplicação em produtos inovadores. São Paulo: Editora Saraiva.
- Banco Mundial. (2013). Gestão pública para resultados na América Latina e Caribe: um diálogo entre governos. Washington, DC: Banco Mundial. <https://documents1.worldbank.org/curated/pt/2013/06/17803042>
- Bardin, L. (2016). Análise de conteúdo. São Paulo: Edições 70.
- Brasil. Instituto de Pesquisa Econômica Aplicada. (2019). Inovação e políticas públicas: superando o mito da ideia. Brasília: Ipea. [https://labges.es.gov.br/Media/labges/Downloads/IPEA%20%20livro_inovacao_e_politicas.pdf](https://labges.es.gov.br/Media/labges/Downloads/IPEA%20%20livro_inovacao_e_politicas_publicas.pdf)
- Di Pietro, M. S. Z. (2019). Direito administrativo (33ª ed.). São Paulo: Atlas.
- Minas Gerais. Coordenadoria Estadual de Gestão de Trânsito – CET-MG. (n.d.). Trânsito.mg em números. <https://transito.mg.gov.br/sobre-1/transparencia/relatorios-de-gestao>
- Minas Gerais. Secretaria de Estado de Planejamento e Gestão. (2018). Guia para inovação na gestão pública. Belo Horizonte: Fundação João Pinheiro. <https://www.mg.gov.br/planejamento/documento/guia-para-inovacao-na-gestao-publica>
- Minas Gerais. (2023). Lei nº 24.313, de 28 de abril de 2023: Estabelece a estrutura orgânica do Poder Executivo do Estado e dá outras providências.
- Organização para a Cooperação e Desenvolvimento Econômico (OCDE). (2020). Digital government review of Brazil: Towards the digital transformation of the public sector. Paris: OECD Publishing. <https://www.oecd.org/governance/digital-government-review-of-brazil.pdf>
- Peci, A., & Sobral, F. (2009). Administração pública: entre o gerencialismo e a gestão social. Rio de Janeiro: Editora FGV.
- Yin, R. K. (2015). Estudo de caso: planejamento e métodos. Porto Alegre: Bookman.

ORIGINATING PEOPLES IN THE STATE OF TOCANTINS: VISCERAL LEISHMANIASIS AND ITS EPIDEMIOLOGICAL ASPECTS

POVOS ORIGINÁRIOS NO ESTADO DO TOCANTINS: LEISHMANIOSE VISCERAL E SEUS ASPECTOS EPIDEMIOLÓGICOS

PUEBLOS ORIGINARIOS EN EL ESTADO DE TOCANTINS: LEISHMANIASIS VISCERAL Y SUS ASPECTOS EPIDEMIOLÓGICOS



<https://doi.org/10.56238/sevened2026.008-192>

Sonia Ferreira Gomes¹, Regiane Cristina Neto Okochi², Jean Rafael Ribeiro³, Keren Sayuri Okochi⁴, Karen Renatta Barros Rodrigues⁵, Claudia Christina Ribeiro Guimarães Neri de Magalhães⁶, Denise Soares de Alcantara⁷, Daurenice Lopes de Araújo Vaz⁸

ABSTRACT

Visceral leishmaniasis (VL) is a severe zoonosis caused by protozoa of the *Leishmania* genus, transmitted through the bite of infected female phlebotomine sandflies. In Brazil, the disease has an endemic character and a heterogeneous distribution, with particular emphasis on the Northern Region, where environmental, social, and cultural factors directly influence its incidence. This study aims to analyze confirmed cases of visceral leishmaniasis in Indigenous populations in the state of Tocantins between 2015 and 2025, correlating the available epidemiological data with geographical and social variables. It is a descriptive and quantitative research based on secondary data extracted from the Notifiable Diseases Information System (SINAN/DATASUS). The results revealed the occurrence of the disease in four health regions of Tocantins, with a predominance in the Capim Dourado region, and showed a higher incidence among Indigenous individuals under 10 years of age. The findings reinforce the need for specific and continuous public policies aimed at prevention, early diagnosis, and monitoring of VL in Indigenous communities, especially in vulnerable and hard-to-reach territories.

Keywords: Visceral Leishmaniasis. Indigenous. Health. Epidemiology. Tocantins.

¹ Undergraduate Student in Nursing. Universidade de Gurupi (UNIRG). Tocantins, Brazil.

E-mail: sonia.f.gomes@unirg.edu.br

² Dr. in Environmental Sciences. Faculdade Damantinense Integrada. Tocantins, Brazil.

E-mail: regianeokochi@unirg.edu.br

³ Master's degree in Forest and Environmental Sciences. Universidade Federal do Tocantins (UFT). Tocantins, Brazil. E-mail: jeanrafael.eng@gmail.com

⁴ Psychiatry Resident. Universidade Federal do Paraná (UFPR). Paraná, Brazil.

E-mail: kerenokochi@gmail.com

⁵ Medical Doctor. Centro Universitário de Goiatuba (UNICERRADO). Goiás, Brazil.

E-mail: karenbrodrigues08@alunos.unicerrado.edu.br

⁶ Master's degree in Health Sciences. Universidade Federal do Tocantins (UFT). Tocantins, Brazil.

E-mail: claudianeri@unirg.edu.br

⁷ Master's degree in Nursing. Universidade de Gurupi (UNIRG). Tocantins, Brazil.

E-mail: denises@unirg.edu.br

⁸ Graduated in Nursing. Universidade de Gurupi (UNIRG). Brazil. E-mail: daure123nice@gmail.com

RESUMO

A leishmaniose visceral (LV) é uma zoonose grave causada por protozoários do gênero *Leishmania*, transmitidos pela picada de flebotomíneos fêmeas infectadas. No Brasil, a doença apresenta caráter endêmico e distribuição heterogênea, com destaque para a Região Norte, onde fatores ambientais, sociais e culturais influenciam diretamente na sua incidência. Este estudo teve como objetivo analisar os casos confirmados de leishmaniose visceral em populações originárias no Estado do Tocantins, no período de 2015 a 2025, correlacionando os dados epidemiológicos disponíveis com variáveis geográficas e sociais. Foi uma pesquisa descritiva e quantitativa baseada em dados secundários extraídos do Sistema de Informação de Agravos de Notificação (SINAN/DATASUS). Os resultados revelaram ocorrência da doença em quatro regiões de saúde do estado do Tocantins, com predominância na região de Capim Dourado, além de evidenciar maior incidência em indivíduos indígenas menores de 10 anos de idade. Os achados reforçam a necessidade de políticas públicas específicas e contínuas voltadas à prevenção, diagnóstico precoce e monitoramento da LV em comunidades indígenas, especialmente em territórios vulneráveis e de difícil acesso.

Palavras-chave: Leishmaniose Visceral. Povos. Originários. Epidemiologia. Tocantins.

RESUMEN

La leishmaniasis visceral (LV) es una zoonosis grave causada por protozoos del género *Leishmania*, transmitida por la picadura de flebotomíneos hembras infectadas. En Brasil, la enfermedad presenta un carácter endémico y una distribución heterogénea, destacándose la Región Norte, donde los factores ambientales, sociales y culturales influyen directamente en su incidencia. Este estudio tiene como objetivo analizar los casos confirmados de leishmaniasis visceral en poblaciones indígenas del estado de Tocantins, en el período de 2015 a 2025, correlacionando los datos epidemiológicos disponibles con variables geográficas y sociales. Se trata de una investigación descriptiva y cuantitativa basada en datos secundarios extraídos del Sistema de Información de Enfermedades de Notificación Obligatoria (SINAN/DATASUS). Los resultados revelaron la ocurrencia de la enfermedad en cuatro regiones de salud de Tocantins, con predominio en la región de Capim Dourado, además de evidenciar una mayor incidencia en individuos indígenas menores de 10 años de edad. Los hallazgos refuerzan la necesidad de políticas públicas específicas y continuas dirigidas a la prevención, el diagnóstico precoz y el monitoreo de la LV en comunidades indígenas, especialmente en territorios vulnerables y de difícil acceso.

Palabras clave: Leishmaniasis Visceral. Salud. Indígena. Epidemiología. Tocantins.

1 INTRODUCTION

Visceral leishmaniasis (VL) is one of the most relevant neglected tropical diseases for global public health, with an estimated incidence of between 50 and 90 thousand new cases per year (World Health Organization, 2023). In Brazil, VL is predominantly caused by the species *Leishmania infantum chagasi*, whose transmission occurs through the bite of the infected female sandfly *Lutzomyia longipalpis*, a vector widely distributed in the North and Northeast regions of the country (Costa et al., 2020).

The territorial expansion of the disease has been associated with multiple factors, such as deforestation, disorderly urbanization, human migrations, and social vulnerability (Cavalcanti et al., 2021). In areas of greater vulnerability, such as indigenous communities, visceral leishmaniasis is more worrisome due to the scarcity of sanitary infrastructure, limitations in access to health services, and sociocultural barriers in diagnosis and treatment (Souza; Lima; Gomes, 2022).

According to the Pan American Health Organization (PAHO, 2023), about 97% of reported cases of VL in Latin America occur in Brazil, with the North and Northeast regions accounting for most of the notifications. The State of Tocantins, located in the transition zone between the Cerrado and the Amazon, has favorable environmental conditions for the proliferation of the vector, with a significant occurrence of the disease in rural and peri-urban areas (Almeida et al., 2024).

In addition to environmental determinants, recent studies show that the social component is essential in maintaining the endemic. Indigenous populations, for example, are disproportionately affected by tropical diseases due to low vaccination coverage, precarious housing, and direct contact with domestic and wild animals, considered potential reservoirs of the parasite (Ferreira; Oliveira; Nascimento, 2023).

The proposal of this research sought to contribute to the understanding of the spatial and temporal distribution of the disease, as well as to subsidize more efficient and culturally appropriate public policies for control and prevention. In view of this panorama, the research aimed to analyze the occurrence of visceral leishmaniasis in populations originating in the State of Tocantins, in the period from 2015 to 2025, based on official epidemiological data.

2 CONCEPTUAL ASPECTS

2.1 VISCERAL LEISHMANIASIS: OVERVIEW AND HISTORICAL OVERVIEW

Transmitted by vectors, leishmaniasis is categorized as a zoonosis, or as a subtype of the same disease, called anthroponosis. When zoonosis, the main parasitic host is animals, while in anthroponotic cases, the human being ends up serving as a secondary or

accidental reservoir, since the primary origin is in animals, with dogs and cats being the most common (Mesquita et al., 2024).

In this scenario, humans end up being a collateral host due to social and environmental factors, such as deforestation and urbanization, fostering vector dispersion and the occurrence of outbreaks (Saha, 2021).

The World Health Organization (2023) infers that the main means of transmission of visceral leishmaniasis is through the bite of female sandflies, belonging to the psychodidae family, and to the *phlebotominae* subfamily. The most present sandfly in Brazil belongs to the genus *Lutzomyia longipalpis*. While the predominant species in Africa and Asia are of the genus *Phlebotomus*.

2.2 LUTZOMYIA LONGIPALPIS: TAXONOMY AND ECOLOGY

The sandflies present in Latin America and Brazil, also called New World Sandflies, have their complex taxonomy explained by the classic author Forattini (1973), schematized in Table 1.

Table 1

Taxonomy of Sandflies

PHILO	CLASS	ORDER	SUBORDER	FAMILY	SUBFAMILY
<i>Arthropoda</i>	<i>Insecta</i>	<i>Diptera</i>	<i>Nematocera</i>	<i>Psychodidae</i>	<i>Phlebotominae</i>

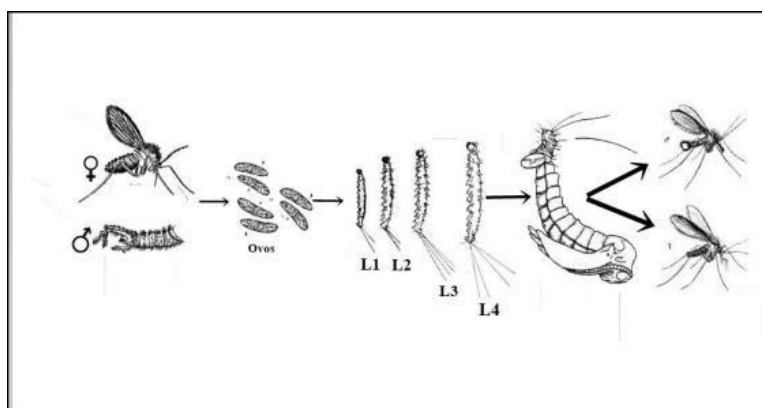
Source: (Prepared by the author, 2025). Adapted from FORATTINI (1973).

In some Brazilian regions they receive the popular name of "sandfly". However, these insects do not fit scientifically into the mosquito family, since their life cycle and morphology are different (World Health Organization, 2023).

Among all sandflies, those of the genus *Lutzomyia* are the most diverse and with the greatest distribution across endemic geographic spaces, containing 11 species and 15 subgenera (Bates et al., 2015). Its size is small, with an average size of 0.3 to 0.4 cm, and its development phases are divided into: egg; four larval stages; pupa is the adult and winged stage of the insect, as shown in Figure 1.

Figure 1

Biological cycle of the insect Lutzomyia longipalpis



Source: (Valença, 2015).

Eggs are deposited in organic matter located in humid and shady environments, whether domestic or not. Hatching occurs variably, depending on the amount of blood ingested by the female and also on the amount of substrate available, and can take from 7 to 17 days, with shorter periods where there are more favorable conditions (Sangiorgi et al., 2012)

Sales (2015) describes the insect *L. Longipalpis* in its adult stage, with a yellowish color and wings that kill themselves erect when at rest, as shown in Figure 2.

Figure 2

Female sandfly L. longipalpis feeding



Source: (Colins, 2011).

Its flight is classified as bouncy, its oral cavity, when in adulthood, serves to sting and sucking, and the diet of males and females is based on the intake of carbohydrates such as glucose and fructose from nectars and plant sap, serving as a source of energy for the execution of basic maintenance and reproduction activities. (Colins, 2011)

It is noteworthy that, even though she has a similar diet, only the female has hematophagous feeding directed to the maturation and laying of the eggs. The practice of

hematophagy usually occurs at night or twilight. Because they are not very selective, sandflies can feed on a varied group of invertebrate animals, which include humans (Sales, 2015).

2.3 VISCERAL LEISHMANIASIS IN HUMANS

Leishmaniasis is a serious vector-borne disease that has broad medical interest, being more common in dogs and, in some cases, in cats. In certain situations and epidemiological conditions, human beings can end up being contaminated and, therefore, the fight against visceral leishmaniasis represents a challenge for agents and agencies responsible for promoting public health (Margen, 2023).

In humans, symptoms can vary, the most recurrent being fever constant weakness, marked weight loss, and other conditions such as pancytopenia (reduction of blood cells) and hepatosplenomegaly (considerable enlargement of the spleen and liver). When not identified and treated, the disease can have a considerably high lethality, especially in cases where the individual has an immunodeficiency such as HIV, or when it affects children (World Health Organization, 2023; Goswami et al., 2020).

It should be noted that infection by direct contact with body fluids such as blood and saliva of infected animals is unfounded, and that in humans, leishmaniasis infection occurs only when the individual is bitten by the infected female *Lutzomyia Longipalpis* mosquito (Rodrigues et al., 2025).

The most effective treatment indicated by the World Health Organization, due to its low toxicity, consists of the individual or combined use of amphotericin A or amphotericin B, which represent a significant advance in reducing treatment time and any associated costs. However, in regions with fewer resources, the most commonly used substances are pentavalents, which present greater risk, toxicity, and parasite resistance (Burza et al., 2022; Van Griensven et al. 2024).

The actions to combat VL are varied, and range from chemical control with insecticides, directed to residential areas to eliminate vectors in places where there are confirmed cases of leishmaniasis, to monitoring through databases and spreadsheets that help in directing actions and strategies (Costa, 2018).

Among the national leishmaniasis monitoring services, the Department of Information and Informatics of the Unified Health System (DATASUS), administered by the Brazilian Ministry of Health, stands out, with data and statistics provided and administered by all federative entities (states) of the country.

2.4 NATIVE PEOPLES OF THE STATE OF TOCANTINS

In Brazil, indigenous peoples "constitute societies with their own social organization, languages, customs, and traditions that distinguish them from the rest of national society" (FUNAI, 2023).

For Silva (2019, p. 45), "native peoples represent the civilizational basis of Brazil, expressing a cultural plurality that precedes and resists the colonial process", they are ethnic groups that inhabited the Brazilian territory before European colonization, having their own forms of social organization, languages, beliefs, productive systems and ways of relating to the environment (Silva, 2019, p. 45).

The State of Tocantins, located in the northern region of Brazil, has as its main biomes the Cerrado and the Amazon Forest. Created in 1988, it is the newest federative entity in the country, also known for housing nine indigenous ethnic groups, three of which are

who form the Iny people (Xambioá, Karajá and Javaé); added to six others; Avá-Canoeiros, Pankararu, Xerente, Krahô, Krahô-Kanela and Apinajê (TOCANTINS, 2021).

Reflecting on the health of indigenous peoples in Tocantins, it is imperative to recognize the complexities and magnitudes of this contemporary issue, but also that they be directed not only to the cultural diversity of the country, but also to enable us to take more effective measures to improve the health and well-being of these historically stigmatized peoples (RIOS; DA COSTA and DA COSTA, 2024).

3 MATERIALS AND METHODS

This was a quantitative, descriptive and documentary research, developed from the analysis of secondary data available in the Notifiable Diseases Information System (SINAN), accessed through the Department of Informatics of the Unified Health System (DATASUS).

The DATASUS system is fed by subsystems such as SINAN (Notifiable Diseases Information System). This system has records of diseases and injuries, carried out from 2007 onwards.

When selecting the State of Tocantins in the DATASUS system, the system divides the state into different health regions, coordinated by Regional Interagency Commissions (CIRs). The CIRs can be classified as instances composed of all the municipal health secretaries of a territory, with the proposal of promoting health at different levels of care, in addition to demonstrating the effectiveness of the SUS regionalization project (Silveira Filho, 2016)

In Tocantins, the CIRs operate in 8 health regions that were defined in CIBnº 161/2012 Resolution, covering a specific number of municipalities, as outlined in Table 02.

Table 2*Composition of the Health Regions (CIR) in the State of Tocantins*

HEALTH REGION	NUMBER MUNICIPALITIES	OF
Cerrado Tocantins Araguaia	23	
Bico do Papagaio	24	
Cantão	15	
Capim Dourado	14	
Ilha do bananal	18	
Médio Norte Araguaia	17	
Sudeste	15	
Amor Perfeito	13	
TOTAL	139	

Source: (Prepared by the author, 2025). Adapted from the State of Tocantins, Resolution CIBn° 161/2012.

The spatial cut covered the State of Tocantins, and the time frame considered the period from 2015 to 2025. Information was collected regarding the distribution of confirmed cases of human visceralleishmaniasis among populations originating from the state of Tocantins. The spatial cut covered the State of Tocantins, and the time frame considered the period from 2015 to 2025. Information was collected regarding the distribution of confirmed cases of human visceral leishmaniasis among indigenous populations, including variables such as health region (CIR), municipality of residence, age group, and gender.

The tabulation and organization of the data were performed with the aid of electronic spreadsheets, allowing the elaboration of tables and graphs for descriptive statistical analysis. The study used as comparative parameters the regional classifications of the IBGE (2017) and CIB Resolution No. 161/2012, which defines the health regions of Tocantins.

As this is a study based on secondary data in the public domain, there was no need to submit it to the Research Ethics Committee, as established by Resolution No. 510/2016 of the National Health Council (Brasil, 2016).

4 RESULTS AND DISCUSSIONS

The research encompassed the health regions of the State of Tocantins (CIR), and all periods within the pre-established time frame (2015-2025). A total of 10 confirmed cases of VL were found in the entire study area.

The temporal analysis of confirmed cases of visceral leishmaniasis in indigenous people, delimited between the periods of 2015 and 2025, showed a mild oscillation over the periods studied, as shown in Figure 3. For the periods of 2016, 2018, 2021, 2022 and 2024, no confirmed cases were recorded in the search source of the survey.

Figure 3

Total number of confirmed VL cases in the indigenous population in Tocantins by period.



Source: (Prepared by the author, 2025).

In the periods of 2017 and 2020, the highest number of confirmed cases of VL in the indigenous population was identified. The graphical analysis also reveals a continuous oscillation between the periods, with a slight stabilization in the number of cases in the last 3 years analyzed.

Among the health regions in the state of Tocantins, the region with the highest number of notifications of confirmed VL cases in indigenous people was the Capim Dourado CIR with 5 of the confirmed cases, as shown in Table 3.

Table 3

Confirmed cases of VL in indigenous people according to time lapse 20-2025 and health regions (CIR) – Tocantins

HEALTH REGIONS (CIR) TOCANTINS					
YEAR	MIDDLE NORTH ARAGUAIA	BEAK OF PARROT	BANANAL ISLAND	GOLDEN GRASS	TOTAL LV CONFIRMED CASES
2015	0	0	0	1	1
2016	0	0	0	0	0
2017	1	1	1	0	3
2018	0	0	0	0	0
2019	0	0	0	1	1
2020	1	0	0	2	3
2021	0	0	0	0	0
2022	0	0	0	0	0
2023	0	1	0	0	1
2024	0	0	0	0	0

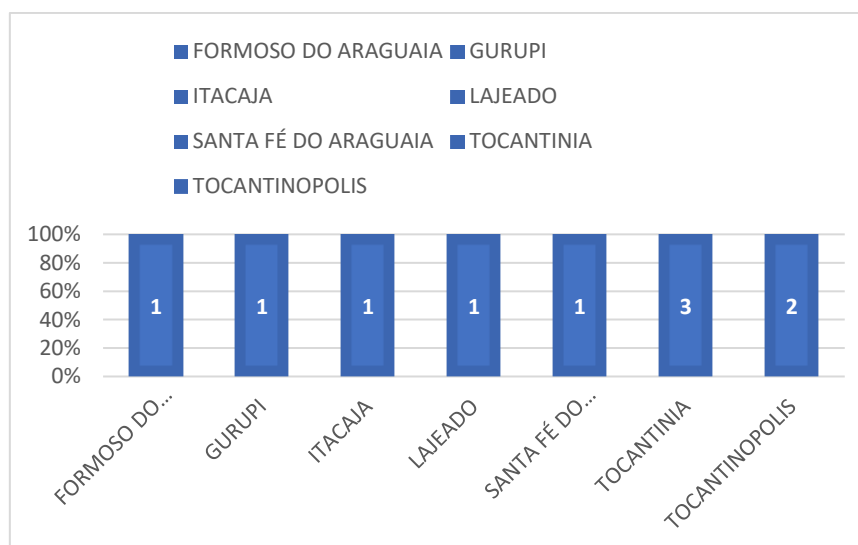
2025	0	0	0	1	1
SUBTOTAL	2	2	1	5	10

Source: (Prepared by the author, 2025).

Of the total of 10 confirmed cases of VL in the study period, Figure 4 shows in which municipalities of residence the cases were confirmed.

Figure 4

Confirmed cases of VL in the indigenous population by municipalities in the state of Tocantins



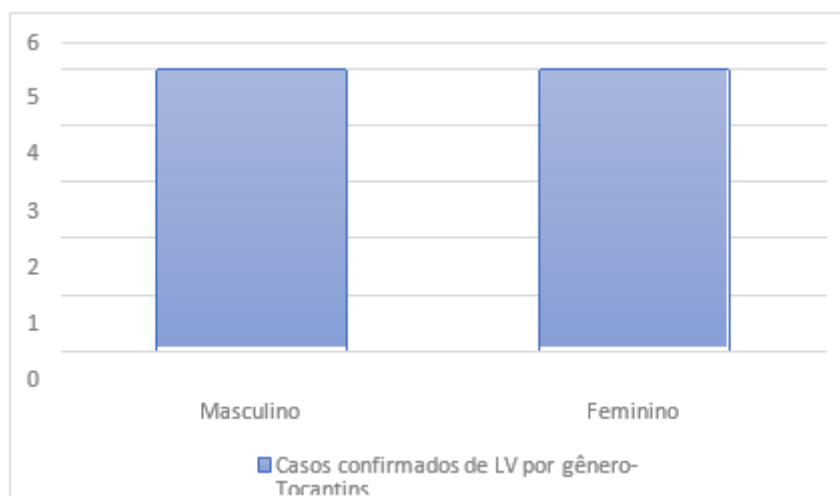
Source: (Prepared by the author, 2025).

The municipality of Tocantína, located on the right bank of the Tocantins River, in the central region of the State of Tocantins, had the highest number of case records. In this region is the territory of the Xerente people. The second municipality with the most records was Tocantinópolis, located in the north of the State of Tocantins, where the territory of the Apinajé people is located.

Another variable analyzed based on the data studied was gender, represented in Figure 5. A bilateral analysis of the information reveals that the number of infections, both for males and females, is proportionally equal.

Figure 5

Confirmed VL cases in indigenous people by gender in the state of Tocantins, 2015 to 2025



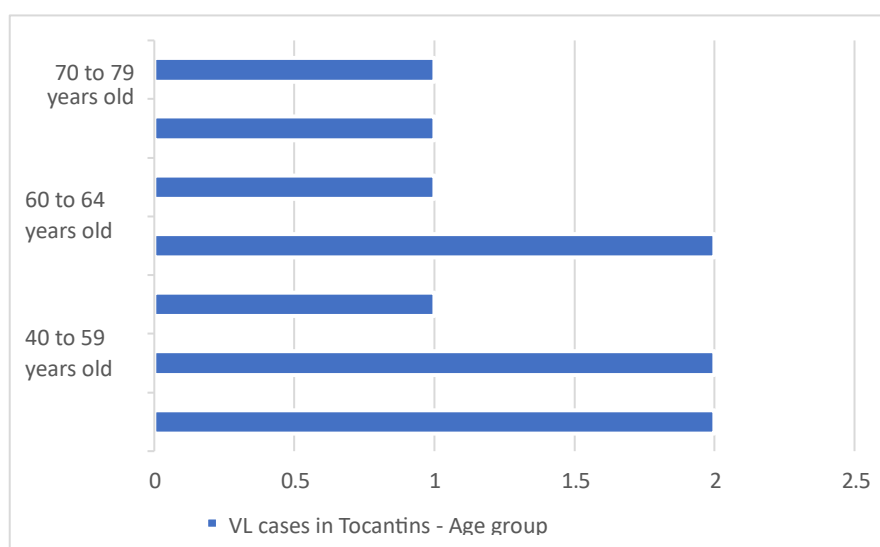
Source: (Prepared by the author, 2025).

The result discards the idea that the biological factor directly influenced the increase or decrease in the rates of infection by the protozoan. On the other hand, the age groups of the individuals show a distribution with more visible contrasts.

Figure 6 shows and highlights the distribution of cases by age group, and is almost uniform, and accentuated in three of the seven age groups studied, namely: <1 year, 1-4 years, and 20 to 39 years. However, when adding the age groups <1 year, 01 to 04 years and 05 to 09 years. It is noted in this analysis that confirmed cases of VL are accentuated in children under 10 years of age.

Figure 6

VL cases in indigenous people, in the state of Tocantins, by age group



Source: (Prepared by the author, 2025).

5 CONCLUSION

The study showed that visceral leishmaniasis remains an important public health problem in the State of Tocantins, especially among indigenous populations. The predominance of confirmed cases in children under ten years of age and the geographic concentration in certain regions, such as Capim Dourado and Médio Norte Araguaia, suggest the persistence of structural and environmental vulnerabilities.

Biological factors such as gender do not demonstrate a direct influence on the increase or decrease in confirmed cases, which highlights the importance of multifaceted analyses.

The data reinforce the need for intersectoral actions aimed at vector control, and the reinforcement of continuous epidemiological surveillance, in addition to health education among native peoples. The adoption of culturally sensitive strategies, the strengthening of primary care, and the training of local Community Health Agents (CHA) and Endemic Disease Control Agents (ACE's) can represent effective measures to reduce the disease.

Finally, recommendations include the continuation of epidemiological and geospatial studies to understand the dynamics of VL and guide long-term public policies, in line with the principles of equity and universality of the Unified Health System (SUS).

REFERENCES

- Almeida, L. P., et al. (2024). Distribuição espacial da leishmaniose visceral no Norte do Brasil: Uma análise ecológica. *Revista Brasileira de Parasitologia Veterinária*, 33(2), 1–12.
- Bates, P. A., et al. (2015). Recent advances in phlebotomine sand fly research related to leishmaniasis control. *Parasites & Vectors*, 8, 131.
- Burza, S., et al. (2022). AmBisome monotherapy and combination therapy trials for visceral leishmaniasis: A review of clinical outcomes. *Clinical Infectious Diseases*, 75(4), 678–687.
- Brasil. Conselho Nacional de Saúde. (2016). Resolução nº 510, de 7 de abril de 2016: Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais. *Diário Oficial da União*.
- Cavalcanti, A. S., Silva, C. R., & Barbosa, V. C. (2021). Urbanização e expansão da leishmaniose visceral no Brasil: Uma revisão de literatura. *Cadernos de Saúde Coletiva*, 29(4), 587–598.
- Collins, F. (2011). Fêmea de flebotomíneo [Fotografia].
- Costa, D. N. C. C., et al. (2018). Human visceral leishmaniasis and relationship with vector and canine control measures. *Revista de Saúde Pública*, 52.

Estado do Tocantins. (2012). Resolução CIB-TO n. 161, de 29 de agosto de 2012: Aprova a conformação das 8 regiões de saúde do Estado do Tocantins e define ações e serviços mínimos a serem ofertados nos territórios.

Ferreira, D. R., Oliveira, M. A., & Nascimento, F. C. (2023). Condições socioambientais e vulnerabilidade à leishmaniose visceral em comunidades indígenas brasileiras. *Saúde e Sociedade*, 32(1), e230102.

Forattini, O. P. (1973). Phlebotominae. Leishmanioses. Bartonelose. In O. P. Forattini, *Entomologia médica* (Vol. 4, p. 658). Edgard Blucher.

Governo do Tocantins. (2021, abril 12). Povos indígenas integram colcha de retalhos da cultura tocantinense.

Goswami, R. P., et al. (2020). Combination therapy against Indian visceral leishmaniasis: A randomized clinical trial. *The Lancet Global Health*, 8(3), e441–e449.

IBGE – Instituto Brasileiro de Geografia e Estatística. (2017). Regiões geográficas do Tocantins / divisão regional do Brasil em regiões geográficas 2017 [Mapa]. IBGE.

Marcondes, M., & Rossi, C. N. (2013). Leishmaniose visceral no Brasil.

Mergen, M. E., & Souza, M. M. (2023). Leishmaniose visceral canina, métodos diagnósticos e tratamento na atualidade – Revisão de literatura. *Revista JRG de Estudos Acadêmicos*, 6(13), 1024–1036.

Mesquita, M. R., et al. (2024). Association between the visceral leishmaniasis vector and urban environment in Brazil. *Parasites & Vectors*, 17(42), 1–10.

Organização Pan-Americana da Saúde. (2023). Informe epidemiológico das doenças negligenciadas nas Américas. OPAS.

Rodrigues, A. C., et al. (2025). Transmissão vertical da leishmaniose visceral: Avanços, desafios clínicos e diagnósticos e seus impactos na saúde materno-fetal (revisão de literatura 2019–2024). *Revista Ciências da Saúde Ceuma*, 3(1), 1–10.

Saha, P. (2021). Sir U. N. Brahmachari and his battle against Kala-Azar. *Indian Journal of History of Science*, 56(2), 173–183.

Sangiorgi, B., et al. (2012). Natural breeding places for phlebotomine sand flies (Diptera: Psychodidae) in a semiarid region of Bahia state, Brazil. *Journal of Tropical Medicine*, 1–5.

Sales, K. G. S. (2015). PCR em tempo real para caracterização de fontes alimentares de flebotomíneos (Diptera: Psychodidae) (Dissertação de mestrado, Fundação Oswaldo Cruz).

Silveira Filho, R. M., et al. (2016). Ações da Comissão Intergestores Regional para gestão compartilhada de serviços especializados no Sistema Único de Saúde. *Physis: Revista de Saúde Coletiva*, 26(3), 853–878.

Souza, T. H., Lima, R. P., & Gomes, A. F. (2022). Determinantes sociais e epidemiológicos da leishmaniose visceral em populações tradicionais da Amazônia brasileira. *Revista Pan-Amazônica de Saúde*, 13, e20220123.

Steverding, D. (2017). The history of leishmaniasis. *Parasites & Vectors*, 10(82), 1–10.

Valença, L. A. F. (2015). Avaliação ultramorfológica de formas imaturas e adultas de *Lutzomyia longipalpis* (Diptera: Psychodidae) procedentes do campo e de colônias de laboratório (Dissertação de mestrado, Universidade Federal Rural de Pernambuco).

Van Griensven, J., et al. (2024). The status of combination therapy for visceral leishmaniasis: Recent clinical evidence and future directions. *The Lancet Infectious Diseases*, 24(2), 123–135.

World Health Organization. (2022). Guideline for the treatment of leishmaniasis. WHO.

World Health Organization. (2023). Leishmaniasis: Fact sheet. WHO.

MIRINGUAVA RIVER BASIN: TOURISM AS A POTENTIAL ACTIVITY FOR IMPROVING THE SOCIOECONOMIC AND ENVIRONMENTAL CONDITIONS OF SÃO JOSÉ DOS PINHAIS

BACIA HIDROGRÁFICA DO RIO MIRINGUAVA: O TURISMO COMO ATIDADE POTENCIAL PARA A MELHORIA DAS CONDIÇÕES SOCIOECONÔMICAS E AMBIENTAIS DE SÃO JO-SÉ DOS PINHAIS

CUENCA HIDROGRÁFICA DEL RÍO MIRINGUAVA: EL TURISMO COMO ACTIVIDAD POTENCIAL PARA LA MEJORA DE LAS CONDICIONES SOCIOECONÓMICAS Y AMBIENTALES DE SÃO JOSÉ DOS PINHAIS



<https://doi.org/10.56238/sevened2026.008-193>

Cinthia Marie Ota Fraletti¹, Cezar Augusto Romano²

ABSTRACT

The Miringuava River basin is located in São José dos Pinhais and is the main source of water for the local population, integrating the basin system that also supplies the capital Curitiba and other cities in the metropolitan region. The Miringuava River dam and reservoir are part of the Curitiba Metropolitan Region Water and Sewage Master Plan, and the demand for restoration of the affected areas will lead to the emergence of new businesses, generating income diversification for local communities, as well as involving actors inside and outside the basin. The objective of this research is to diagnose tourism as a potential activity for improving the socioeconomic and environmental conditions of São José dos Pinhais. The socioeconomic and environmental challenges related to the use of water resources, as well as the economic dependence on agricultural production, are highlighted. Among the possible strategies, sustainable tourism stands out as a potential activity consistent with the socioeconomic development of the region, since it is committed to the conservation of natural resources, the appreciation of regional culture, and the pursuit of improving the living conditions of local residents. It was concluded that tourism is a potential activity for the development of the municipality, with its main attractions being the appeal of water security, its natural beauty, and the local community through historical and cultural preservation.

Keywords: Sustainability. Local Communities. Sustainable Tourism. Rural Tourism.

RESUMO

A bacia hidrográfica do rio Miringuava localiza-se em São José dos Pinhais e é a principal fonte de água da população local, integrando o sistema de bacias que abastece também a capital Curitiba e outras cidades da região metropolitana. A barragem e reservatório do rio

¹ Doctoral student in Urban Environmental Sustainability. Universidade Tecnológica Federal do Paraná (UTFPR). Paraná, Brazil. E-mail: cinthiaota@utfpr.edu.br Orcid: <https://orcid.org/0000-0002-3694-9985>. Lattes: <https://lattes.cnpq.br/6618769999413776>

² Dr. in Production Engineering. Universidade Federal de Santa Catarina (UFSC). Paraná, Brazil. E-mail: caromano@utfpr.edu.br Orcid: <https://orcid.org/0000-0001-5479-3921> Lattes: <http://lattes.cnpq.br/9050177850757366>

Miringuava fazem parte do Plano Diretor de Águas e Esgotos da Região Metropolitana de Curitiba, sendo que a demanda por restauração das áreas afetadas proporcionará o surgimento de novos negócios gerando diversificação de renda às comunidades locais, além de envolver atores dentro e fora da bacia. O objetivo desta pesquisa é diagnosticar o turismo como uma atividade potencial para a melhoria das condições socioeconômicas e ambientais de São José dos Pinhais. Destacam-se os desafios socioeconômicos e ambientais, relacionados ao uso dos recursos hídricos, além da dependência econômica da produção agropecuária. Dentre as estratégias possíveis, o turismo sustentável destaca-se como uma atividade potencial condizente com o desenvolvimento socioeconômico da região, a partir do momento em que está comprometido com a conservação dos recursos naturais, a valorização da cultura regional, como também na busca de melhoria das condições de vida dos moradores locais. Concluiu-se que o turismo é uma atividade potencial para o desenvolvimento do município, tendo como principal atrativo o apelo pela segurança hídrica, suas belezas naturais e a comunidade local, através do resgate histórico-cultural.

Palavras-chave: Sustentabilidade. Comunidades Locais. Turismo Sustentável. Turismo Rural.

RESUMEN

La cuenca del río Miringuava se ubica en São José dos Pinhais y constituye la principal fuente de agua para la población local, integrando el sistema de la cuenca que también abastece a la capital, Curitiba, y a otras ciudades de la región metropolitana. La presa y el embalse del río Miringuava forman parte del Plan Maestro de Agua y Alcantarillado de la Región Metropolitana de Curitiba, y la demanda de restauración de las áreas afectadas propiciará el surgimiento de nuevos negocios, generando diversificación de ingresos para las comunidades locales e involucrando a actores dentro y fuera de la cuenca. El objetivo de esta investigación es diagnosticar el turismo como una actividad potencial para mejorar las condiciones socioeconómicas y ambientales de São José dos Pinhais. Se destacan los desafíos socioeconómicos y ambientales relacionados con el uso de los recursos hídricos, así como la dependencia económica de la producción agrícola. Entre las posibles estrategias, el turismo sostenible se destaca como una actividad potencial compatible con el desarrollo socioeconómico de la región, ya que está comprometido con la conservación de los recursos naturales, la valorización de la cultura regional y la búsqueda de la mejora de las condiciones de vida de los residentes locales. Se concluyó que el turismo es una actividad potencial para el desarrollo del municipio, siendo sus principales atractivos el atractivo de la seguridad hídrica, sus bellezas naturales y la comunidad local a través de la preservación histórica y cultural.

Palabras clave: Sostenibilidad. Comunidades Locales. Turismo Sostenible. Turismo Rural.

1 INTRODUCTION

In 2017, the Sanitation Company of Paraná began the construction of a dam that will be part of the supply system of Greater Curitiba. The Miringuava River reservoir was designed to strengthen water security for more than six hundred thousand people in Curitiba and the Metropolitan Region (SANEPAR, 2025).

The installation of the Miringuava dam and reservoir is a reality, therefore, by itself the project already causes changes in the local way of life, land use, changes in flora and fauna, in addition to impacts on the local community. On the other hand, as long as it occurs in a planned way, opportunities will be created for the development of sustainable tourism.

The objective of this research is to diagnose tourism as a potential activity for the improvement of the socioeconomic and environmental conditions of São José dos Pinhais. The specific objectives are:

- a) Develop the state of the art on rural tourism, sustainable development and local communities;
- b) Describe which potentialities of the Miringuava River basin favor Sustainable Tourism;
- c) Identify how tourism can generate market value for the local economy.

According to the Department of Social and Economic Indicators of the Municipal Secretariat of Planning and Economic Development of the Municipality of São José dos Pinhais, agriculture has always been a traditional sector in the São José economy. With industrialization, technological advances did not prevent farming communities from continuing their development.

The municipality has also been gaining prominence in the production of organic and honey, from the breeding of stingless bees, coordinated by the Association of Organic Producers and Meliponiculturists of São José dos Pinhais (APROMEL).

In addition, the involvement of actors from different sectors with common interests has the advantage of creating shared value and enhancing results. Among the possible strategies, tourism stands out as a potential activity consistent with socioeconomic development, from the moment it is committed to the conservation of natural resources, appreciation of regional culture and improvement of the living conditions of local communities.

In order to contribute to the rural development of São José dos Pinhais, the research was carried out in order to generate subsidies for the implementation of actions and enterprises aimed at tourism in the region.

2 THEORETICAL FRAMEWORK

2.1 RURAL TOURISM

According to Lane *et al.* (2022), rural tourism became a worldwide and growing activity in the late 1970s and early 1980s. At first, it was seen as an unimportant activity, perhaps tending to disappear in the future. However, it has proven to be extremely important to the development of sustainable tourism, leading the way for the creation of new tourism modalities based on growing niche markets.

According to the Ministry of Tourism (BRASIL, 2003), although visiting rural properties is an old practice in Brazil, displacement to rural areas began to be faced with professionalism in the eighties, when some properties in Rio Grande do Sul Santa Catarina, due to the difficulties of the agricultural sector, decided to diversify their activities and began to receive tourists.

According to Souza and Dolci (2019, p. 26), the typical characteristics of the rural environment, such as gastronomy, natural and cultural heritage, customs, as well as the possibility of leisure and rest have increasingly attracted city dwellers.

In this context, several types of tourism proliferate, such as ecotourism, rural tourism and cultural tourism, enabling new ventures in rural spaces.

The concept of rural tourism adopted by the Ministry of Tourism is based on aspects that refer to tourism, territory, economic base, natural and cultural resources and society.

Based on these aspects, Rural Tourism is defined as the set of tourist activities developed in rural areas, committed to agricultural production, in addition to adding value to local products and services, rescuing and promoting the cultural and natural heritage of local communities (BRASIL, 2003, p. 11).

According to Petrović *et al.* (2018), rural tourism contributes not only to the greater profitability of families, but also to the sustainable development of rural areas, diversity of tourist offers and improvement of the quality of life of local communities in the countryside.

In addition to the commitment to agricultural activities, it is characterized by the appreciation of natural and cultural heritage, being part of the tourist offer in rural areas.

Therefore, entrepreneurs must maintain authenticity, through the rescue of regional manifestations and practices such as gastronomy, folklore, handicrafts, in addition to ensuring the conservation of the natural environment.

According to Visentin and Vallerani (2018), the restructuring of the agricultural sector through tourism is an alternative strategy for the development and consequent economic and social growth of rural areas.

Rural tourism is not necessarily located in an intensely productive rural area, but in

specific landscapes with rural characteristics.

This type of tourism finds its roots in rural landscapes where local cultures still influence the Cloydian lifestyles. The increase in demand for rural tourism and the growing demand for organic and authentic products has attracted new residents to the countryside (VISENTIN and VALLERANI, 2018).

For Lane *et al.* (2022), rural tourism, like other forms of tourism, was once based on visiting a place. It's still place-based, but its main draw is providing experiences. In other words, it is necessary to sell long-term and short-term experiences. Just knowing the place is no longer enough.

2.2 SUSTAINABLE DEVELOPMENT

For Barbieri *et al.* (2010), the values linked to sustainable development and respect for environmental policies have been institutionalized in several countries, socio-environmental movements and governments. As a response to these institutional pressures, new organizational models emerge, seen as the most appropriate for this new cycle, as is the case of sustainable innovative organizations.

According to Philippi Jr. *et al.* (2013, p.511), "growing reflections on environmental accidents that occurred and the need to review the paradigms then in force stimulated countries and the international community to develop joint actions". In other words, the population realized the importance of valuing and protecting cultural capital, based on the protection of ecosystems and natural resources.

The first dimension of sustainable development is environmental, whose production and consumption model is compatible with the material base on which the economy is based, as a subsystem of the natural environment. It is, therefore, a matter of producing and consuming in a way that ensures that ecosystems can maintain their capacity for resilience (DO NASCIMENTO, 2012, p. 55).

The second dimension is the economic one, with increased efficiency of production and consumption with increasing savings of natural resources, with emphasis on permissive resources such as fossil sources of energy and resources such as water and minerals. The third dimension is the social one. A sustainable society supposes that all citizens have the minimum necessary for a dignified life and that no one absorbs goods, natural and energy resources that are harmful to others (DO NASCIMENTO, 2012, p. 55).

For Jacobi (2003), the concern with sustainable development generates socio-political changes that do not compromise the ecological and social systems that sustain the communities.

On the other hand, the same balance required to ensure environmental conservation must also be ensured to society, involving the social, economic, political, ethical and environmental variables, which indicate the degree of sustainability of a society, as proposed by Emery (2016).

Thus, the integral development of any territory depends on the construction of sustainable bases, supported by the tripod of social justice, economic viability and environmental balance (PHILIPPI JR. *et al.*, 2014, p.30).

According to Sanches (2000), environmental management aims to "manage the organization's relations and interactions with the environment, evaluating and correcting present environmental problems, minimizing future negative impacts".

In this sense, the production of knowledge must contemplate the natural and social environment, including the analysis of the determinants of the process, the role of the various actors involved and the forms of social organization that increase the power of alternative actions for a new development, with an emphasis on socio-environmental sustainability (JACOBI, 2003, p. 3).

According to Feliciano (2015), the term sustainability can be used to express what is durable and remains over time.

Based on the assumption that social relations are perpetuated through the harmonious interaction between social beings among themselves and in relation to nature.

Although the concepts mentioned above are widely used, there is no single vision of what sustainable development is. Even Dias (2003, p.48) states that for some authors, achieving sustainability is to obtain economic growth through more rational management of natural resources and the use of more efficient technologies. For others, sustainable development is a social and political project aimed at eradicating poverty, raising the quality of life, and meeting the basic needs of the local community.

According to Dias (2003, p. 50), "the search for sustainable development revalues traditional forms of production, generating new forms of productive organization in almost all economic and social activities".

For Sachs (2008), sustainable development obeys the double ethical imperative of solidarity with present and future generations, and requires the explicitness of criteria of social, environmental and economic sustainability. Strictly speaking, solutions that consider these three elements, that is, that promote economic growth with positive impacts in social and environmental terms, deserve the name of development.

For Beni, Sustainable Tourism involves understanding the impacts of tourism; equal distribution of costs and benefits; generation of local jobs; promotion of profitable businesses;

injection of capital with consequent diversification of the local economy; interaction with all sectors and segments of society; strategic and logistical development of means of transport (BENI, 2003, p. 14).

2.3 LOCAL COMMUNITIES

According to Polukhina *et al.* (2021), mass tourism will have to give way to tourism that respects the interests of local communities, not limited to profit alone. This implies new strategic decisions and focuses on tourism modalities such as rural tourism and ecotourism.

According to Streimikiene *et al.* (2020), tourism services have an impact not only on the environments, but also on the local population, generating jobs and contributing to the well-being and development of local communities.

For Aman *et al.* (2019), tourism contributes to economic growth. The concerns associated with the local community contribute to a more participatory management. Planning a sustainable tourist destination requires the support of local communities, as it involves reception and hospitality that are key to the satisfaction of tourists, contributing to local development.

According to Gastal (2021), excluding nature, the picturesque would be redimensioned, when cities start to be sought after by tourists, for differentiated cultural experiences.

The development of sustainable tourism generates additional revenue for actors who invest in the development of local tourism and the conservation of tourist attractions, ensuring the sustainability of tourist areas (AMAN *et al.*, 2019).

According to Flores e Silva, Cunha Lima and Christoffoli (2016), it is important to understand that projects of this nature contemplate the development of rural infrastructure and strengthen the capacity of local communities to foster networks and societies that lead to the creation of institutions, exhibitions and training for the management of this form of tourism.

For Reher (2022), one way for farmers to benefit from tourism is to bring back the original idea of rural tourism, in which tourists experience the work of a farm as a way to escape urban life and return to a cultural environment.

It is necessary to value cultural heritage in order to benefit and empower local communities. This needs to be integrated into a broader sustainable development strategy that emphasizes entrepreneurship and social innovation associated with the cultural landscape. In this sense, measures to maintain and protect the traditional use of local land are practical strategies for the preservation of cultural values (REHER, 2022).

According to Lima (2019), this change in posture receives various denominations according to the vocation of the territories and populations where it occurs, assuming to be: community, local development, creative, experience, solidarity and social.

3 METHODOLOGY

For Marconi and Lakatos (2010), research produces science when it systematizes knowledge, proposes and logically organizes a set of "propositions about the behavior of certain phenomena that one wishes to study". Research, for these authors, "consists of the observation of facts and phenomena as they occur spontaneously, the collection of data related to them and the recording of variables that are presumed relevant, in order to analyze them".

The definition of the research method of this study considered the following classifications: nature of the research, collection environment, objective, nature of the data and research procedure.

Table 1

Research classification table

Classification	Type
Regarding the nature of the research	Applied
Collection environment	Field research
The objective	Exploratory
The nature of the data	Qualitative
Regarding the search procedure	Case Study

Source: Authorship (2025).

From the point of view of its nature, it is an applied research, since it aims to generate knowledge for practical and immediate application in a circumstantial reality, aimed at solving specific problems (GIL, 2010).

It is noteworthy that the applied nature aims to generate knowledge for practical application and solution of specific problems, involving local truths and interests (SILVA; MENEZES, 2005).

As for the collection environment, this research is classified as experimental field research. That is, they will be complemented with semi-structured interviews and questionnaires with a set of social actors (HOUTART, 1994).

The semi-structured interview is a scientific activity that brings the researcher closer to the reality studied, combining everyday facts with the existing theory on the subject. For Richardson (1999, p. 160) the interview "is a technique that allows the development of a close relationship between people".

From the point of view of its objectives, since no scientific studies were found on the potential of the Miringuava River basin for Sustainable Tourism, the research is classified as exploratory.

For Gil (2010), it aims to provide greater familiarity with the problem to make it explicit or to build hypotheses, based on a bibliographic survey, interviews with people who had practical experiences with the problem in question, and analysis of examples that stimulate its understanding.

The approach of this research provides for the investigation of the qualitative characteristics of the phenomenon studied in a subjective way, in order to build its own concepts about the phenomenon studied, as described by Lozada and Nunes (2019).

For the authors, qualitative research has the following characteristics: the native environment is the source of data collection; the researcher is considered the main instrument for data collection; the research uses processes of detailing the observed reality and seeks the meaning of the situations and their impacts for the researched group (LOZADA and NUNES, 2019).

According to Minayo (2014), qualitative research responds to particular questions, which corresponds to a deeper space of relationships, processes and phenomena that cannot be reduced to the operationalization of variables.

Regarding the research procedure, this study is characterized by an approach restricted to the local communities of São José dos Pinhais, a phenomenon with qualitative characteristics studied subjectively.

As for the point of view of technical procedures, in Gil's (2010) view, it is a bibliographic study consisting mainly of scientific articles, added to scientific journals, in addition to research carried out on the internet as part of the theoretical framework of the study. Thus, from the literature review the necessary elements will be obtained for the elaboration of the proposed structure.

3.1 DATA COLLECTION

The data collection phase began with the definition of the criteria for selecting the participants. These criteria determined what requirements the participants needed to meet in order to be selected. This procedure was fundamental to maintain scientific rigor in qualitative research and to establish transparency in relation to the decisions made (FLICK, 2009b).

Those selected from the local community should live near the surroundings of the Miringuava River Dam, work with agricultural activity, tourism or other enterprise in the place.

In the case of regional development support entities, they are professionals who have had contact with projects in the Miringuava River basin region in São José dos Pinhais – PR.

The stage of selecting the sample of interviewees was part of the data collection phase. For Flick (2009a), the sample in qualitative research should follow different criteria from quantitative research and aims to search for examples of individuals who have some relationship with the object studied.

The interviewees were chosen based on the previously established criteria and according to availability, as it was necessary for the individual to be willing to participate in the research over a certain period of time.

Ten residents of the Miringuava River dam region were interviewed, who were within the previously established criteria and willing to participate in the research. The interview was also conducted with eight representatives of entities that support regional development.

The contact with the local community was made in person in the region around the Miringuava River Dam in São José dos Pinhais - PR, in their homes. The criteria for choosing the interviewees was carried out through a visit to the site of the Miringuava River dam.

4 RESULTS AND DISCUSSIONS

The purpose of this chapter is to present the results of the research, in addition to the empirical structure from the collection and analysis of data. The results and discussions were elaborated from the detailed analysis of the bibliographic research that led to a series of reflections regarding the themes that involve the research.

Data collection was done through interviews with the local community and took place in person in the region of the Miringuava River basin. All data collected were properly stored, as well as procedures to ensure the secrecy and confidentiality of the research participant's information.

Data analysis was carried out with previously established criteria and supported by the related literature and documentary research. It is noteworthy that all the interviewees, both from the local community and representatives of entities that support regional development, have knowledge about the construction of the dam and reservoir of the Miringuava River.

According to interviewee E3, the proximity of Curitiba and the coast, both location and access, favor the development of tourism in the region. For interviewee E4, the proximity to large urban centers and favorable relief facilitates the movement of tourists.

In addition to São José dos Pinhais being crossed by three important highways (BR-376, BR-277 and BR-116), it is close to the Port of Paranaguá, in addition to having the Afonso Pena international airport. It is located sixteen kilometers southeast of the capital,

with the limits of the municipalities of: Pinhais and Piraquara to the north; Tijucas from the South to the South; Morretes and Guaratuba to the East; Curitiba, Fazenda Rio Grande and Mandirituba to the west, being accessible by BR-376.

The geographical position of the Miringuava basin, close to two federal highways, the capital and large urban centers, becomes strategic for the development of tourism.

According to interviewee E13, eighty percent of visitors are from Curitiba, that is, the proximity to large urban centers is a potential. They are people who move from the capital in search of contact with nature and contact with the rural environment.

With great potential and a growing tourist demand, the Miringuava River basin region has natural landscapes, family farming properties, colonies of immigrants and their cultures, vineyards, the appeal for water conservation, the historical context of the construction of the dam, in addition to the future reservoir, at first, for contemplation purposes.

In addition to attracting visitors from other regions, tourism has the potential to stimulate local commerce, diversifying the economy and generating jobs. It will also be able to promote historical rescue, gastronomy, in addition to creating business opportunities for the local community, taking advantage of the historical-cultural heritage of European immigrants.

According to interviewee E17, the location of the Miringuava River basin region is strategic and facilitates the reception of tourists.

According to interviewee E7, many local residents are still afraid of the transformations that the dam requires, especially in terms of production. In this case, tourism is an alternative income, generating less environmental impact and providing a positive impact, as they will not need to leave the place to have another source of income.

With the Miringuava dam, the appeal for the conservation of water resources, conservation of biodiversity is enormous. Tourism is an opportunity to generate income, as long as the local community is trained, as the owners of the region are simple people. Local development should be aligned with sustainability, as it is a source area. The main economic aspect of the region is olericulture, but it needs to reduce the use of agrochemicals (E1, 2025).

In the region of the dam there are family enterprises where visitors have the opportunity to pick fresh fruits and vegetables directly from the tree. Some enterprises also have leisure structures such as fish and pay.

Some entrepreneurs already have good practices with receiving a certificate. The potential is an appeal for water preservation. There are several actors working on the ground,

moving the region through projects such as the Viva Água Movement of the Boticário Group Foundation, the city of São José dos Pinhais, and Sanepar (E7, 2025).

According to interviewee E1, sustainable tourism has the potential to promote harmony between the local community and nature, attracting tourists looking for rural activities in the Atlantic Forest.

For Petrović *et al.* (2018), rural tourism contributes not only to the greater profitability of families, but also to the sustainable development of rural areas, diversity of tourist offers and improvement of the quality of life of local communities in the countryside.

In addition to the landscapes, the region has the potential for socio-environmental education through pedagogical tourism in rural areas, aimed at preserving biodiversity and water. It is possible to develop environmental education practices through interpretive trails, tree planting and guidance on water conservation and nature preservation.

It can be seen that the appeal for environmental conservation is enormous because it is the main source of supply for the city of Curitiba and the Metropolitan Region. Rural tourism involves tourist activities developed in rural areas, committed to agricultural production, in addition to adding value to local products and services, rescuing and promoting the cultural and natural heritage of local communities (BRASIL, 2003, p. 11).

The analysis of the research data allows us to conclude that the region of the Miringuava River basin will be able to create experiences such as the contemplation of these landscapes, conversations with the local community in order to learn more about the culture and traditions, cultivation and harvesting of fruits and vegetables, animal handling, beekeeping, awareness of the importance of water for future generations, in addition to raising awareness about the climate impacts caused.

In addition to the commitment to agricultural activities, it is characterized by the appreciation of natural and cultural heritage, being part of the tourist offer in rural areas. Therefore, entrepreneurs must maintain authenticity, through the rescue of regional manifestations and practices such as gastronomy, folklore, handicrafts, in addition to ensuring the conservation of the natural environment.

In other words, it is possible to strengthen the provision of accommodation, food and leisure services in family units, creating tourist activities integrated with environmental protection and historical-cultural rescue of the local community.

According to the survey with representatives of entities that support regional development, tourism will diversify the local economy, generating income and local jobs. It is important to encourage water conservation, socio-environmental education, in addition to the preservation of local biodiversity.

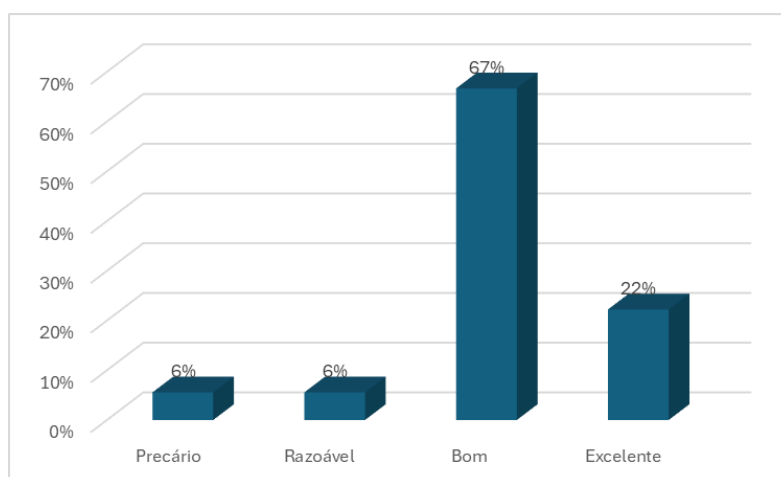
According to interviewee E2, if tourism is developed in a sustainable way, it can help in the development of the local community. Interviewee E18 emphasizes the exuberant nature of the region and the appreciation of culture aimed at tourist interest.

It can be seen that the local community values natural landscapes and is aware of the preservation of biodiversity. For them, it is very important to rescue the historical-cultural and the appreciation of the existing cultures in the region.

According to interviewee E4, the potential is the history of the dam itself and how much it has changed the local community, in addition to the recomposition of vegetation through the formation of an ecological corridor, facilitating the observation of the flora and fauna of the region. It is worth mentioning that for 67% of respondents, the offer of natural and cultural attractions in the region is good.

Figure 1

Natural and cultural attractions



Source: Authorship (2025).

5 CONCLUSION

The study highlights the potential for sustainable tourism, but still facing structural challenges, such as sanitation, precarious access and insufficient signage. Despite this, there is a potential for growth, driven by the training and appreciation of the local community, consolidating tourism as a vector of sustainable development for the region.

It is necessary to satisfy the needs of visitors and the socio-economic needs of the region, in order to maintain cultural aspects, the integrity of natural environments and biological diversity in order to allow the practice of tourism in the long term. In this way, it will be possible to develop urban and environmental sustainability, considering the development of local communities and their current and future environmental, social and economic impacts.

Tourism has the potential to generate jobs, in addition to diversifying the sources of income of the properties, adding value to local products through experiences such as rural coffees, harvest and pay, environmental education, contemplation of nature combined with thematic itineraries.

Therefore, it is important to reduce impacts in order to encourage the inclusion and strengthening of the environmental dimension in the educational process, in order to prevent and mitigate impacts on the environment. It is perceived that there is a strong bond with nature, and tourism is perceived as a way to preserve family traditions, valuing local culture and strengthening community ties.

It is also important to develop tourism products and itineraries that reflect the natural, cultural and social integrity of the destination, taking into account the negative impacts related to climate change, resource depletion, among other factors that may compromise the continuity of tourism activities in the future.

These elements reinforce the role of sustainable tourism as a tool for cultural appreciation, environmental preservation and strengthening of community bonds. In other words, sustainable tourism has potential in the region as long as its planning contemplates new alternatives as a source of work and income, promoting an interaction between the region and other existing tourist routes in São José dos Pinhais.

Within this context, it is necessary to encourage municipal and state public policies, promoting equality and meeting the collective needs of the local community in the region. As well as policies to direct and mobilize economic resources in order to encourage tourism in this region, attracting sources of financing so that small local landowners can promote tourism activity.

In this way, tourism will encourage the restoration of degraded areas within properties, promoting environmental education and awareness, raising awareness about the importance and respect for natural heritage, controlling the flow of visitors and tourist activities in a sustainable way.

REFERENCES

- Aman, J., Abbas, J., Mahmood, S., Nurunnabi, M., & Bano, S. (2019). The influence of Islamic religiosity on the perceived socio-cultural impact of sustainable tourism development in Pakistan: A structural equation modeling approach. *Sustainability*.
- Barbieri, J. C., et al. (2010). Inovação e sustentabilidade: Novos modelos e proposições. *Revista de Administração de Empresas*.
- Beni, M. C. (2003). Como certificar o turismo sustentável? *Revista Turismo em Análise*, 14(2), 5–16.

- Brasil. Ministério do Turismo. (2003). Diretrizes para o desenvolvimento do turismo rural. Brasília, DF.
- Brasil. Ministério do Turismo. (2015). Programa de Regionalização do Turismo – Roteiros do Brasil: Turismo e sustentabilidade. Brasília: MTur.
- DERAL – Departamento de Economia Rural da Secretaria da Agricultura e do Abastecimento (SEAB). (2021). Prognóstico olericultura – novembro de 2020.
- Do Nascimento, E. P. (2012). Trajetória da sustentabilidade: Do ambiental ao social, do social ao econômico. *Estudos Avançados*, 26(74), 51–64.
- Dias, R. (2003). Turismo sustentável e meio ambiente. Atlas.
- Emery, E. B. (2016). Desenvolvimento sustentável: Princípio da eficiência em procedimentos licitatórios. Fórum.
- Feliciano, A. (2015). A importância da implementação de licitações sustentáveis como medida de política pública na busca do desenvolvimento nacional sustentável. *Revista de Discentes de Ciência Política da UFSCAR*, 3(1).
- Flores e Silva, Y., Cunha Lima, F. B., & Christoffoli, A. R. (2016). Turismo rural comunitario: Gestión familiar y estrategias de consolidación en el Estado de Santa Catarina (Brasil). *Estudios y Perspectivas en Turismo*, 25(4), 576–596.
- Flick, U. (2009a). Desenho da pesquisa qualitativa. Artmed.
- Flick, U. (2009b). Qualidade na pesquisa qualitativa. Artmed.
- Gastal, S. (2021). Imagem, paisagem e turismo: A construção do olhar romântico. *Pasos: Revista de Turismo y Patrimonio Cultural*.
- Gil, A. C. (2010). Como elaborar projetos de pesquisa. Atlas.
- Houtart, F. (1994). Sociologia da religião. Ática.
- IPARDES – Instituto Paranaense de Desenvolvimento Econômico e Social. (2025). Indicadores de desenvolvimento sustentável por bacias hidrográficas do Estado do Paraná. Curitiba: IPARDES.
- Jacobi, P. R. (2003). Educação ambiental, cidadania e sustentabilidade. *Cadernos de Pesquisa*, 118, 189–205.
- Lane, B., Kastenholz, E., & Carneiro, M. J. (2022). Rural tourism and sustainability: A special issue, review and update for the opening years of the twenty-first century. *Sustainability*.
- Lima, F. (2019). Turismo comunitário e desenvolvimento local: Uma revisão integrativa sobre a Acolhida na Colônia.
- Lozada, G., & Nunes, K. S. (2019). Metodologia científica. Saaga.
- Marconi, M. A., & Lakatos, E. M. (2010). Fundamentos de metodologia científica (7. ed.). Atlas.

- MMA – Ministério do Meio Ambiente. (2018). Adaptação baseada em ecossistemas frente à mudança do clima – Apostila do curso. Brasília: MMA.
- Minayo, M. C. S. (2014). O desafio do conhecimento: Pesquisa qualitativa em saúde (14. ed.). Hucitec.
- Organização Mundial do Turismo. (2003). Guia de desenvolvimento do turismo sustentável. Bookman.
- Organização Mundial do Turismo. (2005). Tornando o turismo mais sustentável: Um guia para formuladores de políticas. PNUMA & UNWTO.
- Petrović, M. D., Vujko, A., Gajić, T., Vuković, D. B., Radovanović, M., Jovanović, J. M., & Vuković, N. (2018). Tourism as an approach to sustainable rural development in post-socialist countries: A comparative study of Serbia and Slovenia. Sustainability.
- Philippi Jr., A., et al. (2013). Desenvolvimento sustentável, interdisciplinaridade e ciências ambientais. Revista Brasileira de Pós-Graduação, 10(21).
- Philippi Jr., A., Romero, M. de A., & Bruna, G. C. (2014). Curso de gestão ambiental.
- Polukhina, A., Marina, S., Marina, E., Oxana, S., Oksana, A., & Anton A.-Ovseenko. (2021). The concept of sustainable rural tourism development in the face of COVID-19 crisis: Evidence from Russia. Journal of Risk and Financial Management.
- Reher, G. (2022). Heritage as action research. Sustainability.
- Richardson, R. J. (1999). Pesquisa social: Métodos e técnicas. Atlas.
- Sachs, I. (2008). Desenvolvimento: Incluyente, sustentável, sustentado. Garamond.
- Sanches, C. S. (2000). Gestão ambiental proativa. Revista de Administração de Empresas, 40(1), 76–87.
- SANEPAR – Companhia de Saneamento do Paraná. (2025). Plano diretor SAIC: Sistema de abastecimento de água integrado de Curitiba e região metropolitana. Curitiba.
- São José dos Pinhais. (2008). Dados estatísticos de São José dos Pinhais. Secretaria Municipal de Planejamento e Desenvolvimento Econômico.
- São José dos Pinhais. (2009). Mapa de referência geral (Escala 1:160.000). Secretaria Municipal de Urbanismo.
- Silva, E. L., & Menezes, E. M. (2005). Metodologia da pesquisa e elaboração de dissertação (4. ed.). UFSC.
- Souza, M., & Dolci, T. (2019). Turismo rural: Fundamentos e reflexões.
- Streimikiene, D., et al. (2021). Sustainable tourism development and competitiveness: The systematic literature review. Sustainable Development, 29(1), 259–271.
- Visentin, F., & Vallerani, F. (2018). A countryside to sip: Venice inland and the Prosecco's

uneasy relationship with wine tourism and rural exploitation. Sustainability.

LEGAL SECURITY IN DIGITAL ECOSYSTEMS: REGULATION BY PRINCIPLES AND SUPERVISED SELF-REGULATION FOR AI AND BLOCKCHAIN IN BRAZIL

SEGURANÇA JURÍDICA EM ECOSSISTEMAS DIGITAIS: REGULAÇÃO POR PRINCÍPIOS E AUTORREGULAÇÃO SUPERVISIONADA PARA IA E BLOCKCHAIN NO BRASIL

SEGURIDAD JURÍDICA EN ECOSISTEMAS DIGITALES: REGULACIÓN POR PRINCIPIOS Y AUTORREGULACIÓN SUPERVISADA PARA IA Y BLOCKCHAIN EN BRASIL



<https://doi.org/10.56238/sevened2026.008-194>

Sadre Pantoja Alho¹

ABSTRACT

This study addresses the dilemma of reconciling legal certainty—understood as normative predictability and protection of rights—with the accelerated pace of innovation in artificial intelligence and blockchain. It analyzes how principle-based regulation can provide flexibility, while supervised self-regulation (e.g., as provided for in Article 50 of the LGPD) encourages sector participation in the formulation of specific norms. The research proposes a risk-graded hybrid model, combining soft law and hard law, technical interoperability, auditable transparency mechanisms, ODR (Online Dispute Resolution), and economic instruments (insurance and compensation funds) to ensure effectiveness and effective protection in decentralized environments. This model is applied to the case of public registries, under the SIM (Sustainability–Interoperability–Regulatory Framework) hypothesis. As an international example, the MiCA and AI Act in the EU, sectoral arrangements in the USA, and initiatives in Argentina (blockchain digital identity) are examined.

Keywords: Legal Certainty. Artificial Intelligence. Blockchain. Principle-Based Regulation. Self-Regulation. LGPD (Brazilian General Data Protection Law). Digital Ecosystems.

RESUMO

Este estudo aborda o dilema de conciliar a segurança jurídica — entendida como previsibilidade normativa e proteção de direitos — com o ritmo acelerado de inovação em inteligência artificial e blockchain. Analisa-se como a regulação baseada em princípios pode conferir flexibilidade, enquanto a autorregulação supervisionada (p.ex., prevista no art. 50 da LGPD) incentiva a participação dos setores na formulação de normas específicas. A pesquisa propõe um modelo híbrido graduado por risco, combinando soft law e hard law, interoperabilidade técnica, mecanismos de transparência auditável, ODR (Resolução de Disputas Online) e instrumentos econômicos (seguros e fundos de compensação) para assegurar eficácia e proteção efetiva em ambientes descentralizados. Aplica-se esse modelo ao caso dos registros públicos, sob a hipótese SIM (Sustentabilidade–Interoperabilidade–

¹ Doctoral student in Legal Sciences. Universidad del Museo Social Argentino (UMSA)
E-mail: sadrepantoja@gmail.com

Marco regulatório). Como exemplo internacional, examinam-se o MiCA e AI Act na UE, arranjos setoriais nos EUA e iniciativas na Argentina (identidade digital blockchain).

Palavras-chave: Segurança Jurídica. Inteligência Artificial. Blockchain. Regulação por Princípios. Autorregulação. LGPD. Ecossistemas Digitais.

RESUMEN

Este estudio aborda el dilema de conciliar la seguridad jurídica —entendida como previsibilidad normativa y protección de derechos— con el ritmo acelerado de la innovación en inteligencia artificial y blockchain. Analiza cómo la regulación basada en principios puede brindar flexibilidad, mientras que la autorregulación supervisada (p. ej., la prevista en el artículo 50 de la LGPD) fomenta la participación sectorial en la formulación de normas específicas. La investigación propone un modelo híbrido con evaluación de riesgos, que combina derecho indicativo y vinculante, interoperabilidad técnica, mecanismos de transparencia auditables, resolución de disputas en línea (ODR) e instrumentos económicos (seguros y fondos de compensación) para garantizar la eficacia y la protección efectiva en entornos descentralizados. Este modelo se aplica al caso de los registros públicos, bajo la hipótesis SIM (Sostenibilidad-Interoperabilidad-Marco Regulatorio). Como ejemplo internacional, se examinan la Ley de Inteligencia Artificial (MiCA) y la Ley de Inteligencia Artificial en la UE, los acuerdos sectoriales en EE. UU. y las iniciativas en Argentina (identidad digital blockchain).

Palabras clave: Seguridad Jurídica. Inteligencia Artificial. Blockchain. Regulación por Principios. Autorregulación. LGPD (Ley General de Protección de Datos de Brasil). Ecosistemas Digitales.

1 INTRODUCTION

In emerging digital environments (AI and blockchain) there is tension between the need for legal certainty, that is, predictability, coherence and stability in the rules that regulate rights and responsibilities and the speed of technological innovations. While legal certainty favors decisions with *a degree of certainty* as to the legal consequences, innovation requires regulatory flexibility. As a study by the legislative branch observes, "experimentation requires predictability and legal certainty. In innovation, mistakes are expected, as long as they are not gross, because that is how... new technologies ... are developed". The challenge is to reconcile these forces, avoiding gray areas of uncertainty regarding responsibility and jurisdiction in decentralized systems without stifling innovative potential.

The central problem of this work is: how to reconcile normative predictability and the protection of rights with the speed of innovation in AI and blockchain, reducing the areas of uncertainty ("gray zones") about liability, jurisdiction, and redress in decentralized environments? This issue has great public relevance, as deregulation can undermine the confidence of users and investors, while rigid and detailed regulation can stifle technological development.

In particular, blockchain and AI-based systems generate unprecedented enforcement challenges: decentralization makes it difficult to identify who is the holder of the duty (user, developer, or platform) and which law to apply in cross-border cases. The starting hypothesis is that a hybrid regulatory model (principle + supervised self-regulation) graded by risk can offer a dynamic balance, ensuring transparency and effective means of redress even in high innovation scenarios.

The overall objective is to propose a hybrid normative model for AI and blockchain in Brazil, which combines regulation by principles (general high-level norms) with self-regulation supervised by the affected sectors, in order to differentiate duties and responsibilities according to the risk of each activity. It also seeks to establish governance mechanisms (transparency, ODR, insurance, funds) that enable effective execution of duties and reparation of damages. Specific objectives include: analyzing theories and examples of legal certainty, regulation by principles and sectoral self-regulation (e.g. art. 50 of the LGPD); (examine relevant international experiences (Europe, USA, Argentina) in blockchain and AI.

The research follows a qualitative and normative approach, combining bibliographic and documentary review. It uses analysis of constitutional principles (economic, procedural and technological) and doctrine on regulation and digital governance. A comparative study of legislation and proposals (bills and regulations) is carried out, as well as sectoral experiences (e.g., sandbox, codes of conduct). The delimitation falls on the recent Brazilian and

international context (until 2025). Key operational concepts: digital ecosystems (integrated AI and blockchain applications); regulation by principles (regulatory principles that guide, but do not standardize in detail); supervised self-regulation (standards developed by the sectors, recognized and inspected by public authority, according to LGPD art. 50); legal certainty (right to predictability and normative stability).

2 THEORETICAL-NORMATIVE FOUNDATIONS

2.1 LEGAL CERTAINTY AND REGULATION BY PRINCIPLES

Legal certainty occupies a central position in the theory of the Rule of Law and works as a minimum condition of predictability for any project to regulate digital ecosystems. At the Brazilian constitutional level, it is extracted from the set of guarantees of article 5 of the 1988 Constitution – especially the protection of acquired rights, the perfect legal act and *res judicata* (article 5, XXXVI) – as well as from the principles of legality, impersonality, morality, publicity and efficiency provided for in article 37, caput (Brasil, 1988). This constitutional basis indicates that the Law must ensure a minimally stable, comprehensible and predictable horizon, in order to allow individuals and organizations to plan their conduct without being surprised by sudden changes in the legal system.

Humberto Ávila develops perhaps the most influential formulation of this idea when dealing with legal certainty as a structuring principle. In his *Theory of Legal Certainty*, the author distinguishes a static dimension, linked to the knowability of Law, and a dynamic dimension, connected to the reliability and calculability of norms (Ávila, 2016). Knowability refers to the requirement that the legal system be minimally intelligible, so that the citizen can understand the content and scope of legal commands; reliability is aimed at the stability of the normative order, preventing the person from having frustrated the trust placed in a certain state of affairs; calculability, in turn, points to the need for changes to occur smoothly, allowing reasonable projections for the future (Ávila, 2016; Valiati, 2015).

To face this type of scenario, a significant portion of the doctrine points out that rigid models, entirely based on detailed rules, tend to age quickly and produce even greater informational asymmetry. Regulation by strictly casuistic commands, dependent on successive legislative changes, finds it evidently difficult to keep up with the pace of innovation (Freitas, 2016; Moreira Neto, 2005). Hence the growing attention given to the so-called regulation by principles, in which the normative core is composed of open standards – such as transparency, diligence, proportionality, equity or algorithmic accountability – which guide the actions of regulators and economic agents in new situations, not yet foreseen by

the legislator. Argumentative on the part of the regulatory agencies and the regulated themselves.

Lacerda (2021), when analyzing accounting models inspired by principles, shows that:

The use of standards increases the space for professional judgment, but simultaneously reinforces the need for transparency of reasons and more sophisticated institutional controls. This logic can be transposed to the domain of AI and blockchain: principles such as explainability, data governance, and harm prevention do not in themselves exhaust the content of the obligation, but serve as mandatory guidance axes for regulators, developers, and platform operators.

In the current Brazilian debate, the National Petroleum Agency and the Federal Government, in documents of good regulatory practices, already recognize principle-based regulation as an appropriate instrument in sectors characterized by high innovation, precisely because it allows gradual adaptation to technological changes, without giving up minimum commands and enforcement mechanisms (National Petroleum Agency, 2019; Fonseca & Costa, 2020). Recent studies on regulatory law, in turn, describe this movement as a transition from a "command and control" model to more cooperative and responsive arrangements (Guerra, 2011; Freitas, 2016).

It is precisely at this point that the concept of responsive regulation comes in, originally developed by Ian Ayres and John Braithwaite in *Responsive Regulation: Transcending the Deregulation Debate* (Ayres & Braithwaite, 1995). The authors propose a "regulatory pyramid" in which instruments of persuasion, cooperation, and self-regulation occupy the lower rungs, while more severe sanctions and rigid commands appear at the higher levels, activated only in case of resistance or recidivism. The logic of responsiveness consists of calibrating the State's reaction according to the behavior of those regulated, combining stimuli, monitoring, and graduated punishment, with the aim of strengthening voluntary compliance and reducing supervisory costs.

In Brazil, this paradigm is beginning to be absorbed in various sectors, including the administrative law that sanctions regulatory agencies. Rodrigues (2025) describes responsive regulation as a model that seeks to reconcile normative flexibility with the preservation of the public interest, through mechanisms of listening, cooperation, and only subsequent application of sanctions, when necessary (Rodrigues, 2025).

This dialogue between legal certainty, principled regulation, and responsive regulation offers a particularly useful theoretical key for digital ecosystems. Instead of a closed set of detailed rules, what is projected is a system of structuring principles – human dignity, data protection, free enterprise, consumer protection, net neutrality, algorithmic non-

discrimination, transparency, accountability – combined with gradual enforcement mechanisms. Regulators establish mandatory, risk-based general parameters, while private actors develop codes of conduct, compliance programs, and supervised self-regulation arrangements, subject to audits, ongoing oversight, and proportionate sanctions in case of non-compliance.

In the specific field of AI and blockchain, this arrangement is compatible with the requirement of normative predictability without technological stiffening. From the point of view of legal certainty, clear and stable principles – such as the obligation to assess the impact of AI, the duty to record immutable logs in distributed networks, governance requirements, and technical documentation – allow economic agents to understand the parameters of action in advance, even if the concrete form of compliance varies according to the business model and the degree of risk. Responsive regulation, in turn, offers the tools to grade duties and reactions according to the history of compliance, the criticality of the application, and the potential for harm, preserving the ideals of knowability, reliability, and calculability highlighted by Ávila (2016).

2.2 SUPERVISED SELF-REGULATION (LGPD, ART. 50, AND SECTORAL EXPERIENCES)

Supervised self-regulation (or co-regulation) is an instrument where economic sectors develop standards of good practices that are recognized by public authority. In Brazil, the LGPD inaugurated this idea in article 50, allowing controllers and operators, alone or via associations, to formulate "rules of good practice and governance" regarding data processing

. These rules should detail organizational conditions, procedures, safety, technical standards, supervision and risk mitigation (e.g., claims from data subjects, educational actions)

. Paragraph 1 of article 50 requires that these rules consider "nature, scope, purpose, probability and severity of the risks and benefits" of the treatment, demonstrating a focus on sectoral proportionality. Once recognized by the ANPD, such rules are disclosed as a reference for the sector, constituting a kind of certificate of compliance.

In the current Brazilian debate, the National Petroleum Agency and the Federal Government, in documents of good regulatory practices, already recognize principle-based regulation as an appropriate instrument in sectors characterized by high innovation, precisely because it allows gradual adaptation to technological changes, without giving up minimum commands and enforcement mechanisms (National Petroleum Agency, 2019; Fonseca & Costa, 2020). Recent studies on regulatory law, in turn, describe this movement as a

transition from a "command and control" model to more cooperative and responsive arrangements (Guerra, 2011; Freitas, 2016).

It is precisely at this point that the concept of responsive regulation comes in, originally developed by Ian Ayres and John Braithwaite in *Responsive Regulation: Transcending the Deregulation Debate* (Ayres & Braithwaite, 1995). The authors propose a "regulatory pyramid" in which instruments of persuasion, cooperation, and self-regulation occupy the lower rungs, while more severe sanctions and rigid commands appear at the higher levels, activated only in case of resistance or recidivism. The logic of responsiveness consists of calibrating the State's reaction according to the behavior of those regulated, combining stimuli, monitoring, and graduated punishment, with the aim of strengthening voluntary compliance and reducing supervisory costs.

In Brazil, this paradigm is beginning to be absorbed in various sectors, including the administrative law that sanctions regulatory agencies. Rodrigues (2025) describes responsive regulation as a model that seeks to reconcile normative flexibility with the preservation of the public interest, through mechanisms of listening, cooperation, and only subsequent application of sanctions, when necessary (Rodrigues, 2025).

This dialogue between legal certainty, principled regulation, and responsive regulation offers a particularly useful theoretical key for digital ecosystems. Instead of a closed set of detailed rules, what is projected is a system of structuring principles – human dignity, data protection, free enterprise, consumer protection, net neutrality, algorithmic non-discrimination, transparency, accountability – combined with gradual enforcement mechanisms. Regulators establish mandatory, risk-based general parameters, while private actors develop codes of conduct, compliance programs, and supervised self-regulation arrangements, subject to audits, ongoing oversight, and proportionate sanctions in case of non-compliance.

2.3 REGULATORY LAG, HARD/SOFT LAW AND INSTITUTIONAL COORDINATION IN BRAZIL

The concept of regulatory lag refers to the mismatch between the pace of innovation and the ability to create state standards. In the digital world, products and services evolve faster than specific laws. To overcome this mismatch, *soft law instruments* (guidelines, guides, voluntary technical standards) and responsive approaches are adopted. In Brazil, there is a tendency to prioritize general norms and impact assessment when legislating innovations. The State encourages experimental regulation (e.g., financial/technological sandbox decree, cooperative self-regulation) precisely because it recognizes that "regulatory

measures without legislative approval should be preferred, given their potential for celebrated responsiveness." In other words, in the face of lag, it is preferable to delegate powers (via agencies, cooperative agreements, and administrative resolutions) than to allow sandbox or sectoral codes.

This strategy implies institutional coordination between agencies involved. For example, the ANPD has signed technical cooperation agreements with Senacon, CADE, NIC.br and TSE to align data protection with competition and open internet. The CNJ and the CNMP dialogue on judicial AI initiatives, and other regulatory agencies (SUSEP in fintechs, ANATEL in IoT) develop specific sectoral rules. However, Brazil still lacks a central integrated digital governance body. The Judiciary, in turn, deals with emerging litigation without a single standard, which reinforces the need for coherent guidelines. In this panorama, a distinction is made between hard law (laws, decrees, resolutions) and soft law (codes of conduct, recommendations, certifications). The strategic use of soft law can speed up responses without giving up regulation when necessary. Social participation and transparency (public hearings, public consultation) are crucial to legitimize this regulatory flexibility.

2.4 JURISDICTION, LIABILITY AND REDRESS IN DECENTRALIZED ENVIRONMENTS

Werbach (2018) describes blockchain as a new trust architecture, in which participants come to trust the distributed system and its consensus mechanisms, without depending on the reliability of a specific intermediary.

This form of organization, based on relative immutability, transparency, and automation of executions, reconfigures points of contact between fact and right: the "place" of the transaction no longer corresponds to a physical territory, and the very definition of who "acts" starts to involve protocol developers, infrastructure operators, token issuers, wallet providers, access platforms (front-ends), and end users. De Filippi and Wright (2018) call this environment a *rule of code*, indicating that the set of rules inscribed in the blockchain can form a kind of "lex cryptographica", still subject, however, to state orders that continue to provide sanction, legitimate coercion and reparation structures.

In terms of jurisdiction, the Law of Introduction to the Rules of Brazilian Law (LINDB) already guides the resolution of conflicts in time and space, functioning as a statute of private international law, with criteria such as the domicile of the parties, the place of the constitution of the obligation, the place where the damage occurred and the place of performance (articles 7, 9 and 12).

In decentralized environments, these elements become diffuse: the smart contract can be programmed in one country, run on globally distributed nodes, bind parties residing in

different jurisdictions, and produce economic effects in third-state markets. Finck (2019), when examining blockchain regulation and governance in Europe, underlines that decentralization tends to fragment traditional points of connection, which requires renewed focus on actors that "anchor" the network at the physical plane, such as exchanges, enterprise node operators, and user interface providers.

De Filippi and Wright (2018) highlight that many blockchain projects have attempted to present themselves as "beyond the reach" of any national authority, which has led to dramatic experiments, such as the collapse of *The DAO*, which revealed limits of purely algorithmic self-organization.

Werbach (2017; 2018) argues that:

Blockchain and law are both trust mechanisms; Networks that ignore the incidence of state rules end up, at some point, depending on cuts, regulators, or traditional enforcement mechanisms to correct bugs, fraud, or contractual imbalances. Consequently, the difficulty does not lie in the supposed "absence of jurisdiction", but in identifying which States have sufficient connection with the litigation and on which actors decisions on liability and reparation will fall.

In the Brazilian context, the Brazilian Civil Rights Framework for the Internet (Law No. 12,965/2014) has already addressed part of these issues within the scope of centralized platforms, by disciplining the liability of connection and application providers for acts of third parties (articles 18 to 21), as well as by requiring providers operating in the country to comply with Brazilian legislation and comply with court orders. even if they are headquartered abroad (art. 11). Recent debates on the partial constitutionality of article 19, which conditioned liability to the existence of a prior court order, show that models that are excessively protective in relation to intermediaries can generate deficits in the protection of fundamental rights. The discussion still revolves around platforms such as social networks and hosting services, but the logic of gradation of responsibility as a function of control over content, economic benefit, and the ability to prevent harm offers useful parameters for environments in which smart contracts and distributed ledgers structure the provision of services.

The Brazilian experience with the responsibility of application providers in centralized platforms offers relevant lessons. Studies by Micheletti (2023) and Pereira (2022) show that the original design of article 19 of the Marco Civil worked as a containment valve for liability, by requiring a specific court order to form the duty of removal and, consequently, liability for damages arising from third-party content.

The legal evolution that has been relativizing this shielding in situations of serious violation of fundamental rights, indicates a tendency to approximate the responsibility of

digital platforms and expanded duties of care in the protection of assets such as dignity, equality and psychophysical integrity. This movement signals that, in AI and blockchain contexts, it will be difficult to accept a narrative that presents decentralization as an absolute mechanism for excluding liability, especially when there is informational and technical asymmetry to the detriment of the user.

3 INTERNATIONAL COMPARISON

3.1 EUROPEAN UNION: MICA AND AI ACT (SCHEDULE AND RISK OBLIGATIONS)

In recent years, the European Union has consolidated a regulatory bloc focused on digital ecosystems that combines the protection of fundamental rights, financial stability, and the stimulation of innovation. In the crypto field, Regulation (EU) 2023/1114, known as Markets in Crypto-Assets (MiCA), created a uniform framework for crypto-assets that were not covered by previous financial standards, with a focus on crypto-asset issuers and service providers (CASPs) (European Securities and Markets Authority [ESMA], 2024; European Central Bank, 2023).

MiCA structures the market into categories, such as *asset-referenced tokens* (ARTs), *e-money tokens* (EMTs), and other cryptoassets, establishing requirements for authorization, transparency, governance, and prudential rules proportional to the nature of the asset and the associated systemic risk (Hogan Lovells, 2025; Central Bank of Ireland, 2024). In issuers of stablecoins backed by currency or baskets of assets, the regulation imposes reserve requirements, liquidity management policies, disclosure rules, and volume limits, aiming to reduce run risks and financial contagion (Cyfrin, 2025; AMF, 2024).

The application schedule reinforces the gradual and risk-based logic. The text entered into force in June 2023, with the rules on ARTs and EMTs coming into force on June 30, 2024, and the rest of the regime – especially the obligations of CASPs – applicable as of December 30, 2024 (Cyfrin, 2025; ESMA, 2024).

Member states can grant a transition period of up to 18 months for already active providers, which creates a kind of "regulatory ramp" that tries to reconcile legal certainty and not sudden interruption of services (Squire Patton Boggs, 2025).

Another relevant point of MiCA is the *passporting mechanism*: once authorized in a Member State, the CASP can provide services throughout the single market, through notifications and cooperation between national authorities (Central Bank of Ireland, 2024; Hogan Lovells, 2025).

This structure reduces costs of multiple licenses, but requires intense regulatory coordination, with common supervisory guidelines and information exchange channels. In

terms of legal certainty, the main effect is to convert a mosaic of national regimes into a homogeneous set of minimum obligations, which are now valid for the entire European crypto-asset ecosystem.

In the field of artificial intelligence, the European Union approved the AI Act, described by the European institutions themselves as the first comprehensive regulatory framework aimed at AI systems. The regulation adopts a clearly risk-based approach, with a prohibition of certain practices (such as *social scoring* systems and massive real-time biometric surveillance) and a strict regime for "high-risk" systems, which need to comply with governance, documentation, risk management, data quality, and human oversight requirements (European Commission, 2025; European Parliamentary Research Service, 2025).

The implementation timeline is staggered. The bans came into effect in February 2025; as of August 2025, specific obligations for general-purpose models arise; and, in August 2026, the application of the full regime for high-risk systems begins, with an extended deadline for legacy systems until 2027 (European Parliamentary Research Service, 2025; Trilateral Research, 2025; Reuters, 2025).

The regulation also requires each member state to create at least one AI regulatory sandbox by August 2026, with the aim of testing solutions in a controlled environment and under the supervision of the competent authorities (AIAct.eu, 2025).

The literature highlights that both MiCA and the AI Act illustrate a style of regulation in which the European legislator tries to anticipate risks and establish a horizontal framework that will then be implemented by guides, technical standards, and decisions of sectoral authorities (Finck, 2019; Sartor, 2020). In terms of legal certainty, this model tends to produce greater predictability about licensing criteria, risk classification, due diligence duties, and liability possibilities, even though it creates significant regulatory costs.

Another characteristic that is of direct interest to the TCC is the connection between risk-based regulation and reparation mechanisms. In the AI Act, there is provision for robust documentation, event records, and traceability, which facilitate proof in litigation involving damage caused by AI systems (European Commission, 2025; European Parliament, 2025).

In MiCA, CASPs need to have complaint handling mechanisms, conflict of interest management policies, and procedures for handling security incidents, which opens space for integration with ODR and liability insurance (ESMA, 2024; AMF, 2024).

3.2 UNITED STATES: MULTISTEEP ARRANGEMENT OF AGENCIES (FUNCTIONAL SYNTHESIS)

The North American case follows a logic almost opposite to the European one. Instead of a single regulation for AI or cryptoassets, the country operates with a dispersed set of sectoral rules, administrative guidelines, *technical guidelines*, and multi-agency enforcement. The Congressional Research Service survey records that, until mid-2025, there was no broad federal legislation on AI, with a predominance of specific laws and administrative policies, focusing on national security, defense, privacy in specific sectors, and consumption (Congressional Research Service, 2025).

In the field of AI, the federal government has been betting on *soft law instruments*. In 2023, the National Institute of Standards and Technology (NIST) published the AI Risk Management Framework, designed as a voluntary guide for organizations that want to structure risk governance in AI, with an emphasis on reliability, transparency, fairness, and bias mitigation (NIST, 2023).

In 2023, an executive order was issued on "safe and reliable" AI development, followed by *America's AI Action Plan* of 2025, which sets public policy goals and assigns tasks to bodies such as NIST, the Department of Commerce, the Federal Trade Commission (FTC), and the Department of Justice (DOJ) (White House, 2023; White House, 2025).

The literature describes this architecture as a decentralized model, based on independent agencies, with strong use of technical guidelines and ex post enforcement. Davtyan (2025) analyzes that the North American approach is based on a combination of voluntary commitments by companies, *guidelines* from agencies such as NIST, FTC, and FDA, and repressive action by the DOJ in cases of abusive use of AI, without a single framework comparable to the AI Act (Davtyan, 2025; Associated Press, 2024).

In terms of cryptoassets, fragmentation becomes even more evident. The market is overseen by a set of bodies that includes the Securities and Exchange Commission (SEC), the Commodity Futures Trading Commission (CFTC), the Department of the Treasury (via FinCEN and OFAC), federal banking regulators (Federal Reserve, OCC, FDIC), as well as state agencies responsible for securities transfer licenses and consumer protection (Latham & Watkins, 2025; Holland & Knight, 2025).

The SEC generally classifies certain cryptoassets as securities, based on the *investment contract test* derived from *SEC v. Howey Co.*, and oversees public offerings, exchanges, and *tokens* that qualify as securities (Merkle Science, 2024; SEC, 2025).

The CFTC treats cryptoassets as commodities in derivatives markets, with jurisdiction over futures contracts, *swaps*, and margin markets, in addition to overseeing manipulation and fraud (CFTC, 2025; WilmerHale, 2025).

A recent report on the blockchain and crypto regulatory framework in the U.S. describes this arrangement as dynamic overlap: SEC and CFTC vie for spaces of competence, while FinCEN applies anti-money laundering standards and OFAC controls sanctions, generating a scenario in which the same platform may be subject to multiple chains of obligations, often with interpretive divergences (Holland & Knight, 2025).

In the field of liability, the absence of a single framework means that traditional principles of *securities law*, consumer protection, and civil liability are projected on cases involving AI and cryptoassets. The FTC has been signaling that deceptive practices associated with AI – for example, unsubstantiated claims about system capabilities – can be framed as *unfair or deceptive acts or practices*, while the DOJ has already announced that the use of AI to intensify white-collar crimes can aggravate penalties (Department of Justice, 2024).

At the federal level, state initiatives to regulate AI and crypto are increasing, which has led to discussions about an eventual executive order to limit state laws considered overly restrictive (Politico, 2025).

From the perspective of legal certainty, this multi-steep arrangement produces important ambiguity. There is a high capacity for reaction on the part of agencies, which can issue quick guidelines and act in enforcement, but economic agents deal with uncertainty about the legal classification of assets, the boundary between the competence of the SEC and the CFTC, the incidence of state rules and the possibility of changes in guidance according to the Administration in office (Wired, 2025; Latham & Watkins, 2025). At the same time, this model reveals useful instruments for interagency coordination and intensive use of technical standards and *guidelines* that can inspire responsive arrangements in the Brazilian context.

3.3 ARGENTINA: REGISTRY DIGITIZATION, DIGITAL IDENTITY/SIGNATURE, AND AI/BLOCKCHAIN INITIATIVES

The Argentine experience offers an example of a Latin American country that consolidated, relatively early, a legal basis for digital documents and signatures and has progressively been incorporating distributed ledger technologies into digital government policies and sectoral initiatives. Law No. 25,506 of 2001 instituted the digital and electronic signature regime, recognizing the legal effectiveness of digitally signed electronic documents

and creating the Digital Signature Infrastructure of the Argentine Republic (IFDRA) (Argentina, 2001; Argentina.gob.ar, 2016).

Subsequent norms, such as Law 27,446 and regulatory decrees, updated this framework, integrating the digital signature into the electronic document management of the Public Administration and encouraging its use in contracts, administrative petitions, and registration acts (Argentina.gob.ar, 2016; Ecertla, 2023).

The doctrine points out that this arrangement conferred on the digital signature a status equivalent to that of the handwritten signature, provided that certification and integrity requirements were respected, which allowed the expansion of digital legal services, such as electronic orders and distance notarial procedures (CheersContracts, 2025).

In the field of registry digitization, several projects explore the use of blockchain as an additional layer of reliability. A study by Pagella (2022) analyzes the application of blockchain in the Real Estate Property Registry of the Federal Capital, evaluating potential gains in authenticity, immutability, and traceability of registration acts (Pagella, 2022).

The same line appears in projects such as the Public Registry of University Graduates, whose database, linked to the Ministry of Education, has started to use blockchain to authenticate diplomas and academic transcripts, allowing third parties to verify the veracity of the information in a public and auditable way (Blockchain Federal Argentina, n.d.).

There are also regional normative initiatives that explicitly mention distributed ledgers. The Digital Public Transformation Plan of the province of Santa Cruz, for example, authorizes the Executive to employ distributed ledger technologies and blockchain networks, public or private, in digital government services, teleworking, and administrative processes, with a view to increasing transparency and trust (Santa Cruz, 2022). [Saij](#) Public petitions submitted to national authorities request the incorporation of blockchain into public registries on the grounds that the technology could reduce corruption, fraud, and delays in registration procedures (Change.org, 2025).

The most visible case in the international debate, however, is the decentralized digital identity project of the city of Buenos Aires. In 2024, the capital launched the QuarkID system, integrated with the miBA application, with the proposal to offer blockchain-based digital credentials, supported by zero-knowledge proofs, which allow citizens to demonstrate attributes (such as age or educational status) with minimal exposure of personal data (Borak, 2024; Coindesk, 2024; ZKsync, 2024).

Official reports indicate that the project aims to reach around 3.6 million residents, configuring the first decentralized identity initiative enabled by a municipal government on a scale of this magnitude (Dig.watch, 2024; ZKsync, 2024).

The logic behind QuarkID is associated with the idea of *self-sovereign identity (SSI)*, in which the holder maintains control over his credentials, which can be verified by third parties without the need to retain data in large centralized databases. From the point of view of legal certainty, this experience shows an effort to reconcile fundamental privacy rights, robust authentication, and record integrity requirements. The choice of protocols with zero-knowledge proofs indicates an explicit concern with proportionality in data exposure and with the possibility of technical auditing of validation mechanisms (Portaldobitcoin, 2024; Chainwire, 2024; BrazilCrypto, 2024).

It is also possible to observe that the advancement of registry digitization and digital identity projects in Argentina occurs in dialogue with the digital signature framework and the existing certification infrastructure. The dominant interpretation maintains the idea that electronic documents signed with a valid certificate enjoy a presumption of authenticity and integrity, which facilitates the integration between traditional records and solutions based on blockchain and AI, used as additional layers of proof or automation of verifications (Argentina.gob.ar, 2016; CheersContracts, 2025).

Together, these elements make up a scenario in which Argentina combines, on the one hand, a relatively consolidated legal basis in terms of documents and digital signatures; on the other, experimental pilots in decentralized identity and the use of blockchain in public records, still in the maturation phase, but relevant as a normative laboratory for the region.

3.4 COMPARATIVE SYNTHESIS AND LESSONS FOR BRAZIL

The comparison between the European Union, the United States, and Argentina reveals three distinct ways of facing the legal risks associated with AI, cryptoassets, and distributed ledgers. The European model, represented by MiCA and the AI Act, favors horizontal and detailed regulations, anchored in a risk approach and combined with clear timelines, regulatory sandboxes, and structured supervisory mechanisms. The main consequence is a high degree of predictability regarding risk categories, authorization requirements and possible sanctions, with high regulatory costs and strong centrality of European authorities.

The North American arrangement, in turn, is supported by a network of agencies with competences over fragments of the digital ecosystem. The absence of an AI Act or a federal MiCA means that *securities law*, consumer law, anti-money laundering, competition, and data protection standards are projected on AI and blockchain on a case-by-case basis, complemented by technical *guidelines* such as the NIST AI RMF and executive orders (NIST, 2023; Davtyan, 2025; Congressional Research Service, 2025).

This reinforces flexibility, but increases uncertainty regarding the future of interpretations and the division of competence between agencies such as the SEC, CFTC, FTC, FinCEN, and state regulators (Latham & Watkins, 2025; Holland & Knight, 2025).

The Argentine experience occupies an intermediate position. The country has consolidated, with Law 25.506 and updates, a relatively cohesive digital signature and electronic document regime, which serves as a basis for digitizing services, administrative processes and records. From this base, projects for the use of blockchain in property records and diplomas emerge, as well as the QuarkID initiative in Buenos Aires, with decentralized digital identity supported by zero-knowledge proofs (Pagella, 2022; Blockchain Federal Argentina, n.d.; Dig.watch, 2024; ZKsync, 2024).

For the Brazilian debate on legal certainty in digital ecosystems, these three experiences generate some central lessons, directly related to the hypothesis of a hybrid model based on regulation by principles and supervised self-regulation:

Grading duties by risk, as in the AI Act and MiCA, is compatible with the idea of modulating obligations along the protocol, infrastructure, enforcement, and intermediation layers, including in the context of public registries and AI applied to notarial and registry services.

Passportization and mutual recognition of compliance programs, typical of MiCA, point the way for codes of conduct and governance programs in AI and blockchain in Brazil to be recognized by sectoral authorities, with effects on different markets, reducing the costs of multiple authorizations.

Interagency coordination, although unequal in the North American model, provides examples of mechanisms for articulation between financial agencies, consumer protection, data protection, and competition, a relevant aspect in view of the overlap between the Central Bank, CVM, Cade, ANPD, and the Judiciary on the topic of AI/blockchain.

Anchoring in digital identity and signature frameworks, as observed in Argentina, indicates that any blockchain-based registry ecosystem design needs to dialogue with the existing infrastructure of ICP-Brasil, digital certification, advanced signatures, and new identification models, including decentralized solutions compatible with data protection rights (ZKsync, 2024).

From this perspective, the international comparison reinforces the plausibility of the SIM (Sustainability–Interoperability–Regulatory Framework) hypothesis applied to Brazilian public registries.

The institutional sustainability of services, technical-normative interoperability and the construction of a regulatory framework that combines clear principles, supervised self-regulation and effective instruments of execution and reparation are found in the European, North American and Argentine experience.

4 CONCLUSION

In summary, the article started from the observation that the expansion of digital ecosystems based on artificial intelligence and blockchain intensifies a classic dilemma of the Rule of Law: on the one hand, the requirement of legal certainty, translated into predictability, minimum stability, and the possibility of calculating the legal consequences of conduct; on the other hand, the need for sufficient normative openness so as not to stifle innovation processes that develop in cycles much faster than legislative time. The initial question — how to reconcile normative predictability and protection of rights with the speed of innovation in decentralized environments — guided the analysis of constitutional foundations, regulatory models, and foreign experiences, allowing us to propose an intermediate path between deregulation and excessive legal detail.

The reconstruction of legal certainty as a structuring principle showed that it is not reduced to the literal conservation of norms, but involves knowability, reliability and the possibility of planning. From there, the work indicated that a model strictly based on rigid, casuistic, and frequently changed rules tends to aggravate uncertainty in complex technological contexts, as it generates successive "layers" of regulation that are unable to keep up with reality. On the other hand, regulation by principles and responsive regulation emerge as more appropriate alternatives for digital ecosystems: principles such as transparency, prevention, proportionality, and data governance work as stable normative axes, while responsiveness allows calibrating state action according to the risk of the activity and the behavior of the agents.

Within this framework, supervised self-regulation gained special prominence. Recent experience in data protection, with codes of conduct and governance programs recognized by specialized authorities, shows that economic sectors and public agencies can take responsibility for the implementation of standards, as long as they remain subject to constitutional and legal parameters. Instead of a State that tries to anticipate, alone, all technical solutions, a dynamic is designed in which regulators define objectives, principles, and risk benchmarks, while regulated subjects detail operational standards in dialogue with these benchmarks, under monitoring, auditing, and the real possibility of sanction. Such an arrangement demonstrates potential to deal with rapidly changing technologies, without giving up public control or channels of accountability and reparation.

The analysis of jurisdiction, liability, and redress in decentralized environments has shown that the "lawlessness" narrative in blockchain and distributed AI does not hold water. Decentralization complicates the mapping of who acts, where they act, and with which law they are bound, but it does not eliminate the presence of identifiable actors who design

protocols, maintain infrastructures, operate interfaces, and economically exploit digital services. The conclusion that is required is that legal certainty in these ecosystems depends on the construction of a network of graduated responsibilities, distributed across the layers of protocol, infrastructure, application, intermediation and use, with more intense duties for those who have greater technical and economic capacity to prevent damages, without completely excluding the co-responsibility of users when they act intentionally or in manifest contravention of the established rules.

The comparative examination of the European Union, the United States and Argentina reinforced this perception. The European model, with comprehensive regulations and a risk-based approach, shows that it is possible to establish clear categories, implementation schedules and mandatory sandboxes, generating a high degree of predictability, even at the cost of greater regulatory density. The North American arrangement, more fragmented and based on multiple agencies and soft law instruments, reveals a great capacity for reaction and adaptation, but also significant uncertainty regarding the distribution of competences and the future of interpretations. The Argentine experience, by consolidating a regime of documents and digital signatures and from it experimenting with blockchain applications in records and digital identity, highlights the importance of a well-defined legal basis for innovative projects to find institutional and evidentiary anchorage.

When this set of elements is projected on the universe of Brazilian public records, the hypothesis of a hybrid model based on the triad Sustainability-Interoperability-Regulatory Framework gains consistency. Sustainability refers to the economic and institutional viability of services in the face of intensive digitalization, including investments in technological infrastructure, information security, and team training. Interoperability involves building technical and regulatory solutions that allow distributed ledgers, metadata, APIs, and AI systems to converse with registry legislation, civil procedure, public key infrastructure, and personal data protection, in order to ensure evidentiary admissibility, traceability, and auditability. The regulatory framework component, on the other hand, refers to the need to explain, in general rules and supervised self-regulation instruments, who is responsible for which risks in each layer of the digital registry ecosystem, with concrete instruments of protection, such as ODR, insurance, and compensation funds.

From this path stems a central conclusion: legal certainty in digital ecosystems does not require the paralysis of innovation, but rather the construction of an environment in which relevant innovations are developed within a minimally stable framework of principles, duties and consequences. A hybrid model, based on regulation by principles, responsive regulation, and supervised self-regulation, with grading of duties by risk and sectoral application to public

registries under the SIM hypothesis, is capable of reducing gray areas of liability, jurisdiction, and redress in decentralized environments, without stifling technological experimentation. The need to deepen the practical application of these guidelines in pilot projects, to empirically measure their effects in terms of efficiency, trust and reduction of litigation, and to adjust, based on these results, the proposed governance matrix remains open. The point of arrival of this article, therefore, is the assertion that the challenge posed by AI and blockchain to Brazilian Law is not merely technological, but institutional and hermeneutic, and that its most promising response lies in a balanced combination of clear principles, regulatory cooperation, and shared responsibility.

REFERENCES

- Affonso, G. B. (2023). A responsabilidade civil objetiva pelos danos causados por sistemas de inteligência artificial. *Raízes no Direito*, 9(2).
- Agência Europeia de Valores Mobiliários. (2024). Markets in Crypto-Assets Regulation (MiCA). <https://www.esma.europa.eu>
- Agência Nacional de Proteção de Dados. (2023). Relatórios e estudos sobre modelos de fiscalização e regulação responsiva. Brasília: ANPD.
- Agência Nacional do Petróleo. (2019). Manual de boas práticas regulatórias. Brasília: ANP.
- AIAct.eu. (2025). AI regulatory sandbox approaches: EU Member State overview. <https://artificialintelligenceact.eu>
- Almeida, B. S. C. (2020). Aplicabilidade dos smart contracts nas instituições financeiras. *Revista do Banco Central do Brasil*, 16(2).
- Argentina. (2001). Ley 25.506 – Ley de Firma Digital. <https://servicios.infoleg.gob.ar>
- Argentina.gob.ar. (2016). Normativa de firma digital. <https://www.argentina.gob.ar>
- Ávila, H. (2016). Teoria da segurança jurídica (4. ed.). São Paulo: Malheiros.
- Ávila, H. (2021). Teoria da segurança jurídica (6. ed., rev., atual. e ampl.). Salvador: JusPodivm/Malheiros.
- Ávila, H. (2025). Teoria dos princípios: da definição à aplicação dos princípios jurídicos (nova ed.). Salvador: JusPodivm.
- Ayres, I., & Braithwaite, J. (1995). Responsive regulation: Transcending the deregulation debate. New York: Oxford University Press.
- Barbosa, M. M. (2019). Blockchain e responsabilidade civil: inquietações em torno de uma realidade nova. *Revista de Direito e Responsabilidade*.

- Barroso, L. R. (2003). *Agências reguladoras: Constituição, transformações do Estado e legitimidade democrática*. In D. F. Moreira Neto (Org.), *Direito regulatório*. Rio de Janeiro: Renovar.
- Blockchain Federal Argentina. (s.d.). Registro Público de Graduados Universitarios. <https://bfa.ar>
- Borak, M. (2024, 23 outubro). Buenos Aires moves from centralized to decentralized digital identity with QuarkID. *Biometric Update*. <https://www.biometricupdate.com>
- Brasil. (1988). *Constituição da República Federativa do Brasil de 1988*. Brasília: Presidência da República.
- BrazilCrypto. (2024, 31 outubro). Latam Crypto Report #19 – Buenos Aires rolls out decentralized identity. <https://newsletter.brazilcrypto.io>
- Central Bank of Ireland. (2024). *Markets in Crypto-Assets Regulation (MiCAR)*. <https://www.centralbank.ie>
- Change.org. (2025). Incorporar blockchain en la gestión de registros públicos. <https://www.change.org>
- CheersContracts. (2025, 4 novembro). Validez jurídica de la firma electrónica en contratos y pagarés en Argentina. <https://www.cheerscontracts.com>
- Coindesk. (2024, 22 outubro). Buenos Aires adds ZK proofs to city app in bid to boost residents' privacy. <https://www.coindesk.com>
- Congressional Research Service. (2025). *Regulating artificial intelligence: U.S. and international approaches (R48555)*. <https://www.congress.gov>
- Cunha, V. (2019). *A segurança jurídica e sua natureza de sobreprincípio*. Migalhas de Peso.
- Cyfrin. (2025). *MiCA regulation explained: A guide to EU crypto compliance*. <https://www.cyfrin.io>
- Davtyan, T. (2025). The U.S. approach to AI regulation: Federal laws, policies, and proposals. *Journal of Law, Technology & the Internet*, 16(1). <https://scholarlycommons.law.case.edu>
- Dig.watch. (2024, 24 outubro). Buenos Aires introduces pioneering blockchain-based digital identity for 3.6 million residents. <https://dig.watch>
- European Commission. (2025). *AI Act – European approach to artificial intelligence*. <https://digital-strategy.ec.europa.eu>
- European Parliamentary Research Service. (2025). *AI Act implementation timeline (PE 772.906)*. <https://www.europarl.europa.eu>
- Freitas, J. (2016). *Regulação administrativa e vieses decisórios*. *A&C – Revista de Direito Administrativo & Constitucional*, 16(63), 93–105.
- Garcia, L. R. (2021, 29 dezembro). *Boas práticas na proteção de dados: compulsoriedade ou voluntariedade?* Canal Compliance.

- Guerra, S. (2011). Função normativa das agências reguladoras: uma nova forma de atuação estatal? *Revista de Direito GV*, 7(1), 157–194.
- Hahn, T. M. (2024). Regras de boas práticas e governança em privacidade na LGPD: conceitos, controles e projeções. Belo Horizonte: Fórum.
- Heinen, L. (2017). Autolimitação administrativa e segurança jurídica: o setor de infraestrutura brasileiro. Tese de doutorado, Universidade Federal do Paraná.
- Hogan Lovells. (2025). The EU's Markets in Crypto-Assets MiCA regulation: A status update. <https://www.hoganlovells.com>
- Holland & Knight. (2025). Blockchain & cryptocurrency laws and regulations 2026 – USA. Global Legal Insights. <https://www.globallegalinsights.com>
- Justen, M. (2021). A relevância da definição de regras de boas práticas e governança pelos setores econômicos na LGPD: a necessidade de compatibilização de diversas realidades. Curitiba: Justen, Pereira, Oliveira & Talamini.
- Lacerda, C. M. V. (2021). Regulação por princípios e julgamento profissional no setor público: um estudo sobre o regime IPSAS. Dissertação de mestrado, Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa.
- Latham & Watkins. (2025). US crypto policy tracker – Regulatory developments. <https://www.lw.com>
- Lima, J. J. N. de. (2020). Accountability, meta-regulação e proteção de dados pessoais na LGPD (Tese de doutorado, Pontifícia Universidade Católica de São Paulo).
- Merkle Science. (2024). CFTC vs. SEC: Navigating regulatory overlap in the crypto market. <https://www.merklescience.com>
- Moreira Neto, D. F. (2003). Direito regulatório: a alternativa participativa e flexível para a administração pública de relações setoriais complexas no Estado democrático. Rio de Janeiro: Renovar.
- National Institute of Standards and Technology. (2023). AI Risk Management Framework (AI RMF). <https://www.nist.gov>
- Pagella, J. M. (2022). Tecnología blockchain aplicada en el registro de la propiedad. Universidade del Salvador. <https://racimo.usal.edu.ar>
- Portaldobitcoin. (2024, 22 outubro). Prefeitura de Buenos Aires lança serviço de identidade digital baseado em blockchain. <https://portaldobitcoin.uol.com.br>
- Reale, M. (1994). Lições preliminares de Direito (27. ed.). São Paulo: Saraiva.
- Rodrigues, C. H. R. (2025). Regulação responsiva e o futuro do direito regulatório. *Revista de Direito da Unigranrio*, 15(1), 121–134.
- Santa Cruz. (2022). Plan de Transformación Pública Digital – Tecnologías de registros distribuidos y blockchain. <https://www.saij.gob.ar>

Secretaria de Governo Digital. (2020). Guia de boas práticas – Lei Geral de Proteção de Dados (LGPD). Brasília: Governo Federal.

Squire Patton Boggs. (2025). MiCA legal framework: How to comply with the EU's crypto-asset rules. <https://www.squirepattonboggs.com>

Trilateral Research. (2025, 4 setembro). EU AI Act implementation timeline: Mapping your models to the new risk tiers. <https://trilateralresearch.com>

U.S. Commodity Futures Trading Commission. (2025). Digital assets – Backgrounder. <https://www.cftc.gov>

White House. (2023). Safe, secure, and trustworthy development and use of artificial intelligence (Executive Order). <https://www.federalregister.gov>

White House. (2025). America's AI Action Plan. <https://www.whitehouse.gov>

Wired. (2025, março). The SEC is abandoning its biggest crypto lawsuits.

ZKsync. (2024, 22 outubro). World's first ZK-backed digital identity launched in Buenos Aires.

A BIBLIOGRAPHIC REVIEW APPROACH ON THE USE OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

UMA ABORDAGEM SOBRE REVISÃO BIBLIOGRÁFICA SOBRE O USO DA INTELIGÊNCIA ARTIFICIAL NA AGRICULTURA

UN ENFOQUE DE REVISIÓN BIBLIOGRÁFICA SOBRE EL USO DE LA INTELIGENCIA ARTIFICIAL EN LA AGRICULTURA



<https://doi.org/10.56238/sevened2026.008-195>

Luciane de Fatima Rodrigues de Souza¹, Maria Cristina Marques², Kelen Cristina Crivelaro Silvestre³, Pedrinho Antonio Julião Filho⁴

ABSTRACT

Currently, much has been discussed about the use of artificial intelligence in various areas of knowledge, such as economics, medicine, engineering, industry, and also in different segments of agribusiness. In the agricultural context, this technology is present from the machinery used in the field, which is increasingly automated and intelligent, to systems and software aimed at the management of rural properties. It is observed, therefore, that the advancement of machine learning and other artificial intelligence tools has been significantly contributing to the transformation and modernization of the agricultural sector. These technologies enable greater efficiency in production, better decision-making, optimization of the use of natural resources, and increased productivity. As a result, they further strengthen the relevance of agriculture within the Brazilian economy, a sector that plays a fundamental role in the country's economic growth. In this context, the present study aimed to carry out a bibliographic review on the application of artificial intelligence in agriculture, seeking to identify its main applications, benefits, and contributions to development and innovation in the agricultural sector.

Keywords: Artificial Intelligence. Agribusiness. Industry 4.0.

RESUMO

Atualmente, muito se tem discutido sobre o uso da inteligência artificial nas mais diversas áreas do conhecimento, como economia, medicina, engenharias, indústria e também nos diferentes segmentos do agronegócio. No contexto agrícola, essa tecnologia está presente desde os maquinários utilizados no campo, cada vez mais automatizados e inteligentes, até os sistemas e softwares voltados para a gestão das propriedades rurais. Observa-se, portanto, que o avanço do aprendizado de máquina e de outras ferramentas de inteligência artificial vem contribuindo significativamente para a transformação e modernização do setor

¹ Instituto Federal de São Paulo (IFSP). E-mail: luciane_rodrigues@ifsp.edu.br

² Instituto Federal de São Paulo (IFSP). E-mail: cris.keiler@hotmail.com

³ Dr. in Mechanical Engineering. Escola de Engenharia de São Carlos. Universidade de São Paulo (EESC-USP). E-mail: kccsilvestre@gmail.com

⁴ Technologist in Agribusiness. Instituto Federal de São Paulo (IFSP). E-mail: pedrinho.juliao@aluno.ifsp.edu.br

agrícola. Essas tecnologias possibilitam maior eficiência na produção, melhor tomada de decisões, otimização do uso de recursos naturais e aumento da produtividade. Como consequência, fortalecem ainda mais a relevância da agricultura dentro da economia brasileira, setor que desempenha papel fundamental no crescimento econômico do país. Nesse contexto, o presente trabalho teve como objetivo realizar uma revisão bibliográfica acerca da aplicação da inteligência artificial na agricultura, buscando identificar suas principais aplicações, benefícios e contribuições para o desenvolvimento e a inovação no setor agrícola

Palavras-chave: Inteligência Artificial. Agronegócio. Indústria 4.0.

RESUMEN

Actualmente, se ha discutido ampliamente sobre el uso de la inteligencia artificial en diversas áreas del conocimiento, como la economía, la medicina, las ingenierías, la industria y también en los diferentes segmentos del agronegocio. En el contexto agrícola, esta tecnología está presente desde la maquinaria utilizada en el campo, cada vez más automatizada e inteligente, hasta los sistemas y softwares orientados a la gestión de las propiedades rurales. Se observa, por lo tanto, que el avance del aprendizaje automático y de otras herramientas de inteligencia artificial ha contribuido significativamente a la transformación y modernización del sector agrícola. Estas tecnologías permiten una mayor eficiencia en la producción, una mejor toma de decisiones, la optimización del uso de los recursos naturales y el aumento de la productividad. Como consecuencia, fortalecen aún más la relevancia de la agricultura dentro de la economía brasileña, sector que desempeña un papel fundamental en el crecimiento económico del país. En este contexto, el presente trabajo tuvo como objetivo realizar una revisión bibliográfica sobre la aplicación de la inteligencia artificial en la agricultura, buscando identificar sus principales aplicaciones, beneficios y contribuciones al desarrollo y la innovación en el sector agrícola.

Palabras clave: Inteligencia Artificial. Agronegocio. Industria 4.0.

1 INTRODUCTION

In an ever-evolving world, complexity is undeniably prevalent. The challenges that society must face continue to expand in various dimensions, such as the economic, social, and environmental aspects of sustainability. These multifaceted demands require the ability to make informed decisions based on vast amounts of data and information. For example, optimizing profitability must be achievable while maintaining a strong connection with an extremely demanding market and consumers (PINHEIRO et al., 2021).

Envision a future where farmers have analytical tools at their disposal to enhance their decision-making process about crops and livestock; where management practices and combinations of inputs are dictated by physical conditions, biological factors (e.g., pests, diseases), and economic sustainability. Looking at the real world, it's clear that we still have a long way to go. Take pesticides, for example – they are still being sprayed all over the field, not just the affected areas or plants (RUSSO, 2020).

Although agricultural areas have noticeable differences in factors such as fertility and moisture, inputs are applied without taking into account these variations, causing unnecessary waste and environmental damage. The problem is that the tools used to make decisions do not recognize the fact that agricultural systems are subject to non-linear interactions, with multiple variables at play. As they move forward, it becomes evident that it is essential to have a deeper understanding of how various elements interconnect to affect each other in agricultural operations (MEGETO et al., 2021).

To increase the ability to predict and prescribe solutions, improved methodologies are required. Artificial intelligence (AI) could revolutionize this area by offering an area of study that incorporates machines with human-like thought processes, such as rationality. By leveraging these technologies, sophisticated systems absorb knowledge from previous encounters, allowing them to perform actions much faster and more efficiently than humans ever could. With its ability to process large amounts of data continuously, AI can outperform humans in identifying year-round occurrences such as disease, drought, and weed competition, as well as predicting productivity, profitability, and weather patterns (BORBA et al., 2022).

AI-integrated machines can relieve workers of heavy tasks by providing fast and sophisticated results. However, the potential risks of AI need to be anticipated and treated like any innovative development. Because AI relies on connectivity, cybercriminals can manipulate it, producing significant disruptions, damage, and damage. Criminal activity can disrupt the proper functioning of autonomous drones, planters, or harvesters, resulting in irreversible damage. Design errors stemming from a fascination with technology, prioritizing

productivity and profitability over ecological sustainability, are also a cause for concern, as the pursuit of prudent economic outcomes often requires a combination of both (FERNÁNDEZ, 2020).

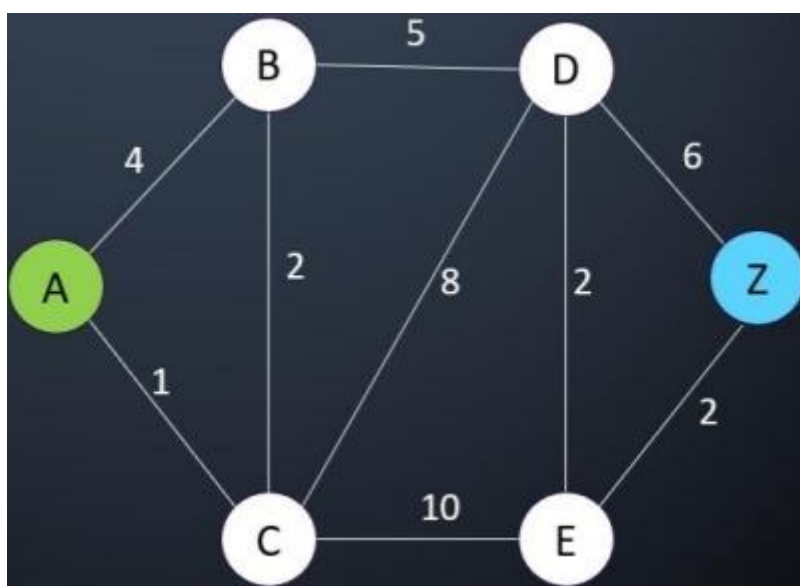
In short, Artificial Intelligence in agriculture is a topic of great relevance amid the wave of technological advances that are bringing more efficiency to the field. In agribusiness, AI has been incorporated into agricultural operations to manipulate data, generate estimates, or even perform image recognition, and the importance of this study is to show the great importance that this technology has for Brazilian agribusiness. In this context, the objective of the present study was to verify artificial intelligence applied to agriculture, aiming to verify how its tools have been used to improve crop monitoring, pest monitoring, etc.

2 THEORETICAL FRAMEWORK

2.1 ARTIFICIAL INTELLIGENCE

British mathematician Alan Turing (Alan Turing) was one of the pioneers who wrote papers on computational intelligence through his book *Computational Machinery and Intelligence* in 1950. In his article, the mathematician developed the Turing test, which is a way of specifying that the performance of intelligent machines is better than that of humans. This test is informally called an imitation game by Turing himself (KAUFMAN, 2019).

One of the common definitions of artificial intelligence is as a branch of computer science responsible for automating intelligent behaviors. Since intelligence is expressed as a form of calculation, formalization and mechanization are subsequent steps. Gottfried Wilhelm introduced a system of formal logic when designing machines that perform tasks automatically. The steps of this mechanical solution can be represented as movement by the study of a tree or figure. In Figure 1, there is a representation of a decision diagram (DA SILVA; MAIRINK, 2019).

Figure 1*Example Graph*

Source: DA SILVA; MAIRINK, (2019).

The construction of graph theory also contributed to the emergence of the concept of state-space search, which is an important technology in artificial intelligence. The chart is used to construct the problem to be solved. The nodes of the state-space graph represent the possible steps of solving the problem, and their arc involves reasoning, the steps to follow to solve the problem. The solution to this type of problem is obtained by investigating the state-space diagram, which is a path to a solution. In this way, they represent a powerful tool to specify the complexity of the problem to be solved and the efficiency of the analysis of the solution strategy (PEIXOTO; SILVA, 2019).

From the 18th to the 20th century, science and mathematics became the academic prerequisites for the research and development of artificial intelligence, but it was not until the beginning of digital computing in the 20th century that artificial intelligence became scientifically viable. It is now possible to implement a formal reasoning system on a computer and empirically test its ability to demonstrate intelligence (DONEDA, et al., 2018).

2.2 MAIN ASPECTS OF ARTIFICIAL INTELLIGENCE

Many current artificial intelligence logics are elaborated through a set of modular components and rules of behavior, which do not follow a strict order when executed, but are activated in response to the specific situation of a given problem (BARBOSA, 2017).

There are several studies involving artificial intelligence for different applications. Connectionism is based on the functioning of logic and rational thought. People are working hard to get intelligence by building the architecture of the human brain. The neural network

model demonstrates the brain's ability to adapt to the world in which it finds itself, creating and modifying connections between neurons (MAIA FILHO; JUNQUILHO, 2018).

Another intelligent model based on biological tissues is related to the process of interaction between species that adapt to the environment. In this way, they apply the principles of biological evolution to the problem of finding solutions to difficult problems. This method does not seek solutions to problems through logical reasoning, but creates groups of competing responses and evolves them into a better solution for simulating biological evolution (CORVALÁN, 2020).

The social system represents another metaphor for intelligence, as it presents a joint behavior that allows dealing with problems that cannot be solved by just one member (OLIVEIRA, 2019). For example, while no one can accurately predict the amount of bread New York City will consume on any given day, New York's bakery system does the job as a whole, providing bread to the city with minimal waste (LOBO, 2017).

This metaphor in academia established the concept of IAD (Distributed Artificial Intelligence), which they interpreted as a very promising branch of artificial intelligence research, which is still little explored today. It is different from the classical model of artificial intelligence, because traditional research aims to analyze individual human behavior and its focus is on the representation of knowledge and reasoning methods. On the other hand, the IAD model is based on social behavior and its focus is on the actions and interactions between agents. This proposition introduces the concept of agent, which is characterized by reflecting the collective behavior of many simple individuals who interact with each other (PORTO, 2019).

3 ARTIFICIAL INTELLIGENCE IN AGRICULTURE

Since the turn of the century, big tech companies have pondered the idea of creating an automated field that can sustain itself through harvesting. The management of pre-planting, planting and harvesting has presented difficulties, leading to the emergence of Smart Agriculture. The idea is to link entire fields to one or more smart grids, using artificial intelligence and machine learning. Today, Digital Agriculture or Smart Agriculture is the preferred term to describe an agricultural management methodology that seeks the most productive production while minimizing crop losses and maximizing profit without expanding land (SEGOVIA; ROJAS; QUISHPE, 2021).

It is important to note that another critical concept, IOT (Internet of Things), exists to facilitate fast and secure communication between machines and users, ensuring the integrity of the information shared. Imagine an expansive field, linked to several machines capable of

detecting problems and providing various resolutions. However, if access to this information is only feasible through the physical approximation of the machines, this would consume as much time as manual field verifications (MENDES-MOREIRA; FERREIRA; DIAS, 2022).

This is where the Internet of Things becomes relevant, by allowing a seamless exchange between machine and user. This concept essentially involves the connection of machines to each other (machine-to-machine), as well as the user (machine-to-user). By establishing connectivity, the previous scenario is solved, and the collected data can be easily transmitted to a desktop or smartphone over any distance. Data science and artificial intelligence are poised to revolutionize the sector, granting farmers resources to optimize every square meter of available land (MEIRELLES; MOREIRA; COELHO, 2004).

Industry 4.0, with its focus on smart factories and smart manufacturing, has been greatly aided by advances in information and communication technologies, including the use of artificial intelligence. The outdated nature of traditional systems for more complex tasks has led to the utilization of on-board computing, real-time schematics, and resource scheduling strategies for improved manufacturing operations. Within the field of agriculture and industry 4.0, product testing has emerged as a key application (SANTOS, 2020).

When it comes to producing and developing items of greater complexity, automated testing becomes a vital tool. That said, there is a significant problem presented by the considerable delay in testing that occurs across multiple geographic networks, but fortunately a solution has emerged in the form of an automated testing system that can support testing in geographically dispersed environments. With this in mind, this particular subject presents a promising path for the development of algorithmic machine learning (XAVIER, 2020).

In addition, there is an underlying need for flexibility in all aspects of product development, while also recognizing that human learning is a valuable factor that cannot be overlooked. One solution to these limitations is to integrate artificial and human intelligence to work together in harmony, with a focus on the former mimicking human behaviors and reasoning through the use of pattern recognition, logical applications, and final conclusions (ADORNO, 2021).

3.1 CROP MONITORING

Precision agriculture is a management system that emerged for this purpose. However, precision agriculture, which was based only on miraculous technological solutions, is slowly evolving into a more promising situation that is truly revealing its potential and results. Its growth develops with technological advances, including: Global

Positioning System (GSP or GPS), Remote Sensing, Variable Rate Input applications, Geographic Information Systems (GIS or GIS), among others (PIRES et al., 2004).

To ensure optimal crop monitoring, drones equipped with high-quality cameras have emerged as the latest and most innovative solution. By utilizing the remote control, growers can effortlessly navigate through the entire plantation while the lens captures images in real-time. These images are then analyzed by an AI or stored in a database for further treatment. As a result, producers are equipped with all the necessary information to accurately assess the quality of their production (CONFORTO et al., 2016).

Figure 2

Analysis of the plant carried out through drones



Source: climatefieldview.com.br

Google has gone so far as to train its AI to recognize more than 5,000 distinct types of plants and animals, making it much easier to detect crop diseases and other problems. Thanks to this approach, results are achieved effectively and reliably, allowing producers to act with a greater probability of success. On another front, image sensors embedded in the soil allow continuous monitoring, efficiently avoiding unpleasant surprises at harvest time, such as pest and disease outbreaks (PÉREZ et al., 2019).

The application of pesticides depends on the level of pest infestation found in the area, which can be determined by the producer. By collecting images, the producer can make informed decisions about what agricultural input to use and how much to use it to optimize productivity on the farm. To reduce water and electricity use, technology is being tested to predict the amount of water each irrigator will need for irrigation. This can lead to increased productivity by ensuring that the appropriate amount of water is used (MORETI et al., 2021).

3.2 AUTOMATION OF AGRICULTURAL MACHINERY

Smart tractors incorporate familiar technologies such as autopilot, but their impact on agriculture is critical. The concept of an unmanned tractor alone can significantly reduce cultivation time and increase the consistency and accuracy of yields. Similarly, tractor developers are utilizing sensors linked to vast databases to minimize potential setbacks and maximize farmers' profitability (RUSSO, 2020).

Figure 3

Unmanned tractor



Source: chbagro.com.br

Through advanced technology and machine learning, the project is developing intelligent machines that can detect and reroute barriers, distinguish ripe and spoiled products, and increase the efficiency of agricultural operations. These machines even analyze soil conditions in real-time and provide recommendations to farmers for improvements (MEGETO et al., 2021).

Figure 4

System allows rapid diagnosis of the crop for the correct application of various products.



Source: www.farmfor.com.br

According to Pires et al. (2004), the tools used can be used individually or combined, depending on the financial resources available and the specific needs identified for each area. The entire cycle of precision agriculture involves not only field evaluation, but also data processing and the creation of prescription maps or properties for path correction. Several computational applications have been developed by research institutions and private companies to maximize the use of the collected data and obtain relevant information about the system. Each tool available operates according to its own unique principles. For example, organic matter sensors utilize optical properties of soil, nutrient sensors utilize ion-specific electrodes, soil salinity and moisture analysis is performed using electrical conductivity, and soil texture analysis is performed by studying acoustic properties of soil.

Pires et al. (2004) also state that among the various possible uses, the mapping of soils and crops to obtain productivity maps, application of input doses at variable speeds, orientation of air and land inputs and use in management decision support systems stand

out. The technology is also used to map and monitor areas infested by weeds, diseases, and pests to help take appropriate control measures. In some studies based on the differential reflection of radiation incident on vegetation, sensors can distinguish between soil and weeds and target those specific areas. This can reduce herbicide use, reduce production costs, and increase food production.

4 FINAL CONSIDERATIONS

Looking ahead, Digital Agriculture presents a practical solution that focuses on optimizing productivity while minimizing the use of resources, which is imperative to avoid potential risks and create effective proposals. The need for human intelligence in this process would require time and resources that we simply cannot do without. Recent studies show that in the coming years, the demand for food will increase globally, and consequently, technological advancements driven by artificial intelligence will arouse interest.

Techniques such as Deep Learning, Machine Learning, and IOT have played an essential role in the agricultural sector, identifying pestilences and diseases, reducing crop damage and losses, shortening the time it takes to harvest crops, collecting relevant soil data, and making informed decisions, which ultimately reduces environmental damage. The journey towards smart agriculture is never-ending as technology, and its applications continue to evolve every day, further advancing the agricultural technology market.

Across a range of disciplines, artificial intelligence (AI) is advancing in agriculture. With machine learning revolutionizing every corner of the economy, the agricultural sector is carving out its own territory in the production pipeline. Investments and adoption of AI are increasing, as its ability to interpret and analyze data surpasses that of humans, aiding in the acceleration of rapid processes. These developments are manifesting themselves in a variety of industries, including manufacturing, transportation, agribusiness, and real estate.

With the arrival of technology, there is an increasing need for fast and efficient processing of large volumes of data that the human intellect cannot meet. This is especially pronounced in the seed industry, from sowing to quality control testing, which requires careful analysis of multiple seed lots. Quality control tests look at germination, emergence, accelerated aging, electrical conductivity, cold test, and water content. All of this needs careful interpretation to ensure safe information about the seeds.

However, the high demand for lot analysis is impossible to meet with human intelligence, especially with regard to the commercialization of seeds and grains. The implementation of AI-based technology in various industries, including agriculture, has proven to be a valuable tool for streamlining operations and overcoming obstacles. With the ability

to detect soil contents, monitor crop growth, and even automate weeding and planting, farmers have been able to increase their yields and minimize resource use.

This improvement in efficiency has led to better quality crops and, as a result, faster time to market. AI enables farmers to collect and analyze vast amounts of data, providing solutions to their toughest challenges and enabling faster, more informed decision-making. In a field where innovation is essential, the integration of artificial intelligence has revolutionized the agricultural sector by increasing productivity and optimizing resource allocation.

REFERENCES

- Adorno, S. (2021). Inteligência artificial. *Estudos Avançados*, 35, 3–3.
- Barbosa, M. M. (2017). Inteligência artificial, e-persons e direito: desafios e perspectivas. *Revista Jurídica Luso-Brasileira*, (6), 1475–1503.
- Borba, M., et al. (2022). Gestão no meio agrícola com o apoio da inteligência artificial: Uma análise da digitalização da agricultura. *Revista em Agronegócio e Meio Ambiente*, 15(3), 1–22.
- Conforto, D., et al. (2016). Inteligência artificial: As possibilidades de sistemas especialistas na agricultura. In VI Mostra Científica.
- Corvalán, J. G. (2020). Inteligencia artificial GPT-3, Pretoria y oráculos algorítmicos en el derecho. *International Journal of Digital Law*, 1(1), 11–52.
- Silva, J. A. S., & Mairink, C. H. P. (2019). Inteligência artificial. *LIBERTAS: Revista de Ciências Sociais Aplicadas*, 9(2), 64–85.
- Doneda, D. C. M., et al. (2018). Considerações iniciais sobre inteligência artificial, ética e autonomia pessoal. *Pensar – Revista de Ciências Jurídicas*, 23(4), 1–17.
- Embrapa. (2023). Discutindo agricultura de precisão: Aspectos gerais. http://www.cnpt.embrapa.br/biblio/do/p_do42.htm
- Fernández, F. (2020). Inteligencia artificial y agricultura: Nuevos retos en el sector agrario. *Campo Jurídico*, 8(2), 123–139.
- Kaufman, D. (2019). A inteligência artificial irá suplantar a inteligência humana? *Estação das Letras e Cores*.
- Lobo, L. C. (2017). Inteligência artificial e medicina. *Revista Brasileira de Educação Médica*, 41, 185–193.
- Maia Filho, M. S., & Junquilha, T. A. (2018). Projeto Victor: Perspectivas de aplicação da inteligência artificial ao direito. *Revista de Direitos e Garantias Fundamentais*, 19(3), 219–238.

- Megeto, G. A. S., et al. (2021). Aplicações de inteligência artificial na era da agricultura 4.0. *Revista Ciência Agronômica*, 51.
- Meirelles, M. S. P., Moreira, M., & Coelho, F. B. N. (2004). Uso de inteligência artificial em agricultura de precisão: Redes bayesianas e neurais. In *Agricultura de precisão para o manejo da fertilidade do solo em sistema plantio direto* (p. 175).
- Mendes-Moreira, J., Ferreira, C. A., & Dias, D. (2022). Inteligência artificial na agricultura. *INESC TEC Science & Society*, 1(4).
- Moreti, M. P., et al. (2021). Inteligência artificial no agronegócio e os desafios para a proteção da propriedade intelectual. *Cadernos de Prospecção*, 14(1), 60.
- Oliveira, A. (2019). Inteligência artificial. Fundação Francisco Manuel dos Santos.
- Peixoto, F. H., & Silva, R. Z. M. (2019). Inteligência artificial e direito (Vol. 1). Alteridade.
- Pérez, J. L., et al. (2019). Impacto de las tecnologías disruptivas en la percepción remota: Big data, internet de las cosas e inteligencia artificial. *UD y la Geomática*, (14).
- Pinheiro, R., et al. (2021). Inteligência artificial na agricultura com aplicabilidade no setor sementeiro. *Diversitas Journal*, 6(3), 2996–3012.
- Porto, F. R. (2019). O impacto da utilização da inteligência artificial no executivo fiscal: Estudo de caso do Tribunal de Justiça do Rio de Janeiro. *Direito em Movimento*, 17(1), 142–199.
- Russo, I. F. D. (2020). O impacte da inteligência artificial na sustentabilidade ambiental: Uma agricultura sustentável (Tese de doutorado). Universidade de Lisboa.
- Santos, R. (2020). Inteligência artificial em prol da agricultura. *Agroanalysis*, 40(12), 30–31.
- Segovia, J. S. B., Rojas, F. A. D., & Quishpe, M. W. V. (2021). Estudio del uso de técnicas de inteligencia artificial aplicadas para análisis de suelos para el sector agrícola. *RECIMUNDO*, 5(1), 4–19.
- Xavier, R. A. (2020). As vantagens e desvantagens da inteligência artificial na agricultura. *Kur'yt'bya: Revista Multidisciplinar de Educação, Ciência e Cultura*, 12(1).

PERSONAL DATA PROTECTION IN PUBLIC HEALTH IN MANAUS: LEGAL CHALLENGES OF LGPD APPLICATION IN THE PROCESSING OF SENSITIVE DATA

PROTEÇÃO DE DADOS PESSOAIS NA SAÚDE PÚBLICA DE MANAUS: DESAFIOS JURÍDICOS DA APLICAÇÃO DA LGPD NO TRATAMENTO DE DADOS SENSÍVEIS

PROTECCIÓN DE DATOS PERSONALES EN LA SALUD PÚBLICA DE MANAUS: DESAFÍOS JURÍDICOS DE LA APLICACIÓN DE LA LGPD EN EL TRATAMIENTO DE DATOS SENSIBLES



<https://doi.org/10.56238/sevened2026.008-196>

Alessandra Souza Garcia¹, Alexandra Pantoja Monteiro², Elauton Guerra Mota de Farias³, João Lopes Rodrigues⁴, Keyciane Cardoso Lima Mascarenhas⁵, Moisés da Silva Gomes Filho⁶, Rick Wesley Feitosa Pinto⁷, Dimas Melo Gonçalves⁸

ABSTRACT

The increasing use of digital technologies in public health management has significantly expanded the processing of sensitive personal data, requiring legal mechanisms capable of ensuring the protection of privacy and fundamental rights. In this context, the Brazilian General Data Protection Law establishes regulatory parameters governing the processing of personal information by public and private institutions, including those operating in the healthcare sector. This study aims to analyze the legal challenges related to the application of the General Data Protection Law in the processing of sensitive data within the public health system of Manaus, Amazonas. The research is characterized as a qualitative and descriptive literature review, based on recent scientific articles and academic studies addressing personal data protection, information governance and public sector responsibility in health data processing. The results indicate that the implementation of the legislation faces challenges related to technological infrastructure, the absence of consolidated institutional information security policies and the need for training of public agents responsible for data

¹ Undergraduate Student in Law. Universidade Nilton Lins. Amazonas, Brazil.
E-mail: Alessandra.alvesgarcia56@gmail.com

² Undergraduate Student in Law. Universidade Nilton Lins. Amazonas, Brazil.
E-mail: alexandrapantojamonteiro.3@gmail.com

³ Undergraduate Student in Law. Universidade Nilton Lins. Amazonas, Brazil.
E-mail: farias_guerra@hotmail.com

⁴ Undergraduate Student in Law. Universidade Nilton Lins. Amazonas, Brazil.
E-mail: joaolopes.05@icloud.com

⁵ Undergraduate Student in Law. Universidade Nilton Lins. Amazonas, Brazil.
E-mail: Keycianelima7@gmail.com

⁶ Undergraduate Student in Law. Universidade Nilton Lins. Amazonas, Brazil.
E-mail: moises.filho2011@gmail.com

⁷ Undergraduate Student in Law. Universidade Nilton Lins. Amazonas, Brazil.
E-mail: ricky.wesley22@gmail.com

⁸ Master's degree in Process Engineering. Faculdade Santa Teresa. Amazonas, Brazil.
E-mail: dimasmelogoncalves@gmail.com

processing. It is observed that the effectiveness of data protection regulations depends on the integration between legal norms, administrative practices and governance mechanisms capable of ensuring transparency, security and accountability in the use of personal information. The study concludes that strengthening institutional strategies aimed at protecting sensitive data represents an essential element for the consolidation of safer public health services aligned with the protection of fundamental rights, particularly within the Amazonian context.

Keywords: Manaus. Personal Data Protection. Public Health. Sensitive Data. General Data Protection Law.

RESUMO

A intensificação do uso de tecnologias digitais na gestão dos serviços públicos de saúde tem ampliado o tratamento de dados pessoais sensíveis, exigindo mecanismos jurídicos capazes de assegurar a proteção da privacidade e dos direitos fundamentais dos cidadãos. Nesse contexto, a Lei Geral de Proteção de Dados Pessoais estabelece parâmetros normativos voltados à regulamentação do tratamento de informações pessoais por instituições públicas e privadas, incluindo aquelas relacionadas à área da saúde. O presente artigo tem como objetivo analisar os desafios jurídicos da aplicação da LGPD no tratamento de dados sensíveis no âmbito da saúde pública do município de Manaus, Amazonas. A pesquisa caracteriza-se como revisão de literatura, de abordagem qualitativa e natureza descritiva, fundamentada em artigos científicos recentes e produções acadêmicas que discutem a proteção de dados pessoais, a governança informacional e a responsabilidade estatal no tratamento de informações em saúde. Os resultados indicam que a implementação da legislação enfrenta entraves relacionados à infraestrutura tecnológica, à ausência de políticas institucionais consolidadas de segurança da informação e à necessidade de capacitação dos agentes públicos responsáveis pelo tratamento de dados. Verifica-se que a efetividade da LGPD depende da integração entre normas jurídicas, práticas administrativas e mecanismos de governança capazes de garantir transparência, segurança e responsabilização no uso das informações pessoais. Conclui-se que o fortalecimento de estratégias institucionais voltadas à proteção de dados sensíveis constitui elemento essencial para a consolidação de serviços públicos de saúde mais seguros e alinhados à tutela dos direitos fundamentais, especialmente no contexto amazônico.

Palavras-chave: Dados Sensíveis. LGPD. Manaus. Proteção de Dados Pessoais. Saúde Pública.

RESUMEN

El creciente uso de tecnologías digitales en la gestión de los servicios públicos de salud ha ampliado significativamente el tratamiento de datos personales sensibles, lo que exige mecanismos jurídicos capaces de garantizar la protección de la privacidad y de los derechos fundamentales de los ciudadanos. En este contexto, la Ley General de Protección de Datos Personales de Brasil establece parámetros normativos destinados a regular el tratamiento de información personal por instituciones públicas y privadas, incluyendo el sector sanitario. El presente estudio tiene como objetivo analizar los desafíos jurídicos de la aplicación de la Ley General de Protección de Datos en el tratamiento de datos sensibles en el ámbito de la salud pública del municipio de Manaus, Amazonas. La investigación se caracteriza como una revisión de literatura de enfoque cualitativo y naturaleza descriptiva, fundamentada en artículos científicos recientes y producciones académicas relacionadas con la protección de datos personales, la gobernanza de la información y la responsabilidad estatal en el tratamiento de datos en salud. Los resultados indican que la implementación de la legislación enfrenta obstáculos relacionados con la infraestructura tecnológica, la ausencia de políticas institucionales consolidadas de seguridad de la información y la necesidad de capacitación

de los agentes públicos responsables del tratamiento de datos. Se concluye que la efectividad de la normativa depende de la integración entre disposiciones jurídicas, prácticas administrativas y mecanismos de gobernanza capaces de garantizar transparencia, seguridad y responsabilidad en el uso de la información personal, especialmente en el contexto amazónico.

Palabras clave: Datos Sensibles. LGPD. Manaus. Protección de Datos Personales. Salud Pública.

1 INTRODUCTION

The digital transformation of public services has promoted significant changes in the way personal information is collected, stored, and shared, especially in the health sector, in which data processing is an essential element for the execution of public policies and for the continuity of care. In this scenario, the growing circulation of clinical and registration information intensifies the need for legal mechanisms capable of ensuring the protection of the privacy and fundamental rights of citizens, especially in view of the sensitive nature of health-related data.

The enactment of Law No. 13,709/2018 instituted, in the Brazilian legal system, a specific normative regime aimed at the discipline of the processing of personal data, applicable to both the private sector and the Public Administration. As established by Brasil (2018), data processing comprises any operation carried out with personal information, including collection, use, storage, and sharing, imposing legal limits aimed at preserving the intimacy, freedom, and dignity of the natural person. From this regulation, information protection began to be a structuring part of state action, especially in areas that depend on intensive data management, such as public health.

In the health context, the advance in the computerization of services has expanded interoperability between systems and institutions, enabling greater administrative efficiency, but also increasing legal risks related to improper access and inappropriate use of personal information. Balian (2025) observes that the sharing of health data between different platforms requires strict governance and security criteria, since technological integration can amplify vulnerabilities when not accompanied by adequate regulatory controls.

In addition, recent literature shows that the implementation of the LGPD in the health sector requires institutional adaptations that go beyond the technological dimension, involving administrative reorganization and redefinition of responsibilities of public agents. Hawryliszyn (2021) highlights that compliance with legal requirements requires professional training and the establishment of internal protocols capable of ensuring continuous compliance in the processing of sensitive data. In addition, Lima (2023) points out that the application of legislation within the scope of public health services imposes the challenge of balancing the efficiency of health policies with the guarantee of users' informational rights.

In view of this panorama, it is verified that the protection of sensitive personal data is a central theme in the contemporary legal debate, especially when analyzed from the perspective of public health management. The expansion of the use of electronic medical records, integrated systems, and digital platforms highlights the need to understand how the instruments provided for in the LGPD are operationalized in administrative practice, as well

as what legal challenges emerge from this process. Thus, it is relevant to investigate the application of legislation in the context of municipal public health, considering the structural and social specificities that characterize the Amazonian reality.

The application of the General Law for the Protection of Personal Data in the health sector is particularly relevant due to the nature of the data processed by health institutions, legally classified as sensitive personal data. Information related to the health status, clinical history, and biometric conditions of individuals require high levels of protection, since their undue exposure can generate direct impacts on dignity, privacy, and equitable access to public services. Martins (2021) highlights that the information protection of the patient is closely related to the fundamental right to health itself, showing that data security is an integral element of the quality of care.

The expansion of digital health and technology-mediated care has intensified the flow of information between professionals, hospital units, and administrative systems, simultaneously increasing the efficiency of care and the risks related to inadequate data processing. Zaganelli (2023) points out that the expansion of telemedicine and electronic records requires institutional mechanisms capable of ensuring confidentiality, traceability, and access control to clinical information, reinforcing the need for permanent information governance policies in the health environment.

In the context of public management, it is observed that the implementation of the LGPD faces challenges related to the organizational structure of health institutions and the historical absence of consolidated data protection policies. Gonçalves (2024) points out that Brazilian public hospitals still have difficulties in standardizing procedures and clearly defining the responsibilities of the agents involved in the processing of personal information. In a convergent way, Praça Neto (2023) shows that the impact of legislation on the health sector requires a review of administrative flows and the adoption of institutional practices aimed at preventing informational risks.

From the perspective of social control and administrative transparency, Silva (2023) states that the digitalization of public health policies expands the state's capacity for health planning and monitoring, but also imposes the need for legal safeguards that prevent uses that are incompatible with the public purpose. In this sense, Soares (2021) emphasizes that the duty of confidentiality, traditionally associated with professional secrecy, has taken on an expanded institutional dimension, requiring shared responsibility between professionals and public managers.

In view of these considerations, the analysis of the legal challenges related to the application of the LGPD in the processing of sensitive data in the scope of municipal public

health is established as a research problem. Thus, this article aims to examine the protection of personal data in public health in Manaus, Amazonas, identifying normative and institutional obstacles arising from the implementation of the legislation, as well as its repercussions for the guarantee of the fundamental rights of users of the public health system. The investigation is justified by the need for scientific production focused on the Amazonian reality, contributing to the strengthening of safe and legally adequate administrative practices in the treatment of sensitive personal information.

2 THEORETICAL FRAMEWORK

The protection of personal data has consolidated itself as one of the main contemporary legal challenges in the face of the intensification of the digitalization of public services, especially in the field of health. The enactment of Law No. 13,709/2018, called the General Law for the Protection of Personal Data, represented a fundamental normative milestone by recognizing the need for specific protection of information related to natural persons, especially those classified as sensitive data, including health data. In this context, it is observed that the informational management carried out by the government began to demand new mechanisms of governance, transparency and institutional accountability, especially within the scope of the Unified Health System.

According to Lima and Gonçalves (2023), the application of the LGPD in public health services imposes a significant administrative restructuring, since the processing of personal data is no longer understood only as an operational activity and becomes a legal obligation linked to the guarantee of fundamental rights. The authors point out that the collection and sharing of clinical information requires strict observance of the principles of purpose, necessity and security, under penalty of violation of the citizen's privacy and state liability.

The expansion of the use of hospital computerized systems and digital platforms has intensified the flow of medical data, making evident the need for compatibility between administrative efficiency and protection of the patient's privacy. In this sense, Gonçalves et. al (2024) point out that public hospitals face structural difficulties for the full implementation of the LGPD, especially due to the absence of an institutional culture focused on data protection and the technological limitation present in several public health units. Such a scenario reveals that normative effectiveness depends not only on the existence of the law, but also on the administrative capacity of public entities to internalize compliance practices.

The discussion about information protection in public health is also directly related to the social control of health policies. Silva et. al (2023) argue that the digital transformation of the SUS has expanded the capacity for epidemiological monitoring and state planning,

however, simultaneously, it has increased the risks related to the misuse of personal information. For the authors, health data governance must balance the collective interest in the formulation of public policies with the preservation of individual rights, avoiding practices that may generate undue exposure of vulnerable populations.

From the perspective of medical practice, the protection of sensitive data assumes an ethical and legal dimension that is inseparable from the duty of professional secrecy. According to Soares (2021), the processing of patient data requires extra caution, as clinical information has high discriminatory potential, which can impact the individual's social, work, and security relationships. The author points out that the LGPD reinforces existing obligations in the field of bioethics, expanding the responsibility of professionals and institutions regarding the safekeeping and sharing of this information.

The growing adoption of telemedicine and digital health technologies has further intensified the debate about the confidentiality of medical information. In this scenario, Zaganelli (2023) observes that the digital environment has expanded the exposure of clinical data, requiring technical and legal mechanisms capable of ensuring traceability, security, and access control to information. The author points out that medical confidentiality depends not only on professional conduct, but also on the technological infrastructure used by health institutions.

It is verified that the protection of personal data in the health sector goes beyond the merely normative dimension, inserting itself in a broader context of reorganization of the digital public administration. The implementation of the LGPD, especially in complex regional realities such as that of Brazilian public health systems, highlights the need for integration between law, technology, and public policies, an aspect that will be deepened in the following sections.

The implementation of the General Data Protection Law in the health sector requires the redefinition of institutional responsibilities related to the processing of personal information of users of the public and private system. In this context, Hawryliszyn (2021) highlights that the regulatory adequacy of health institutions is not restricted to the adoption of technological tools, but also involves organizational changes capable of ensuring information security and adequate control of access to clinical data. Such a perspective shows that compliance with the LGPD depends on the integration between administrative management, professional training, and efficient technological structure.

The processing of sensitive personal data, especially those linked to the medical history of patients, requires additional care in view of the harmful potential resulting from their undue exposure. Praça Neto (2023) observes that the health sector operates with a high

volume of information shared between different institutional agents, a circumstance that increases the risks related to leaks and uses incompatible with the originally established purpose. Thus, data governance starts to assume a central role in preserving the fundamental rights of data subjects.

Information protection is also presented as an extension of the fundamental right to health itself, since safe access to health services presupposes trust between patient and institution. Martins (2021) argues that the preservation of the confidentiality of medical data is an indispensable element for the realization of the dignity of the human person, considering that the unauthorized disclosure of clinical information can generate relevant social, economic, and psychological impacts on the individual.

From the perspective of institutional legal compliance, there is the strengthening of adaptation programs specifically aimed at the hospital environment. Dias Carneiro (2021) states that the LGPD introduced the need to implement permanent mechanisms for controlling and monitoring data processing operations, including internal security policies, risk assessment, and clear definition of the responsibilities of the agents involved. The author emphasizes that the health sector has a high degree of informational vulnerability due to the complexity of care routines.

The increasing technological integration of public health systems has intensified the debate about the interoperability of government databases. Balian (2025) points out that the structured sharing of health information contributes to the planning of more efficient public policies, however it requires strict compliance with the principles of necessity and purpose provided for in the LGPD. According to the author, the absence of clear limits on automated data processing can compromise the protection of citizens' privacy.

Thus, it is perceived that the application of data protection legislation in the field of health represents a continuous process of institutional adaptation, in which information security becomes part of the very concept of quality of the public service provided. The consolidation of this model highlights the need for a balance between technological innovation and safeguarding fundamental rights, preparing the debate for the analysis of the concrete legal challenges faced in the reality of public health administration.

The consolidation of personal data protection in public health is part of a broader scenario of digital transformation of state administration, in which the intensive use of information technologies has come to guide the formulation and execution of health policies. In this context, Lima (2023) highlights that the application of the LGPD within the scope of the Unified Health System imposes on the public authorities the duty to structure mechanisms capable of ensuring not only administrative efficiency, but also the preservation of the privacy

of the citizens served. The author shows that the processing of sensitive data requires compatibility between collective interest and individual protection, especially in public systems characterized by high information flow.

The digitalization of health services has significantly expanded the state's capacity for epidemiological monitoring and care management, but it has also intensified the risks related to the inappropriate use of personal information. Gonçalves (2024) observes that the practical implementation of the LGPD in public hospitals faces structural obstacles, including technological limitations, absence of standardized protocols, and insufficient technical training of the agents responsible for data processing. This reality demonstrates that normative effectiveness depends directly on the administrative capacity of public entities to internalize information governance practices.

The collective dimension of data protection in health becomes evident when analyzed from the perspective of social control of public policies. Silva (2023) argues that the expansion of the SUS digital bases strengthened the production of health indicators and government planning, but simultaneously increased the informational exposure of socially vulnerable groups. In this sense, the author emphasizes that the protection of personal data must be understood as an instrument of democratic guarantee, preventing the massive use of information from resulting in discriminatory practices or indirect violations of fundamental rights.

In the field of care practice, the protection of sensitive data is closely related to the ethical duty of professional secrecy. Soares (2021) states that the LGPD legally reinforced obligations historically associated with medical ethics, expanding the responsibility of health institutions regarding the storage and sharing of clinical information. The author highlights that the confidentiality of data is an essential element for maintaining trust between the patient and the health system, an indispensable factor for the effectiveness of public health policies.

The expansion of telemedicine and care mediated by digital technologies has also redefined the traditional parameters of information protection. Zaganelli (2023) points out that the digital environment requires additional security mechanisms, considering that the remote treatment of clinical data increases the points of informational vulnerability. According to the author, the protection of health data depends simultaneously on legal guarantees, secure technological infrastructure, and appropriate institutional protocols.

Given this scenario, it is verified that the application of the LGPD in the public health sector represents a continuous legal challenge, especially in regional contexts marked by structural inequalities and technological limitations. The reality of municipal health systems highlights the need for regulatory adaptation to local specificities, making it essential to

develop public policies capable of reconciling digital innovation, administrative efficiency, and protection of citizens' fundamental rights. Thus, the protection of sensitive personal data is an indispensable element for the strengthening of public health management and for the consolidation of a legally safe and socially responsible care model.

3 METHODOLOGY

The present study is characterized as a qualitative research, developed through a literature review, with a legal-dogmatic approach, focused on the analysis of legal challenges related to the application of the General Law for the Protection of Personal Data in the treatment of sensitive data in the context of public health, focusing on the administrative reality of the municipality of Manaus, Amazonas.

As for the objectives, the research is classified as exploratory and descriptive, as it seeks to identify, systematize and critically analyze the recent scientific production on the protection of personal data in the health area, allowing to understand the legal impacts arising from the implementation of the LGPD in public health services. According to the methodological guidelines provided for in the structural model of the scientific article, the methodological section must qualify the type of research, the methods used, and the investigative path adopted, ensuring clarity and scientific reproducibility.

The methodological procedures consisted of conducting a narrative literature review, based exclusively on scientific articles published between the years 2021 and 2025, available entirely in digital format. The selection of productions took place according to previously defined inclusion criteria, comprising: publications in scientific journals classified in the Qualis A and B strata, thematic relevance to the General Data Protection Law applied to health and a specific approach to the processing of sensitive personal data, information governance and institutional responsibility in the health sector.

The research universe corresponds to the national scientific literature focused on the interface between digital law and public health, while the sample was composed of ten scientific studies selected for their adherence to the problem investigated. The time limit was established with the objective of ensuring theoretical updating and alignment with contemporary discussions on the digital transformation of public administration and personal data protection.

The analysis of the bibliographic material was carried out through the technique of qualitative content analysis, involving exploratory reading, analytical reading and thematic categorization of the information extracted from the selected studies. The following categories of analysis were defined: protection of sensitive health data, responsibility of the public

authorities in the processing of personal information, informational security in hospital environments, and legal challenges of implementing the LGPD in public health management. The development of the research occurred in successive stages, starting with the survey of scientific productions in academic digital databases, followed by screening according to inclusion and exclusion criteria, organization of theoretical contributions and subsequent critical interpretation of the results in the light of the Brazilian legal system. This procedure allowed the establishment of a relationship between the theoretical framework analyzed and the concrete challenges faced by the public health administration in specific regional contexts.

As a methodological limitation, the absence of direct empirical investigation with public health institutions is recognized, an inherent characteristic of literature review studies. However, this delimitation is adequate to the proposed objective, which consists of the critical systematization of existing scientific knowledge, enabling the construction of a consistent theoretical basis for legal analysis of the investigated phenomenon.

Thus, the methodology adopted allows us to understand, in a structured and systematic way, the main legal challenges related to the protection of sensitive personal data in public health, offering analytical support for discussion of the results and their implications in the context of municipal health management in Manaus, Amazonas.

In order to systematize the scientific references used in the construction of this study, the following is a summary table containing the selected authors, the respective titles of the academic productions and the year of publication. The organization of this information allows us to visualize in a structured way the theoretical basis that supports the discussion about the protection of sensitive personal data in public health, evidencing the relevance of the sources used and their adherence to the proposed research problem.

Table 1

Authors used in the research

Author	Title	Year
BALIAN, R. A.	A Legal Analysis of Healthcare Data Interoperability Under the LGPD	2025
DIAS CARNEIRO	LGPD in health	2021
GONÇALVES, R. M.	LGPD and public health services: challenges of implementation in public hospitals	2024
HAWRYLISZYN, M.	Applicability of the LGPD in health services	2021
LIMA, I. S.	General Law for the Protection of Personal Data in Public Health Services	2023
MARTINS, F. R.	The application of the LGPD in private hospitals and the fundamental right to health	2021
PRAÇA NETO, A. A.	General Law for the Protection of Personal Data: impacts on the health sector	2023

SILVA, L. B. da	General Data Protection Law and the social control of health	2023
SOARES, M. A. S.	LGPD in healthcare: questions and answers for medical practice	2021
ZAGANELLI, M. V.	Medical confidentiality and sensitive data in telemedicine in light of the LGPD	2023

Source: The authors.

From the information presented in Table I, it is observed that the selected scientific production focuses on recent analyses on the application of the General Law for the Protection of Personal Data in the health sector, evidencing the growing academic and legal concern with the processing of sensitive data within the scope of public health policies. It is noted that the studies contemplate different complementary perspectives, involving information governance, institutional responsibility, clinical data security, and the impacts of digital transformation on health services.

Such theoretical diversity enables the construction of a consistent analytical base, allowing us to understand the legal challenges arising from the implementation of the LGPD, especially when considering the reality of municipal public administration and the structural specificities of the health system in the Amazonian context.

4 RESULTS AND DISCUSSIONS

The analysis of the selected scientific productions allowed us to identify that the implementation of the General Law for the Protection of Personal Data in the Brazilian public health sector represents a process still in consolidation, marked by normative advances and relevant operational challenges. The studies examined demonstrate that the expansion of the use of digital technologies in health services has significantly modified the dynamics of collection, storage and sharing of users' clinical information, increasing the need for legal mechanisms aimed at the protection of sensitive data.

In this context, Lima (2023) observes that the computerization of public health policies has contributed to greater integration between care units and administrative systems, favoring state planning and the continuity of health care. However, the author emphasizes that the increase in the flow of information requires strict observance of the principles of purpose and necessity, considering that medical data have a high potential for exposing the individual's intimacy.

The results also indicate that institutional governance is a determining factor for the effectiveness of the LGPD in the public hospital environment. Gonçalves (2024) highlights that the implementation of the legislation faces obstacles related to the absence of standardized information security protocols and the limited technical training of the agents

responsible for processing personal data. Such a scenario shows that normative adequacy depends on the internalization of permanent administrative practices aimed at information protection.

From the perspective of public policies, Silva (2023) argues that the expansion of the digital bases of the Unified Health System strengthened the production of epidemiological indicators and expanded the state's capacity for health monitoring. However, the author warns that the massive processing of population data can generate risks of undue exposure, especially in social contexts marked by economic and territorial vulnerability, a situation often observed in peripheral urban regions.

In the context of care practice, it was found that the protection of personal data assumes an ethical dimension directly linked to the duty of professional secrecy. Soares (2021) states that the LGPD legally reinforced obligations traditionally associated with medical ethics, expanding the responsibility of health institutions regarding the storage and sharing of clinical information. Thus, confidentiality becomes an essential element for maintaining trust between the patient and the health system.

Thus, the results show that the protection of sensitive data is no longer an exclusively technological issue, but is now part of the structure of public health service provision. The literature analyzed demonstrates that the implementation of the LGPD implies progressive institutional transformation, requiring articulation between public management, digital infrastructure, and effective guarantee of the fundamental rights of citizens.

In the set of studies analyzed, it is observed that the main contribution to understanding the challenges in the processing of sensitive health data stems from the normative structure of the General Law for the Protection of Personal Data, by defining processing as any operation carried out with personal data and by establishing foundations and principles that bind the performance of the public sector, including in the execution of public health policies, such as purpose, necessity, transparency, safety, prevention and accountability. Brasil (2018) reinforces that the protection of personal data is guided by the protection of fundamental rights, which shifts the discussion beyond administrative efficiency and imposes a legal standard of information governance.

The reviewed literature points out that, in the public health environment, complexity increases because the State often acts as a controller, with multiple operators and care routines that demand constant circulation of information, a scenario in which compliance with principles such as necessity and safety tends to be strained by structural and technological limitations (Lima, 2023). This finding is relevant to the municipal reality, as it shows that compliance is not limited to internal documents, requiring operational capacity and

institutional culture to implement protection routines.

By relating the legal hypotheses of treatment, the results indicate that the health field operates recurrently on bases that may dispense with consent, especially when there is compliance with legal obligations, execution of public policies and health protection in procedures performed by professionals and health entities. Brasil (2018) delimits these hypotheses and, at the same time, requires that the treatment remains adherent to the public purpose and the public interest, with clear information on procedures and practices, which suggests that institutional transparency becomes a material requirement to legitimize administrative activity in health.

At the organizational level, the review shows that the effective implementation of these normative commands in public hospitals comes up against gaps in protocols, standardization, and training, producing a risk of non-compliance, even if the public purpose is legitimate (Gonçalves, 2024). In terms of governance, this implies that the legal challenge is not only to choose the correct legal basis, but to sustain, through evidence and internal controls, the accountability and security expected by the holder.

Another recurring finding refers to the role of good practices and governance as risk mitigation mechanisms, especially because the LGPD provides for technical and administrative measures to prevent unauthorized access, in addition to administrative sanctions applicable by the competent authority and civil liability for damages resulting from irregular treatment. Brasil (2018) guides this axis by demanding demonstration of effective measures, which, in the public health sector, requires integration between management, technology, and care routines, including in sharing processes necessary for public policies.

The studies highlight that interoperability and the shared use of data, when they increase sanitary efficiency, also increase the risk surface and require proportional controls, especially in databases that concentrate sensitive data. Balian's (2025) analysis converges with this result by indicating that the integration between systems needs to be compatible with purpose limits and security mechanisms, at the risk of amplifying vulnerabilities and compromising the citizen's informational privacy, a central aspect for the legitimacy of public health actions.

The synthesis of the analyzed studies shows that, although the LGPD provides a robust regulatory framework, the effectiveness of the protection of sensitive data in public health depends on institutional conditions that vary according to the local administrative reality, which makes the debate especially relevant when considering municipal health management. The literature points out that the operationalization of principles such as security, prevention, and accountability requires minimum standards of infrastructure,

governance, and control, at the risk of data processing occurring in a formally justified manner, but materially vulnerable to failures and incidents, an aspect that weakens the user's trust in the public service and increases the possibility of informational damage.

In this sense, Hawryliszyn (2021) argues that adapting to the LGPD in health services requires continuous organizational changes, including training of professionals, definition of internal routines, and establishment of information security protocols, as the care environment involves multiple points of contact with personal data throughout the service. This result reinforces that compliance cannot be treated as a one-off action, but as a permanent institutional policy, capable of absorbing the complexity of the information flow in hospitals and public units.

By analyzing the field of supplementary health and the debate on confidentiality, the reviewed production indicates that the inadequate treatment of medical data can have repercussions beyond the individual, generating collective and institutional effects, including stigmatization and discrimination. Martins (2021) discusses this impact by relating information protection to the fundamental right to health and the dignity of the human person, showing that the violation of sensitive data compromises the very quality of access to services, as it produces insecurity and reduces the user's willingness to share information essential to care.

From the perspective of medical practice, the results suggest that the LGPD legally reinforces the duty of confidentiality, expanding the institutional responsibility for the storage and sharing of clinical information. Soares (2021) highlights that care with sensitive data should be understood as an ethical and legal requirement of the care activity, as undue exposure can generate social and professional consequences for the patient. This discussion gains greater density when connected to the daily life of public services, in which there is greater circulation of medical records, referrals and records on digital platforms.

The expansion of telemedicine and care mediated by digital technologies appears, in the review, as a factor of intensification of informational risk, as it expands points of vulnerability and requires greater access control, traceability, and technical safeguards. Zaganelli (2023) points out that, in the digital environment, medical confidentiality also depends on the level of security of the platforms used and the adequacy of internal procedures, which reinforces the need for clear data governance policies and preventive measures capable of avoiding incidents in processing operations.

In terms of compliance and risk management, there is theoretical convergence regarding the need for structured compliance programs specific to the health sector, with continuous monitoring, risk assessment, and internal safety standards. Dias Carneiro (2021) argues that the complexity of the hospital environment makes it essential to institutionalize

permanent data protection mechanisms, considering the volume and sensitivity of the information handled daily. This result dialogues with the reality of municipal systems, in which the adoption of standardized practices can reduce operational asymmetries and strengthen accountability.

The review indicates that the legal challenges of the LGPD in public health intensify when there is interoperability and data sharing between systems, as the search for administrative efficiency can increase the risk of leakage and improper access if there is no limitation by purpose and proportional controls. Silva (2023) points out that the digital transformation of the SUS expands the state's monitoring capacity, but can expose vulnerable populations if adequate governance is lacking, while Praça Neto (2023) points out that the flow of information in health increases the need for clear governance policies to prevent violations.

In addition, Lima (2023) and Gonçalves (2024) indicate that normative effectiveness depends on the internalization of institutional security and standardization practices, reinforcing that the protection of sensitive data must be treated as a structural component of the quality of the public health service.

Thus, the results and discussions demonstrate that the application of the LGPD in public health requires a balance between public interest and fundamental rights, requiring informational governance, training, security protocols, and permanent compliance policies. These elements provide sufficient theoretical basis to, in the concluding stage of the article, consolidate propositions aimed at municipal management, with the potential to guide strategies of institutional adequacy in the Amazonian context, without losing adherence to the national normative framework.

In order to synthesize the theoretical contributions that underlie the present research, the following table is presented, in which the authors used throughout the study are organized, their respective theoretical positions and the year of publication of the analyzed works. The systematization allows us to visualize the scientific contributions used in the construction of the legal analysis about the protection of sensitive personal data in the field of public health, evidencing the convergence between the adopted references and the problem investigated

Table 2

Authors and sources used in the research, positioning and year

Author	Positioning	Year
BALIAN, R. A.	It discusses the legal risks of interoperability and sharing of health data, highlighting the need for proportional limits in informational treatment	2025

BRAZIL	Establishes the normative foundations for the protection of personal data, principles, legal bases and responsibilities in the processing of sensitive data	2018
DIAS CARNEIRO	Advocates the implementation of compliance and governance programs to mitigate risks in data processing in healthcare institutions	2021
GONÇALVES, R. M.	It points out structural and institutional difficulties in the implementation of the LGPD in public hospitals	2024
HAWRYLISZYN, M.	It highlights the need for organizational adequacy and institutional training for compliance with the LGPD in health services	2021
LIMA, I. S.	It analyzes the application of the LGPD in the SUS and the expansion of the responsibilities of the public authorities in the processing of data personal	2023
MARTINS, F. R.	Relates data protection to the dignity of the human person and the fundamental right to health	2021
PRAÇA NETO, A. A.	Examines legal impacts of the LGPD on the flow of information between health institutions	2023
SILVA, L. B.	Discusses data governance and social control in the face of the digitalization of public health policies	2023
SOARES, M. A. S.	Addresses data protection as an extension of professional secrecy and medical ethics	2021
ZAGANELLI, M. V.	It analyses the challenges of protecting sensitive data in the context of telemedicine and digital health	2023

Source: The authors.

The analysis of the positions presented in Table II demonstrates that the scientific literature converges to the recognition of the protection of sensitive personal data as a structuring element of contemporary management in public health. It is observed that the authors approach the topic from complementary perspectives, involving normative foundations, informational governance, institutional responsibility, and the impacts of digital transformation on health services.

Such theoretical diversity makes it possible to understand that the application of the LGPD goes beyond the merely legal dimension, requiring administrative, technological and ethical adequacy of the institutions responsible for data processing. Thus, the references analyzed contribute to sustain the discussion proposed in this study, allowing us to relate the legal challenges identified to the reality of public health administration, especially in the Amazonian municipal context.

5 CONCLUSION

The present research aimed to analyze the legal challenges related to the application of the General Law for the Protection of Personal Data in the processing of sensitive data in the context of public health, especially considering the administrative reality of the municipality of Manaus, Amazonas.

The results obtained demonstrate that the implementation of the LGPD in the health

sector is not limited to the formal compliance with legal requirements, but is a continuous process of institutional transformation. The protection of sensitive data requires structural adaptation of public organizations, involving technological adequacy, definition of secure information flows, professional training, and establishment of permanent governance and control mechanisms. In this sense, it is verified that the normative effectiveness depends directly on the administrative capacity of public entities to incorporate information security practices compatible with the complexity of the treatment of clinical data.

It was also observed that the processing of personal data in public health has particularities resulting from the care purpose of the service itself, in which the sharing of information is an indispensable element for the continuity of care and the formulation of public policies. This characteristic imposes the need for a balance between the public interest in health management and the preservation of the fundamental rights of citizens, especially those related to privacy, intimacy, and informational self-determination.

In the context analyzed, it is evident that municipal health systems located in regions with structural limitations face additional challenges for the full implementation of legal requirements, making it essential to develop specific institutional policies aimed at data protection. The Amazonian reality demonstrates that technological inequalities, infrastructure limitations, and the historical absence of an organizational culture focused on information security can compromise the effectiveness of the protection measures provided for in the legislation.

The consolidation of personal data protection in public health depends on the integration between law, technology, and public management, requiring strategic planning, institutional investment, and strengthening of administrative practices guided by the prevention of informational risks. The research shows that the LGPD represents not only a regulatory instrument, but a mechanism for strengthening social trust in public health services, contributing to the construction of safer, more transparent and legally responsible care models.

Thus, it is highlighted that the study achieved the proposed objectives by systematizing the main legal challenges related to the processing of sensitive data in public health, indicating the need for further empirical investigations. Such advances may contribute to the improvement of local public policies and to the development of institutional adequacy strategies compatible with the regional specificities of Amazonas, strengthening the protection of fundamental rights within the scope of public health administration.

ACKNOWLEDGMENTS

On behalf of all the authors of this work, we register our deep gratitude to all those who contributed to making this research possible. This article carries not only legal analyses and academic reflections, but also the voice of students who believe in education as an instrument of social transformation.

Along this path, we understood that research is also taking responsibility for the reality that surrounds us, especially with the challenges experienced in public health and in the protection of fundamental rights in our region.

We speak here as Amazonian researchers, aware that producing knowledge from Amazonas is to reaffirm the intellectual strength of our land and demonstrate that the science built in the North region has national relevance. This work symbolizes our respect for the Amazonian population and our desire to contribute to a fairer, safer and more humane society.

We dedicate this research to Amazonas, in the hope that each page written represents not only an academic requirement fulfilled, but a gesture of recognition, belonging and honor to our history, our people and the future we seek to build through knowledge.

REFERENCES

- Balian, R. A. (2025). Uma análise jurídica da interoperabilidade de dados de saúde sob a LGPD. *Revista Foco Publicações*. <https://ojs.focopublicacoes.com.br/foco/article/view/8733>
- Brasil. (2018). Lei nº 13.709, de 14 de agosto de 2018. Lei Geral de Proteção de Dados Pessoais (LGPD). Brasília, DF: Presidência da República. https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/lei/l13709.htm
- Dias Carneiro. (2021). LGPD na saúde. <https://www.diascarneiro.com.br/app/uploads/2021/09/LGPDSaude.pdf>
- Gonçalves, R. M. (2024). LGPD e serviços de saúde pública: desafios da implementação em hospitais públicos. *Revista do Centro Acadêmico Afonso Pena*. <https://periodicos.ufmg.br/index.php/caap/article/download/52340/45604/205048>
- Hawryliszyn, M. (2021). Aplicabilidade da LGPD nos serviços de saúde. *Revista Univap*. <https://doi.org/10.18066/revistaunivap.v27i54.2589>
- Lima, I. S. (2023). Lei Geral de Proteção de Dados Pessoais nos serviços de saúde pública. *Revista Processus de Políticas Públicas e Desenvolvimento Social*. <https://periodicos.processus.com.br/index.php/ppds/article/view/1002>
- Martins, F. R. (2021). A aplicação da LGPD nos hospitais privados e o direito fundamental à saúde. In *Anais do VII Seminário Internacional*. <https://homacdhe.com/wp-content/uploads/2021/01/Anais-do-VII-Semin%C3%A1rio-Internacional.pdf#page=70>

Praça Neto, A. A. (2023). Lei Geral de Proteção de Dados Pessoais: impactos no setor de saúde. Revista Ibero-Americana de Humanidades, Ciências e Educação. <https://periodicorease.pro.br/rease/article/view/10177>

Silva, L. B. (2023). Lei Geral de Proteção de Dados e o controle social da saúde. Rede Unida. <https://editora.redeunida.org.br/wp-content/uploads/2023/06/Livro-Lei-Geral.pdf>

Soares, M. A. S. (2021). LGPD na área da saúde: perguntas e respostas para a prática médica. FEMINA. https://docs.bvsalud.org/biblioref/2021/05/1224079/femina-2021-493-p156-160-perguntas-e-respostas-sobre-a-lgpd-na_mQFOICL.pdf

Zaganelli, M. V. (2023). O sigilo médico e os dados sensíveis na telemedicina à luz da LGPD. RECIIS. <https://www.reciis.iciict.fiocruz.br/index.php/reciis/article/view/3689>

AN ANALYSIS OF THE IMPORTANCE OF MENTAL CALCULATION IN THE 5TH GRADE OF ELEMENTARY SCHOOL AT THE PEDRO LUDOVICO TEIXEIRA MUNICIPAL SCHOOL IN THE MUNICIPALITY OF COLINAS DO TOCANTINS

UMA ANÁLISE SOBRE A IMPORTÂNCIA DO CÁLCULO MENTAL NO 5º ANO DO ENSINO FUNDAMENTAL EM UMA ESCOLA MUNICIPAL PEDRO LUDOVICO TEIXEIRA NO MUNICÍPIO DE COLINAS DO TOCANTINS

UN ANÁLISIS DE LA IMPORTANCIA DEL CÁLCULO MENTAL EN EL 5º AÑO DE LA ENSEÑANZA PRIMARIA DE LA ESCUELA MUNICIPAL PEDRO LUDOVICO TEIXEIRA DEL MUNICIPIO DE COLINAS DO TOCANTINS



<https://doi.org/10.56238/sevened2026.008-197>

Marilene Pessoa da Silva Augusti¹, Margareth Araújo e Silva², Luciana Cristina Porfírio³

ABSTRACT

This text is part of a research project on how students should be encouraged to perform mental calculations. The main hypothesis is that when stimulated, it can become a habitual and simple skill to improve calculation abilities in various contexts. This article explores the application of activities that stimulate mental calculation in the 5th grade of elementary school. The objective is to demonstrate the effectiveness of mental calculation in elementary school, showing how students' autonomy and critical thinking can be developed, promoting the acquisition of a skill that will be useful in daily activities ranging from simple to highly complex, involving numbers and mathematics as a whole. Through research with a qualitative and quantitative approach, the results obtained with 15 students from a class chosen due to their difficulty in performing simple calculations are presented. Practical activities were carried out, divided into two groups, which helped to identify difficulties with mental calculation. The group with simpler activities had a high number of correct answers. The use of calculators was not encouraged in any of the activities, as the focus was on evaluating the students' level of mental calculation skills. The more complex activities showed a higher error rate, and only 37% of the students achieved an excellent grade, meaning they had more than 60% correct answers out of the total grade. Analyzing the grades and the activities applied, the class had an average level, as some propositions that were considered simple were not solved.

Keywords: Mental Calculation. Mathematics. Teaching and Learning.

¹ Master's degree in Education Sciences. Universidad de San Lorenzo (recognized by Universidade do Vale do Sapucaí (UNIVAS)). E-mail: fmecolinasdotocantins@gmail.com

² Dr. in Education. Universidade Federal do Espírito Santo (UFES). Universidade Federal de Jataí (UFJ). E-mail: margareth@ufj.edu.br

³ Dr. in Education. Faculdade de Educação da Universidade de São Paulo (FE-USP). Universidade Federal de Jataí (UFJ). E-mail: Luciana_cristina@ufj.edu.br

RESUMO

Esse texto é parte de uma pesquisa sobre como o aluno deve ser estimulado a realizar o cálculo mental. A principal hipótese é que quando estimulado, pode incorporar como algo habitual e simples para aprimorar a habilidade de calcular em diversos contextos. Este artigo trabalha a aplicação da realização de atividades que estimulem o cálculo mental no 5º ano do Ensino Fundamental. O objetivo é demonstrar a eficácia da ferramenta do cálculo mental no Ensino Fundamental, mostrando como a autonomia e o pensamento crítico dos alunos podem ser desenvolvidos, promovendo a aquisição de uma habilidade que levarão para as atividades diárias de simples a alta complexidade que envolve os números e a matemática como um todo. Através de uma pesquisa com abordagem qualitativa e quantitativa, apresentam-se os resultados obtidos com 15 alunos de uma turma escolhida devido à dificuldade de fazer cálculos simples. Foram realizadas atividades práticas divididas em dois grupos que ajudaram a identificar as dificuldades quanto ao cálculo mental, o grupo de atividades mais simples teve grande número de acertos. O uso da calculadora não foi estimulado em nenhuma das atividades, pois o foco era avaliar o nível em que estavam sobre o cálculo pensado. As atividades mais complexas apresentaram nível maior de erros e apenas 37% dos alunos tiveram conceito ótimo, ou seja, tiveram mais que 60% de acertos do total da nota. Analisando as notas e as atividades aplicadas, a turma teve nível mediano, pois algumas proposições que eram consideradas simples, não foram resolvidas.

Palavras-chave: Cálculo Mental. Matemática. Ensino e Aprendizagem.

RESUMEN

Este texto forma parte de un proyecto de investigación sobre cómo estimular el cálculo mental en los estudiantes. La hipótesis principal es que, al estimularlo, puede convertirse en una habilidad habitual y sencilla para mejorar las habilidades de cálculo en diversos contextos. Este artículo explora la aplicación de actividades que estimulan el cálculo mental en 5.º de primaria. El objetivo es demostrar la eficacia del cálculo mental en primaria, mostrando cómo se puede desarrollar la autonomía y el pensamiento crítico de los estudiantes, promoviendo la adquisición de una habilidad útil en actividades cotidianas, desde las más sencillas hasta las más complejas, que involucran números y matemáticas en general. Mediante una investigación con un enfoque cualitativo y cuantitativo, se presentan los resultados obtenidos con 15 estudiantes de una clase seleccionada por su dificultad para realizar cálculos simples. Se realizaron actividades prácticas, divididos en dos grupos, lo que ayudó a identificar las dificultades con el cálculo mental. El grupo con actividades más sencillas tuvo un alto número de respuestas correctas. No se fomentó el uso de calculadoras en ninguna de las actividades, ya que el enfoque se centró en evaluar el nivel de cálculo mental de los estudiantes. Las actividades más complejas mostraron una mayor tasa de error, y solo el 37% de los estudiantes obtuvo una calificación excelente, lo que significa que obtuvieron más del 60% de respuestas correctas de la calificación total. Al analizar las calificaciones y las actividades aplicadas, la clase tuvo un nivel promedio, ya que algunas proposiciones consideradas simples no se resolvieron.

Palabras clave: Cálculo Mental. Matemáticas. Enseñanza y Aprendizaje.

1 INTRODUCTION

This work seeks to highlight the importance of mental calculation in Elementary School, specifically in the 5th grade. The definition of mental calculation, within the scope of the former National Curriculum Parameters (PCN) of Mathematics for the teaching of the first grades of Elementary School, contemplates that *"it can be said that one calculates mentally when an operation is carried out, using reliable procedures, without written records and without the use of instruments"* (Brasil, 1997, p. 76).

In the highlights of the PCN, there was a focus on the importance of simultaneously working on the different types of calculation and their foundations, including written calculation, estimates, mental calculation, and the use of calculators. In the current National Common Curriculum Base (BNCC) of 2017, an approach to the theme in the early years of Elementary School is planned.

This work presents the application and importance of developing activities in classrooms that stimulate mental calculation. Such activities can show that the student develops critical thinking and greater flexibility in operations with numbers. The main idea is not to eliminate the calculator or written calculation, but to associate them with the practice of mental calculation.

The main objective of this article is to demonstrate the potential of the practice of mental calculation in Elementary School, specifically in the 5th grade, showing how students' autonomy and critical thinking can be developed, promoting the acquisition of a skill that will lead to daily activities from simple to high complexity that involves numbers and mathematics as a whole.

The study was developed in the 5th grade of the Pedro Ludovico Teixeira Municipal School, in the municipality of Colinas do Tocantins, where it was diagnosed, after carrying out activities on the practice of head calculations, students' difficulties in performing mental calculations. It is not intended to point out solutions or causes, but rather to demonstrate how the problem occurs and suggest some activities that could stimulate this practice among students, giving them more autonomy in performing calculations with their heads.

After reading authors such as Kamii (2001), Parra (2001) and others, we initially have historical veins of the insertion of mental calculation in mathematics curricula. Subsequently, it was necessary to elaborate and apply a proposal for specific activities on mental calculation in the classroom, with the purpose of collecting data on the possibility of a more significant inclusion of mental calculation in basic school.

The proposal is to study a specific case, delve into the application of these activities in the 5th year of Elementary School at Escola Mul. Pedro Ludovico Teixeira in Colinas do

Tocantins. The investigation aims to search for answers, exploring mental calculation in its concepts and conceptions, as well as its importance as a necessary tool for the construction of knowledge of numbers and the four basic operations.

In addition to the exploration of the theme, the application of mental calculation as a proposal for intervention in the classroom will raise data that will support deeper studies on the possibility of including mental calculation in basic school, including in early grades. With the data that will be collected, it will be possible to demonstrate through Figures and other tools, the experiences lived in the application.

All activities were carried out during scientific research and based on the researcher's regency as a starting point of daily empirical perception with the students' difficulties in dealing specifically with mental calculation. After the application of the activities, an analysis of the results obtained and the benefits and effectiveness of the use of mental calculation in the classroom and in individual daily activities will be presented.

2 METHODOLOGICAL PROCEDURES

The research has a quantitative-qualitative approach, using as its main tool, the study of the results of activities applied to students of the 5th grade of elementary school at the school. The data presented were collected in a case study and aim to discover the acquired reactions and autonomy. With the reported data, it is possible to demonstrate through Figures and other tools, the experiences lived in the application, as well as critically analyze all the points observed.

Data collection was done through the observation of the activities carried out in the classroom by the teacher. The exercises consisted of proposing to the students calculations, mathematical and logical tasks in various ways that they needed to use mental calculation.

The classroom has 29 students, however, 15 children were selected from this number to participate in the activities, since class attendance was a hindrance to the consistency of the application of the tasks. The activities were applied during mathematics classes and were appropriate to the age group and grade of the students. The common age was between 9 and 11 years old. Given the vast experience of the observer in the classroom, all the activities carried out presented levels of common complexity and that the 5th year of Elementary School, considering that the student at this stage, must have sufficient mathematical perception to carry them out.

As a way to understand the students' performance, an activity that we call diagnostic was applied. The researcher was a regent teacher in the researched classroom, and everyone was informed about all the activities applied and their purpose.

The research was carried out in 2013, during the school term. In the first diagnostic stage, scores were assigned to each activity, where one group of activities had a maximum value of 8.0 and another group had a maximum value of 7.0. In the diagnostic activity on the theme, two groups of exercises were applied to the students and a grade was established for both. In the municipal school network, a use of 60% of the total value of the activities is considered for approval.

The students were divided into two groups of activities, with Group I with activities of low level of complexity, with a maximum score of 8.0, and Group II, with more difficult tasks, with a maximum score of 7.0. The grade considered satisfactory for the research was the average (60% of correct answers), that is, for the activities with a value of 8.0, the students should get a grade above 4.8, and for the activity that was worth 7.0, the students should get grades above 4.2.

In the first activity, copies were distributed to the students with simple calculations such as $3 + 3$, in which they should have immediate answers, this activity had a maximum score of 8.0 and to have a satisfactory result, the student had to get 60% right, that is, above 4.8. The second activity contained problems that should be solved mathematically also using mental calculation, where the maximum score was 7.0 and the satisfactory result should be above 4.2.

As part of the activities, the Human Domino game was carried out in which each student received a strip of paper with two phrases indicating operations. Thus, each one should look for the one who has the answer to their question and pay attention to the colleague's question to check if they had the other's answer. As they completed each other, they were to stand next to each other, thus forming a circle.

The first activity applied consisted of performing common calculations such as $3+3$ or $2+5$, where 73% of the students achieved a grade above 60% of the value and 27% achieved a grade below average. The resource used by most was automatic calculation, or counting on the fingers, imagining the math in their heads and solving it, some used paper to write the math in another way. One student got all the calculations right, each resolution had a value of 1.0 point, however, it was considered half a point by the correct reasoning, but incorrect result, that is, the student used the appropriate reasoning, however, he did not reach the right result and the final answer was wrong.

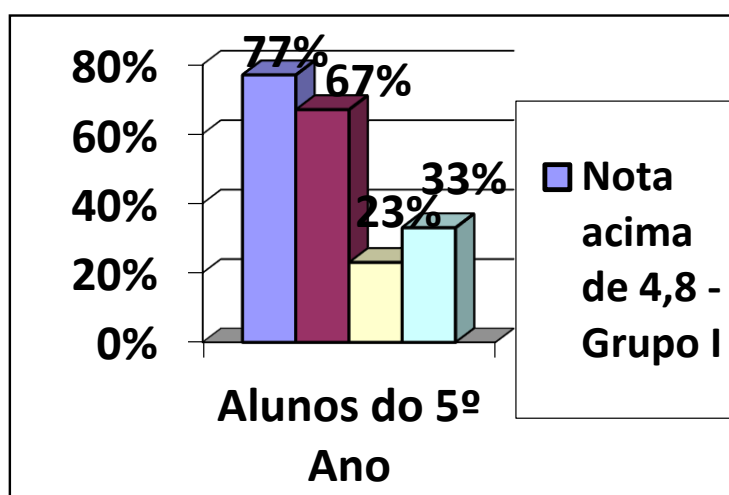
3 RESULTS AND DISCUSSION

During the performance of the activities, many looked at each calculation, thought, looked up, as in the realization of a mental writing, trying to associate the visualization of the calculation to solve it.

It was observed that most of the students had a higher than average grade, and the notorious difficulties of some of them can be explained by the knowledge already acquired previously. It is notorious in the students, the lack of stimulation for activities aimed at mental calculation in the previous grades. And many do not have the patience to calculate and reach the correct or estimated result. The resources used were almost always the same.

Figure 1

Grades by Activity Group



Source: Authors.

The simplest operations such as $1 + 1$ or $2 + 1$ had a large number of hits. When students had to resort to other tools, most tried to remember automatic multiplication table calculations, as several multiplication table memorization activities were done with everyone for some time. The use of the calculator was not encouraged in any of the activities, as the objective was to assess the level at which they were on the thought calculation. The association of the counts is natural in calculations like this, as it simplifies the process of acquiring the result.

In the second activity that consisted of completing a problem using calculus, such as "You have 4 notebooks". To complete 19, there are _____ left. In this task, 67% of the students achieved more than 60% of the total value and 33% obtained a grade below the average. The answers should be respectively: 15 notebooks, 23 erasers, 11 pencils, 14 books, 20 dolls, 12 balls, 9 stickers, 8 dresses. As in the previous activity, most achieved an above-average grade and the resources used involved automatic calculations with the

multiplication table, imagining the account in their heads, or writing the account in another way on paper to help.

The objective of this activity was to associate the student with daily situations to facilitate the calculation. Thus, each problem could easily be imagined to be solved. The inclusion of terms and objects from the children's daily lives can even lead them to remember real situations that may have involved the items in the question.

While doing the math, students could be observed trying to imagine probably a colleague, or brother, or sister with that certain amount of books, notebooks or erasers. This certainly helps in solving problems and also contributes to the day-to-day interaction of each one within the classroom.

Each time we explore the student's reality, we bring to the classroom another element that serves as a tool for learning, so each child learns by contextualizing what they have at home, in the family and with friends, whether they are from the school where they study or not.

The students had a reasonable amount of time to answer the activity in group I, as the level is quite simple and they should only resort to the calculation designed to solve the questions. However, an important observation is that only 01 student got all the calculations right, and the others achieved the grade through the table below:

Table 1

Diagnostic activity scores – Group I (Maximum Value: 8.0)

Note	Qty	%
8,0	1	7
7,5	4	26
7,0	2	13
6,0	1	7
5,5	1	7
5,0	2	13
4,0	3	20
2,5	1	7
Total	15	100

Source: Authors.

The activities of group II were more complex. The objective was to associate the concept of number individually and in the operation as a whole. For example, what is the result of the sum $1245+897=$ 2142 or 2340 or 2102. The students had more time to develop these questions, as the level of complexity was a little higher than the activities of the first group.

The results should be, respectively: 9474, 3150, 7012, 525, 5159, 14, 8805, 15 and 2916. For the addition operations, the ease was greater and most of the students got the

results right, the division and subtraction operations were the most difficult, according to the students and the errors demonstrated this. However, in general terms, the class performed well, they used the resources of writing the math in another way to solve, count on their fingers, help with the multiplication table and imagine the math in their heads to achieve the result.

For the diagnostic activity of group II, with a greater complexity in relation to the previous activities, the objective was to understand the level of each student to perform the calculations and identify the result without "guessing" the answer in order to get it right.

In terms of evaluation of the students' level, some concepts were considered. For the activity of Group I with a value of 8.0, the following were assigned:

- Below-average grades: regular concept
- Scores between 50 and 60: good concept
- Scores above 60: optimal concept

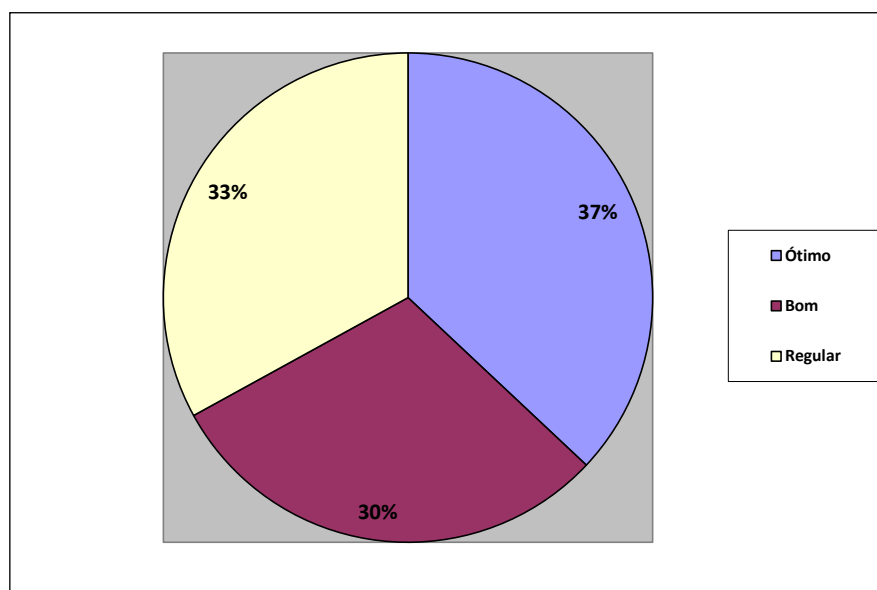
For the Group II activity, the classification was as follows:

- Below-average grades: regular concept
- Grades between 40 and 50: good concept
- Scores above 50: optimal concept

Thus, the conceptualization was as shown in the following Figure:

Figure 2

Class Concept in the Diagnostic Activity



Source: Authors.

Another activity applied was as a game so that the ability in a group and with greater agility on mental calculation could be perceived. The game was called Human Dominoes and consisted of the following procedure:

The human dominoes, after being well explained and started, did not generate major doubts and by playing, the students were able to carry out the activity. In the first resolutions before really understanding the game, some students presented difficulties, then little by little and with the interaction of the class they did what was asked more easily.

After many explanations and accomplishments of activities, we moved on to the stage in which the students would be stimulated to do the calculations mentally with another series of exercises. In view of the realization of the activities, we can make some considerations about the students' performance here. Everything that was carried out for the research presented a level appropriate to the research series.

It is observed that, in general, the level of the students can be considered average, as some simple propositions were not resolved. In another aspect, it must be taken into account that they did not do these activities in the first grades to be stimulated to do so. Therefore, there is a need to include more activities on calculus in the classroom, given its importance for the students' daily lives, not only in this grade, but throughout their lives.

When observed in a general context, the presence of "head-on" calculations in daily activities is notorious. Furthermore, it is also unquestionable that the child can develop skills with the use of this tool that will not be used only in mathematics.

"In the school environment, mental calculation is still not as valued as the armed account. However, a reasoning that may seem disorganized, in fact, may be supported by properties of operations and the numbering system and should be encouraged already in the initial grades. To help you understand the different mental strategies of calculation and teach your students to use them more and more efficiently" (Drumond, 2014).

The curriculum guidelines for the teaching of Mathematics have mental calculation, and not only for Brazil, present among the suggestions of strategies for the execution of mathematical calculations that teachers can develop with their students in the classroom.

Therefore, realizing how important this tool is for students in the teaching and learning of mathematics, it is necessary to demonstrate a study carried out through field research, how the "head counts" can be relevant for the development of students' critical and autonomous thinking.

In view of these questions, it is relevant to study the effectiveness of activities that stimulate this type of calculation in practical terms. To this end, it is ideal to apply the tool in

the classroom and observe the results obtained later. This is what this research is about, after many years with experience in the classroom, it is questioned why when reaching the 5th year of Elementary School, students have so much difficulty with counts, if mental calculation should already be stimulated in previous grades.

There are several uses of numbers, however, not so many people make use of them mentally, this often happens because they have not been stimulated to this practice. People become accustomed to calculators or become enemies of numbers due to learning disabilities and math trauma. This statement is not so rarely noted when we hear that it is the worst subject, or the most difficult. But the fact is that children should be stimulated from an early age to manipulate numbers mentally.

Mental calculation has appeared in some form in mathematics curricula for more than 70 years (Brocardo & Serrazina, 2008). However, it is noted that the advancement of technology contributes to the devaluation of basic calculation skills. For Elementary School I, the 2007 Guide to the National Textbook Plan (PNLD) emphasizes that "a good pedagogical work for the construction of this indispensable competence in the formation of the student" (Brasil, 2006, p. 27). In this way, mental calculation and its importance can be included in the construction of the entire contextualization of the number, it plays a fundamental role in the educational context for students in the initial grades that are the basis for future learning.

Thus, it is necessary to reflect on the importance of mental calculation for the construction of student autonomy, taking a look at its value and role in the field of mathematics education. It can be inferred that students have less and less capacity for mental calculation and more difficulty with basic operations.

In this research, students had a common performance, and were encouraged to use support materials for calculus such as pencil and paper. Thus, the definition of mental calculation is not unanimous, however, it is agreed that when calculating mentally, strategies are mobilized that allow speed and efficiency in the response, and as several authors argue, paper and pencil can be used for intermediate calculations.

If each student is encouraged to do so, he incorporates it into his daily life by noting how effective it is. We rely on Kamii and Livingston (2001, p.104), when they state that "children become inventive as they are encouraged to be inventive". Thus, practice with children reveals that when asked to perform a task, in the case of basic calculations and that they cannot use pencil and paper or calculator, it is observed that they find their own ways to solve it. This is because the brain, when motivated, finds its ways out to solve problems.

Playfulness develops the student's individual autonomy. By involving these activities, the educator can create an environment in the classroom that provides space for the

acquisition of new knowledge, that is, students have to feel free to find their paths, including making mistakes and speaking their minds without censorship. This stimulates learning naturally. If such a practice applies in other disciplines, in mathematics it cannot be different.

When planning a class, the teacher needs to have as one of his goals the search for student autonomy. According to Parra (1996), "responding to social need indicates an approximation with calculus that makes students capable of choosing the appropriate procedures, finding results and judging the validity of the answers".

Therefore, the tool used to solve mathematical calculations must be chosen by each one according to the need or even requirement of their activity. But for this to happen, it is necessary to know different ways of carrying them out. Over time, the calculator has been used more and more for this purpose, and this can be an important tool, however, associated with other techniques such as mental calculation.

Children can use different tools to calculate and this was observed in the activities. Pimentel and Vale (2009, p. 4) observed that many children aged 3 and 4 need to count on their fingers to calculate $16 + 10$. To discuss and problematize such situations and others involving calculus, it is also suggested to work with tables and number lines to stimulate the discovery of numerical patterns and develop mental calculation skills.

Teacher training is quite broad, however, there is a lack of didactic resources for the activities to be carried out. Workshops and constant training activities are carried out, however, the schools do not have the physical resources to subsidize the teachers. Even for the application of the activities of this work, all costs were personal, due to the school's lack of needs.

The family structure of the students also influences. Many belong to families with different compositions, and those responsible do not follow the student's school development as they should. Finally, in the face of this system, it is possible to understand that the deficiencies are many, however, some attitudes are possible. The application of the activities was a challenge, but the students developed them all without difficulty.

The main advantage of applying activities that stimulate mental calculation is that the child learns to build personal calculation strategies and to decide, in various situations, on the most effective one. He also acquires habits of reflection on calculations and has permanent means of approximation and control over what he obtains using techniques such as algorithms. By estimating results, it can self-correct: if the answer is too far from the estimate, something is wrong.

4 CONCLUSION

In view of the applications of the activities and the research carried out, it was possible to understand the process of development and stimulation of mental calculation, in addition to understanding how the student can be more autonomous in this process.

Conti and Nunes (2019) make an important reflection to be made: it is that, even though this modality is cited and valued in textbooks and other Brazilian documents, it does not mean that there really is a work in the classroom with it, because the greatest agents in the classroom are the teachers, and not the textbooks. Teachers, whether they have degrees in Mathematics or Pedagogy, were often not prepared to deal with the practice of mental calculation in the classroom.

It is unanimous the understanding of how relevant it is to provoke the student to be thinking, safe, contesting and creative. According to Paulo Freire (2002): there is no teaching without research and research without teaching. These what-to's are found in each other's bodies. While I teach I continue seeking, searching. I teach because I seek, because I inquired, because I inquire and I inquire myself. I research to verify, verifying, I intervene, intervening, educating and educating myself. I research to know and what I still don't know and communicate or announce the news.

Thus, analyzing the teaching of calculus in elementary school was a complex task, however, pleasurable, given the daily teaching practice for many years, it is possible to be clear about many aspects that are not included in official documents. The students of the 5th year of Elementary School of the Pedro Ludovico Teixeira Municipal School, were the background of this work and through them it was possible to realize that the application of the curricula is quite deficient in the municipal education system.

Mental calculation is still a challenge, because despite being among the curricular matrices, it is one of the most practical contents of mathematics. Performing the calculations by head, or with the head, in an agile and efficient way is only real through stimulation, practice, repetition. And for that, the teacher needs to diversify in the classroom. Thus, there are many challenges to be overcome.

It is important to emphasize once again that mental calculation contributes significantly and abundantly to the development of learning with understanding. According to Sadovisky quoted by Wolman and Quaranta (undated) when he states that it is necessary to think of a student who is convinced that, in some way, he can face complex situations, in the sense that he can start trying to introduce himself into the problems that are posed to him, "roll up his sleeves", experiment with what he knows, make decisions, respect and consider the

production of others, introduce oneself into it in order to understand it, discuss it, assume it, etc.

Perhaps such a statement leads one to think that this is a utopia, however, as educators the attempt is always for a thinking, reflective, safe, flexible, autonomous, aggregating and creative student. In fact, this is a right of individuals, not just children.

Hope (p. 54, 1996) said that a correct answer can be the destination of a mental calculation, but it is the path followed, more than the destination, that reveals the traveler's understanding. A person who knows how to calculate mentally is more likely to travel by other paths than a person who does not have this ability.

In view of the realization of the activities, we can make some considerations about the students' performance here. Everything that was carried out for the research presented a level appropriate to the research series.

It is observed that, in general, the level of the students can be considered average, as some simple propositions were not resolved. In another aspect, it must be taken into account that they did not do these activities in the first grades to be stimulated to do so. Therefore, it is recommended to include more activities on calculus in the classroom, given its importance for the students' daily lives, not only in this grade, but throughout their lives.

This recommendation is based on the observation that many of the problems in which estimation is used are linked to day-to-day issues. For example: how long it takes to get somewhere or how much gasoline is needed. When it comes to mental calculation, both exact and approximate results, memory is an important tool.

These questions should be proposed in specific didactic sequences, systematization activities and as permanent work, linked to the contents seen in the classroom. And so we believe it is possible to provide means for the student to develop their own techniques, discover their own paths and become this thinking, autonomous and creative being. And whenever there is a class that stimulates the development of this being, there will be a true educator, not only about mental calculation, but about any other contents. Because one must educate for life.

REFERENCES

- Brasil. Secretaria de Educação Básica. (2006). Guia de livros didáticos: PNLD 2007 – Matemática: séries/anos iniciais do Ensino Fundamental. Brasília: MEC/SEB.
- Brocardo, J., Serrazina, L., & Kraemer, J. M. (2003). Algoritmos e sentido do número. *Educação e Matemática*, 75(1), 5–8.
- Conti, K. C. C., & Nunes, L. M. de A. (2019). Cálculo mental em questão: fundamentação teórica e reflexões. *Revemop*, 1(3), 361–378.

- Freire, P. (2002). *Pedagogia da autonomia: saberes necessários à prática educativa* (25. ed.). São Paulo: Paz e Terra.
- Hope, J. A. (1986). Mental calculation: Anachronism or basic skill? In H. L. Schoen (Ed.), *Estimation and mental computation*. Reston: National Council of Teachers of Mathematics.
- Kamii, C., & Livingston, S. J. (2001). *Desvendando a aritmética: implicações da teoria de Piaget* (6. ed.). Campinas: Papirus.
- Nuno, V. (2015). *Análise de provas finais revela necessidade de melhorar textos e cálculo mental*. <http://observador.pt/2015/04/25/analise-provas-finais-revela-necessidade-melhorar-textos-calculo-mental/>
- Parra, C., & Saiz, I. (Orgs.). (2001). *Didática da matemática: reflexões psicopedagógicas*. Porto Alegre: Artmed.
- Pimentel, T., & Vale, I. (2009). A descoberta de padrões no desenvolvimento do cálculo mental: uma experiência com professores do 1.º ciclo. In C. Costa, E. Mamede, & F. Guimarães (Orgs.), *Números e estatística: reflectindo o presente, perspectivando o futuro*. Vila Real: XIX Encontro de Investigação em Educação Matemática.
- Santos, D. M. dos. (2014). *Cálculo mental: diagnóstico de estratégias espontâneas de alunos do 6º ano*. Revemat.
- Sowder, J. (1988). Mental computation and number comparison: Their roles in the development of number sense and computational estimation. In J. Hiebert & M. Behr (Eds.), *Number concepts and operations in the middle grades*. Reston, VA: Lawrence Erlbaum.
- Valente, W. R. (Org.). (2004). *Euclides Roxo e a modernização do ensino de matemática no Brasil*. Brasília: UnB.

MENTAL HEALTH IN CHILDHOOD AND ADOLESCENCE: WELCOMING AND CONTINUOUS SUPPORT

A SAÚDE MENTAL NA INFÂNCIA E ADOLESCÊNCIA: ACOLHIMENTO E ACOMPANHAMENTO CONTÍNUO

LA SALUD MENTAL EN LA INFANCIA Y ADOLESCENCIA: ACOGIDA Y SEGUIMIENTO CONTINUO



<https://doi.org/10.56238/sevened2026.008-198>

Raquel Oliveira Santos¹, Sálvia Viviane Agra Belota², Gleyce Adrielle da Silva Rodrigues³, Graciene Rabelo Mota e Silva⁴

ABSTRACT

The increase in diagnoses of mental disorders in childhood and adolescence, together with the constitutional provision of health as a fundamental right, highlights the social and legal relevance of child and adolescent mental health. This scenario imposes the need to deepen the discussion on care strategies that ensure healthy development and social inclusion. The objective is to analyze the social and individual impacts of mental disorders in children and adolescents, emphasizing the importance of early diagnosis, qualified support, and continuous follow-up, as well as the coordination between family, school, and health services. To this end, a bibliographic research was conducted using a deductive approach, grounded in specialized literature and in legislation relevant to the field of health, covering the period from 2020 to 2026. Thus, it is observed that fragility in early identification and the integration of care networks can intensify vulnerabilities and compromise integral development. It is concluded that the realization of the right to child and adolescent mental health requires intersectoral public policies, humanized care practices, and continuous monitoring, capable of ensuring protection, health promotion, and social inclusion.

Keywords: Mental Health. Childhood. Adolescence. Mental Disorders. Support.

RESUMO

O aumento dos diagnósticos de transtornos mentais na infância e adolescência, aliado à previsão constitucional da saúde como direito fundamental, evidencia a relevância social e jurídica da saúde mental infantojuvenil. Esse cenário impõe a necessidade de aprofundar a discussão sobre estratégias de cuidado que assegurem desenvolvimento saudável e inclusão social. Objetiva-se analisar os impactos sociais e individuais dos transtornos

¹ Master's degree in Health Sciences (PROCISA). Universidade Federal de Roraima (UFRR).

E-mail: raquel.tainara.santos@gmail.com Orcid: <https://orcid.org/0009-0006-8664-0739>

Lattes: <https://lattes.cnpq.br/3610634510930773>

² Medical student. Faculdade Santa Teresa. E-mail: nutribelota@gmail.com

Lattes: <http://lattes.cnpq.br/3830475716762735>

³ Medical student. Faculdade Santa Teresa. E-mail: gleyceadrielle30@gmail.com

Lattes: <https://lattes.cnpq.br/4025689873181497>

⁴ Medical student. Faculdade Santa Teresa. E-mail: gracienerabello12@gmail.com

Lattes: <http://lattes.cnpq.br/1719792691295268>

mentais em crianças e adolescentes, ressaltando a importância do diagnóstico precoce, do acolhimento qualificado e do acompanhamento contínuo, bem como da articulação entre família, escola e serviços de saúde. Para tanto, procede-se à pesquisa bibliográfica, com abordagem dedutiva, fundamentada na doutrina especializada e na legislação pertinente à área da saúde, no período de 2020 a 2026. Desse modo, observa-se que a fragilidade na identificação precoce e na integração das redes de cuidado pode intensificar vulnerabilidades e comprometer o desenvolvimento integral. Conclui-se que a efetivação do direito à saúde mental infantojuvenil requer políticas públicas intersetoriais, práticas de acolhimento humanizadas e acompanhamento contínuo, capazes de garantir proteção, promoção da saúde e inclusão social.

Palavras-chave: Saúde Mental. Infância. Adolescência. Transtornos Mentais. Acolhimento.

RESUMEN

El aumento de los diagnósticos de trastornos mentales en la infancia y la adolescencia, junto con la previsión constitucional de la salud como derecho fundamental, evidencia la relevancia social y jurídica de la salud mental infantojuvenil. Este escenario impone la necesidad de profundizar la discusión sobre estrategias de cuidado que aseguren un desarrollo saludable y la inclusión social. Se pretende analizar los impactos sociales e individuales de los trastornos mentales en niños y adolescentes, resaltando la importancia del diagnóstico temprano, de la atención calificada y del seguimiento continuo, así como de la articulación entre la familia, la escuela y los servicios de salud. Para tal fin, se realizó una investigación bibliográfica con enfoque deductivo, fundamentada en la doctrina especializada y en la legislación pertinente al área de la salud, en el período de 2020 a 2026. De este modo, se observa que la fragilidad en la identificación temprana y en la integración de las redes de cuidado puede intensificar vulnerabilidades y comprometer el desarrollo integral. Se concluye que la efectividad del derecho a la salud mental infantil y juvenil requiere políticas públicas intersectoriales, prácticas de acogida humanizadas y seguimiento continuo, capaces de garantizar protección, promoción de la salud e inclusión social.

Palabras clave: Salud Mental. Infancia. Adolescencia. Trastornos Mentales. Acogida.

1 INTRODUCTION

Child and adolescent mental health has been consolidated as one of the main contemporary priorities in public health, considering its epidemiological magnitude and its impacts throughout the life course (LEITÃO, 2025). Childhood and adolescence represent critical periods of human development. As described by Mastorci et al. (2024, p. 1), "the transition from childhood to adolescence is an extraordinary time in life, associated with major physical, emotional, cognitive, and social changes". Within this quadrant, international evidence indicates that a significant portion of mental disorders begin before the age of 14, which reinforces the centrality of early detection and intervention actions (LIMA, 2025).

In the Brazilian scenario, there has been a significant increase in manifestations related to anxiety, depression, and other forms of psychological distress among adolescents (LOPES, 2020). This phenomenon cannot be understood in isolation, as it is intrinsically linked to recent social transformations and the persistent structural inequalities that mark the country. Factors such as poverty, exposure to violence, weakening of family ties, and difficulties in accessing health services are social determinants that directly impact mental health outcomes (ALEGRÍA, 2023). Thus, mental illness in adolescence should be analyzed in the light of the material, social and symbolic conditions that shape the life experiences of this population.

The literature points out that mental disorders not diagnosed in childhood tend to persist or worsen in adulthood, expanding educational, occupational, and relational impacts (COPELAND, 2023). In this sense, early diagnosis, associated with evidence-based psychosocial interventions, is an essential strategy to modify trajectories of suffering and promote a higher quality of life. However, structural gaps persist with regard to the organization of care networks articulated between health, education and social assistance, which compromises the comprehensiveness of care.

The guarantee of the right to mental health, as a duty of the State, is based on the Constitution of the Federative Republic of Brazil of 1988 (articles 6 and 196), which ensures health as a right of all and a State duty, to be implemented through public policies. In the specific scope of mental health, Law No. 10,216 establishes the protection and rights of people with mental disorders and guides the community care model, in line with the principles of the SUS provided for in Law No. 8,080. However, in view of the insufficiency of supply or the fragmentation of services, there is a growing judicialization of health as a mechanism for access to specialized treatments and services. Such a scenario highlights tensions between legal normativity and the concrete operationalization of public policies (RODRIGUES, 2026).

In this context, there is a need to increase awareness about mental health from the

first years of life, articulating intersectoral actions and strengthening preventive initiatives in school and community spaces. The consolidation of integrated support networks, involving family, school, health services and the community, is a central strategy for coping with child and adolescent psychological suffering, contributing to the reduction of stigmas and the promotion of more welcoming, protective and favorable environments for integral development.

The present study aims to analyze the relevance of child and adolescent mental health in the contemporary Brazilian scenario, with emphasis on the promotion of early diagnosis and the articulation of intersectoral care networks. The specific objectives are: (i) to identify, based on the national scientific literature, the main risk and protective factors associated with psychological distress in children and adolescents; (ii) to analyze the impact of child and adolescent mental disorders in school, family and social contexts; (iii) to examine the strategies for prevention and promotion of mental health described in public policies and government programs; and (iv) to discuss the importance of integrating health, education and social assistance in the consolidation of support networks capable of ensuring comprehensive and continuous care. These objectives are structured in such a way as to clearly delimit the scope of the investigation, allowing the systematic evaluation of the available evidence and the proposition of feasible strategies for the strengthening of public policies aimed at child and adolescent mental health.

2 THEORETICAL FRAMEWORK

The contemporary debate on child and adolescent mental health has been marked by the recognition of its centrality in the public health agenda, both due to its epidemiological magnitude and the cumulative impacts throughout the life course. International evidence indicates that a significant portion of mental disorders begin in childhood and, above all, in adolescence, a period in which neurobiological, emotional, and social transformations are intensified. According to the World Health Organization (2025), it is estimated that approximately one in seven children and adolescents (10–19 years old) has a mental disorder, which reinforces the need for early identification, continuous care, and disease prevention strategies. This scenario supports the understanding that child and adolescent mental health cannot be treated as a peripheral issue, but as a structuring dimension of human development, education and social protection policies.

On the conceptual level, the literature distinguishes psychic suffering from mental disorders themselves, even though both are interconnected. In Chapter 2 – Psychiatric Reform and Psychosocial Paradigm, in *Mental Health and Psychosocial Care*, by Paulo

Amarante (2007), he argues that psychic suffering should not be automatically reduced to a psychiatric diagnosis, as it involves social, cultural and historical dimensions. This perspective is widely used in Brazilian public health to differentiate subjective suffering from mental disorders structured in classification systems.

According to recent studies, psychological distress, often referred to as *psychological distress* in the literature, refers to a set of subjective manifestations of emotional distress, including symptoms of sadness, anxiety, nervousness, irritability, and other negative psychological reactions in the face of adverse situations or psychic stressors, without necessarily corresponding to a diagnosable mental disorder. On the other hand, mental disorders are conditions that can be diagnosed with specific clinical criteria, differing from transient emotional distress because they involve functional impairment and the need for systematic follow-up. (CURELARU, 2025; GERAGHTY, 2024). This differentiation is essential to avoid both underdiagnosis and excessive pathologization of developmental experiences. Childhood and adolescence are critical phases of the life cycle, in which environmental, family and school factors exert a decisive influence on the constitution of mental health, which demands context-sensitive approaches based on multiprofessional assessment.

The perspective of the social determinants of health has broadened the understanding of the factors that influence psychological distress in childhood and adolescence. Evidence indicates that poverty, food insecurity, violence, discrimination, weakening of family ties and barriers in accessing services increase mental vulnerability. On the other hand, stable affective bonds, community support, a protective school environment, and timely access to psychosocial care act as protective factors (OBERLE et al., 2025). The Pan American Health Organization (n.d.) emphasizes that many cases remain undiagnosed and without adequate treatment, increasing the risks of school dropout, social isolation and future losses. This situation highlights the need for interventions that articulate clinical, educational and social assistance actions.

In the Brazilian context, the organization of mental health care is structured in the Psychosocial Care Network (RAPS), established within the scope of the Unified Health System with the objective of promoting comprehensive, territorialized and networked care. RAPS proposes the articulation between Primary Care, specialized services, community devices and intersectoral strategies, recognizing that child and adolescent mental health care is not restricted to the clinical space. This model reinforces the importance of continuity of care and co-responsibility between different points of the network. However, the literature also identifies challenges related to unequal coverage, fragmentation of care flows, and insufficient integration between sectors.

In this sense, intersectoriality emerges as a central theoretical and operational axis for the consolidation of support networks capable of guaranteeing comprehensive and continuous care. The articulation between health, education and social assistance is pointed out as an indispensable strategy for the early identification of signs of suffering, the construction of unique therapeutic projects and longitudinal follow-up. The school, for example, is often a privileged space for observation and referral, while social assistance services contribute to coping with structural vulnerabilities that have a direct impact on mental health. However, although widely defended in normative frameworks and public policies, intersectoriality still faces practical obstacles, still fragmented communication between services, weaknesses in shared protocols, and limitations of resources allocated to child and adolescent care (LEITÃO; AVELLAR, 2025).

Thus, the theoretical framework that underlies the present study is based on the convergence between three main axes: the approach to the social determinants of health, the perspective of human development throughout the life course, and the model of integrated care networks. By analyzing the relevance of child and adolescent mental health in the contemporary Brazilian scenario, with an emphasis on early diagnosis and intersectoral articulation, the study dialogues with consensus established in the literature, such as the need for timely and territorial interventions, and with persistent gaps, especially with regard to the effectiveness of public policies and the consolidation of integrated care networks. Thus, the theoretical framework not only contextualizes the phenomenon, but also guides the critical analysis of the evidence and the proposition of feasible strategies for strengthening policies aimed at the mental health of children and adolescents.

3 METHODOLOGY

This is a qualitative study, developed through bibliographic research, with a deductive approach, whose relevance lies in the complexity of the object investigated, which involves social, legal, political and subjective dimensions in the field of health. The qualitative nature is fundamental because it enables interpretive, critical and contextualized analysis of the phenomena, allowing the understanding of meanings, normative foundations and practical implications. In addition, Lakatos and Marconi (2021) base bibliographic research as a method based on the systematic analysis of scientific productions already published, allowing the theoretical construction of the object of study through a deductive approach.

Data collection was carried out through a systematic search in national and international scientific databases, covering journals in the areas of public health, psychiatry, psychology and social sciences, as well as through consultation of official documents, current

legislation and technical reports of national and international organizations. The research used descriptors articulated in Portuguese and English, including terms such as "mental health", "infantojuvenil", "mental disorder", "acolhimento", "Brasil", *mental health, child and adolescent, mental disorder, welcoming and Brazil*, in order to increase the sensitivity of the search and ensure greater coverage of the survey.

The following inclusion criteria were adopted: publications in Portuguese or English; studies that directly addressed the conceptual, normative, epidemiological or social aspects related to the object of the research; and publications within the previously defined time frame: 2020 to 2026. Duplicate studies, texts without thematic relevance or that did not present a consistent analytical contribution to the problem investigated were excluded, ensuring the reliability of the information compiled.

After the selection, the material was submitted to exploratory and analytical reading, proceeding to the organization of the references in thematic axes: Risk factors and protection for psychic suffering, Impacts of mental disorders in life contexts, Public policies, prevention and promotion of mental health and Intersectoriality and care networks, according to their theoretical and normative contribution. The analysis was guided by the deductive method, starting from general principles, especially constitutional and legal, for the interpretation of specific situations and for the construction of critical argumentation developed throughout the study.

The ethical principles that guide scientific production were observed throughout the study, through the due attribution of credit to the works consulted, ensuring respect for intellectual property and the originality of the academic productions used. As this is a bibliographic research, without direct involvement of human beings, there was no need to submit it to the Research Ethics Committee, in accordance with current regulations. Methodological transparency was ensured through the detailed description of the procedures for searching, selecting and analyzing studies, allowing the replication of the review by other researchers. The main limitation of this study is the dependence on the quality and availability of scientific publications, which may not fully reflect knowledge about child and adolescent mental health in Brazil, especially in view of underreporting, underdiagnosis, and barriers to access to mental health services.

Table 1

Academic References and Their Contributions to Research

Author	Title	Year	Contributions
LOPES, C.	How is the mental health of Brazilians? The importance	2020	It highlights the high burden of mental disorders in Brazil, their early onset and relationship with social inequalities,

	of birth cohorts for a better understanding of the problem.		emphasizing the importance of birth cohorts to guide public policies.
OLIVEIRA, P.; SANTANA, F.; JÚNIOR, J.; SANTOS, K.; ARAUJO, P.; FORTUNA, C.	Matrix support in child and adolescent mental health in Primary Health Care: institutional socioclinical intervention research	2021	It analyzes matrix support in child and adolescent mental health, demonstrating its contribution to expanding the co-responsibility between ESF and CAPS, transforming institutional practices and qualifying the organization of care.
RICHTER, R. H.; MATSUKURA, T. S.; TAÑO, B. L.; CID, M. F	Portraits of the discharge process in mental health care for children and adolescents from the perspective of occupational therapists.	2022	It examines the process of discharge in CAPSij, showing that its effectiveness depends on gradual planning, intra and intersectoral articulation and co-responsibility of the network, strengthening the psychosocial perspective and the Psychiatric Reform.
ALEGRIA, M.; ALVAREZ, K.; CHENG, M.; FALGAS-BAGUE, I.	Recent Advances on Social Determinants of MentalHealth: Looking Fast Forward.	2023	It synthesizes recent advances on the social determinants that influence mental health, evidencing their impact on the occurrence and evolution of mental disorders.
COPELAND, W. E.; HALVORSON-PHELAN, J.; MCGINNIS, E.; SHANAHAN, L.	Adult mental health, substance use disorders, and functional outcomes of children resilient to early adversity	2023	It demonstrates that resilience to adversity in childhood is uncommon and that children considered resilient have, in adulthood, a higher risk of anxiety and depressive disorders and worse functional outcomes, indicating that reducing early exposure to adversity should be a public health priority.
GERAGHTY, A. W. A. et al	Distinguishing emotional distress from mental disorder in primary care.	2024	It shows that the distinction between emotional distress and mental disorder, through the 4DSQ, is perceived as clear and useful by primary care patients, favoring self-understanding, qualification of clinical dialogue and greater therapeutic direction.
MASTORCI, F.; LAZZERI, M. F. L.; VASSALLE, C.; PINGITORE, A.	The Transition from Childhood to Adolescence: Between Health and Vulnerability	2024	It analyzes the transition from childhood to adolescence as a period of intense vulnerability and developmental potential, evidencing the interaction between biological, psychosocial and environmental factors in the construction of resilience, well-being and health throughout the life course.
CURELARU, M.; CURELARU, V	Academic Difficulties: Development and Validation of Scale to Measure Students' Mental Health Problems in Online Learning	2025	They propose and validate a concise instrument to assess mental health problems in online teaching, evidencing a hierarchical structure composed of psychological suffering and academic difficulties, with good psychometric indicators.
LEITÃO, I. B. et al.	Child and adolescent mental health: analysis of therapeutic itineraries in a city in the interior and without Child and Adolescent Psychosocial Care Centers.	2025	It points out that, in a municipality without CAPSij, child and adolescent mental health care is organized by fragmented itineraries, with the centrality of the school, predominance of specialized referrals and barriers to the continuity of care, evidencing weaknesses in the local network.
LEITÃO, I.; AVELLAR, L.	Overview of child and adolescent mental health policies in Latin America: insufficiencies and needs for intersectoral articulation.	2025	It presents an overview of child and adolescent mental health policies in Latin America, evidencing normative advances coexisting with low investment, precariousness of services and fragmented implementation, and defending the need to strengthen the network and greater prioritization of the SMIJ in the public agenda.
LIMA, R. F. et al.	Epidemiological scenario of mental disorders reported	2025	It describes the epidemiological profile of mental disorders in children and adolescents

	in children and adolescents in the state of Bahia between the years 2020 and 2024.		in Bahia, showing a predominance in adolescence, an increase in notifications and a high hospital impact.
OBERLE, E. et al.	Mental well-being trends and school-based protective factors among adolescents in British Columbia (2015–2022): A population-based study.	2025	It shows a decline in the mental well-being of adolescents, demonstrating that school factors such as adult support and a sense of belonging act as important protective elements.
WORLD HEALTH ORGANIZATION (WHO).	Adolescent mental health	2025	It presents updated data on mental health in adolescence (10-19 years), showing a high prevalence of disorders, impact on the global burden of diseases and the need for intervention and specific public policies.
RODRIGUES, E	Judicialization of mental health: challenges and solutions in the Brazilian justice system.	2026	It analyzes the phenomenon of judicialization of mental health in Brazil, discussing its impacts on public management, the structural challenges of the SUS and the need to improve policies and the articulation between the health system and the justice system to ensure effective access to care.

Source: Elaborated by the authors.

The systematization presented allows us to visualize, in chronological order, evidence that demonstrates how child and adolescent mental health guides more qualified decisions in the formulation of policies and in the organization of care networks. By bringing together studies on social determinants, early onset of disorders, organization of Primary Care and specialized services, intersectoral articulation and protective factors, the possibility of identifying vulnerabilities, reducing care fragmentation and subsidizing prevention and promotion strategies is evident. In addition, by integrating discussions on the distinction between emotional distress and mental disorder, therapeutic itineraries, structural weaknesses of the network, and challenges related to judicialization, the framework reinforces that promoting mental health is not limited to diagnosis or punctual treatment, but involves strengthening the governance of the system, qualifying professional practices, reducing inequalities, and protecting development processes that sustain well-being and resilience throughout the course of the year. life course.

4 RESULTS AND DISCUSSIONS

The analysis of the selected studies shows that child and adolescent mental health has been understood as a multifactorial phenomenon, crossed by social determinants, organization of care networks and impacts throughout the life course. In the axis referring to risk and protective factors for psychological suffering, from an epidemiological perspective, a high burden of mental disorders is observed in Brazil, with often early onset and a strong association with socioeconomic inequalities (Lopes, 2020). Recent international data

reinforce this magnitude by indicating a high prevalence of disorders among adolescents aged 10 to 19 years and a relevant participation in the global burden of diseases (WHO, 2025). In the state context, the growth in notifications and the hospital impact on children and adolescents point to a worsening trend and greater visibility of cases (Lima et al., 2025).

With regard to social determinants, the literature shows that structural factors, such as poverty, social exclusion, and exposure to violence, exert a significant influence on mental health throughout the life course (Alegría et al., 2023). Similarly, when analyzing the effects of adversity accumulated throughout childhood, Copeland et al. (2023, p. 911) highlight that "resilient children who experienced multiple forms of adversity in childhood had the highest risk of exposure to trauma in adulthood", showing that early resilience does not eliminate the cumulative impacts of adverse experiences. In addition, the authors state that "thus, exposure to adversity in childhood appears to have a significant long-term effect, the impact of which is delayed among individuals who initially appeared to be resilient," indicating that the effects of adversity may manifest late, which reinforces the importance of preventive strategies and continuous monitoring throughout development.

In the axis of the impacts of mental disorders in life contexts, studies demonstrate that, in the clinical and evaluative field, the distinction between emotional distress and mental disorder is fundamental to qualify the dialogue in Primary Health Care and direct more appropriate interventions. In this sense, as highlighted by Geraghty et al. (2024, p. 440), "Differentiating suffering from disorder was perceived as useful, both to support self-understanding and to potentially improve conversations with clinicians", showing that such differentiation favors both the patient's subjective understanding and communication in the care context.

Regarding public policies and the organization of mental health care networks, the findings indicate that matrix support in child and adolescent mental health strengthens the co-responsibility between Family Health Strategy and CAPS teams, qualifying practices and expanding the comprehensiveness of care (OLIVEIRA et al., 2021). However, the discharge process at CAPSij requires gradual planning, intra- and intersectoral articulation, and co-responsibility of the network to avoid care discontinuity (RICHTER et al., 2022). In municipalities without CAPSij, fragmented therapeutic itineraries, centrality of the school, and predominance of specialized referrals are observed, evidencing structural weaknesses in the local network (LEITÃO, I. B. et al. 2025). At the Latin American regional level, normative advances are identified coexisting with low investment and fragmented implementation of policies (LEITÃO; AVELLAR, 2025).

Finally, the judicialization of mental health reveals tensions between social demand and the structural capacity of the public system, impacting management and highlighting gaps in the supply of specialized services (RODRIGUES, 2026). In an integrated way, the findings corroborate the understanding of child and adolescent mental health as a multifactorial phenomenon, socially determined and crossed by structural and institutional dynamics. The high epidemiological burden and the early onset of disorders reinforce the need for early detection and intervention strategies, especially in contexts marked by socioeconomic inequalities. The association between accumulated childhood adversities and late outcomes, even in individuals initially considered resilient, demonstrates that the impacts of adverse experiences can manifest themselves in a deferred manner, requiring longitudinal follow-up and sustainable public policies throughout the life course.

From the perspective of the school, family and social contexts, the findings explain that mental disorders are not restricted to the clinical field, but have a structuring impact on educational development and interpersonal relationships. The distinction between emotional distress and mental disorder is shown to be strategic to qualify interventions in Primary Care, avoiding both excessive medicalization and neglect of conditions that require systematic care. This differentiation contributes to improving clinical dialogue and strengthening the autonomy of subjects in the care process.

In the field of public policies, the coexistence between normative advances and fragmented implementation shows a mismatch between the formulation and effectiveness of actions. Judicialization emerges as an expression of structural gaps and the insufficiency of the regular supply of specialized services, signaling the need for greater investment and systemic planning. Strategies for prevention and promotion of mental health must assume a structuring character, incorporating intersectoral actions and expanding the centrality of Primary Care.

Finally, the consolidation of integrated intersectoral networks is a fundamental condition to ensure comprehensive and continuous care. The strengthening of matrix support, the articulation between health, education and social assistance, and the adequate planning of the discharge process in specialized services are central elements to reduce the fragmentation of therapeutic itineraries. In an articulated way, the results indicate that the guarantee of mental health care in childhood and adolescence requires not only the treatment of already established cases, but also investment in developmental protection, promotion of protective factors and reduction of structural inequalities that affect psychological suffering.

5 FINAL CONSIDERATIONS

This study aimed to analyze the relevance of child and adolescent mental health in the contemporary Brazilian scenario, with emphasis on the promotion of early diagnosis and the articulation of intersectoral care networks. The investigation showed that mental health in childhood and adolescence is a multifactorial phenomenon, resulting from the confluence of social, structural, institutional and relational determinants that affect the course of life. The findings indicate that psychological distress and mental disorders in children and adolescents cannot be understood from an exclusively clinical perspective, requiring a broader approach that considers socioeconomic inequalities, exposure to early adversities and weaknesses in the organization of care networks.

The interpretation of the findings indicates that strengthening child and adolescent mental health in Brazil requires structuring strategies that integrate prevention, early diagnosis, and continuous care in a network. This presupposes investment in Primary Health Care, qualification of the Psychosocial Care Network and effective articulation between health, education and social assistance. The strengthening of family bonds, school support and qualified access to PHC are central protective factors. In addition, it is essential to address socioeconomic inequalities as structural determinants of psychological suffering, ensuring sustainable public policies oriented to full protection throughout the life course.

The contributions of this work lie in the critical synthesis of evidence on child and adolescent mental health in Brazil, offering an integrated view of risk and protective factors, impacts on school, family and social contexts, and challenges related to the organization of public policies and care networks. The analysis made it possible to identify contexts of greater vulnerability and reinforces the need for strategies aimed at early diagnosis, prevention, and equitable allocation of resources. It was also evidenced that the promotion of mental health in childhood and adolescence requires intersectoral actions that go beyond the health sector, involving education, social assistance and other protection policies, an essential perspective to ensure comprehensive and continuous care throughout the life course.

Among the limitations of the study, its bibliographic nature stands out, depending on the productions available in the consulted databases, which may not fully contemplate the Brazilian regional diversity. Underreporting of cases, underdiagnosis in Primary Care, and inequalities in access to specialized services also restrict the accuracy of estimates. In addition, there is a concentration of research in urban and institutional contexts, with less attention to children and adolescents in greater social vulnerability, such as those living in peripheral territories, traditional communities or situations of extreme exclusion, which limits the generalization of the findings to the country as a whole

Future studies should prioritize longitudinal investigations that follow the development of children and adolescents over time, allowing the identification of risk trajectories and protective factors, as well as evaluating the effectiveness of preventive interventions and intersectoral care strategies in the Brazilian context. Investigations that integrate quantitative and qualitative approaches can broaden the understanding of lived experiences, family and school dynamics, and institutional barriers to care. Systematic evaluations of the effectiveness of public policies, prevention programs, and matrix support strategies in the Brazilian context are a priority to support evidence-based practices that are culturally sensitive to local specificities.

The final reflection of this research highlights the urgency of recognizing child and adolescent mental health as a fundamental right and collective responsibility, which requires continuous political commitment and sustainable public policies aimed at prevention, early identification and networked care. Although the country has regulatory frameworks and the Psychosocial Care Network, weaknesses persist in implementation, financing and intersectoral articulation. Thus, strengthening Primary Care, qualifying specialized services, and addressing socioeconomic inequalities are central measures to ensure comprehensive care and promote healthy development throughout the life course.

REFERENCES

- Alegría, M., Alvarez, K., Cheng, M., & Falgas-Bague, I. (2023). Recent advances on social determinants of mental health: Looking fast forward. *American Journal of Psychiatry*, 180(7), 473–482.
- Amarante, P. (2007). *Saúde mental e atenção psicossocial*. Rio de Janeiro: Editora Fiocruz.
- Brasil. (1988). *Constituição da República Federativa do Brasil de 1988*. Brasília, DF: Senado Federal.
- Brasil. (2001). Lei nº 10.216, de 6 de abril de 2001. Dispõe sobre a proteção e os direitos das pessoas portadoras de transtornos mentais e redireciona o modelo assistencial em saúde mental. *Diário Oficial da União*, Brasília, DF.
- Brasil. (1990). Lei nº 8.080, de 19 de setembro de 1990. Dispõe sobre as condições para a promoção, proteção e recuperação da saúde, a organização e o funcionamento dos serviços correspondentes. *Diário Oficial da União*, Brasília, DF.
- Brasil. Ministério da Saúde. (s.d.). Rede de Atenção Psicossocial (RAPS). <https://www.gov.br/saude/pt-br/composicao/saes/desmad/raps>
- Copeland, W. E., Halvorson-Phelan, J., McGinnis, E., & Shanahan, L. (2023). Adult mental health, substance use disorders, and functional outcomes of children resilient to early adversity. *American Journal of Psychiatry*, 180(12), 906–913.

- Curelaru, M., & Curelaru, V. (2025). Psychological distress and online academic difficulties: Development and validation of scale to measure students' mental health problems in online learning. *Behavioral Sciences*, 15(1), 1–20.
- Geraghty, A. W. A., et al. (2024). Distinguishing emotional distress from mental disorder in primary care. *British Journal of General Practice*, 74(744), 434–441.
- Lakatos, E. M., & Marconi, M. de A. (2021). *Fundamentos de metodologia científica* (9. ed.). São Paulo: Atlas.
- Leitão, I. B., et al. (2025). Saúde mental infantojuvenil: análise de itinerários terapêuticos em município de interior e sem Centros de Atenção Psicossocial Infantojuvenis. *Cadernos de Saúde Pública*, 41(1), 1–15.
- Leitão, I., & Avellar, L. (2025). Panorama das políticas de saúde mental infantojuvenil na América Latina: insuficiências e necessidades de articulação intersectorial. *Physis: Revista de Saúde Coletiva*, 35(1), e350110.
- Lima, R. F., et al. (2025). Cenário epidemiológico dos transtornos mentais notificados em crianças e adolescentes no estado da Bahia entre os anos de 2020 a 2024. *Brazilian Journal of Implantology and Health Sciences*, 7(9), 372–391.
- Lopes, C. (2020). Como está a saúde mental dos brasileiros? A importância das coortes de nascimento para melhor compreensão do problema. *Cadernos de Saúde Pública*, 36(2), e00005020.
- Mastorci, F., Lazzeri, M. F. L., Vassalle, C., & Pingitore, A. (2024). The transition from childhood to adolescence: Between health and vulnerability. *Children*, 11(8), 989.
- Oberle, E., et al. (2025). Mental well-being trends and school-based protective factors among adolescents in British Columbia (2015–2022): A population-based study. *Social Science & Medicine*, 380, 118201.
- Oliveira, P., Santana, F., Júnior, J., Santos, K., Araujo, P., & Fortuna, C. (2021). Apoio matricial em saúde mental infantojuvenil na Atenção Primária à Saúde: pesquisa intervenção socioclínica institucional. *Revista da Escola de Enfermagem da USP*, 55, e03731.
- Organização Mundial da Saúde. (2025). Adolescent mental health. Geneva: World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health>
- Organização Pan-Americana da Saúde. (s.d.). Saúde mental dos adolescentes. Washington, D.C.: OPAS. <https://www.paho.org/pt/topicos/saude-mental-dos-adolescentes>
- Richter, R. H., Matsukura, T. S., Taño, B. L., & Cid, M. F. (2022). Retratos do processo de alta na atenção à saúde mental de crianças e adolescentes na perspectiva de terapeutas ocupacionais. *Physis: Revista de Saúde Coletiva*, 32(1), e320102.
- Rodrigues, E. (2026, janeiro). Judicialização da saúde mental: desafios e soluções no sistema de justiça brasileiro. JusBrasil. <https://www.jusbrasil.com.br/artigos/judicializacao-da-saude-mental-desafios-e-solucoes-no-sistema-de-justica-brasileiro/5451040976>

DIAGNOSTIC ENGINEERING: PATHOLOGICAL ANALYSIS OF THE FEDERAL GOIANO INSTITUTE – TRINDADE CAMPUS

ENGENHARIA DIAGNÓSTICA: ANÁLISE PATOLÓGICA DO INSTITUTO FEDERAL GOIANO CAMPUS TRINDADE

INGENIERÍA DIAGNÓSTICA: ANÁLISIS PATOLÓGICO DEL INSTITUTO FEDERAL GOIANO – CAMPUS TRINDADE



<https://doi.org/10.56238/sevned2026.008-199>

Ana Clara Alves Nunes¹, Ana Júlia Bezerra Martins², Arthur Rodrigues Lourenço³, Pedro Filipe de Luna Cunha⁴, Vitória Régia Araújo Ribeiro⁵, Andre Augusto Nobrega Dantas⁶

ABSTRACT

The study and development of a diagnosis of pathologies in civil construction occurs through the analysis of the construction method and the quality of materials, the maintenance frequency, and whether it is being carried out according to technical guidance, in order to identify the cause of the problem. The issue may result from construction defects, low-quality materials used, lack of maintenance, or improper use. This analysis can also indicate the level of criticality, the priority for intervention, and possible methods for treatment. The present work aims to analyze the main construction pathologies found at the Trindade Campus of the Federal Institute Goiano. The methodology used is based on the Building Inspection Standard of the Brazilian Institute of Engineering Evaluations and Expertise (IBAPE), through the visual analysis of pathologies, classifying them according to their level of criticality and nature, as well as indicating the priority for treatment. Therefore, through the study developed, the Institution will be able to take appropriate actions to address the main pathologies that affect the Campus.

Keywords: Pathology. Construction. Diagnosis. Post-Construction. Maintenance.

RESUMO

O estudo e o desenvolvimento de um diagnóstico de patologias na construção civil ocorrem por meio da análise do método construtivo, da qualidade dos materiais e da periodicidade da manutenção, verificando-se se esta está sendo realizada conforme orientação técnica, a fim de identificar a causa do problema, se é decorrente da obra ou baixa qualidade dos materiais empregados, ausência de manutenção ou uso incorreto, podendo indicar a criticidade, nível de prioridade para intervenção e até formas para tratamento. O presente

¹ Graduated in Civil Engineering. Instituto Federal Goiano. E-mail: ana.nunes@estudante.ifgoiano.edu.br

² Graduated in Civil Engineering. Instituto Federal Goiano. E-mail: ana.bezerra1@estudante.ifgoiano.edu.br

³ Graduated in Civil Engineering. Instituto Federal Goiano. E-mail: arthur.lourenco@estudante.ifgoiano.edu.br

⁴ Dr. in Structural Engineering. Instituto Federal Goiano. E-mail: pedro.cunha@ifgoiano.edu.br

⁵ Doctoral student in Environmental Technology and Water Resources. Universidade de Brasília (UnB). E-mail: vitoria.rib@hotmail.com

⁶ Dr. in Geotechnical Engineering. Instituto Federal de Brasília (IFB). E-mail: andre.nobrega@ifb.edu.br

trabalho visa analisar as principais patologias da construção do Campus Trindade do Instituto Federal Goiano. A metodologia utilizada se baseia na Norma de Inspeção Predial do Instituto Brasileiro de Avaliações e Perícias de Engenharia, através da análise visual das patologias, classificando-as quanto ao grau de criticidade e natureza, além de indicar a prioridade de tratamento. Portanto, por meio do estudo desenvolvido, a Instituição poderá tomar medidas para o tratamento das principais patologias que afetam o Campus.

Palavras-chave: Patologia. Construção. Diagnóstico. Pós-Obra. Manutenção.

RESUMEN

El estudio y desarrollo de un diagnóstico de patologías en la construcción civil se realiza mediante el análisis del método constructivo y de la calidad de los materiales, la periodicidad del mantenimiento y si este se está realizando conforme a las orientaciones técnicas, con el fin de identificar la causa del problema. Este puede derivarse de fallas en la obra, baja calidad de los materiales empleados, ausencia de mantenimiento o uso incorrecto, pudiendo además indicar el nivel de criticidad, la prioridad de intervención e incluso posibles formas de tratamiento. El presente trabajo tiene como objetivo analizar las principales patologías constructivas del Campus Trindade del Instituto Federal Goiano. La metodología utilizada se basa en la Norma de Inspección Predial del Instituto Brasileño de Evaluaciones y Pericias de Ingeniería (IBAPE), mediante el análisis visual de las patologías, clasificándolas según su grado de criticidad y naturaleza, además de indicar la prioridad de tratamiento. Por lo tanto, a través del estudio desarrollado, la Institución podrá tomar medidas para el tratamiento de las principales patologías que afectan al Campus.

Palabras clave: Patología. Construcción. Diagnóstico. Post-Obra. Mantenimiento.

1 INTRODUCTION

Civil Engineering and its technological advances are constantly innovating in the market and in its lines of research. Civil construction has sought agility in the execution of buildings with the use of construction techniques and methods that enable this acceleration, however, such progress needs attention to avoid possible problems during and after the completion of the work, and it is essential to carefully control quality, in addition to knowledge in the execution process and good practice of construction techniques. In turn, the failure to take due care, for example, errors in the compatibility of projects, failures in the execution of the work, use of low-quality materials, as well as the lack of preventive/corrective maintenance after the end of construction, can lead to the emergence of pathologies that are capable of compromising the operation, aesthetic comfort, durability and safety of the building.

In this way, Diagnostic Engineering has been taking a considerable strand in the daily life of Civil Construction, being an analysis tool, both at the time of the work for the care of execution and verification of the projects, and in the post-work, used in the diagnosis of pathologies and indication of the causes, in addition to the presentation of a recovery and maintenance plan, thus, ensuring a method to maintain the durability and effectiveness of buildings.

The Federal Institute of Goiás, Trindade campus, had its first class in 2015 for technical courses integrated with high school and subsequent, housing a considerable flow of teachers, students and administrative staff. Over time, from the first year of collective use, the building is faced with apparent pathologies, in order to impair the functioning of certain areas and facilities, in addition to the aesthetic discomfort caused by these constructive anomalies.

Due to the functionalities and continuous use by hundreds of people, there is a constant concern about the "deterioration" of some points of common use, and it is necessary, initially, a building inspection to prepare an action plan to correct the identified flaws and to ensure the proper maintenance of the building in the long term, extending its usefulness and useful life.

In this context, there are methodologies for expert evaluation and analysis of pathologies in civil construction, as provided by the Brazilian Association of Technical Standards (ABNT) and the Brazilian Institute of Engineering Evaluations and Expertise (IBAPE, 2021). Finally, the objective of this work is to identify, characterize and expose the possible causes of constructive pathologies at the Federal Institute of Goiás – Trindade Campus.

2 THEORETICAL FRAMEWORK

2.1 PATHOLOGY IN CIVIL CONSTRUCTION

The study of pathology can be defined as the study of diseases, their causes, effects, as well as the development of treatments and prevention of diseases. In civil construction, pathology refers to the study of anomalies, defects, damages, or manifestations that occur in buildings, structures, and other constructions, and are associated with some factors such as design or execution errors, actions of time that cause deterioration, or actions of external agents (IBDA, 2017).

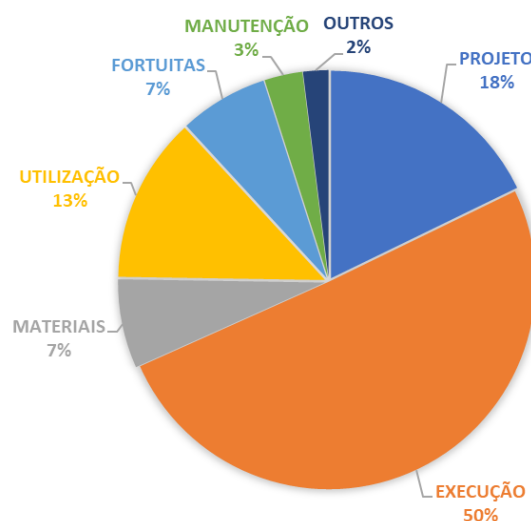
These pathological manifestations may be visible or they may be internal problems. In order to reduce costs and speed up construction, the procedures that prevent the appearance of pathological manifestations end up not being practiced. With the emergence of these manifestations, there is a need for studies to understand the causes, extent of the anomalies, as well as the recommendation of solutions to repair them and prevent their recurrence (Fachin, 2016).

The study of pathology can be divided into some parts, such as the existence and investigation of the problem and the feasibility of the proposed solution. A concern of the occurrence of pathological manifestations is the number and frequency they occur, and for greater effectiveness in correcting problems and lower cost, it is necessary to identify and solve them as soon as possible. This resulted in cost reduction over time (Silva et al., 2020).

The study of pathologies in civil construction is extremely important, as the lack of attention to the components can affect the safety, functionality and useful life of a building, as well as the well-being of the occupants. And with a quick identification of a pathology, in addition to reducing the costs of corrective actions, it allows the building to have a longer useful life and durability.

2.2 PATHOLOGICAL MANIFESTATIONS

The origin of the pathological manifestations is related to the stage of the structure's life, and is associated with failures that occur during the development of activities throughout the construction processes. According to Piancastelli (2017), the highest rate of pathological occurrences in Brazil is in the construction execution phase (Figure 1).

Figure 1*Incidence and origin of pathological manifestations in Brazil*

Source: Piancastelli (2017).

2.3 SERVICE LIFE AND DURABILITY

The useful life of a building is the period in which it can be used for the purpose for which it was built, with satisfactory performance in terms of safety, comfort and functionality. The useful life of a building can vary depending on several factors, such as the type of use, the design, the quality of the materials, and proper maintenance.

The ABNT NBR 15575:2013 (ABNT, 2013) standard establishes the minimum requirements for the performance of residential buildings, including the minimum expected useful life, which is 50 years. However, it is important to note that the useful life of a building can be longer or shorter than the expectation established by the standard, depending on several factors, such as the level of use, the quality of the materials, the climate, and proper maintenance. Proper and preventive maintenance can significantly extend the useful life of a building, while lack of maintenance can accelerate degradation and reduce its useful time.

2.4 MAINTENANCE

Maintenance of pathologies in civil construction is the set of preventive and corrective actions that aim to ensure the integrity, safety, functionality and durability of buildings, based on their identification and correction. According to the NBR 5674 standard (ABNT, 2012) that portrays the maintenance of buildings, it presents the concept of maintenance, which is the set of actions performed with the purpose of conserving or recovering the functionality of a building and its parts, meeting the established criteria as well as the safety of its users.

The maintenance of pathologies can be preventive or corrective. Preventive maintenance is carried out with the objective of avoiding the occurrence of future problems,

through the periodicity of verification and review of the integrity of the construction components. Corrective maintenance, on the other hand, is performed to correct existing problems and defects, such as cracks, infiltrations, corrosion, among others.

The maintenance of pathologies in civil construction is essential to ensure the safety and proper functioning of buildings and with the lack of maintenance, pathologies can worsen, compromising the structure of the building and putting the safety of users at risk. Therefore, it is important to carry out maintenance regularly and rely on qualified and experienced professionals to perform the necessary interventions.

2.5 EVALUATION OF PATHOLOGIES

With the constant updating of standards related to the performance and quality of construction, it was necessary to highlight a front of services aimed at the evaluation of constructive pathologies, which is a demand under the responsibility of the diagnostic engineering methodology in order to study the origin, the degree of risk and propose repair and prevention methods. NBR 13752 (ABNT, 1996) presents the basic guidelines, concepts, criteria and procedures related to engineering expertise in civil construction, providing for the classification of the object as to the nature, basic methodology and criteria to be used.

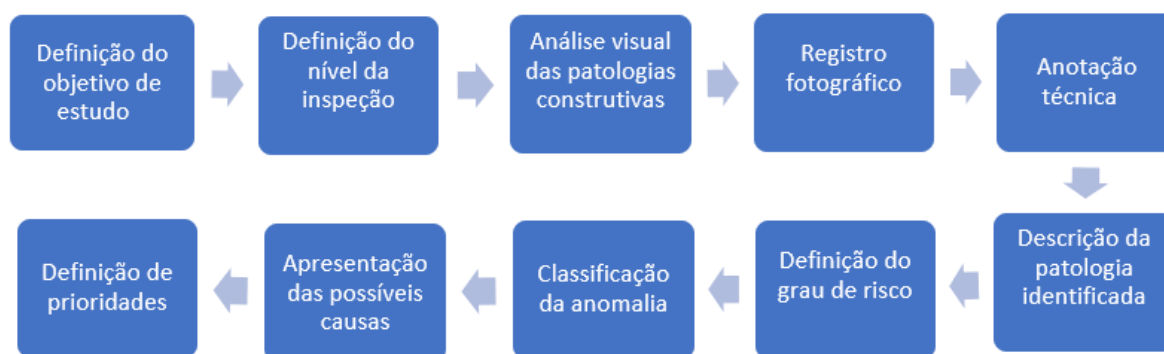
In addition, IBAPE (2021) presents the definitions contained in the IBAPE/NACIONAL Glossary of Terminology and complements the definitions contained in the related ABNT standards, bringing the most used expert evaluation method for diagnostic engineering in Civil Construction.

It should be noted that the method exposed by IBAPE (2021) is the same as that adopted in this work, giving the definition of the type of building inspection adopted, as well as the level of complexity of the evaluation, definition of the degree of risk of the pathologies found according to the technical concept, definition of priorities, technical recommendations and evaluation of maintenance and use, finally, indication of responsibilities. Thus, with the mixture of the referenced methodology with the research objective, the expected results will be achieved.

3 METHODOLOGY

3.1 RESEARCH ROADMAP

Figure 2 shows the Research Guide, referring to the steps that were carried out during the study on pathologies in civil construction.

Figure 2*Flowchart of the research script*

Source: Prepared by the authors themselves.

3.2 OBJECT OF THE RESEARCH

The building analyzed refers to the second stage of the expansion plan of the Federal Network of Professional and Technological Education. Located in the city of Trindade - Goiás, the Trindade Campus began its activities in the first semester of 2015, and over the years it has expanded its audience and its built area.

The unit currently (2023) has a built area of 43 thousand square meters, located in the urban area of the city. Its structure includes an auditorium with support for 200 people, library, professional and specific laboratories, classrooms, administrative facilities, sports court and living area (Figure 3).

Figure 3

Federal Network of Professional and Technological Education – IF Goiano - Trindade Campus – 2023



Source: Google Earth (2023) Drone photography (IF Goiano – Trindade Campus).

Taking into account the first structures of the Campus, the case study of this work focuses on the environments of the main block of rooms, library, auditorium and laboratory of materials and soils. In each environment mentioned as a case study, a technical inspection

was carried out for data collection, which is essential for the composition of the results. During the analysis of the identified pathologies, visual and photographic records were made, later using authorial theoretical foundations to reference each deterioration.

In order to highlight the methodology adopted for the identification of apparent pathologies at the Federal Institute of Goiano - Trindade Campus, fundamental concepts were used, following the idea proposed by this article through the method of evaluation and characterization of pathologies through direct visual inspection, as provided in the Building Inspection Standard of the Brazilian Institute of Engineering Evaluations and Expertise (IBAPE, 2012).

3.3 APPLICABILITY OF THE BUILDING INSPECTION STANDARD METHOD

3.3.1 Level of Inspection

The IBAPE National building inspection standard presents definitions regarding the isolated or combined analysis of the technical, use and maintenance conditions of the building, bringing the classification of the level of building inspection as to its complexity and preparation of a report. This inspection referring to the levels that are classified as 1, 2 and 3 are carried out by professionals in a specialty, but these professionals also prepare the report (IBAPE, 2021).

Level 1: Building Inspection carried out in buildings with low technical, maintenance and operation complexity of their elements and construction systems. Usually used in buildings with very simple or non-existent maintenance plans.

Level 2: Building Inspection carried out in buildings with medium technical complexity, maintenance and operation of their elements and construction systems, of medium construction standards and with conventional systems. Usually used in buildings with several floors, with or without a maintenance plan, but with outSourced companies hired to perform specific activities such as: maintenance of pumps, gates, water reservoirs, among others.

Level 3: Building Inspection carried out in buildings with high technical complexity, maintenance and operation of their elements and construction systems, of higher construction standards and with more sophisticated systems. Usually used in buildings with several floors or with construction systems with automation. At this level of building inspection, a maintenance based on ABNT NBR 5674 is mandatorily performed in the building. It also has a qualified professional in charge of the technician, a maintenance plan with planned activities and detailed procedures, management software, and other management tools for the existing maintenance system. At this level of inspection, the work may be called Technical Audit.

3.3.2 Degree of risk and classification of anomalies

Regarding the classification of the Degree of Risk, IBAPE (2012) recommends the criterion regarding the existence of anomalies and flaws in the building found by the evaluation, considering the risk offered to users, the environment and property, within the limits of the building inspection, which can be classified as follows:

Critical Risk Level: Risk of causing damage to the health and safety of people and the environment; excessive loss of performance and functionality causing possible downtime; excessive increase in maintenance and recovery costs; significant impairment of useful life.

Medium Risk Degree: Risk of causing partial loss of performance and functionality of the building without prejudice to the direct operation of systems, and early deterioration.

Minimum Degree of Risk: Risk of causing minor damage to aesthetics or programmable and planned activity, without incidence or without the probability of occurrence of critical and regular risks, in addition to low or no impairment of real estate value.

In addition to the degree of risk that must be analyzed, it is also important to understand the classifications of anomalies that can occur when there are pathologies in buildings. Thus, IBAPE (2012) classifies them as: endogenous, exogenous, natural and functional. Endogenous occurs in the building itself, and can be design, materials and execution. Exogenous, on the other hand, originates from factors external to the building, caused by third parties. The definition of natural pathology occurs in relation to the events of natural phenomena. Finally, the constructive anomaly defined as functional originates from the degradation of construction systems by natural aging and, consequently, the end of the useful life.

3.3.3 Classification of failures and definition of priorities

Planning Failure: Resulting from failures in procedures and inadequate specifications of the maintenance plan, without adherence to technical issues, use, environmental exposure and, mainly, reliability and availability of the facilities, according to the maintenance strategy. In addition to the design aspects of the plan, there are flaws in the periodicities of execution.

Execution failure: Associated with maintenance arising from failures caused by the improper execution of maintenance plan procedures and activities, including improper use of materials.

Operational: Relating to inadequate procedures for registrations, controls, patrols and other pertinent activities.

Managerial: Resulting from the lack of quality control of maintenance services, as well as lack of cost monitoring.

The definition of priorities will have the functionality of alerting about the need for repair, aiming to prevent further damage to the structure of the building or to the lives of users, and will be carried out through the degree of risk, where the indicated pathologies should be pointed out with priority of intervention as "High", "Medium" and "Low".

4 RESULTS AND DISCUSSION

After performing the visual inspection of the environments defined for this case study, it was possible to identify 5 (five) predominant pathological occurrences, with the respective definitions:

Infiltration: refers to the process by which a liquid penetrates the voids of a solid (IBDA Forum, 2017). Water infiltration entails a series of pathological consequences such as corrosion of reinforcement, efflorescence, degradation of concrete and mortar, blistering and bubbles in paints, short circuits, among others (GRANATO, 2002).

Oliveira (2012) defines cracks, fissures and cracks as pathological manifestations of buildings observed in masonry, beams, columns, slabs, floors, among other elements, usually caused by material stresses. If the materials are ordered with an effort greater than their resistance, failure occurs, causing an opening, and according to their thickness, it will be classified as fissure, crack, crack, crack or breach (Table 1).

Table 1

Thicknesses and classification of anomalies

ANMALIES	Fissure	Crack	Crack	Crack	Breach
OPENINGS (mm)	Up to 0.5	From 0.5 to 1.5	From 1.5 to 5.0	From 5.0 to 10.0	Over 10.0

Source: Oliveira, 2012.

Menezes (2006) defines efflorescence as saline deposits that form on the surface of construction materials, resulting from the migration and subsequent evaporation of salinized aqueous solutions. The soluble salts that give rise to efflorescence can have various origins, including raw materials, construction materials, water in the subsoil, among others.

Mold and mildew is the common occurrence in tropical climates. It is associated with the existence of a high moisture content in the attacked component and in the environment, which can interfere with the healthiness and habitability of the building (GRANATO, 2002). Classifying the inspection as level 2, according to figures 4, 5, 6, 7 and 8, pathologies with different degrees of risk, definitions of the nature of the pathology, and the environments where they were found were observed.

According to Figure 4A, infiltrations were found in the ceilings of almost all the environments of the campus case study, considering the origin of the pathology as exogenous, that is, due to factors external to the building, caused by third parties, considering it as a critical risk level, and it can also be highlighted in Figure 4C that in the laboratories infiltrations in the ceiling (also considered as exogenous of critical degree) were identified. According to IBAPE (2012) states that this degree is a risk of causing damage to the health and safety of people and the environment; excessive loss of performance and functionality causing potential outages; excessive increase in maintenance and recovery costs; sensitive impairment of service life.

Figure 4

Pathologies of molds and infiltrations – IF Goiano - Trindade Campus – 2023.



Source: Prepared by the authors.

In figure 4B, it showed infiltration in the ceramic coating, located in the courtyard, classified as endogenous and medium grade. Figure 4C showed another infiltration, located in the pillars of the courtyard and on the ramp, classified as endogenous. According to IBAPE (2012), this type of nature originates from the building itself, as in the case of a possible failure of execution, thus defining it as a medium degree. This degree means that the risk of causing partial loss of performance and functionality of the building without prejudice to the direct operation of systems, and early deterioration.

Table 2 – Part 1 presents the classifications, intervention priorities and observations considered according to the main pathologies of mold and infiltrations identified during the visual inspection.

Table 2

Classification of pathologies - level 02 inspection - part 1

Main Pathologies	Classification	Priority of intervention	Notes
Infiltration in the ceiling	Managerial	High	The classification as managerial and exogenous in nature is given by the identification of lack of corrective maintenance in the roofing systems, causing infiltration damaging the physical structure of the affected components.
Infiltration in the ceramic coating	Execution failure	Average	The classification as an execution failure and of an endogenous nature is given by the identification of a possible waterproofing failure causing infiltration of ceramic water, damaging the ceramic pieces.
Wall infiltration	Managerial	Average	The classification as managerial and exogenous in nature is given by the identification of lack of corrective maintenance in the roofing systems, causing infiltration damaging the physical structure of the affected components.
Infiltration in the ceiling	Managerial	High	The classification as managerial and exogenous in nature is given by the identification of lack of corrective maintenance in the roofing systems, causing infiltration damaging the physical structure of the affected components.

Source: Prepared by the authors.

Figure 5 presented the possible cause of the infiltrations of the campus, with the analysis of the drone cracks were observed in the roof slab. The cracks found can allow rainwater or other Sources to enter, causing additional damage to the structure and interior of the building, consequently causing infiltrations.

Figure 5

Pathologies of molds and infiltrations – IF Goiano - Trindade Campus – 2023



Source: Prepared by the authors.

Ceramic detachment, which is the detachment or detachment of ceramic plates, is defined through the loss of adhesion between the substrate and the ceramic coating, or of the adhesive mortar, which occurs when the stresses on the components exceed the competence of adhesion between the materials to remain stable (Fontenelle; Moura, 2004 and Oliveira, 2012). Because this pathological manifestation affects the physical integrity of users and with the high cost of repair, this anomaly is considered the most serious among them. According to figure 6A, the pathology showed the ceramic detachment, located in the pillars of the courtyard and in some rooms, classified as endogenous. According to IBAPE (2012), this type of nature originates from the building itself, as in the case of a possible failure of execution, thus defining it as a medium degree.

Figure 6

Crack, peel and fissure pathologies – IF Goiano - Trindade Campus – 2023



Source: Prepared by the authors.

In Figure 6B, cracks were found in the classroom, considering the origin of the pathology as endogenous, that is, originating from the building itself, as in the case of a possible failure in execution, as a degree of critical risk, which can also be highlighted in the

laboratories, in the auditorium, on the ramp, in the rooms and in the courtyard, cracks were identified in the corners (Figure 6C), also considered as endogenous of medium degree.

Table 3 – Part 2 presents the classifications, intervention priorities and observations considered according to the main pathologies of cracking, fissure and detachment identified during the visual inspection of the citation figures.

Table 3

Classification of pathologies - level 02 inspection - part 2

Main Pathologies	Classification	Priority of intervention	Notes
Crack	Execution failure	High	The classification as execution failure and endogenous nature is given by the identification of possible overload around the opening due to poor sizing of lintel and counter-lintel, causing cracks damaging the physical structure of the affected components.
Fissure	Execution failure	Average	The classification as an execution failure and endogenous nature is given by the identification of a possible execution failure in the masonry fastening, leaving weakened abutments, causing vertical cracks in the corners damaging the physical structure of the affected components.
Ceramic Peeling	Execution failure	Average	The classification as an execution failure and of an endogenous nature is given by the identification of a possible execution failure in the adhesion of the mortar with the ceramic piece, causing the pieces to peel off.

Source: Authors.

Figure 7

Pathologies of efflorescence, mold, mildew and warping of frames – IF Goiano - Campus Trindade – 2023



Source: Prepared by the authors.

According to Figure 7A, efflorescence was found on the façade of the auditorium, considering the origin of the pathology as exogenous, that is, due to factors external to the building, caused by third parties, considering it as a medium risk level, which can also be highlighted in the laboratories, the library, mold and mildew were identified (Figure 7B) also considered as exogenous of medium degree. According to IBAPE (2012) states that this degree is a risk of causing partial loss of performance and functionality of the building without prejudice to the direct operation of systems, and early deterioration.

In Figure 7, C presented another type of pathology, which was the warping of the frames, located in the classroom, classified as functional. According to IBAPE (2012), this type of nature originates from the degradation of construction systems by natural aging and, consequently, the end of useful life, thus defined as a critical degree. This degree means that the risk of causing damage to the health and safety of people and the environment; excessive loss of performance and functionality causing potential outages; excessive increase in maintenance and recovery costs; sensitive impairment of service life.

Table 4 presents the classifications, intervention priorities and observations considered according to the main pathologies identified during the visual inspection related to Figures 7. According to the figures, level 2 pathologies were observed, presenting different degrees of risk, definitions of the nature of the pathology, the environments where they were found, the classifications, intervention priorities and observations considered according to the main pathologies identified during the visual inspection.

Table 4

Classification of pathologies - level 02 inspection - part 3

Main Pathologies	Classification	Priority of intervention	Notes
Efflorescence	Managerial	Average	The classification as managerial and exogenous in nature is given by the identification of a lack of corrective maintenance on the façade to ensure that the surface remains clean, causing the accumulation of salts, forming efflorescence.
Mold and mildew	Managerial	Average	The classification as managerial and exogenous in nature is given by the identification of a lack of corrective maintenance in the frames to ensure that the surface remains clean, causing the accumulation of moisture, forming mold.
Warping of the frames	Managerial	High	The classification as managerial and functional is given by the identification of misuse of the frame, due force used to open and close the window, causing warping and affecting the correct sealing.

Source: Prepared by the authors.

According to figure 8A, infiltration was found on the floor of the auditorium, considering the origin of the pathology with endogenous, defining it as a critical degree, leading to the priority of intervention being high. The pathology was considered as a possible failure to execute the waterproofing of the floor, causing water infiltration by capillary absorption and undermining water in the floor, damaging the physical structure of the affected components. Figure 8B presented another pathology, which was the detachment of the laminate flooring from the auditorium, classified as functional, defined with a degree of critical risk, classified as managerial, identified as a possible lack of corrective maintenance of the laminate floor, causing detachment and significant impairment of useful life, which can lead to the loss of laminate flooring.

Figure 8

Infiltration and detachment pathologies – IF Goiano - Trindade Campus – 2023



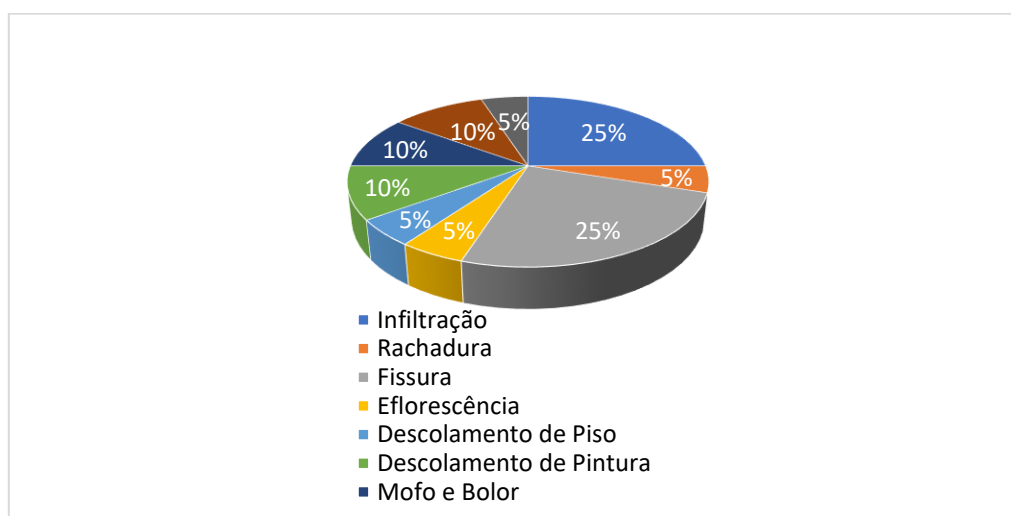
Source: Prepared by the authors.

According to Figure 8C, paint detachment was found in the laboratories, considering the origin of the pathology as exogenous, that is, due to factors external to the building, considering as a degree of critical risk, classified as managerial as a possible lack of corrective maintenance in the frames, causing infiltration and humidity in the masonry, damaging the paint leading to its displacement.

Figure 9 shows the summary of the types of pathologies found on campus. It is possible to see that the pathologies with the highest incidence were infiltrations and fissures with 25% each. These pathologies largely arise from executive failures, such as inadequate waterproofing in the case of infiltration, failure to execute the masonry in the case of cracks, and mainly due to lack of preventive and periodic maintenance. According to BONIFÁCIO; SANTANA; PERIOTT (2020) After the completion of the building, there is a need to carry out preventive and reparative maintenance, since certain anomalies are linked to the way a building is being operated.

Figure 9

Pathologies found at IF Campus Trindade - 2023

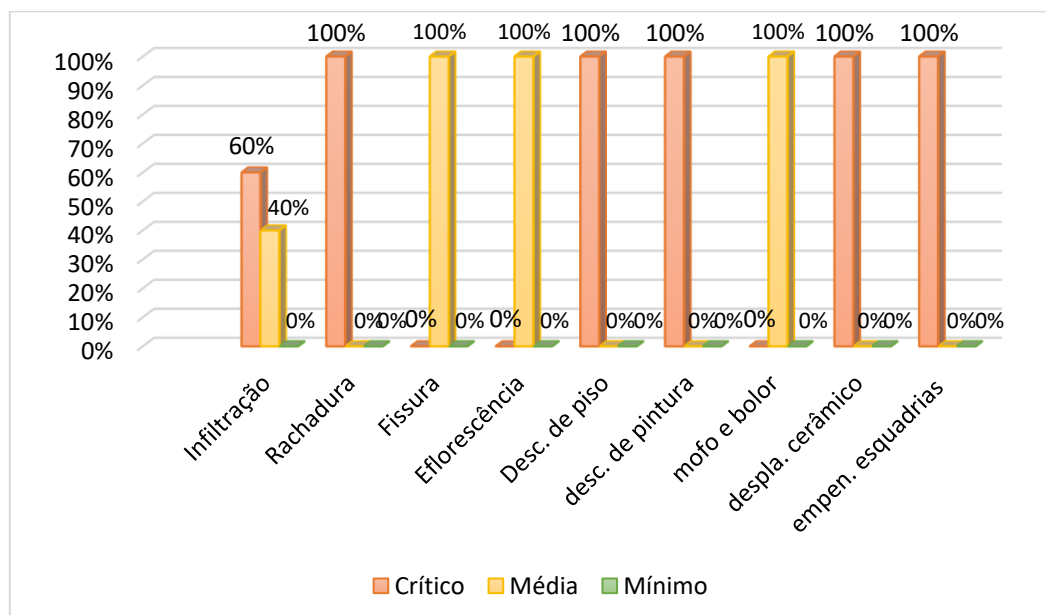


Source: Prepared by the authors.

Figure 10 shows that these pathologies were not classified with the minimum risk level. IBAPE (2012) states that the degree of risk causes small damage to the aesthetics or programmable and planned activity, without incidence or without the probability of occurrence of critical and regular risks, in addition to low or no impairment of real estate value.

Figure 10

Degree of Risk for pathologies found at IF Campus Trindade – 2023.



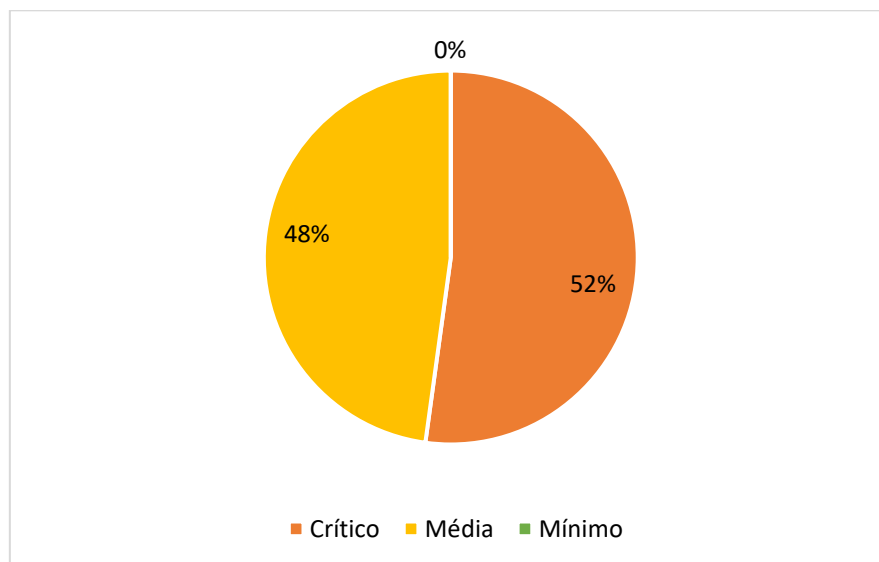
Source: Prepared by the authors.

Figure 11 shows that the pathologies were classified as medium and critical risk, so it is understood that with preventive and periodic maintenance they could reduce the number

of pathologies with the most serious risks, avoiding an excessive increase in maintenance and recovery costs.

Figure 11

Degree of Risk for pathologies found at IF Campus Trindade – 2023



Source: Prepared by the authors.

5 CONCLUSIONS

As exposed in the work, the various problems presented at the Federal Institute of Goiano – Trindade Campus become evident. In view of the above, it became possible to identify the causes according to their degree of risk and criticality. In this case, it is essential to be careful in relation to the preparation of a project that complies with the appropriate specific standards, the monitoring of the engineer/person responsible for the work throughout the executive process, the performance of periodic maintenance, and consequently, the government financial investment for these purposes, since it is a public educational institution.

However, it is possible to affirm that the objectives set at the beginning of the research were achieved, considering the assumption of the characterization of the constructive anomalies, their causes and degree of risk. Furthermore, it is worth noting that the theoretical foundations analyzed, for the most part, are based on the useful life of the building, since its functionality is directly related, that is, the deterioration is proportional to the continuous use of the Campus, as well as any other building. However, when you have a frequent and proper inspection, the useful life tends to increase.

Finally, from a general perspective, with regard to civil construction, the topics based on the writing were necessary to the point of resulting in a possible continuity of the theme

addressed, since it is a Campus that offers opportunities for an audience with different identities, but that value the same objective, education. It is recommended, in the case of future analyses related to this case, that specific preventive and repair methods for each type of pathology identified be investigated and presented, in order to further contribute to this line of research.

REFERENCES

- Associação Brasileira de Normas Técnicas. (2013). NBR 15575-1: Edificações habitacionais – Desempenho. Parte 1: Requisitos gerais. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (2012). NBR 5674: Manutenção de edificações – Requisitos para o sistema de gestão de manutenção – Especificação. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (1996). NBR 13752: Perícias de engenharia na construção civil. Rio de Janeiro: ABNT.
- Bonifácio, D. R., Santana, F. R. C., & Periotto, C. M. (2020). Análise de patologias em residências unifamiliares no ambiente quente e úmido da Amazônia. *Revista de Engenharia e Tecnologia*, 12(2), 260–270. <https://revistas.uepg.br/index.php/ret/article/view/15058/209209213428>
- Fachin, K. A., & Rivelini, A. R. B. (2016). Manifestações patológicas decorrentes em edificações religiosas. *Uningá Review*, 28(3), 85–91. <https://revista.uninga.br/uningareviews/article/view/1903>
- Granato, J. E. (2002). Impermeabilidade nas construções. In *Patologia das construções*.
- Instituto Brasileiro de Avaliações e Perícias de Engenharia. (2012). Norma de inspeção predial nacional (Ed. 1). São Paulo: IBAPE.
- Instituto Brasileiro de Avaliações e Perícias de Engenharia. (2021). Norma de inspeção predial. São Paulo: IBAPE.
- Instituto Brasileiro de Desenvolvimento de Arquitetura. (s.d.). Fissuras em paredes: como resolver essa patologia. *Fórum da Construção*. <http://www.forumdaconstrucao.com.br/conteudo.php?a=17&Cod=2510>
- Menezes, R. R., Ferreira, H. S., Neves, G. A., & Ferreira, H. C. (2006). Sais solúveis e eflorescência em blocos cerâmicos e outros materiais de construção – revisão. *Cerâmica*, 52(321), 37–49. <https://doi.org/10.1590/S0366-69132006000100006>
- Oliveira, A. M. (2012). Definições de fissuras, trincas e rachaduras. In A. M. Oliveira, *Fissuras, trincas e rachaduras causadas por recalque diferencial de fundações* (pp. 9–10). Monografia de especialização, Universidade Federal de Minas Gerais.
- Piancastelli, E. M. (2023). Patologias de concreto. <https://www.aecweb.com.br/revista/materias/patologias-do-concreto/6160>

Silva, L. A., Pires, R. C. S., Farias, B. M., & Bispo, E. R. (2020). Estudo sobre patologia estrutural em um reservatório de água de concreto armado. *Augustus*, 25(50), 66–80.

CHARACTERIZATION AND PERFORMANCE OF SOIL-CEMENT BRICKS PRODUCED WITH SOILS FROM THE ARARIPINA REGION (PE)

CARACTERIZAÇÃO E DESEMPENHO DE TIJOLOS SOLO CIMENTO PRODUZIDOS COM SOLOS DA REGIÃO DE ARARIPINA (PE)

CARACTERIZACIÓN Y DESEMPEÑO DE LADRILLOS DE SUELO- CEMENTO PRODUCIDOS CON SUELOS DE LA REGIÓN DE ARARIPINA (PE)



<https://doi.org/10.56238/sevned2026.008-200>

Weverton dos Santos Faria¹, Patrícia Costa de Andrade²

ABSTRACT

The Araripe region in the state of Pernambuco is home to vast clay mineral reserves overlapping gypsum deposits. They have been considered waste, therefore, disposed of without any exploitation, which could lead to environmental threats. Taking into consideration the need for sustainable materials in the construction field, this study has assessed the technical viability of bricks manufacturing using soil cement from Araripina's horizons A, B, and C - with and without adding crushed-stone dust. After running tests of physical characterization, granulometry and consistency, the results showed a predominance fraction of sand and lack of clay in relation to ABNT NBR 10833/2012, besides revealing fissuration after retraction tests. Bricks molded into traces 1:6 and 1:6:0,25 were submitted to both mechanical and absorption tests. The ones molded into 1:6:0,25 traces revealed a better performance, showing technical viability through adequate stabilization.

Keywords: Soil-Cement Bricks. Crushed Stone Dust Waste. Sustainable Construction.

RESUMO

A região do Araripe (PE) possui extensas reservas de argilominerais sobrepostas às jazidas de gipsita, atualmente tratadas como rejeitos e acumuladas sem aproveitamento, o que pode gerar impactos ambientais. Considerando a necessidade de materiais mais sustentáveis na construção civil, este estudo avaliou a viabilidade técnica da produção de tijolos de solo-cimento com solos dos horizontes A, B e C de Araripina (PE), com e sem adição de pó de brita. Foram realizados ensaios de caracterização física, granulométrica e de consistência. Os resultados indicaram predominância de fração arenosa e déficit de argila em relação à ABNT NBR 10833/2012, além de fissuração no ensaio de retração. Tijolos moldados nos traços 1:6 e 1:6:0,25 foram submetidos a ensaios mecânicos e de absorção. O traço 1:6:0,25 apresentou melhor desempenho, atendendo às exigências das NBR 8497/2012 e 8491/2012, demonstrando viabilidade técnica mediante estabilização adequada.

Palavras-chave: Tijolos de Solo-Cimento. Resíduos Pó de Brita. Construção Sustentável.

¹ Undergraduate Student in Civil Engineering. Instituto Federal do Sertão Pernambucano.
E-mail: weverton.farias@aluno.ifsertao-pe.edu.br

² Master's degree in Mineral Technology. Instituto Federal do Sertão Pernambucano.
E-mail: patricia.andrade@ifsertao-pe.edu.br

RESUMEN

La región de Araripe (PE) posee extensas reservas de argilominerales superpuestas a los yacimientos de gipsita, actualmente tratadas como residuos y acumuladas sin aprovechamiento, lo que puede generar impactos ambientales. Considerando la necesidad de materiales más sostenibles en la construcción civil, este estudio evaluó la viabilidad técnica de la producción de ladrillos de suelo-cemento con suelos de los horizontes A, B y C de Araripina (PE), con y sin adición de polvo de piedra triturada. Se realizaron estudios de caracterización física, granulométrica y de consistencia. Los resultados indicaron predominancia de la fracción arenosa y déficit de arcilla en relación con la norma ABNT NBR 10833/2012, además de agrietamiento en el ensayo de retracción. Los ladrillos moldeados con dosificaciones 1:6 y 1:6:0,25 fueron sometidos a ensayos mecánicos y de absorción. La dosificación 1:6:0,25 presentó mejor desempeño, cumpliendo los requisitos de las normas NBR 8497/2012 y 8491/2012, lo que demuestra la viabilidad técnica del material mediante una estabilización adecuada.

Palabras clave: Ladrillos de Suelo-Cemento. Residuos de Polvo de Piedra Triturada. Construcción Sostenible.

1 INTRODUCTION

According to Bezerra (2009), in gypsum mining in the Araripe gypsum pole, there is a need to remove the surface clay capping, which is revealed as the main environmental problem and which covers the mineral layer, being an economic conditioning factor in the feasibility of the type of mining used in the region, which has been stored for later backfill in the recovery phase of the mined area. Considering the maximum limit of the overburden/ore ratio up to 1:1. The volume of waste generated represents an environmental cost for society and a financial cost for the miner.

For this reason, in the Araripe Gypsum Pole, where the magnitude of the problem is increased by the tonnage produced and the years of mining activity, some studies have been carried out with a view to taking advantage of this capping, which remains, however, unapplied. The technological routes pursued are directed by the mineralogical, chemical and physical characteristics of the capping clays.

The civil construction sector stands out as one of the sectors that most consumes natural resources and generates waste. Given this scenario, the industry has intensified the adoption of innovative practices aimed at incorporating sustainability into its production chain (Vilela et al., 2020). Among the most relevant advances is the use of materials with less environmental impact, such as soil-cement bricks, which are presented as an economically viable and environmentally more appropriate alternative in relation to traditional masonry systems. One notable advancement is the use of eco-friendly materials, such as soil-cement bricks, which offer a cost-effective and environmentally conscious alternative to conventional masonry materials. These bricks can be produced on-site using locally sourced materials, thereby reducing transportation demands and associated energy consumption (Silva et al, 2024).

2 THEORETICAL FRAMEWORK

2.1 SOLO

According to Silva (2005), soil consists of an unconsolidated material present in the surface layer of the Earth, being composed of several minerals, classically defined as a set of mineral particles arising from the weathering of the mother rock. This material has voids filled by fluids (water and/or air) and can be classified as residual soil.

2.1.1 Soil Properties

Soil, as an engineering material and natural substrate, has a behavior that is intrinsically determined by the nature of its primary constituents. As Chiossi (2015) postulates,

two physical attributes are crucial for predicting the behavior of soils: particle size (particle size) and grain morphology (particle shape). The interdependence of these factors not only establishes the formal classification of soil, but also governs its characteristics of permeability, strength, and plasticity.

Particle size represents the distribution of soil particle diameters and is the first key to their categorization. ABNT, through NBR 6502/1995, establishes a hierarchy of classes in descending order of size: boulders, sands, silts and clays. This differentiation is key, as the size of the particles determines the specific surface area of the soil, the ratio between the total area of the particles and the volume or mass of the soil.

The coarse fractions (boulders and sands) dominate in soils with low specific surface area, which gives them high permeability and a predominantly friable behavior (dependent on friction).

Fine fractions (silts and clays), in contrast, have a significantly larger specific surface area. This enhances the surface electrostatic forces, increasing cohesion and drastically reducing permeability.

In addition to the size, the geometric shape of the particles exerts a direct influence on the packaging (structure) and interlocking of the grains, crucial factors for the shear and compressive strength of the soil. For the coarser fractions (boulders, sands, and silts), the grains tend to be equidimensional (approximate dimensions in all directions). The geometry, which varies from angular to spherical depending on energy and transport time, affects friction. More angular particles result in a higher meshing and, consequently, in greater strength and lower compressibility for a given porosity.

Clay particles, on the other hand, exhibit a unique morphology: they are lamellar or placoid. In these submicroscopic grains, two dimensions far outweigh the third, resembling laminae or platelets. This morphology gives clay its colloidal properties and its remarkable plasticity, allowing that, in the presence of water, the particles organize themselves into complex structures (flocculated or dispersed) that dictate the cohesion and moisture retention capacity of the fine soil.

2.1.2 Chemical and Mineralogical Composition

Soils whose mineralogical composition demonstrates enrichment in silica, kaolinite or quartz tend to present a favorable reactivity to cement treatment, culminating in adequate geotechnical stability (Pinto, 2006).

Silica and Quartz: Quartz, while structurally stable, indirectly contributes to stability. Silica, in its amorphous or high-reactivity form (common in weathered residual soils), allows

the occurrence of essential pozzolanic reactions with the calcium hydroxide released by the cement. Such reactions are responsible for the synthesis of hydrated calcium silicates (C-S-H), the main cementing component that gives strength and durability to the soil.

Kaolinite: This clay mineral has a stable crystal structure and a low specific surface area, compared to other clay minerals. Kaolinitic soils tend to present less ionic interference in the hydration kinetics of cement, promoting a more efficient pozzolanic reaction and a more predictable strength gain (Pinto, 2006).

The presence of these minerals is therefore associated with a lower binder demand and a superior performance of the stabilized material.

On the other hand, the presence of certain clay minerals and organic compounds can inhibit or severely compromise the stabilization process, classifying these soils as unsuitable for treatment with cement (Pinto, 2006).

Montmorillonite: This clay mineral is characterized by its expansive structure and high specific surface area. Its remarkable ability to adsorb water between the interlamellar layers gives it a high potential for expansion and retraction. In the presence of cement, montmorillonite competes for hydration water and, due to its high reactivity, can adsorb essential ions from cement, inhibiting the formation of C-S-H. This structural and chemical interference severely compromises the final strength and durability of the cemented soil.

Organic Matter: The high content of organic matter is a factor that chemically inhibits the hydration of cement. Organic components, in particular humic and fulvic acids, can act as chelating agents, encapsulating cement grains and slowing or paralyzing the hydration reaction.

2.2 PORTLAND CEMENT

Portland cement is known worldwide as a fine powder material, with different shades of gray, which manifests binding properties when mixed with water, and is often referred to as just 'cement' (Barbosa, 2015). This agglutination characteristic defines it as a binder, given its ability to bond other materials.

The final properties and characteristics of Portland cement are directly related to the characteristics and properties of the raw materials and the production process. According to the American Concrete Institute (ACI), Portland cement is a hydraulic binder obtained by grinding Portland clinker, composed essentially of hydraulic calcium silicates and aluminates. The process includes the addition of small amounts of calcium sulfate (gypsum) and often higher percentages of mineral additions, such as Granulated Blast Furnace Slag (EGAF), pozzolans and/or limestone filler.

Also in the composition, gypsum is added to Portland clinker in percentages of 2% to 6% before grinding with the fundamental objective of controlling the cement hardening (setting) time. Adding small amounts results in very rapid hardening, while high amounts can promote cracking in the hardened cement paste.

In addition to gypsum, mineral additions constitute a strategic and increasingly relevant component in the formulation of contemporary Portland cement, acting as essential modifiers of its physical and chemical properties. The impact of these additions on cement performance is two-phase. In general, a reduction in the initial mechanical strength of the material is observed, since the pozzolanic reaction and hydraulic latency occur at a slower pace than the primary hydration of the clinker. However, the long-term technical benefit is significant: the additions promote a progressive and noticeable increase in long-term mechanical strength and dramatically increase the durability of the hardened cement paste. This increase in durability is associated with the densification of the microstructure, reduced porosity and greater resistance to chemical attacks, allowing the production of optimized cements for more aggressive environments.

2.3 CRUSHED POWDER

Crushed stone dust is a fine aggregate that originates directly from the rock crushing process. This material, characterized by its fine granulometry, has important technical functions when incorporated into cementitious or soil-cement mixtures, such as those used in the production of bricks or other precast elements.

Its use is strategic and brings significant benefits to the properties of the final mixture:

- a) Improvement of Granulometry: The insertion of gravel dust contributes to the optimization of the global granulometric curve of the mixture. By filling the voids between the larger particles of the other aggregates (sand or coarse gravel), it promotes a denser and more homogeneous distribution of materials;
- b) Increased Compactness: As a direct consequence of the granulometric improvement, the gravel dust increases the compactness of the mixture. Greater compactness results in fewer voids, which is critical to the durability and mechanical performance of the final product.
- c) Shrinkage Reduction: The presence of fine and well-distributed aggregates, such as gravel dust, helps to restrict the amount of cement paste needed and to control water loss, helping to reduce shrinkage during drying and curing. This minimizes the risk of cracking.
- d) Contribution to Strength: The increase in compactness and densification of the structural matrix, together with the filling of voids, increase the final mechanical strength of the brick or component.

According to Menossi (2004), the use of gravel dust as a fine aggregate in concrete is

of great interest both for its economic and environmental aspects because it is a material from tailings, which originally brought inconvenience to the quarries due to storage and disposal, but became a product endowed with a more affordable final value.

2.4 SOIL STABILIZATION

According to Brito and Silva (2017), soil stabilization is a process carried out to stabilize and supplement the resistance properties of the soil, adapting it for a given use.

The main objective is to improve critical characteristics such as mechanical strength, durability and compressibility, making the soil able to support structural loads more efficiently. Among the various methodologies for soil improvement, chemical stabilization with Portland cement stands out as one of the most effective and widely used in Brazil (Pinto, 2006). This technique consists of adding cement to the soil, resulting in the formation of the composite material known as soil-cement.

2.5 SOIL-CEMENT

Soil-cement is a fundamental technique of civil engineering, based on soil stabilization through a controlled and homogeneous mixture of soil, cement and water, followed by a rigorous compaction process. This methodology aims to transform the geomechanical properties of the original material, giving it greater strength and durability.

The improvement of soil properties occurs as a function of the cement's hydration mechanism in the presence of water. This chemical reaction is responsible for the formation of hydrated crystals that fill the voids and establish a rigid cementitious matrix, which permanently binds the soil grains. Consequently, this stabilization causes a drastic reduction in the permeability and susceptibility of the soil to moisture variations, which is crucial to limit expansion in sensitive clay soils.

Although there is no absolute consensus as to its initial framework for large-scale application, the use of soil-cement in civil construction gained national prominence in Brazil from the 1930s onwards. This period coincided with the regulation of its manufacturing process by the Brazilian Association of Portland Cement (ABCP), a factor that boosted the development and acceptance of the technique, as referenced by Lima, cited in Nascimento (2018).

In addition to its high structural performance, soil-cement stands out for its low environmental impact, as highlighted by Nachtigal (2014). The predominant use of the local soil itself as the main aggregate significantly reduces the need for conventional material transportation, which in turn minimizes greenhouse gas emissions associated with logistics.

Structurally, the consolidated material offers a durable and cost-effective solution, being widely employed as a base layer and sub-base in road pavements and in the production of no-burn building blocks, reinforcing its position as a sustainable and efficient technique for the improvement of infrastructure and civil construction.

2.5.1 Soil-cement brick

The soil-cement brick (or soil-cement block) has established itself as a technological and sustainable alternative in civil construction, distinguishing itself from traditional ceramic materials mainly by its manufacturing method. The process begins with the pressing of the homogeneous mixture of soil, cement and water in specific metal molds.

The quality of the final block depends intrinsically on the particle size characteristics of the soil used. The most suitable soils must have basic specifications, according to Silva (2005): a) Sand Content: between 45% and 90%. b) Silt + Clay Content: between 10% and 55%. c) Clay content: less than 20%. d) Liquidity Limit (LL): less than 45%.

The fundamental step that replaces the firing step of conventional bricks is wet curing. After molding and pressing, the bricks should be kept in an environment with high humidity for at least 7 days (Nachtigal, 2014). This period is crucial as it allows the cement hydration reactions to occur, creating the cementitious matrix that gives the block its ultimate strength and durability. The cure can be extended to optimize the desired strength.

The rigid cementitious matrix gives the brick a set of properties that make it superior in several aspects. It has high durability and resistance to compression, in addition to being less susceptible to disintegration by weathering. The modular design of the blocks also contributes to good thermal insulation in buildings, helping with energy efficiency.

In terms of economic viability, the advantage is twofold: a) Cost Reduction at the Base: Elimination of the burning process, which consumes a large amount of energy (wood or gas), reducing the cost of production; b) Economy on Site: The precise shape of the soil-cement brick allows a perfect fit, resulting in a significant reduction in the use of laying mortar and coating (roughcast/plaster), minimizing waste.

3 MATERIALS AND METHODS

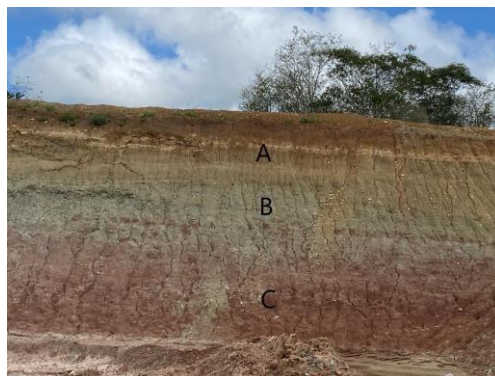
3.1 MATERIALS

3.1.1 Soils

The soil used as raw material was collected from the mining company located in the rural area of Araripina – PE, as shown in Figure 1.

Figure 1

Site of extraction of the studied material. Representation of horizons A (yellow), horizon B (greenish) and horizon C (red) of the Araripina region



Source: Authors (2025).

3.1.2 Other Materials Used

Throughout the research, composite Portland cement of two different types was used:

- CP II-Z 32 (Portland Cement Composite with Pozzolanic Material).
- CP II-F 32 (Portland Cement Composite with Filler).

The gravel dust used was collected in a mining company located in Ouricuri – PE, as can be seen in Figure 2.

Figure 2

Place of extraction of the studied material: Sample crushed stone dust



Source: Authors (2025).

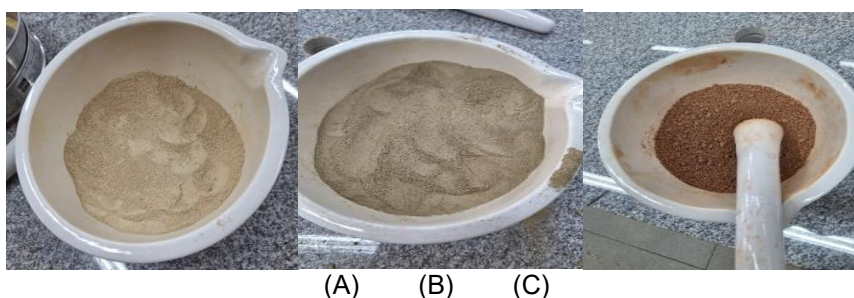
3.2 METHODS

3.2.1 Characterization of the samples

The tests are described below, and for sample preparation, the procedures described in the Brazilian standard NBR 6457 (2016) are observed, such as pre-drying, unraveling and sieving in the 4.8 mm sieve, which can be seen in Figure 3.

Figure 3

Clearance of the soil horizons of the Araripina region: A) horizon A. B) horizon B. C) horizon C



Source: Authors (2025).

3.3 PHYSICAL CHARACTERIZATION OF THE SAMPLES

The tests presented in table 1 are used for the physical characterization of the soil.

Table 1

Standards for soil characterization

Propriedades	Normas
Umidade higroscópica	ABNT NBR 6457/1986
Massa específica	ABNT NBR 6458/2016
Análise granulométrica	ABNT NBR 7181/2016
Limite de liquidez	ABNT NBR 6459/1984
Limite de plasticidade	ABNT NBR 7180/2016

Source: Authors (2025).

3.4 RETRACTION

The fundamental principle observed is the phenomenon of soil retraction, which manifests itself as the reduction in volume of a mass of soil as a result of moisture loss. This volumetric decrease, when it occurs in a confined or uneven manner, is the direct cause of the potential appearance of cracks or fissures on the surface of the analyzed sample.

Figure 4*Wooden box*

Source: Authors (2025).

The procedure, known as the Channel Test, as can be seen in Figure 5, begins with the preparation of the sample. Then, the initial consistency is determined, the soil is gradually mixed with water in a metal tray, using a trowel, until it reaches the point where the mixture has a mortar consistency, characterized by its adhesion to the instrument.

For molding, the wooden box is previously lubricated with oil, as observed in Figure 4. The soil in the given consistency is thrown into the box at a height of 30 cm and carefully planed.

Figure 5*Procedure of the retraction test*

Source: Authors (2025).

After molding, the specimen is subjected to the curing phase, being kept sheltered from the sun and rain for a period of 7 days, which ensures a slow and controlled drying in the air.

The result of the test is measured at the end of this period, based on two criteria: the analysis and measurement of the retraction observed in the two directions of the sample inside the box and the verification of the appearance (or absence) of cracks or fissures on the surface of the specimen. This adapted test provides valuable data to infer the behavior of the soil in terms of its volumetric stability.

3.5 DEFINITION OF TRAITS

In the first phase, bricks were manufactured by mixing the A, B and C horizons with different lines: 1:6, 1:8, 1:10 and 1:12.

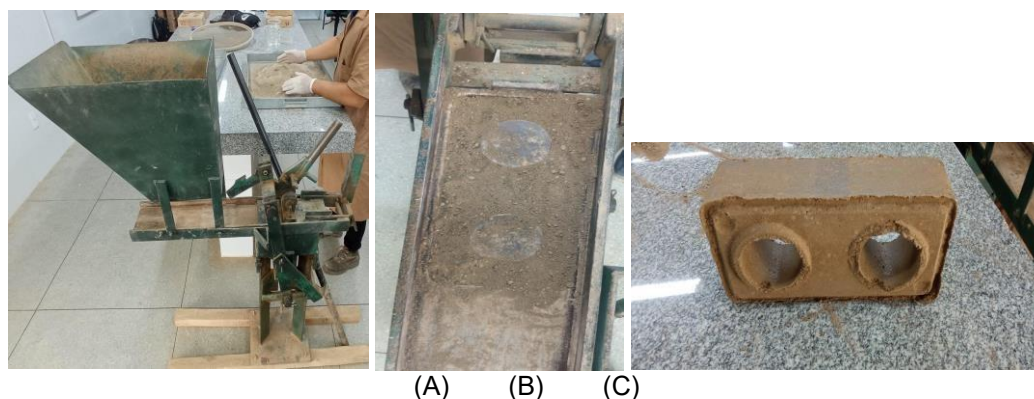
Subsequently, soil-cement bricks were manufactured with the addition of gravel powder using the 1:6:0.5 traces; 1:6:0.25 (cement, soil and gravel dust).

3.6 SOIL-CEMENT BRICK MAKING

For the production of bricks, a manual press was used with molds of dimensions 12.5 cm x 25 cm x 6.5 cm (width x length x thickness) and fittings that allow direct tying between the components in the execution of the masonry, as can be seen in Figure 6.

Figure 6

Manufacture of bricks. (A) Manual press (B) Molding (C) Brick



Source: Authors (2025).

After manufacturing, wet curing was carried out, where the bricks were wrapped with a plastic, sheltered from the sun and wind for 7 days.

3.7 DIMENSIONAL ANALYSIS

The Dimensional Analysis Test is a fundamental quality control procedure that aims to verify that the geometric dimensions of the brick conform to the nominal dimensions specified in the standard.

NBR 8491/2012 establishes that the brick is a rectangular parallelepiped. Dimensional stiffness is ensured by extremely tight tolerances, with a maximum deviation of only 1.0 mm from the nominal dimensions of length, width and height being permitted. This precision is essential to ensure the plumb, level and uniformity of the wall, minimizing the need for adjustments on site and the excessive consumption of laying mortar.

3.8 COMPRESSIVE STRENGTH TEST

Before the compression test, seven bricks were prepared according to the specifications of NBR 8492 (ABNT, 2012). The bricks were cut with the aid of a circular saw (Makita) in order to obtain uniform halves. From these halves, the specimens were made, using a cement paste as the binding material between the surfaces, as can be seen in Figure 7. After molding, the paste remained curing for approximately 24 hours, ensuring sufficient strength for handling and subsequent steps.

Figure 7

Compressive strength test procedures



Figure 8

Compressive strength test



Source: Authors (2025).

3.9 WATER ABSORPTION

The method used for the test to determine the water absorption in the blocks is prescribed by the NBR 13555 (ABNT, 2012) and NBR 8492 (ABNT, 2012) standards. The water absorption test aims to determine the amount of water that soil-cement bricks are able to absorb when subjected to controlled immersion, observed in Figure 9. This parameter is essential to evaluate the quality of the material, since high absorption rates can indicate lower density, higher porosity and, consequently, lower durability and mechanical resistance of the brick.

The values of the average absorption percentage of the specimens cannot exceed 20%, and individually cannot exceed 22%.

Figure 9*Absorption assay procedure*

Source: Authors (2025).

4 RESULTS AND DISCUSSIONS

4.1 HYGROSCOPIC MOISTURE AND SPECIFIC MASS ANALYSES

Table 2 presents the results of hygroscopic moisture and specific mass of horizons A, B, C, A+B+C, A+B+C+gravel dust from the region of Araripina (PE).

Table 2

Experimental values obtained for hygroscopic moisture and specific mass for the Araripina regio

Horizon	Hygroscopic Humidity (%)	Specific mass (g/cm ³)
A	2,24	2,42
B	2,47	1,85
C	2,05	1,75
A+B+C	2,31	2,55
A+B+C+crushed stone dust	3,28	2,57

Source: Authors (2025).

4.2 PARTICLE SIZE ANALYSIS

From the particle size test by screening and sedimentation, the distribution of grain diameters and their respective soil percentages in each specific size range was determined. Figure 10 shows the granulometric curve of the soils analyzed. Analyzing the graph, it is possible to notice that 100% of the soil samples pass through the 4.8 mm sieve, according to the recommendations for the production of cement soil bricks of NBR 10833/2012.

It is observed that, in the mixtures of the A+B+C and A+B+C horizons plus gravel dust, the percentage of material passing through the 0.075 mm sieve was lower than that

established by ABNT NBR 10833 (2012), evidencing a deficiency of clay fraction in the samples. With this test, we have that the soils of horizons "A" and "C" have approximately 80% sand and the soil of horizon "B" has approximately 70% sand. Showing the clay deficit in these soils, since according to the Soil-cement Brick Production Booklet, the quantities should be approximately 25% clay, 25% silt and 50% sand. (IEP, 2016).

Table 3

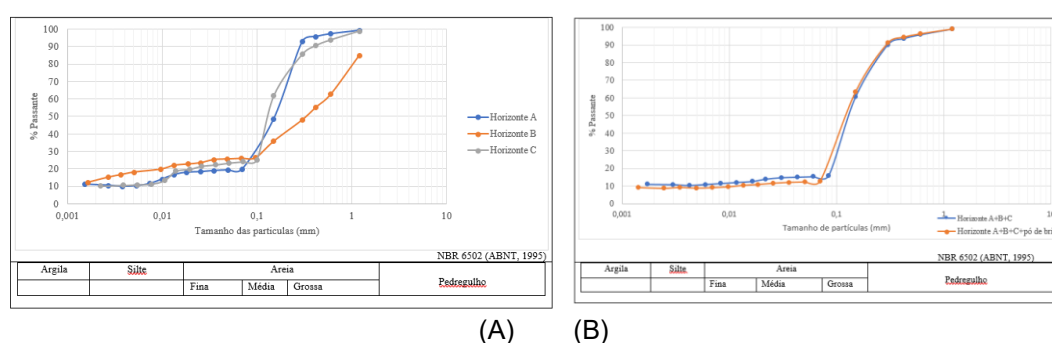
Composition of the samples according to particle size

Composition	Diameter (mm)	Sample A (%)	Sample B (%)	Sample C (%)	Sample A+B+C (%)	Sample A+B+C+powder gravel (%)
Clay	<0.02	10	15	10	11	11
Silt	≥ 0.002 to ≤ 0.06	10	15	10	5	5
Sand	≥ 0.06 to ≤ 2.0	80	70	80	86	86

Source: Authors (2025).

Figure 10

Particle size analysis: (A) of the A, B and C horizons of the Araripina region (B) of the A+B+C and A+B+C+gravel dust horizons



Source: Authors (2025).

4.3 CONSISTENCY LIMITS

The results of the plasticity limit, liquidity limit, and plasticity index tests of the samples are presented in Table 4. The plasticity limit is related to the amount of water added to the clay for the molding stage, which is important for processing in technological applications (SANTOS, 1989).

Table 4

Atterberg Indices

Parameter	Requirement (%)	Horizon A	Horizon B	Horizon C	Horizon A+B+C	Horizon A+B+C+residue ceramic
Limit	≤ 45	33,38	48,58	36,80	39,80	32,67

liquidity(%) (LL)						
Plasticity Limit(%) (LP)		26.36 ± 0.93	27.73 ± 4.10	29.34 ±2.04	23.35±0.25	23.38±0.80
Index of Plasticity(%) (IP)	≤18	7,02	20,85	7,46	16,45	9,29

Source: Authors (2025).

4.4 RETRACTION TEST

After the full seven days of soil in the box, it is recommended that there are no cracks in the soil or that it moves more than 20 mm away from the channel. However, the appearance of cracks and retraction in soil masses can be identified, as can be seen in Figure 11.

Figure 11

Result of the soil shrinkage test



Source: Authors (2025).

It was observed that the test carried out with the soil under study showed the formation of cracks and the separation of the ends of the gutter, varying between 0.5 mm and 1.55 cm, which led to its disqualification in the test, as can be seen in Figure 11. However, it is noteworthy that soil stabilization with cement tends to minimize the effects of shrinkage, contributing to a more adequate structural performance.

4.5 DIMENSIONAL ANALYSIS

NBR 8491 (2012), for each dimension of the specimens, it was essential to perform at least 3 determinations at different points on each face of the samples. Table 5 shows the means of the categories of length, width, and height for each line, obtained with the aid of the digital caliper, in tenth of a unit, expressed in millimeters (mm).

Table 5

Dimensional analysis (cm) - Mean values

Trace	Length (cm)	Width(cm)	Height (cm)
1:6	25,10	12,60	6,82
1:8	25,20	12,60	7,06
1:10	25,19	12,60	7,01
1:12	25,04	12,60	6,95

1:6:0,25	25,20	12,60	7,14
1:6:0,50	25,35	12,60	7,00

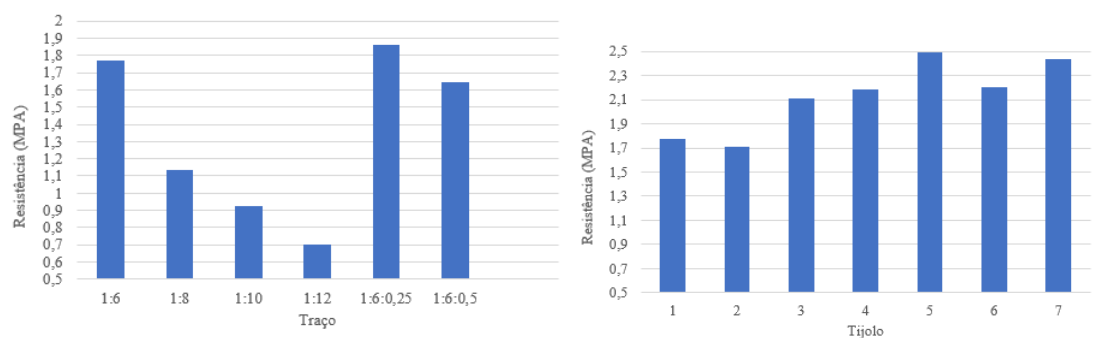
Source: Authors (2025).

4.6 COMPRESSIVE STRENGTH

Observing the mean resistance for each trait, it was found that only the 1:6 and 1:6:0.25 traits obtained satisfactory results higher than the minimum of 1.7 Mpa, as can be seen in Figure 12. For the 1:6:0.25 trace, it can be observed that only 2 samples obtained a result higher than 1.7 Mpa and the other samples obtained values higher than those required by the NBR 8497/2012 standard.

Figure 12

(A) Graph of the mean compressive strength. (B) Graph of the mean compressive strength (1:6:0.25)



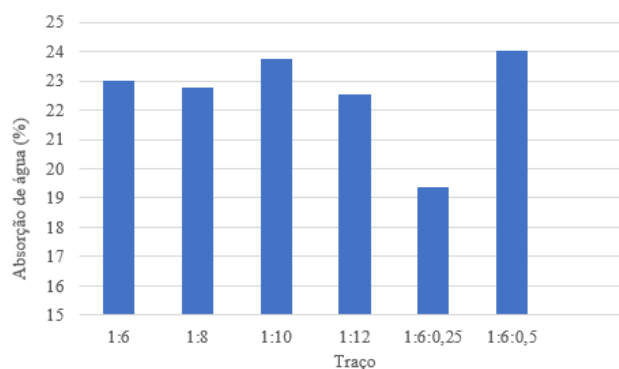
Source: Authors (2025).

4.7 WATER ABSORPTION

According to NBR 8491/2012, the average water absorption values of soil-cement bricks should not exceed 20%, and no individual unit can present absorption higher than 22%, as observed in Figure 13.

Figure 13

Absorption graph



Source: Authors (2025).

Among the samples submitted to the water absorption test, the 1:6:0.25 Trace was the only one to present satisfactory performance, reaching the requirements established by the current technical standard. This result validates the effectiveness of this mixture in reducing the porosity of the material, ensuring its durability and suitability for the proposed use.

5 CONCLUSION

Based on the results obtained, it is concluded that the soils of the A, B and C horizons of the region of Araripina (PE) have predominantly sandy characteristics, with a deficit of clay fraction in relation to the recommendations of the technical literature for the production of soil-cement bricks. The particle size analysis showed that all samples met the requirement of 100% through the 4.8 mm sieve, according to ABNT NBR 10833/2012; however, the percentage of material passing through the 0.075 mm sieve was lower than the minimum recommended for the mixtures A+B+C and A+B+C+gravel powder, indicating low potential plasticity and lower natural cohesion of the soil.

The consistency limit tests showed that the B horizon presented a plasticity index higher than the recommended limit, while the mixtures A+B+C and A+B+C+residue remained within the normative parameters.

In the shrinkage test, it was observed the formation of cracks and separation of the ends, leading to the disqualification of the natural soil, which reinforces the need for stabilization to improve technological performance.

In mechanical performance, it was found that only the 1:6 and 1:6:0.25 traces met the minimum requirement of compressive strength established by NBR 8497/2012 (≥ 1.7 MPa), and the 1:6:0.25 trace presented more consistent results.

Regarding water absorption, only the 1:6:0.25 trace fully complied with the limits of NBR 8491/2012, demonstrating better performance in terms of durability and lower porosity.

Thus, it is concluded that, despite the granulometric limitations and the clay deficiency of the soils studied, the stabilization with cement, especially in the 1:6:0.25 trait, proved to be technically feasible for the production of soil-cement bricks in the Araripina region, meeting the main normative requirements of strength and absorption. It is recommended, for future work, the granulometric correction of the soil with the addition of fine material or adjustments in the stabilizer content, in order to further optimize the mechanical and physical performance of the products.

REFERENCES

- Associação Brasileira de Normas Técnicas. (2012). NBR 10833: Fabricação de tijolo e bloco de solo-cimento com utilização de prensa manual ou hidráulica — Procedimento. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (2012). NBR 13555: Solo-cimento — Determinação da absorção de água — Método de ensaio. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (2024). NBR 6457: Solos — Preparação de amostras para ensaios de compactação, caracterização e determinação do teor de umidade. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (2016). NBR 6458: Grãos de pedregulho retidos na peneira de abertura 4,8 mm — Determinação da massa específica, da massa específica aparente e da absorção de água. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (1984). NBR 6459: Solo — Determinação do limite de liquidez. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (2016). NBR 7180: Solo — Determinação do limite de plasticidade. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (2025). NBR 7181: Solo — Análise granulométrica. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (2012). NBR 8491: Tijolo de solo-cimento — Requisitos. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (2012). NBR 8492: Tijolo de solo-cimento — Análise dimensional, determinação da resistência à compressão e da absorção de água. Rio de Janeiro: ABNT.
- Barbosa, T. F. (2015). Estudo sobre o comportamento do cimento Portland e suas propriedades aglomerantes (Dissertação de mestrado). Universidade Federal de Minas Gerais.
- Bezerra, M. S. (2009). Relatório técnico 34 – Perfil da gipsita. Ministério de Minas e Energia. http://www.mme.gov.br/sgm/galerias/arquivos/plano_duo_decenal/a_mineracao_brasileira/P24_RT34_Perfil_da_Gipsita.pdf
- Brito, L. C., & Paranhos, H. S. (2017). Estabilização de solos. Revista Científica Multidisciplinar Núcleo do Conhecimento.
- Chiossi, N. J. (2015). Mecânica dos solos (6. ed.). Curitiba: IESDE Brasil.
- Instituto Educacional Piracicabano da Igreja Metodista. (2016). Cartilha produção de tijolos de solo-cimento. Piracicaba: Editora Unimep.
- Menossi, R. T. (2004). Utilização do pó de pedra basáltica em substituição à areia natural do concreto (Dissertação de mestrado). Universidade Estadual Paulista, Faculdade de Engenharia de Ilha Solteira.

- Nachtigal, J. C., Barbosa, R. R., & Pereira, M. F. C. (2014). Tijolo de solo-cimento: análise das características físicas e viabilidade econômica. *Revista E-xacta*, 7(1), 13–26.
- Nascimento, A. M., et al. (2018). Tijolo modular de solo-cimento como material na construção civil. *Revista InterScience*, 6(1), 187–202.
- Pinto, C. de S. (2006). *Curso básico de mecânica dos solos* (3. ed.). São Paulo: Oficina de Textos.
- Vilela, A. P., Eugênio, T. M. C., Oliveira, F. F., Mendes, J. F., Ribeiro, A. G. C., Vaz, L. E. V. D. S. B., & Mendes, R. F. (2020). Technological properties of soil-cement bricks produced with iron ore mining waste. *Construction and Building Materials*, 262, 120883.
- Silva, M. V. V., Garcia, R. L. M., Siqueira, R. A., & Júnior, G. A. D. S. (2024). Técnicas de estabilização e reforço sustentável do solo. *Rev. FT*, 29, 29–30.
- Silva, E. D. (2005). *Uso de agregado miúdo de resíduo de construção e demolição em solo-cimento* (Dissertação de mestrado). Universidade Federal de São Carlos.
- Santos, P. S. (1989). *Ciência e tecnologia das argilas* (Vol. 1, 2. ed. rev. atual.). São Paulo: Editora Edgard Blücher.

ALBEDOMAPS: PROPOSAL OF A DIGITAL PLATFORM FOR MONITORING URBAN HEAT ISLANDS IN THE CUIABÁ METROPOLITAN REGION

ALBEDOMAPS: PROPOSIÇÃO DE UMA PLATAFORMA DIGITAL PARA MONITORAMENTO DE ILHAS DE CALOR URBANAS NA BAIXADA CUIABANA

ALBEDOMAPS: PROPUESTA DE UNA PLATAFORMA DIGITAL PARA EL MONITOREO DE ISLAS DE CALOR URBANAS EN LA REGIÓN METROPOLITANA DE CUIABÁ



<https://doi.org/10.56238/sevened2026.008-201>

Matheus Nunes dos Santos¹, Luiz Carlos de Almeida², Mario Marcos Morel³, Nayara Gomes de Oliveira⁴, Olivia Fernandes Boretti⁵, Paulo Ricardo dos Santos Silva⁶, Phelipe Matheus Sales Kinack⁷, Quedna Brito dos Reis⁸, Rander Teixeira Barros⁹, Regis Alves Dourado¹⁰, Gracyeli Santos Souza Guarienti¹¹, Lidia Martins da Silva¹²

ABSTRACT

Tropical cities have experienced increasing urban heat island intensification due to rapid urban expansion, soil sealing, and the reduction of vegetative cover, factors that negatively affect public health, energy consumption, and overall quality of life. In the Cuiabá metropolitan region, characterized by persistently high temperatures, there is a lack of accessible digital platforms capable of integrating climate data and supporting urban planning strategies. In response to this gap, this study proposes the development of AlbedoMaps, a collaborative digital platform designed to monitor urban heat islands using remote sensing data. The

¹ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: Matheus.nunesufg@gmail.com

² Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: lucadealmeida@gmail.com

³ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: morel.tsi@gmail.com

⁴ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: oliveiragnayara@gmail.com

⁵ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: oliviaboretti@gmail.com

⁶ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: pauloshutt@gmail.com

⁷ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: phellipem19@gmail.com

⁸ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: quedna71@hotmail.com

⁹ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: randernet@hotmail.com

¹⁰ Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: regis@rg.com.br

¹¹ Dr. in Environmental Physics. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: gracyeli.guarienti@ufmt.br

¹² Dr. in Applied Computing. Universidade do Vale do Rio dos Sinos (UNISINOS). Mato Grosso, Brazil. E-mail: lidiamartins10@gmail.com

methodological approach is based on the conceptual modeling of the system, integrating Landsat 8/9 satellite data and Land Surface Temperature (LST) estimates obtained through the Split-Window technique into a web-based architecture developed in Python. The outcome of this proposal was the structuring of a Minimum Viable Product (MVP) capable of generating interactive thermal maps while incorporating principles of citizen science and corporate environmental governance (ESG). The results indicate that the proposed platform presents significant potential as a tool to support local climate governance, democratize environmental information, and contribute to sustainable urban planning initiatives.

Keywords: Urban Heat Islands. Remote Sensing. Urban Albedo. Citizen Science. Sustainable Urban Planning.

RESUMO

As cidades de clima tropical enfrentam intensificação das ilhas de calor urbanas em decorrência da expansão urbana desordenada, da impermeabilização do solo e da redução da cobertura vegetal, fatores que impactam a saúde pública, o consumo energético e a qualidade de vida. Na região da Baixada Cuiabana, caracterizada por temperaturas elevadas ao longo do ano, observa-se a ausência de plataformas acessíveis que integrem dados climáticos e ferramentas de visualização voltadas ao planejamento urbano. Diante desse cenário, o presente estudo propõe o desenvolvimento do AlbedoMaps, uma plataforma digital colaborativa destinada ao monitoramento de ilhas de calor urbanas por meio de dados de sensoriamento remoto. A metodologia fundamenta-se na modelagem conceitual da solução, utilizando dados dos satélites Landsat 8/9 e estimativas de Temperatura da Superfície Terrestre (LST), processadas por técnica Split-Window, integradas a uma arquitetura web desenvolvida em Python. Como resultado, estruturou-se um Produto Mínimo Viável (MVP) capaz de gerar mapas térmicos interativos e de incorporar princípios de ciência cidadã e sustentabilidade corporativa (ESG). Conclui-se que a proposta apresenta potencial como instrumento de apoio à governança climática local, contribuindo para a democratização do acesso à informação ambiental e para o planejamento urbano sustentável.

Palavras-chave: Ilhas de Calor Urbanas. Sensoriamento Remoto. Albedo Urbano. Ciência Cidadã. Planejamento Urbano Sustentável.

RESUMEN

Las ciudades de clima tropical han experimentado una intensificación de las islas de calor urbanas debido a la expansión urbana acelerada, la impermeabilización del suelo y la reducción de la cobertura vegetal, factores que impactan negativamente la salud pública, el consumo energético y la calidad de vida. En la región metropolitana de Cuiabá, caracterizada por altas temperaturas a lo largo del año, se observa la ausencia de plataformas digitales accesibles que integren datos climáticos y apoyen la planificación urbana. Frente a esta problemática, el presente estudio propone el desarrollo de AlbedoMaps, una plataforma digital colaborativa orientada al monitoreo de islas de calor urbanas mediante el uso de datos de teledetección. La metodología se fundamenta en la modelación conceptual del sistema, integrando datos de los satélites Landsat 8/9 y estimaciones de Temperatura de la Superficie Terrestre (LST) obtenidas mediante la técnica Split-Window, incorporadas en una arquitectura web desarrollada en Python. Como resultado, se estructuró un Producto Mínimo Viable (MVP) capaz de generar mapas térmicos interactivos e integrar principios de ciencia ciudadana y gobernanza ambiental corporativa (ESG). Se concluye que la propuesta presenta potencial como herramienta de apoyo a la gobernanza climática local y al desarrollo de estrategias de planificación urbana sostenible.

Palabras clave: Islas de Calor Urbanas. Teledetección. Albedo Urbano. Ciencia Ciudadana. Planificación Urbana Sostenible.

1 INTRODUCTION

The process of intensive urbanization in recent decades has caused significant changes in the energy balance of cities, contributing to the emergence and intensification of the so-called urban heat islands. This phenomenon is mainly due to the replacement of natural surfaces by impermeable and low-reflectance materials, such as asphalt and concrete, which alter the local thermal dynamics and increase heat retention (Oke, 1987). According to Landsberg (1981), cities profoundly modify the fluxes of radiation, ventilation and humidity, configuring their own microclimates that differ substantially from the surrounding rural areas. In tropical regions, such effects tend to be more expressive due to the high solar incidence throughout the year.

In the Brazilian context, studies have shown that cities with hot climates are more vulnerable to the impacts of heat islands, with direct repercussions on public health, energy consumption, and the thermal comfort of the population (Amorim, 2019). In an investigation on urban thermal dynamics, Morais et al. (2013) highlight that heat islands occur mainly in cities with a high degree of urbanization and result in an increase in average temperatures in urban areas compared to rural areas. In the Baixada Cuiabana, especially in the conurbation between Cuiabá and Várzea Grande, the high average annual temperatures associated with disorderly urban growth reinforce the need for technical instruments that support mitigation and urban planning strategies (Souza et al., 2025).

The advancement of remote sensing technologies has significantly expanded the possibilities of urban environmental monitoring. The estimation of Land Surface Temperature (LST) by means of thermal images from Landsat satellites has been consolidated as a method widely used in the scientific literature (Sobrino; Jiménez-Muñoz; Paolini, 2004). According to Jiménez-Muñoz et al. (2014), split-window algorithms allow the recovery of surface temperature with greater accuracy, becoming strategic tools for spatio-temporal analysis in urban contexts. However, despite the methodological robustness of these approaches, the results produced remain, in many cases, restricted to the academic environment, with low public accessibility and limited integration with local governance instruments.

In this scenario, initiatives based on citizen science emerge as promising alternatives to bring scientific production and society closer together. Bonney et al. (2009) highlight that collaborative projects expand community engagement and strengthen scientific literacy, contributing to more participatory decision-making processes. At the same time, the incorporation of environmental impact metrics and corporate sustainability practices has been pointed out as a relevant mechanism for the viability and continuity of socio-environmental

projects, especially when articulated with international reporting and transparency benchmarks (GRI, 2021).

It is in this context that AlbedoMaps is inserted, whose conception originated in the Bachelor of Science and Technology course at the Federal University of Mato Grosso (UFMT), within the scope of the discipline Integrator Seminar IV. Structured by academics of the course as an extension action aimed at real problems of society, the project articulated knowledge of thermal physics, remote sensing and development of web systems, proposing a digital platform for interactive visualization of urban thermal patterns in the Baixada Cuiabana. Although born in an academic environment, the project was conceived with the potential for practical applicability and scalability.

In view of the gap identified — not in the absence of thermal analysis methods, but in the lack of accessible digital tools that integrate data, visualization, and social participation — the following research question is formulated: how can a digital platform based on Landsat data contribute to the monitoring of urban heat islands and support climate governance strategies in the Baixada Cuiabana?

Thus, the general objective of this work is to propose and describe AlbedoMaps as an interactive web platform structured in the format of Minimum Viable Product (MVP) for visualization of urban thermal patterns. Specifically, it seeks to: (i) integrate LST estimates derived from Landsat 8/9 data through the split-window technique; (ii) develop web architecture capable of providing interactive thermal maps; (iii) outline engagement mechanisms based on citizen science; and (iv) propose a sustainability model based on environmental impact metrics aligned with international benchmarks. By delimiting these objectives, it is intended to contribute to the debate on digital innovation applied to the urban climate, offering a technological proposal applicable to cities with a tropical climate.

2 THEORETICAL FRAMEWORK

2.1 URBAN HEAT ISLANDS AND TRANSFORMATIONS IN THE CLIMATE OF CITIES

Initially, it is important to understand that Urban Heat Islands (ICU) are defined as a horizontal thermal anomaly, characterized by the increase in temperature in the built environment compared to its rural surroundings (Amorim, 2019). This phenomenon is mainly due to the replacement of the natural soil cover by impermeable surfaces, such as asphalt and concrete, which significantly alter the urban energy balance by increasing the flow of sensible heat and reducing the evaporative cooling provided by vegetation (Sales; Sales; Mendonça, 2022). As a result, there is greater thermal storage during the daytime and gradual release of heat throughout the night, intensifying thermal discomfort in urbanized areas.

From a theoretical point of view, heat islands can be classified into three distinct levels: surface, related to the temperature of the earth's surface; the urban canopy layer, associated with the air between buildings; and the urban border layer, which surrounds the atmospheric portion above the city (Amorim, 2019). This distinction is particularly relevant, as it guides both analysis methodologies and mitigation strategies, especially when remote sensing techniques are employed to estimate the Earth's Surface Temperature (LST).

In addition, although heat islands are often associated with large metropolises, recent research shows that small and medium-sized cities also have significant thermal differences in relation to rural areas. Amorim (2019, p. 23) highlights that the urban climate problem is not restricted to large centers, stating that:

It is evident that problems related to the urban climate, such as the generation of heat islands, the impacts triggered by precipitation events or the problems resulting from atmospheric pollution are more visible and perceived by the population in large urban agglomerations. However, in the various studies carried out in Brazilian climatology, and at the international level, it has been verified that as well as in large urban centers, medium and small cities have also undergone strong transformations in the natural landscape, materialized through different forms of air, water, soil and subsoil pollution, in addition to transformations in the morphology and structure of the urban environment. Rivers and streams are channeled or have their courses altered; the morphology is modified through embankments and constructions; The vegetation is removed. (Amorim, 2019, p. 23)

From this perspective, the understanding that heat islands are an expression of the socio-spatial transformations promoted by the urbanization process, regardless of the demographic scale of the city, is expanded. Studies carried out in Brazilian municipalities indicate thermal differences of more than 6 °C between urban and rural areas (Amorim, 2020), showing that the phenomenon is not restricted to large capitals. In addition, a strong correlation is observed between surface water stress and temperature increase, reaching rates of up to 96% between soil moisture reduction and thermal intensification (Sales; Sales; Mendonça, 2022). These data consolidate the scientific consensus regarding the central role of vegetation cover and water availability in urban climate regulation.

At the same time, the impacts of heat islands go beyond the environmental dimension, reaching the sphere of public health. Technical reports indicate that heat waves are associated with increased mortality from cardiovascular, respiratory, and kidney diseases (Brasil, 2025). In this context, vulnerable groups, such as the elderly – due to their lower capacity for thermoregulation – and children – due to physiological immaturity – become particularly susceptible to the extreme effects of district heating.

Given this scenario, the literature points to different mitigation strategies. Bioclimatic Urbanism proposes the use of natural ventilation through urban parameters, such as the coefficient of use and progressive setbacks between vertical buildings (Brandão; Barbosa; Barbirato, 2019). In a complementary way, the implementation of green infrastructure and the use of high reflectivity materials, associated with the increase in urban albedo, are recognized as effective measures in reducing the accumulation of sensible heat (Cutieru, 2021; Brandão; Barbosa; Barbirato, 2019).

2.2 URBAN ALBEDO AND RADIATIVE BALANCE OF BUILT SURFACES

In the context of urban climate change, urban albedo — understood as the ability of city surfaces to reflect incident solar radiation — is a fundamental variable in the thermal regulation of the built environment. In physical terms, the greater the reflectance of a surface, the lower the amount of energy absorbed and converted into sensible heat. However, the urbanization process has promoted the replacement of natural surfaces by artificial materials, such as asphalt and concrete, whose radioactive properties favor greater energy absorption, directly contributing to the intensification of heat islands.

In this context, mitigation strategies based on the modification of the optical properties of materials have been widely discussed in the literature. It is recommended to use cold materials, characterized by high solar reflectance and high thermal emittance, attributes that make it possible to maintain lower surface temperatures. As demonstrated by Muniz-Gäal et al. (2018), the thermal efficiency of roofs is directly related to their ability to reflect solar radiation and emit accumulated heat. The authors show that light colors have higher reflectance values; however, they point out that surface roughness can increase absorptance due to the greater number of interreflections of the incident radiation. Thus, the relationship between reflectance and thermal performance proves to be more complex than a simple association between color and temperature.

To measure this solar heat rejection capacity, the Solar Reflectance Index (SRI) is used, which incorporates both the reflectance and the emissivity of the material. Comparative studies indicate that glazed ceramic tiles, especially in light shades, have superior thermal performance when compared to concrete tiles (Muniz-Gäal et al., 2018). Thus, the choice of construction materials plays a strategic role in urban thermal mitigation, particularly in cities located in regions with a hot climate.

However, the analysis of albedo cannot be dissociated from urban morphology. The radiative balance in cities is profoundly influenced by the configuration of so-called urban canyons, where multiple internal reflections of solar radiation produce the so-called "cavity

effect". Pereira and Marinoski (2022) demonstrate that increasing solar reflectance on facades and pavements can reduce surface temperatures; however, simultaneously, it can raise the radiation incident inside the canyon due to the successive reflections between the vertical surfaces. Therefore, interventions based exclusively on increasing albedo must consider the geometric complexity of urban space.

In addition, the distribution of radiative flux in long waves is a central element to understand urban thermal behavior. Machado (2009) demonstrates that urban morphology directly influences the redistribution of nocturnal thermal radiation, especially in vertical areas, where there is greater heat trapping. The relationship between the height of the buildings and the width of the roads — expressed by the H/W ratio — proves to be decisive in this process, since deeper canyons tend to reduce thermal dissipation and intensify energy storage.

More recently, the literature has broadened the discussion by incorporating albedo as an indicator of urban resilience. Ferreira and Vieira (2025, p. 3), when relating surface reflectance and climate adaptation, state that:

The albedo or hemispheric reflectance — which represents the fraction of solar radiation reflected by a surface — plays a crucial role in urban thermal regulation, influencing the urban climate, energy consumption in buildings, and greenhouse gas emissions [...] Given the relevance of albedo for urban resilience and mitigation of climate impacts, this article presents the methodology used to calculate the percentage of urban areas with high albedo (AAA), devoid of vegetation cover. The measurement of this indicator, described in ABNT NBR ISO 37123:2021, contributes to monitoring and promoting resilience to heat in urban areas, supporting strategies to mitigate greenhouse gas emissions, and promoting adaptations, contributing to sustainable urban development. This process requires a systemic approach, with integration of multidisciplinary data, where data collection and systematization of information is essential for the consolidation of integrated municipal management plans in parallel with the development of public policies. (Ferreira; Vieira, 2025, p. 3)

From this approach, it is observed that albedo is no longer just a physical-radiative variable and starts to assume a strategic role in sustainable urban planning. The need for multidisciplinary data integration and information systematization reinforces the importance of digital tools capable of translating technical metrics into accessible spatial representations.

3 METHODOLOGY

The present study is characterized as an applied research, of exploratory and descriptive nature, oriented to the development of a technological solution aimed at the monitoring of urban heat islands. It is the conception and modeling of a digital artifact — AlbedoMaps — structured from the perspective of design science research, a methodological approach aimed at the creation and evaluation of artifacts intended to solve real problems

(Hevner et al., 2004). Unlike purely empirical research, this approach prioritizes the construction of technological solutions that are theoretically grounded and validated for their technical feasibility.

The delimited study area corresponds to the Baixada Cuiabana, covering mainly the municipalities of Cuiabá and Várzea Grande, in the state of Mato Grosso. The choice of this region is based on its tropical continental climate condition, marked by high temperatures throughout the year and prolonged periods of drought, factors that favor the intensification of heat islands. In addition, the dynamics of urban expansion and the scarcity of public thermal visualization platforms reinforce the relevance of the proposal.

To estimate the Land Surface Temperature (LST), data from the Landsat 8 and Landsat 9 satellites were used, especially the thermal bands of the TIRS (Thermal Infrared Sensor) sensor. The use of Landsat images is widely consolidated in the scientific literature for urban thermal analysis, due to its adequate spatial resolution and free availability (Sobrino; Jiménez-Muñoz; Paolini, 2004). The processing of the images followed standardized steps: conversion of digital values (Digital Numbers – DN) into spectral radiance; conversion of radiance to brightness temperature; and application of the split-window technique for atmospheric correction and obtaining the LST.

The split-window technique was adopted for its efficiency in recovering surface temperature from thermal bands, considering atmospheric variations and surface emissivity (Jiménez-Muñoz et al., 2014). As the authors point out, the application of algorithms based on the difference between thermal bands allows reducing errors associated with atmospheric interference, increasing the reliability of thermal estimates. The processing was carried out through scripts developed in Python language, using libraries aimed at the manipulation of geospatial data, which ensures replicability and methodological transparency.

As far as the development of the platform is concerned, the architecture was structured into two main components: backend and frontend. The backend was responsible for the organization, storage and treatment of geospatial data, while the frontend was designed as an interactive interface for cartographic visualization of thermal patterns. This modular structure favors scalability and future integration with new indicators, such as metrics related to urban albedo and climate resilience.

The conceptual modeling of the platform also considered the possibility of integration with normative indicators, such as the percentage of urban areas with high albedo (AAA), described in ABNT NBR ISO 37123:2021, as discussed by Ferreira and Vieira (2025). Although the complete calculation of this indicator has not been operationalized at this stage, its methodological forecast reinforces the systemic character of the proposal and its

compatibility with sustainable urban planning strategies.

From an ethical point of view, the research used exclusively public remote sensing data made available by international space agencies, not involving the collection of personal data or sensitive information, which does not require submission to a research ethics committee.

Finally, limitations inherent to the study are recognized, especially those related to the spatial resolution of the Landsat data and the dependence on adequate atmospheric conditions for image acquisition. In addition, as it is a Minimum Viable Product (MVP), the platform still requires improvements in terms of automatic data updating and integration with local sensors. However, such limitations do not compromise the conceptual validity of the proposal, but indicate paths for future development.

4 RESULTS AND DISCUSSIONS

Based on the methodology adopted, a Minimum Viable Product (MVP) of the AlbedoMaps platform was structured, capable of integrating remote sensing data and providing interactive thermal maps referring to the Baixada Cuiabana. The processing of Landsat 8 and 9 images allowed the estimation of the Earth's Surface Temperature (LST), evidencing spatial patterns compatible with the literature on urban heat islands. The areas with higher building density and lower vegetation cover had higher surface temperatures than the less urbanized peripheral regions, corroborating findings previously described by Amorim (2019) and Morais et al. (2013).

The cartographic visualization revealed more intense thermal concentrations in areas characterized by high soil impermeabilization, which reinforces the understanding that the replacement of vegetation cover by artificial surfaces contributes significantly to the increase of sensible heat flux (Sales; Sales; Mendonça, 2022). Such spatial patterns confirm the scientific consensus that urban morphology and land use exert a determining influence on the thermal dynamics of cities (Oke, 1987).

From a technological point of view, the platform demonstrated functional feasibility by allowing interactive navigation, identification of critical areas, and potential future integration with normative indicators, such as the percentage of urban areas with high albedo (AAA), as discussed by Ferreira and Vieira (2025). The modular structure adopted, with Python backend and interactive frontend, proved to be adequate for the organization and presentation of geospatial data, ensuring transparency and methodological replicability.

When comparing the results obtained with the literature, there is convergence regarding the relevance of remote sensing as a tool for urban thermal diagnosis. According

to Sobrino, Jiménez-Muñoz and Paolini (2004), the estimation of the LST by means of Landsat data is a robust method for spatial analysis of heat islands. In addition, the application of the split-window technique, as systematized by Jiménez-Muñoz et al. (2014), proved to be adequate to reduce atmospheric interference, increasing the reliability of thermal estimates.

However, unlike most of the studies analyzed, which focus exclusively on the technical analysis of data, this proposal advances by structuring a digital instrument aimed at democratizing access to climate information. In this sense, AlbedoMaps is close to the perspective of citizen science discussed by Bonney et al. (2009), by enabling technical data to be translated into representations understandable to the non-specialized public, expanding the potential for social engagement and support for urban governance.

However, it is necessary to recognize limitations inherent to the study. The spatial resolution of Landsat images (30 meters) may not capture thermal microvariations at a very local scale, especially in areas of complex urban morphology. In addition, the absence of in situ validation by means of meteorological stations or urban sensors constitutes a methodological limitation, restricting the comparative analysis between surface temperature and air temperature. Such aspects point to the need for future integration with local weather data and urban IoT sensors.

Another limitation refers to the fact that the system is in the MVP stage, requiring improvements related to the automatic updating of images and the incorporation of additional metrics, such as vegetation indices and formal indicators of urban resilience described in ABNT NBR ISO 37123:2021. Despite this, the results obtained indicate technical feasibility and practical relevance of the proposal.

Thus, the results not only confirm patterns already described in the literature on heat islands, but also contribute by proposing a model of integration between climate diagnosis, interactive visualization and potential articulation with public policies. By combining remote sensing, digital architecture, and an environmental governance perspective, AlbedoMaps positions itself as a promising tool to support sustainable urban planning in tropical cities.

5 CONCLUSION

This article presented AlbedoMaps as a proposal for an experimental application developed within the scope of the Integrator Seminar III discipline of the Bachelor's Degree in Science and Technology at the Federal University of Mato Grosso (UFMT). The initiative emerged as an extension action aimed at the practical application of interdisciplinary

knowledge acquired throughout the training, articulating fundamentals of urban climatology, remote sensing and development of web systems.

By proposing a digital platform for viewing urban thermal patterns in the Baixada Cuiabana, the study sought to respond to the gap between scientific production on heat islands and the accessible availability of this information to public managers and civil society. In this sense, the work reinforces the importance of integrating environmental data, technological tools and urban planning, contributing to the strengthening of local climate governance.

Although the application is in the experimental phase and structured as a Minimum Viable Product (MVP), its conception demonstrates technical feasibility and potential for expansion. More than presenting consolidated results, the study offers a replicable methodological and technological model, which can be improved through the incorporation of new metrics, empirical validations, and integration with urban sensors.

Thus, the main contribution of the work lies in the articulation between teaching, extension and technological innovation, showing that academic projects can transcend the university environment and be configured as instruments to support urban sustainability. By emerging from a curricular component aimed at solving real problems, AlbedoMaps reaffirms the role of interdisciplinary training in the construction of digital solutions applied to contemporary climate challenges.

ACKNOWLEDGMENTS

We would like to thank the Faculty of Science and Technology (FCT), an academic unit of the University Campus of Várzea Grande (CUVG) of the Federal University of Mato Grosso (UFMT), for the institutional support and the academic environment that enabled the development of this work within the scope of the Bachelor's Degree in Science and Technology. Also recognizing the importance of the curricular component Integrator Seminar III as a training space that encouraged the articulation between teaching, extension and technological innovation applied to real problems.

REFERENCES

- Amorim, M. C. C. T. (2019). Ilhas de calor urbanas: Métodos e técnicas de análise. *Revista Brasileira de Climatologia*.
- Amorim, M. C. C. T. (2020). Ilhas de calor urbano em cidades de pequeno e médio porte no Brasil e o contexto das mudanças climáticas. *Confins*, (46).

- Bonney, R., et al. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience*, 59(11), 977–984.
- Brandão, L. K. V., Barbosa, R. V. R., & Barbirato, G. M. (2019). Verticalização e ambiente térmico urbano: Estudo de parâmetros urbanísticos em fração urbana na cidade de Arapiraca/AL. In 15º Encontro Nacional de Conforto no Ambiente Construído. ANTAC.
- Brasil. Ministério da Ciência, Tecnologia e Inovação. (2025). Clima em síntese: Estudos sobre saúde e ondas de calor no Brasil (2015–2025). MCTI.
- Cutieru, A. (2021, 26 de setembro). Cidades do mundo todo começam a implementar novas estratégias de combate às ilhas de calor. ArchDaily Brasil.
- Ferreira, F. L. S., & Vieira, R. M. S. P. (2025). O albedo das superfícies como indicador de resiliência urbana. In 18º Encontro Nacional de Conforto no Ambiente Construído. ANTAC.
- Global Reporting Initiative. (2021). Consolidated set of GRI sustainability reporting standards 2021. GRI.
- Hevner, A. R., et al. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75–105.
- Jiménez-Muñoz, J. C., et al. (2014). Land surface temperature retrieval methods from Landsat-8 thermal infrared sensor data. *IEEE Geoscience and Remote Sensing Letters*, 11(10), 1840–1843.
- Landsberg, H. E. (1981). *The urban climate*. Academic Press.
- Machado, A. J. (2009). Distribuição espacial do fluxo radiativo em ondas longas na Região Metropolitana de São Paulo (Tese de doutorado). Universidade de São Paulo.
- Morais, H. F., Albuquerque, E. M., Andrade, S. C., & Santos, C. A. C. (2013). Identificação do fenômeno de ilhas de calor urbano em Belo Horizonte – MG. In XVI Simpósio Brasileiro de Sensoriamento Remoto (pp. 7423–7430). INPE.
- Muniz-Gäal, L. P., et al. (2018). Eficiência térmica de materiais de cobertura. *Ambiente Construído*, 18(1), 7–22.
- Oke, T. R. (1987). *Boundary layer climates* (2nd ed.). Routledge.
- Pereira, N. H. G., & Marinoski, D. L. (2022). Análise do impacto da refletância solar das superfícies no fluxo de radiação de onda curta em cânions urbanos. In 19º Encontro Nacional de Tecnologia do Ambiente Construído (pp. 1–11). ANTAC.
- Sales, R. S. B., Sales, D. S., & Mendonça, J. C. (2022). Balanço de energia e ilhas de calor no perímetro urbano de Campos dos Goytacazes, RJ: Um estudo de caso. *Revista Brasileira de Geografia Física*, 15(6), 3093–3105.
- Sobrino, J. A., Jiménez-Muñoz, J. C., & Paolini, L. (2004). Land surface temperature retrieval from Landsat TM 5. *Remote Sensing of Environment*, 90, 434–440.

Souza, N. S., Nogueira, M. C. J. A., Santos, F. M. M., & Sanches, L. (2025). Urban heat and cool island dynamics in a rapidly growing tropical city: Land-use implications for the built environment of Cuiabá, Brazil. *Journal of Housing and the Built Environment*.

AN ALTERNATIVE APPROACH FOR DEFINING PLANT BREEDING

UMA ABORDAGEM ALTERNATIVA PARA DEFINIR MELHORAMENTO DE PLANTAS

UN ENFOQUE ALTERNATIVO PARA DEFINIR EL MEJORAMIENTO VEGETAL



<https://doi.org/10.56238/sevened2026.008-202>

Paulo Sérgio Lima e Silva¹

ABSTRACT

Currently, the definition of plant breeding most widely accepted by breeders describes breeding as the art and science of improving plant heredity to benefit mankind. According to the proponents of this definition, the art lies in the intuition, discernment or ability of the breeder to identify superior phenotypes, or in their capacity for making better decisions, etc.; while, the science of plant breeding, lies in applying the knowledge of various fields of science so that the breeder can achieve his goals. This study proposes an alternative approach for defining plant breeding. Considering that the various actions taken by breeders when carrying out their work depend on human cognition and emotion, it is suggested that breeding be defined as a science in which cognitive and emotional processes are employed to modify a plant genotype in order to make the plants more useful to man.

Keywords: Action. Cognition. Emotion. Concept.

RESUMO

Atualmente, a definição de melhoramento de plantas mais aceita pelos melhoristas descreve que o melhoramento é a arte e a ciência de melhorar a hereditariedade das plantas em benefício da humanidade. De acordo com os defensores desta definição, a arte dependeria da intuição ou discernimento ou da habilidade do melhorista para identificar fenótipos superiores ou ainda da capacidade do melhorista de tomar melhores decisões etc. A ciência do melhoramento de plantas, segundo a definição, implicaria na aplicação dos conhecimentos de várias ciências para que o melhorista possa alcançar seus objetivos. No presente trabalho, propõe-se uma abordagem alternativa para se definir melhoramento de plantas. Considerando-se que as várias ações dos melhoristas para realizar seu trabalho dependem da cognição e da emoção humanas, sugere-se que o melhoramento seja definido como a ciência em que processos cognitivos e emocionais são empregados para modificar o genótipo das plantas de modo a torná-las mais úteis ao homem.

Palavras-chave: Ação. Cognição. Emoção. Conceito.

¹ Dr. in Genetics and Plant Breeding. Universidade Federal Rural do Semi-Árido (UFERSA) Rio Grande do Norte, Brazil. E-mail: paulosergio@ufersa.edu.br Orcid: 0000-0002-4465-6517 Lattes: <http://lattes.cnpq.br/9117523177339947>

RESUMEN

Actualmente, la definición más aceptada de fitomejoramiento entre los fitomejoradores la describe como el arte y la ciencia de mejorar la herencia vegetal para beneficio de la humanidad. Según quienes defienden esta definición, este arte depende de la intuición o el discernimiento del fitomejorador, de su capacidad para identificar fenotipos superiores o de su capacidad para tomar mejores decisiones, entre otras. La ciencia del fitomejoramiento, según esta definición, implica la aplicación de conocimientos de diversas ciencias para que el fitomejorador pueda alcanzar sus objetivos. En este artículo, se propone un enfoque alternativo para definir el fitomejoramiento. Considerando que las diversas acciones de los fitomejoradores para llevar a cabo su trabajo dependen de la cognición y la emoción humanas, se sugiere definir el fitomejoramiento como la ciencia en la que se emplean procesos cognitivos y emocionales para modificar el genotipo de las plantas y hacerlas más útiles para los humanos.

Palabras clave: Acción. Cognición. Emoción. Concepto.

1 INTRODUCTION

Cognition — defined as the mental processes used by animals to gather, accumulate and use information about the external world — is fundamental to the decisions they make, such as where to live, what to eat or with whom to mate (Sol et al., 2025).

Various researchers have drawn attention to the importance of cognition in science. For example, Nersessian (2024) argues that scientific thinking is one of the most sophisticated expressions of the creative potential of human cognition. However, the way scientists think has, until now, played a limited role in research into cognitive science (Nersessian, 2024). Concern with the importance of cognition in research is not new: the book, 'The Cognitive Basis of Science', published more than 20 years ago, includes 18 topics on the subject (Carruthers et al., 2002).

Cognition is being studied in several areas, including aviation (Martins, 2016), education (Weidman and Baker, 2015), sports (Eldadi and Tenenbaum, 2025) and medicine (Stiegler and Tung, 2014). In plant breeding, the subject has been addressed rarely, directly or indirectly, in relation to decision-making. Directly, some articles have been published dealing with strategies (Kusmec et al., 2021), criteria (Jones and Cassells, 1995), models (Michel et al., 2025) and simulations (Sun et al., 2011) to assist in decision-making in breeding. Indirectly, the topic has been mentioned occasionally. For example, in defining plant breeding as both science and art, Hallauer et al. (2006) and Vencovsky et al. (2012) state that art remains a component of plant breeding since the breeder has to make decisions. In some articles, decision-making is considered one of the most important cognitive processes (Shahsavarani and Abadi, 2015).

The study of cognitive processes is crucial for understanding the way humans think (Shi, 2021), learn (Weizmann, 2023) and interact with the world (Olschewski et al., 2024). This allows for the development of interventions to address cognitive deficiency (Vance et al., 2016), improve educational practices (Cherukunnath and Singh, 2022) and enhance decision-making in various areas of life (Olschewski et al., 2024). Cognition differs among individuals (Logie, 2018), which can affect training in plant breeding and in improving the efficiency of breeding programmes. In medicine, probably the area where the most studies on cognition and emotion have been conducted, and excluding the fields that make up the cognitive sciences, such studies are relatively common. For example, it has been found that training in Surgical Cognitive Simulation has a statistically significant impact on improving surgical performance (Cragg et al., 2021).

Several of the suggested definitions for plant breeding are similar and consider it to have two components: art and science. For example, "Breeding is the art and science of

improving plant heredity for the benefit of humankind” (Sleper and Poehlman, 2006). “Plant breeding is the science, art, and business of improving plants for human benefit” (Bernardo 2002).

The aim of this study is to present a definition for plant breeding from the point of view of cognition.

2 PLANT BREEDING AS ART AND SCIENCE

The definition of plant breeding as both art and science has now been accepted by several generations of breeders. The art of plant breeding implies the breeder's ability to discern, through observation, the differences between the plants they manage in order to make selections (Agrawal, 1998). As an art, plant breeding depends on the intuition and previous experiences of each breeder (Borém et al., 2002; Elsen et al., 2013), as well as requiring subjective judgment when planning and implementing a breeding program. The art of plant breeding also involves the so-called “breeder's eye”—the intuition that tells the breeder that one parent, progeny group or cultivar is better than another (Bernardo, 2002). The art of plant breeding lies in the breeder's ability to distinguish between desirable and undesirable plant characteristics, so that only plants with the best agricultural merit reproduce in succeeding generations (Chahal and Gosal, 2006). As such, the success of plant breeding depends on the breeder's ability to identify which phenotypes will be expressed in the next generation (Hallauer et al., 2006).

As a science, plant breeding depends on a theoretical and practical knowledge of several areas of science, including genetics, statistics, agronomy and phytopathology, among many others (Borém et al., 2002; Agrawal, 1998; Chahal and Gosal, 2006). The sciences related to plant breeding provide the breeder with an objective basis for deciding which parents to cross, which selection methods to use, which progenies to keep and which cultivars to release (Bernardo, 2002).

3 EVOLUTION OF THE CONCEPT OF PLANT BREEDING

The concept (Table 1) of plant breeding evolved (Duvick, 1996; Hallauer, 2011) based on when it was formulated, but it has never lost its essence of being the art and science of manipulating plants for the benefit of man (Hallauer, 2011).

Has the definition of plant breeding also evolved to keep pace with the evolution of the concept? Apparently, one could say yes, with two changes. Firstly, including science, since plant breeding was originally considered only as an art. Secondly, for some, placing more

emphasis on science and, for others, more emphasis on art. Essentially, the definition has not evolved.

According to Hallauer et al. (2006), both art and science have contributed significantly to cultivar development; however the relative importance of art versus science has changed significantly over the last 150 years. Initially, phenotypic selection was practised between individual plants to obtain the ideal phenotype: success depending on the breeder's ability to identify phenotypes that would be expressed in the next generation. This ability to identify superior phenotypes depended on how effectively the plant breeder could visualise what might constitute superior improved cultivars. The art of the plant breeder was effective in developing cultivars that were phenotypically uniform for specific characteristics, however, the selected characteristics did not directly contribute to increased productivity. Selection was effective for characteristics of higher heritability, but relatively ineffective for those where heritability was lower, such as grain yield (Hallauer et al., 2006).

Figure 1

Concept and Definition

Concept and definition

Concepts are cognitive symbols (or abstract terms) that specify the characteristics, attributes or properties of a phenomenon in the real or phenomenological world that they are intended to represent and that distinguish them from other related phenomena (Podsakoff et al., 2016). The formation of concepts is the gathering and compilation of true statements concerning a given object. To determine the result of this compilation, an instrument is necessary. This instrument consists of any word or sign that can translate and establish the compilation (Dahlberg, 1978). From a scientific point of view, a concept is a cognitive symbol that has meaning for the scientific community that uses it (Podsakoff et al., 2016).

A definition is a statement that describes a concept, allowing it to be distinguished from other associated concepts (Lara, 2004). Definitions are indispensable assumptions in argumentation and communication, and are necessary elements in the construction of scientific systems (Dahlberg, 1978).

Science has become a more important component of plant breeding as fresh knowledge (from genetics, breeding, statistics and various other sciences) has generated methods, processes, techniques and concepts that help increase breeding efficiency. These concepts and studies, often referred to as 'milestones in breeding', have afforded a scientific basis for plant breeding. Several authors present lists of such milestones (Gonal et al., 2023; Ramalho et al., 2025).

Art, however, also remains a component of plant breeding, as the breeder needs to make decisions such as the choice of parents to be included in crosses, the size of the population to begin the selection, the phenotype preferred by producers (or clients), the generation(s) to be used for testing, and the target environments in which the cultivars will mainly be grown. But due to the statistical analyses available to assist plant breeders in their choices, such decisions are becoming ever more grounded in science (Hallauer et al., 2006).

It is the opinion of various breeders that plant breeding emerged as an art before becoming a combination of art and science (Elsen et al., 2013), and that the trend is for it to become more of a science than art (Hallauer et al., 2006; Jiang, 2013). However, for others, the trend is for it to remain more art than science (Duvick, 1996). According to Duvick (1996), plant breeders universally rely more on experience and art than on genetics.

4 AN ALTERNATIVE APPROACH TO DEFINING PLANT BREEDING

Definitions (Figure 1) that do not fully express scientific concepts can complicate learning a science and hinder the effective learning of a student. Poor definitions can be the result of (Wong et al., 2020) a lack of precision, lack of consistency, circularity and a lack of scope. (Podsakoff et al., 2016; Wong et al., 2020).

At least three points should be considered when defining plant breeding in terms of art and science. Art, presented as the intuition, distinction, skill, etc. of the breeder seems somewhat vague. There also seems to be some inconsistency among plant breeders: some value art more, others science. Thirdly, it can be questioned whether art and science should be considered in isolation or whether they should interact? Should the definition of plant breeding include other components in addition to art and science? What are the underlying processes of art and science?

5 STAGES OF PLANT BREEDING

Plant breeding is a continuous and cyclical process that involves identifying plants with desirable characteristics (yield, quality, resistance to abiotic and biotic factors, etc.) and developing strategies to combine these characteristics in order to obtain superior varieties (Acquaah, 2012). Although plant breeding is a continuous process, some authors tend to divide it into stages or phases.

Schnell (1982) was the first to divide a plant breeding programme into stages. He considered the following: the generation of genetic variability, selection, and the experimental testing of cultivars. Other breeders began to consider the stages defined by Schnell (1982) in varying degrees of detail (Bishaw and Gastel, 2009; Ceccarelli, 2009; Weltzien and Christinck, 2009, among others).

6 ACTIONS

6.1 DEFINITION

Action control is one of the most fundamental topics in cognition, as humans interact with the environment through goal-directed behaviours, i.e. through actions. Action is a fairly

generic term that describes several different types of phenomena, from a movement directed towards achieving a specific goal to behaviours in which the means and ends are temporally distant. The term action can be used in two ways: as a generic term indicating any type of intentional motor behaviour and as a specific term referring to goal-directed behaviours that produce a reward for the individual (Rizzolatti et al., 2001).

The notion of 'action' is not synonymous with 'movement'; this concept will be used in the broader sense of 'intentional action'. Such a notion implies that actions: (i) are motivated by goals and may or may not achieve those goals; (ii) often involve some degree of volitional control; (iii) require planning and decisions between alternatives; (iv) involve forecasting or anticipating an intended outcome; (v) are often, though not always, associated with a sense of agency, i.e. awareness by the agent of performing the specific action and of its objectives (Engel et al., 2013).

An activity comprises a pattern of multiple actions over time. Activities are intuitively far more complex than actions, but also better represent the actual life of a human being. This is because humans often carry out multiple actions simultaneously in a variety of temporal combinations (Liu et al., 2016).

Branchi (2022) defined behaviour as all the actions and associated mental states carried out or experienced by an individual in interacting with the environment. Behaviour includes everything an organism does, whether observed or not. This emphasis on behaviour should be valued in biopsychology, as behaviour is a crucial evolutionary determinant of survival. It is what organisms do (e.g. finding shelter, escaping predators, mating, or caring for offspring) that matters. As a result, the nervous system has evolved to meet the demands of interaction with and adaptation to the environment. As Engel and Schneiderman (1984) observed, "the *raison d'être* of the central nervous system is to optimise the organism's ability to interact with its environment". Behaviour is the way living beings interact with the world. Behaviour is a phenotype and, as such, depends on genetic and environmental factors. Behaviour is a product of a nervous system that processes sensory data from the environment: a nervous system that is integrated with the skeletal, circulatory, digestive and other systems to generate and regulate behaviours. The activities of this nervous system involve thousands of expressed genes but itself does not express behaviour. Although brain activity can be detected in the form of electrical impulses or bright spots on a computer screen during a brain scan, these phenotypes are not behaviours in themselves. Thought is an internal process that occurs in the brain but that cannot be directly detected by an external observer (Wahlsten, 2019).

6.2 TYPES OF ACTION

Humans interact with the environment in at least two different ways depending on whether the behaviour pattern is selected by the agents themselves or determined by external information (Wenke et al., 2009).

One type of action is carried out primarily in response to environmental demands. In this case, the choice of action is implied by external information. For example, it's normal to stop at an intersection when the traffic light is showing red. Such an action is considered stimulus-controlled. Once stimulus-response associations are established, external stimuli trigger their associated reactions more or less automatically (Wenke et al., 2009).

In another type of action, the agents themselves select the appropriate action. This selection is usually aimed at producing a specific environmental effect or satisfying a particular need. This class of action has two distinctive psychological characteristics: it involves internal generation of the action and a mental representation of the effects of the action (Wenke et al., 2009).

The regions of the brain involved in these two types of action are separable, at least in part. The response to external stimuli predominantly recruits a circuit that involves the parietal lobes and lateral premotor areas. In contrast, the generation of internal actions depends more on the medial-frontal areas of the brain, including the supplementary premotor area and the cingulate motor areas (Wenke et al., 2009).

6.3 FACTORS THAT INFLUENCE ACTIONS

Several factors influence an action, including: motivation (Aunger et al., 2025), sensation (Khilkevich et al., 2024) and perception (McDonough et al., 2019); biological and psychological factors such as genetics (Zhou et al., 2024), neurotransmitters (Sarmiento Rivera and Gouveia, 2022), hormones (Asokan and Falkner, 2025) and physical health (Umegaki et al., 2021); basic bodily needs such as sleep (Pickersgill et al., 2022), learning (Coddington and Dudman, 2019) and memory (Heuer and Rolfs, 2020); personality traits (Akmal et al., 2025); social and cultural factors, which may include the presence of other people (Rolison et al., 2020), social norms (Zinchenko and Arsalidou, 2018), social expectations (Cloutier et al., 2011) and social context or background (Saltapidas and Ponsford, 2007); and the sensorimotor system (Riemann and Lephart, 2002). However, several authors discuss action in terms of two types of processes, cognitive and emotional, that take into account the above factors. The concepts of 'cognition' and 'emotion' are simply abstractions for two aspects of a brain at the service of action (Storbeck and Clore, 2007). Cognition and emotion contribute jointly to ongoing behaviours (Pessoa et al., 2012). The

brain constructs not only concepts of emotion, but also cognitions and perceptions, all of which serve to guide action (Hoemann and Barretta, 2019). Cognitive processes have developed to enhance the preparation, execution and regulation of action (Kiesel et al., 2023); therefore, cognition serves action (Allport, 1987). Furthermore, it has been proposed that the distinction between cognition and emotion be eliminated (Pessoa, 2018; Pessoa, 2019).

7 COGNITIVE PROCESSES

Few authors have presented any definition of cognitive processes (Aizawa, 2015; Jarecki et al., 2020). Newen (2015), in a study entitled 'What are cognitive processes? An example-based approach', argues that cognitive processes can only be characterised with a clear scientific definition of what cognition is. According to Newen, cognitive processes are procedures that process all the information (be it multiple or complex) that human beings receive from the surrounding environment. This processing has the aim of transforming the information into easily manageable cognitive tasks (Newen, 2015). Table 1 presents a list of cognitive processes based on the brain model proposed by Wang and Wang (2006).

Is there any evidence that cognitive processes are involved in actions? According to Wurm and Eriguc (2024), recognising goal-directed actions is a computationally challenging task, requiring not only a visual analysis of body movements but also an analysis of how these movements causally impact and consequently induce a change in the target objects of the action. They tested the hypothesis that analysing body movements and the effects they induce depends on distinct neural representations in the superior parietal lobe and the anterior inferior parietal lobe. In four sessions of functional magnetic resonance imaging (fMRI), participants viewed videos of actions (e.g. breaking a stick, crushing a plastic bottle) together with stick figures in point-light displays, pantomimes and corresponding abstract animations of agent-object interaction. According to the authors, the results showed that the parietal cortex and the lateral occipitotemporal cortex are attuned to the physical characteristics of action, such as how body parts move in space relative to each other and how they interact with objects to induce a change (e.g. in position or shape/configuration). The high level of abstraction revealed by the results suggests a general neural code that underlies mechanical reasoning of how entities interact with each other and have an effect on one another.

8 EMOTIONS

8.1 THE NATURE OF EMOTIONS

Lindquist et al. (2022) argue that emotions are determined by both biological and cultural factors. According to those authors, academic debate about the nature of emotion traditionally pits biological and cultural influences against each other. One side of the debate emphasises the role of genetics, neurophysiological anatomy and the biological evolution of mammals as causal mechanisms of universal human emotions. These biological factors have led some scholars to look for emotional similarities among different human cultural groups, which are possibly the product of shared biological adaptations. For example, one study used machine learning to classify facial expressions that were repeated in 6 million YouTube videos across 144 countries during emotional events (such as weddings, sporting competitions and protests). The authors found global variation in the basic rate of emotional situations and in the movements of facial muscles that occurred in these situations, but they also discovered that an *a priori* set of 16 patterns of facial-muscle movements appeared worldwide. Each time a particular pattern occurred, up to 70% of the time and across various cultural contexts, it was in a similar situation (such as at a wedding). These findings have led researchers to conclude that discrete emotions are products of biological natural selection.

Table 1

Layered model of the brain (Wang and Wang, 2006, with modifications)

Subconscious processes		Conscious processes	
Layer 1 (sensations)	Layers 2 to 4 (memories, perception, actions)	Layer 5 (metacognitive processes)	Layer 6 (cognitive processes)
Sensory cognitive processes	Subconscious cognitive processes	Metacognitive processes	Higher cognitive processes
1.1. Vision	2. Memory	5.1. Attention	6.1. Recognition
1.2. Hearing	3. Perception	5.2. Concept Formation	6.2. Images
1.3. Smell	3.1. Self-awareness	5.3. Abstraction	6.3. Comprehension
1.4. Touch	3.2. Motivation	5.4. Search	6.4. Learning
1.4.1. Heat	3.3. Disposition	5.5. Categorisation	6.5. Reasoning
1.4.2. Pressure	3.4. Goal definition	5.6. Memorisation	6.6. Deduction
1.4.3. Weight	3.5. Emotions	5.7. Knowledge representation	6.7. Induction
1.4.4. Pain	3.6. Sense of spatiality		6.8. Decision- making
1.4.5. Texture	3.7. Sense of movement		6.9. Problem- solving
1.5. Taste			6.10. Explanation
1.5.1. Salty	4. Actions		6.11. Analysis
1.5.2. Sweet			6.12. Synthesis
1.5.3. Bitter			6.13. Creation
1.5.4. Sour			6.14. Analogy
1.5.5. Pungency			6.15. Planning
			6.16. Quantification

The other side of the debate emphasises the roles of local ecology and cultural learning in the production of culturally relative emotions. Human groups live in different ecologies, follow different norms and values, and throughout history have experienced different levels of intergroup exposure. These cultural facts have led some scholars to assume that different cultural backgrounds vary how humans around the world experience, express and perceive emotions. For example, cross-cultural variation can be seen in self-reported emotional experiences in the neural correlates of emotional experience and perception, in producing facial-muscle movements and in perceiving emotion in the faces and voices of other people (Lindquist et al., 2022).

8.2 DEFINITION OF EMOTION

There is no consensus among researchers regarding the definition of emotion (Mobayed, 2024, for example). Kleinginna and Kleinginna (1981) reviewed the topic and proposed the following definition: emotion is a complex set of interactions between subjective and objective factors, mediated by neuro-hormonal systems that can (a) give rise to affective experiences, such as feelings of arousal, pleasure or displeasure; (b) generate cognitive processes, such as emotionally relevant perceptual effects, evaluations and labelling; (c) activate generalised physiological adjustments to conditions of arousal; (d) lead to behaviours that are often, but not always, expressive, goal-oriented and adaptive.

Izard (2010) administered questionnaires containing questions related to emotion to 35 researchers. She found that several researchers stated that emotion influences thinking, decision-making, actions, social relationships, well-being, and physical and mental health. However, there was no consensus among the researchers on a definition of the word emotion, and current data suggest that it cannot be defined as a unitary concept. Theorists and researchers have attributed very different meanings to emotion.

8.3 CLASSIFYING EMOTIONS

Ekman (1969) identified six basic emotions: anger, disgust, fear, joy, sadness and surprise. Anger is defined as fury, frustration and resentment towards others. Disgust is synonymous with aversion, distaste or repugnance, and is the most visceral of the six emotions. Fear arises in the presence of a stressful or dangerous stimulus perceived by the sensory organs. When the fight-or-flight response appears, the heart rate and respiratory rate increase. In addition, the muscles become more tense to deal with threats in the environment. Joy or happiness is a pleasant emotional state, synonymous with contentment, satisfaction and well-being. Sadness is the opposite of happiness, characterised by sorrow,

disappointment and anguish. Surprise is triggered by an unexpected outcome to a situation, ranging from astonishment to shock.

Russell and Mehrabian (1977) proposed a dimensional approach in which any emotion is represented in relation to three dimensions: valence (positive/pleasurable or negative/unpleasant), activation (engaged or unengaged) and dominance (degree of control a person has over their affective states).

Plutchik (2003) proposed a model in the shape of a wheel comprising eight basic emotions that include joy, confidence, fear, surprise, sadness, disgust, anger and anticipation. The model describes emotions based on intensity, with strong emotions placed in the centre and weaker emotions placed towards the edge of a flower-shaped model.

8.4 EVIDENCE THAT EMOTIONS INFLUENCE ACTIONS

There are many studies that demonstrate how emotion impacts perception and behaviour. For example, Pereira et al. (2006) showed that viewing unpleasant images interfered with the performance of a basic non-emotional visual detection task. In a subsequent study, Pereira et al. (2010) used functional magnetic resonance imaging to test the hypothesis that, if the interaction of affective and motor signals underlies the effects of behavioural interference, the responses evoked by viewing unpleasant images would be correlated with the brain responses evoked during motor action. They further predicted that the slowdown in response times during unpleasant blocks might be linked to responses in regions of the brain involved in integrating emotional and motor signals, such as the cingulate cortex. As in the first study (Pereira et al., 2006), the participants performed a simple target-detection task following the presentation of unpleasant or neutral images. The results showed that an unpleasant emotional context modulated the responses evoked in various regions involved in the simple target-detection task (Pereira et al., 2010). In particular, the mid cingulate cortex was recruited when participants performed target-detection tests during the unpleasant context, with the signal responses in this region closely reflecting the behavioural interference pattern (as revealed by the reaction time). According to the authors, the results suggest that the mid cingulate cortex may be an important site for the interaction between negative valence signals and motor signals in the brain, and that it may be involved in implementing defensive responses.

9 RELATIONSHIP BETWEEN EMOTION AND COGNITION

Okon-Singer et al. (2015) showed that emotional signals, emotional states and emotional traits can strongly influence key elements of continuous information processing,

including selective attention, working memory and cognitive control. This influence often persists beyond the duration of transient emotional challenges, perhaps reflecting slower changes in neurochemistry. In turn, the circuits involved in attention and working memory contribute to the voluntary regulation of emotion. The distinction between the 'emotional' and 'cognitive' brain is tenuous and context-dependent. In fact, there is compelling evidence that regions (e.g. dorsolateral prefrontal cortex, mid cingulate cortex) and processes (e.g. working memory, cognitive control) conventionally associated with cognition play a central role in emotion. Furthermore, supposedly emotional and cognitive regions dynamically influence each other through a complex network of recurring, often indirect, anatomical connections, in ways that jointly contribute to adaptive behaviour. Taken together, these observations show that emotion and cognition are deeply intertwined in the structure of the brain, suggesting that widely held beliefs about the main constituents of the 'emotional brain' and of the 'cognitive brain' are fundamentally flawed.

10 RELATIONSHIP BETWEEN THE ACTIONS OF PLANT BREEDERS AND COGNITIVE AND EMOTIONAL PROCESSES

With the aim of completing each stage of plant breeding, breeders carry out various activities, including writing texts, taking notes, acquiring materials and equipment; implementing, conducting and harvesting experiments; keeping or disposing of seeds, performing calculations, giving lectures, etc. An observer watching the plant breeder would see the actions used in these activities. For example, when the breeder is writing a text, the observer might note the arrangement of the breeder's fingers and hands on the keyboard, or when consulting a source, the breeder's gaze directed at the monitor, etc. In short, the observer would see the action processes, but not the cognitive or emotional processes. The former might include the choice of words, the way the text is organised, the topics covered, etc.; while the latter might include, among others, the joy of having done a good job, the fear of having failed to include relevant information, and the anxiety that some readers may not have understood what was written.

Marano et al. (2025) conducted a study that illustrates what has been presented regarding cognitive processes. They assessed how handwriting and typing differentially activate regions of the brain associated with motor control, sensory perception and higher-order cognitive functions. Handwriting activates a broader network of brain regions involved in motor, sensory and cognitive processing. Typing involves fewer neural circuits, resulting in more-passive cognitive engagement.

In terms of emotional processes, Citron (2012) found that more-recent electrophysiological studies, together with hemodynamic neuroimaging, have clearly demonstrated that emotional variables affect written word processing at the very early stages, facilitating and enhancing the processing of emotionally important words, and recruiting areas of the brain previously associated with both more-basic emotional processing (e.g. the amygdala) and emotional experience (e.g. the anterior cingulate cortex and the medial prefrontal cortex).

11 A DEFINITION OF PLANT BREEDING

Based on the above, the following definition of plant breeding is proposed: a science which employs cognitive and emotional processes to modify plant genotypes in order to make the plants more useful to man. This definition may have certain limitations. Existing knowledge of cognitive and emotional processes is still limited. For example, there is no consensus on how to define cognition and emotion. It is not known whether cognition and emotion are the same process. It is also still debated whether cognition is brain-bound or extended, embodied, embedded or enacted. However, the proposed definition will surely be improved as knowledge of the cognitive sciences increases.

REFERENCES

- Acquah, G. (2012). *Principles of plant genetics and breeding* (2nd ed.). John Wiley & Sons.
- Agrawal, R. L. (1998). *Fundamentals of plant breeding and hybrid seed production*. Science Publishers.
- Aizawa, K. (2015). What is this cognition that is supposed to be embodied? *Philosophical Psychology*, 28(6), 755–775.
- Akmal, F., Arifin, Z., Sabiruddin, S., Busral, B., Yuni, S., & Miagustin, V. (2025). The relationship between personality and human behavior. *Al-Ashri: Ilmu-Ilmu Keislaman*, 10(1), 31–36.
- Allport, D. A. (1987). Selection for action: Some behavioral and neurophysiological considerations of attention and action. In H. Heuer & H. F. Sanders (Eds.), *Perspectives on perception and action* (pp. 395–419). Lawrence Erlbaum Associates.
- Asokan, M. M., & Falkner, A. L. (2025). Hormonal regulation of behavioral and emotional persistence: Novel insights from a systems-level approach to neuroendocrinology. *Neurobiology of Learning and Memory*, 220, Article 108064.
- Aunger, R., Gallyamova, A., & Grigoriev, D. (2025). Network psychometric-based identification and structural analysis of a set of evolved human motives. *Personality and Individual Differences*, 233, Article 112921.

- Bishaw, Z., & Gastel, A. J. G. van. (2009). Variety release and policy options. In S. Ceccarelli, E. P. Guimarães, & E. Weltzien (Eds.), *Plant breeding and farmer participation* (pp. 565–587). FAO.
- Borém, A., Guimarães, E. P., Federizzi, L. C., & Toledo, J. F. F. (2002). From Mendel to genomics, plant breeding milestones: A review. *Crop Breeding and Applied Biotechnology*, 2(4), 649–658.
- Branchi, I. (2022). Recentring neuroscience on behavior: The interface between brain and environment is a privileged level of control of neural activity. *Neuroscience and Biobehavioral Reviews*, 138(2), Article 104678.
- Carruthers, P., Stich, S., & Siegal, M. (Eds.). (2002). *The cognitive basis of science*. Cambridge University Press.
- Ceccarelli, S. (2009). Main stages of a plant breeding programme. In S. Ceccarelli, E. P. Guimarães, & E. Weltzien (Eds.), *Plant breeding and farmer participation* (pp. 63–74). FAO.
- Chahal, G. S., & Gosal, S. S. (2006). *Principles and procedures of plant breeding: Biotechnological and conventional approaches*. Alpha Science International.
- Cherukun nath, D., & Singh, A. P. (2022). Exploring cognitive processes of knowledge acquisition to upgrade academic practices. *Frontiers in Psychology*, 13, Article 682628.
- Cisek, P., & Kalaska, J. F. (2010). Neural mechanisms for interacting with a world full of action choices. *Annual Review of Neuroscience*, 33, 269–298.
- Citron, F. M. M. (2012). Neural correlates of written emotion word processing: A review of recent electrophysiological and hemodynamic neuroimaging studies. *Brain & Language*, 122(3), 211–226.
- Cloutier, J., Gabrieli, J. D. E., O'Young, D., & Ambady, N. (2011). An fMRI study of violations of social expectations: When people are not who we expect them to be. *NeuroImage*, 57(2), 583–588.
- Coddington, L. T., & Dudman, J. T. (2019). Learning from action: Reconsidering movement signaling in midbrain dopamine neuron activity. *Neuron*, 104(1), 63–77.
- Cragg, J., Mushtaq, F., Lal, N., Garnham, A., Hallissey, M., Graham, T., & Shiralkar, U. (2021). Surgical cognitive simulation improves real-world surgical performance: Randomized study. *BJS Open*, 5(3), Article zrab003.
- Dahlberg, I. (1978). Teoria do conceito. *Ciência da Informação*, 7(2), 101–107.
- Duvick, D. N. (1996). Plant breeding, an evolutionary concept. *Crop Science*, 36(3), 539–548.
- Ekman, P., Sorenson, E. R., & Friesen, W. V. (1969). Pan-cultural elements in facial displays of emotions. *Science*, 164(3875), 86–88.
- Eldadi, O., & Tenenbaum, G. (2025). Team cognition (TC) in sport: Foundations, development, and performance implications. *Psychology of Sport and Exercise*, 80, Article 102927.

- Elsen, A. van, Gotor, A. A., Vicente, C. di, Traon, D., Gennatas, J., Amat, L., Negri, V., & Chable, V. (2013). Plant breeding for an EU bio-based economy; The potential of public sector and public/private partnerships. In E. R. Cerezo (Ed.), *JCR Scientifica and Policy Reports* (pp. ?–?). Publications Office of the European Union. (Nota: páginas do capítulo não informadas no original)
- Engel, B. T., & Schneiderman, N. (1984). Operant conditioning and the modulation of cardiovascular function. *Annual Review of Physiology*, 46, 199–210.
- Engel, A. K., Maye, A., Kurthen, M., & Konig, P. (2013). Where's the action? The pragmatic turn in cognitive science. *Trends in Cognitive Sciences*, 17(5), 202–209.
- Gonal, B., Somveer, Doggalli, G., Kumar, B., Bhushan, S., Surekha, Malathi, G., & Singh, L. (2023). Exploring the future of plant breeding: Advancements and challenges. *International Journal of Plant & Soil Science*, 35(24), 49–55.
- Hallauer, A. R. (2011). Evolution of plant breeding. *Crop Breeding and Applied Biotechnology*, 11(3), 197–206.
- Hallauer, A. R., Curtiss, C. E., & Pandey, S. (2006). Defining and achieving plant-breeding goals. In K. R. Lamkey & M. Lee (Eds.), *Plant breeding: The Arnel R. Hallauer international symposium* (pp. 73–89). Blackwell Publishing.
- Heuer, A., & Rolfs, M. (2020). Memory for action: A functional view of selection in visual working memory. *Visual Cognition*, 28(5–8), 388–400.
- Hoemann, K., & Barrett, L. F. (2019). Concepts dissolve artificial boundaries in the study of emotion and cognition, uniting body, brain, and mind. *Cognition & Emotion*, 33(1), 67–76.
- Izard, C. E. (2010). The many meanings/aspects of emotion: Definitions, functions, activation, and regulation. *Emotion Review*, 2(4), 363–370.
- Jarecki, J. B., Tan, J. H., & Jenny, M. A. (2020). A framework for building cognitive process models. *Psychonomic Bulletin & Review*, 27(6), 1218–1229.
- Jiang, G.-L. (2013). Plant marker-assisted breeding and conventional breeding: Challenges and perspectives. *Advances in Crop Science and Technology*, 1(3), Article 1000e106.
- Jones, P. W., & Cassells, A. C. (1995). Criteria for decision making in crop improvement programmes – Technical considerations. *Euphytica*, 85, 465–476.
- Khilkevich, A., Lohse, M., Low, R., Orsolic, I., Bozic, T., Windmill, P., & Masic-Florl, T. D. (2024). Brain-wide dynamics linking sensation to action during decision-making. *Nature*, 634(8035), 890–900.
- Kiesel, A., Fournier, L. R., Giesen, C. G., Mayr, S., & Frings, C. (2023). Core mechanisms in action control: Binding and retrieval. *Journal of Cognition*, 6(1), 1–6.
- Kleinginna, P. R., & Kleinginna, A. M. (1981). A categorized list of emotion definitions, with suggestions for a consensual definition. *Motivation and Emotion*, 5(4), 345–379.

- Kusmec, A., Zheng, Z., Archontoulis, S., Ganapathysubramanian, B., Hu, G., Wang, L., Yu, J., & Schnable, P. S. (2021). Interdisciplinary strategies to enable data-driven plant breeding in a changing climate. *One Earth*, 4(3), 372–383.
- Lindquist, K. A., Jackson, J. C., Leshin, J., Satpute, A. B., & Gendron, M. (2022). The cultural evolution of emotion. *Nature Reviews*, 1, 669–681.
- Liu, Y., Nie, L., Liu, L., & Rosenblum, D. S. (2016). From action to activity: Sensor-based activity recognition. *Neurocomputing*, 181, 108–115.
- Logie, R. (2018). Human cognition: Common principles and individual variation. *Journal of Applied Research in Memory and Cognition*, 7(4), 471–486.
- Marano, G., Kotzalidis, G. D., Lisci, F. M., Anesini, M. B., Rossi, S., Barbonetti, S., Cangini, A., Ronsisvalle, A., Artuso, L., Falsini, C., Caso, R., Mandracchia, G., Brisi, C., Traversi, G., Mazza, O., Pola, R., Sani, G., Mercuri, E. M., Gaetani, E., & Mazza, M. (2025). The neuroscience behind writing: Handwriting vs. typing—who wins the battle? *Life*, 15(3), Article 345.
- Martins, A. P. G. (2016). A review of important cognitive concepts in aviation. *Aviation*, 20(2), 65–84.
- Michel, S., Loschenberger, F., Ametz, C., Bistrich, H., & Burstmayer, H. (2025). Predicting plant breeder decisions across multiple selection stages in a wheat breeding program. *Crops*, 5(5), 69–82.
- Miller, W. B., Jr. (2023). *Cognition-based evolution: Natural cellular engineering and the intelligent cell*. Taylor & Francis/CRC Press.
- Mobayed, T. (2024). A concept in flux and starved of the metaphysical: Desecularizing emotion. *Frontiers in Psychology*, 15, Article 1373443.
- Nersessian, N. J. (2024). How do scientists think? Contributions toward a cognitive science of science. *Topics in Cognitive Science*, 17(1), 1–27.
- Newen, A. (2015). What are cognitive processes? An example-based approach. *Synthese*, 194(11), 4251–4268.
- Okon-Singer, H., Hendler, T., Pessoa, L., & Shackman, A. J. (2015). The neurobiology of emotion–cognition interactions: Fundamental questions and strategies for future research. *Frontiers in Human Neuroscience*, 9, Article 58.
- Olschewski, S., Luckman, A., Mason, A., Ludvig, E. A., & Konstantinidis, E. (2024). The future of decisions from experience: Connecting real-world decision problems to cognitive processes. *Perspectives on Psychological Science*, 19(1), 82–102.
- Pereira, M. G., Oliveira, L., Erthal, F. S., Joffily, M., Mocaiber, I. F., Volchan, E., & Pessoa, L. (2010). Emotion affects action: Midcingulate cortex as a pivotal node of interaction between negative emotion and motor signals. *Cognitive, Affective, & Behavioral Neuroscience*, 10(1), 94–106.
- Pereira, M. G., Volchan, E., Souza, G. G. L., Oliveira, L., Campagnoli, R. R., Pinheiro, W. M., & Pessoa, L. (2006). Sustained and transient modulation of performance induced by emotional picture viewing. *Emotion*, 6(4), 622–634.

- Pessoa, L. (2018). Embracing integration and complexity: Placing emotion within a science of brain and behaviour. *Cognition & Emotion*, 33(1), 55–60.
- Pessoa, L. (2019). Neural dynamics of emotion and cognition: From trajectories to underlying neural geometry. *Neural Networks*, 120, 158–166.
- Pessoa, L., Padmala, S., Kenzer, A., & Bauer, A. (2012). Interactions between cognition and emotion during response inhibition. *Emotion*, 12(1), 192–197.
- Pickersgill, J. W., Turco, C. V., Ramdeo, K., Rehisi, R. S., Foglia, S. D., & Nelson, A. J. (2022). The combined influences of exercise, diet and sleep on neuroplasticity. *Frontiers in Psychology*, 13, Article 831819.
- Plutchik, R. (2003). *Emotions and life: Perspectives from psychology, biology, and evolution*. American Psychological Association.
- Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2016). Recommendations for creating better concept definitions in the organizational, behavioral, and social sciences. *Organizational Research Methods*, 19(2), 159–203.
- Ramvalho, M. A. P., Gonçalves, F. M. A., Techio, V. H., & Souza, L. C. de. (2025). Advances in genetics and plant breeding 160 years after the publication of Mendel's research. *Crop Breeding and Applied Biotechnology*, 25(2), Article e521725212.
- Riemann, B. L., & Lephart, S. M. (2002). The sensorimotor system, part I: The physiologic basis of functional joint stability. *Journal of Athletic Training*, 37(1), 71–79.
- Rizzolatti, G., Fogassi, L., & Gallese, V. (2001). Neurophysiological mechanisms underlying the understanding and imitation of action. *Nature Reviews Neuroscience*, 2(9), 661–670.
- Rolison, M. J., Naples, A. J., Rutherford, J. V., & McPartland, J. C. (2020). The presence of another person influences oscillatory cortical dynamics during dual brain EEG recording. *Frontiers in Psychiatry*, 11, Article 246.
- Russell, J. A., & Mehrabian, A. (1977). Evidence for a three-factor theory of emotions. *Journal of Research in Personality*, 11(3), 273–294.
- Saltapidas, H., & Ponsford, J. (2008). The influence of cultural background on experiences and beliefs about traumatic brain injury and their association with outcome. *Brain Impairment*, 9(1), 1–13.
- Sarmiento Rivera, L. F., & Gouveia, A. (2022). Neurotransmitters and hormones in human decision-making. In P. Á. Gargiulo & H. L. Mesones Arroyo (Eds.), *Psychiatry and neuroscience update* (pp. 149–167). Springer International Publishing.
- Schnell, F. W. (1982). Synoptic study of methods and categories of plant breeding. *Zeitschrift für Pflanzenzüchtung (Journal of Plant Breeding)*, 89(1), 1–18.
- Shah savarani, A. M., & Abadi, E. A. M. (2015). The bases, principles, and methods of decision-making: A review of literature. *International Journal of Medical Reviews*, 2(1), 214–225.
- Shi, Z. (2021). Introduction. In Z. Shi, *Intelligence science: Leading the age of intelligence* (pp. 1–31). Institute of Computing Technology, Chinese Academy of Sciences.

- Sleper, D. A., & Poehlman, J. M. (2006). *Breeding field crops* (5th ed.). Blackwell Publishing.
- Sol, D., Bateman-Neubert, A., Noguer, L., & Taylor, A. H. (2025). The evolutionary puzzle of cognition: Challenges and insights from individual-based studies. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 380(1929), Article 20240123.
- Stiegler, M. P., & Tung, A. (2014). Cognitive processes in anesthesiology decision-making. *Anesthesiology*, 120(1), 204–217.
- Storbeck, J., & Clore, G. L. (2007). On the interdependence of cognition and emotion. *Cognition & Emotion*, 21(6), 1212–1237.
- Sun, X., Peng, T., & Mumm, R. H. (2011). The role and basics of computer simulation in support of critical decisions in plant breeding. *Molecular Breeding*, 28(4), 421–436.
- Umegaki, H., Sakurai, T., & Arai, H. (2021). Active life for brain health: A narrative review of the mechanism underlying the protective effects of physical activity on the brain. *Frontiers in Aging Neuroscience*, 13, Article 761674.
- Vance, D. E., Bail, J., Enah, C. C., Palmer, J. J., & Hoenig, A. K. (2016). The impact of employment on cognition and cognitive reserve: Implications across diseases and aging. *Nursing: Research and Reviews*, 6, 61–71.
- Vencovsky, R., Ramalho, M. A. P., & Toledo, F. H. R. B. (2012). Contribution and perspectives of quantitative genetics to plant breeding in Brazil. *Crop Breeding and Applied Biotechnology*, S2, 7–14.
- Wahlsten, D. (2019). *Genes, brain function, and behavior: What genes do, how they malfunction, and ways to repair damage*. Academic Press.
- Wang, Y., & Wang, Y. (2006). Cognitive informatics models of the brain. *IEEE Transactions on Systems, Man and Cybernetics – Part C: Applications and Reviews*, 36(2), 203–207.
- Weidman, J., & Baker, K. (2015). The cognitive science of learning: Concepts and strategies for the educator and learner. *Neuroscience in Anesthesiology and Perioperative Medicine*, 121(6), 1586–1599.
- Weltzien, E., & Christinck, A. (2009). Methodologies for priority setting. In S. Ceccarelli, E. P. Guimarães, & E. Weltzien (Eds.), *Plant breeding and farmer participation* (pp. 75–105). FAO.
- Wenke, D., Waszak, F., & Haggard, P. (2009). Action selection and action awareness. *Psychological Research*, 73(4), 602–612.
- Wong, C. L., Chu, H.-E., & Yap, K. C. (2020). A framework for defining scientific concepts in science education. *Asia-Pacific Science Education*, 6(2), 615–644.
- Wurm, M. F., & Erişug, D. Y. (2024). Decoding the physics of observed actions in the human brain. *eLife*, 13, Article RP98521.
- Zhou, Y., Song, H., & Ming, G.-L. (2024). Genetics of human brain development. *Nature Reviews Genetics*, 25(1), 26–45.

Zinchenko, O., & Arsalidou, M. (2018). Brain responses to social norms: Meta-analyses of fMRI studies. *Human Brain Mapping*, 39, 955–970.

POWER AND PHOTOGRAPHY: SIGNS OF INFORMATION IN PUBLIC AND POLITICAL COMMUNICATION

O PODER E A FOTOGRAFIA: OS SIGNOS DE INFORMAÇÃO NA COMUNICAÇÃO PÚBLICA E POLÍTICA

EL PODER Y LA FOTOGRAFÍA: LOS SIGNOS DE INFORMACIÓN EN LA COMUNICACIÓN PÚBLICA Y POLÍTICA



<https://doi.org/10.56238/sevened2026.008-208>

Bibiana de Paula Friderichs¹, Alahna de Oliveira Lopes²

ABSTRACT

This research aims to understand how photography is constituted as a sign of information on the Instagram account of the Federal Government of Brazil. To achieve this, we will conduct a study of discursivity at a non-verbal level, analyzing a set of 15 photographs published on this social network during the week of March 30, 2024, in carousel format. Considering the role of language in society and of discourse in the organization of reality, this general objective unfolds into other specific objectives, selected according to the Principle of Pertinence (Barthes, 2001). Among them is the reflection on the relationships between information and power, as well as between public communication, oriented toward citizenship, and political communication, oriented toward ideological propaganda. Anchored in Barthesian semiology, the following analytical categories were adopted: discourse (sub-category: photography) and power according to Barthes (1978), information according to Capurro (2007), and the reflection by Brandão (2009) on public and political communication. Finally, we observe that the fabric of discourse indicates the subjection of the signs of information to the meanings of Lula's Power, converting public communication into political communication.

Keywords: Public Communication. Political Communication. Photography. Information. Discourse.

RESUMO

Esta pesquisa tem como objetivo compreender de que forma a fotografia se constitui como signo de informação no instagram do Governo Federal do Brasil. Para isso, realizaremos um estudo da discursividade em nível não verbal, de um conjunto de 15 fotografias publicadas nesta rede social, na semana do dia 30 de março de 2024, em formato carrossel. Considerando o papel da linguagem na sociedade, e do discurso na organização da realidade, esse objetivo geral se desdobra em outros, específicos, eleitos pelo Princípio da Pertinência (Barthes, 2001). Entre eles está a reflexão sobre as relações entre informação e poder, assim como entre a comunicação pública, orientada para a cidadania, e a comunicação política, orientada para a propaganda ideológica. Ancoradas na semiologia Barthesiana, pautamos as seguintes categorias de análise: discurso (sub-categoria, fotografia) e poder para Barthes (1978), informação para Capurro (2007), e na reflexão de

¹ Dr. in Social Communication (PUCRS). Universidade de Passo Fundo (UPF). E-mail: bibiana@upf.br

² Graduated in Journalism (UPF). Universidade de Passo Fundo (UPF). E-mail: oalahna@gmail.com

Brandão (2009) sobre comunicação pública e política. Por fim, observamos que a trama do discurso indicia o assujeitamento dos signos da informação aos sentidos do Poder de Lula, convertendo a comunicação pública em uma comunicação política.

Palavras-chave: Comunicação Pública. Comunicação Política. Fotografia. Informação. Discurso.

RESUMEN

Esta investigación tiene como objetivo comprender de qué manera la fotografía se constituye como signo de información en el Instagram del Gobierno Federal de Brasil. Para ello, se realizará un estudio de la discursividad a nivel no verbal, a partir del análisis de un conjunto de 15 fotografías publicadas en esta red social durante la semana del 30 de marzo de 2024, en formato carrusel. Considerando el papel del lenguaje en la sociedad y del discurso en la organización de la realidad, este objetivo general se desdobra en otros objetivos específicos, seleccionados según el Principio de Pertinencia (Barthes, 2001). Entre ellos se encuentra la reflexión sobre las relaciones entre información y poder, así como entre la comunicación pública, orientada a la ciudadanía, y la comunicación política, orientada a la propaganda ideológica. Ancladas en la semiología barthesiana, se adoptaron las siguientes categorías de análisis: discurso (subcategoría: fotografía) y poder para Barthes (1978), información para Capurro (2007), y la reflexión de Brandão (2009) sobre comunicación pública y política. Finalmente, observamos que la trama del discurso evidencia la sujeción de los signos de la información a los sentidos del Poder de Lula, convirtiendo la comunicación pública en una comunicación política.

Palabras clave: Comunicación Pública. Comunicación Política. Fotografía. Información. Discurso.

1 INTRODUCTION

Language, as a system of signs, and the discourses we produce through it, are forms of man's intervention in the world, which constitute a dialectical game through which the subject realizes himself, relates to the other (or others), and understands and explains the world around him. There is no subject outside language, just as there is no non-discourse (Barthes, 1981).

Media discourses, in turn, occupy a privileged place in society, since they are produced and distributed quickly and comprehensively: they are everywhere, all the time. Constituted by a diversity of languages, they manifest themselves in different ways, in multiple supports, and are intermediaries of social daily life. Therefore, such discourses can be opinion makers, consensus, reproduction or transformation of ways of being in the world.

It is these media discourses, for example, that express the places of power in the social structure, and offer lenses through which we can read this world. Therefore, the media space is also a public space (Habermas apud Correia, 1998). In addition to being constituted by the discourses of private life, consumption and leisure, they should be a place for the circulation of discourses about collective life, what we need to share as a society. In this sense, it deserves a close look at the very notion of what is public, and of public communication.

The concept of "public" indicates a wide range of meanings and contexts, from the public realm of information and resources, to the public space where social and political interactions take place. Public communication, on the other hand, ranges from government and institutional communication to mass media and social networks on the internet, where individuals can express themselves and interact on a global scale. The task of guaranteeing communication of this nature is everyone's, but above all, of the institutions that work for citizenship, and that, therefore, are also crossed by political institutions, of active participation in the construction of society through the propagation of certain ideas of the world, which want to be dominant.

Added to this scenario is the diversity of languages, formats and supports through which media discourses, and therefore political audiences, materialize. According to Kossoy (2000), we live in the civilization of the image, a cultural and social phenomenon in which discursive forms do not materialize solely, nor primarily, in verbal form, but overflow into imagetic languages, with the production of videos, photographs, illustrations and a myriad of other manifestations and developments, which circulate beyond the traditional means of communication, also in cyberspace.

Photography, as a particular reference of these manifestations, is a preponderant form of visual communication and as a discourse, it is multifaceted. It can be used in different ways

to communicate, inspire, provoke reflections and point to various perspectives of reality, contributing to the construction of an idea of the world and the formation of identities. As a means of capturing and "freezing" moments, events, and lived realities, photography carries information, produces meaning, and offers a tangible, and often emotionally impactful, visual interpretation of the world around us.

These are the assumptions that motivated us to combine: discourse, communication (public and political), information, photographic image and power, translating them into the following research problem: how photography constitutes itself as a sign of information on the Instagram of the Federal Government of Brazil. This general objective unfolds into other specific ones, chosen by the Principle of Belonging (Barthes, 2001), such as the reflection on the relations between information and power, as well as between public communication, oriented towards citizenship, and political communication, oriented towards ideological propaganda.

To answer this question, we chose to carry out a study of discursivity at a non-verbal level, from a set of 15 photographs published on *Instagram* (a social network on the internet), in the week of March 30, 2024, in carousel format by the profile *@govbr*. Anchored in Barthesian semiology, as the theoretical foundation of the research and method of approaching the object, we guided the following categories of analysis: discourse (sub-category, photography) and power, both for Barthes (1978), information, for Capurro (2007), and public communication, for Brandão (2009).

2 SEMIOLOGY: A THEORY AND A METHOD

Semiology is the science that studies signs and the processes of meaning production. According to Roland Barthes (1978), semiology is a discipline that examines how signs function in systems of signification. He says that signs are the fundamental units of meaning that make up complex semiotic systems. The semiologist, when speaking of the construction of the sign, distinguished the "signifier", which is the physical form of the sign (for example, a written word or a gesture), from the "signified", which is the concept or idea associated with the signifier. The simultaneous association of both generates what we call a sign. A set of signs organized in a system, in turn, constitutes Language.

Barthes (1978) states that society uses language to structure reality, organize signs and weave a discourse to "understand" the world around it. When we analyze the ways in which this discursivity manifests itself, we will perceive expressed in these manifestations, the ideas (or ideologies) that certain subjects or groups have of reality. In this way, we affirm that Power is always present in the discourse.

Above all, because of the old tenacity of a Barthesian certainty: what makes language suffer is ideology. Our Western languages are tired of making sense, in vicious and vicious semantic circles. We have arrived at a kind of engorgement, of semantic bottling, in which the meanings fight and self-annul, in a historical-discursive situation that Barthes characterized. (BARTHES, 1978, p.44)

Semiology is a theory and it is a methodology. As an investigation procedure, it is constituted through the Principle of Relevance (Barthes, 2001), which presupposes the explanation of facts, linked to a point of view, taking advantage of certain traits and discarding others. It is the pertinence between the object and its problematization that is materialized in a set of categories of analysis, responsible for intermediating the translinguistic (social reality) and the discourse. The author says that anchored by these categories we can question the discourses about the relations of meaning they produce among themselves and with the translinguistic (that which, strictly speaking, is outside a certain discourse, but crosses it).

These categories are also markers that point to structural elements of this reality, observable in the use of figures of speech, their conflicts, their subversions and their achievements. In this study, the *a priori categories* are: discourse (sub-category photography), power, information and public communication.

Guided by these questions, we cut out our corpus of analysis: a post made by the Federal Government of Brazil, on the social network Instagram, on March 30, 2024. There are 10 photographs in the form of a carousel (which brings together 15 images), compiled in a single post. To make such a cut, we established a set of criteria that, in a coherent way, preserves the photographic image as the only narrative. Thus, we exclude cards, videos and photographs with graphic intervention.

As part of the methodology, the conceptualization of the analytical categories will provide us with the theoretical assumptions to study their discursive marks in the structure of the text, in the use of figures of speech, and in the game between the signs constituted by the chosen images.

2.1 SPEECH

Barthes (1978) explains discourse as the possibility of saying something about something to someone. It is a dialectical game, based on the structure and mobility of signs, which combined give the receiver the opportunity to construct meanings about what is being said. Barthes (1981) believes that all the discourses we produce, but also those to which we connect, are constituted by who we are, the time in which we are living, by the relationships we create with the subjects who make up the scenarios with us, and by the way we install meanings in the text fabric.

As a category of analysis, to think about discourse is to think about its form, the resources we use to construct our narratives, the organization we propose to signs and the plasticity we give it, especially because the grammar of languages, in some way, crystallizes certain structures, and they are tensioning of the senses, which often force us to say.

It is not only phonemes, words and syntactic articulations that are subject to a parole regime, since we cannot combine them in any way; it is the entire sheet of discourse that is fixed by a network of rules, constraints, oppressions, repressions, massive or tenuous at the rhetorical level, subtle and acute at the grammatical level [...]. (Barthes, 1978, p. 14).

In the case of this investigation, the language of discourse is visual, and its form is photography, so to think about its grammar, or its foundations, is to think about the objective principles that can affect semiosis, and its polysemy. Therefore, photography is a sub-category of analysis.

2.1.1 Photography

When we look at the theme in Barthes (1984), we find an association between photography and death, like a death certificate. Historically, it is marked by the action of reproducing to infinity something or some moment that happened only once, but that through this materiality can be revisited by the reader. For Barthes (1984), every photograph represents a referent, present in the image through an aesthetic trait that reproduces it, but which after the registration, as a referent, no longer exists in our space of time, outside the photographic image.

However, it is the photographer who makes a choice, when he finds the referent, in the act of registration. According to Flusser (2002), this gesture is characterized as a leap, or a series of leaps, through which the photographer overcomes the barriers that separate time and space. From his lens, he looks, limits and puts into perspective what he wants to resonate with the image. On the other hand, in this act, he also delimits and excludes what he does not want to capture, what he wants to leave on the sidelines, allowing us to think about what the photograph does not show, but which may have been there at that moment.

Barthes (1981) says that these choices are guided by the photographer's ideology, and his subjective perception of the captured object and the world. Therefore, when we propose to analyze a photographic record, it is necessary to rescue certain contexts from which the subject speaks, so that we can recognize the meanings produced not only by what we see, but also from what is absent in the image. For the author, photography communicates different meanings for each reader, and for the photographer. Seeking to objectify these

distinctions, he associates these meanings to the feelings provided by the photographic image in the subjects.

There is a *studium* and a *punctum* in the photographs for each reader. "The *Punctum* of a photo is the chance that stings me in it" (Barthes, 1984, p. 28), that which particularly touches me, and may even indicate a feeling of loss or pain. The *Studium* is that which, in the image, carries a historical or social relevance, reflecting the intentions of the person who is photographing, and which can be perceived as a function of the culture of the person who reads it. In other words, after all, what makes us want to record a scene? They are "the same vague, uniform, irresponsible interests that we have for people, spectacles, books, which we consider distinct" (Barthes, 1984, p. 27). To observe these two elements is to signify the photographic image.

2.2 POWER

The manifestation of power is present in the most varied social actions, whether formal or informal, passing through the fraternal and family relationship, and moving to business organizations and political institutions. Power, for Barthes (1978), however, is not a matter of polarization (where some have it and others do not), but it is one of the means of ideological expression present in human relations and that is not reserved to the spaces of the State or institutionalized hierarchies (Barthes, 1978). It invariably accompanies our history, but it varies over time and contexts, and also exists as a potency, a libido that gives pleasure to the world.

We then guess that power is present in the finest mechanisms of social exchange: not only in the State, in classes, in groups, but also in fashions, in current opinions, in spectacles, in games, in sports, in information, in family and private relationships, and even in the liberating impulses that try to contest it [...] (Barthes, 1978, p.6).

In turn, language appears here as an alternative expression for these relations, and discourse can behave as excluding or inclusive, depending on the way in which power manifests itself, and in the face of it, it can mean its maintenance or subversion.

2.3 INFORMATION

According to Capurro (2007), two contexts in which the term information is used must be taken into account : the act of communicating knowledge and the act of shaping the mind. In the sense of communicated knowledge, it plays an important role in contemporary society, since it refers to the set of knowledge gathered on a given subject that can be transmitted or shared. In the second context, that of shaping the mind, it refers to the consequence of data

processing, in such a way that it represents a modification in the knowledge of the human or non-human system, which receives it.

Information can be presented in written form (printed or numerical), oral, sound or audio and visual, and its intense and fast circulation is one of the main characteristics of our society, called the information society.

Reinforcing the meaning of Capurro (2007), Hohlfeldt (2001) says that information is a set of organized and processed data, which can produce meaning or knowledge. It has the potential to be stored, transmitted by various means of communication, and interpreted. "In its etymological sense, 'inform' means 'to give shape to'. But what exactly is being 'formatted'? On the one hand, matter, very certainly, because it is a matter of elaborating material traces", on the other, a potential communication that enables the sharing of meanings between consciousnesses (Hohlfeldt 2001, p.17). Thus, information is a communication that can be activated and understood by the subjects of the discourse.

2.4 PUBLIC COMMUNICATION

The main concept of public communication concerns the practice of communication carried out by government organizations and public institutions to inform, engage and interact with citizens, legitimate ways for a government to bring information to the attention of all. This field encompasses a variety of activities and strategies aimed at promoting civic participation and building trust in so-called public institutions.

According to the author Brandão (2009), to the extent that public communication is oriented towards accountability, engaging the population in the programs adopted, recognizing the actions that are promoted in the political, economic and social areas, promoting a public debate, can also be recognized as an instrument for building the public agenda.

The communication promoted by the governments (federal, state and municipal) can be concerned with awakening civic sentiment (examples of recent advertising campaigns are: "the best of Brazil is the Brazilian" and "good example"); (elections, recently the referendum on the sale of firearms and ammunition); protect and promote citizenship (vaccination campaigns, traffic accidents, etc.), or call on citizens to fulfill their duties (the "Lion" of the Federal Revenue, military enlistment). (BRANDÃO 2009, p.5)

The Federal Constitution of Brazil recognizes and guarantees the right to information as a fundamental right of citizens, establishing the obligation of public bodies to provide information of public interest. In this sense, the author observes a gradual change in the scenario of public communication from the first decade of the twenty-first century. For her,

this change is linked both to the growing demands for transparency and accountability, and to the transformations in the field of communication, especially with the popularization of social media.

Brandão (2009) recalls that the concept of public communication must take into account the different agents involved in the communication process and recognize their interdependence. Under this assumption, an effective approach would involve the collaboration and active participation of all these actors, aiming to promote dialogue, inclusion and accountability in the public sphere. However, even with the advances of the last decades, it is noticeable that there are still setbacks in the development and implementation of public communication projects in Brazil.

According to Duarte (2009), one of the main challenges in this sector is to make this issue a priority within organizations, by allowing the population to know about the actions developed for the dissemination of information. Still, it is possible to highlight another "difficulty", which the author mentions: the difficulty of detaching public communication from the image of politicians. Neto (2004, p. 101) corroborates this orientation: "government propaganda should primarily inform what is being done and not who is doing it", so that the constitutional principle of impersonality is respected (BRASIL, 1988, art. 37, caput).

Based on these assumptions, a secondary question of this research is related to information and public communication: what are the profile photos of the Brazilian Federal Government informing? From these categories, we move on to the analysis.

3 ANALYSIS: A CAROUSEL OF INFORMATION ON POWER

The present work analyzed the discursivity in a publication made on March 31, 2024, on the official instagram of the Federal Government of Brazil. The post refers to the agenda experienced by the federal government that week. Among the events is the visit of the President of France, Emmanuel Macron, who was in Brazil to strengthen the partnership between the nations, learn about the riches of Brazil and make agreements.

The photographs reveal themselves to the reader in the form of a carousel³. These are 15 images, presented in a linear sequence of 10 clicks. In some of these images there is more than one photograph, usually two, pasted horizontally on the same interface. Below are the 10 figures corresponding to these images, presented in the order of scrolling of the carousel, as they are published on the Federal Government's Instagram profile:

³ Carousel is a publishing format offered by the digital social networking platform, *Instagram*. This format consists of the publication of a set of images, in a pre-defined sequence, which can be accessed by the reader user by passing his finger over the initial image, in a lateral direction.

Figure 1



Source: Federal Government Instagram Profile – @govbr

Figure 2



Source: Federal Government Instagram Profile – @govbr

The sequence of images refers to the most important events of the week for the federal government, as they are endorsed by the set of featured photographs. Figures 1 to 7 illustrate the visit of the President of France, Emmanuel Macron to sign military cooperation agreements, launch of the 3rd Brazilian submarine, the result of this partnership, and a visit to the Amazon rainforest, the focus of interest and collaboration of numerous foreign countries under the justification of environmental preservation. Finally, the last 3 images (**figures 8, 9 and 10**) show the "Pé de Meia" program, which is configured as a financial incentive from the government to high school students who are in the public network.

That said, we move on to the first category of analysis, that is, the **Discourse category**. As we have already mentioned, this category focuses on the form of the discourse, or rather the material substance that a given discourse appropriates to pronounce itself. In this case, this substance is mainly the photographic image. However, in this case, it is also the form that the structure of the social network imprints on the non-verbal text, based on the resources it makes available by housing the compilation of images.

Paying attention to this element is as important as looking at the very linguistic materiality that the discourse appropriates, since photographs published on Instagram configure the discourse from different connections and under different aspects: the post itself, the post as part of so many other posts in the same feed, and this feed as a discourse among many others, officially produced by the Federal Government, by the press, and by the conversation of people in circulation on the network.

Thus, we can say that each photographic image of this carousel means by itself, but it also means from the relationship it establishes with all the other images that compose it, and along the sequence to which it belongs. But, in addition, each image, and the images in sequence, also signify in relation to the translinguistic, that is, to all other contextual texts and discourse that tension the production of a narrative, this *feed* or other *feeds*, this network or other networks, in the digital space or outside it. Meanings are produced through intersubjectivity (the punctual dialogue between these images and the subjects), but also through intertextuality, that is, between this imagetic text and all the other texts (and the discourses in them), in different languages, around them.

There is, for example, a weave between the images of Lula and Macron, in the carousel, and the numerous memes that circulated on the internet, and on social networks themselves, throughout the same period of this post. They are speeches that draw the relationships of meaning between presidents, countries, these people, these men. In this case, the memes were created from photographs of the two presidents visiting the Amazon, suggesting an intimate relationship between them, with hands intertwined, as in the pre-wedding photo shoots, which take place before wedding ceremonies. By making this allusion, indicating the idea of a 'honeymoon' between the presidents, the memes tension multiple meanings, from the connotation of Brazil's good international relations, to the institution of a lascivious character to the relationship between Lula and Macron. This tension is not deflated by the official photographs (very similar to those used in memes) published by the official profile of the federal government, on the same platform where the comic discourse circulates.

To understand this dialectical game of meanings, constituted by the crossing of both discursiveness, requires recognizing the role of the translingual, that is, of that which is outside the discourse, but is dragged into it (Barthes, 1978). This happens through understanding the context of the creation of the meme, for example, but also to the extent that we recognize its appropriation and circulation in the public space.

This intertextuality, and the very hipertextual form of cyberculture, often allow a certain discourse, in this case, that of the meme and, by contiguity, that of our carousel, to resignify itself dialogically. When a discourse falls on the net and is appropriated by public conversation, it gains in longevity and overflows the original meanings (of the meme, in the initial intention of its creation, and of the carousel, as an official government document).

Considering this, we could say that the meanings of Macron's visit, materialized by this set of images in *@gov.br*, can also mean the response to an ideological dispute, guided by the political polarization that marks the current scenario of the country. In a recent episode,

in 2019, Macron was in conflict with the Brazilian federal government, at the time, represented by Jair Messias Bolsonaro. On that occasion, the French president expressed his dislike for Bolsonaro, mainly because the Brazilian has never shown commitment to environmental agendas. Also, they had a disagreement in an internet post where Bolsonaro mocked the appearance of the French first lady, Brigitte Macron.

Thus, from the perspective of their discursiveness, alone the images used in the meme can take on a jocular tone, but in the carousel, these photographs take on an official tone. But what meanings would they have when they dialogue? We believe that in the conversation between them, and in view of their association with the translinguistic context, they can take on an official, answering tone, an inside joke, and fine irony. This impression seems to be reinforced when Macron reproduces such mimetic images in his personal profile, endorsing their meaning as a response to a past event, and pointing to the resumption of good relations between the two countries, only achieved in the face of Lula's victory in the presidential elections. It is not possible, in the conjuncture that involves nations, to read these photographs disregarding the dialogue between these discourses.

In time, still on the Discourse category, there are primordial elements of this format (instagram carousel), which are tensioners of meaning. An example is the requirement of a certain linearity of reading in front of the 15 images. Even though it is a publication on a digital platform, which means the predominance of hypertextuality, reading this set of images in particular is an essentially linear practice: they can only be accessed one after the other, in a pre-established order. This condition, in itself, establishes a hierarchy of relevance between the images and the narrative.

Established as signs, the photographs, in the order in which they are placed, tell us a story, which we can call *storytelling*. Without having to read the caption of the post, we interpreted the photographs and it could mean that Lula was with Macron signing agreements, visiting the Amazon, the indigenous people.

In fact, after 10 images of Macron, when referring to the program "Pé de meia", we feel his absence: a sign whose disappearance means. Observing the sequence and we have the impression that it is a remnant of information, which bothers us, which does not seem to be part of the narrative. Curiously, or not so much, it is precisely in these last five images that the women are, in a more expressive way. And, almost as an apology, Vice President Geraldo Alckmin appears for the first time (so that he is not forgotten).

From the point of view of the information format, a carousel composed of 10 images is configured as a long text, especially in the logic of the network and the fast-updating feeds. The farther the images are from the first photograph, the less relevant they become. After 7

passes, the last 3 images (which hold these 5 photos) draw little or no attention. To speak of this organization of the narrative, and of the arrangement of the signs, is to speak of a structural form of discourse, which is not fixed, and which, according to Barthes (1988), exerts a kind of authority over the signs, articulating them. This structure involves more than the grammar of a plane of expression, it is what creates marks to indicate a certain reading path or even limit it.

The strengthening form of the hierarchical logic of this structure also includes the framing (general plan, medium plan); the verticality of the image; the size; and the very fact that these photographs will be accessed primarily by cell phone, in a moving feed. Since it is an automatic update system, where every second the algorithm renews the profile of the users shown on the screen, and displays a variability of carousel images, the user may not receive the post immediately with the first image selected by the profile; you may not realize that there is a sequence of photographs; and you can also lose interest in scrolling the images on the second click. In view of this ellipse, reinforcing the same meaning in each image, that is, saying the same thing in different images, can guarantee the support of the main discursive argument drawn by the proposal of the post, in particular, or of the profile, in general.

Considering the aspects of the carousel shape on Instagram, we still need to observe the materiality of photography. Barthes (1984) points out that the system of signs of the photographic image is based on the game between a **studium** and a **punctum**. The first refers to a sensible interest that the image arouses, linked to the collective context of the event or the referent portrayed. The second refers to the signs that draw the reader's attention, often overflowing with sensible meaning and falling into the particularity of a subjectively evoked emotion.

In the case of **figures 1 and 2**, this historical and sensible interest of *the studium* seems to be directly linked to the understanding that nations are united and strengthened, since the centrality of the image is occupied by handshakes, smiles and official documents. When we refer to the *punctum*, this collection of elements can shed meanings, since the particular impression we have is that their combination produces a metonymy, not only because they are in sequence, but because their contiguity produces the effect of movement from the hands to the smile, from the nations to the men who represent it.

In **figure 3**, the *studium* points to the renewal of military forces, whose common sign is the submarine. However, *the punctum* refers us directly to the sense of crowd. It becomes more important than the submarine itself, in the background of the photograph, so that the people in the cluster draw more attention than the characters, Janja, Lula, Macron and the commander. A sense deconstructed by the studium of the following images, **figures 4**,

focused on the submarine, and which seems to point to the people who matter, and who together, can press the button to start launching the submarine into the sea: "not just anyone can press the button".

In **figures 5 and 6**, in the same way as **figures 1 and 2, 3 and 4**, as a narrative structure that reruns itself, we have a relationship of contiguity, submitting the signs to the structuring lines of an ideology. In them, the *studium* is associated with the sensible interest in meeting Macron and Lula in an indigenous village, dialoguing intertextually with all the narratives that have previously circulated in the conversation of the networks and in the press, where France supposedly defends the preservation of the Amazon, or where Lula and Macron are close friends. There is **nothing singular in figure 5** that echoes subjectively.

However, **figure 6** wakes us up, sharpening our gaze in the face of the mid-shot framing of the indigenous leader. The *punctum* is revealed when we notice the mouth enlarger, the headdress and the paraphernalia that adorn his face, including a necklace with his name written. According to Barthes (1981) it is the names that give us existence, the ability to name, to transform the world into language is human and subjective. The word "Raoni" printed on the adornment, works here as a meta sign, considering that "Raoni" is the sign of the indigenous, of the chief; the necklace is Raoni's sign; and, finally, the name is the sign of chief.

In **figure 7**, the *studium* is marked by the presence of the tree trunk that extends from the ground to the sky, signifying not only the Amazon forest, but its extension and sumptuousness. The *punctum*, on the other hand, appears marked by the size of these two characters, which are small compared to the trunk of the tree. The Kapok is the largest tree in Brazil, and being under these men means the grandeur of nature, before which we (humans) are only a small part.

Still, in the same figure (7), the second photograph, the *studium* sets the place of the visit: a cocoa producer. The *punctum* marks us with the presence of Lula holding a broom and doing the work of turning over the seeds. It is not someone else who does this service, Lula is doing it, and "feeling" it in his skin, what the process is like, while Macron right behind, observes. Here, we cannot help but think of the metonymy between the colonizer and the colonized, the standard and the employee.

Figures **8, 9 and 10** represent a rupture, the emergence of a new subject, suppressing common elements of the previous 7 figures. However, they reiterate a structural form, of images that appear side by side, and that seems to exist more to prove the strength of the referent than to signify the details of the event. The *studium* in both photographs points to the negotiations and the launch of yet another government assistance program. The *punctum*, on

the other hand, stands out in figure 10, lower image, associated with the presence of women, which even has its meaning highlighted in view of the absence in most of the previous photos.

The number of women in the image can even work as a compensation, given their fleeting presence in all the other figures on the carousel. Around the president, there are ministers, deputies and voters, who make the "L" sign with their hand, a sign of support for Lula. However, this "L" is also the indictment of the male provider, which associated with the previous figure (9), can mean "protective father", the one we need.

When we look at these figures, guided by the category of discourse, we perceive the liabilities of the structural forms that, from the beginning, rhetorically indicate the places of **Power**. Its signs sometimes assume ordinary and regular forms, sometimes punctual forms, but in any case, they are always present. In fact, observing the progress of the analysis so far, evidently, in the set of images, we see the institutionalized power of the president, of the Federal Government, but also of Brazil.

The power of the countries is connoted by the image of the flags (**figures 1, 2 and 8**), which serve as a backdrop for the handshake (**figure 1**); in the image of the presidents, holding the book of international agreements (**figure 2**); in the dominant colors of each nation (**figures 1, 2 and 8**), and also strengthened by the colors under the blue background, formed from fireworks that explode in the sky, behind the submarine (**figure 4**). In addition, we observe the power of France, represented by the figure of Macron, especially in these formal photographs (**figures 1, 2, 4**), but also, in a less institutional and more contextual way, as a power, due to the contribution and prominent place that this nation, coming from the developed world, illustrates through images, to give to Brazil, a developing country. In this sense, we also mean the power of Brazil, as less powerful, although revealed, to receive attention and contribution from this nation.

The agglomeration of people in the hangar also becomes a sign of Power (**figure 3**), connoting the idea of crowd. To the extent that they surround Lula and Macron, the workers dissolve the image of the authorities present in the photograph. Presidents almost do not stand out in the face of the number of people. We could associate this composition with the sign of power of the people, but we understand that in the image, it is a purposely artificial meaning, used as a resource to tension semiosis.

There is also military power or the power of physical force, made tangible by the size of the submarine, with the colors of the Brazilian flag painted on the hull and marked in the sky; as well as the group of men, made up of the president, who together press the device to launch the submarine into the sea (**figure 4**). It is as if the narrative produced the meaning of "those who can" or "of the few who have the power to do so".

We also read the signs of power of the original peoples, marked by the game between the image of nature and the indigenous. The presence of the leader Raoni among the presidents, almost as equals, and then in an exclusive portrait of him (**figure 6**). We say "almost equal", because, in fact, the one who stands out in the image is the indigenous leader himself, since the supposed authorities are wearing white, but Raoni holds a headdress of vibrant colors. The combination, in sequence, of the three images: two of the authorities, among whom Raoni is, and soon after an exclusive photograph of him, reinforce the discursive strategy of protagonism of the native peoples. This perception gains tone if we observe the intertextuality with the translingual, since the narratives about this culture have intensified since the inauguration of this government, translating into public policies and visibility. The sign of power of this cultural group has been regularly circulated by official narratives.

In dialogue with the power of the indigenous people, there is the power of nature and the forest. The first is materialized in the trunk of the Kapok, which is very large compared to the human figure (**figure 7**). There is also a direct association between the images of the tree, the cocoa and the indigenous, as a form of metonymy of the Amazon. An object of discussion between Macron and Bolsonaro, the reference to Floresta is an obvious sign and raised by the translingual, while the Brazilian political-ideological dispute, through the narrative, is effected in an obtuse way, as a crossing that disturbs the meaning. According to Barthes (1990), the obtuse is characterized by the unexpected, a meaning that emerges from the complexity of semiosis and attacks the observer.

At the same time, we have agreements being signed by handshakes (**figures 1, 2 and 8**), and the striking figure of the entrepreneur (**figure 8**), as the protagonist of the "future", through which the signs of market power or economic power are revealed.

In the last 2 images (**figures 9 and 10**), which add up to three photographs, we can see the power of women, since they add up, visually, as the majority. However, this power seems to be subjugated by the set of images that constitute the carousel, predominantly starring men. Thus, it is possible to understand that this power of women exists as a power, but a power that is not realized. Furthermore, the power of young people is materialized in the last image (**figure 10**), associated with the investment in education made by the federal government. It is about the strengthening of the power of the government and, finally, the emergence of a new power, the power of the future, consensually linked to young people, and by metonymy: "to the future of the country". Barthes (apud Friderichs, 2010) reminds us that power cannot be understood in a simplistic way, where some have it and others not, but as an energy that mobilizes us, a source of disputes.

The revelation of man's power is also predominantly observed. In this sense, when we review the sequence of images established, in a linear way, by the Carousel, the uninterrupted presence of the male figure that insistently reprints itself, gradually signifying the power of man, stands out: the hands that seal an agreement between nations are men's, the presidents are men, those who "can" launch the submarine, are men, The one who has the economic power to guarantee the future is a man, the indigenous leaders are men and, even in the images where women appear, among many, there he is, a single man, "the blessed one to the fruit", "the benevolent father who embraces and smiles" (**figure 9**). It is men who occupy the center of images and places of power, constituting a sign of the patriarchal and macho culture, through which we constitute ourselves as a society and which, for now, also prevails as a dominant discourse.

Therefore, accessing these images, in the order in which they are, makes us feel the marked presence of men in the images, especially that of the president of the republic, which is in 13 of the 15 photographs. Therefore, we believe that, through the power of men and their centrality, we also see, in a redundant way, another power, the power of Lula.

His image, in a rhetorical way, is there, to reprise the same meaning. The actions recorded, the positions chosen, the cutouts, the choice of narrative structures and the combination of signs that reveal his power: Lula as president, Lula as a political figure, Lula as a diplomat, Lula as a businessman, Lula as a lover and defender of nature and native peoples, Lula as a friend of Macron, Lula as a father who cares, and guarantees the future: a white and hetero man, which is a criterion of acceptability in the society and context in which we are inserted.

However, this power does not appear associated with the sign of the subject Lula, but with the superhero Lula, of the character Lula, artificially forged to occupy this place. Thus, although power, as a sign and mobilizing energy of the world, according to Barthes (1978), can metamorphose into a variation of forms and places, Lula's power interdicts all of them, with its own luminance of occupying the center of the spectacle.

We also have in the images the signs of **Information**. Photographs communicate the events, where we can perceive different environments and people, and apparently provide information. We perceive their signs, in a less marginal way, in figures **2, 4, 7, 8** and **10**. This is because they point to a reference materialized in action: the closing of an agreement between two nations, the launch of a submarine, a visit to the forest, a closing of deals, the launch of a program.

It is relevant to point out here the role of the articulation between the photographs that constitute figures **4, 7, 8** and **10**, in a narrative way, as well as the side-by-side sequences of

figures 1 and 2, 4 and 5, 8, 9, and 10. In the absence of other languages, the sequence of two photos, forming a single image, or of two photos of the same scene, plays the role of constructing the representation of the fact, taking us from one sign to another, from one action to another. These photographs become a sign of information because something evidently takes shape in them, as Hohlfeldt (2001) proposes, something that needs to be informed, communicated to the public, something done by the government. When they are structured in sequence or side by side, they are transfigured into signs in dialogue, producing meaning, constituting the message that carries a set of data or knowledge.

In this set of images, we believe that the data are indicted by the characters, by the elements of scenery and objects that make up the scenes, they inform us. However, it is the actions that produce knowledge, the knowledge about what is happening, what the Government is doing. Thus, when going from one term to another, such as from characters to handshakes, we have the sign of information.

However, in the Carousel format, these images are not alone, they also mean to the extent that they come into play with the set of all the other published photographs, in a narrative sequence imposed by linearity. It is considering this discursive form that we observe a disturbance in this original informative sense, since the centrality of the power endorsed by the other 5 images, the protagonism of certain characters and the *punctum* that overflows the general interest of the photo, tension and repress by the imposition of other meanings, other than the merely informative.

Far from arousing civic feeling, as Brandão (2009) requires, the construction of trust in so-called public institutions is replaced by the construction of trust in Lula. And, even though it connotes accountability, publicizing implemented programs, it fails to motivate and/or educate the population to participate in specific moments in the life of the country, to the detriment of the protagonism of this man, benevolent and hero.

Consequently, the images, published on the official profile of the federal government of Brazil, which should offer information of public interest, disclosing the government's work on behalf of the citizen, with transparency, give up doing so. **Public communication** is subject to **political communication**, and this happens in the web of signs, where Lula's power interdicts the informative sense and converts it into a propagandistic sense, as conceptualized by Neto (2004): the sequence of images indicates more who is doing it than what is being done.

4 FINAL CONSIDERATIONS

The analysis carried out on the carousel of photographic images posted on March 31, 2024, on the profile of the Federal Government of Brazil on Instagram, indicates the subjection of the signs of information, about the Federal Government's agenda, to the meanings of Lula's Power, which are reprised in the narrative, occupying a central place AND assuming the most varied signifiers: president, political figure, diplomat and father. Even in the face of the other posts on the feed, these photographic images have a narrative that uninterruptedly reinforces how Lula is a good, humble man, who knows how to "do" politics and is working for the reconstruction of a new Brazil.

In this way, public communication, expected in the official profile of the Federal Government, also surrenders to Lula's political communication, by revealing more who is doing it, than what is being done. Thus, we understand that the dynamics of the play of signs is essentially in the production of a narrative of the whole, that is, of the sequence of images, rather than of each one of them separately. This discursive form is materialized in the Carousel.

Throughout the process of this study, we are faced with the revelation of a new category, political communication, which is opposed to the category of public communication. Brandão (2009) briefly reflects on the approach frequently adopted by government communication in Brazil, with a propagandistic bias, which would represent a distortion of the objectives of communication for citizenship, something that we observed in this case: the images have an objective of promoting Lula's image.

Throughout the research we came across some difficulties and limitations, one of which would be the study of political communication, here little explored as *an a posteriori category*, and also the study of the discursive relations between the different posts in the *feed*.

REFERENCES

- Barthes, R. (1978). Aula. Cultrix.
- Barthes, R. (1981). O grão da voz. Edições 70.
- Barthes, R. (1984). A câmara clara (2. ed.). Nova Fronteira.
- Barthes, R. (2001). Elementos de semiologia. Cultrix.
- Brandão, E. P. (2009). Conceito de comunicação pública. In J. Duarte (Org.), Comunicação pública: Estado, mercado, sociedade e interesse público (3. ed., pp. 1–33). Atlas.
- Capurro, R. (2007). O conceito de informação. Perspectivas em Ciência da Informação, 12(1). <https://www.scielo.br/j/pci/a/j7936SHkZJkpHGH5ZNYQXnC/?format=pdf>

- Correia, J. C. (1998). Jornalismo e espaço público. In Estudos de comunicação. Universidade da Beira Interior.
- Dawkins, R. (2007). O gene egoísta (1. ed.). Companhia das Letras.
- Duarte, M. Y. M. (2009). Comunicação e cidadania. In J. Duarte (Org.), Comunicação pública: Estado, mercado, sociedade e interesse público. Atlas.
- Flusser, V. (2002). Filosofia da caixa preta. Relume Dumará.
- Friderichs, B. de P. (2010). Comunicação, discurso, fait divers e poder em O Nacional: Uma abordagem dialética (Tese de doutorado, Pontifícia Universidade Católica do Rio Grande do Sul).
- Hohlfeldt, A., Martino, L. C., & França, V. V. (2001). Teorias da comunicação: Conceitos, escolas e tendências (4. ed.). Vozes.
- Kossoy, B. (2000). Realidades e ficções na trama fotográfica. Ateliê Editorial.
- Neto, G. F. (2004). Direito da comunicação social. Revista dos Tribunais.

PATHOLOGICAL MANIFESTATION IN INTERNAL CERAMIC COATING: A CASE STUDY IN A BUILDING IN GOIÂNIA-GO

MANIFESTAÇÃO PATOLÓGICA EM REVESTIMENTO CERÂMICO INTERNO, ESTUDO DE CASO EM UMA EDIFICAÇÃO EM GOIÂNIA-GO

MANIFESTACIÓN PATOLÓGICA EN REVESTIMIENTO CERÁMICO INTERIOR: ESTUDIO DE CASO EN UNA EDIFICACIÓN EN GOIÂNIA-GO



<https://doi.org/10.56238/sevened2026.008-204>

Emily Pereira Lima¹, Pedro Filipe de Luna Cunha², Vitória Régia Araújo Ribeiro³, Andre Augusto Nobrega Dantas⁴, Yuri Sotero Bomfim Fraga⁵, Gabriel Lima Oliveira Martins⁶, Pollyanna Laurindo de Oliveira⁷, Jeanisson Cesar Mariano Silva⁸

ABSTRACT

Ceramic coatings are a hallmark of Brazilian construction culture, enhancing buildings with their aesthetic impact and being widely used in the national context for several decades. The appropriate selection of materials, combined with precise application processes, directly reflects on the durability and longevity of buildings. This study emphasizes that specialized knowledge not only in the selection and application of coatings, but also in the identification and understanding of possible failures, is a key factor in preventing future problems. The relationship between the individual characteristics of materials, installation methods, and exposure to environmental conditions is crucial to avoid pathologies such as detachment, which may compromise structural stability. Therefore, by deepening the analysis of ceramic coatings and presenting a case study that illustrates these concepts, this work contributes to improving the understanding of coating systems and to the continuous evolution of construction practices in the national scenario, promoting more resilient and durable buildings for the future of Brazilian construction.

Keywords: Ceramic Coating. Building Pathology. Detachment. Building Performance. Construction Quality.

RESUMO

Os revestimentos cerâmicos são uma marca na cultura construtiva brasileira, valorizando as edificações com seu impacto estético, sendo utilizados no cenário nacional por várias

¹ Graduated in Civil Engineering. Instituto Federal Goiano. E-mail: emilypereira942@gmail.com

² Dr. in Structural Engineering. Instituto Federal Goiano. E-mail: pedro.cunha@ifgoiano.edu.br

³ Dcotoral student in Environmental Technology and Water Resources. Universidade de Brasília (UnB). E-mail: vitoria.rib@hotmail.com

⁴ Dr. in Geotechnical Engineering. Instituto Federal de Brasília (IFB). E-mail: andre.nobrega@ifb.edu.br

⁵ Dr. in Structural and Civil Construction Engineering. Universidade de Brasília (UnB).

E-mail: yuri.fraga@unb.br

⁶ Dr. in Structural and Civil Construction Engineering. Universidade Federal do Tocantins (UFT).

E-mail: gabriellima@uft.edu.br

⁷ Dr. in Chemistry. Instituto Federal Goiano. E-mail: pollyanna.oliveira@ifgoiano.edu.br

⁸ Dr. in Mechanical Sciences. Instituto Federal Goiano. E-mail: jeanisson.mariano@ifgoiano.edu.br

décadas. A escolha adequada dos materiais, aliada a processos de aplicação precisos refletem diretamente na resistência e longevidade das edificações. Este estudo enfatiza que o conhecimento especializado não apenas na seleção e aplicação dos revestimentos, mas também na identificação e compreensão das possíveis falhas, é um fator preponderante para impedir problemas futuros. A conexão entre as características individuais dos materiais, os métodos de instalação e a exposição às condições ambientais é crucial para evitar patologias como o deslocamento, que pode comprometer a estabilidade das estruturas. Assim, ao aprofundar-se na análise dos revestimentos cerâmicos e ao oferecer um estudo de caso que ilustra esses conceitos, este trabalho contribui para aprimorar não apenas a compreensão dos sistemas de revestimento, mas também para a contínua evolução das práticas construtivas no cenário nacional, promovendo edificações mais resilientes e duráveis para o futuro da construção brasileira.

Palavras-chave: Revestimento Cerâmico. Patologia das Construções. Deslocamento. Desempenho das Edificações. Qualidade Construtiva.

RESUMEN

Los revestimientos cerámicos son una característica destacada de la cultura constructiva brasileña, valorizando las edificaciones por su impacto estético y siendo utilizados en el contexto nacional durante varias décadas. La adecuada elección de los materiales, combinada con procesos de aplicación precisos, se refleja directamente en la resistencia y longevidad de las edificaciones. Este estudio destaca que el conocimiento especializado no solo en la selección y aplicación de los revestimientos, sino también en la identificación y comprensión de las posibles fallas, es un factor fundamental para prevenir problemas futuros. La relación entre las características individuales de los materiales, los métodos de instalación y la exposición a las condiciones ambientales es crucial para evitar patologías como el desprendimiento, que puede comprometer la estabilidad de las estructuras. Así, al profundizar en el análisis de los revestimientos cerámicos y presentar un estudio de caso que ilustra estos conceptos, este trabajo contribuye a mejorar la comprensión de los sistemas de revestimiento y a la evolución continua de las prácticas constructivas en el contexto nacional, promoviendo edificaciones más resilientes y duraderas para el futuro de la construcción brasileña.

Palabras clave: Revestimiento Cerámico. Patología de las Construcciones. Desprendimiento. Desempeño de Edificaciones. Calidad Constructiva.

1 INTRODUCTION

Civil construction plays a crucial role in Brazil's economic development, generating a large number of jobs. According to the Brazilian Chamber of the Construction Industry (CBIC, 2023), the sector will continue to grow in 2023, with the expectation of a growth of 2.5%, being the third consecutive year of growth in this market.

In the context of this scenario, it is important to acquire knowledge about the materials applied in civil construction, in order to facilitate the appropriate choice of their various applications and define their properties and technological qualities. In addition, it is essential to know the construction techniques available in the market, so that there is greater training of the professionals involved, and enabling the choice of the best actions that fit into each project and execution of civil works (CALLISTER, 2002). In this context, a problem that can be pointed out is the construction defects that cause pathologies in buildings. In this work, the causes and actions necessary to treat recurrent pathologies in ceramic tiles will be discussed.

In turn, ceramic tiles are widely used in civil construction due to their durability, surface resistance, cost-effectiveness and designs, playing a fundamental role in the final finish of a project, influencing aesthetics and the whole as a whole. However, even with good durability, ceramic pieces are subject to environmental and use factors, which can result in the emergence of pathologies (ANFACER, 2021).

Detachment, cracking, cracking, efflorescence and deterioration of joints are pathologies that can occur in ceramic tiles in indoor and outdoor environments. These defects can manifest themselves in the first years after the delivery of the work due to construction failures and vices, inadequate projects and planning errors. To avoid these pathologies, it is essential to have qualified labor and follow proper planning. In addition, it is essential to carry out regular maintenance of the coatings, to extend their useful life (ESTEVEZ, 2020).

A common pathology in ceramic tiles is the detachment of the pieces, which occurs when the pieces come loose or detach from the substrate. This can result in swelling of the coating, cracking, or even complete removal of the coating. Therefore, to treat problems in ceramic tiles, it is essential to carefully analyze each situation, considering the type of ceramic, place of use, environmental conditions, and specific problems. Based on this analysis, it is possible to develop restoration solutions adapted to the needs of the affected coating, ensuring its preservation and performance (PARREIRA, 2017).

Based on the information mentioned above, the detachment of the ceramic tile in the Porto Dourado Residential condominium, Goiânia-GO, was identified, where a case study was carried out, raising the possible causes for the appearance of pathologies after the

completion of the work.

A detailed analysis of the problem, an on-site evaluation to identify the possible causes and a literature review were carried out, in order to find possible solutions for the detachment of the ceramic tile. These resolutions may involve choosing the correct bonding binder, reviewing the executive methods of laying, and performing proper maintenance.

2 THEORETICAL FRAMEWORK

In the literature review, the history of ceramics, its manufacture and properties will be addressed. As well as ceramic pathology, emphasizing the flaws, especially the ceramic detachment. Finally, executive methods and the types of mortar used to prevent these problems, highlighting their importance in the durability and performance of the material.

2.1 HISTORY AND CHARACTERIZATION OF CERAMIC MATERIALS

The first ceramics appeared in the middle of 500 BC, remaining a difficult material to access for several centuries due to its high cost and for being an innovation. The greatest advances in the area were incorporated by Italian potters between the 1950s and 1960s, introducing innovative production processes. Potters exploited the Raku method, introducing fast firing and harsh cooling for unique effects. There was a shift to contemporary ceramics, focusing on unconventional forms and sculptures. In addition, innovations in enamels allowed for vibrant colors and unique textures, revitalizing ceramics as a form of artistic expression.

Ceramics are made up of inorganic materials and chemicals, excluding metals and their alloys, which are usually produced through heat treatment at high temperatures (ABCERAM, 2004). Ceramic materials are known for their unique properties, such as hardness, resistance to high temperatures, low electrical and thermal conductivity, high chemical resistance, and good wear resistance. These properties make them useful in a wide range of applications, such as in the manufacture of traditional ceramics, advanced ceramics, glass, refractories, electrical insulators, catalysts, biomaterials, and many others. Traditional ceramics, such as clay and porcelain ceramics, are widely used in everyday products such as dinnerware, tiles, and bricks. Advanced ceramics, on the other hand, are high-tech materials with inscribed properties applied in sectors such as electronics, energy, aerospace, automotive, medical and chemical (SILVA, 2005).

It is important to note that ceramic materials are not necessarily resistant, as they are often associated, but they can have high mechanical resistance when designed and industrialized correctly. In addition, they offer advantages such as chemical stability, low density, and excellent performance in indoor and outdoor environments (CARVALHO, 2012).

2.2 CERAMIC COATING

Ceramic coating, used to cover floor and wall surfaces in indoor and outdoor spaces, is a versatile material, made from raw materials such as clay, feldspar and quartz, molded into plates and fired at high temperatures to provide strength and impermeability. It offers a wide variety of colors, textures, and prints, mimicking other materials such as wood, stone, and metal, making it a popular choice for homes, offices, hospitals, and other high-traffic environments (SABATTINI, 2000). Their advantages include easy cleaning, wear resistance, durability, and low water absorption, but disadvantages can arise such as cracks, breakage when exposed to severe impacts, the need for careful installation, and potential difficulty in replacing them if they become damaged, requiring professional installation to avoid irregularities (NUNES et al., 2015). In short, ceramic tiles combine beauty, practicality and resistance in different spaces.

2.3 MANUFACTURE OF CERAMIC COATING

The useful life of a building is the period in which it can be used for the purpose for which it was built, with satisfactory performance in terms of safety, comfort and functionality. The useful life of a building can vary depending on several factors, such as the type of use, the design, the quality of the materials, and proper maintenance.

Standard NBR 15575 (ABNT, 2013) establishes the minimum requirements for the performance of residential buildings, including the minimum expected useful life, which is 50 years. However, it is important to note that the useful life of a building can be longer or shorter than the expectation established by the standard, depending on several factors, such as the level of use, the quality of the materials, the climate, and proper maintenance. Proper and preventive maintenance can significantly extend the useful life of a building, while lack of maintenance can accelerate degradation and reduce its useful time.

2.4 PROPERTIES OF CERAMIC PLATES

Ceramic tiles for coating have characteristics determined by their properties, and through this understanding we can make specifications for their proper use.

2.4.1 Water absorption

Water absorption in ceramic tiles is an important property to consider, and is linked to their porosity, when choosing a coating for wet areas such as bathrooms, kitchens, and outdoor areas. It is measured by the amount of water that a ceramic material absorbs in relation to its weight. Coatings are classified into different water absorption groups according

to technical norms and industry standards. These ratings usually vary depending on the percentage of water in the material. The lower the percentage of water absorption, the greater its resistance to water penetration (MADEIRA, 2019).

In addition, the absorption of the ceramic allows the analysis of the type of mortar that should be used for each installation. In this way, it is clear that the proper laying of the piece depends on the assertive use of the mortar, ensuring durability and resistance, increasing the useful life of the piece.

2.4.2 Hardness

Another important property of ceramic tile is hardness, which refers to the material's resistance to deformation, scratches, or abrasion. It is a mechanical property that determines the ability of ceramics to withstand loads and resist wear and tear (MACEA, 2018).

There are several hardness scales for measuring the strength of materials, with the Mohs scale, created in 1812 by Friedrich Mohs, focusing on natural minerals, and the Vickers hardness scale, created in 1921 by Smith & Sandland in Great Britain, being more appropriate for ceramics and hard materials. The Mohs scale ranges from 1 to 10, rating the hardness of minerals. However, for ceramics, the Vickers scale is preferred, involving a specific load applied to a given area, measuring the resulting impression (HOTZA et al, 2015).

The hardness of ceramics varies considerably, with aluminum oxide, silicon carbide, and silicon nitride being examples of ceramics notable for their high hardness and wear resistance. However, when choosing a ceramic, it is crucial to consider not only hardness but also properties such as fracture resistance, toughness, and chemical resistance, according to the specific needs of the application (HOTZA et al, 2015).

2.4.3 Surface abrasion resistance

The ability to resist surface wear caused by contact with people and objects is related to abrasion resistance. This resistance can be divided into two types: surface abrasion, which occurs in enameled products, and deep abrasion, which affects non-enameled products. The Porcelain Abrasion Index (PEI), is an abrasion resistance rating system used to evaluate the durability of ceramic tiles on floors and walls. It provides information on the abrasion resistance of ceramic surfaces, classifying them according to their ability to withstand wear. The measurement of abrasion itself involves specific tests, which assess the loss of material due to deterioration (NUNES et al, 2015).

2.5 CONCEPT OF PATHOLOGY

Pathology in ceramic tile refers to problems or defects that may arise during the installation, use, or maintenance of ceramic coated floors, walls, or other surfaces. These problems can be caused by various factors, such as problems in the manufacturing process of materials, failures in the installation process, or even improper use, or lack of maintenance (DOUGLAS et al., 2017).

One of the main factors that can lead to pathology in ceramic tiles is the poor quality of the substrates on which the tile is applied. If the substrate has irregularities, cracks or deformations, this can compromise the adhesion and stability of the coating, which can lead to cracks, detachments and other types of defects (LANNA, 2012).

Another factor that can contribute to pathology in ceramic tiles is the lack of planning and efficiency of the installation process. The choice of adhesive, for example, can affect the adhesion of the coating and compromise its durability. Likewise, the lack of care in the handling and transportation of the pieces can lead to damage that will later manifest itself in the form of defects (LANNA, 2012).

In addition, the choice of the type of ceramic tile can also have an impact on the occurrence of pathologies. For example, low-quality ceramic tiles can have cracks, peeling, and other defects even when installed correctly, while high-quality and high-strength tiles can perform better in harsh conditions.

2.6 FAILURES

There are several types of failures that can occur in ceramic tiles, and their occurrence can be influenced by a number of factors, such as the quality of the substrates, the installation process, the type of coating used, among others. According to DOUGLAS et al (2017), some of the most common types of flaws found in ceramic tiles are listed.

Design or design failure: design failures in ceramic tiles can occur for various reasons, including miscalculation, external specifications, or lack of consideration of environmental conditions, and can happen in the planning part, especially in the lack of project compatibility.

Execution failure: they can be attributed to problems in the substrate, such as its inadequacy, which can result in detachment, cracks or breaks in the floor. It is essential to check and correct problems on the substrate, including removing damaged flooring if necessary. Another common failure involves poor adhesion of the mortar, which can lead to peeling and cracking. Therefore, ensuring clean and appropriate substrates for ceramics, as well as choosing the appropriate mortar, is critical. The fixation of ceramic pieces is also

critical; An even application of mortar and proper pressure during installation are essential to avoid detachment or voids. Using spacers can help maintain proper spacing between parts.

Failure of use: this type of failure occurs mainly because the user of the product does not have the necessary knowledge for the correct use of the material, and ends up resulting in misuse of it, generating several pathologies.

2.7 PEELING OFF THE CERAMIC COATING

Ceramic tile peeling occurs when the ceramic tile detaches from the base where it was laid, as shown in figures 1 and 2. This problem can be caused by several factors, such as lack of adhesion of the mortar used in laying, as the surface that will receive the mortar must be clean, free of dust, dirt, oils or other contaminants, if the surface is not properly prepared, the adhesion of the mortar can be compromised. There is also the absence of leveling of the base, which can affect the direction of the mortar, since when the base is not level, there may be empty spaces between the mortar and the surface, which reduces adhesion, this can occur in several situations, one of them being the irregular surface, since if the surface where the mortar is applied has irregularities, such as ripples, holes or bumps, this can also affect the adhesion of the mortar.

For this reason, it is important to level the surface before applying the mortar, using appropriate techniques and materials for each specific case. Finally, there is excess moisture, which, like the other reasons, also compromises the adhesion of the mortar. Excessive humidity can compromise the mortar's ability to adhere to the surface and can lead to the appearance of efflorescence, stains, and detachment, which is the focus of the work. (MADEIRA, 2019).

Figure 1

Representation of peeling in ceramic tiles



Source: QUARTZOLIT (2018).

Figure 2*Peeling off in ceramic coating*

Source: RESMASTER ENGENHARIA (2018).

2.7.1 Types of mortar

According to MADEIRA (2019), there are three types of adhesive mortars that are the most used in works for the laying of ceramic tiles. The first of these is ACI, used specifically to fix floors and natural stones in internal areas, such as floors and walls. The "AC" refers to the acronym "Adhesive Mortar", and the number "1" indicates the performance rating of the product. Adhesive mortars are designed to provide a strong and long-lasting direction between the coating and the application surface. The ACI rating generally refers to a mortar that performs well for indoor areas, with little exposure to moisture, and no specific deformation requirements.

When using ACI adhesive mortar, it is important to follow the manufacturer's instructions for mixing ratio, application time, surface preparation, and other specific requirements. Each manufacturer may have different formulations and recommendations for their products, so it is essential to read and follow the guidance provided.

The ACII adhesive mortar is a type of adhesive mortar with a higher performance rating compared to the ACI. It is designed for indoor and outdoor applications with increased exposure to moisture, such as bathrooms, kitchens, and laundry areas.

The ACII rating indicates that this mortar has a higher capacity for deformation and adhesion compared to ACI. It is more suitable for situations in which there may be greater movement of the experiments, such as thermal expansion, vibration or differential settlement. When using ACII sticky grout, it is important to follow the manufacturer's instructions for the best results. This includes correctly preparing the surface, applying the mortar according to the recommended proportions, and keeping track of the indicated curing and drying times.

Be sure to read and follow the specific instructions provided by the manufacturer of your chosen ACII adhesive mortar.

Finally, ACIII sticky mortar is another type of sticky mortar with an even higher performance rating compared to ACII. It is designed for indoor and outdoor applications with high exposure to moisture, movement, and deformation, such as swimming pools, facades, and floors with radiant heating. The ACIII rating indicates that this mortar has a higher capacity for deformation and adhesion compared to ACII. It is specially formulated to withstand more intense loads and movements, maintaining a secure and lasting fixation of the coatings (GIULIANO, 2015).

As with the other classifications, it is essential to follow the manufacturer's instructions for the best results when using ACIII adhesive mortar. This includes preparing the interface, mixing the mortar as per the recommended instructions, applying it correctly, and following the curing and drying times indicated by the manufacturer. Each manufacturer may have specific formulations and recommendations for their products, so it is important to read and follow the guidance provided by your chosen manufacturer.

2.7.2 Executive methods

For a proper laying of the ceramic tile, it is necessary to use appropriate tools, as well as a qualified workforce for the service. The tools needed for the service are: carpenter's pencil, hose level, plumb, trowel, spirit level, pointer, nylon line, aluminum ruler, tape measure, articulated meter, square, nail, brush, chisel, steel or nylon brushes and sledgehammer. Other materials that may have been essential are spacers, to maintain the thickness of the joints, and soft sponges to promote the cleanliness of the environments (REBELO, 2010).

To avoid peeling in ceramic tiles, it is important to follow the manufacturer's guidelines regarding the characteristics of the substrates and mortar to be used, as well as the instructions for laying and finishing the ceramic, as specified in NBR 13754 (ABNT, 1996). It is also important to ensure that the base where the ceramic will be laid is firm, level, and free of excessive moisture, always remembering the importance of a quality system in the execution of services on the construction site.

If it has already caused detachment in the ceramic tile, it is necessary to evaluate the cause and the degree of severity of the problem. Small areas of peeling can be corrected by applying adhesive mortar or grout, while large areas may require replacing damaged coating. In more severe cases, a technical diagnosis is necessary to verify whether the cause of the detachment is related to related or design problems (DOUGLAS et al., 2017).

3 METHODOLOGY

In the methodology, the focus will be exclusively on a case study, providing specific details for a deeper understanding and analysis of the data obtained.

3.1 CASE STUDY

The study presented addresses a real case of detachment of internal ceramic coatings in a construction located in Goiânia-GO, in Residencial Porto Dourado 01, in which the possible causes of the emergence of this pathology will be addressed, such as lack of qualified labor, inadequate preparation of the substrate, use of mortar in an erroneous way or even the use of mortar not suitable for the situation and material. As well as the possible solutions, based on the literature review made.

Thus, the objective of the case study is to understand and describe the phenomenon in question, analyzing its characteristics, processes, causal relationships and contexts. It allows for an in-depth analysis of the particular case, allowing the exploration of numerous variables and perspectives.

In summary, the case study is especially useful to analyze the situation in loco, obtaining a detailed and contextualized understanding of a phenomenon considered complex. However, by observing closely, it is possible to better see how the service was performed and thus understand, through studies and research, the causes and solutions to the observed problem.

4 RESULTS AND DISCUSSION

This segment will focus on the case study, presenting the location where it occurred, a detailed description of the affected building, and the analysis of the causes that led to the identified problem. In addition, images will be displayed that illustrate the pathology in question. Consequently, the solutions adopted to effectively resolve the situation in question will be explored and detailed.

4.1 AREA UNDER STUDY

The peeling of coatings is a common pathology in vertical constructions, involving the detachment of the applied coatings. This problem can arise due to problems in the application, improper use of materials, inferior quality of the mortar, structural movements, external action and weathering. In addition to compromising aesthetics, this detachment can lead to infiltrations, impairing the integrity of the structure and contributing to problems such as the emergence of fungi, corrosion of metal structures, among others. Preventing this

pathology requires qualified professionals, compatible materials, and the study of environmental conditions. In cases of occurrence, a detailed investigation of the causes is crucial, followed by corrective measures such as removal and reapplication of coatings and structural corrections, always with specialized support.

4.1.1 Location of the building

This work is a case study carried out in a residential building, located in the city of Goiânia and in the Andreia Sector, Block 02 Lot 01, in the Porto Dourado Residential 01, and in the following geographic coordinates: 16°47'44" S (latitude) and 49°21'42" W (longitude). In Figure 3, the image of the geographical location of the construction, acquired through Google Earth, clearly reveals the presence of other vertical buildings in the same area, pointing to a clear trend towards this type of construction in the region.

Figure 3

Representation of the location of Residencial Porto Dourado 01



Source: Prepared by the authors.

4.1.2 Description of the building

It is a multifamily residential building, which was built by Vila Brasil Engenharia. It consists of 46m² apartments with two bedrooms, bathroom, living room, kitchen, service area and garage. Condominium with gym station, adult pool and children's pool, fitness area, shower, sauna, playroom, party room, square, barbecue grills, playground and grassy field.

4.1.3 Description of Observed Pathological Manifestations

The presence of issues in ceramic tile has a vital connection with the quality of the installation, playing a crucial role in its durability. As the investigation deepens, the impact of sound installation techniques will be thoroughly examined, highlighting how consistent and

careful practices can prevent and solve potential problems. In addition, the role of the materials used will be discussed, highlighting the importance of appropriate choices to ensure the integrity of the coating over time. Exploring these aspects not only broadens the understanding of the associated challenges, but also offers valuable insights to improve future facilities, promoting more resilient and high-quality outcomes. In several housing units, small protrusions were identified on the ceramic plates in bathrooms, kitchens and laundry rooms, as shown in Figures 4 and 5.

Figure 4

Representation of protrusion in ceramic coating



Source: Prepared by the authors.

Figure 5

Ceramic coating protrusion



Source: Prepared by the authors.

In some regions, there was significant detachment of the ceramic tile, indicating a lack of adhesion between the tile and the mortar used to fix it, as illustrated in Figures 6 and 7. The back of the ceramic pieces showed a lack of connection with the adhesive mortar,

resulting in little or no adhesion. This highlights the importance of proper installation and attention to detail to avoid future problems.

Figure 6

Representation of the location of Residencial Porto Dourado 01



Source: Prepared by the authors.

Figure 7

Representation of the location of Residencial Porto Dourado 01



Source: Prepared by the authors.

4.1.4 Diagnosis of possible causes and origins of pathological manifestations

Coating peeling can happen for a variety of reasons, including planning issues that didn't account for possible movement in the substrate or used a low-quality base. In addition, leaks in the walls or floor that cause moisture are also a frequent cause of this problem.

Alteration of the substrate, whether due to factors such as thermal variations, vibrations, or improper settlement, can result in the peeling off of the coating. The lack of qualification of the workforce and the application of the coating without proper preparation of the substrate are also factors that contribute to this issue.

The excessive use of water in the fixing mortar, the use of expired mortar and the adoption of inappropriate practices, methods and tools weaken the adhesion between the coating and the substrate, resulting in peeling. In addition, the choice of inappropriate products for the application of the coating can compromise its adhesion.

Based on inspections and data collected during the investigation of ceramic detachment in a specific apartment, one of the first points of analysis was directed to the possible influence of structural movement as an underlying cause of this phenomenon.

However, despite the proximity of neighboring buildings, no cracks or any signs of movement that could affect the ceramic pieces inside the apartment under study were identified. This absence of relevant structural changes in the nearby constructions led to the exclusion of structural movement as a determining factor for the observed detachment.

This finding not only dismisses one of the possible initial causes of detachment, but also highlights the structural stability of adjacent buildings, contributing to direct the investigation to other possible reasons underlying the phenomenon of ceramic delamination.

The next step of this study focuses on the detailed analysis of other hypotheses, seeking to accurately identify the underlying cause of the detachment of the ceramic pieces inside the apartment under study.

In addition to the analysis performed to rule out structural movement as the cause of ceramic detachment, another possible hypothesis considered was infiltration. Given the potentially destructive nature of the water infiltrated in the construction materials, the presence of infiltration in the apartment under study was investigated.

Contrary to initial expectations, the inspections did not reveal any traces or evidence of infiltration in the areas affected by ceramic peeling. The absence of traces of moisture, stains or damage characteristic of infiltration contributed to the discarding of this hypothesis as the cause of the observed detachment.

As in the case of structural movement, the exclusion of infiltration as an underlying cause of the detachment reinforces the need to explore other potential causes that may explain the phenomenon that occurred inside the apartment under study.

In addition, a third hypothesis considered was the displacement due to the joints between the ceramic pieces. After some evaluations, no evidence of excessive wear, adhesion failures or other problems in the joints between the ceramic tiles affected by the

peeling was identified. This finding led to the exclusion of displacement due to joints as an underlying cause of the observed phenomenon.

Thus, the absence of evidence of wear or failures in these junctions reinforces the conclusion that they are not responsible for the detachment of ceramic pieces, directing the investigation to other possible causes for this specific phenomenon.

After an analysis of the remaining hypotheses, a more concrete conclusion emerges about the cause of the ceramic detachment observed in the apartment under study. Among the possible reasons investigated, the misapplication of the laying mortar emerges as the main cause for the observed phenomenon.

Details provided by the engineer in charge corroborate the hypothesis that the inadequate technique in the application of the mortar may have played a crucial role in the detachment of the ceramic pieces. This finding is reinforced by the lack of in-depth research on the quality of the material used, suggesting that poor application may have been a determinant for the problem faced.

Considering the relevance of this finding, the understanding of the misapplication of mortar as the main cause of ceramic peeling not only clarifies the observed phenomenon, but also highlights the critical importance of the proper execution of laying processes in construction projects.

The observation during the inspection of the work revealed an inadequate application of the adhesive mortar, evidenced by its fragmented and uneven distribution on the ceramic pieces. Different points of the pieces were partially covered, leaving empty spaces and areas with little adhesion to the substrate. In some places, the application was practically non-existent, resulting in inadequate or no adhesion.

This irregular and deficient execution resulted in an unsatisfactory adhesion of the mortar, which, as a direct consequence, led to the detachment of the ceramic pieces. The inconsistent and poorly executed application of the laying mortar emerged as the preponderant factor for the observed detachment, demonstrating the critical importance of adequate procedures in the installation phase for the durability and stability of ceramic structures.

4.1.5 Discussion

The detachments identified in the apartments arose as a result of an inadequate application of the adhesive mortar. In this process, the mortar was applied in small quantities, resulting in poor adhesion between the mortar and the coating. This deficiency in adhesion caused the detachment of the coating in several units of the condominium. This phenomenon

deserves further analysis, as it has an impact not only on the aesthetics but also on the structural integrity of the housing units in question.

The coatings of the apartments underwent a replacement process due to the detachment that occurred previously. To solve this problem, it was necessary to perform a complete leveling of the base. In addition, the application of the mortar was conducted according to the appropriate techniques, ensuring effective adhesion between the mortar and the new coating. This intervention not only restored the aesthetics of the environments, but also ensured the structural integrity of the housing units, providing a safe and visually pleasing environment for residents.

5 CONCLUSIONS

The work consisted of compiling information about the elements of the ceramic tile, describing the application process and characterizing the pathologies that may arise, identifying their origins. The objective was to connect this knowledge to facilitate the understanding of the origin of failures in ceramic tiles, including specific insights obtained through the case study on delamination.

The research developed provided several conclusions about ceramic tiles and the issues related to their failures. It was possible to thoroughly examine the individual characteristics of the materials that make up this system, from the ceramic block and its properties to the mortar layers and their respective roles in the coating. In addition, we have covered ceramic plates, highlighting their proper handling and storage ways.

Identifying these elements in isolation facilitated the understanding of the system as a whole, enabling an integrated analysis of the characteristics and how they are related to the emergence of problems. We also describe the proper procedure for attaching the ceramic slabs, from the production of the mortar to the selection of the appropriate tools and the laying process, including quality checks throughout the work.

Additionally, it is important to mention that a specific case study was conducted on the delamination of ceramic tiles. This study provided an understanding of the possible causes and factors involved in this specific problem, contributing to a deeper knowledge of failures within the context of ceramic tiles.

In addition, the most common pathologies observed in ceramic tiles were detailed, with emphasis on ceramic peeling, illustrating the problem with images. Based on the knowledge acquired about the elements and processes involved, possible causes for these failures were identified.

REFERENCES

- Almeida, L. L. de. (2012). Patologias em revestimento cerâmico de fachada (Monografia de especialização). Universidade Federal de Minas Gerais.
- Associação Nacional dos Fabricantes de Cerâmica para Revestimentos, Louças Sanitárias e Congêneres. (2021). <https://www.anfacer.org.br>
- Associação Brasileira de Normas Técnicas. (1996). NBR 13753: Revestimento de piso interno ou externo com placas cerâmicas e com utilização de argamassa colante – Procedimento. Rio de Janeiro: ABNT.
- Associação Brasileira de Normas Técnicas. (1996). NBR 13754: Revestimento de paredes internas com placas cerâmicas e com utilização de argamassa colante – Procedimento. Rio de Janeiro: ABNT.
- Bresciani Filho, E. (1986). Seleção de materiais metálicos. Campinas: Editora da UNICAMP.
- Bucher, H. R. E., & Nakakura, E. H. (1999). Argamassas colantes flexíveis. In III Simpósio Brasileiro de Tecnologia das Argamassas (pp. 417–424). Vitória: UFES/PPGEC.
- Callister Jr., W. D. (2002). Ciência e engenharia de materiais: uma introdução (5. ed.). Rio de Janeiro: LTC.
- Douglas, T. (2017). Estudo de manifestações patológicas em revestimento cerâmico de fachada em edifícios residenciais (Monografia de especialização). Pontifícia Universidade Católica de Goiás.
- Esteves, B. N., Calixto, R. D., & Meurer, C. E. (2020). Patologias em revestimento cerâmico na construção civil (TCC de graduação). Rede de Ensino Doctum Juiz de Fora.
- Externos, Ambientes. (2020). A história da cerâmica no Brasil. <https://blog.gail.com.br/a-historia-daceramica-no-brasil/>
- Externos, Ambientes. (2020). Patologia em revestimentos cerâmicos: O que é e quais as causas? <https://blog.gail.com.br/patologia-em-revestimentos-ceramicos-o-que-e-e-quais-as-causas/>
- Faria, V. G. (2018). Desplacamento de revestimento cerâmico interno em edifícios residenciais: estudo de caso (TCC de graduação). Universidade Federal de Goiás.
- Ferrante, M. (2002). Seleção de materiais (2. ed.). São Carlos: Editora da UFSCar.
- Freire, J. M. (1989). Materiais de construção mecânica: tecnologia mecânica. Rio de Janeiro: LTC.
- Machado, P. I. de L. (2018). Patologias em revestimentos cerâmicos (Tese de doutorado). Universidade Federal do Ceará.
- Nascimento, O. L. (2012). Caracterização sistema de colagem dupla-face para assentamento de revestimento cerâmico. Construindo, 1–9.

- Nunes, M. P. S., Uzeda, U. S. B., Igor, M. F., & Santos, G. S. (2015). Revestimentos cerâmicos e suas aplicabilidades. *Ciências Exatas e Tecnológicas*, 87–97.
- Oliveira, J. A. da C., Pantoja, J. da C., & Costa, W. C. (2020). Estudo de caso de patologias em revestimentos cerâmicos (TCC de graduação). Universidade de Brasília.
- Parreira, F. de A., & Ramos, M. R. (2017). Estudo do deslocamento de revestimentos cerâmicos em paredes internas (TCC de graduação). UniEvangélica.
- Rebelo, C. da R. (2010). Projeto e execução de revestimento cerâmico – interno (Monografia de especialização). Universidade Federal de Minas Gerais.
- Silva, J. R. R. da. (2005). Caracterização físico-química de massas cerâmicas e suas influências nas propriedades finais de revestimentos cerâmicos (Dissertação de mestrado). Universidade Federal do Paraná.
- Tognetti, G. (2015). Tipos de argamassas colantes. <https://engenheironocanteiro.com.br/o-guia-simples-e-pratico-para-escolher-o-tipo-de-argamassa-colante-para-assentar-pisos-e-azulejos/>

RAPID ASSESSMENT PROTOCOL AS A PEDAGOGICAL RESOURCE FOR THE SOCIO-ENVIRONMENTAL READING OF URBAN RIVERS: ADAPTATIONS IN THE DEVELOPMENT AND VALIDATION OF A DIDACTIC GUIDE

PROTOCOLO DE AVALIAÇÃO RÁPIDA COMO RECURSO PEDAGÓGICO PARA A LEITURA SOCIOAMBIENTAL DE RIOS URBANOS: ADAPTAÇÕES NO DESENVOLVIMENTO E NA VALIDAÇÃO DE UM GUIA DIDÁTICO

PROTOCOLO DE EVALUACIÓN RÁPIDA COMO RECURSO PEDAGÓGICO PARA LA LECTURA SOCIOAMBIENTAL DE RÍOS URBANOS: ADAPTACIONES EN EL DESARROLLO Y LA VALIDACIÓN DE UNA GUÍA DIDÁCTICA



<https://doi.org/10.56238/sevened2026.008-205>

Helaine de Oliveira Menezes¹, Felipe Fontana²

ABSTRACT

This article analyzes the development, structure, and validation of a didactic guide constructed through the adaptation of a Rapid Assessment Protocol (RAP) for elementary education, seeking to address the problem of how such an instrument can promote critical environmental learning and assist students in understanding the socio-ecological determinants of urban river degradation. Grounded in a qualitative approach, the study combined documentary analysis, methodological adaptation of the RAP, pedagogical workshops, and field activities conducted with students from a public school in Janiópolis, Paraná (Brazil). The theoretical framework engages with references on urban water resources (Tucci, 2008; Tundisi, 2014; 2020), Rapid Assessment Protocols (Callisto et al., 2002; Guimarães, Rodrigues & Malafaia, 2012), and Critical Environmental Education (Guimarães, 2004; Layrargues & Lima, 2014), as well as the principles of the National Water Resources Policy and Sustainable Development Goal 6 (SDG 6). The results indicate that the guide fostered a critical reading of the Água dos Peões stream, enhanced students' interpretive capacity, strengthened their understanding of anthropogenic pressures, and stimulated argumentative positioning in relation to local environmental conflicts. The product proved to be scientifically and pedagogically robust, with high potential for replication in public schools and practical relevance – particularly in terms of public management – for small municipalities. It is concluded that the guide constitutes a relevant educational technology for improving school-based environmental management, fostering social participation, and supporting formative practices aligned with the National Water Resources Policy, the SDGs, and critical perspectives in Environmental Education, thereby justifying its academic, public, and social significance.

¹ Master's degree in Environmental Science Teaching. Universidade Estadual de Maringá (UEM).

E-mail: helaine.oliveiramenezes@gmail.com Orcid: <https://orcid.org/0000-0002-1676-9768>

Lattes: <http://lattes.cnpq.br/9599067746663953>

² Dr. in Political Science. Universidade Federal de São Carlos (UFSCar). E-mail: felipefontana@unicentro.br

Orcid: <https://orcid.org/0000-0001-9582-2178> Lattes: <http://lattes.cnpq.br/6129448426028004>

Keywords: Participatory Diagnosis. Urban Water Resources. Investigative Learning. Socio-Environmental Management. Critical Environmental Education. Rapid River Assessment.

RESUMO

Este artigo analisa o desenvolvimento, a estrutura e a validação de um guia didático construído a partir da adaptação de um Protocolo de Avaliação Rápida (PAR) para o Ensino Fundamental, buscando responder ao problema de como tal instrumento pode promover aprendizagens ambientais críticas e auxiliar estudantes na compreensão dos determinantes socioecológicos da degradação de rios urbanos. Ancorado em uma abordagem qualitativa, o estudo articulou análise documental, adaptação metodológica do PAR, oficinas pedagógicas e atividades de campo junto a estudantes de uma escola pública de Janiópolis (PR). A fundamentação teórica dialoga com referências sobre recursos hídricos urbanos (Tucci, 2008; Tundisi, 2014; 2020), Protocolos de Avaliação Rápida (Callisto et al., 2002; Guimarães; Rodrigues; Malafaia, 2012) e Educação Ambiental Crítica (Guimarães, 2004; Layrargues; Lima, 2014), além dos princípios da Política Nacional de Recursos Hídricos e do ODS 6. Os resultados evidenciam que o guia favoreceu a leitura crítica do córrego Água dos Peões, ampliou a capacidade interpretativa dos estudantes, fortaleceu sua compreensão das pressões antrópicas e estimulou posicionamentos argumentativos diante dos conflitos ambientais locais. O produto mostrou-se robusto do ponto de vista científico e pedagógico, com alto potencial de replicabilidade em escolas públicas e de utilidade – em termos de gestão pública – para municípios de pequeno porte. Conclui-se que o guia constitui uma tecnologia educacional relevante para qualificar a gestão ambiental escolar, fomentar a participação social e subsidiar práticas formativas coerentes com a PNREH, com os ODS e com perspectivas críticas da Educação Ambiental, justificando sua importância acadêmica, pública e social.

Palavras-chave: Avaliação Rápida de Rios. Diagnóstico Participativo. Recursos Hídricos Urbanos. Aprendizagem Investigativa. Gestão Socioambiental. Educação Ambiental Crítica.

RESUMEN

Este artículo analiza el desarrollo, la estructura y la validación de una guía didáctica construida a partir de la adaptación de un Protocolo de Evaluación Rápida (PER) para la Educación Primaria, con el propósito de responder al problema de cómo dicho instrumento puede promover aprendizajes ambientales críticos y ayudar a los estudiantes a comprender los determinantes socioecológicos de la degradación de los ríos urbanos. Basado en un enfoque cualitativo, el estudio articuló análisis documental, adaptación metodológica del PER, talleres pedagógicos y actividades de campo realizadas con estudiantes de una escuela pública del municipio de Janiópolis (PR, Brasil). El marco teórico dialoga con referencias sobre recursos hídricos urbanos (Tucci, 2008; Tundisi, 2014; 2020), Protocolos de Evaluación Rápida (Callisto et al., 2002; Guimarães, Rodrigues y Malafaia, 2012) y Educación Ambiental Crítica (Guimarães, 2004; Layrargues y Lima, 2014), además de los principios de la Política Nacional de Recursos Hídricos y del Objetivo de Desarrollo Sostenible 6 (ODS 6). Los resultados evidencian que la guía favoreció la lectura crítica del arroyo Água dos Peões, amplió la capacidad interpretativa de los estudiantes, fortaleció su comprensión de las presiones antrópicas y estimuló posicionamientos argumentativos frente a los conflictos ambientales locales. El producto se mostró sólido desde el punto de vista científico y pedagógico, con alto potencial de replicabilidad en escuelas públicas y utilidad – en términos de gestión pública – para municipios de pequeño porte. Se concluye que la guía constituye una tecnología educativa relevante para cualificar la gestión ambiental escolar, fomentar la participación social y sustentar prácticas formativas coerentes con la Política Nacional de Recursos Hídricos, los ODS y las perspectivas críticas de la Educación Ambiental, lo que justifica su importancia académica, pública y social.

Palabras clave: Evaluación Rápida de Ríos. Diagnóstico Participativo. Recursos Hídricos Urbanos. Aprendizaje Investigativo. Gestión Socioambiental. Educación Ambiental Crítica.

1 INTRODUCTION

The degradation of Brazilian urban rivers, intensified in recent decades, has evidenced (i) the fragility of aquatic ecosystems in the face of anthropogenic pressures and, above all, (ii) the structural limits of traditional management and education models regarding water resources. The disorderly expansion of cities, the increasing impermeabilization of the soil, the continuous discharge of effluents and solid waste and the suppression of riparian forests configure a picture of degradation that compromises the quality of water, biodiversity and the socio-ecological balance of urban environments³. These problems deepen socio-environmental asymmetries, reinforcing historical inequalities that mainly affect vulnerable and/or racialized populations – see environmental racism – whose access to quality water is systematically threatened⁴.

This scenario directly confronts the principles of the National Water Resources Policy (PNREH), which recognizes water as a public good and demands integrated, participatory and decentralized management practices (Brasil, 1997). Likewise, it highlights the distance between the global normative projections enshrined in the Sustainable Development Goals (SDGs), especially SDG 6, and the concrete reality experienced in Brazilian urban micro-basins, still marked by *deficits* in planning, monitoring and territorialized environmental education (UN, 2015). In view of this, it is found that the environmental crisis of urban rivers is simultaneously ecological, political, pedagogical and epistemological – and therefore demands strategies that transcend exclusively technical diagnoses, calling for training processes that promote a critical reading of reality and community engagement.

In this sense, Critical Environmental Education (EAC) becomes central by proposing the overcoming of merely informative practices and the defense of emancipatory pedagogical processes capable of questioning productivist rationalities and the logics of degradation of common goods⁵. By incorporating the analysis of power relations, socio-environmental inequalities and the complexity of natural and social systems, EAC positions itself as an essential training field for students to understand their territory, identify local problems, interact with their socio-natural environments and recognize themselves as subjects capable of transforming their realities.

However, school practice still lacks qualified didactic methodologies that bring students closer to environmental research, stimulating intellectual autonomy, ecological sensitivity and ability to read the territory. The absence of pedagogical materials specifically aimed at the participatory diagnosis of urban rivers constitutes one of the gaps that limit the school's

³ Tucci, 2008; Andrade et al., 2019.

⁴ Tundisi, 2014; Brazil, 2021.

⁵ Guimarães, 2004; 2013; Layrargues; Lima, 2014.

commitments to scientific, citizen and environmentally critical education. Thus, it is urgent to develop and analyze didactic instruments that articulate ecological, geographical, chemical, social and political knowledge, especially in contexts of public schools located in municipalities that face the direct effects of water degradation.

It is in this context that this article is inserted, whose main objective is to present, analyze and discuss the development and validation of a didactic guide built from a Rapid Assessment Protocol (PAR) adapted for elementary education. This educational product, derived from research linked to the Professional Master's Degree in the National Network for the Teaching of Environmental Sciences (ProfCiamb), seeks to integrate investigative practices with participatory environmental diagnosis, bringing students closer to the critical analysis of the Água dos Peões stream, in the municipality of Janiópolis (PR). The guide was developed to allow an integrated reading of the physical, biological and anthropic factors that affect the environmental quality of urban rivers, seeking to transform field activity into interdisciplinary and critical formative practice.

The problem that guides this study is summarized as the following question: how can a didactic guide structured from an adapted PAR promote environmental learning and help elementary school students in understanding and diagnosing urban rivers? To answer it, the following objectives were defined: a) to present the conceptual and methodological foundations that support the elaboration of the guide; b) describe its process of construction and adaptation, considering the specificities of the PAR and the challenges of didactic transposition; c) analyze its application and validation with students, identifying learning, limits and potentialities; d) to discuss the contribution of the guide – an interdisciplinary educational product – in the context of ProfCiamb.

Methodologically, the study is based on a qualitative approach⁶, involving document analysis, technical adaptation of the PAR, pedagogical workshops, field activities and formative evaluation of students' learning. The construction of the guide emerges from the articulation between (i) theoretical references of the EAC, (ii) technical-ecological foundations of the Rapid Assessment Protocols⁷ and (iii) pedagogical demands identified in the school context. In addition, the study contributes to the field of Environmental Science Teaching by offering a replicable, low-cost and theoretically grounded educational technology, aligned with the principles of the PNREH, the commitments of the SDGs and the transformative perspectives of the EAC. In addition, the guide mobilizes the territory as a pedagogical space, stimulates participatory research processes and expands the methodological repertoire

⁶ Minayo, 2001; Gil, 2008; Silveira; Córdova, 2009.

⁷ Callisto et al., 2002; Guimarães; Rodrigues; Malafaia, 2012; Angels; Vasconcelos; Negreiros, 2021; Bersot, Menezes and Andrade, 2015; Pedroso; Colesanti, 2018.

available to educators and environmental managers. Finally, before presenting the development of the guide and the results of the research, it will be understood below the theoretical contributions that supported its conception – especially those related to water resources, the rapid evaluation of rivers, the critical perspectives of Environmental Education and the role of educational products in professional master's degrees.

2 THEORETICAL BACKGROUND

Understanding the socio-environmental dynamics that structure the relationship between society and water resources requires an interdisciplinary and critical approach, capable of articulating legal frameworks, scientific references and pedagogical perspectives that illuminate the contemporary challenges of water management and environmental education. In a context marked by increasing pressure on aquatic ecosystems, especially in urbanized areas, it is essential to analyze how water degradation is related to historical, economic, and cultural processes that shape the territory (Tucci, 2008; Andrade et al., 2019). At the same time, the literature shows that social participation, applied research and critical school education play a strategic role in promoting qualified readings of these environments and, consequently, in subsidizing public decisions and more sustainable community practices (Guimarães, 2004; Tundisi, 2014; CAPES, 2019). In this scenario, environmental diagnosis methods such as PARs and educational products developed in professional teaching programs emerge as important mediation devices between science, education and territorial management.

The present theoretical framework, therefore, discusses four fundamental axes: (i) the degradation and pollution of water resources and the need for integrated management; (ii) the principles and educational potential of the Rapid Assessment Protocols; (iii) Critical Environmental Education as an epistemological matrix; and (iv) the role of educational products within the scope of professional master's degrees, especially in ProfCiamb.

2.1 WATER RESOURCES: DEGRADATION, POLLUTION AND INTEGRATED MANAGEMENT

Water, constitutionally recognized as a good for the common use of the people and essential to life (Brasil, 1988; 2020a; 2020b), has been subjected to increasing pressures resulting from hegemonic models of urbanization and agro-industrial expansion in Brazil. Such models have produced significant impacts on water systems, expressed, among other aspects, by (i) extensive soil sealing, (ii) irregular occupation of permanent preservation areas, (iii) discharge of domestic and industrial effluents without adequate treatment, and (iv)

diffuse input of contaminants associated with agro-industrial practices, such as fertilizers, pesticides, and sediments, compromising the quality and availability of water in urban and peri-urban environments (Tucci, 2008). The literature shows that such processes intensify the physical, chemical, and biological degradation of water bodies, promoting siltation, eutrophication, contamination, and loss of biodiversity (Montagner; Vidal; Acayaba, 2017; Nova; Tenório, 2019). In addition, studies on the environmental history of Brazilian cities reveal that water pollution is articulated with cultural practices and development patterns that have naturalized the transformation of urban rivers into waste receptors, as demonstrated in the analysis of Lake Guaíba by Andrade et al. (2019).

At the institutional level, the National Environmental Policy (Brasil, 1981) and the National Water Resources Policy (Brasil, 1997) structured a new management paradigm, based on decentralization, social participation and integration between multiple uses of water. The creation of the National Water Agency (Brasil, 2000) reinforced the need to expand the monitoring, framing and regulation of water bodies, recognizing that decision-making must dialogue with continuous territorial diagnoses. Tundisi (2014) reinforces that integrated management is not limited to hydrological or technical aspects; In fact, it requires considering ecological, social and political dimensions that influence the availability and quality of water.

It is not by chance that the 2030 Agenda (UN, 2015) has internationally consolidated the understanding that the protection of aquatic ecosystems is inseparable from education, urban planning, public health, and environmental justice policies. In this sense, schools and communities play a strategic role by engaging in processes of critical reading of the territory, since water degradation represents, above all, an indicator of the ways in which society organizes, distributes and consumes its resources.

2.2 RAPID ASSESSMENT PROTOCOLS: FOUNDATIONS, POTENTIALITIES AND EDUCATIONAL USES

Rapid Assessment Protocols represent environmental diagnostic methodologies widely used to analyze the quality of lotic ecosystems in an agile, integrated and low-cost manner (Callisto et al., 2002). Its synthetic character allows the systematic observation of variables such as (i) vegetation cover of the banks, (ii) bed stability, (iii) presence of sediments, (iv) anthropogenic changes, (v) solid waste and (vi) flow conditions, resulting in an interpretative classification of the integrity of the environment. Based on these variables, the PAR offers not only an overview of ecological conditions, but also subsidies to understand the socio-environmental pressures that structure the territory.

In recent years, applied research has shown that PAR is highly effective in educational

contexts because it favors situated learning, critical thinking, and student engagement with real environmental problems. For example, Guimarães, Rodrigues and Malafaia (2012) showed that elementary school students are able to identify significant environmental changes from the use of the protocol, understanding relationships between human practices and impacts on rivers. Anjos, Vasconcelos, and Negreiros (2021), as well as Oliveira, Veloso, and Rossoni (2021), reaffirm the tool's formative potential, highlighting its contribution to developing observation, argumentation, and scientific interpretation skills.

Other authors reinforce the importance of PAR in field activities to sensitize students about degradation processes, promoting the articulation between ecological theory and territorial experience (Machado, 2019; Amorim, 2021). Pontini and Coelho (2019) and Silva et al. (2019) demonstrate that, even in highly impacted urban contexts, the application of the methodology allows the identification of patterns of erosion, siltation, irregular occupation and waste deposition, qualifying environmental perception and subsidizing discussions on public policies and conservation practices. The literature points out, therefore, that the educational use of the PAR goes beyond the simple physical diagnosis: it is configured as an epistemic device that enables students to understand the complexity of society-nature relations, connecting it to debates on environmental justice, collective rights and democratic water management.

2.3 CRITICAL ENVIRONMENTAL EDUCATION: FORMATION OF A SOCIO-ECOLOGICAL READING OF THE TERRITORY

Critical Environmental Education, according to Guimarães (2004; 2013) and Layrargues and Lima (2014), is a theoretical-political field that interprets the socio-environmental crisis from its historical, social and economic foundations. From this perspective, environmental problems are understood as resulting from structural processes associated with the forms of organization of production, the appropriation of nature and the reproduction of inequalities that characterize capitalist modernity. The centrality of this approach lies in the understanding that the relations between society and nature are mediated by conflicts, interests and social projects, which are expressed in an unequal way in territories and social groups.

By assuming this understanding, the EAC is guided by a political-pedagogical dimension that articulates training, social awareness and collective action, thus establishing an epistemology of environmental complexity⁸. Its commitment is focused on strengthening

⁸ The epistemology of environmental complexity, according to Leff (2003) and Riojas (2003), constitutes a framework that understands environmental problems as non-linear phenomena, historically situated and crossed by multiple rationalities, in which ecological, social, economic, cultural and political dimensions are

community participation, problematizing hegemonic socioeconomic practices and building integrated readings of socio-environmental reality. The dialectical analysis of these relations makes it possible to understand environmental phenomena as dynamic and historically situated processes, opening space for educational practices that promote critical reflection, the production of collective meanings and the transformation of the social conditions that sustain environmental degradation.

In this theoretical matrix, the environment is conceived as a socio-historical totality, and the school becomes a privileged space to promote critical readings of the territory, articulating scientific, cultural and popular knowledge. Applied studies in the field of water education and conservation (Maciel; Sousa, 2022; Raupp; Fransciscato; Lima, 2019) highlight that field activities, when planned from this approach, contribute to the formation of subjects capable of problematizing environmental degradation, questioning inequalities and understanding water as a common good.

The PAR, in this context, works as a methodology congruent with the EAC, after all, it offers subsidies for students to understand environmental impacts as products of human decisions, public policies, economic practices and environmental conflicts. By interpreting the conditions of an urban river, they identify environmental indicators and develop, at the same time, socio-environmental awareness, engagement and argumentative capacity – essential subsidies for current socio-ecological citizenship.

2.4 EDUCATIONAL PRODUCTS: RELEVANCE TO ENVIRONMENTAL EDUCATION

The professional master's degrees in Teaching, according to CAPES guidelines (2019), presuppose the articulation between research, teaching practice and development of educational products. Such products – such as didactic guides, didactic sequences, adapted protocols, and field materials – constitute educational technologies that dialogue with real problems in schools and promote the transposition of academic knowledge into concrete pedagogical practices (Gonçalves et al., 2019; Rosa; Batista, 2021).

Within the scope of ProfCiamb, this conception is intensified, since the program is

intertwined. This perspective questions the disciplinary fragmentation inherited from modern rationality and proposes integrative approaches capable of dealing with the indeterminacy, uncertainty, and plurality of knowledge implied in the understanding of socio-environmental systems. This foundation sustains the interdisciplinary approach mobilized in the dissertation that gave rise to this research, offering the conceptual framework to interpret the watershed as a "living fabric", in which natural and social processes are articulated. However, the development of this debate would imply resuming ontological and epistemological discussions of greater scope, involving the critique of instrumental rationality, transdisciplinarity and the multiplicity of analytical perspectives, which goes beyond the methodological and didactic objectives of this article. In view of this, a more pragmatic approach is chosen, centered on the development and validation of the didactic guide, without prejudice to the recognition of the epistemology of environmental complexity as one of its structuring theoretical foundations.

based on the dialogue between environmental sciences, education and territorial management. The development of educational products aimed at understanding water resources thus simultaneously promotes continuing teacher training, pedagogical innovation and approximation of the school with the territory. In this sense, a didactic guide based on a Rapid Assessment Protocol is an instrument consistent with the guidelines of Critical Environmental Education (Brasil, 1999; Brasil, 2012a), dialoguing with the need to strengthen socio-environmental reading, student participation and interdisciplinary analysis of urban rivers. In this way, the educational product presented/analyzed here is, in addition to a didactic resource, a scientific-pedagogical artifact that integrates certain theoretical foundations, a participatory methodology and critical socio-environmental training.

3 METHODOLOGY

The methodology of this study is articulated with three interdependent dimensions: (i) the methodological logic that guides the elaboration of this article, based on a qualitative, analytical and documentary approach; (ii) the methodology of the empirical research that gave rise to the educational product and the set of data and analyses used here; and (iii) the specific methodological path of adaptation of the Rapid Assessment Protocol (PAR) and the subsequent elaboration of the didactic guide. This structure, in a triple complementary layer, simultaneously comprises the scientific, pedagogical and technical process that sustains the development of the educational program presented in this work.

3.1 METHODOLOGICAL DIMENSION OF THE ARTICLE

Epistemologically, this article uses a qualitative and interpretative approach, appropriate to the analysis of complex socio-environmental and educational phenomena that involve meanings, practices and cultural mediations (Minayo, 2001). The theoretical-analytical approach favors the articulation between water resources management, critical environmental education and environmental diagnosis methodologies, allowing the interpretation of the production of the didactic guide as a pedagogical, scientific and technological artifact.

The analytical corpus used stems from the dissertation developed within the scope of the Graduate Program in the National Network for the Teaching of Environmental Sciences (ProfCiamb-Associada UEM) – by Helaine de Oliveira Menezes entitled "Use of Didactic Guide with Rapid Assessment Protocol in the Diagnosis of Urban Water Systems" (2023) –, including: field records, photographs, files of the protocol applied by the students, workshop transcripts and questionnaires, in addition to the educational product itself. The analysis of

this material was guided by the principles of content analysis (Bardin, 2016; Silva; Fossá, 2015), especially to identify categories that emerge from the students' perception of the investigated river and the use of the PAR. By structuring the article under this logic, this methodology allowed us to reconstruct the process of elaboration of the guide, to discuss its theoretical-pedagogical robustness, and to situate it in the context of river evaluation methodologies and Critical Environmental Education.

3.2 METHODOLOGICAL DIMENSION OF THE ORIGIN RESEARCH

The empirical research that underlies this article adopts a qualitative and investigative approach, articulating field procedures, didactic activities and data analysis instruments of a descriptive and interpretative nature (Gil, 2008; Kauark; Mornings; Medeiros, 2010). The study was developed with elementary school students from a state school, involving three main stages: (1) introductory workshop and environmental awareness; (2) application of the Rapid Assessment Protocol in the analyzed stream; and (3) systematization and discussion of the results obtained.

Different instruments were used, ensuring triangulation and analytical depth (Fontana, 2018; Fontana and Rosa, 2021): (i) diagnostic questionnaire, aimed at capturing students' previous conceptions about water resources and environmental impacts; (ii) direct observation during fieldwork; (iii) structured PAR forms, filled out by the students; (iv) photographic records for visual validation of the observed environmental conditions. From these materials, a database was organized that later subsidized the construction and validation of the didactic guide.

The data from the questionnaires and workshops were analyzed through Content Analysis (Gaspi; Maron; Magalhães Júnior, 2021; Bardin, 2016), allowing the identification of categories such as perception of the environment, understanding of impacts, relationship with the territory and learning resulting from the application of the PAR. The protocol data were systematized according to criteria previously defined in the technical-scientific literature on rapid assessment (Callisto et al., 2002; Guimarães; Rodrigues; Malafaia, 2012), applying environmental scores and classifications that make up the final diagnosis. This process generated the empirical bases that guided both the theoretical discussion and the elaboration of the educational product.

3.3 METHODOLOGICAL DIMENSION OF THE ADAPTATION OF THE RAPID ASSESSMENT PROTOCOL (PAR)

The adaptation of the PAR was a central methodological step in the research and development of the didactic guide. The starting point was the protocol proposed by Callisto et al. (2002), widely used in teaching research and river monitoring because it integrates agility, rigor and applicability. However, the school use of this tool requires methodological adjustments, as demonstrated by authors who have worked with similar adaptations for teaching (Guimarães; Rodrigues; Malafaia, 2012; Pontini; Coelho, 2019; Machado, 2019; Amorim, 2021). Thus, the process followed four stages: (a) review of the parameters; (b) adequacy of the scoring scale; (c) field testing and photographic record; and (d) pedagogical validation.

In view of this, a critical analysis of the parameters of the existing protocols was carried out, including those applied in different urban and peri-urban basins (Anjos; Vasconcelos; Negreiros, 2021; Oliveira; Veloso; Rossoni, 2021; Lima et al., 2017; Rangel; Botelho, 2017), with the objective of reorganizing the criteria into observation categories understandable to students, preserving scientific rigor and, simultaneously, adopting a pedagogical language compatible with the school context (a). Considering that the literature points out that excessively complex scales tend to compromise student comprehension and the didactic functionality of the instruments (Machado, 2019), we proceeded to simplify the descriptors and reorganize the score levels, seeking greater intuitiveness without breaking the methodological coherence with consolidated studies in the area (b). The experimental application of the protocol in the Água dos Peões stream was a fundamental step in the process, as it made it possible to identify ambiguities, overlaps, and interpretative gaps in the parameters, in line with methodological approaches that advocate the testing of protocols in real field conditions as an instrumental refinement strategy (Silva et al., 2019; Pontini; Coelho, 2019; Rodrigues, 2017) (c). In this context, the students carried out the full application of the protocol and participated in a workshop oriented to discuss the results, a procedure aligned with the formative experiences described by Machado (2019) and Amorim (2021), which allowed them to confront the perceptions built in the educational process with the technical data obtained (d). From this integrated analysis, a version adapted to the school context was consolidated, characterized by scientific consistency, visual clarity and accessible language, constituting the central methodological basis of the didactic guide developed.

3.4 METHODOLOGY FOR THE CONSTRUCTION OF THE DIDACTIC GUIDE

The preparation of the didactic guide was guided by principles that prioritize clarity, replicability, and pedagogical coherence (Gonçalves et al., 2019; Rosa; Batista, 2021), involving the integrated organization of its conceptual, visual, and methodological contents. In this process, the selection and articulation of central concepts related to water resources, environmental impacts, relevant legislation and EAC was carried out, in order to dialogue with the adapted PAR. The structuring of the material sought to ensure its self-sufficiency, allowing teachers to use it autonomously, without the need for prior external training. At the same time, the parameters of the PAR were translated pedagogically through contextualized explanations, photographic records, practical examples, and accessible descriptors, in line with studies that highlight the relevance of visual resources and teaching materials in the mediation of complex ecological processes (Machado, 2019; Amorim, 2021).

The construction of the guide was organized in three articulated movements – theoretical awareness, field activity and reflective analysis –, a structure that favors the integration between knowledge, empirical experience and critical problematization, according to the assumptions of the EAC (Guimarães, 2013; Layrargues; Lima, 2014). The validation of the guide occurred from the analysis of the results of the pedagogical workshops and the questionnaires applied, ensuring coherence between the proposed objectives, the methodological procedures adopted and the formative potential of the educational product. This stage gave consistency to the material and was aligned with the guiding principles of professional master's degrees, especially with regard to the articulation between academic production, pedagogical applicability, and social relevance (CAPES, 2019).

3.5 SUMMARY OF THE METHODOLOGICAL APPROACH

The methodology adopted articulates empirical investigation, critical literature review, methodological adaptation and technical-pedagogical development. The integration of these dimensions ensures that the didactic guide presented in this article is simultaneously: (i) scientifically based; (ii) validated in a real teaching context; (iii) conformed within an interdisciplinary perspective⁹; (iv) consistent with contemporary methodologies for river

⁹ The relationship between interdisciplinarity and the adaptation of the PAR is treated in a synthetic way in this article, since its deepening would require recovering, with greater amplitude, the epistemological discussion developed in the dissertation that gave rise to the research. Even so, it is important to highlight that the adaptation of the PAR itself constituted an interdisciplinary exercise, by articulating contributions from river ecology, physical geography, school cartography and Critical Environmental Education, mobilized in the reconstruction of the parameters and in the redefinition of its pedagogical uses. This process implied sensitive methodological decisions, involving the didactic transposition of indicators originally conceived for specialists (Callisto et al., 2002), the problematization of the limits and potentialities of simplified assessments in educational contexts (Guimarães; Rodrigues; Malafaia, 2012) and the need to make them intelligible to students through adequate pedagogical translations (Pontini; Coelho, 2019). The detailed inclusion of this debate would

diagnosis; and (v) aligned with the principles of Critical Environmental Education and the guidelines of professional master's degrees in teaching.

4 THE ORIGIN RESEARCH

The research on which this article is based was developed within the scope of ProfCiamb-Associada UEM (Menezes, 2023) and was structured as a qualitative investigation, of a formative and participatory nature, oriented both (i) to the construction of a socio-environmental diagnosis of an urban water body and (ii) to the elaboration of a didactic guide aimed at Basic Education. Since its conception, the study has adopted an integrated perspective between education, territory and water resources, understanding the investigative process as a space for the production of knowledge and training of the subjects involved. This orientation implied the development of methodological instruments capable of articulating technical rigor, student participation and pedagogical applicability, in line with references that defend integrated approaches in the field of water management and EE (Brasil, 1997; Callisto et al., 2002; Guimarães, 2013).

4.1 OBJECTIVES AND LOCUS OF THE RESEARCH

The study aimed to understand how the pedagogical application of a PAR – adapted for educational purposes – could foster critical learning about the degradation of urban water resources and contribute to the construction of a replicable and grounded educational product. As specific objectives, it was sought: (i) to analyze the students' initial perception of rivers, environmental impacts and water management; (ii) develop and test a PAR adapted to the school context; (iii) to assess the students' understanding after fieldwork; and (iv) systematize the process in a didactic guide consistent with the EAC guidelines (Menezes, 2023).

The research was carried out in a state school in Janiópolis/PR (PPP, 2022), ¹⁰a small city located in a territory marked by disorderly urban expansion, waterproofing processes,

shift the focus of the article, centered on the educational product and its validation, to a broader discussion on the epistemology of participatory environmental assessment. This elaboration is extensively developed in the dissertation – see (Menezes, 2023) –, in which it is demonstrated how the PAR adaptation methodology, by integrating different fields of knowledge around the socio-environmental reading of urban rivers, constituted itself as an interdisciplinary practice in itself.

¹⁰ The role of the school as a territorial institution – understood as a structuring agent of the relations between subjects, territory, culture and public policies – is addressed in this article in a synthetic way. However, in the theoretical perspective that underlies the dissertation (Menezes, 2023), the school is understood as a social actor inserted in the processes of production of the territory, capable of mediating local and institutional knowledge, articulating scales of action and bringing communities, public management and environmental policies closer together. In this condition, the school participates in the construction of collective practices of reading and socio-environmental intervention, contributing to the formation of critical subjects and to the strengthening of participatory dynamics at the local level (Tucci, 2005; 2008; Cirilo, 2019). The in-depth

and diffuse pressures on watercourses (Dangui, 2022; IBGE, 2022; Ipardes, 2025). The environment selected for the application/testing of the PAR was the Água dos Peões stream¹¹, an urban water body that expresses the tensions between human occupation, territorial planning and environmental quality – characteristics that make it particularly significant for didactic-analytical purposes (Tucci, 2008; Nova; Tenório, 2019).

4.2 METHODOLOGICAL PATH OF THE RESEARCH

The research was organized in three articulated movements, conceived as dialogical stages between theory, practice and critical reflection: (a) initial diagnosis and environmental awareness; (b) application of the adapted pair in the field; (c) systematization and collective analysis. Thus, the students participated in an introductory workshop in which fundamental concepts of water resources, anthropic impacts and integrated water management were discussed (Brasil, 2000; Tundisi, 2014). The activity sought to identify previous perceptions and stimulate the investigative look, favoring the understanding of water as a common good and structuring element of the territory.

Then, the students carried out fieldwork in the Água dos Peões stream, applying the PAR in its preliminary version. This stage was crucial to observe (i) the environmental conditions of the river and (ii) the way in which the students interpreted the parameters, understood the environment and articulated evidence – a process widely discussed in research that evaluates the educational use of environmental protocols (Guimarães; Rodrigues; Malafaia, 2012; Pontini; Coelho, 2019; Machado, 2019; Amorim, 2021). Finally, the data produced in the field were analyzed in a subsequent workshop, in which the students compared observations, discussed interpretative divergences, and related visual, ecological, and social evidence. This dialogical dimension consolidated the critical understanding of the

development of this argument would imply analyzing the school as a socio-political space, with emphasis on its interfaces with public management and territorial planning instruments, which goes beyond the focus of this article, centered on the didactic guide. The option adopted, therefore, stems from an editorial and analytical choice, without prejudice to the recognition of the centrality of the school as a territorial institution in the broader approach to research.

¹¹ The articulation between the results produced by the students and municipal management, especially with regard to the Janiópolis Master Plan (2022), is little addressed in this article. In general, the socio-environmental diagnosis elaborated from the application of the PAR subsidized reflections on the use and occupation of the soil, the preservation of permanent protection areas and the environmental conditions of the Água dos Peões stream, aspects related to urban planning instruments and the management of water resources at the local level. The systematization of this information in a technical-pedagogical report made it possible to establish a channel of dialogue between the school and the public authorities, by making visible, in an organized way, empirical evidence on the environmental state of the watercourse. However, the deepening of this articulation, involving the analysis of decision-making processes, planning instruments and related public policies, goes beyond the objectives of this article, which privileges the pedagogical-methodological dimension of the didactic guide. For broader discussions on watershed management, urban planning, and water resources policies, see Brasil (1997), Tucci (2005; 2008), and Prado, Johnsson, and Marques (2017).

territory and revealed the pedagogical power of the PAR as an instrument that produces socio-environmental reading.

4.3 CONSTRUCTION AND TESTING OF THE ADAPTED PAIR

The adapted PAR emerged as an essential intermediate product of the research, having been developed from an analytical process that articulated specialized literature, experimentation and pedagogical validation. Although the previous methodological section described the technical procedures for adaptation, here we highlight the academic foundations that justified this movement and the empirical evidence produced during its testing. The initial version was built based on the protocol of Callisto et al. (2002), a consolidated reference in the evaluation of lotic ecosystems. In addition, adaptations employed in school and urban contexts by authors such as: (a) Guimarães, Rodrigues and Malafaia (2012), in studies focused on elementary education; (b) Anjos, Vasconcelos, and Negreiros (2021) and Oliveira, Veloso, and Rossoni (2021), which analyze heavily anthropized rivers; (c) Pontini and Coelho (2019) and Machado (2019), who highlight elements of morphological and anthropic interpretation; (d) Silva et al. (2019) and Rangel and Botelho (2017), who discuss sensitive parameters for urban environments; (e) Amorim (2021), who emphasizes pedagogical aspects of environmental protocols. It is not by chance that the convergence of these studies allowed the definition of a set of parameters accessible to students, but scientifically valid, ensuring the dual pedagogical and technical function of the instrument.

The application of the protocol in the Água dos Peões stream revealed central environmental aspects – such as the presence of residues, changes in the flow, erosion of banks, reduced riparian vegetation and signs of siltation – which are in line with the literature on water degradation in urban areas (Tucci, 2008; Montagner; Vidal; Acayaba, 2017). From a pedagogical point of view, the testing showed that the students were able to: (i) distinguish physical, biological and anthropic parameters; (ii) relate observed impacts to social practices; (iii) and interpret the river as part of a larger system of urban management and planning. These results confirmed the adequacy of the adapted PAR and provided direct support for the elaboration of the didactic guide¹².

¹² In addition to the pedagogical results resulting from the application of the PAR – fundamental for the construction and validation of the didactic guide –, the research produced material results that enabled the elaboration of a socio-environmental diagnosis of the Água dos Peões stream which, in turn, was able to evidence the spatial heterogeneity of the ecological conditions along the urban stretch analyzed. The evaluation carried out at six sampling points, distributed from upstream to downstream, revealed a gradient of environmental conservation directly associated with the forms of use and occupation of the banks, anthropogenic interventions in the bed and the presence of degradative processes. The points located at the ends of the urban stretch, especially P1 and P6, presented the highest overall scores, being classified as

4.4 FIELD PROCESS AND PEDAGOGICAL WORKSHOPS

The construction of the educational product was influenced by the field process and the workshops, which functioned as moments of experimentation, reflection and collective validation. The fieldwork was constituted as an experience of "incarnate reading of the territory", in which the environment, in addition to being an object of analysis, became a living space of interaction between subjects, society and nature – a perspective consistent with the EAC (Guimarães, 2013; Leff, 2003; Roos; Becker, 2012). During the workshops, it was observed that there was a significant development of argumentation skills, ecological perception and interpretation of evidence. The collective discussion of the PAR forms¹³ allowed the students to confront their analyses, identify contradictions and construct explanations anchored in environmental indicators. This dynamic reproduces what the literature calls "ecological pedagogical mediation", in which field activity acts as a catalyst for processes of awareness and critical reading (Maciel; Sousa, 2022; Raupp; Fransciscato; Lima, 2019). These experiences formed the epistemological and pedagogical core of the

"natural", due to the greater vegetation cover, lower intensity of anthropogenic changes, absence of odors and oiliness and better visual conditions of the water. On the other hand, the intermediate points (P2, P3, P4 and P5) were classified as "altered", reflecting the intensification of urbanization, the reduction of riparian vegetation, the occurrence of erosive processes and siltation, the recurrent presence of solid waste, changes in the channel of the watercourse and less diversity of visible organisms. The integrated analysis of the macroscopic parameters also showed that, although the direct presence of domestic or industrial sewage discharge at all points was not found, the signs of anthropogenic pressure are expressed in a diffuse way, especially through the occupation of the banks, the channeling of stretches, inadequate soil management and the degradation of the Permanent Preservation Area. In this sense, the PAR proved to be effective in characterizing the Água dos Peões stream as an urban water system subjected to processes of progressive environmental degradation, while at the same time it made it possible to identify segments with greater potential for conservation and recovery. These results allowed us to characterize the stream as an urban water system subjected to diffuse and progressive anthropogenic pressures, while indicating segments with greater potential for conservation and environmental recovery. The set of this information was condensed into a technical-pedagogical report prepared collectively by the student participating in the research, in which the data obtained in the field, photographic records, schematic maps, interpretations of the evaluated parameters and recommendations of an educational and environmental nature were systematized. This report was formally forwarded to the municipal government, configuring itself as another product of the research and as an instrument of dialogue between school, community and public management, by materializing the results of the diagnosis and increasing the visibility of the socio-environmental conditions of the Água dos Peões stream at the local level.

¹³ The Rapid Assessment Protocol, after the adaptation process developed in this research, became a socio-environmental diagnostic instrument with a dual purpose – pedagogical and technical – organized in such a way as to allow its application in school contexts without prejudice to scientific rigor. The adapted PAR was structured based on a set of macroscopic parameters related to the physical conditions of the watercourse, the use and occupation of the banks, the integrity of the riparian vegetation, the presence of solid waste, signs of erosive processes and siltation, as well as visual and olfactory signs associated with water quality. Each parameter was accompanied by objective descriptors, illustrative examples, and reference photographic records, organized into simplified and progressive scoring scales, which enable the identification of different levels of environmental change. The reorganization of the categories and the redefinition of the scales aimed to favor the readability of the instrument for students, maintaining methodological coherence with protocols consolidated in the literature. The adapted PAR provides for application at previously defined sampling points, systematic recording of observations in standardized forms and subsequent integrated analysis of the results, allowing the general classification of the evaluated stretch and the comparison between different segments of the watercourse. By articulating direct observation, data systematization, and collective interpretation, the protocol assumes a mediating role in the educational process, operating as a support for the critical reading of the territory and the understanding of the relationships between socio-spatial dynamics and the degradation of urban water systems – see the PAR in its final version in Menezes, 2023.

didactic guide, ensuring that its elaboration represents an organic movement based on educational praxis and the materiality of the territory.

5 DEVELOPMENT OF THE DIDACTIC GUIDE

The didactic guide was the main product of this investigation, the result of an elaboration process related to the articulation between theory, field, participatory observation and critical reflection. Its development expresses the understanding that EAC demands instruments that promote rigorous socio-environmental readings of the territory, sensitive and politically situated (Guimarães, 2013; Layrargues; Lima, 2014). In this way, the guide sought to overcome traditional prescriptive approaches, offering material that invites students and teachers to understand the complexity of urban rivers, recognizing them as living expressions of historical, political and ecological processes.

The elaboration of the guide, therefore, ended an investigative path that involved methodological adaptation, practical experimentation, collective analysis and theoretical support. Its form and content respond to what the research itself revealed about the potentialities and limits of teaching about water resources in the school context, dialoguing with the empirical findings recorded in the dissertation (Menezes, 2023) and with the literature that discusses both PARs¹⁴ and field methodologies in EAC¹⁵.

5.1 PRINCIPLES OF CONSTRUCTION OF THE GUIDE: LANGUAGE, REPLICABILITY AND VISUALITY

The construction of the guide was guided by three complementary didactic and epistemological principles, defined based on the requirements of the public school, the characteristics of the students involved and the theoretical assumptions of the EAC: (a) dialogical and accessible language without loss of conceptual density; (b) replicability as a public commitment; and (c) visibility as cognitive and affective mediation. In view of this, it is noted that the language of the guide was conceived in such a way as to balance communicative clarity and analytical rigor. The central concern was to avoid both hermetic technicality and excessive simplification – common vices in teaching materials on environmental topics. This methodological choice stemmed from the understanding that forming critical readers of their territory requires that concepts such as *water resources*, *anthropic impacts*, *integrated management*, and *socio-environmental justice* be presented with precision, but mediated by examples, images, and analyses connected to the students'

¹⁴ Callisto et al., 2002; Pontini; Coelho, 2019; Angels; Vasconcelos; Negreiros, 2021.

¹⁵ Machado, 2019; Amorim, 2021; Maciel; Sousa, 2022.

daily lives (Brasil, 1997; Tundisi, 2014). Language, therefore, informs, tensions, provokes and instigates.

The guide was planned to be replicable in different schools, preserving its methodological coherence independently of the original researcher. This characteristic meets the guidelines of professional master's degrees, which demand educational products capable of having an expanded impact on the reality of basic education (CAPES, 2019). Replicability, in addition to the possibility of use, also involved teacher autonomy, procedural clarity and contextual flexibility, allowing the PAR to be applied in urban and peri-urban rivers or even in rural micro-basins.

The use of photographs, schemes, and visual records – many of them produced by the students themselves during fieldwork – derives from the conception that learning in EE is strengthened when observation is guided, structured, and contextualized (Machado, 2019; Amorim, 2021). Images of siltation, erosion, the presence of residues, changes in the flow and degradation of the riparian forest functioned, in the guide, as perceptual anchors that allowed us to understand abstract phenomena through the materiality of the territory. Visuality, in this sense, rather than a simply illustrative resource, becomes a pedagogical device for critical reading.

5.2 INTERNAL STRUCTURE OF THE DIDACTIC GUIDE

The organization of the guide established a pedagogical flow aligned with the logic of the Teaching of Environmental Sciences and with the EAC. The structure is simultaneously progressive and circular: each section prepares the next and all return to the central idea that to understand a river is to understand a territory, a society and its contradictions; Thus, the guide was divided into: (1) Conceptual introduction; (2) field orientations; (3) the adapted PAR; and (4) synthesis and reflection activities

The first section translates into didactic language the theoretical basis of the dissertation: ecological functions of rivers, impacts of urbanization, anthropogenic pressures and principles of the National Water Resources Policy (Brasil, 1997; Brasil, 2000). The narrative seeks to show that the process of degradation is not natural; in fact, it is historically produced, in line with the reflections of Tucci (2008) and Nova and Tenório (2019).

In the field orientations, methodological, ethical and operational care are presented, articulating geographical, ecological and safety procedures. This section values the investigative dimension of the field trip, reinforcing that to observe is to see/see and, above all, to interpret and situate (Raupp; Fransciscato; Lima, 2019).

The core of the guide is the PAR adapted, reorganized and explained step by step. The arrangement of the parameters on clear cards and accompanied by images facilitated the autonomy of the students, allowing the interpretation of substrate, flow, oiliness, establishment of margins and residues based on criteria inspired by the specialized literature (Callisto et al., 2002; Pontini; Coelho, 2019). Finally, the last section proposes exercises that stimulate critical and analytical thinking and the articulation of empirical evidence with public policies and social practices. In this part of the guide, Freire's logic of critical reading of the world finds its materiality in the analysis of an urban river, bringing the theory closer to praxis (Guimarães, 2013).

5.3 PARAMETERS ADAPTED FROM THE PAIR: SUBSTRATE, OILINESS, MARGINS, RESIDUES AND FLOW

The adaptation of the PAR parameters was a central stage of the research, as it enabled the conversion of a technical-scientific instrument into an accessible pedagogical resource, preserving its analytical and interpretative capacity. This process was guided by the theoretical contributions mobilized in the dissertation, as well as by the empirical data produced in the Água dos Peões stream, resulting in the reformulation of the following parameters: (a) substrate; (b) oiliness and superficial films; (c) margins and riparian vegetation; (d) solid waste; and (e) flow and obstructions. The redefinition of these categories sought to ensure legibility to the instrument in the school context, articulating scientific concepts, direct observation and critical interpretation of the socio-environmental reality.

The parameter referring to the type of bottom – sandy, muddy, rocky or mixed – was maintained as a structuring element of the evaluation, due to its ecological relevance for the understanding of erosion processes, siltation and dynamics of the benthic community (Callisto et al., 2002). Its adaptation involved the conceptual translation of the technical descriptors and the incorporation of comparative images, facilitating visual identification in the field. In an articulated way, the analysis of the presence of oiliness and superficial films began to be mediated by examples from everyday life and by photographic records of the stream itself, favoring the understanding of the relationships between urban runoff, effluent discharge and anthropogenic pressures, as indicated in the specialized literature (Montagner; Vidal; Acayaba, 2017).

The parameters related to the margins and riparian vegetation were expanded to include aspects such as stability, slope, occurrence of erosive processes and degree of vegetation cover, recognizing the sensitivity of these variables in the characterization of environmental degradation in urban areas (Rangel; Botelho, 2017; Pontini; Coelho, 2019).

With regard to solid waste, the classification adopted began to distinguish between floating materials, deposition in the bed, and accumulation on the banks, enabling the identification of spatial patterns and the inference of probable origins, in line with approaches proposed by Anjos, Vasconcelos, and Negreiros (2021). The interpretation of the flow incorporated the observation of visible changes in water velocity, the presence of physical barriers and interventions associated with urbanization, fundamental elements for understanding the local water dynamics and their links with soil sealing processes (Oliveira; Veloso; Rossoni, 2021). Together, the adapted parameters were anchored in empirical evidence produced in the field and later discussed with the students, strengthening the articulation between systematic observation, critical interpretation and socio-environmental learning.

5.4 VALIDATION THE DIDACTIC GUIDE WITH STUDENTS

The validation of the guide was configured as a process of shared critical reading, developed in the context of the analysis workshops, in which the students used the material to interpret the observations made in the field, review records produced and problematize divergences identified throughout the application of the PAR. This dynamic favored the construction of a dialogical space in which the guide operated as a mediator of the training process, in line with the assumptions of the EAC.

During this process, the following were observed: (a) the progressive appropriation of the technical language associated with environmental assessment, articulated with the capacity for contextual analysis of the observed phenomena; (b) the establishment of consistent relationships between the parameters evaluated and the social practices that affect the watercourse, indicating a broader socio-environmental understanding; (c) the strengthening of the investigative protagonism of the students, who began to recognize themselves as subjects who produced knowledge about the territory in which they are inserted; and (d) the coherence between the structure of the instrument and its application in the field, showing that the guide sustains consistent investigative practices that can be replicated in other school contexts. The validation of the guide, understood in this way, dialogues with analyses by Maciel and Sousa (2022) and Raupp, Franciscato and Lima (2019), when they indicate that educational products built from situated practices tend to constitute powerful and formative devices for the promotion of critical reflection and socio-environmental learning.

6 RESULTS AND DISCUSSIONS

The results of this research process show the formative potential of the didactic guide developed, as well as its effectiveness as an instrument of participatory environmental diagnosis. Such findings should be interpreted in the light of Critical Environmental Education, which understands the educational process as a social practice of producing meanings about the territory and the relationships that are established in it (Guimarães, 2013; Layrargues; Lima, 2014). In this context, the results indicate qualitative transformations in the ways in which students began to read, interpret and critically position themselves in the face of the socio-environmental conditions of the Água dos Peões stream, expanding their capacity for understanding and symbolic intervention in the local reality.

6.1 LEARNING: CRITICAL READING OF THE TERRITORY AND ECOLOGICAL UNDERSTANDING

In terms of learning, students have developed more refined analytical skills on the degradation processes of urban rivers. Initially, many participants had diffuse perceptions about water quality and the factors that contribute to its deterioration – a perception similar to that recorded in studies such as those by Maciel and Sousa (2022) and Santos and Corrêa (2020). However, after the application of the didactic guide and the completion of the field activities, a set of specific learnings emerged. First, students began to identify phenomena such as siltation, erosion of the banks, presence of solid waste, alteration of the flow and signs of contamination with greater precision, articulating these elements with urban dynamics and sanitation policies (Brasil, 2020b; Tucci, 2008). In addition, they recognized the importance of Permanent Preservation Areas (PPAs) and the ecosystem services provided by riparian vegetation, bringing their reading of the territory closer to the analyses found in Pontini and Coelho (2019) and Miranda, Botezelli, and Pamplin (2021).

Another significant learning refers to socio-environmental awareness¹⁶. The students' reports and records indicate that they understood environmental degradation as a consequence of human and political choices, management failures and historically

¹⁶ The field narratives produced throughout the research – which include students' speeches, interpretative conflicts that emerged during the application of the PAR, episodes that tensioned initial readings of the stream and records built in the observation process itself – are not developed in detail here, in view of the need for objectivity and conciseness that guides the article. Even so, it is important to note that such narratives constituted a central element of the research, as it revealed how the empirical experience in the watershed of the Água dos Peões stream mobilized disputes of meaning, revisions of perception and interpretative reconfigurations about the territory. The dissertation deepens these experiences, demonstrating how direct contact with the environment, mediated by the guide and the adapted PAR, expanded the students' analytical repertoire and favored the construction of meaningful learning, as indicated by Santos and Corrêa (2020) and Amorim (2021). In this text, the identification of general interpretative trends and consolidated results is privileged, to the detriment of the reproduction of specific narratives, in order to preserve the analytical focus on the educational product and its validation.

consolidated social practices – a perspective emphasized by Tucci (2005) and Tundisi (2014). In summary, the guide mediated learning about river ecology and, at the same time, contributed to a critical reading of the relationship between society and nature.

6.2 EFFECTIVENESS OF THE GUIDE IN ENVIRONMENTAL DIAGNOSIS: ACCURACY, AUTONOMY AND INTERPRETATION

The application of the guide was effective as a didactic-scientific tool. The students demonstrated the ability to correctly fill in the parameters of the adapted PAR, evaluating substrate, margins, flow, oiliness and presence of residues with coherence and precision. The comparison between the evaluations made by the participants and those recorded by the researcher indicates significant convergence, which reveals that the material was able to properly translate technical concepts without compromising their analytical quality, as recommended by Callisto et al. (2002), Anjos, Vasconcelos, and Negreiros (2021), and Oliveira, Veloso, and Rossoni (2021).

The autonomy of the students during the diagnosis is another indicator of the effectiveness of the guide. Unlike excessively technical protocols, whose application requires specialized training, the adapted material made it possible for groups of students to carry out direct observations, debates and internal deliberations on the scoring of the parameters. This autonomy is consistent with the logic of educational products proposed in the professional master's degrees (CAPES, 2019) and reinforces the importance of pedagogical instruments that democratize access to ecological knowledge. In addition, the results also indicate that the guide favored complex discussions on the causes and consequences of degradation, articulating the empirical diagnosis with broader socio-environmental interpretations, as suggested by the studies consulted in our "theoretical framework" – section two –, and certain documents that currently discipline/regulate Environmental Education in Brazil and Paraná¹⁷.

¹⁷ The articulation of Menezes' (2023) research with the National Common Curricular Base (Brasil, 2018), with the Curriculum of the State Network of Paraná – CREP (2018; 2021) and with the guiding documents of EE in Brazil is not developed extensively in this article, since these curricular and normative references constitute a broad set of documents, whose analysis would require a specific section. However, it should be noted that the conception, structure, and application of the didactic guide dialogue with the principles and competencies provided for in these milestones, especially with regard to argumentation, scientific investigation, socio-environmental responsibility, and the critical reading of the territory (BNCC, 2018). In the dissertation, it is demonstrated how such competencies are materialized in pedagogical practice through the diagnosis of urban rivers, articulating contents of Natural Sciences, Geography and Critical Environmental Education in an interdisciplinary perspective. In this article, we choose to privilege the presentation of the guide as an educational product and the description of its methodological dynamics.

6.3 COMPARISON WITH OTHER MATERIALS AND APPROACHES FOUND IN THE LITERATURE

The comparative analysis allows us to observe that the guide constructed presents singularities that differentiate it from other didactic materials and protocols presented in the literature. First, materials such as those by Machado (2019) and Amorim (2021) emphasize the didactic dimension of adapted PARs; however, they maintain structures closer to the original technical models. The guide produced by this research, in turn, presents greater integration between concept, visuality and socio-environmental contextualization, which enhances its critical function.

In addition, while traditional protocols – such as those applied in Pontini and Coelho (2019), Lima et al. (2017) and Silva et al. (2019) – use parameters that are difficult to translate into the school environment, the guide of this research simplifies, without impoverishing, the language and evaluation criteria. This dialogical simplification is a relevant innovation for teaching practice, especially in public schools. Another significant difference lies in the reflective character of the guide: instead of being a solely evaluative instrument, it incorporates activities of synthesis, discussion and articulation with public policies, which do not exist in conventional environmental protocols. This characteristic brings it closer to what Guimarães (2013) identifies as the transformative praxis of EAC.

6.4 POTENTIAL FOR REPLICATION IN OTHER SCHOOLS AND MUNICIPALITIES

The analysis of the results allows us to affirm that the guide has high potential for replication and scalability. Its modular structure, accessible language, detailed visuality and methodological coherence allow it to be applied in different territorial realities – whether urban, peri-urban or rural – as long as there is a viable water body for observation. From an institutional point of view, the guide converges with the National Common Curricular Base (Brasil, 2018) and with the state Curricular Frameworks (Paraná, 2018), which emphasize competencies related to scientific research, understanding the territory, and sustainability. This curricular convergence strengthens its applicability in public school systems.

In the context of environmental management, the guide can serve as a complementary tool for participatory monitoring, expanding democratic mechanisms for monitoring water quality, as proposed by Tundisi (2014), Cirilo (2019) and the National Water Resources Policy (Brasil, 1997). Thus, in addition to its pedagogical value, the instrument has social and institutional utility. Finally, the engagement of the students and the autonomy demonstrated throughout the application of the protocol constitute evidence that the guide can foster continuous educational processes, not restricted to the punctual intervention of the research.

Replicability, therefore, is not only technical, but also political, as it stimulates the formation of critical subjects capable of acting and intervening in their communities.

7 INTERDISCIPLINARY CONTRIBUTIONS

The construction and application of the didactic guide show its interdisciplinary character and its ability to integrate knowledge from Education, Ecology, Geography and Environmental Policies. This interdisciplinarity, far from being a mere conceptual adornment, constitutes a structuring element of the educational product and constitutes one of the main scientific contributions of this research to the field of Teaching and Environmental Sciences.

7.1 INTERSECTIONS BETWEEN EDUCATION, ECOLOGY AND GEOGRAPHY: THE CRITICAL READING OF THE TERRITORY

The first interdisciplinary contribution is manifested in the way the guide articulates principles of Critical Environmental Education (Guimarães, 2013; Layrargues; Lima, 2014) with ecological and geographical foundations on the functioning of urban rivers. Such articulation allows students to recognize the environment as (i) a natural scenario and, above all, (ii) a geographical scenario historically produced and marked by socio-environmental conflicts – a perspective that dialogues with Tucci (2008) and Tundisi (2014).

In the field of ecology, the guide translates processes such as siltation, substrate quality, flow dynamics, and integrity of riparian zones into observable and measurable parameters. However, this translation is not reductionist: it incorporates historical, social and cultural dimensions associated with human occupation of the margins, approaching studies that understand water degradation as a synthesis of multiple urban pressures (Montagner; Vidal; Acayaba, 2017; Nova; Tenório, 2019).

From a geographical point of view, the analysis of the stream as part of a larger hydrographic basin – influenced by land use patterns, urban infrastructure and socio-spatial relations – allowed the students to operate with different scales, understanding the river as a key element of territorial organization, which is also mathematically relevant. This approach strengthens skills in landscape reading, cartographic interpretation, and recognition of geomorphological processes (Paraná, 2006/2013/2020; IAT, 2011), reaffirming the interdisciplinary character of the activity. In this way, the guide highlights what the literature points out as the foundation of environmental interdisciplinarity: the understanding of the territory as a unit of analysis in which natural and social processes are inextricably intertwined.

7.2 PUBLIC POLICIES FOR THE ENVIRONMENT AND EDUCATION: TRANSVERSALITY AND CRITICALITY

Interdisciplinarity is also materialized in the relationship between the content of the guide and the legal frameworks of Brazilian public policies. The National Policy on Water Resources (Brazil, 1997), the National Policy on Environmental Education (Brazil, 1999), Conama Resolution No. 357 (Brazil, 2005) and the National Common Curriculum Base (Brazil, 2018) converge in demanding educational processes that integrate technical knowledge, social participation, and research on local realities (Brazil, 2007). In view of this, the guide responds to these demands by proposing an investigative practice in which students carry out environmental diagnosis in a contextualized way.

At the interface between education and politics, the material favors the understanding that water management is a shared responsibility between the State, society, and the school – a view present in Cirilo (2019) and reaffirmed by studies on water governance (Tucci, 2005; Prado; Johnsson; Marques, 2017). It is not by chance that this articulation reinforces that the analysis of an urban river is, in addition to an ecological exercise, a practice of environmental citizenship that exposes inequalities, management omissions, and possibilities for social intervention. It is an interdisciplinary contribution useful for the critical training of students and potentially relevant for the dialogue between schools and environmental agencies.

From this perspective, the transversal aspects of the research that is the basis of this article can be understood as formative dimensions that cross the different curricular components and fields of knowledge, conferring pedagogical, evaluative and social unity to the practices developed, without depending exclusively on processes of epistemological integration between disciplines. Within this approach, EE assumes the role of a structuring transversal axis, by guiding the critical reading of the territory, the problematization of the relations between society and nature, and the formation of ethical dispositions aimed at socio-environmental responsibility. This dimension permeates field activities, the application of the PAR, the production of reports and the discussions held in the classroom, manifesting itself recurrently in the Sciences and Geography, as well as in the Portuguese Language, Mathematics, Art and Human Sciences, without being limited to a specific curricular component. The environment operates, in this way, as a cross-cutting theme capable of articulating values, educational purposes and formative meanings, in line with the guiding documents of EE in Brazil.

Another relevant cross-cutting aspect concerns citizenship education and social participation, since the research mobilizes reflections on the right to water, the public function of water bodies, municipal management and the production of diagnoses that dialogue with

the public power. These elements cross the different stages of the work, promoting the development of skills related to argumentation, collective responsibility and ethical positioning in the face of socio-environmental problems, regardless of the disciplinary area from which they are approached.

The scientific and institutional language also assumes a transversal character, as it permeates the production of field records, the organization of data, the preparation of the technical report and the socialization of the results. The use of formal language, the appropriation of textual genres typical of science and public management, and the construction of argumentative narratives cross the entire pedagogical process, articulating reading, writing, and communication practices in different areas.

Finally, the valorization of the lived territory is configured as a transversal dimension by promoting the recognition of the local space as a legitimate object of knowledge, reflection and intervention. This perspective crosses the curriculum by connecting school content to students' daily experiences, favoring the feeling of belonging, the critical reading of the place and the understanding of socio-environmental inequalities as historical and social constructions. In this way, the transversality of the research is expressed by the continuous circulation of values, problems and educational purposes – especially those related to the environment, citizenship, language and territory – that cross the different areas of knowledge.

7.3 THE DIDACTIC GUIDE AS AN INSTRUMENT OF ACTIVE INTERDISCIPLINARITY

The guide, in addition to being interdisciplinary in its foundation, operates as an instrument of active interdisciplinarity, allowing different areas to interpenetrate each other in pedagogical practice. This characteristic reflects a movement of rupture with the curricular fragmentation typical of basic education and with merely ecological, depoliticized or decontextualized approaches to the reality of urban rivers. In this sense, the material invites teachers of Science, Geography, Mathematics, Art and even Portuguese Language to work together, articulating empirical investigation, environmental interpretation and argumentative expression¹⁸. Interdisciplinarity emerges, in this way, as a concrete practice: students

¹⁸ The study on which this article is based has the potential for broad interdisciplinary articulation, since the socio-environmental diagnosis of urban rivers, mediated by adapted PAR, mobilizes knowledge and practices from different fields of knowledge in an integrated and situated way. In the field of Natural Sciences, the protocol favors the understanding of ecological processes related to fluvial dynamics, environmental quality, biodiversity and anthropogenic impacts on aquatic ecosystems. In dialogue with Geography, the reading of the stream as a structuring element of the territory makes it possible to analyze the hydrographic basin as a spatial unit, articulating relief, land use and occupation, urbanization, water flows and scales of analysis. Critical Environmental Education operates as an integrating axis of this process, by guiding the interpretation of data beyond the technical description, incorporating ethical, political and formative dimensions that connect nature, society and social practices. The interface with Sociology and Political Science emerges in the analysis of socio-environmental inequalities, the relations between the State, community and public policies, as well as in the problematization of water governance, urban planning and social participation. Anthropology contributes by

observe ecological phenomena, situate them geographically, critically analyze them in the light of public policies and communicate their conclusions in a structured way – a process that echoes the reflections of Guimarães (2013) on a critical reading of the world. In addition, the guide fosters competencies that go beyond traditional disciplinary boundaries, such as systems thinking, multi-scale analysis, and integration of empirical evidence with theoretical frameworks. This approach is in line with the conception of interdisciplinarity as a "cognitive and political strategy" present in the studies of Riojas (2003), reaffirming that complex socio-environmental problems require equally complex instruments.

7.4 INTERDISCIPLINARITY AND POTENTIAL FOR SOCIAL TRANSFORMATION

Finally, the interdisciplinary character of the guide is also manifested in its potential for social transformation¹⁹. By promoting the critical analysis of the watershed and by bringing the school closer to the issues of municipal water management, the educational product contributes to the construction of subjects capable of understanding and intervening in their

allowing the understanding of perceptions, narratives, cultural practices and forms of symbolic appropriation of the river by the subjects, recognizing the watercourse as a lived and socially signified space. Mathematics is mobilized in the reading of scales, in the organization of data, in the comparison of scores and in the construction of quantitative syntheses that help environmental interpretation, without losing sight of its insertion in broader qualitative contexts. Art is integrated into the process through the photographic record of the points evaluated, the choice of framing, the visual composition and the aesthetic reading of the landscape, contributing to the development of the sensitive look and to the construction of visual narratives about the territory. The Portuguese language crosses the entire investigative path by structuring the production of technical reports, the argumentative organization of the results, the use of formal language and the appropriation of textual typologies typical of the scientific field and public management. Other areas, such as History, by contextualizing the processes of occupation and transformation of the territory, and Information Technology, in the treatment and organization of records, can also be incorporated in a transversal way. This articulation does not occur through the juxtaposition of contents: it is made effective through an organic correlation between knowledge, practices and languages, making the environmental diagnosis an interdisciplinary pedagogical device capable of integrating scientific reading, social analysis, cultural expression and critical training.

¹⁹ The experiential dimension of interdisciplinarity, central to the research on which this article is based, is addressed here in a synthetic way, since its analytical development would require mobilizing theoretical references related to corporeality, environmental perception, the pedagogies of the sensible and the processes of subjectivation, which would significantly expand the scope between didactic methodology and critical training. In the dissertation, this dimension is expressed in the direct experience of students on the banks of the Água dos Peões stream, in episodes of estrangement, discomfort and recognition of the dynamics of degradation, as well as in the situated production of meanings about the territory, configuring an intrinsic interdisciplinary exercise that articulates ecology, geography, critical environmental education and sociopolitical reading of space. Such experiences constitute fundamental socio-environmental mediations of the educational process, as discussed by Guimarães (2013) and Layrargues and Lima (2014), as they favor the construction of interpretations that link empirical observation, critical reflection and ethical-political positioning. In an articulated way, the socio-environmental critique that structures the dissertation – oriented to the understanding of water inequalities, the social production of river degradation and the tensions between State, territory and community – is dealt with in this article only indirectly, in order to avoid shifting the discussion to a broader socio-political analysis. Its deepening would imply examining issues such as environmental injustice, poor sanitation, territorial vulnerabilities and conflicts over the use of water (Montagner; Vidal; Acayaba, 2017; Nova; Tenório, 2019), constitutive themes of the basic research that, however, exceed the purpose of this text, centered on the elaboration, adaptation and validation of the didactic guide as an educational product. In this way, the option adopted corresponds to an analytical delimitation without prejudice to the recognition that experiential interdisciplinarity and socio-environmental criticism constitute structuring foundations of research and its formative developments.

socio-environmental reality. This perspective breaks with the myth of neutrality of environmental content and positions the guide as a tool for strengthening democracy. If, as Guimarães (2013) argues, EAC is an emancipatory educational practice, then interdisciplinarity is a methodological option and, above all, a condition for the formation of situated, analytically and politically active/critical environmental awareness.

8 CONCLUSION

The present study sought to understand to what extent a didactic guide, developed from an adapted PAR, could contribute to the critical education of elementary school students and to the participatory diagnosis of urban rivers, taking the Água dos Peões stream as its locus, in the municipality of Janiópolis (PR). The question that guided the entire process – **how can a didactic guide based on an adapted PAR promote critical environmental learning and assist in reading the socio-ecological reality of urban rivers?** – was faced in an articulated way between theory, methodology and pedagogical practice, allowing for consistent responses, although necessarily provisional and situated.

When returning to the objectives outlined at the beginning of the investigation, it is observed that they were met/answered as the process of research and pedagogical intervention itself complexified the initial understanding of the problem. The first objective – to present the theoretical and methodological foundations that supported the elaboration of the guide – was contemplated through the critical integration between literature on urban water resources, Rapid Assessment Protocols and Critical Environmental Education. This articulation demonstrated that the guide is a didactic material and, together, an **epistemological artifact** built from conceptual choices that reaffirm the centrality of the critical reading of the territory and the active participation of students.

The second objective – to describe the process of construction and adaptation of the PAR – was achieved, revealing that the didactic transposition of the traditional parameters of the protocols required technical adjustments and pedagogical decisions based on principles of conceptual clarity, accessibility, ecological relevance and adequacy to the material conditions of the school. In this sense, the guide was consolidated as a **product** whose consistency derived from (i) the literature that supports it and (ii) the adherence between its parameters and the ecological and socio-territorial reality of the analyzed stream.

The third objective – to analyze the application and validation of the guide with the students – was met through the investigation of the learning mobilized during the workshops and fieldwork. The results showed that the guide expanded the students' ability to identify anthropogenic pressures, understand ecological dynamics, interpret environmental

evidence, and relate forms of urban occupation to patterns of water degradation. More than that, it stimulated critical questioning about the role of the community, the public power and the school itself in the conservation of urban rivers, evidencing its potential as an instrument of critical education aligned with the principles of EAC.

The fourth objective – to discuss the potential of the guide as an interdisciplinary educational product – was fully met. The structure of the material demonstrated articulations between knowledge from ecology, geography, chemistry, environmental policies and social sciences, bringing students closer to a more integrated and complex understanding of the phenomena analyzed. In addition, the guide proved to be able to promote the transition between reading the environment, critical analysis and reasoned argumentation, essential aspects for a citizen education committed to the democratic management of the commons, as recommended by the PNREH (Brazil, 1997) and SDG 6 (UN, 2015).

The results show, therefore, that the research problem was answered: **the didactic guide, when used as a structured methodological mediation, enabled students to carry out coherent environmental diagnoses, develop analytical and interpretative skills and recognize the socio-environmental conflicts that cross urban rivers.** In addition, it allowed students to approach the territory in a critical way, providing elements for them to understand the political, ecological and social character of water management in their municipality.

Regarding the relevance of the study, its potential for educational and public impact is highlighted. In small municipalities, such as Janiópolis (PR), where environmental monitoring structures are scarce and community participation is historically limited, pedagogical tools such as this guide can represent important catalysts for training processes and social mobilization. The guide offers a tool that is **simple to use, low cost, highly replicable and scientifically based**, making it able to subsidize schools, educators, community projects and even municipal initiatives for the diagnosis and management of watersheds. However, like any applied study, this one has limits that must be recognized.

The use of the guide was tested in a specific context, with a limited number of students, in a short time frame and concentrated in a single microbasin. Although consistent, the results do not allow automatic generalizations, and the pedagogical nature of the adapted protocol does not replace deeper physicochemical analyses. In addition, the students' understanding, although significant, could be expanded through longitudinal monitoring processes, recurrence of activities over different school years, comparisons between schools and effective integration with given public policies. These limits, however, constitute **future potentialities**. Subsequent research may investigate: (a) the application of the guide in

different municipalities/socio-environmental realities; (b) impacts of the activity on citizenship education in the long term; (c) its integration with municipal environmental councils; (d) its use in conjunction with the Master Plan and other territorial planning instruments; (e) or the expansion of the protocol with simplified physicochemical indicators for school use.

The contributions of this work are simultaneously aligned with the educational field and the sphere of local environmental management. The didactic guide emerges as an educational technology with the potential to strengthen student protagonism, qualify the critical reading of the territory, democratize access to scientific knowledge and stimulate social participation in water management. In municipalities such as Janiópolis/PR, which live with continuous impacts of water degradation and have limited institutional structures, instruments of this nature are, in addition to pedagogical materials, **devices of environmental citizenship**, capable of bringing together school, territory and community around the defense of water resources as common goods. In view of this, this study reaffirms that educational practices grounded, contextualized and guided by EAC can play decisive roles in the formation of subjects capable of understanding and transforming the socio-environmental reality in which they live. The guide developed and analyzed constitutes a contribution in this sense and opens promising paths for new research, policies and pedagogical actions committed to sustainability, environmental justice and the democratic management of water resources.

REFERENCES

- Amorim, A. F. A. (2021). Ferramenta para o ensino de educação ambiental na avaliação ecológica de riachos urbanos [Dissertação de mestrado, Universidade de Brasília]. Repositório Institucional da UnB. https://repositorio.unb.br/bitstream/10482/42511/1/2021_AnwarFaizAhmadAmorim.pdf
- Andrade, L. C., & cols. (2019). Lago Guaíba: Uma análise histórico-cultural da poluição hídrica em Porto Alegre, RS, Brasil. *Engenharia Sanitária e Ambiental*, 24(2), 229–237. <https://www.scielo.br/j/esa/a/8fQdYrLS3wCKtRdcY4D8Ztz/?format=html&lang=pt>
- Anjos, A. P. R., Vasconcelos, F. C. W., & Negreiros, D. (2021). Diagnóstico ambiental do córrego do Bálsamo, Ibirité – MG, por meio de um protocolo de avaliação rápida. *Acta Geográfica*, 15(39), 42–61. <https://revista.ufrr.br/actageo/article/view/5041/3464>
- Bardin, L. (2016). *Análise de conteúdo*. Edições 70.
- Bersot, M. R. O. B., Menezes, J. M., & Andrade, S. F. de. (2015). Aplicação do Protocolo de Avaliação Rápida de Rios (PAR) na bacia hidrográfica do rio Imbé-RJ. *Ambiência*, 11(2), 277–294. <https://core.ac.uk/reader/230458610>
- Brasil. (1981). Lei nº 6.938, de 31 de agosto de 1981. Dispõe sobre a Política Nacional do Meio Ambiente. <http://www.progere.ufc.br/wp-content/uploads/2015/08/Lei-6.938-de-31-de-agosto-de-1981-Pol%C3%ADtica-Nacional-do-Meio-Ambiente.pdf>

- Brasil. (1988). Constituição da República Federativa do Brasil. Senado Federal. https://www2.senado.leg.br/bdsf/bitstream/handle/id/566968/CF88_EC105_livro.pdf
- Brasil. (1997). Lei nº 9.433, de 8 de janeiro de 1997. Institui a Política Nacional de Recursos Hídricos. <https://progestao.ana.gov.br/portal/progestao/destaque-superior/eventos/oficinas-de-intercambio-1/outorga/sao-luis-2019/lei-9433-1997-recursos-hidricos.pdf/view>
- Brasil. (1999). Lei nº 9.795, de 27 de abril de 1999. Dispõe sobre a educação ambiental. <http://portal.mec.gov.br/secad/arquivos/pdf/educacaoambiental/lei9795.pdf>
- Brasil. (2000). Lei nº 9.984, de 17 de julho de 2000. Cria a Agência Nacional de Águas. http://www.planalto.gov.br/ccivil_03/leis/L9984.htm#art30
- Brasil. (2005). Resolução Conama nº 357, de 17 de março de 2005. Dispõe sobre a classificação dos corpos de água. https://www.icmbio.gov.br/cepsul/images/stories/legislacao/Resolucao/2005/res_conama_357_2005_classificacao_corpos_agua_rtfcdaltrd_res_393_2007_397_2008_410_2009_430_2011.pdf
- Brasil. Ministério da Educação. (2007). Educação ambiental: Aprendizizes de sustentabilidade (Cadernos Secad 1). <http://portal.mec.gov.br/dmdocuments/publicacao2.pdf>
- Brasil. Conselho Nacional de Educação. (2012). Resolução CNE/CP nº 2, de 15 de junho de 2012. Estabelece as Diretrizes Curriculares Nacionais para a Educação Ambiental. http://portal.mec.gov.br/dmdocuments/rcp002_12.pdf
- Brasil. Ministério da Educação. (2018). Base Nacional Comum Curricular (BNCC). http://basenacionalcomum.mec.gov.br/images/BNCC_EI_EF_110518_versaofinal_site.pdf
- Brasil. Agência Nacional de Águas e Saneamento Básico. (2020a). Conjuntura dos recursos hídricos no Brasil 2020: Informe anual. <https://www.snirh.gov.br/portal/centrais-de-conteudos/conjuntura-dos-recursos-hidricos/conjuntura-2020>
- Brasil. (2020b). Lei nº 14.026, de 15 de julho de 2020. Atualiza o marco legal do saneamento básico. <https://cetesb.sp.gov.br/aguas-interiores/wp-content/uploads/sites/12/2021/08/Lei-Federal-no-14.026-DE-15-DE-JULHO-DE-2020.pdf>
- Brasil. Agência Nacional de Águas e Saneamento Básico. (2021). Conjuntura dos recursos hídricos no Brasil 2021: Relatório pleno. <https://relatorio-conjuntura-ana-2021.webflow.io/>
- Callisto, M., & cols. (2002). Aplicação de um protocolo de avaliação rápida da diversidade de habitats em atividades de ensino e pesquisa (MG-RJ). Acta Limnologica Brasiliensia, 14(1), 91–98. https://www.researchgate.net/publication/320258459_Aplicacao_de_um_protocolo_de_avaliacao_rapida_da_diversidade_de_habitats_em_atividades_de_ensino_e_pesquisa_MG-RJ
- CAPES. (2019). Documento de área 46 – Ensino. <https://www.gov.br/capes/pt-br/centrais-de-conteudo/ensino1.pdf>
- Cirilo, B. B. (2019). Elemento de benção, região de maldição: Uma análise da gestão de recursos hídricos no Estado do Pará [Tese de doutorado, Universidade Federal do Pará]. Repositório Institucional da UFPA. <http://repositorio.ufpa.br/jspui/handle/2011/11909>

- Dangui, J. (2022). História de Janiópolis: Querido rincão. Nova História Editora e Gestão Cultural.
- Fontana, F. (2018). Técnicas de pesquisa. In A. V. Zambello et al. (Orgs.), Metodologia da pesquisa e do trabalho científico. FUNEPE. <http://funepe.edu.br/arquivos/publicacoes/metodologia-pesquisa-trabalho-cientifico.pdf>
- Fontana, F., & Rosa, M. P. (2021). Observação, questionário, entrevista e grupo focal. In C. A. O. Magalhães Júnior & M. C. Batista (Orgs.), Metodologia da pesquisa em educação e ensino de ciências. Massoni.
- Gaspi, S., Maron, L. H. P., & Magalhães Júnior, C. A. O. (2021). Análise de conteúdo numa perspectiva de Bardin. In C. A. O. Magalhães Júnior & M. C. Batista (Orgs.), Metodologia da pesquisa em educação e ensino de ciências. Massoni.
- Gil, A. C. (2008). Métodos e técnicas de pesquisa social. Atlas.
- Gonçalves, C. É. L. C., & cols. (2019). (Alguns) desafios para os produtos educacionais nos mestrados profissionais nas áreas de ensino e educação. Educitec, 5(10), 74–87. <https://sistemascmc.ifam.edu.br/educitec/index.php/educitec/article/view/500/259>
- Gonçalves, F., & cols. (2017). Evolução da legislação brasileira sobre recursos hídricos. In Anais do XVII Simpósio Brasileiro de Geografia Física Aplicada (pp. 806–817). UNICAMP. <https://ocs.ige.unicamp.br/ojs/sbgfa/article/view/1835>
- Guimarães, A., Rodrigues, A. S. L., & Malafaia, G. (2012). Adequação de um protocolo de avaliação rápida de rios para ser usado por estudantes do ensino fundamental. Ambiente & Água, 7(3), 241–260. <https://www.scielo.br/pdf/ambiagua/v7n3/v7n3a19.pdf>
- Guimarães, M. (2004). Educação ambiental crítica. In P. P. Layrargues (Coord.), Identidades da educação ambiental brasileira (pp. 25–34). Ministério do Meio Ambiente. <http://www.forumeja.org.br/ea/files/Identidades%20da%20Educa%C3%A7%C3%A3o%20Ambiental%20Brasileira.pdf>
- Guimarães, M. (2013). Por uma educação ambiental crítica na sociedade atual. Margens Interdisciplinares, 7(9), 11–22. <https://periodicos.ufpa.br/index.php/revistamargens/article/view/2767>
- Instituto Água e Terra. (2011). Rede hidrográfica ottocodificada. <http://www.iat.pr.gov.br/Pagina/Mapas-e-Dados-Espaciais#>
- Instituto Brasileiro de Geografia e Estatística. (2022). Cidades e estados: Janiópolis. <https://www.ibge.gov.br/cidades-e-estados/pr/janiopolis.html>
- Instituto Paranaense de Desenvolvimento Econômico e Social. (2025). Perfil do município de Janiópolis. http://www.ipardes.gov.br/perfil_municipal/MontaPerfil.php?codlocal=343&btOk=ok
- Kauark, F. S., Manhães, F. C., & Medeiros, C. H. (2010). Metodologia da pesquisa: Um guia prático. Via Litterarum.
- Layrargues, P. P., & Lima, G. F. C. (2014). As macrotendências político-pedagógicas da educação ambiental brasileira. Ambiente & Sociedade, 17(1), 23–40. <https://www.scielo.br/j/asoc/a/8FP6nynhjdZ4hYdqVFdYRtx/?lang=pt&format=pdf>
- Leff, E. (Coord.). (2003). A complexidade ambiental (E. Wolff, Trad.). Cortez.
- Lima, P. A. C., & cols. (2017). Avaliação ambiental do ribeirão do Inferno em Grão Mogol – MG, através de um protocolo de avaliação rápida de rios. In Anais do IX Simpósio

Brasileiro de Engenharia Ambiental (pp. 1–8). Faculdades Santo Agostinho. <https://www.proceedings.blucher.com.br/article-details/avaliacao-ambiental-do-ribeiro-do-inferno-em-gro-mogol-mg-atravs-de-um-protocolo-de-avaliacao-rpida-de-rios-26770>

Machado, A. P. F. (2019). Adaptação de um protocolo de avaliação rápida de rios e sua utilização como recurso didático em educação ambiental no ensino médio [Dissertação de mestrado, Instituto Federal de Educação, Ciência e Tecnologia Goiano]. Repositório Institucional do IF Goiano. https://repositorio.ifgoiano.edu.br/bitstream/prefix/385/1/Disserta%c3%a7%c3%a3o_An%c3%a1a%20Paula%20Favorito.pdf

Maciel, S. A., & Sousa, F. W. A. (2022). Educação ambiental e conservação hídrica do rio Poti em Teresina – PI. Meio Ambiente e Sustentabilidade, 11(22), 72–84. <https://www.revistasuninter.com/revistameioambiente/index.php/meioAmbiente/article/view/1010>

Menezes, H. de O. (2023). Utilização de guia didático com protocolo de avaliação rápida no diagnóstico de sistemas hídricos urbanos [Dissertação de mestrado, Universidade Estadual de Maringá]. <https://dci.uem.br/ProfCiamb/publicacoes/dissertacoes>

Minayo, M. C. S. (Org.). (2001). Pesquisa social: Teoria, método e criatividade. Vozes.

Miranda, R. F., Botezelli, L., & Pamplin, P. A. Z. (2021). Conservação ambiental em zonas ripárias de dois córregos urbanos no município de Três Pontas, sul de Minas Gerais. Pesquisa, Sociedade e Desenvolvimento, 10(13), 1–11. <https://rsdjournal.org/index.php/rsd/article/view/21184/18940>

Montagner, C. C., Vidal, C., & Acayaba, R. D. (2017). Contaminantes emergentes em matrizes aquáticas do Brasil: Cenário atual e aspectos analíticos, ecotoxicológicos e regulatórios. Química Nova, 40(9), 1094–1110. <https://www.scielo.br/j/qn/a/NJr4QLWkxCkXJd6gHvdwtNk/?format=pdf&lang=pt>

Nova, F. V. P. V., & Tenório, N. B. (2019). Doenças de veiculação hídrica associadas à degradação dos recursos hídricos, município de Caruaru – PE. Caminhos de Geografia, 20(71), 250–264. <http://www.seer.ufu.br/index.php/caminhosdegeografia/article/view/45545>

Oliveira, E. S., Veloso, J. H. P., & Rossoni, H. A. V. (2021). Aplicação do protocolo de avaliação rápida (PAR) na caracterização da qualidade ambiental de trechos do rio Piumhi, Minas Gerais – Brasil. ForScience, 9(2), 1–17. <http://www.forscience.ifmg.edu.br/forscience/index.php/forscience/article/view/968/346>

Organização das Nações Unidas. (2015). Transformando nosso mundo: A Agenda 2030 para o Desenvolvimento Sustentável. <http://svs.aids.gov.br/dantps/acesso-a-informacao/acoes-e-programas/ods/publicacoes/transformando-nosso-mundo-a-agenda-2030-para-o-desenvolvimento-sustentavel.pdf>

Paraná. (2006). Atlas geomorfológico do Estado do Paraná – Escala base 1:250.000. Minerais do Paraná/Universidade Federal do Paraná. http://www.iat.pr.gov.br/sites/agua-terra/arquivos_restritos/files/documento/2020-04/atlas_geomorforlogico_parana_2006.pdf

Paraná. (2013). Lei nº 17.505, de 11 de janeiro de 2013. Política Estadual de Educação Ambiental. <http://www.uel.br/prograd/docentes/documentos/pp/lei17505.pdf>

Paraná. Secretaria de Estado da Educação. (2018). Referencial curricular do Paraná: Princípios, direitos e orientações.

http://www.educadores.diaadia.pr.gov.br/arquivos/File/bncc/2018/referencial_curricular_parana_cee.pdf

Paraná. (2020). Decreto nº 4.230, de 16 de março de 2020. <https://www.legisweb.com.br/legislacao/?id=390948>

Paraná. Secretaria de Estado da Educação. (2021). Currículo priorizado da rede estadual de ensino 2021 – CREP. <https://drive.google.com/file/d/11FEgKLPjP0bWmSkNrVLDbmFgbajKA4gD/view>

Pedroso, L. B., & Colesanti, M. T. M. (2018). Aplicação do protocolo de avaliação rápida de rios durante período de estiagem em trechos da bacia hidrográfica do ribeirão da Areia, Goiás. *Revista de Geografia*, 35(3), 248–268. <https://periodicos.ufpe.br/revistas/revistageografia/article/view/229351>

Prefeitura Municipal de Janiópolis. (2022). Plano diretor do município de Janiópolis – PR.

Pontini, V. V., & Coelho, A. L. N. (2019). Emprego de protocolo de avaliação rápida no diagnóstico ambiental de sistemas fluviais: Estudo de caso em áreas urbanas de Iconha e Piúma (ES). *Geotextos*, 15(2), 175–196. <https://periodicos.ufba.br/index.php/geotextos/article/view/32409/20223>

Projeto Político Pedagógico. (2022). Escola Estadual Dom Pedro II – Ensino Fundamental, Janiópolis.

Prado, R. B., Johnsson, R. M. F., & Marques, G. (2017). Uso e gestão da água: Desafios para a sustentabilidade no meio rural. *Boletim Informativo da SBCS*. <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/167338/1/2017-043.pdf>

Rangel, L. A., & Botelho, R. G. M. (2017). Análise ambiental da trilha Sahy-Rubião no Parque Estadual Cunhambebe em Mangaratiba (RJ) por meio de um protocolo de avaliação rápida. *Geo UERJ*, 30, 391–418. <https://www.e-publicacoes.uerj.br/index.php/geouerj/article/view/23655/20931>

Raupp, D. T., Fransciscato, L., & Lima, L. B. (2019). Abordando a temática poluição hídrica no Ensino Médio: Uma proposta de sequência didática com foco nos contaminantes emergentes para o ensino de funções orgânicas mistas. *Revista Brasileira de Ensino de Ciências e Matemática*, 2(2), 407–430. <http://seer.upf.br/index.php/rbecm/article/view/10015/114115183>

Riojas, J. (2003). A complexidade ambiental na universidade. In E. Leff (Coord.), *A complexidade ambiental* (E. Wolff, Trad.). Cortez.

Rodrigues, J. N. (2017). Aplicação de um protocolo de avaliação rápida de impacto ambiental no córrego Tanque do Fanchão no município de Várzea Grande – MT [Trabalho de conclusão de curso, UNIVAG Centro Universitário]. Repositório Digital UNIVAG. <https://www.repositoriodigital.univag.com.br/index.php/bio/article/view/457/451>

Roos, A., & Becker, E. L. S. (2012). Educação ambiental e sustentabilidade. *Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental*, 5(5), 857–866. <https://periodicos.ufsm.br/reget/article/viewFile/4259/3035>

Rosa, C. T. W., & Batista, M. C. (2021). A pesquisa e os produtos educacionais nos programas profissionais. In C. A. O. Magalhães Júnior & M. C. Batista (Orgs.), *Metodologia da pesquisa em educação e ensino de ciências*. Massoni.

Santos, K. O., & Correa, S. J. (2020). Oficina de educação ambiental na Casa do Caminho: Uma discussão a respeito da poluição do solo e poluição hídrica. In E. C. Torres (Org.),

Educação ambiental e Geografia VI: Sensibilizações, práticas e desafios. https://www.academia.edu/42120521/Educa%C3%A7%C3%A3o_Ambiental_e_Geografia_VI_Sensibiliza%C3%A7%C3%B5es_pr%C3%A1ticas_e_desafios_Org_Eloiza_Cristiane_Torres

Silva, A. C., & cols. (2019). Protocolo de avaliação rápida da qualidade ambiental aplicado a um trecho do córrego do Onça, em Belo Horizonte, Minas Gerais. In Anais do X Congresso Brasileiro de Gestão Ambiental (pp. 1–8). IBEAS. <https://www.ibeas.org.br/congresso/Trabalhos2019/XI-091.pdf>

Silva, A. H., & Fossá, M. I. T. (2015). Análise de conteúdo: Exemplo de aplicação da técnica para análise de dados qualitativos. *Qualitas Revista Eletrônica*, 17(1), 1–14. <http://www.fei.am.gov.br/wp-content/uploads/2020/06/2113-7552-1-PB.pdf>

Silveira, D. T., & Córdova, F. P. (2009). A pesquisa científica. In T. E. Gerhardt & D. T. Silveira (Orgs.), *Métodos de pesquisa*. UFRGS.

Tucci, C. E. M. (2005). Gestão de águas pluviais urbanas. Unesco. https://files.cercomp.ufg.br/weby/up/285/o/Gest%C3%A3o_de_Aguas_Pluviais__.PDF?1370615799

Tucci, C. E. M. (2008). Águas urbanas. *Estudos Avançados*, 22(63), 97–112. <https://www.scielo.br/pdf/ea/v22n63/v22n63a07.pdf>

Tundisi, J. G. (Coord.). (2014). Recursos hídricos no Brasil: Problemas, desafios e estratégia. Academia Brasileira de Ciências. <http://www.abc.org.br/IMG/pdf/doc-5923.pdf>

Tundisi, J. G., & Matsumura-Tundisi, T. (2020). A água. *Scienza*. https://sbhsf.com.br/wp-content/uploads/2020/08/novo_A_AGUA.pdf

THEATRE BETWEEN MANAUS AND PARINTINS: STAGES AND MEMORIES

TEATRO ENTRE MANAUS E PARINTINS: PALCOS E MEMÓRIAS

TEATRO ENTRE MANAOS Y PARINTINS: ESCENARIOS Y MEMORIAS

<https://doi.org/10.56238/sevened2026.008-206>Dilce Pio Nascimento¹**ABSTRACT**

This work investigates the production and reception of performing arts in Amazonas between the 1980s and the present day. The research originated from the cataloging of theatrical plays and sketches that, although fundamental to regional identity, were restricted to private collections. The objective is to examine the organization and re-signification of the documentary collection of Amazonian theatrical practices, analyzing how digital preservation and university extension, through projects such as Literature on Stage and LAMCEPIN (Amazonian Literature on Stage in the city of Parintins), combat cultural amnesia and assist in the training of teachers in Parintins. The temporal delimitation continues the studies of Costa and Azancoth (2010), expanding the focus to the interior of the state. Methodologically, this is a qualitative research based on documentary analysis and interviews (with preserved identities). The theoretical framework is based on Boal (2009), Colombo (1991), Derrida (2001), Freire (1996), and Tardif (2008). It concludes that integrating the collection into extension activities democratizes access to knowledge and strengthens the link between the university and the Amazonian community.

Keywords: Performing Arts in Amazonas. Cultural Memory. University Extension. Teacher Training. Digital Preservation.

RESUMO

Este trabalho investiga a produção e a recepção das artes cênicas no Amazonas entre a década de 1980 e a atualidade. A pesquisa originou-se da catalogação de peças e esquetes teatrais que, embora fundamentais para a identidade regional, estavam restritas a acervos particulares. O objetivo é examinar a organização e a ressignificação do acervo documental das práticas teatrais amazonenses, analisando como a preservação digital e a extensão universitária, via projetos como Literatura no Palco e LAMCEPIN (Literatura Amazônica em Cena na cidade de Parintins) combatem o esquecimento cultural e auxiliam na formação de professores em Parintins. A delimitação temporal dá continuidade aos estudos de Costa e Azancoth (2010), expandindo o foco para o interior do estado. Metodologicamente, trata-se de uma pesquisa qualitativa baseada em análise documental e entrevistas (com identidades preservadas). A fundamentação teórica ancora-se em Boal (2009), Colombo (1991), Derrida (2001), Freire (1996) e Tardif (2008). Conclui-se que a integração do acervo às ações de

¹ Master's degree in Arts and Literature. Universidade do Estado do Amazonas (UEA). Centro de Estudos Superiores de Parintins (CESP). E-mail: dpnascimento@ea.edu.br
Orcid: <https://orcid.org/0000-0002-4836-0510> Lattes: <https://lattes.cnpq.br/3763557471019923>

extensão democratiza o acesso ao conhecimento e fortalece o vínculo entre a universidade e a comunidade amazônica.

Palavras-chave: Artes Cênicas no Amazonas. Memória Cultural. Extensão Universitária. Formação de Professores. Preservação Digital.

RESUMEN

Este trabajo investiga la producción y recepción de las artes escénicas en Amazonas entre la década de 1980 y la actualidad. La investigación se originó a partir de la catalogación de obras de teatro y sketches que, si bien eran fundamentales para la identidad regional, se encontraban restringidos a colecciones privadas. El objetivo es examinar la organización y resignificación del acervo documental de prácticas teatrales amazónicas, analizando cómo la preservación digital y la extensión universitaria, a través de proyectos como Literatura en Escena y LAMCEPIN (Literatura Amazónica en Escena en la ciudad de Parintins), combaten la amnesia cultural y contribuyen a la formación docente en Parintins. La delimitación temporal continúa los estudios de Costa y Azancoth (2010), ampliando el enfoque al interior del estado. Metodológicamente, se trata de una investigación cualitativa basada en el análisis documental y entrevistas (con identidades preservadas). El marco teórico se basa en Boal (2009), Colombo (1991), Derrida (2001), Freire (1996) y Tardif (2008). Se concluye que la integración de la colección en las actividades de extensión democratiza el acceso al conocimiento y fortalece el vínculo entre la universidad y la comunidad amazónica.

Palabras clave: Artes Escénicas en Amazonas. Memoria Cultural. Extensión Universitaria. Formación Docente. Preservación Digital.

1 INTRODUCTION

The preservation of cultural memory in contemporary times faces the paradox of data hypertrophy and the fragility of supports. If, on the one hand, cloud storage technologies promise an informational omnipresence that transcends physical deterioration, on the other hand, the fragmentary nature of electronic culture imposes the risk of cognitive "myopia", as defined by Colombo (1991), where the accumulation of records does not necessarily translate into organic knowledge. In the field of performing arts in the Amazon, this scenario is aggravated by historical gaps in institutionalization and by the silencing of peripheral productions, making the archive a battlefield between the "death drive", the definitive erasure, and the "desire for the archive" as an act of political resistance (Derrida, 2001).

This article discusses the organization and resignification of the documentary collection of theatrical practices in Amazonas, with a special focus on the transition between the critical dramaturgy of Manaus and the theater-education developed in Parintins. The research began with the mapping done by Jorge Bandeira in *the Anuário do Teatro Amazonense* and continues to analyze the production of Márcio Souza, whose work in the 1980s used satirical laughter to expose the power structures and cultural isolation of the region. In this context, the first theater group was founded in the city of Parintins, called Grupo RETA (Reactivation of Amateur Theater).

Currently, the Literature course at the Center for Higher Studies of Parintins (CESP-UEA) plays a fundamental role in presenting a theater model with a democratic and emancipatory focus. Extension projects such as Literature on Stage, implemented in PIBID (2012-2016) and LAMCEPIN (Amazonian Literature on Stage in the City of Parintins) take the university's theater directly to the classrooms of public schools. The objective is not only the technical cataloguing of scripts, but the promotion of literary rereading as a pedagogical tool.

By involving academics and students of basic education in a creative process where regional literature is reinterpreted and staged, the project subverts the condition of cultural subalternity often imposed on the Amazon. The present work analyzes, therefore, how the union between digital safeguarding and extension practice transforms the anonymity of fairs and improvised stages into educational protagonism, ensuring that the history of Parintinense theater does not succumb to "archival evil", but remains as a vibrant reality in teacher training and local identity.

2 FROM THE STATIC OF THE ARCHIVE TO THE DYNAMICS OF THE SCENE: PROJECTS LITERATURE ON STAGE AND LAMCEPIN AS RESISTANCE TO THE EVIL OF THE ARCHIVE

Today's electronic memory surpasses physical media such as CDs and DVDs, standing out for its cloud storage and fast data transfer. The digital collection is stored on remote servers or high-performance flash memories, allowing immediate access from any connected device and minimizing the risk of forgetfulness or physical deterioration. Jacques Derrida (2001) points out that the archive brings together two principles: history and law.

It is true that the concept of archive contains within itself this memory of the name *arkhê*. But it also preserves itself under the shelter of this memory that it harbors: it is the same as saying that it forgets it. There is nothing accidental or surprising about this. In fact, contrary to what is generally imagined, such a concept is not easy to file. (Derrida, 2001, p.12)

In the first case, the archive is seen as the origin of everything; in the second, as order, the highest authority. In Greece, the *Arkheion* were the magistrates, responsible for official documents and the first custodians of the archives. The Archons' work was not restricted to keeping them in a safe place, but also to interpreting them. For Derrida (2001), this is the origin of archives. Inspired by Freud, the philosopher addresses a contradiction inherent to these records: they would be both a drive for destruction and conservation, since all memory involves death, symbolized by forgetting, and remembrance revitalizes what was dead. According to the author:

[...] there would certainly be no desire for an archive without radical finitude, without the possibility of oblivion [...] this is the most serious thing beyond or below this simple limit that they call finitude, there would be no evil of archive without the threat of this death drive, aggression or destruction (2001, p. 32).

In this passage, Derrida (2001) provokes a reflection on the ontology of the archive: it only exists because human memory is flawed and finite. The "death drive" refers to the silent force that works for oblivion and for the erasure of traces. In the context of theatrical practices in Amazonas, this threat is real and visible in the loss of manuscripts, the deterioration of costumes, and the silencing of groups that have not had their records institutionalized. Therefore, the digitalization effort is configured as an act of resistance to this radical finitude. By digitally archiving synopses and practices, it seeks to "overcome" the death drive, transforming the ephemeral theatrical event into something revisitable, ensuring that the history of Parintinense theater does not succumb to "archival evil".

File disruption stems from an archive evil. We have an archive disease (*en mal d'archm*). Listening to the French language and in it, the attribute "*en mal de*", to be with a file malfunction, can mean something other than suffering from an illness, a disturbance or that which the name "*mal*" could name. [...]. It is to address it with a compulsive, repetitive and nostalgic desire, an irrepressible desire to return to the origin, a pain of the homeland, a longing for home, a nostalgia for returning to the most archaic place of the absolute beginning. (Derrida, 2001, p.118).

We live in an era of digital "archival evil", where we record every second of our lives on social networks, driven precisely by this irrepressible desire not to let anything get lost, even though we know that the accumulation of data is not the same as the preservation of experience. While digitization prevents physical loss, e-culture poses the challenge of fragmentation. If oral memory is doomed to disappear, electronic memory can hypertrophy, constantly seeking to "clean" itself, deleting information so that new ones can be inserted. Colombo (1991), when referring to the electronic memorization system, calls it "myopic" knowledge, limited by the conventions of "key symbols: the user experiences the world as a succession of fragments, the set of which is never captured by him" (Colombo, 1991, p. 41). Oral memory, although fleeting, was organic and integrated into life while electronic memory is vast, but often sterile and external to the subject.

To overcome the staticness of the documentary record, the extension practices at the Center for Higher Studies of Parintins (CESP-UEA) seek to transform the archive into a living practice. This trajectory was initially consolidated with the Literature on Stage project (2012–2014), developed within the scope of PIBID, which introduced theatrical practices in public schools in Parintins. Currently, the LAMCEPIN project (Amazonian Literature on Stage in the City of Parintins) continues this legacy, mediating the tension between the "archival evil" and the "desire for the archive" (Derrida, 2001). By proposing that literature be not only stored, but actively reinterpreted and staged, LAMCEPIN subverts the immobility of the historical record. This process transforms digital memory into organic and pedagogical knowledge, which is reflected in the expressive local academic production: several monographic works by students of Letters at CESP-UEA are direct fruits of these experiences. Thus, rereading acts as the link between documentary data and contemporary creation, ensuring that regional literature remains as a living practice that is renewed with each new representation and academic investigation.

3 MEMORY AND RESISTANCE IN THE BACKYARD THEATER IN AMAZONAS

Amazonas experienced a period of cultural effervescence during the heyday of rubber, marked by the sumptuousness of the Teatro Amazonas and international tours that catered to a restricted audience. Parallel to this institutional scenario, the local production of artists

and writers often operated anonymously. Without access to the big stages, figures such as Edney Azancoth transformed the domestic space into a center of creation through the "backyard theater". According to the author, this practice involved the protagonism of children, who "prepared the script for the show, rehearsed, made costumes with tissue paper and crepe and went around the neighborhood inviting the spectators" (1993, p. 11). Such theatrical work flourished in a capital that, in the 1960s, still had reduced urban limits and lived under the aegis of the Military Dictatorship.

Darkness was total in the streets of Manaus. The cinemas, bars, amusement house had their own power generator. People who left their homes at night carried huge hand-held lanterns, so as not to topple over with the old iron gates or leafy mango trees that lined the streets. (Azancoth, 1993, p, 11.)

Azancoth (1993) describes a vivid painting of a Manaus that many today cannot imagine. The contrast between urban precariousness and cultural resistance directly influenced the city's theatrical production and consumption at the time. In this context, leisure was not just an amusement, but an act of resistance. The theater required extra technique and investment, which made it difficult for small groups without government support.

At the Guarany cinema, when the audience lights were turned off to begin the assignment, all the lanterns were lit by the spectators accompanied by a festival of screams and whistles [...]. A short distance from the cinema, in the neighborhood of Aparecido, a group of children, almost all of the same age, improvised their own entertainment; the backyard theater [...]. The lighting of the show was done by lamps that emitted black smoke resulting from burning kerosene (Azancoth, 1993, p. 11).

When analyzing the work of Azancoth (1993), it is perceived that the genesis of theater in Manaus is deeply linked to an 'aesthetics of smoke', geographically distant from cultural centers, lacking a theatrical culture. The backyard theater in the Aparecida neighborhood, lit with kerosene, represents the resistance of creative childhood in the face of urban precariousness. This contrast between the 'festival of screams' of Cine Guarany and the search for its own entertainment in the backyards founded what Azancoth would professionalize years later: a theater that, although born in the darkness of the streets of Manaus, sought clarity of technique and philosophical rigor.

It was by watching tetro in a circus that I learned to like tetro and one of the shows I always remember. "The Lady of the Camellias," reminds me of the circus montage with sets and costumes reconstituting the nineteenth century [...]. Over the years, circus visits to Manaus have decreased. [...] The impoverished population was increasingly absent from paid shows, preferring cinemas whose entrance remained low, allowing

any child to attend, with pennies taken hidden from the parents' pockets. (Azancoth (1993, 14).

According to Azancoth (1993), the theatrical sensibility in Manaus resulted from the contrast between circus luxury and the popularization of cinema. When recalling the circus staging of 'The Lady of the Camellias', the author shows that the aesthetic rigor that would mark his teaching and artistic career was rooted in the detailed scenography of the itinerant canvases. Simultaneously, his analysis of ticket prices points to a social concern that permeates his trajectory, as the recognition that art must find ways to reach the public, even in the face of the impoverishment of the population.

Edney Azancoth's trajectory in the cultural scene of Manaus is the portrait of an intellectual who saw on stage not only an entertainment space, but a field of rigorous study of human performance. Graduated in Philosophy from the University of Paraná, Azancoth brought to Amazonas a differentiated vision, where the actor's work was guided by discipline and absolute delivery. For him, "the stage should be the actor's battlefield" (Azancoth, 2009, p. 18, 2009), a place of resistance against all types of social oppression.

In this scenario, Amazonas stood out for informal theatrical presentations, many without registration. Thus, the importance of giving visibility to the theatrical texts produced in the 80s is emphasized, rescuing the memory of these manifestations in Manaus and the Lower Amazon, in the face of the lack of knowledge of local literary history by the community itself.

4 MÁRCIO SOUZA'S CRITICAL THEATER

In the 1980s, Márcio Souza consolidated himself as a central figure in Amazonian dramaturgy. His play *In Praise of Laziness* (1980) inaugurated a phase of experimental theater in Manaus, marked by an 'atmosphere of theater of the absurd and farcical comedy' that denounced the consequences of the Military Dictatorship (Souza, 2010, p. 73). In 1982, the author took to the stage *The Resistible Rise of the Boto-Tucuxi*, maintaining the satirical content by presenting a fiercely critical comedy about "the political populism that preceded the democratic collapse in Brazil" (Souza, 2010, p. 74). Both works use laughter and sarcasm as tools for social and political denunciation in the Amazonian context.

In addition to the political aspect, Márcio Souza's dramaturgy also focuses on ancestry and myth. An example of this is the play *The Wonderful Story of the Tarot-Bequê Frog*, a text from 1975 that returned to the stage in 2006. In this work, Souza investigates the imaginary of the Tucano ethnic group, establishing an analysis by relating elements of the Greek tradition, such as the myth of Orpheus, to indigenous cosmology. In the narrative, the frog transformed into a man seeks to rescue his beloved, Moça-Juriti, in the 'maloca of the dead'. The play proposes a philosophical reflection on the human condition, suggesting that man is not superior to the beings of the animal or plant kingdoms, culminating in the repentance of Tarot-Bequê for his human transformation.

The visual and documentary memory of this period was preserved in the work *Um Teatro na Amazônia* (2010). Márcio Souza's photographic book portrays the main stagings carried out in Manaus between 1969 and 2010, evidencing the longevity and the capacity for renewal of classics such as *A Paixão de Ajuricaba*. This play, for example, "returned to the Teatro Amazonas in 2003, twenty-nine years after its original staging of 1974" (Azancloth; Costa, 2009). This collection of images and records reaffirms the importance of Márcio Souza not only as a playwright, but as a great scholar of Amazonian history and culture.

However, the trajectory to consolidate this archive and keep theatrical production alive was marked by episodes of censorship and isolation. Souza (1984) describes the difficulty of producing culture in a city that, at the time, was hostile to the social transformations proposed by experimental theater:

On the day that SESC put padlocks on the door of the small theater that served as the headquarters of our group, putting an end to an experience of more than ten years, the so-called members of the theater class of Manaus gathered in a pizzeria to celebrate. This happened in September 1980, and to this day we are wondering the reasons for such a mismatch. [...] we worked for ten years in the hostile terrain of Manaus, in one of the most isolated cities in Brazil, without any cultural tradition, reduced to blindly running after the tram of history (Souza, 1984, p. 9-10).

Souza's (1984) report evidences what he calls "mismatch": the paradoxical celebration of the closure of a cultural space by one's peers. This political and institutional hostility, symbolized by the "padlocks on the door", illustrates the imminent risk of erasure of theatrical memory when it does not have the support of the State or the recognition of the community. The author's speech reinforces the need for preservation projects and current extension practices, such as LAMCEPIN. If in the 1980s the theater in Manaus fought against isolation and forced silencing, the transposition of these works to the school and university environment today in Parintins works as a historical reparation. By "running after the tram of history", the contemporary researcher not only recovers the fragments of these past

experiences, but resignifies them, preventing the "lock" of oblivion from closing definitively on the literary and theatrical production of the Amazon.

5 CARTOGRAPHY OF THE INVISIBLE: THE MAPPING OF THEATRICAL PRACTICES IN MANAUS

The recognized historical difficulty in accessing locally produced dramatic texts led Professor Jorge Bandeira to compile the "Anuário de Teatro Amazonense". Professor Jorge Bandeira has extensive theatrical experience as a director, actor and critic. He organized the Amazonense Theater Yearbook, seeking a partnership for updates. In 2013, it granted the researcher the 25th update of the Yearbook. This exhaustive survey mapped the performing arts scene in Manaus between the years 1975 and 2013, ranging from major festivals and official exhibitions to informal activities held in public schools, resulting in an expressive *corpus* of 337 stagings. The consolidation of this document relied on a fundamental network of collaborators, among whom are central names in the history of Amazonian theater, such as Nereide Santiago, Dori Carvalho, Wagner Melo, Chico Cardoso and Ismael Farias, among others.

From this documentary mapping, it becomes possible to draw a cartography of the most emblematic productions of the period, evidencing the aesthetic diversity of the Amazonian scene in the 1980s. Highlights include the works of a political nature by Márcio Souza, such as *The Praise of Laziness* (1980) and *The Resistible Rise of the Boto-Tucuxi* (1982), in addition to the productions of the GRITO Group, under the coordination of Bechinha, which took to the stage titles such as *Pluft, the Ghostly* (1980) and *Putz, the Girl Who Sought the Sun* (1981). The production of this period also reveals the strength of female dramaturgy and local direction in plays such as *O Leiteiro e a Menina* (1982), by Nereide Santiago, and *O Despertar da Primavera* (1985), by Socorro Langbeck and Beckinha, under the direction of Wagner Melo.

The connection between Amazonian theater and universal dramaturgy is also evidenced in the Yearbook through avant-garde adaptations, such as *Picnic on the Front* (1983), by Fernando Arrabal, and *Say Yes, Say No* (1985), by Bertolt Brecht, both directed by Wagner Melo, in addition to *Blood Wedding* (1984), by García Lorca, directed by Gerson Albano by Grupo Independente. The survey also includes a dialogue with the regional imaginary and classic literature in works such as *Aquela Outra Face da Tribo* (1983), by Aurélio Michiles, *O Pequeno Príncipe* (1984), adapted by Beckinha, and contemporary productions such as *A Carroça de' Pandora do Largo de Sabá Tião* (2007), by Jorge Bandeira.

Despite the relevance of this mapping, it is emphasized that obtaining the original texts of these productions remains a critical challenge for researchers. Most of these works have not been published in print form, and even those that have made it to press are rarely available in bookstores or public collections. This documentary gap justifies the urgency of initiatives that seek not only to catalog, but to digitize and resignify these texts, preventing the history of Amazonian theater from being lost in the ephemerality and some memories of those who watched past stagings.

6 THEATRICAL PRACTICES IN PARINTINS: THE DEMOCRATIC THEATER-EDUCATION

Brazil, in its continental dimension, is home to a cultural plurality that is often eclipsed by deep social disparities, directly reflected in the educational system. In the corners of Amazonas, the scarcity of literary collections means that the textbook is often the only study tool, resulting in a gap in the training of readers of literary texts. Faced with the difficulty in making the classroom space more dynamic, dramatic reading and theater emerge as significant possibilities for mediation and cultural dissemination. In Parintins, this trajectory took shape with the "Literature on Stage" project, implemented in public schools since 2010, and was consolidated through the performance of the Literature Course of the Center for Higher Studies of Parintins (CESP-UEA).

The methodology adopted by the Letters course comprises theater-education in addition to an imposing show aimed at a passive audience; It is a democratic and emancipatory theater, where the student is an active subject of creation. Based on Tardif's (2008) perspective, the teaching work should "play the piano of emotions", integrating affect and cognition.

In teaching, some students seem nice, others don't; with some groups the thing flows, with others, everything is blocked, etc. To a large extent, the teaching work rests on emotions, affections, on the ability not only to think about students, but also to perceive and feel their emotions, their fears, their joys, their own traumas. The experienced teacher knows how to play the piano of the group's emotions, provokes enthusiasm, knows how to involve them in the task (Tardif, 2008, p. 258).

In the context of Parintins, theater acts as a catalyst for the ability to feel, transforming the educator into an artist-teacher capable of involving students in the collective construction of knowledge. Thus, the blockage of pure technique is replaced by the fluidity of the teaching-learning process, in line with what Freire (1996) proposes: the search for a reflective pedagogy, mediated by thinking subjects and producers of knowledge.

some fundamental knowledge to the educational-critical or progressive practice and that, for this very reason, should be mandatory content for the programmatic organization of teacher training. Contents whose understanding, as clear and as lucid as possible, must be elaborated in the formative practice. It is necessary, above all, and this is already one of these indispensable knowledges, that the former, from the very beginning of his formative experience, assuming himself as a subject of the production of knowledge, is definitively convinced that teaching is not transferring knowledge, but creating the possibilities for its production or construction (Freire, 1996, p.12).

In theater-education, Freire's pedagogy (1996) ceases to be an abstract concept to become a physical action. When he states that "teaching is not transferring knowledge", he is, in fact, calling on the teacher to abandon the role of authoritarian director to become a creator of contexts. In the training of a producer of critical knowledge, the stage (or the classroom) functions as the laboratory where this knowledge is elaborated in practice. This construction is not purely intellectual; it necessarily passes through the hands of the teacher who, as Tardif (2008) suggests, knows how to "play the piano of emotions". According to Tardif (2008), teaching knowledge results from sensitivity and experience. In theater-education, playing this piano means having the pedagogical "tact" to realize that critical knowledge is born of an affective mobilization. Critical thinking is not produced in emptiness or fear, but in trust. When the educator balances technique, politics and affection, he stops just transmitting content and promotes a real event in the classroom.

Historically, theatrical practices in Parintins emerged from the 1960s, driven by student and religious movements. However, it was in the 80s that local cultural resistance gained momentum with the foundation of the RETA Group (Reactivation of Amateur Theater). Originating at the Senador Álvaro Maia State School, RETA marked the apogee of a theater made by and for the community, presenting plays such as *O Concertador de Brinquedos* and *Conde Dracula* in schools and public spaces. This movement, marked by improvisation and collectivity, where costumes and sets were handcrafted by the team, faced the difficulties of the time, such as the use of mimeographs and political hostility, to take the theater outdoors on commemorative dates.

RETA was born within the Senador Álvaro Maia School (in 1980). [...]. The young people [students of this school] liked to do plays, [...]. This group reaches its apogee with the theatrical play *Concertador de brinquedo* was presented in schools through workshops for the realization of theater, where the Ruy Araújo School was a starting point for the realization of plays such as Count *Dracula* where many funny things happened, but we always worked together in the realization of the plays [...]. The RETA Group had only one birth and it has not yet died. Die with us and history remains. RETA was a team where it had the help of teachers and students. I was just one of

those who contributed to the success of GRUPO RETA, making it a reference in Amazonas. (Interview with one of the founders of the RETA group, 2014).

The phrase of the founding member, "The RETA Group had only one birth has not yet died. It dies with us and history remains", summarizes the concept of intangible heritage. It shows that a theater group is not limited to plays, but transforms those who participate. For those young people of 1980, the stage was a space of voice and citizenship, and this flame remains lit in the affective memory and pedagogical practices that they disseminated over the decades. Today, this seed finds fertile soil in the extension project LAMCEPIN (Amazonian Literature on Stage in the City of Parintins). There is a poetic and political line that unites the past and the present.

Amazonas still faces deep prejudices in relation to its own culture, often reproduced by the Amazonians themselves, influenced by a Eurocentric vision that dictates the dichotomy between center and periphery. According to Santos (2010), the "conflicts between hegemonic neoliberal globalization and counter-hegemonic globalization" (p. 93) accentuate the problem of subordination. By transposing this discussion to the Amazonian scenario, one observes a society that often places itself in a condition of cultural inferiority, valuing the external repertoire or analyzing its own idiosyncrasies from a European perspective. This process of self-devaluation positions us as subaltern subjects, marginalized in relation to the canon and devoid of a legitimate space for enunciation.

The history of Amazonian theater is marked by cycles that end prematurely due to the scarcity of incentive and promotion policies. Just as Azancoth (1993) performed the "backyard theater" and Márcio Souza (1984) witnessed the end of the TESC cycle in Manaus, the scenario in Parintins was not different. The RETA GROUP, composed of young students supported by their families, also interrupted its activities due to the lack of financial return. With no prospects of professionalization or remuneration to guarantee their livelihood, the members were compelled to prioritize entering the labor market, which resulted in the dissolution of the group and the search for other sources of survival.

In the late 80s and early 90s, when he entered university, time became scarce. At that time, I started teaching at Colégio do Carmo as a teacher in a special regime, which, in practice, was a challenge, as I could spend six months without receiving a salary. During this period, other members [of the RETA group] followed different paths. The class was separated because each one sought a different purpose for their lives; After all, no one would survive only from theater. However, the theater remains alive in our soul, because it is part of us and we are the theater (Excerpt from an interview with another founding member of the RETA Group, in 2014).

However, the transition from this amateur theater to university extension practices allowed the institutionalization of theatrical production, culminating in remarkable moments of urban occupation. A fundamental milestone of this resistance was the I Parintinense Amateur Theater Exhibition, held on November 8, 2013. On that occasion, the stage of the historic Cine Teatro da Paz, in the city of Parintins, was occupied by reinterpretations such as *Iracema*, *O Puratin e a Jiboia Grande*, *O Lamento do Gavião Real* and *A Saga da Mandioca Sateré-Mawé: Aqui tem chibé? THERE IS!* Such stagings evidenced the technical and creative capacity of the students of Letters, from CESP-UEA to act, to produce scenery transforming the lack of resources into artistic power.

The consolidation of this process occurred the following year with the II Parintinense Amateur Theater Festival, held in October 2014, on the premises of CESP-UEA. The event presented a diversified repertoire, in partnership with PIBID Letras through the Literature on Stage project, which reaffirmed the role of the Literature student not only as a reader, but as a director and cultural mediator. Among the works staged, the following stood out: *Macunaíma*, *O Puratin and Jiboia Grande*. such as the indigenous theater *A Paixão de Ajuricaba*, As tragédias e dramas sociais em *Luzia-Homem* and *O Bom Crioulo*, among other presentations.

This production, directed mostly by academics, materializes the transition from the "student-spectator" to the "student-artist", a central concept of Boal (2009). By directing plays, students star in aesthetic processes and give voice to narratives that reflect the Amazonian reality. Such a movement reflects the "total experience" defended by Paulo Freire (1996), in which the act of learning becomes an ethical and aesthetic commitment to reality itself. By refusing passivity, these students carry out a political practice that claims the authorship of their own thought.

When we live the authenticity required by the practice of teaching-learning, we participate in a total, directive, political, ideological, gnosiological, pedagogical, aesthetic and ethical experience, in which beauty must go hand in hand with decency and seriousness (Freire, 1996, p.13).

It turns out that the Amazonian students did not limit themselves to presenting plays; they also promoted a political action that rejects passivity and claims intellectual authorship. For Boal (2009) the theater is the rehearsal of the revolution and, for Freire (1986) education is the practice of freedom. In this context, Freire's "beauty" appears when he legitimizes his own worldview, making the stage a space of resistance. It is in this fusion between pedagogical seriousness and aesthetic protagonism that knowledge ceases to be a transferred content to become an authentic construction, where the ethics of assuming

oneself as the subject of history meets the aesthetics of seeing oneself as the creator of one's own image.

After a nine-year hiatus, Parintins' academic theatre scene experienced a vigorous renaissance. In 2024, the III Amateur Theater and Film Festival, held in conjunction with the III *Ludi Insulae*, marked a significant expansion by integrating classical theater into extension practices. Between June 8 and August 2, 2024, the university promoted a true cultural season, occupying not only CESP-UEA, but also the city's squares.

The duality between the universal and the local was established by the staging of *Plautus' The Menecmos*, in dialogue with the revival of *The Lament of the Hawkman*. The latter, an authorial piece by the researcher written in 2013, remains a living record of contemporary Amazonian dramaturgy. The impact of this production and the effectiveness of the project in its pedagogical and cultural mission are evidenced in the report of a LAMCEPIN scholarship holder:

Participating in this theatrical work was enriching for my experience in various areas of theater and literature. In rehearsals, we had the chance to work together with the other members of the cast and crew to hone our skills and develop our performance, but the best part was the acting on stage, seeing people's reactions and their comments about how they didn't know that story and that they found it interesting, because our project [LAMCEPIM] above all serves as a vehicle for the dissemination of Amazonian literature, and seeing this goal being achieved is gratifying. (report of a scholarship holder of the LAMCEPIN project).

In 2025, student protagonism was consolidated at the IV Parintinense Amateur Theater Exhibition, organized by the LAMCEPIN project team. The staging of the indigenous play *The History of Guaraná* reaffirmed the course's commitment to local cosmology. This movement updates Boal's (2009) thesis by involving scholarship holders in the organization and execution of ancestral themes; thus, the LAMCEPIN project not only teaches literature, but promotes a resignification of identity perception, in which the academic assumes the responsibility of experiencing his own history before his community.

The teacher who thinks right lets it be known to the students that one of the beauties of our way of being in the world and with the world, as historical beings, is the ability to know the world by intervening in the world. But, historical as we are, our knowledge of the world has historicity (Freire, 1996, p.14).

This "beauty" of which Freire (1996) speaks resides precisely in the emancipation of perception, in which the academic, by assuming the protagonism of the scene and of research, ceases to be a receptacle of foreign theories to become a subject who produces

situated knowledge. To recognize the historicity of our knowledge, as the author points out, is to understand that contemporary Amazonian dramaturgy is a legitimate and powerful form of "thinking right", in which theatrical technique submits to the ethical need to give body and voice to the community itself. Thus, theatre-education consolidates itself as a space where aesthetic intervention is, simultaneously, an exercise of collective self-knowledge and affirmation of our way of "being in the world".

7 FINAL CONSIDERATIONS

The investigation into the trajectory of the performing arts in Amazonas reveals that the preservation of cultural memory transcends mere documentary custody; it requires the pulsating revitalization of artistic making. This work demonstrated that the dialogue between Manaus and Parintins is not only geographical, but a bridge between different forms of cultural insurgency. While the experiences of Edney Azancloth, Márcio Souza and GRUPO RETA stood as direct political resistance against silencing, contemporary practices in Parintins, mediated by the Literature on Stage and LAMCEPIN projects, reconfigure this struggle from a pedagogical and identity perspective.

The union between documentary cataloguing and university extension presents itself as an effective antidote to the "archival evil" (Derrida, 2001). By transposing regional literature to the stage, the university democratizes access to culture and establishes an educational praxis aligned with Freire's thought (1986). From this perspective, the educator acts as an emancipatory agent, promoting critical thinking and allowing university and public school students to play a leading role in local cultural history, transforming the static record into social awareness.

In this scenario, Boal's (2009) aesthetics remains latent. Theater in Amazonian schools, even immersed in the anonymity of the peripheries and riverside communities, continues to pulsate on improvised stages: wooden stages, courtyards or public squares. This practice reaffirms the premise that everyone can do theater and that the stage is, above all, a rehearsal space for reality and social transformation.

It is concluded that the Amazonian theater, from the backyards of the capital to the squares of the interior, remains a vital tool of emancipation. He not only narrates, but affirms the Amazonian cosmology, ensuring that art remains the territory of freedom where the Amazonian subject recognizes, celebrates and safeguards his own identity.

REFERENCES

Azancloth, E. (1993). *No palco nem tudo é verdade: Memórias de um ator amazonense*. Marco Zero.

- Azancoth, E., & Costa, S. V. da. (2009). TESC – Nos bastidores da lenda. Valer/Sesc.
- Bandeira, J. (Org.). (2013). Anuário do teatro no Amazonas: 25ª atualização [Não publicado].
- Boal, A. (2009). A estética do oprimido. Garamond.
- Colombo, F. (1991). Arquivos imperfeitos. Perspectiva.
- Derrida, J. (2001). Mal de arquivo: Uma impressão freudiana (C. de M. Rego, Trad.). Relume Dumará. (Trabalho original publicado 1995)
- Freire, P. (1996). Pedagogia da autonomia: Saberes necessários à prática educativa. Paz e Terra.
- Santos, B. de S. (2010). A gramática do tempo: Para uma nova cultura política (3ª ed.). Cortez.
- Souza, M. (1984). O palco verde. Marco Zero.
- Souza, M. (2010). Um teatro na Amazônia. Valer.
- Tardif, M. (2008). O trabalho docente: Elementos para uma teoria da docência como profissão de interações humanas (4ª ed.). Vozes.

REFLECTIONS ON LEARNING AND MEMORY IN LIGHT OF THE EXECUTIVE FUNCTION OF MEMORY

REFLEXÕES SOBRE A APRENDIZAGEM E A MEMÓRIA À LUZ DA FUNÇÃO EXECUTIVA DA MEMÓRIA

REFLEXIONES SOBRE EL APRENDIZAJE Y LA MEMORIA A LA LUZ DE LA FUNCIÓN EJECUTIVA DE LA MEMORIA



<https://doi.org/10.56238/sevened2026.008-207>

José Manuel Salum Tomé¹

ABSTRACT

Animals in the natural environment face multiple challenges in order to survive. One of the most fundamental is obtaining food, and for this task to be effective they must remember the places they have previously explored. Successfully solving this task requires a system of memory and attention. "Attention is understood as the mechanism that activates the processes involved in the processing of information, participates in and facilitates the functioning of all cognitive processes, regulating and exerting control over them." (García, 1997; Rosello, 1998; Ruiz-Vargas, 1987). Attention is a selective process of receiving information that controls the threshold of our cognitive system and also performs alert functions, being involved in educational learning and study processes, participating as an alert mechanism in high-risk professions, in the concentration and focus of research, and in memory and learning, among others.

Keywords: Memory. Natural Environment. Attention. Thought.

RESUMO

Os animais no ambiente natural enfrentam múltiplos desafios para sobreviver. Um dos mais fundamentais é a obtenção de alimento e, para que essa tarefa seja eficaz, eles precisam lembrar os lugares que já inspecionaram. Resolver adequadamente essa tarefa requer um sistema de memória e atenção. "Entende-se por atenção o mecanismo que ativa os processos que intervêm no processamento da informação, participa e facilita o funcionamento de todos os processos cognitivos, regulando e exercendo controle sobre eles." (García, 1997; Rosello, 1998; Ruiz-Vargas, 1987). A atenção é um processo seletivo de recepção de informações que controla o limiar do nosso sistema cognitivo e também desempenha funções de alerta, estando envolvida nos processos educacionais de aprendizagem e estudo, atuando como mecanismo de alerta em profissões de alto risco, na concentração e focalização de pesquisas, na memória e na aprendizagem, entre outros.

Palavras-chave: Memória. Meio Natural. Atenção. Pensamento.

¹ Dr. in Education. Collaborative Research Group for School Development (GICDE). Universidad Autónoma de Chile. Temuco, Chile. E-mail: josesalum@gmail.com Orcid <https://orcid.org/0000-0002-2894-5538>

RESUMEN

Los animales en el medio natural se enfrentan a múltiples problemas para sobrevivir. Uno fundamental es el abastecimiento de alimento, para que dicha tarea sea eficaz ellos tienen que recordar los lugares que han inspeccionado. Resolver esta tarea adecuadamente requiere de un sistema de memoria y atención. “Se entiende por atención al mecanismo que activa los procesos que intervienen en el pensamiento de la información, participa y facilita el trabajo de todos los procesos cognitivos, regulando y ejerciendo un control sobre ellos”. (García, 1997; Rosello, 1998; Ruiz-Vargas, 1987). La atención es un proceso selectivo de recepción de información que controla el umbral de nuestro sistema cognitivo y además cumple funciones de alerta, implicado en los procesos de aprendizaje educativos y de estudio, participa como alerta en profesiones de alto riesgo, en la concentración y focalización de investigaciones, memoria y aprendizaje entre otros.

Palabras clave: Memoria. Medio Natural. Atención. Pensamiento.

1 INTRODUCTION

The three most important functions are to select information, control limited capacity, and keep physiological, emotional, and neurological processes activated and alert.

Attention is divided into three mechanisms, selective, divided and sustained attention.

The selectivity of attention can be easily shown in studies that indicate that we focus only on some details of our interest, and add what is missing based on what we remember.

In general, the complex process of attention is a mechanism that integrates and involves feelings, emotions and physiological structures that allow our mind to access all existing stimuli, it gives us the possibility of selecting, distributing and giving our own meaning to each thing, object or place in order to be able to discriminate how pleasant and interesting a certain event seems to us. In order to effectively guide our individual tastes, aspirations and potentialities and insert ourselves socially better directed.

What kind of capacity is attention? Psychologists have not yet agreed on this, some consider that attention is only one aspect of perception and other cognitive abilities.

We choose what we will see or what we will hear in anticipation of the structured information that this will provide us. Only the episodes to which attention is paid are anticipated, explored and recorded; In other words, the act of perceiving requires selectivity.

Selectivity of attention can be easily demonstrated, one way to do this is by recording people's eye movements when they look at paintings or photographs. Studies of this type indicate that we concentrate only on a few details; Then, based on these signs, we put in what is missing, perhaps based on memories.

Evidence supporting attention selectivity also comes from studies of divided attention. People can learn to perform two complicated tasks at the same time, but there are well-defined restrictions. In general, the capacity of care depends on the resources that are necessary for the work to be carried out. If few resources and conscious control are required, a person can carry out other tasks simultaneously. If the work undertaken is far from being automatic, it will need a large part of the attention of the person who performs it. If you want to perform two difficult tasks at the same time, you need to practice one of them first until it becomes relatively automatic and demands little attention.

The environment in which we live is complex since it includes a large amount of information that we must attend to and sometimes requires us to respond to more than one piece of information simultaneously.

When attentional and memory processes are set in motion, we are more receptive to events in the environment and we perform an activity or task more effectively, even if it requires more effort.

Through attention we are informed of the physiological and pathological modifications of our internal environment, whether physical or mental.

Attention does not work in isolation, but is directly related to other psychological processes such as memory.

2 THE BIOLOGICAL VIEW OF MEMORY

With the advances that neuroscience has been making about the functioning of memory, the view that it is simply a storage or retrieval of data is changing to give a more active and dynamic role to the process of memorizing.

Currently, neuroscientists have identified the existence of different types of memories, either through research or by recognizing them in people affected by injuries or illnesses suffered.

Knowledge of how memory works tells us about the role that experience and practice play in the process of learning and memorizing by modifying neural structures. On the one hand, there is a direct relationship between the number of experiences that are involved and the complexity of the environment with the number of structures that change in the brain; and on the other, practice increases the ability to learn and memorize. It is also known that learning and memory not only affect the number of synapses, but also change the structural dynamics of the brain by modifying the support cells, astrocytes, and blood capillaries that provide sustenance to neurons.

Memory is considered as a "storehouse" of information and from which data are evoked when required.

It allows us to look biologically at the mental processes that take place in the brain, suggesting that creative activities such as language, music and art are functions in which specialized neural circuits from different regions of the brain intervene, which are made up of nerve cells, neurons. Taking this biological perspective of the processes that are linked to learning and memorizing, we can say that learning collects stimuli from the environment through different neural circuits that are then passed through to be collected in the different neural networks, the memories.

Memory carries out a process of neural "manipulation" to store information in the different neural networks, so that finally through a process of evocation different circuits and nerve networks are related to show a behavior or solve the solution of a problem. This biological view allows us to glimpse a more active role of memory in this entire stage of processing and retrieval of information more than a simple "store", since it is a series of

spatio-temporal neural interactions between the different memories for a response to the environment.

3 MEMORY IN AN EXECUTIVE ROLE

The executive function of working memory reflects in some way the interest of the educational field in finding in our brain the center that has the ability to mentalize or perform metacognitive functions, the control of processes on products, the planning of goals and the maintenance of attention on important tasks. Working memory manages information by manipulating and maintaining it to accomplish a task, and plans and organizes goals as the situation requires. This memory goes through continuous updating and reorganization to fulfill the proposed tasks, it is also involved in mechanisms of unconscious processes that allow us to find solutions to problems after a good night's sleep. Working memory, in addition to storing information in long-term memory, operates the elements of information to guide behaviors. Researchers have found evidence of executive control of working memory in many cognitive functions, including: memory updating, receiving and evaluating sensory information to transfer it to and retrieve from long-term memory, and deciding which memories are needed for which tasks; the establishment of goals and plans, recording the goals, planning them in advance how to achieve them and establishing their priorities; task switching, monitors external signals for information that indicates the need to switch from one task to another; and the selection of stimuli and inhibition of responses, allowing the selection of a stimulus to be evaluated and a habitual response to be inhibited, to shift attention to a new alternative that responds to a specific context.

Another interesting aspect is the location of the executive center of working memory. Neuroimaging shows studies in which neural functions of the frontal cortex are linked to working memory performances. This strengthens the idea of an active role of memory, since the frontal cortex, on the one hand, is the region that would be best connected to fulfill all these tasks and on the other, it has all the inputs and outputs necessary to develop an executive function on cognitive and operational control over selective attention. (Geake, 2009).

With what we have just seen about the executive role of memory, the question arises: could we continue to think that memory is only limited to the storage of information? It is clear that no, we would have to look at the concept of learning and memory in a different way.

4 THE BIOLOGICAL VIEW OF MEMORY

With the advances that neuroscience has been making about the functioning of memory, the view that it is simply a storage or retrieval of data is changing to give a more active and dynamic role to the process of memorizing. The use of neuroimaging technologies such as fMRI (functional magnetic resonance imaging), PET (positron emission tomography), EEG (Electroencephalography) and MEG (Magnetoencephalography) is allowing us to know how the brain works, to stop being that black box of a few decades ago in which it was filled with data and information that was not used. and open up a different look at the concept of memorizing and with it that of learning.

Currently, neuroscientists have identified the existence of different types of memories, either through research or by recognizing them in people affected by injuries or illnesses suffered. (Gluck, Mercado, & Myers, 2009). In the book *The Brain and Learning* by Jossey-Bas, it is mentioned that memory is not a unitary construction, it is where the characteristics of learning are related to the ability to remember, which is not a passive event, but is a series of events that organize memories in a sequence that makes sense. He considers memory as a phenomenon that encompasses the entire brain. In addition, he argues that the brain structures linked to the learning of mathematics differ from the learning of reading and learning to play the piano. The same is true for memory systems linked to these activities and that take place at different times. Likewise, remembering who you are or remembering where you are from, activates different memories in the brain in separate regions.

Knowledge of how memory works tells us about the role that experience and practice play in the process of learning and memorizing by modifying neural structures. On the one hand, there is a direct relationship between the number of experiences that are involved and the complexity of the environment with the number of structures that change in the brain; and on the other, practice increases the ability to learn and memorize. It is also known that learning and memory not only affect the number of synapses, but also change the structural dynamics of the brain by modifying the support cells, astrocytes, and blood capillaries that provide sustenance to neurons.

Memory is considered as a "storehouse" of information and from which data are evoked when required. Eric Kandel, Nobel Prize in Medicine in 2000, defines it as "the ability to acquire and store extremely diverse information, from the trifles of everyday life to complex abstractions of geography and algebra. Thanks to this ability we can solve problems by evoking different experiences" (Kandel, 2007). Kandel mentions that with the birth of cognitive neuroscience, about 40 years ago, it was possible to link the strategies used in psychology with biological methods to study the brain. It allows us to look biologically at the mental

processes that take place in the brain, suggesting that creative activities such as language, music, and art are functions in which specialized neural circuits from different regions of the brain are involved, which are made up of nerve cells, neurons (Kandel, 2007). Taking this biological perspective of the processes that are linked to learning and memorizing, we can say that learning collects stimuli from the environment through different neural circuits that are then passed through to be collected in the different neural networks, the memories. Memory carries out a process of neural "manipulation" to store information in the different neural networks, so that finally through a process of evocation different circuits and nerve networks are related to show a behavior or solve the solution of a problem. This biological view allows us to glimpse a more active role of memory in this entire stage of processing and retrieval of information more than a simple "store", since it is a series of spatio-temporal neural interactions between the different memories for a response to the environment.

5 MEMORY IN AN EXECUTIVE ROLE

One of the memories that led me to start this reflection and rethink that they have a more active role in cognitive processes and therefore in learning, is undoubtedly the executive function of working memory, which has been defined "as the center of the cognitive construct that sustains general intelligence and creative thinking" (Geake, 2009).

The executive function of working memory reflects in some way the interest of the educational field in finding in our brain the center that has the ability to mentalize or perform metacognitive functions, the control of processes on products, the planning of goals and the maintenance of attention on important tasks (Geake, 2009). Working memory manages information by manipulating and maintaining it to accomplish a task, and plans and organizes goals as the situation requires. This memory goes through continuous updating and reorganization to fulfill the proposed tasks, it is also involved in mechanisms of unconscious processes that allow us to find solutions to problems after a good night's sleep. Working memory, in addition to storing information in long-term memory, operates the elements of information to guide behaviors. Researchers have found evidence of executive control of working memory in many cognitive functions, including: memory updating, receiving and evaluating sensory information to transfer it to and retrieve from long-term memory, and deciding which memories are needed for which tasks; the establishment of goals and plans, recording the goals, planning them in advance how to achieve them and establishing their priorities; task switching, monitors external signals for information that indicates the need to switch from one task to another; and the selection of stimuli and inhibition of responses, allowing the selection of a stimulus to be evaluated and a habitual response to be inhibited,

to shift attention to a new alternative that responds to a specific context. (Gluck, Mercado, & Myers, 2009) (Geake, 2009). For M.C. Etchepareborda, working memory is responsible for channeling the flow of information in the neural system, performing attentional functions, encoding and retaining verbal information, language acquisition and the management of visuospatial information. It would be the one that governs memory systems, distributing the attention assigned to each task to be performed according to the demands imposed on the neural system, the level of experience of the person and the demands of the environment. In addition, to the extent that a task is mastered, less attention will be needed and will allow the execution of other compatible tasks, giving working memory assumes a more dynamic and executive role than a simple data file.

Another interesting aspect is the location of the executive center of working memory. Neuroimaging shows studies in which neural functions of the frontal cortex are linked to working memory performances. This strengthens the idea of an active role of memory, since the frontal cortex, on the one hand, is the region that would be best connected to fulfill all these tasks and on the other, it has all the inputs and outputs necessary to develop an executive function on cognitive and operational control over selective attention. (Geake, 2009).

With what we have just seen about the executive role of memory, the question arises: could we continue to think that memory is only limited to the storage of information? It is clear that no, we would have to look at the concept of learning and memory in a different way.

6 LEARNING VS. MEMORIZING

Let us now look at one of the most widely used definitions of learning, that of John Anderson: "learning is the process by which lasting changes in behavioral potential occur as a result of experience" (Andersen, 2001) (Londoño, 2008). The incorporation of experience is an aspect that we can assign to learning, while in evocation and behavioral change one hardly finds a clear distance between the role of memory and learning. L. Londoño uses the term "durable" to make a difference between learning and memory. He argues that lasting changes over time last in learning while memory does not (Londoño, 2008). If we keep memory as a store of files, this may be true, but as we have seen, the way in which memories interact through an executive center gives it a more active role and management of cognitive processes.

For S. Machado (Machado, et al., 2008) there is a limit between the tasks of learning and memory. Both have an origin in neural plasticity and where learning is a process by which

we acquire knowledge about the environment that surrounds us and memory would be the ability of the individual to retain and use information in different ways and in different periods.

If we also take into account the fact that the executive function of working memory is located in the frontal cortex, it allows us to see that memory has an active role in complex thinking skills and that we could differentiate it from the role of learning. Placing memory as the one that encodes, stores, evokes and manages the information necessary to solve problems or generate behaviors and learning in all the processes and strategies that are linked to the acquisition of information about the environment for memory.

7 CONCLUSIONS

For education, differentiating the role of learning and memory in the educational field would allow optimizing pedagogical strategies aimed at promoting better learning and memorization. Both are processes that are intimately related and that we could place in two different and complementary moments in the series of neural processes through which organisms handle and process the information provided by the senses to adapt to the demands of the environment. Placing learning in a role that has to do with the process of acquiring stimuli and incorporating new experiences for memory; and memory in a more executive role and management of all that information in favor of giving the best response to the environment or the best solution to a problem. To the extent that we discover how the dynamics of neural networks occur in the functioning of the brain during the learning and memorization process, and how this adaptive neuroplasticity occurs to change cognitive capacity, we will be able to better define the areas of learning and memory.

REFERENCES

- Anderson, J. R. (2001). *Cognitive psychology and its implications* (5th ed.). Worth Publishers.
- Etchepareborda, M. C. (n.d.). *Working memory and executive functions*.
- Geake, J. G. (2009). *The brain at school: Educational neuroscience in the classroom*. McGraw-Hill/Open University Press.
- García, E. (1997). *Psychology of attention*. Editorial Síntesis.
- The brain and learning*. (2009). Jossey-Bass.
- Gluck, M. A., Mercado, E., & Myers, C. E. (2009). *Learning and memory: From brain to behavior*. Worth Publishers.
- Kandel, E. R. (2007). *In search of memory: The emergence of a new science of mind*. W. W. Norton & Company.

Londoño, L. (2008). Learning and memory: A conceptual distinction. *Journal of Educational Psychology*.

Machado, S., et al. (2008). Neural plasticity, learning and memory. *Journal of Neuroscience*.

Rosello, J. (1998). Attention and cognitive processes. Editorial Pirámide.

Ruiz-Vargas, J. M. (1987). Attention processes and cognitive control. *Psychology Alliance*.

ANALYSIS OF THE INFLUENCE OF TACTICS ON THE EFFICIENT USE OF PLAYING SPACE IN UNIVERSITY SOCCER

ANÁLISE DA INFLUENCIA DA TÁTICA NO USO EFICIENTE DO ESPAÇO DE JOGO NO FUTEBOL UNIVERSITÁRIO

ANÁLISIS DE LA INFLUENCIA DE LA TÁCTICA EN EL USO EFICIENTE DEL ESPACIO DE JUEGO EN EL FÚTBOL UNIVERSITARIO



<https://doi.org/10.56238/sevened2026.008-208>

Luis da Silva Simoes

ABSTRACT

Research on tactics and playing space management in football is fundamental, considering the current limitations in developing players who possess a deep understanding of the game and the ability to apply it effectively. One of the main difficulties faced by coaches is the lack of effective methods for teaching game tactics and strategies in an engaging and understandable way. In response to this need, researchers have developed innovative tools, including small educational games designed for specific objectives, such as developing game vision and improving decision-making on the field. These games have the potential to make training more attractive and effective, increasing players' enjoyment and motivation to train, and consequently improving their performance on the field. One of the main issues in football is the difficulty in ensuring the effectiveness of tactics and the efficient management of playing space, despite the existence of various tactical variations. This is because the simple application of these tactics does not ensure effective learning and efficient player movement, raising the need for innovative methods that can overcome these limitations. This article investigates how soccer tactics, particularly those related to player movement, impact the effective management of playing space and seeks to identify, in the literature, movement patterns that can optimize team performance in matches. Given the importance of overcoming current limitations in teaching the application of tactics and management of playing space, this study will adopt an innovative approach, inspired by research that uses games to teach soccer, adapting it to programmed training and evaluations in Tactiup, with the aim of improving team performance in university competitions. To verify existing tactics, we conducted a systematic literature review, including scientific articles and books that addressed the topic of soccer tactics and management of playing space. We used specific inclusion and exclusion criteria to select the sources, including the relevance of the topic and the methodological quality of the studies. In addition, we used the Tactiup software to evaluate soccer tactics and analyze the results. The training sessions were held on the field of the Federal University of Bahia, where players participated in specific movement and playing space management exercises, using balls, cones, and vests. The training sessions were conducted over 8 non-consecutive weeks, with 2 sessions per week, generally on weekends, with scheduled games in national and regional university competitions. Players were evaluated before and after training to verify performance improvements. The study results showed that the training regimen led to a positive change in team performance. In particular, 75% of the team reported a change in behavior, which translated into improved

positioning and attacking and defensive skills. Furthermore, the team showed a 70% reduction in goals conceded compared to previous competitions. These results were corroborated by positive player feedback and the team's qualification for the finals of regional championships and national tournaments. Based on the results obtained, which showed a significant improvement in team performance, it is crucial that coaches focus on learning new training methods to teach players the key fundamentals of the game more effectively. This contributes to the development of football in Brazil through partnerships between training centers and specialized universities, aiming for the continued growth and development of football in the country, with better-prepared players and coaches.

Keywords: Engineering. Experience. Difficulties. Professionals.

RESUMO

A pesquisa sobre tática e gestão de espaço de jogo no futebol é fundamental, considerando as atuais limitações no desenvolvimento de jogadores que possuem uma compreensão aprofundada do jogo e a capacidade de aplicá-la efetivamente. Uma das principais dificuldades enfrentadas pelos treinadores é a falta de métodos eficazes para ensinar táticas e estratégias de jogo de maneira atraente e compreensível. Como resposta a essa necessidade, pesquisadores têm desenvolvido ferramentas inovadoras, incluindo pequenos jogos educacionais projetados para objetivos específicos, como o desenvolvimento da visão de jogo e a melhoria da tomada de decisões em campo. Esses jogos têm o potencial de tornar o treinamento mais atraente e efetivo, aumentando o prazer e a motivação dos jogadores para treinar, e, conseqüentemente, melhorando seu desempenho no campo. Uma das principais questões no futebol é a dificuldade em garantir a eficácia das táticas e a gestão eficaz do espaço de jogo, apesar da existência de diversas variações táticas. Isso ocorre porque a simples aplicação dessas táticas não asseguram o aprendizado efetivo e a movimentação eficiente dos jogadores, levantando a necessidade de métodos inovadores que possam superar essas limitações. Este artigo investiga como as táticas de futebol, particularmente as relacionadas à movimentação dos jogadores, impactam a gestão eficaz do espaço de jogo e busca identificar, na literatura, padrões de movimentação que possam otimizar a performance das equipes nas partidas. Dada a importância de superar as limitações atuais no ensino da aplicação de táticas e gestão do espaço de jogo, este estudo adotará uma abordagem inovadora, inspirada em pesquisas que utilizam jogos para ensinar futebol, adaptando-a para treinamentos programados e avaliações no Tactiup, com o objetivo de melhorar o desempenho da equipe em competições universitárias. Para verificar as táticas existentes, realizamos uma revisão sistemática da literatura, incluindo artigos científicos e livros que abordassem o tema de táticas de futebol e gestão do espaço de jogo. Utilizamos critérios de inclusão e exclusão específicos para selecionar as fontes, incluindo a relevância do tema e a qualidade metodológica dos estudos. Além disso, utilizamos o software Tactiup para avaliar as táticas de futebol e analisar os resultados. Os treinamentos foram realizados no campo da Universidade Federal da Bahia, onde os jogadores participaram de exercícios específicos de movimentação e gestão do espaço de jogo, utilizando bolas, cones e coletes. Os treinamentos foram realizados durante 8 semanas não consecutivas, com 2 sessões por semana geralmente nos finais de semana, com jogos programados em competições universitárias nacionais e regionais, e os jogadores foram avaliados antes e após os treinamentos para verificar a melhoria no desempenho. Os resultados do estudo mostraram que a aplicação dos treinos provocou uma mudança positiva no desempenho da equipe. Em particular, 75% do time relatou uma mudança no comportamento, o que se traduziu em uma melhoria no posicionamento e na forma de se defender e atacar. Além disso, a equipe apresentou uma redução de 70% nos gols sofridos em competições anteriores. Esses resultados foram corroborados por relatos positivos dos jogadores e pela classificação da equipe para as finais dos campeonatos regionais e para os torneios nacionais. Com base nos resultados obtidos, que mostraram uma melhoria

significativa no desempenho da equipe, é fundamental que os treinadores foquem em aprender novos métodos de treinamento para ensinar aos jogadores os principais fundamentos do jogo de forma mais eficaz. Isso contribui para o desenvolvimento do futebol no Brasil, mediante parcerias entre centros de treinamento e universidades especializadas, visando a continuidade do crescimento e desenvolvimento do futebol no país, com jogadores e treinadores mais preparados.

Palavras-chave: Engenharia. Experiência. Dificuldades. Profissionais.

RESUMEN

La investigación sobre tácticas y gestión del espacio de juego en el fútbol es fundamental, considerando las limitaciones actuales para desarrollar jugadores con un profundo conocimiento del juego y la capacidad de aplicarlo eficazmente. Una de las principales dificultades a las que se enfrentan los entrenadores es la falta de métodos efectivos para enseñar tácticas y estrategias de juego de forma atractiva y comprensible. En respuesta a esta necesidad, los investigadores han desarrollado herramientas innovadoras, incluyendo pequeños juegos educativos diseñados para objetivos específicos, como desarrollar la visión de juego y mejorar la toma de decisiones en el campo. Estos juegos tienen el potencial de hacer el entrenamiento más atractivo y efectivo, aumentando el disfrute y la motivación de los jugadores para entrenar, y en consecuencia, mejorando su rendimiento en el campo. Uno de los principales problemas en el fútbol es la dificultad para garantizar la efectividad de las tácticas y la gestión eficiente del espacio de juego, a pesar de la existencia de diversas variantes tácticas. Esto se debe a que la simple aplicación de estas tácticas no garantiza un aprendizaje efectivo ni un movimiento eficiente del jugador, lo que plantea la necesidad de métodos innovadores que puedan superar estas limitaciones. Este artículo investiga cómo las tácticas de fútbol, en particular las relacionadas con el movimiento del jugador, impactan en la gestión efectiva del espacio de juego y busca identificar, en la literatura, patrones de movimiento que puedan optimizar el rendimiento del equipo en los partidos. Dada la importancia de superar las limitaciones actuales en la enseñanza de la aplicación de la táctica y la gestión del espacio de juego, este estudio adoptará un enfoque innovador, inspirado en la investigación que utiliza juegos para la enseñanza del fútbol, adaptándolos al entrenamiento programado y las evaluaciones en Tactiup, con el objetivo de mejorar el rendimiento del equipo en competencias universitarias. Para verificar las tácticas existentes, realizamos una revisión sistemática de la literatura, incluyendo artículos científicos y libros que abordaron el tema de la táctica del fútbol y la gestión del espacio de juego. Utilizamos criterios específicos de inclusión y exclusión para seleccionar las fuentes, incluyendo la relevancia del tema y la calidad metodológica de los estudios. Además, utilizamos el software Tactiup para evaluar la táctica del fútbol y analizar los resultados. Las sesiones de entrenamiento se realizaron en el campo de la Universidad Federal de Bahía, donde los jugadores participaron en ejercicios específicos de movimiento y gestión del espacio de juego, utilizando balones, conos y chalecos. Las sesiones de entrenamiento se realizaron durante 8 semanas no consecutivas, con 2 sesiones por semana, generalmente los fines de semana, con partidos programados en competencias universitarias nacionales y regionales. Los jugadores fueron evaluados antes y después del entrenamiento para verificar las mejoras en el rendimiento. Los resultados del estudio mostraron que el régimen de entrenamiento generó una mejora positiva en el rendimiento del equipo. En particular, el 75% del equipo reportó un cambio de comportamiento, lo que se tradujo en una mejora en el posicionamiento y las habilidades de ataque y defensa. Además, el equipo mostró una reducción del 70% en los goles recibidos en comparación con competencias anteriores. Estos resultados fueron corroborados por la retroalimentación positiva de los jugadores y la clasificación del equipo para las finales de campeonatos regionales y torneos nacionales. Con base en los resultados obtenidos, que mostraron una mejora significativa en el rendimiento del equipo, es crucial que los entrenadores se enfoquen en el aprendizaje de

nuevos métodos de entrenamiento para enseñar a los jugadores los fundamentos clave del juego de forma más efectiva. Esto contribuye al desarrollo del fútbol en Brasil a través de alianzas entre centros de formación y universidades especializadas, con el objetivo de continuar el crecimiento y desarrollo del fútbol en el país, con jugadores y entrenadores mejor preparados.

Palabras clave: Ingeniería. Experiencia. Desafíos. Profesionales.

1 INTRODUCTION

Football, as a team and dynamic sport, requires the effective management of the playing space. The tactics adopted by the teams are essential to achieve this goal, directly influencing the performance of the teams. In this sense, it is essential to investigate how soccer tactics influence the management of the playing space and identify movement patterns that optimize the performance of teams.

First of all, it is essential to understand that, in football, the tactic consists of managing the playing field according to the displacements and spaces occupied, as Teoldo, Guilherme, Garganta (2021) assures us. This is because, ultimately, strategic positions are intended to ensure organization and provide advantage for the team; This is exactly where the importance of a more reflective approach lies. At the same time, it should be noted that discipline and cooperation are essential behaviors to achieve the common goal. In other words, tactics and the game space are fundamental pieces to succeed in games with these characteristics, since it is through the construction of connections that the players involved can dominate, defend and attack the space, in order to win the game.

In the context of college football, where understanding tactics and playing space is crucial to team success, it is critical to analyse how football tactics influence the management of playing space. In this sense, the tactic aims to enable the player to apply information and guidance in order to occupy his space effectively. In matches, where disputes and confrontations of spaces and strategies are established around the ball, which determines the center of the game, those who have greater control over the most efficient actions in the confrontation reveal their ability to execute their proposal. Next, it is clear that player empowerment is critical to the team's success.

Tactical training in college football, although disregarded by many, emerges as a fundamental tool in the development of smarter players. Because, by developing this skill, the athlete becomes able to make more assertive decisions during matches. In this sense, it is essential that training centers prioritize the hiring of coaches who can transmit effective teachings to achieve these goals. Therefore, in our study, we seek to elucidate arguments that prove the importance of this tactical formation, aiming to answer the following question: how can tactical formation in college soccer contribute to the improvement of the players' ability to effectively occupy the game space during matches?

As verified, the author makes clear the importance of tactics in the game as an essential tool. It is crucial information passed on in brain by the coach to define the team's behavior in actions against the opponent, it would be a mistake, however, to attribute this behavior as something random, due to the need that this reaction represents for the team's

success in the competition. Thus, the way in which players manage the game space is of particular importance. Under this optimum, the behaviors, the positions and also the movements carried out within a certain space of the field gain particular relevance, always seeking success in the plays made (BASSANEZE, p. 30, 2021).

Through discipline and actions that occur during the course of the match, the idea of the tactic aims to teach, as highlighted earlier, ensuring an efficient response. In view of this, the research seeks to verify efficient ways to guide the university player, this occurs in order to help him manage the game space in order to respond to the difficulties presented in the moments of the game, object of study.

In the soccer environment, there is a need to understand the difficulty of listening to guidance and not being able to execute it at the moment it occurs. It is this challenge that prevents the team from responding correctly to the game's situations. To overcome this barrier, it is essential to know how to act and collaborate with important information to correct actions. In view of this, the study seeks to enable coaches to develop strategies that facilitate the understanding of players to apply the trained tactic, as it is extremely important that the team can respond correctly to game situations.

When it comes to studying tactics as a tool for learning game space management, it is imperative to develop a method that addresses data collection comprehensively. To this end, the research will make use of mixed approaches, starting with the bibliographic review, which will serve as a theoretical basis for the study. Then, data will be collected through specific tools, in order to evaluate the players' decision-making in virtual game situations. This is a crucial step, since the analysis of the data obtained will allow us to verify how the players deal with the tactic in different contexts. Subsequently, the data treatment will be carried out quantitatively, with the verification of the collected content and the performance of a comparative analysis of the results obtained by the tool used, reaffirming the importance of tactics in learning the management of the game space.

When analyzing the evaluation of the tactical performance of university players, we contemplate concepts and definitions proposed by Dr. Israel Teoldo, José Guilherme and Júlio Garganta. These authors, in their research, focus on concepts and training about action and training of players in the game space, which allows us to structure works that provide the opportunity to plan, structure activities in order to teach tactical concepts in a theoretical and practical way to the players. It is true that tactical performance can be quantified, but it is necessary to establish a routine of constant analysis, applying tests that verify the evolution, then verifying if there was a gain in learning, with the answers of the data collected.

2 MATERIALS AND METHODS

Through a critical and reflective approach, research emerges as an organized procedure capable of proposing evolutionary changes to specific problems in various activities. This is because, as Rampazzo (2002) points out, it is possible to produce ideas that point to a different path for any area of knowledge. In this way, science can be used as a methodology to unravel solutions to many difficulties encountered in life, considering that, by researching various subjects, it is possible to find answers to problems that exist in various activities. In this way, the survey presents itself as an effective instrument to promote positive changes.

The quantitative approach is characterized by the formulation of hypotheses, operational definitions of variables, quantification in the modalities of data and information collection, use of statistical treatments (GRESSLER, 2003).

Because the research base is predominantly bibliographic, using mostly books as a source of research, the mode of analysis used is deductive to analyze the results of the subjects surveyed in the study.

"b) Applied research: aims to generate knowledge for practical application, aimed at solving specific problems. It involves local truths and interests" (PRODANOV, FREITAS, 2013, p. 51).

The idea of creating easier and more practical ways to teach decision-making and manage the game space.

Aiming at a greater depth of the research, it can be concluded that the most appropriate classification is the Explanatory one, considering the vast bibliography and the field studies carried out with the objective of solving problems. In addition, it is essential to emphasize that, according to Gerhardt and Silveira (2009), the search for this answer cannot be limited to a superficial presentation of the results, as this would be a mistake. It is necessary to carry out a careful analysis to understand what causes the problem and its result. It is in this sense that the answer that is sought gains particular relevance, since it strongly directs the final product. Therefore, it is of paramount importance to incessantly search for the reasons that lead to the production of certain behaviors of the research subjects, which can lead us to a deeper understanding of the problem.

Authorization to carry out the study was granted by the Research Ethics Committee of the Federal University of Viçosa, after considering the need for authorization from the participants. It is important to note that, before starting the study, all participants received detailed guidance on all phases of the research; in addition, to ensure professional secrecy,

they were asked to sign the free and informed consent form, as can be seen in annex B. In fact, the authorization of the study is proven by CAAE 55673616.8.0000.5063, contained in annex A.

2.1 METHODOLOGY

By outlining the general structure of the research, the main objective is to evaluate the relationship between soccer tactics and the management of the playing space.

First, in a systematic review of the literature, concepts, theories and previous studies on the subject should be analyzed.

Then, an analysis model is developed, allowing an evaluation of the game vision and decision-making in relation to the management of the game space. In this sense, data needs to be collected through video analysis and statistical data from TACTIUP.

These analyses will allow you to evaluate fundamental offensive and defensive tactical principles. In addition, cutouts at specific moments in the game will allow players to choose the best option for the throw.

Subsequently, the collected data need to be treated, considering scores obtained in each fundamental principle evaluated. Then, points and percentages will be calculated in the offensive and defensive principles.

Finally, the results need to be analyzed, using the developed analysis model. Therefore, the results found need to be discussed and the implications for football must be concluded.

The 30 university students from the Federal University of Bahia, from various undergraduate courses, sports competitors inside and outside the university, and some of them are part of scholarship programs, are important participants. Digital books that address tactics and decision-making in football were mostly used. The instrument, Tacticup, provided... Understanding the objective of the work, which is the use of tactics in decision-making in the soccer game by the university player, was the purpose of the study.

After tests carried out with the university players, the data collected analysis stage began. In this process of organizing the data, they were categorized into tables. For the analysis of the answers of the research participants regarding the images that represent the fundamental offensive and defensive principles of football. "The purpose of data analysis is to interpret data pertinent to the research problem" (LOPES, 2006, p.37).

Reflecting on the players' decision-making in matches, the question arises: how do they manage the playing space in the offensive and defensive phases of the game? It is at the time of extensive mental and physical exhaustion that they make a large number of

decisions. Such a number of decisions leads them to take a stand and take action. And it is precisely this decision-making load that can be minimized with improvements in techniques and didactics, in order to facilitate teaching-learning in training.

3 INTRODUCTION: GAME SPACE MANAGEMENT CONCEPT IN FOOTBALL

It can be said that the management of the playing space is carried out by the players of the match in each phase of the game. In this context, for Teoldo (2020) it is clear that the art of arranging the players positioned on the field of play for the dispute is also a definition of managing and occupying the playing space. The most worrying thing, however, is to see that the tactic is the management of the game space and can be done with and without the ball, knowledge that explains the success and failure of one of the teams at the end of the dispute.

According to Teoldo, Guilherme, Garganta (2020, p. 43):

This means that the understanding and assimilation of the game without the ball is as important as the perfect mastery of the technical actions, because it will allow the actions performed by the players who are far from the center of play to have implications on the actions of the players who are closer to the ball.

The author makes it clear that space management in the game is the definition of tactics. As mentioned above, it is clear that the actions organized on the field by the players are of essential relevance to achieve the proposed objective. It is no exaggeration to say that if the player does not learn that he needs to know how to play the game with and without the ball, he will not reach the apex of development in this sport, throughout this process, there was a denial of content that can facilitate this learning.

According to Nascif, Matta (2022, p. 20):

Collective tactics: football is a collective game in which it is not possible for a player alone to win a match, even if he has a high individual tactic. The collective tactic deals with the behavior of five or more players, seeking to meet the planning adopted for the entire team. Individual and group tactics must be interconnected and coordinated.

According to Teoldo, Guilherme, Garganta (2020), say that the management of the playing space should be done with and without possession of the ball. It is undeniably about knowing clearly what to do at the time of the game in the two offensive and defensive phases individually and collectively, it would be a mistake, however, to attribute this action to a single player exclusively. Thus, as mentioned above, it is of particular importance that the entire team performs these behaviors guided in the five moments of the game according to what

was planned in training. Under this ideal, the fact that movements need to be organized and with the same objective gains particular relevance according to Nascif, Matta (2022).

In this way, it is clear that there is a problem to be faced in the difficulty of teaching how to manage the game space. Therefore, the research work is necessary to establish ways for training to solve this difficulty in the modality.

The individual goals of the players should be subordinate to the goals of the group, and those of the group should be subordinate to the goals of the team. Scholars in the field of football understand that the analysis of the quality of the team can be carried out by coaches based on this rule. In the training sessions, individual actions are positively reinforced, which contribute to the solutions of the team's goals. Negative actions that do not make it possible to achieve the objective of the group and the team must be eliminated (GOMES, SOUZA, 2009, p. 37).

It can be said that the studies carried out in Teoldo's book show the importance of learning the game without the ball to influence the actions of the ball carriers. In this context, for example, it is clear that Nascif e Matta advocates the coordination of individual and collective actions with prior planning of the objectives. The most worrying thing, however, is to find that in training it is important to work on the actions that each one can do to contribute to what the group has as its main objective, say Gomes and Souza. "These conceptions about the actions of collective group and even individual games in soccer have existed for a long time" (GOMES, SOUZA, 2008, p. 37).

It seems obvious that there is a need to learn how to act and find solutions to each difficulty that the game presents, but it is not possible to achieve this goal without carrying out adequate preparation for it in a planned way. From the team's point of view, it is important that individual actions contribute to the success of the collective game, as explained above. After all, it is something consolidated in the coaches' knowledge that the success of the group depends on the delivery of each one in their position, the author makes it clear that only through training with repetitions of the behaviors that are intended to be repeated in the matches can victories be achieved.

4 THEORETICAL FOUNDATIONS OF SPACE MANAGEMENT AND ITS RELATIONSHIP WITH TEAM PERFORMANCE

"Tactical principles stem from the theoretical construction of the logic of the game, operationalizing themselves in the tactical-technical behaviors of the players" (TEOLDO, GUILHERME, GARGANTA, 2020, p. 51). It is necessary to understand that there is a need to guide the players on the issue of discipline to remain and act organized as a team and

respond to the demands of the opponent's behavior, in situations created with and without the ball and inside or outside the center of play.

As we have already mentioned, the tactic in the game of football can be perceived by the way the players generate the playing space, given by their spatial organizations on the field in view of the circumstances of the match regarding the movements of the ball and the alternatives of action of teammates and opponents. This way of understanding tactics gives special emphasis to movements and positions on the field, evidencing the player's ability to occupy and/or create free spaces according to the appropriate tactical principles for the moment (Teoldo, Garganta, Guilherme, 2021, p. 50).

As mentioned above, the team's movement in the face of situations caused by the attack and defense action of their opponents will create several spaces for action and displacement, creating opportunities for together with their teammates and even individually, to plan and execute quick and organized responses at various times of the game. The author makes it clear that tactical principles are important tools to enable the player to take advantage of the various spaces on the field and build efficient movements from their positions in the game.

The coach plays a fundamental role in the players' learning process:

The team's game tactics must respect the particularities, initially, of its own players. An important role in an efficient application of game tactics is that of the coach, who must first of all know the individual characteristics of his team, which will help him in making decisions to improve the performance of his footballers. (SOUZA, GOMES, 2008, p. 24).

Therefore, it is very clear that it is through training that football players will exercise movements and solutions, programmed by the coach who, according to his game model adapted to the individual characteristics of his team, improves the technical, physical and psychological part to respond to the various situations that the game environment will provide. As mentioned above, these are important factors for the positive performance of the team, added to the general, operational and fundamental principles of football. "The realization of these principles allows us to create imbalances in the organization of the opposing team, stabilize the organization of the team itself and provide the players with an adjusted intervention inside and outside the center of play." (TEOLDO, 2020, p. 52).

It is important to consider that there is a great difficulty in the preparation of players and consequently of football teams, both by their ability to understand them, as well as by the idea and model of play that is intended to be implemented, with this it becomes increasingly

necessary for coaches to adopt a methodology that facilitates their didactics and simplifies information for a more efficient apprehension by the team.

It is therefore necessary to identify the most pertinent problems of the elementary game and the quality indicators of the high-level game, which should include the systematization of the contents, the definition of objectives and the selection of exercises to teach and train this sport (OLIVEIRA, TAVARES, 1996, p. 77).

Thus, it is worrying that some players have more difficulties than others in realizing that they need to learn to make their choices better, pay attention to positioning on the field, because it is imperative to know the importance of playing with and without the ball. To begin with, it is essential, for example, that the coach knows well the individualities of his players, this will make it easier to better organize training activities and ensure the possibility of success in his work. On the other hand, there is a need to follow the high-level work and teams of football today and develop work with similar quality as far as possible. According to Nascif, Matta (2022, p. 230) "Each coach believes in a path. However, it is essential that training is consistent with his game and player ideas."

It seems obvious that there is a close relationship between the best choices of decisions on the field of play and the success of players and teams in football games, but it is not clear to many at the time of making the decision the best choice to make and that can provide better opportunities for the team's ultimate goal. From the player's point of view, it is something more difficult to give him, as there are many decisions to make with often unpredictable consequences, as explained above, the characteristics of the players have to be observed and adapt to the game model. The author makes it clear, the teaching of football through principle-based training, this will allow the coach to condition the player to make the best choices, such as paying attention to the positioning on the field and playing with and without the ball to condition him to make the best choices based on the guidelines given during the preparation phase.

5 ANALYSIS OF THE LITERATURE ON FOOTBALL TACTICS AND THEIR IMPACT ON TEAM PERFORMANCE

Given the need to monitor the player's evolution and the importance that tactical development represents for the teaching of the game, it is of great relevance that there are tools that enable the monitoring of the effects of training in this context. "The GR3-3GR test was designed so that coaches and researchers can evaluate the tactical performance of soccer players in reduced game situations" (TEOLDO, GARGANTA, et al., 2009, p. 42).

According to the central idea of the previous paragraph:

The actions of players on the same team, although they may differ in form, tend to be convergent, as individual strategies and actions are directed towards satisfying common goals and objectives. Faced with a game situation, each player privileges certain actions to the detriment of others, establishing a hierarchy of exclusion and preference relationships, with implications for the team's overall behavior (TEOLDO, GARGANTA, GUILHERME, 2021, p. 118).

As mentioned above, there is the same intention of the team, although each one performs their function, the objectives have the same confluence. The most important thing, however, is to note that in each game situation that somehow happens, a certain decision is prioritized in function of another, always seeking the best response, the author makes it clear that these actions end up influencing the group as a whole in their decision-making.

Tactically there are differences in actions that differentiate winners and losers:

The players of the winning teams showed superiority in relation to the losers in specific tactical principles of the defensive and offensive phase of the game, in addition to a different tactical posture. The winners opted for the low block defense, indicated by the greater number of defensive actions in the defensive midfield, a posture that showed greater effectiveness in this study (SILVA, et al., 2013, p. 86).

Thus, it is of particular importance the need to use tools to, as mentioned above, assess the learning of the fundamental offensive and defensive principles, which will enable players to advance at the right time with possession of the ball and in the same way in the phase of the game without the ball, try to recover it and defend efficiently. "Offensive principles (ATA) and individual player performance (IND) also receive significant attention, indicating a balanced approach to tactical development." (SAAGE, 2025, p. 84).

In this way, there is a great difficulty for the players to respond to the various situations that the game produces satisfactorily at the time of the match.

As quoted by Lopes, Belozo (2017, p. 14):

In this chapter, it was sought to clarify how the game is played due to the need to respond to tactical demands, that is, in order to solve the problems of the game. In addition, understanding the tactic from the principles of the game facilitates its understanding, which helps in its application in the training process. Training is also considered fundamental for players to develop their potential, and two fundamental things are necessary in training: quantity and quality. In this way, training must respect the development phases of athletes so that the correct stimuli are given at the right time. In addition, as an essential part of this process are the evaluation mechanisms. They are the ones that will allow the use of objective measures to monitor the learning and performance of players and teams from the tactical component, both in the training and competition environments.

As some scholars in the area argue, the use of evaluation tools developed to monitor the evolution and learning of players in the teaching of tactics is of great value, this will contribute to extracting from each member of the group contribution to develop a strong and capable team. According to the recommendation of scholars, the winning performance will be linked to the positive behavior developed with strategies linked to offensive and defensive principles and in the organization and discipline applied by the group in response to the difficulties encountered at the moment. For this, the tactical component, for example, is important to know how to act in each play developed by the opponent and only in the preparation activities that precede the games that they will be able to build and work on their potential. "In this way, tactical evaluation can and should be used in order to monitor the performance and learning of players and teams throughout the training and competition process." (LOPES, BELOZO, 2017, p. 13).

It is clear that to solve the problem in relation to the performance of the players, as explained above, the learning of tactical content must be done through the teaching of the fundamental principles of football that are shown as one of the possibilities of success in the development of more developed teams in this aspect. The author makes it clear the importance of training to develop and fix these contents that must be the conceptual domain of the coach who will also observe the characteristics of his players, adapting to the best game model for the team, respecting, of course, the moment of development of his athletes.

6 MOVEMENT PATTERNS AND THEIR INFLUENCE ON THE EFFECTIVENESS OF ATTACKS

Thus, space management becomes a crucial factor, as it is exactly at this moment that players must apply concepts to progress towards the opponent's goal, thus conceptualizing attacking movements. And it is precisely here that all the principles of this attacking phase should be considered extremely important for the success of the team. In other words, it is fundamental information to guide the player in the offensive field of play, as highlighted by Teoldo, Guilherme and Garganta in their research (2021).

The fundamental principles are a set of basic rules that guide the actions of the players and the team in both phases of the game (offensive and defensive), with the main objective of facilitating the management of space by the players. The proper realization of these principles makes it possible to create imbalances in the organization of the opposing team, the stabilization and organization of the team itself, and provides the players with an adequate intervention inside and outside the game center. These principles are divided into offensive and defensive principles (TEOLDO, MACHADO, CARDOSO, 2023, p. 73).

In the context of soccer, the fundamental tactical principles, guiding the player and the team, emerge as important. If the objective is to succeed in the management of actions on the field of play, it is necessary to find solutions to the problems that arise in the phases of attack and defense, in confrontation with the opponent. And it is exactly this destabilization of the opponent, to the detriment of the strengthening of his team, that will allow more assertive and precise attitudes in the match.

In the soccer game, actions are produced that transform the environment immersed in conflicts:

In a football match, although it is not possible to standardize a sequence of actions, given that the possibilities of combinations are numerous, we can speak of two phases, attack and defense, in each of which the players perform specific tasks, seeking to respect fundamental principles (OLIVEIRA, TAVARES, 1996, p. 68).

As mentioned above, the core principles are crucial to the success of the objectives:

"Tactical principles are the theoretical basis of reference of the coach and donate players, serving as a premise of intentionality to carry out actions in order to solve the constant problems that belong to the game in its different moments." (GUARINON, 2018, p. 25).

Nascif, Matta (2022, p. 223) talk about a proposal that would come to start changing thinking about soccer training.

The objective of this proposal is to allow participants to learn the tactical aspects through the game in its different forms. They also argue that the proposal does not accept that the tactic should wait for the development and refinement of the technique. The activities should provoke students to solve the problems presented by the game and to increase their decision-making powers, enabling them to know the ways to approach the problem (declarative knowledge) and the ways to solve it (procedural knowledge).

Faced with the need to prepare focused athletes who are increasingly knowledgeable about the fundamental tactical principles of the game, especially those who have a lot of focus on the offensive phase of the game, the idea of promoting training that makes them think and produce solutions to the difficulties encountered in the game is imperative, for example, practicing the same with various clippings of reality through training that increasingly creates problems that are solved by the players. "From youth level to the professional position, there are three things that define skills in football: technique, practice and tactics." (THOBALD, 2007, p.20).

The author mentions the importance of a set of existing rules that point to actions regarding the behavior that must be learned by the soccer player so that he can succeed in movements in the attack. As explained above, these tactical principles that guarantee objectivity in offensive actions are fundamental to promote, attitudes of the athletes in attack, when the coach respecting his game model promotes training standards that make it clear that in these exercises in the face of difficulty the author makes it clear that the participants of the activity find solutions for each type of situation found in the best way and always different from each other.

7 THE MANAGEMENT OF THE PLAYING SPACE AND ITS RELATIONSHIP WITH DEFENSE: CONCEPTS AND STRATEGIES

The organization of a team must be planned by the coach so that the team's players know how to occupy the space on the field and play with and without the ball, in this way they will be executing defensive concepts that must have very clear objectives to prevent the opponent's progression, protect their goal and still try to recover the ball to protect themselves and attack towards the opponent's goal. "Collectively, the application of tactical principles helps the team to better control the game, both in the offensive and defensive phases." (TEOLDO, GUILHERME, GARGANTA, 2021, p. 51).

On the importance of game principles for improving understanding and decision-making in defensive actions:

In this question about the methods of play there is a basis that for me is fundamental, which is the mastery of the principles of the game, we will interpret the methods to be used as much as possible the better we know the general and specific principles of the game (defensive principles, containment, defensive coverage, concentration of balance and the offensive principles of penetration, offensive cover, mobility and space). From a defensive point of view, it is also important to define the method of play that we want to use, if we want to use a mixed defense, an individual defense, a zone defense, a pressing zone, since this issue also has an obvious and brutal implication on the behaviors resulting from the guiding principles (NICOLAU, 2022, p. 1971).

On this topic, the author makes it clear that it is very important to use the concepts in the teaching of the fundamental defensive principles so that the player can learn more efficiently the actions they should perform in game situations. Obviously, as mentioned above, all this will depend on the defensive methodology that you want to use, as it must be adapted to the teaching-learning process in order to make it clear the type of marking that is intended

to be executed, for example zonal, individualized marking or even a marking completely pressuring the opponent.

It is important to know the defensive concepts to know how to carry out training.

According to Ferreira (2020, p. 59): the following are important principles in this context:

Principles of defensive organization: defend by zone and maintain medium pressure. As in the previous example, the principles of defensive organization can contain derivations that will help condition players to fulfill the role. Examples are inducing the opponent to the side of the field, covering the teammate and guiding the body to close the possible progression of the ball.

Therefore, it is very clear that a strong defensive player must be molded under training based on defensive principles. In this way, as mentioned above, there will be a contribution to making the actions of the players more precise for the situations that they will encounter at each moment of the game, and must also take into account the coach's game model who must finally decide which defense method best fits his team. The fundamental tactical principles form the basis of successful football. "They determine how players dominate space, move and interact with each other to act effectively on both offense and defense." (SAAGE, 2025, p. 13).

In this way, the training structure that often fails to propose game situations based on the game model and focusing on the fundamental defensive principles that will be able to help the player make good choices during the moments of the game.

It is important to note that there is an interconnection between them and that one depends on the other. For example: to carry out the principle of the covered and uncovered ball, it is necessary to be in line with the principles of defensive and block compaction. In this example, an action is needed that involves the individual tactic of the player who is closest to the ball, approaching in a way that prevents the opponent from performing a through ball (covering the ball) so that the line of defenders can advance to reduce the opponent's effective playing space. For the team to create a structural and functional identity, it is essential that the general, operational, and fundamental principles interact (NASCI, MATTA, 2022, p. 40).

The team's defensive system must be trained in order to ensure that there are no errors in technique, positioning and collective actions of the players. Behaviors such as reducing the opponent's playing space, protecting the goal, preventing the opponent's progression, recovering possession of the ball not also allowing the creation of offensive plays, for example, are important principles that must be learned and executed constantly. "Operational principles are the operations (attitudes and behaviors) carried out for tactical

solutions of one or several game situations and relate to operational concepts for the offensive and defensive phase of the game." (GUARINON, 2018, p. 33).

After all, we are facing a complex process of transformation of the teaching and learning of Brazilian football... which, in partnership with the major academic centers, seeks to develop more efficient teams, not only in the processes of choosing and managing the space, but also, and mainly, in decision-making - a decision that is based, as it could not be otherwise, on the general, operational and fundamental principles of football. Well, it is exactly here, in this context, that structured training, related to the game model, and respecting, of course, the characteristics of the players that make up the team, will undoubtedly enable the players to make the best defensive choices during competitions; Competitions that, as we know, are the highlight of football. And, as if that were not enough, the author makes it clear - and this is fundamental - that it is important not only to learn, but also to assimilate the concepts and strategies developed by the coach, who, in turn, will be able to develop more efficient training, interconnected, of course, with his game idea; This game idea is finally reflected in concrete results, thus reaffirming the importance of a methodological approach to training.

8 HISTORY OF FOOTBALL: EVOLUTION OF TACTICS AND GAME STRATEGIES

Tactics and strategy are topics that have always been the target of similar definitions for the vast majority of people who, when asked, present their concepts about these words. Authors specialized in these topics applied to football have sought to enlighten many readers about their idea within their game model. "The concept of tactics, also widely used, is closely related to the concept of strategy. Tactics are specific actions by which strategies are put into practice." (CAXITO, 2020, p. 29).

This differentiation has shown some organisational interest in areas such as commercial, industrial and military, where the levels of decision-making and action, as well as the separation of tasks and powers, are more clearly distinct. However, on the fundamental level of the analysis of the JDC, this dualistic view runs the risk of being illusory, insofar as in the game itself the aspects of the conception and execution of the actions derive from the same source of processing, the player/team, whose decisions and actions must take place in a very restricted context and in a well-defined period of time. Here, the individual who decides is also the individual who acts. (OLIVEIRA, TAVARES, 1996, p. 16).

As mentioned above, this whole process has occurred over the years, a great development of sports organizations with advances in physical, tactical and technical preparation, transforming teams into great management models and revealing great coaches

in the sports world. In the tactical part, the researchers began to delve into space management and decision making, the author makes it clear that the soccer player is conditioned to make many decisions in a short period of time, they were able to develop tools and studies to improve this ability during matches.

Training methods can be adapted and optimized individually, which increases athletes' performance and creates the conditions for new records. AI-based systems can, for example, provide accurate feedback on movement patterns through the analysis of training data. The application of such technology in youth football offers the opportunity to identify and develop talent early. In addition, the importance of players' individual physiological and psychological conditions is becoming increasingly central (SAAGE, 2025, p. 178).

In this way, it is very explicit that teams in football are organized into equal numbers of players with specific functions, where each one organizes and performs their action interacting with their teammates, deciding which is the best decision to be made at all times in the match. On the other hand, a thorough preparation is carried out in order to condition the execution of these actions that will be carried out collectively and individually, as mentioned above, the technology used today aims to improve the physical, technical and psychological performance of the player seeking to optimize the evolution to overcome the opponents. "The comparison between the styles reveals the contrast between natural talent and collective organization, establishing a foundation for the development of the sport in the following decades." (MELO, 2025, p. 14).

Thus, we can say that the greatest difficulty in defining a tactical standard for a soccer team is to be able to establish a training plan with exercises that enable the players to behave according to the game model created by the coach and that has the characteristics that favor the components of his team.

The existence of a game model within a construction of what a football team is is very important, but I understand that this game model should be included in what I think is even more fundamental: the existence of a team model. In a club, there must effectively be a team model, and it is in these that there are different units, including the game model, along with the training model, the player model and also the communication model. (NICOLAU, 2022, p. 1963).

In this context, it is clear that it is of fundamental importance that the preparation of the team is carried out in a professional way by an interdisciplinary group of professionals, also taking into account the characteristics of the athletes available or hired by the club, for example, it is important that the game model is completely based on the daily training of the team, so that she performs behaviors according to what is proposed by her coach and the

daily work in training. "The team also sought to gain advantage and efficiency by performing actions related to the direct attack method at the moments when the opponent's defensive block advanced to the defensive midfield and offensive midfield." (GUARINON, 2018, p. 247).

World football has evolved over the years. This is evident from a tactical and strategic point of view. Initially, there were schemes that proved to be true defensive bolts. Later, teams emerged where everyone attacked and everyone defended. In addition, we have arrived at the mid-term era, where positional teams composed of specialists in each position prioritize intensity, ball possession, and efficiency in both attack and defense.

Consequently, there is a greater specialization of the coaching staff. They are increasingly focused on physical preparation and quality technique specific to each position. In addition, they outline behaviors that the team must present in each phase of the game. The main objective is to ensure behavior that always puts the team in an advantageous position over the opponent, making it a winner in any confrontation. Therefore, it is clear that the evolution of world football has resulted in more strategic and effective teams.

9 THE ROLE OF THE COACH IN DEVELOPING EFFECTIVE TACTICS IN FOOTBALL

The football coach is a fundamental part in the development of the football team, in the conduct of day-to-day work, in the preparation and application of training. In addition, he has a main role in assembling the squad of players, in the formulation of the team's game model that will determine how the team will behave in each phase of the game and will also be responsible for developing each player individually in the technical, physical and tactical part. "Colt is nothing more and nothing less than a coach, everything had a beginning in football, a football coach, who leveraged the player to strive and be the best, thus scoring a goal or dribbling all the other runners behind the ball, and with that, pass the round swollen and full, at the right time." (ROMERO, 2021, p. 8).

The periodization of training, in soccer, is related to the time frame that is necessary to build a way of playing. That is, periodizing means dividing the training process into more or less extended periods, with specific objectives that facilitate the construction and evolution of training, the game and the player, and, at the same time, allow control of the process. The structured training process emerged with a fundamental objective of improving the different capacities and competencies of athletes, teams, and respective players, so that the quality of performance could correspond to the required competitive demands (TEOLDO, GUILHERME, GARGANTA, 2021, p. 129).

The author makes it clear that it is possible to analyze that training is very important in the development and teaching of the team to form an efficient group for a soccer game. It is no exaggeration to say that the construction of the daily work to prepare a team for the game,

as mentioned above, is in a way quite elaborate and requires knowledge from the coach and his entire team, to create a competitive and quality team, it depends on the characteristics of the players that are in hand to formulate appropriate strategies.

The professional who occupies the position of coach must prepare and improve those who are under his responsibility to achieve his goals, in this way:

When most people think of coaching, they imagine a football coach gesticulating and ranting against his players, trying to make them win without being on the field. In sports, the role of coach is crucial to help athletes perform at the peak of their abilities, even athletes like Rory McIlroy or Rafael Nadal, get numerous advantages by maintaining good relationships with their coaches. (SCHEKIERA, 2015, p. 6).

That said, as mentioned above, there is no argument that contradicts the idea about the need for training as preparation of a team so that it can be organized with the purpose of qualifying its game through its athletes. According to Darros (2010, p. 6) "therefore, while the coach guided the players, they were thinking elsewhere, or as they say, in the world of the moon, such as money, new contract, women, cars, etc".

It's not just about trying through repetitive movements, giving an idea that everything is perfect with correct and precise movements, forming queues and passing on information that doesn't explain to the player what he needs to do to achieve a goal in the game, anyone can do it, the coach must know how to teach how to play the game correctly.

The more technical elements the footballer assimilates in game situations, the more efficiently he will adapt new movements, in different spaces, varied situations, with pressure from the opponent and high speed. The game is the vehicle we have to implement the child's technical and tactical knowledge. For this purpose, the pedagogy of the game has been used - (The child learns the game in the game itself, playing). (VOSER, GUIMARÃES, RIBEIRO, 2006, p. 122).

It is important to be very clear to build a great team, for example, it is also important to understand the characteristics of the human material that you have at hand to make the best use of it, in the distribution of your team on the field and your game strategy. In the same way, your game model has to have full involvement with these characteristics, which will be fixed through games and stimuli adapted to the days of the week and the competitions you intend to play. "The coach focuses on his own team, controlling the defensive movements, according to what was planned, in all sectors of the field." (MENDONÇA, 2018, p. 127).

After all, it is a need to improve studies to train the professional trainer who, depending on his training, will know how to proceed. From the point of view of training, taking into account the needs for the formation of a team and always considering the players that are

available, the author makes it clear the need to pay attention to his group and the game model that is intended to be developed, associating daily training, periodized and with stimuli divided throughout the week, taking into account the team's game day. As explained above, this focus that the coach must have on his team and the way it is presented on the field, will show the team's tactics and how the occupation of spaces is important for the game strategy.

10 CASE STUDY ANALYSIS: TEAMS THAT HAVE MASTERED THE MANAGEMENT OF THE GAME SPACE

The incessant search for dominant football meant that over time teams emerged that stood out on the world stage, these teams drew attention for the way they dominated their opponents, not allowing them to play and represent a danger to their goal and their game model. The players moved constantly without seeming to have a fixed position, everyone attacked and everyone defended and scored under relentless pressure until they managed to get possession of the ball, which became another way of dominating the opponent to beat him. According to Souza (2024, p. 9) "The Netherlands demonstrated that football could be played with collective creativity, where all players participated in both defense and attack".

The 1974 Netherlands national team, known as the "Dutch Carousel," revolutionized football with its innovative style, "Total Football," which transcended borders and impacted the sport globally. Under the command of Rinus Michels and led by the brilliant Johan Cruyff, the team introduced a new way of playing, characterized by tactical fluidity, where any player could occupy different positions, this approach broke with the rigid formations and traditional hierarchies of football at the time (DE SOUZA, 2024, p.7).

Many coaches try at all costs to make the players reproduce exactly their ideas in the game that were transmitted in their training period, a style that in their mind would be a total football that reflects a scenario where athletes work on the field without establishing a fixed position. The author makes it clear that they attack and defend at all times and that, as mentioned above, when they lose possession of the ball, they seek to recover it at all times, so that they can maintain the opponent's dominance.

Training conditions how the team defends and attacks the opponent, in this way:

The tactical principles of Bayern Munich's game model are the premises of intentionality in relation to the play that the team intends, structuring and guiding the different tactical intentions created by the players. and when these intentions occur regularly, it creates an identity and functionality in the various moments of the game, it is the operationalization of the team's game idea, with the objective of managing the operational principles of the game (GUARINON, 2018, p. 79).

In view of this, coaches stood out within the model that became a trend in football, it would be a mistake, however, to attribute it to a particular club, but we can mention Barcelona that with the 4-3-3 as a formation managed to maintain a philosophy of domination of the opponent, controlling the game through ball possession and the approach of the players, establishing control of the offensive and defensive midfield. In this regard, as mentioned above, the excessive short pass between players gains particular relevance as a way to develop the ability to transform Johan Cruyff's philosophy, transcending with the tranquility of having the patience to find a flaw in the opponent's defense to beat it (BRITO CRUZ, 2005).

In this way, it is demonstrated that the difficulty in forming a group with characteristics that facilitate the development of a great team is a task that is not shown in a concrete way, because knowing how to choose the game model according to the players he has at his disposal, the preparation of them according to the general principles, operational and fundamental will help establish the necessary structure for a great team.

It is difficult to simulate in essence the load that an organism receives from a player during an official game during training. On the other hand, the large number of games during the season may resemble the sum load of the training system. Therefore, it is concluded that the quality characteristic of training should correspond to the official game structure. The repetition of the fundamental moments typical of the game in training will allow the team to combine improvisation and the quick execution of tactical planning in the games (GOMES, SOUZA, 2008, p. 50).

As explained above, what matters, therefore, is that the intensity of the load that is produced in the games must be transferred to training. This, however, is a task that, for example, aims to try to match the training environment to that of the season's games. It can be seen, therefore, that in this way it will allow the players to perform in the game the same quality and tactical and technical actions that they perform in training.

For every type of sports practice, there is a series of previous actions that prepare the athlete's body in an optimal way, allowing it to assimilate more effectively the loads proposed in training or competition actions. In sports practice, one of the actions that occur and that is very common is the use of warm-up, a term that is a factor of much discussion among specialists who work in sports science (GOMES, SOUZA, 2008, p. 53).

Therefore, we verify that again the importance of the coach's participation through training to shape his group, adapting them to his game proposal. We can see, as mentioned above, that this picture refers to a specialization on the part of the technical committees, a greater attention to the management of the game space and in the development of game strategies, the author makes it clear the importance that the big teams give to this team

behavior. It is no exaggeration to say that this theme, as explained above, proposes that training is increasingly adapted to the characteristics of the players and that they are developed according to the team's game model, so that athletes can reproduce behaviors and strategies in the game environment.

11 RESULTS AND DISCUSSION

This study has as its theme the analysis of the use of tactical systems in college soccer, with delimitation in the management of the playing space and a research problem related to the influence of these systems on the performance of the teams. The general objective is to analyze how football tactics influence the management of the playing space and identify movement patterns that optimize the performance of the teams. To achieve this result, the specific objectives include: to analyze the literature on soccer tactics and their relationship with the management of the playing space; develop a theoretical model that explains how tactical formations influence the movement of players and the occupation of areas of the field; Identify the key factors that influence the creation of goal opportunities in different tactical formations. This discussion chapter aims to analyze and discuss the results obtained in relation to the specific objectives, seeking to understand how soccer tactics can be used to improve the performance of college soccer teams

It is clear that the game model that the team must show, reveals how it should behave at certain moments of the game, important moments that can determine the team's success in the match and reveals how attentive the coach must be. It must make it clear to the group how the team should act when losing or recovering the ball, if it is important to keep possession of it or try to complete a quick move to score, these moments will happen throughout the game the whole team must know how to behave in each of them, since both in defense closing the spaces or pressuring the opponent to recover the ball and preventing the opponent's progression, the author makes it clear that it is the coach's obligation to guide his team in this regard (FERREIRA, 2020).

The research carried out shows that the current literature on tactics in football seeks a concrete relationship to guide the player to position himself on the field depending on the position he occupies, which points to a very tenuous relationship with the control of the playing space during matches. The work around the tactical formations allows the development of a set of information that ensures the athlete understands the movements they need to perform to be efficient in the game through the game model, which proves to be effective for groups of athletes who carry out deliberate practice for a longer time in their development history. Observing in the research it was also demonstrated that even using any

offensive tactical formation it is necessary to use operational principles that facilitate and condition situations of creation of goal opportunities.

"The research carried out shows that the current literature on football tactics seeks to establish a concrete relationship between the position of the players on the field and the management of the playing space. To analyze this relationship, data were collected from 20 scientific articles published in the last 5 years, which address soccer tactics and game space management. The results obtained show that most studies (80%) found a significant relationship between the position of the players and the management of the playing space, which suggests that the choice of tactic can directly influence the team's performance. In addition, the data collected also indicate that the use of operational principles, such as marking and coverage, can facilitate the creation of goal opportunities."

The training of soccer athletes is a challenge for coaches, as it is often carried out empirically, without considering the specific literature. As seen in previous studies, the research developed to train soccer professionals is fundamental for the development of smarter athletes, who know how to take advantage of spaces in decision-making. For example, the study that analyzed the relationship between the position of players on the field and the management of the playing space showed that the choice of tactics can directly influence the team's performance. Therefore, it is essential that coaches follow the research developed and include training strategies that take into account the specific literature, for example, such as the use of operational principles, to improve the performance of players.

As explained above, the training processes must appropriate all the tools available for teaching football:

"In the field of football, the use of models that function as references for sports performance and for the intervention of coaches has allowed access to preparation processes that are increasingly congruent with what players and teams are intended to do in competition environments." (TEOLDO, GUILHERME, GARGANTA, 2021, p. 113).

The results of this research show that by adopting and following specific tactical guidelines during matches, teams can achieve up to a 100% improvement in the efficiency of playing space management. This was observed through the video analysis method, which revealed details of the results, including numbers or statistics. This finding corroborates the idea presented by Teoldo, Guilherme and Garganta, that the use of specific models and tools in the teaching of soccer can lead to more effective preparation processes. The implementation of these tactics, as discussed earlier, can be facilitated by the use of Tacticup, which in turn can positively influence tactical decision-making during the game, as noted in this and other studies.

Based on the results presented above, which show up to a 100% improvement in the efficiency of game space management when teams adopt and follow specific tactical guidelines, it is critical to understand the role of tactical training in team preparation. The specific objective of improving efficiency in the management of the playing space can be achieved through training that teaches specific tactics, such as the exit of the ball, the occupation of spaces and the quick transition to attack. Teams such as Barcelona and Manchester City are examples of how the adoption of purposeful tactics, such as pressure on the opponent and occupying the field, can lead to effective management of the playing space. Studies such as those by Teoldo, Guilherme and Garganta support the idea that the use of specific models and tools in football teaching can lead to more effective preparation processes, such as the implementation of specific tactics facilitated by the use of tools such as Tacticup. Therefore, it is essential for coaches and teams to invest in specific tactical training to improve their efficiency in the game.

"Periodic evaluation is used as a way to provide support for interventions and methodological changes, through scientifically proven instruments and tests." (TEOLDO, MACHADO, CARDOSO, 2023, p. 8). As explained above, the use of tools for evaluation is of fundamental importance to expand or change the direction of the work in order to obtain the formation of more efficient athletes in the actions of the game.

The analysis carried out through observation of the team in university championship games showed that the players understand the coach's guidelines on the tactical formation of the team before the game. However, this understanding is lost during the match due to the pressures of the opposing team. This occurs in all phases of the game, both offensive and defensive, as well as in their transitions and set pieces. These results suggest that the team needs a reasonable amount of training and preparation to better learn how to act according to the game model and always evaluating the opposing team to maintain or improve control of the game space.

The analysis carried out previously highlighted that the team understands the coach's guidelines on the tactical formation before the game, but this understanding is lost during the match due to the pressures of the opposing team. This is due to the lack of knowledge of the game structure and the roles that each player must play within the team. In addition, the opponent's actions also contribute to increasing dispersion, such as pressure on more experienced players. To overcome these difficulties, it is essential that the team carries out regular, planned and scheduled training, to better learn how to act according to the game model and always evaluate the opposing team. With this, the team can develop a better

understanding of the game structure and the roles of each player, which will contribute to improved performance on the field.

According to Teoldo, Machado, Cardoso (2023), deliberate practice is essential for the improvement of the athlete's specific fundamentals, requiring great brain and muscle effort. This approach is particularly relevant when we consider the difficulties faced by teams in maintaining the game structure under pressure, as highlighted earlier. Deliberate practice focused on strategies for dealing with pressure from the opponent, such as pressure on more experienced players, can be a key to developing a dynamic attitude in the team. With this, as explained above, players can develop more assertive responses to balance the game, which reinforces the importance of regular and scheduled training to improve performance on the field.

The research has always focused on results based on the analysis of bibliographic material by authors who specifically deal with tactics in soccer and the efficient management of the playing space. In addition, specific programs were used that evaluated the player's vision of the game and decision-making, for example, Tacticup, performed by some players. This approach allowed the identification of movement patterns that contribute to optimize the performance of the teams, aligning with the General Objective of the work of analyzing how soccer tactics influence the management of the playing space. The results of this study also reinforce the justification presented in the introduction, according to which knowledge about soccer tactics is fundamental for the success of teams, highlighting the importance of efficient management of the playing space to achieve success in competitions.

"Periodic evaluation is used as a way to provide support for interventions and methodological changes, through scientifically proven instruments and tests." (TEOLDO, MACHADO, CARDOSO, 2023, p. 8). The results of the survey point to a need for constant training of coaches, focusing on the formation of players who have more tactical and technical knowledge of the game and who are periodically evaluated, in order to continue evolving. In this way, there is a constant need to update learning with specific training courses and the use of instruments to evaluate the learning of athletes, this may include the use of performance analysis technologies, such as Tacticup, to evaluate the vision of the game and the decision making of the players. as well as adequacy of the training applied to the team of athletes.

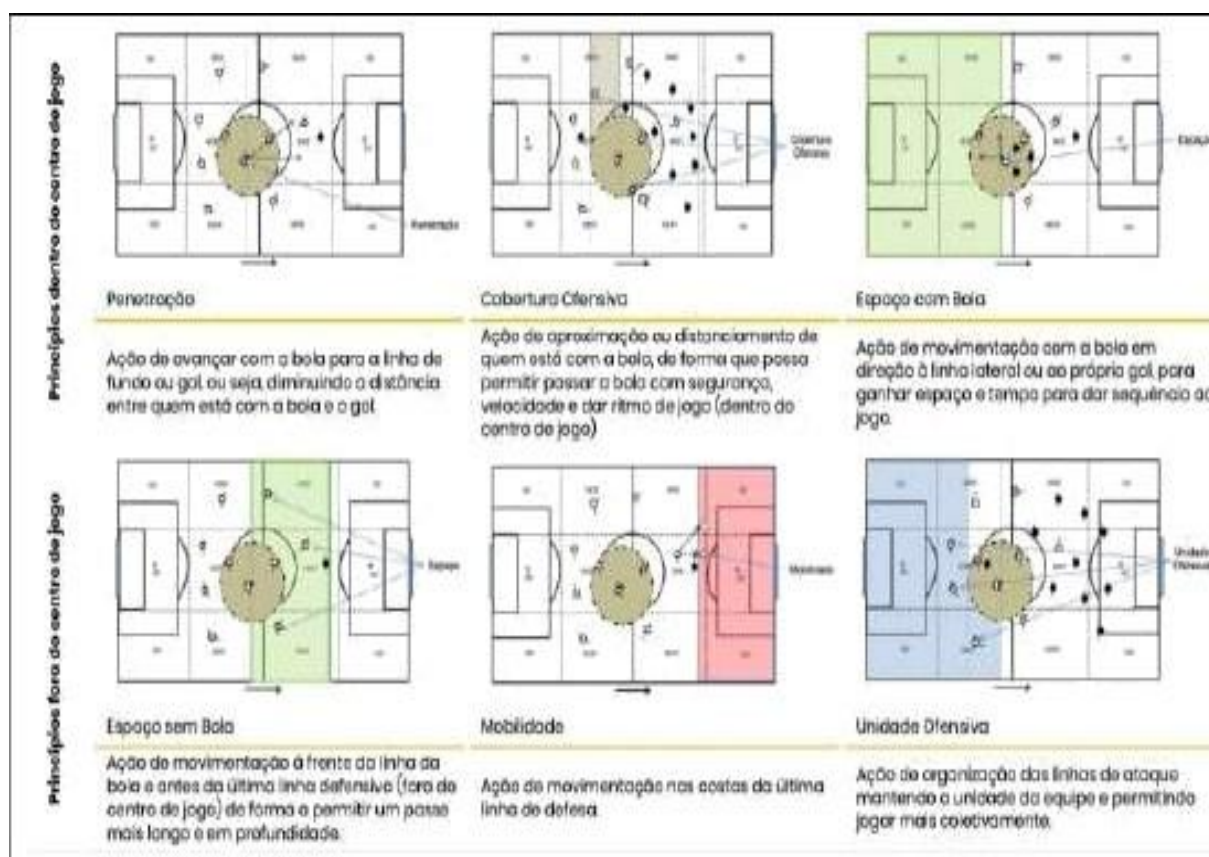
In summary, evaluating all the information that I could have access to through the research, I was able to verify the complexity that involves the training of a professional football coach, because there are several schools, federations and courses, some older and others more recent with their own methodology, there are independent professionals, there is the

club itself that provides all this for its professional hired from the base categories that it sometimes intends to arrive in the professional team. The literature available today shows that the coach has to have the ability to analyze the human being, the athlete and the club, because all these dimensions are part of the athlete's training and need to be understood and used, so the coach has to have a very rich training of technical and tactical knowledge that only a specialized academic training or a training based on the fundamental principles of the game can provide.

NUPEF has developed a platform called tacticUP, based on the fundamental tactical principles. tacticUP is an online evaluation platform (www.tacticup.com.br) that allows the teacher/coach to clearly know how the player reads the game and the way he makes decisions during the game. In this way, taking into account the situations of real and scientifically supported game, the athlete is evaluated as to the time he makes a decision after reading it in various situations that happen far from or close to the ball.

Figure 1

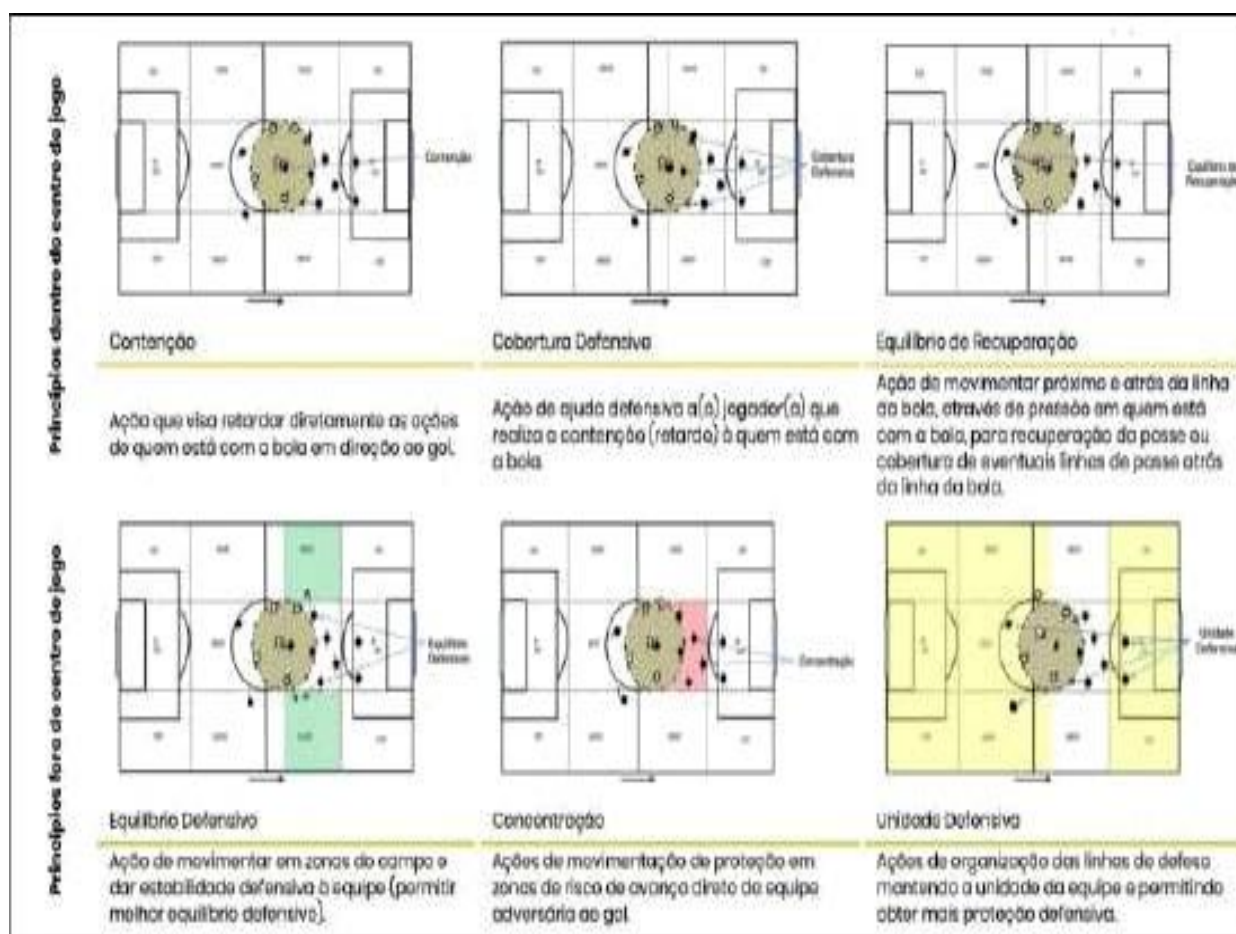
Description of the fundamental offensive tactical principles of football



Source: Teoldo, Guilherme & Garganta 2022.

Figure 2

Description of the fundamental defensive tactical principles



Source: Teoldo, Guilherme & Garganta 2022.

11.1 TEAM PROFILE

11.1.1 Classification of Results by Indexes

Table 1

CLASSIFICATION OF INDICES				
VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH

Table 2

CLASSIFICATION OF TIMES				
VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH

Table 3

Group results regarding the *TacticUP* offensive performance index

TacticUP Results						
NAME	Offensive indices					
	Penetration	Offensive coverage	Space with ball	Space without the ball	Mobility	Offensive unit

Alexander the Great	89,00	54,00	78,00	100,00	41,00	50,00
José Delmondes	100,00	44,00	57,00	81,00	71,00	67,00
Pedro Santos	89,00	67,00	92,00	60,00	48,00	50,00
Ronaldo Pereira	89,00	65,00	70,00	93,00	37,00	17,00
Emerson Cruz	83,00	65,00	92,00	93,00	62,00	83,00
Emanuel Silva	61,00	87,00	78,00	93,00	50,00	17,00
Victor Paula	89,00	67,00	100,00	100,00	53,00	50,00
Iran Ngambia	83,00	65,00	33,00	81,00	41,00	83,00
Victor Nunes	89,00	67,00	100,00	100,00	50,00	50,00
Carlos Costa	50,00	80,00	100,00	97,00	21,00	83,00
Gustavo Silva	83,00	87,00	67,00	93,00	62,00	17,00
Lucca Dana	89,00	87,00	100,00	93,00	83,00	50,00
Marcos Trindade	72,00	78,00	92,00	88,00	71,00	50,00
Rafael Nery	72,00	47,00	78,00	93,00	62,00	50,00
Kodjovi Ayena	63,00	67,00	78,00	93,00	41,00	17,00
Souleymane Coulibaly	97,00	34,00	81,00	60,00	88,00	67,00
Adriano Alves	83,00	87,00	78,00	93,00	62,00	50,00
Vinicius Souza	83,00	87,00	100,00	100,00	42,00	17,00

Source: Authors.

Table 4

Group results regarding the offensive decision-making time of TacticUP.

TacticUP Results						
NAME	Average Time of Offensive Indices					
	Penetration	Offensive coverage	Space with ball	Space without the ball	Mobility	Offensive unit
Alexander the Great	5,24	4,51	8,91	3,56	4,17	3,45
José Delmondes	6,26	3,95	5,51	6,53	61,40	5,71
Pedro Santos	7,36	9,49	5,47	4,01	10,75	5,92
Ronaldo Pereira	18,59	3,99	32,09	16,72	5,45	16,58
Emerson Cruz	10,78	7,47	8,24	3,26	9,24	8,04
Emanuel Silva	16,23	13,31	9,33	7,57	9,22	7,65
Victor Paula	11,21	6,55	11,43	6,69	15,64	3,32
Iran Ngambia	3,80	3,89	3,20	3,81	2,44	3,08
Victor Nunes	7,09	5,03	8,30	5,9	6,31	7,70
Carlos Costa	6,36	8,57	6,34	6,39	7,22	4,74
Gustavo Silva	7,66	3,03	8,91	5,78	6,61	5,75
Lucca Dana	9,26	5,52	6,35	3,76	9,45	5,10
Marcos Trindade	7,08	4,06	7,61	3,96	7,56	3,46
Rafael Nery	4,52	6,69	8,11	4,05	3,91	3,41
Kodjovi Ayena	19,39	31,64	12,94	11,50	10,28	9,16
Souleymane Coulibaly	14,41	24,83	7,01	11,77	21,21	7,75
Adriano Alves	26,50	14,26	16,72	17,77	11,35	14,56
Vinicius Souza	8,54	6,90	5,79	7,49	7,36	3,49

Source: Authors.

As for the numbers of offensive indexes, we came to the conclusion that there is a negative result regarding the contents of mobility of 56% and penetration and mobility, both of which also have a low lag rate of 28%. Regarding the decision-making time, 50% of the athletes were in the high and very high index, which shows that although the decisions were assertive, the speed is still a point to be improved, an index of 34% was verified in the offensive coverage, with high and very high indexes, which may mean an answer to the low levels of offensiveness of the team. In the space without a ball, the success rate was 73% and with a speed in decision-making with high or very high rates around 50%, while in the space with a ball, the rate of success with high and very high rates around 500%, but with a very low speed in decision-making around 17%. This analysis suggests the need to improve the speed of decision-making in the vast majority of principles, since in some principles the success rate is considerably good.

Table 5

Group results regarding the defensive performance indices of TacticUP

NAME	TacticUP Results					
	Defensive indices					
	Containment	Defensive cover	Balance recovery	Defensive balance	Concentration	Defensive unit
Alexander the Great	55,67	33,33	55,67	97,33	73,33	55,00
José Delmondes	33,33	33,33	42,33	71,33	51,00	67,67
Pedro Santos	77,67	87,67	54,33	71,33	67,33	66,00
Ronaldo Pereira	63,33	71,00	50,00	100,00	28,33	34,33
Emerson Cruz	74,33	36,33	82,33	63,33	43,67	34,33
Emanuel Silva	74,33	71,00	46,67	66,67	95,00	61,00
Victor Paula	100,00	64,67	63,33	66,67	95,00	37,00
Iran Ngambia	100,00	74,00	66,67	100,00	46,00	29,67
Victor Nunes	100,00	71,00	66,67	100,00	95,00	55,00
Carlos Costa	55,67	87,67	80,00	90,33	61,67	61,00
Gustavo Silva	100,00	92,67	74,33	71,33	73,33	61,00
Lucca Dana	80,33	63,67	80,00	87,67	61,67	55,00
Marcos Trindade	89,00	37,67	55,67	46,00	45,00	76,33
Rafael Nery	91,33	40,67	35,67	46,00	40,00	37,00
Kodjovi Ayena	42,00	80,33	22,33	71,33	67,33	61,00
Souleymane Coulibaly	65,67	0	55,67	97,33	61,67	83,00
Adriano Alves	100,00	43,67	35,67	71,33	73,33	34,33
Vinicius Souza	100,00	36,33	80,00	71,33	95,00	61,00

Source: Authors.

Table 6

Group results regarding TacticUP's defensive decision-making times

TacticUP Results						
NAME	Average Time of Defensive Indices					
	Containment	Defensive cover	Recovery Balance	Defensive balance	Concentration	Defensive unit
Alexander the Great	3,63	4,70	6,89	4,94	3,30	3,61
José Delmondes	3,40	10,63	6,56	6,00	5,29	73,43
Pedro Santos	3,74	7,21	7,77	4,61	4,59	9,15
Ronaldo Pereira	18,64	20,26	26,06	6,74	16,09	20,45
Emerson Cruz	10,45	12,17	8,49	7,67	10,16	14,51
Emanuel Silva	7,31	8,75	7,13	11,48	7,44	5,87
Victor Paula	21,39	15,08	9,10	6,97	5,70	9,83
Iran Ngambia	2,15	5,77	5,25	2,47	3,70	5,16
Victor Nunes	5,69	6,01	10,82	5,67	3,74	4,07
Carlos Costa	5,54	9,44	5,49	5,71	6,34	3,81
Gustavo Silva	4,43	7,86	10,55	9,64	7,56	6,45
Lucca Dana	7,41	4,94	6,69	8,69	10,37	9,24
Marcos Trindade	16,66	6,47	11,67	5,66	9,01	13,52
Rafael Nery	3,49	6,29	5,98	4,24	5,50	6,78
Kodjovi Ayena	22,32	42,38	59,59	16,88	24,24	18,35
Souleymane Coulibaly	10,48	10,24	17,91	8,56	13,44	13,24
Adriano Alves	23,48	14,95	21,45	19,72	19,10	9,74
Vinicius Souza	5,07	8,78	9,19	5,30	9,58	9,17

Source: Authors.

In the defensive indices that most require adjustments are Defensive coverage and recovery balance with 45% and 56% respectively, classified in the low and very low categories respectively. The indices that should also be worked on with the objective of improvement are containment, concentration and defensive unit with 34% in low and very low categories, while the defensive balance was around 29% in the same previous indices. Regarding the decision-making time, the indexes were mostly in the high and very high categories, showing the need for adjustments and in the high and very high categories, containment, defensive coverage was 34%, recovery balance and defensive balance 45%, concentration 39% and defensive unit 34%, all requiring reduction.

Table 7

Group results regarding the general performance indexes of tacticUP

TacticUP Results			
NAME	GENERAL INDICES		
	Offensive	Defensive	General
Alexander the Great	68,72	61,72	65,22
José Delmondes	69,94	49,83	59,89
Pedro Santos	67,72	70,72	69,22
Ronaldo Pereira	61,83	57,83	59,83
Emerson Cruz	64,44	55,72	60,08
Emanuel Silva	79,89	69,11	74,5
Victor Paula	76,61	71,11	73,86
Iran Ngambia	64,56	69,39	66,97
Victor Nunes	76,06	81,28	78,67
Carlos Costa	71,94	72,72	72,33
Gustavo Silva	68,28	78,78	73,53
Lucca Dana	83,83	71,39	77,61
Marcos Trindade	75,11	58,28	66,69
Rafael Nery	67,17	48,44	57,81
Kodjovi Ayena	60,06	57,39	58,72
Souleymane Coulibaly	71	60,56	65,78
Adriano Alves	75,78	59,72	67,75
Vinicius Souza	71,61	73,94	72,78

Source: Authors.

Table 8

Group results regarding decision-making times in the general performance indices of tacticUP

TacticUP Results			
NAME	AVERAGE TIME OF THE INDICES		
	Offensive	Defensive	General
Alexander the Great	4,97	4,51	4,74
José Delmondes	14,89	17,55	16,22
Pedro Santos	7,17	6,18	6,67
Ronaldo Pereira	15,57	18,04	16,80
Emerson Cruz	7,84	10,58	9,21
Emanuel Silva	10,55	8,00	9,27
Victor Paula	9,14	11,35	10,24
Iran Ngambia	3,37	4,08	3,73
Victor Nunes	6,72	6,00	6,36
Carlos Costa	6,60	6,06	6,33
Gustavo Silva	6,29	7,75	7,02
Lucca Dana	6,57	7,89	7,23
Marcos Trindade	5,62	10,50	8,06
Rafael Nery	5,11	5,38	5,25
Kodjovi Ayena	15,82	30,63	23,22

Souleymane Coulibaly	14,50	12,31	13,40
Adriano Alves	16,86	18,07	17,47
Vinicius Souza	6,60	7,85	7,22

Source: Authors.

In the general indexes, the athletes presented similar results in the offensive and defensive indexes, being around 50% in the high and very high category and in the low and very low indexes with 34% and 23%, respectively. Regarding decision-making, the athletes presented a low and very low index, around 62%, indicating that decisions were made very slowly and needed to be faster.

Table 9

Group results in September and October 2025 regarding the TacticUP offensive performance index

TacticUP Results						
NAME	Offensive indices					
	Penetration	Offensive coverage	Space with ball	Space without the ball	Mobility	Offensive unit
Franck Nguema	72,33	77,67	59,33	100	54,33	50
Pedro Vieira	72,33	67,33	92	93,33	54,67	50
Iure Santos	66,67	87,33	73	93,33	62,33	50
Jarlis Trindade	16,67	77,67	72,67	93,33	36,67	83,33
John Born	50	87,33	58,67	100	74,67	16,67
Samuel Sobreira	72,33	87,33	92	66,67	70	16,67
Yago Bezerra	96,67	52	100	66,67	81,33	66,67
Marcos Trindade	72,33	77,67	78,33	100	88	50
Adriano Silva	83,33	80	45	66,67	69	66,67
Cauã Santos	50	35,67	92	70	41,33	66,67

Source: Authors.

Table 10

Group results in September and October 2025 regarding the offensive decision-making time of TacticUP

TacticUP Results						
NAME	Average Time Offensive Indexes					
	Penetration	Offensive coverage	Space with ball	Space without the ball	Mobility	Offensive unit
Franck Nguema	40,18	41,30	49,78	57,22	42,84	35,39
Pedro Vieira	8,50	8,60	10,01	8,16	5,70	8,87
Iure Santos	13,20	19,49	25,25	17,83	10,13	9,36
Jarlis Trindade	4,73	4,03	4,18	2,81	4,22	2,25
John Born	13,86	8,42	10,97	14,91	10,23	6,15
Samuel Sobreira	8,90	3,96	9,58	7,85	6,01	10,34

Yago Bezerra	5,55	3,96	3,26	4,01	4,51	2,79
Marcos Trindade	6,29	4,16	6,13	10,86	11,49	2,73
Adriano Silva	7,06	9,39	10,96	16,22	5,15	5,21
Cauã Santos	6,83	25,35	27,02	7,15	20,88	6,32

Source: Authors.

As for the results of the offensive indices of TacticUP, it was found that the athletes presented a 70% success rate in the high and very high categories in the tactical contents of offensive coverage, space with the ball and space without the ball. In the Tactical principles of penetration, mobility and defensive unit they reached 60%, 50% and 40% respectively showing in general a good vision of the game in the moments of the plays. In the decision-making time in the tactical principles of offensive coverage, mobility and offensive unit, only 40% of the athletes reached the high and very high categories and a percentage of penetration, space with the ball and space without the ball with 20%, 30% and 20% respectively, showing that assertive choices were not always made quickly.

Table 11

Group results in September and October 2025 regarding the TacticUP defensive performance index

NAME	TacticUP Results					
	Defensive indices					
	Containment	Defensive cover	Recovery balance	Defensive balance	Concentration	Defensive unit
Franck Nguema	33,33	48	70	100	66,67	61,67
Pedro Vieira	42	25	36,67	66,67	95	37
Iure Santos	100	48	66,67	100	58,67	55
Jarlis Trindade	100	33,67	42,33	100	45	16,33
John Born	100	59,33	62,33	97,33	95	61,67
Samuel Sobreira	66,67	71	42,33	66,67	95	41,67
Yago Bezerra	74,33	77	33,33	57	77	66
Marcos Trindade	31	87,67	43,33	64	72,33	28,33
Adriano Silva	100	54,33	62,33	66,67	73,33	76,33
Cauã Santos	91,33	52,33	42,33	33,33	40,67	37

Source: Authors.

Table 12

Group results in September and October 2025 regarding TacticUP's defensive decision-making time

TacticUP Results						
NAME	Average Time Defensive Indexes					
	Containment	Defensive cover	Recovery balance	Defensive balance	Concentration	Defensive unit
Franck Nguema	49,59	37,88	55,57	37,9	61,94	78,84
Pedro Vieira	5,70	10,49	6,66	7,23	8,93	6,28
Iure Santos	14,23	62,76	13,27	14,36	31,61	22,43
Jarlis Trindade	2,50	3,17	5,21	3,68	2,64	2,32
John Born	7,62	12,62	16,82	9,28	7,53	11,30
Samuel Sobreira	5,02	7,88	5,51	6,4	4,92	5,48
Yago Bezerra	4,62	3,61	5,70	7,12	17,11	3,57
Marcos Trindade	5,10	11,91	5,47	3,01	8,34	3,01
Adriano Silva	7,28	20,20	9,29	9,41	6,08	6,96
Cauã Santos	7,65	12,79	16,83	16,49	6,44	8,55

Source: Authors.

As for the defensive indexes, the ones that stood out the most were the principles of defensive balance and concentration with 70% and 60% with high and very high categories, while the principles of containment, defensive unit and recovery balance and defensive coverage with 50%, 40%, 40% and 30% respectively. Indicating that decision-making in high and very high categories did not include most athletes quickly.

Table 13

Group results regarding the overall performance indices of tacticUP

TacticUP Results			
NAME	GENERAL INDICES		
	Offensive	Defensive	General
Franck Nguema	68,94	63,28	66,11
Pedro Vieira	71,61	50,39	61
Iure Santos	72,11	71,39	71,75
Jarlis Trindade	63,39	56,22	59,81
John Born	64,56	79,28	71,92
Samuel Sobreira	67,5	63,89	65,69
Yago Bezerra	77,22	64,11	70,67
Marcos Trindade	77,72	54,44	66,08
Adriano Silva	68,44	72,17	70,31
Cauã Santos	59,28	49,5	54,39

Source: Authors.

Table 14

Group results regarding decision-making times in the general tacticUP performance indexes

TacticUP Results			
NAME	AVERAGE TIME OF THE INDICES		
	Offensive	Defensive	General
Franck Nguema	44,45	53,62	49,04
Pedro Vieira	8,31	7,55	7,93
Iure Santos	15,88	26,45	21,16
Jarlis Trindade	3,70	3,25	3,48
John Born	10,76	10,86	10,81
Samuel Sobreira	7,77	5,87	6,82
Yago Bezerra	4,01	6,96	5,48
Marcos Trindade	6,94	6,14	6,54
Adriano Silva	9,00	9,87	9,43
Cauã Santos	15,59	11,46	13,529

Source: Authors.

As for the general indexes, the worst results were in the defensive principles 40% of the total athletes with very low and low categories. And with regard to decision-making time, there was a small difference in tactical principles, in which a total of 60% presented high and very high in the categories, indicating that decisions were made slowly and need to be improved. Slow decisions can cost you defeat in an important game.

12 CONCLUSION

The development of this study allowed an in-depth analysis of the training of the professional soccer coach and the most relevant contents for his performance with university teams. It was possible to evaluate how the training of these professionals can contribute to the development of players with more advanced knowledge in tactics and game space management, thus optimizing the performance of the teams. In addition, the use of didactic resources and equipment available in the literature, developed by national and international researchers, can play a crucial role in the training of players and coaches. It is important to note that the university environment presents unique challenges that need to be considered in this process. Finally, this research demonstrates the importance of investing in the continuous training of coaches, since this can positively reflect on the development of players and, consequently, on the performance of university teams, thus contributing to the advancement of knowledge in the academic environment.

In summary, the training of football coaches has evolved significantly in recent years, with an increased emphasis on academic training and knowledge about game tactics and positioning on the field. However, there are still challenges to be overcome, such as the lack

of resources and the need to improve the training of coaches. Based on the results of this research, it is possible to conclude that the continuous training of coaches is fundamental for the development of players and university teams. In addition, the use of didactic resources and equipment available in the literature can play a crucial role in the training of players and coaches. Ultimately, the training of football coaches is a complex process that requires an integrated and continuous approach, involving academic training, sports practice and the use of didactic resources and equipment

Based on the results of the survey, it is possible to conclude that the continuous training of coaches is fundamental for the development of players and university teams. The results show that the available academic literature favors teaching and facilitates the work of trainers with important content for training. In addition, the use of didactic resources and equipment available in the literature can play a crucial role in the training of players and coaches. Therefore, it is necessary that coaches seek to overcome difficulties and be able to find effective ways to constantly improve teams, through the practical application of available information

In the analysis carried out, it was possible to verify that the literature on soccer tactics and game space management, composed by authors such as Israel Teoldo, José Guilherme and Júlio Garganta, provided a solid theoretical basis for the formation of players, allowing them to improve specific skills of the game through reduced games. In addition, the application of game vision assessment and game space management instruments provided a broad view of how each player analyzed and solved situations during the game phases, allowing them to identify and improve the observed difficulties. Finally, the use of game videos to guide the positioning and performance of players in the team proved to be effective in minimizing incorrect actions and correcting the positioning on the field, according to the position in the team. These results demonstrate the effectiveness of combining these resources for the continuous improvement of teams

In view of the results of the research, which demonstrated the effectiveness of combining resources for the continuous improvement of teams, it is essential that future investigations explore new approaches to the training of football coaches. Based on the reviewed literature, which highlighted the importance of game space management and game vision for team performance, we suggest that future research use innovative methods of coach training that focus on the formation of winning squads and an efficient coaching staff. In addition, it would be interesting to investigate the relationship between the Brazilian and European formation and the performance of the teams in the competitions, in order to better understand the differences that affect the teams and the performance in the competitions.

This could be achieved through comparative studies between coach education approaches in different countries and contexts.

In summary, the training of football coaches based on the tactical principles of the game and the management of the playing space is essential for the success of teams. Suggestions presented above for future research highlight the importance of exploring new approaches to training coaches. In this sense, the use of material resources and fundamental equipment, such as Tacticup, can be a valuable tool to improve the performance of teams. By combining these approaches, it is possible to create a more qualified and effective training of football coaches, which contributes to the success of teams in competitions.

REFERENCES

- Bassaneze, B. (2021). Manual do futebol peneira: Tudo para você mudar o jogo! Futebol Peneira.
- Cruz, J. P. B. (2025). A evolução tática no futebol: Como as formações mudaram o jogo.
- Darido, S. C., & Souza Júnior, O. M. D. (2007). Para ensinar educação física: Possibilidades de intervenção na escola. Papirus.
- Darros, H. B. (2010). O maior tesouro do mundo. Clube de Autores.
- De Souza, R. (2024). Holanda 1974: Carrossel holandês. Professor Ricardo de Souza.
- Ferreira, R. C. A. (2020). Metodologia do ensino de futebol e futsal (1ª ed.). IESDE.
- Gomes, A. C. (2008). Futebol: Treinamento desportivo de alto rendimento. Artmed.
- Guarinon, R. C. (2018). Bayern de Munique 2015/2016 (1ª ed.). Chiado Editora.
- Lopes, C., & Belozo, F. (2017). Futebol sistêmico: Conceitos e metodologias de treinamento. Paco e Lettera.
- Melo, W. (2025). Século XXI e a crise no futebol brasileiro. Viseu Ltda.
- Mendonça, P. (2018). Preparação para a competição: O método de Maurizio Sarri. Pedro Mendonça.
- Nascif, A. M. M. (2022). Futebol: Conhecer e proceder: Uma proposta curricular de formação do futebolista (1ª ed.). Appris.
- Oliveira, J., & Tavares, F. (1996). Estratégia e tática nos jogos desportivos coletivos. Tip Minerva.
- Rampazzo, L. (2002). Metodologia científica para alunos dos cursos de graduação e pós-graduação (3ª ed.). Edições Loyola.
- Romero, G. (2021). Seja seu próprio coaching (1ª ed.). Clube de Autores.
- Saage, B. M. L. (2025). Futebol tático: Técnicas, treinamento e truques avançados. Saage Media GmbH.
- Schekiera, A. A. (2015). Manual do coach (1ª ed.). Clube de Autores.

Teoldo, I. da C., Guilherme, J., & Garganta, J. (2021). Para um futebol jogado com ideias (2ª ed.). Appris.

Theobald, T., & Cooper, C. (2007). Negócios e o jogo maravilhoso: Como você pode aplicar as técnicas e as paixões no futebol para ser um vencedor nos negócios. Clío Editora.

THE UNIVERSITY AS A HUB OF URBAN TERRITORIAL DEVELOPMENT: THE CASE OF THE CITY OF MARINGÁ-PR

A UNIVERSIDADE ENQUANTO POLO DE DESENVOLVIMENTO TERRITORIAL URBANO: O CASO DA CIDADE DE MARINGÁ-PR

LA UNIVERSIDAD COMO POLO DE DESARROLLO TERRITORIAL URBANO: EL CASO DE LA CIUDAD DE MARINGÁ-PR



<https://doi.org/10.56238/sevened2026.008-209>

Lúcio Paulo Alves Pires¹

ABSTRACT

This article contributes to the body of research that assigns higher education institutions a central role in urban territorial development, highlighting the contribution of extension programs and social activities to the development of critical awareness in society. The objective, based on a descriptive and qualitative approach, was to describe the territorial development of the city of Maringá-PR in relation to the universities operating within its urban territory, obtained through systematic and objective procedures of description using content analysis. As a result, it contributes to the construction of diversity of thought and activities within Brazilian universities, affirming the relevance of the society–university relationship.

Keywords: University. Urban Territory. Development. Extension. Society.

RESUMO

Este artigo alimenta a produção de pesquisas que conferem às instituições de ensino superior uma centralidade perante o desenvolvimento territorial urbano; destacando a contribuição dos programas de extensão e de atividades sociais na contribuição com a sociedade, de uma consciência crítica. Teve como objetivo, perante uma abordagem descritiva e qualitativa, descrever o desenvolvimento territorial da cidade de Maringá-PR relacionado as universidades que operam em seu território urbano, obtido por procedimentos sistemáticos e objetivos de descrição da análise de conteúdo. Por desenlace, contribui para a construção da diversidade de pensamentos e das atividades nas universidades brasileiras, afirmando a relevância da relação sociedade-universidade.

Palavras-chave: Universidade. Território Urbano. Desenvolvimento. Extensão. Sociedade.

RESUMEN

Este artículo contribuye a la producción de investigaciones que otorgan a las instituciones de educación superior una centralidad en el desarrollo territorial urbano, destacando la contribución de los programas de extensión y de las actividades sociales en la construcción de una conciencia crítica en la sociedad. Tuvo como objetivo, a partir de un enfoque descriptivo y cualitativo, describir el desarrollo territorial de la ciudad de Maringá-PR en

¹ Dr. Universidade Estadual de Maringá. E-mail: lpapires@pireseducacao.com

relación con las universidades que operan en su territorio urbano, obtenido mediante procedimientos sistemáticos y objetivos de descripción a través del análisis de contenido. Como resultado, contribuye a la construcción de la diversidad de pensamientos y actividades en las universidades brasileñas, afirmando la relevancia de la relación sociedad–universidad.

Palabras clave: Universidad. Territorio Urbano. Desarrollo. Extensión. Sociedad.

1 INTRODUCTION

The educational institution, which comprises the set of schools aimed at professional and scientific specialization, offering services to the community in the various areas of knowledge is the university. According to Pereira (2013), it is the institution that contributes to society through the production of a critical consciousness, strengthening the power of vindication and provocation of a people; for the author, the university assumes a special meaning for the general development of the nation (PEREIRA, 2013).

According to Goulart and Vieira (2008), the university institution produces a centrality in the social universe, that is, in an urban territory, the perennality and permanent state of effectiveness and sociocultural pertinence have a *modus operandi*, influencing human social development. And within this context, this article aims to affirm the relationship between the development of an urban territory related to the implementation of universities in it; aiming to describe the territorial development of the city of Maringá-PR related to the universities that operate in its urban territory.

In this way, it presents the foundation of the first Brazilian universities, highlighting the Getúlio Vargas Foundation, EASP, as the first Brazilian school of administration, and the promulgation of the constitutions, which formalized Brazilian higher education. Remembering that, according to Paulo Freire (1983), education is, above all, communication and dialogue, a meeting of interlocutors who seek the meaning of meanings.

Thus, this article, inserted in the area of Administration, contributes to the construction of the diversity of thoughts and activities in Brazilian universities, producing relevant relationships with society and the urban territory. According to Santos (2004), the university must confer a new centrality of social extension, conceiving alternative modes to global capitalism. For the author, universities attribute active participation in the construction of social cohesion, in the deepening of democracy, in the fight against social exclusion, environmental degradation and in the defense of cultural diversity (SANTOS, 2004).

By outcome, it concludes that the improvement in the quality of life of the urban territory occurs with the implementation of universities and the construction of their relationship with the territory, developed through the university-society relationship. Because the institution of higher education offers vast horizons to the extension of society, in its centrality in the social, sociocultural, political and economic universe in the face of human diversities.

2 DEVELOPMENT

Conducted annually by the National Institute of Educational Studies and Research Anísio Teixeira (Inep), the Higher Education Census is an important instrument for obtaining

data for the generation of information that subsidizes the formulation, monitoring and evaluation of public policies aimed at Brazilian education; in addition to being the important element for the preparation of studies and research on the sector (BRASIL, 2020).

The census collects information on Higher Education Institutions (HEIs), undergraduate and sequential courses of specific training and on students and professors linked to these courses; according to the latest census of 2020, there are 2,457 higher education institutions in Brazil, of which 77% are colleges (BRASIL, 2020, p. 10).

Brazil has 6.5 million university students, 6.3 million in undergraduate courses and 173 thousand in graduate courses; in 2020, 41,953 undergraduate courses and 25 sequential courses were surveyed offered in 2,457 higher education institutions.

2.1 THE EMERGENCE OF THE UNIVERSITY IN BRAZIL

An effort towards popular education, whether or not associated with professional training, in the agricultural or urban field, with the fundamental objective of problematizing social relations and explanations of nature, which enables the deepening of awareness of reality and makes the composition of knowledge, according to Freire (1983), is education.

Educator Paulo Freire defends questioning learning that does not repeat information, data and techniques, but reflects on them and includes them in their social context, formalizing transformations; for the author, this path is pointed out as the true meaning of education (FREIRE, 1983). And the institution that broadens the human vision, integrating social reality through the extension of transformative, emancipatory and democratic service is the university.

In Brazil, the enunciation of this transformative service was attributed to the central power, according to article 35 of the 1891 Constitution, which was entrusted to Congress, not exclusively, creating institutions of higher and secondary education in the States (FÁVERO, 2006). However, only through Decree No. 14,343, of September 7, 1920, which had its regulations approved by Decree No. 14,572, on December 23 of the same year, the first Brazilian university, the University of Rio de Janeiro (BORTOLANZA, 2017), was founded.

Art. 1 The Polytechnic School of Rio de Janeiro, the Faculty of Medicine of Rio de Janeiro and the Faculty of Law of Rio de Janeiro are hereby gathered in the "University of Rio de Janeiro", the latter being exempted from inspection. Paragraph 2 - The regulations of the University shall be drawn up within thirty days by a commission composed of the president of the Superior Council of Education and the directors of the Polytechnic School and of the Faculties of Medicine and Law, followed by its approval, within fifteen days, by the three congregations convened for this purpose by the said president. (BRASIL, 1920, p. 15115).

However, administration, as an area of knowledge and academic discipline, according to Souza (2007), was born in the United States of America, breaking the stages followed by the European tradition of studies and research in the area, which then focused more on the analysis of the State and its institutions than on the production of theories of government; in Europe, the area emerged, according to the author, as an offshoot of works based on explanatory theories about the State and about the role of one of the most important institutions of the State, that is, the government, which par excellence is a producer of public policies. (SOUZA, 2007)

Only in the 1950s, during the historical period called the Cold War, according to Cook (2004), there were international investments in the academic area of Administration through the promotion of external assistance programs for development management, of a donor agency to carry out a predetermined task. The Brazilian historical landmark in the area of knowledge is the foundation of the School of Business Administration of São Paulo in 1953, by the Getúlio Vargas Foundation (FGV-EAESP), according to Alcadipani and Bertero (2012), FGV-EAESP is the university located among the main and most prominent in the country, despite not being the first, it consolidates as a leader and model for other educational institutions in administration in Brazil, counting on the support and the American teaching model. According to the authors, EAESP has become the center of the area and production of Brazilian academic knowledge in administration (ALCADIPANI; BERTERO, 2012).

Regarding university autonomy, only with the promulgation of the democratic constitution in 1988, the Federal Constitution in its article 207, reaffirms the principle of inseparability between teaching, research and extension, establishing university autonomy: "Universities enjoy didactic-scientific, administrative, and financial and patrimonial management autonomy, and will obey the principle of inseparability between teaching, research and extension" (BRASIL, 1988, CF, art. 207).

After the university system suffered from economic crises that reduced funding for its activities and political crises that generated long and frequent strikes by civil servants and students, and the promulgation of the 1988 constitution, universities assumed significant roles in relations with society (VIZONI, 2021). Pereira (2013) states that the participation of universities in public policy programs has taken on special significance for the general development of the nation.

The university contributing to the increase of critical social awareness, strengthening the power of social claim, provoking enunciations of the population in the face of urban territorial developments through its extension relations.

2.2 THE UNIVERSITY AS A CENTER OF URBAN TERRITORIAL DEVELOPMENT;

The influence that university fields produce in the territories is composed of the relations of extension and production of knowledge. Since, the activities of universities and other higher education institutions "have broad and complex repercussions on the personal and professional trajectory of the people who participate in them and on the general evolution of the living conditions of the population in the cities, regions and countries where they are located" (VIZONI, 2021, p. 23 apud. VILA, 2018).

However, as the author adds, the existence, or even the creation of universities, does not in itself guarantee regional economic growth, since the transfer of knowledge and the generation of innovations are not automatic and much less immediate, in addition to the fact that universities have different vocations, organizational cultures, internal heterogeneities and preferences (VIZONI, 2021, apud. SERRA; ROLIM; BASTOS, 2018)

The socioeconomic characteristics of the urban territories where universities are located matters a lot. In this sense, according to Vizoni (2021, p. 24), "their success in transferring knowledge and technology is directly associated with the regional productive structure, the potential for mobilization of governments, and the region's capacity to absorb the knowledge produced in academia itself". However, the central point is the pertinence, relevance and the need for universities to play a proactive role in the development process of the territories in which they are coupled (SERRA; ROLIM; BASTOS, 2018)

3 METHODOLOGICAL PROCEDURES

The methodological procedure was initiated through a bibliographic survey on the theme of universities and higher education institutions, having as a contextualization the authors that focuses on the extension of university centers, as a character the relationship between society-university, and national development through education.

As a complement to data collection, this research uses a descriptive qualitative approach, designed by Denzin and Lincoln (2006), aiming to activate the public data demonstrated by the main Brazilian demographic research institutes, such as INEP and IBGE.

To formalize the research analysis, a content analysis was instrumentalized, based on the epistemological and empirical bases activated during data collection, based on the writings of Laurence Bardin (BARDIN, 1977). This analysis, according to Silva, Gobbi and Simão (2005), allows the understanding of the representations that the body presents in relation to its reality and the multiple interpretations of meanings. Activating a set of instruments, which, according to Bardin (1977), allow us to come from the theoretical and

intentional strand, which aims at inference, through the objective identification of the characteristics of the messages.

4 RESULTS AND DISCUSSIONS

For Paulo Freire (1983), education is above all communication, dialogue, a meeting of interlocutors who seek the meaning of meanings, and universities, as institutions of academic higher education, produce the encounter between society and knowledge.

4.1 THE UNIVERSITY IN THE CONTEXT OF MARINGÁ'S DEVELOPMENT

According to Santos (1989), since the nineteenth century the university has been intended to be the place par excellence for the production of scientific knowledge. The university, whose institutional character suggests the capacity for access and action at all contextual levels, has always been assigned the central role in the development of countries due to its capacity for the production and transmission of knowledge and for the training and qualification of the workforce (GOULART; VIEIRA, 2008).

The university is faced with a complex situation, since increasing demands are made by society at the same time that funding policies by the State become increasingly restrictive, forcing the collection of funds to support university activities outside the public environment (SANTOS, 2010). However, the broader idea of social responsibility, participation in communities and reformist intervention in social problems is current in the imagination of many higher education institutions, strengthening itself in historical periods of transition or democratic deepening, as demonstrated in previous constitutions.

However, it is difficult to track and measure the impact of social engagement activities instrumentalized by universities, as some of these activities are inserted in continuing education and technology transfer activities, making it almost impossible to have data that can be recorded in urban territories (MORA; SERRA; VIEIRA, 2018). However, according to the authors, the benefits arising from social engagement activities formalize the development of the quality of social life (health, infrastructure and education); producing the improvement of the human and social capital of these territories.

For universities, social engagement activities are beneficial because they allow them to help the community, establish permanent links with citizens, carry out activities aimed at the public good and develop new skills, such as the improvement of human professionals; the preservation of cultures and traditions and, in general, the social, economic, cultural and environmental benefits, preserving critical reflection (MORA; SERRA; VIEIRA, 2018).

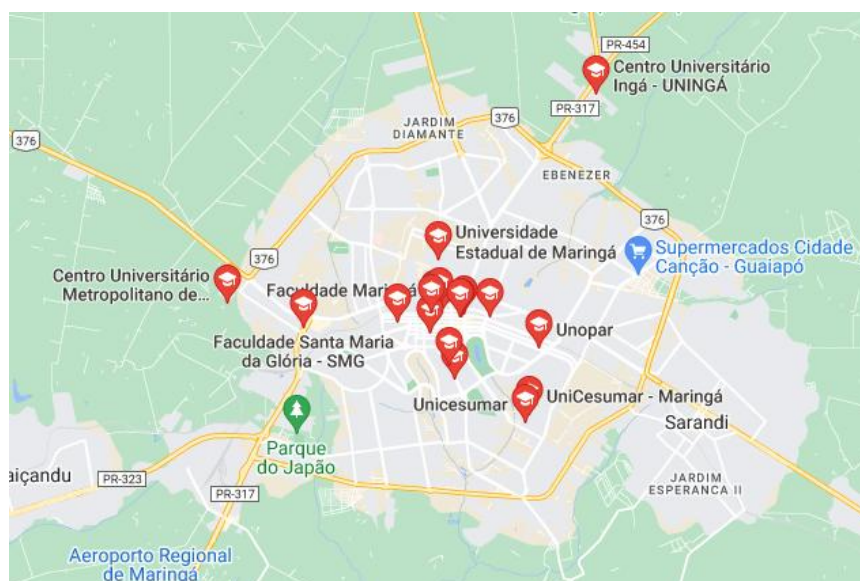
"This social approach has gained relevance in recent years in the face of the realization that the engagement of universities with local communities can be a fruitful instrument in regional social and economic transformation, generating mutual benefits, since universities also take advantage of this close involvement to test new ideas and find more efficient ways to achieve the desired results." (VIZONI, 2021, p. 26)

In view of this approach, the preservation and social development of urban territories are highlighted through the implementation of university centers in it. Therefore, higher education institutions assume a special significance for development, conferring a new centrality of social extension, conceiving alternative modes to global capitalism and critical consciousness.

This logic benefits the development of the urban territory, producing a prospect of a city with excellence, as in the case of Maringá-PR, which is instrumentalized as "the best city to live in the country in 2021" (PREFEITURA MUNICIPAL, 2021).

Title mobilized in a survey by the *Macroplan institute*, in 2021, when evaluating the indices of challenges in municipal management in Brazil, Maringá – PR occupied the first position. "Macroplan's selection follows several criteria, such as employment index, safety, health and education. And Maringá stood out in education and health (fifth highest national score), in addition to being among the leaders in basic sanitation." (CITY HALL, 2021). It is the result of a territory composed of more than 20 internationally recognized higher education fields, such as the State University of Maringá; UniCesumar; the Metropolitan University Center of Maringá Unifamma; Unopar; Unespar, among others, demonstrated on the map of the city of Maringá-PR, in the following figure, highlighted in red dots, through the *google maps application* (GOOGLE MAPAS, 2022).

Figure 1



Source: search in *the google maps* app by Maringá-PR universities, google maps, 2022.

The urban territory of the navy, integrates several institutions of higher education, involving in its municipality, a vast area of provision and services, having as the society in general the recipient, through university extension. According to Santos (2010), University extension should have as its priority objective the solidarity support in solving society's problems, that is, the development of the territory in which the university is located.

And the city of Maringá covers a GDP per capita [2019] of R\$ 45,582.78, with a Municipal Human Development Index (MHDI) of 0.808; eIn 2020, the average monthly salary was 2.6 minimum wages, with a proportion of employed persons in relation to the total population of 46.4%. When compared to other municipalities in the state of Paraná, it occupies position 12 out of 399 and 10 out of 399, respectively; and in comparison with cities throughout the country, it ranks 373 out of 5570 and 91 out of 5570, respectively. (BRAZIL, 2020)

When considering households with monthly income of up to half a minimum wage per person, the municipality of Maringá has 26.1% of the population in these conditions, which places it in position 377 out of 399 among cities in the state and in position 5233 out of 5570 among cities in Brazil (BRASIL, 2020). The territory of the municipality of Maringá has 83% of households with adequate sanitary sewage, 97.3% of urban households on public roads with trees and 90.6% of urban households on public roads with adequate urbanization, that is, with the presence of culvert, sidewalk, pavement and curb; when compared to the other municipalities in the state of Paraná, according to the 2020 census, the territory is in position 21 out of 399, 88 out of 399 and 2 out of 399, respectively; in relation to other cities in Brazil, its position is 806 out of 5570, 518 out of 5570 and 6 out of 5570 (BRASIL, 2020).

Regarding education, the focus of this article, the city of Maringá is composed of high quality public and private education, from the basic education network to higher education, with postgraduate studies enrolled in the sense and in the broad sense; showing the schooling rate at 98.4% in the first years, with the IDEB of the public network of 7.2; Making up part of this production, 41,291 students enrolled in elementary school with 2583 teachers [2021], 12,130 enrolled in high school with 946 teachers [2021] with more than 200 educational establishments in its territory. (BRAZIL, 2020)

Despite the public disincentives operated by the federal government, and the national drop recorded in the number of graduates in undergraduate courses of 6.0% compared to 2019 (BRASIL, 2022), in the municipality of Maringá, the data demonstrate a territory in full development.

5 FINAL CONSIDERATIONS

As demonstrated by the authors, the relationship between the university and society is part of the relationship in favor of urban territorial development. There is a difficulty in tracking and measuring the impact of social engagement activities instrumentalized by higher education institutions, as some of these activities are inserted in continuing education activities, however, from an analysis arising from the theoretical aspect and intentionality, aiming at the inference of the objective data, offered by national research instruments such as INEP and IBGE, This article states the relationship between the development of the urban territory of the city of Maringá-PR related to the implementation of higher education fields.

Therefore, the society-university relationship is beneficial because it allows helping the community and its entire territory, establishing permanent links between citizens, carrying out activities aimed at the public good, such as the improvement of human professionals; the preservation of cultures and traditions and, in general, the social, economic, cultural and environmental benefits, preserving critical social reflection; demonstrated in the data and tables of the main national demographic institutes, the development of the urban territory, producing a prospect of a city with excellence, named as the best city to live in the country in the year 2021. Therefore, universities help with a proactive role, enabling territorial development in the cities in which they are inserted; through a set of instruments, which allow the production of intentionality, the inference of the society-university relationship.

By outcome, this research from the case of the city of Maringá-PR, as a pole of a university territory, opens perspectives for new research related to university extension aiming at a solidary support in the resolution of society's problems, that is, in the development of the national territory. Contributing to the construction of the diversity of thoughts and

activities in Brazilian universities, producing relevant relationships with society and the urban territory. Since, Santos (2004) highlights the university, as a social centrality, conceiving alternative modes to global capitalism.

REFERENCES

- Bardin, L. (1997). *Análise de conteúdo*. Edições 70.
- Bortolanza, J. (2017, November 24). *Trajetória do ensino superior brasileiro: Uma busca da origem até a atualidade*. In *Anais do XVII Colóquio Internacional de Gestão Universitária*. <https://repositorio.ufsc.br/xmlui/handle/123456789/181204>
- Brasil. (1994). *Constituição da República Federativa do Brasil* (9ª ed.). Saraiva.
- Brasil. Instituto Brasileiro de Estudos e Pesquisas Educacionais Anísio Teixeira. (2022). *Censo da educação superior*.
- Brasil. Instituto Brasileiro de Geografia e Estatística. (2020). *Cidades e estados: Panorama de Maringá*. <https://cidades.ibge.gov.br/brasil/pr/maringa/panorama>
- Denzin, N. K., & Lincoln, Y. S. (2006). *Introdução: A disciplina e a prática da pesquisa qualitativa*. In N. K. Denzin & Y. S. Lincoln (Orgs.), *O planejamento da pesquisa qualitativa: Teorias e abordagens*. Artmed.
- Fávero, M. L. A. (2006). *A universidade no Brasil: Das origens à reforma universitária de 1968*. *Educar em Revista*, (28), 17–36.
- Freire, P. (1983). *Extensão ou comunicação?* (7ª ed.). Paz e Terra.
- Freire, P. (2018). *Pedagogia da tolerância* (6ª ed.). Paz e Terra.
- Google. (2022). *Google Maps [Aplicativo]*. <https://www.google.com>
- Goulart, S., & Vieira, M. M. F. (2008). *Desenvolvimento e organizações: As universidades como eixo de articulação entre o local e o global*. *Organizações & Sociedade*, 15(45), 91–106. <https://portalseer.ufba.br/index.php/revistaoes/article/view/10952/7878>
- Goulart, S., Vieira, M. M. F., & Carvalho, C. A. (2005). *Universidades e desenvolvimento local: Uma abordagem institucional*. Sagra Luzzatto.
- Mora, J.-G., Serra, M., & Vieira, M. J. (2018). *O engajamento social como motor do desenvolvimento regional: Contribuição das universidades latino-americanas*. In M. Serra, C. Rolim, & A. P. Bastos (Orgs.), *Universidades e desenvolvimento regional: As bases para a inovação competitiva* (pp. 123–154). Ideia.
- Pereira, L. B. (2013). *Extensão universitária e políticas públicas*. *Revista Extensão & Cidadania*, 1(1), 91–104. http://periodicos.uesb.br/index.php/recuesb/article/viewFile/5440/pdf_354

Prefeitura Municipal de Maringá. (2021). Maringá é a melhor cidade do Brasil para se viver. <http://www2.maringa.pr.gov.br/site/noticias/2021/02/15/maringa-e-a-melhor-cidade-do-brasil-para-se-viver/37083>

Santos, B. de S. (2004). A universidade no século XXI. Cortez.

Santos, B. de S. (2010). Pela mão de Alice: O social e o político na pós-modernidade (13^a ed.). Cortez.

Serrano, R. M. S. M. (2008). Conceitos de extensão universitária: Um diálogo com Paulo Freire. Extelar Grupo de Pesquisa em Extensão Popular. https://crystine-tanajura.webnode.com/_files/200000021-e6560e752b/conceitos_de_extensao_universitaria.pdf

Vizioni, F. N. C. (2021). O acolhimento dos problemas públicos locais pelos projetos de extensão universitária do campus avançado em Jandaia do Sul da Universidade Federal do Paraná. BCE-UEM.

INNOVATION PROCESS IN TRANSPORTATION: A STUDY ON THE USE OF TELEMETRY IN THE ARTICULATED BUS SYSTEM OF THE BRT-RJ

PROCESSO DE INOVAÇÃO NO TRANSPORTE: UM ESTUDO SOBRE O USO DA TELEMETRIA NO SISTEMA DE ÔNIBUS ARTICULADOS DO BRT-RJ

PROCESO DE INNOVACIÓN EN TRANSPORTE: UN ESTUDIO SOBRE EL USO DE LA TELEMETRÍA EN EL SISTEMA DE AUTOBUSES ARTICULADOS BRT- RJ



<https://doi.org/10.56238/sevenced2026.008-210>

Cleber Rebelo Israel Reis¹, Tabatha Moreira Pacheco², Pedro Augusto Cardoso da Silva³, Valeria Cristina de Souza Corrêa⁴, Michele da Silva Feitoza⁵, Fernanda Souza de Sales⁶, Daniel Sypriano de Sales⁷, Fabricio Ziviani⁸

ABSTRACT

Considering the economic scenario of recent years, the current low growth prospects for the country, the serious public security situation, the growth of home office work, and the emergence of new solutions that are changing the way people move around cities, innovative initiatives are necessary to guarantee the survival of companies and the continued provision of quality service to the population. To face this new reality, organizations must consider innovation as one of their main strategic drivers. The workforce must have its creativity stimulated, and interaction between different departments must occur more and more in order to jointly identify solutions that improve overall results. This project presents a study on innovation as a competitive differentiator in the articulated bus (BRT) segment in the Metropolitan Region of Rio de Janeiro, aiming to understand which factors make innovation a competitive advantage for this segment. Critical factors with a high impact on results were identified and – with the help of technology – monitoring and control methods were defined. Managers analyze the numbers and develop action plans to reduce poor performance by an employee or the misuse of a part, for example. The results prove the efficiency of this innovation and suggest that its large-scale application can be a critical success factor for the segment, aiming to guarantee the future of the transport system and the continued provision of quality services to the people of Rio de Janeiro.

Keywords: BRT Telemetry. Transportation System. Road Transport. Process Optimization. Innovation.

¹ Cambrian College. Ontario College. Fundação Dom Cabral. E-mail: rebeloc@outlook.com.br

² Universidade Candido Mendes. E-mail: tabatha.pacheco@outlook.com

³ Fundação Dom Cabral. E-mail: Pedro.augustoengenharia@gmail.com

⁴ Fundação Dom Cabral. E-mail: vscorreia@gmail.com

⁵ Fundação Dom Cabral. E-mail: Mfeitoza2018@gmail.com

⁶ Fundação Dom Cabral. E-mail: Fernanda.sales1810@gmail.com

⁷ Universidade Candido Mendes. E-mail: Sypriano.daniel@outlook.com.br

⁸ Fundação Dom Cabral. E-mail: fazist@hotmail.com

RESUMO

Considerando o cenário econômico dos últimos anos, a atual baixa perspectiva de crescimento do País, a grave situação de segurança pública, o crescimento do home office e o surgimento de novas soluções que estão alterando a forma como as pessoas se deslocam pelas cidades, fazem-se necessárias iniciativas inovadoras para garantir a sobrevivência das empresas e a continuidade da prestação do serviço à população com qualidade. Para fazer frente a essa nova realidade, as organizações devem considerar a inovação como um dos seus principais direcionadores estratégicos. O quadro funcional deve ter sua criatividade provocada e a interação entre diferentes departamentos deve acontecer cada vez mais afim de juntos identificarem soluções que melhorem os resultados como um todo. O presente projeto apresenta um estudo sobre a inovação trabalhada como diferencial competitivo no segmento de ônibus articulados (BRTs) na Região Metropolitana do Rio de Janeiro, tendo como propósito compreender quais são os fatores que fazem da inovação um diferencial competitivo para esse segmento. Fatores críticos com alta participação nos resultados foram identificados e – com a ajuda da tecnologia – formas de acompanhamento e controle foram definidas. Gestores analisam os números e traçam planos de ação com o objetivo de reduzir a má operação de um colaborador ou a má utilização de uma peça, por exemplo. Os resultados comprovam a eficiência dessa inovação e sugerem que a sua aplicação em larga escala pode ser um dos fatores críticos de sucesso para o segmento, visando garantir o futuro do modal e a continuidade da prestação de serviços de qualidade para o povo da Cidade do Rio de Janeiro.

Palavras-chave: Telemetria BRT. Sistema de Transporte. Transporte Rodoviário. Otimização de Processos. Inovação.

RESUMEN

Considerando el escenario económico de los últimos años, las bajas perspectivas de crecimiento del país, la grave situación de seguridad pública, el aumento del teletrabajo y la aparición de nuevas soluciones que están transformando la forma de desplazarse en las ciudades, se requieren iniciativas innovadoras para garantizar la supervivencia de las empresas y la prestación continua de servicios de calidad a la población. Para afrontar esta nueva realidad, las organizaciones deben considerar la innovación como uno de sus principales motores estratégicos. Es necesario estimular la creatividad de la plantilla y aumentar la interacción entre los diferentes departamentos para identificar conjuntamente soluciones que mejoren los resultados generales. Este proyecto presenta un estudio sobre la innovación como diferenciador competitivo en el segmento de autobuses articulados (BRT) de la Región Metropolitana de Río de Janeiro, con el objetivo de comprender qué factores convierten la innovación en una ventaja competitiva para este segmento. Se identificaron factores críticos con un alto impacto en los resultados y, con la ayuda de la tecnología, se definieron métodos de seguimiento y control. Los gerentes analizan las cifras y desarrollan planes de acción para reducir, por ejemplo, el bajo rendimiento de un empleado o el uso indebido de una pieza. Los resultados demuestran la eficacia de esta innovación y sugieren que su aplicación a gran escala podría ser un factor clave para el éxito del segmento, con el objetivo de garantizar el futuro del sistema de transporte y la prestación continua de servicios de calidad a los cariocas.

Palabras clave: Telemetría BRT. Sistema de Transporte. Transporte por Carretera. Optimización de Procesos. Innovación.

1 INTRODUCTION

Within a process of continuous improvement, aiming to obtain better results and face the current economic crisis, urban passenger transport companies have prioritized the search for innovation and cutting-edge technological solutions to improve their results. Bus Rapid Transit (BRT) was an urban mobility solution that emerged – first in Brazil – in 1974, with the Integrated Transport Network (RIT) in Curitiba (Paraná). The first BRT/RJ corridor in operation in Rio de Janeiro (RJ) was the TransOeste, whose initial phase was inaugurated in 2012.

Currently, in Rio de Janeiro, the system has a fleet of 440 articulated buses that circulate through the corridors of TransOeste (60 km), TransCarioca (39 km) and TransOlímpica (26 km). According to BRT/RJ data, a bus replaces 126 cars, on average. The system has 125 km of exclusive corridors, 2,100 employees and about 450 thousand passengers per day (Figure 1). In Rio de Janeiro, the BRT/RJ is managed by a consortium (private passenger transport companies) and, currently, the system is already present in 140 countries around the world.

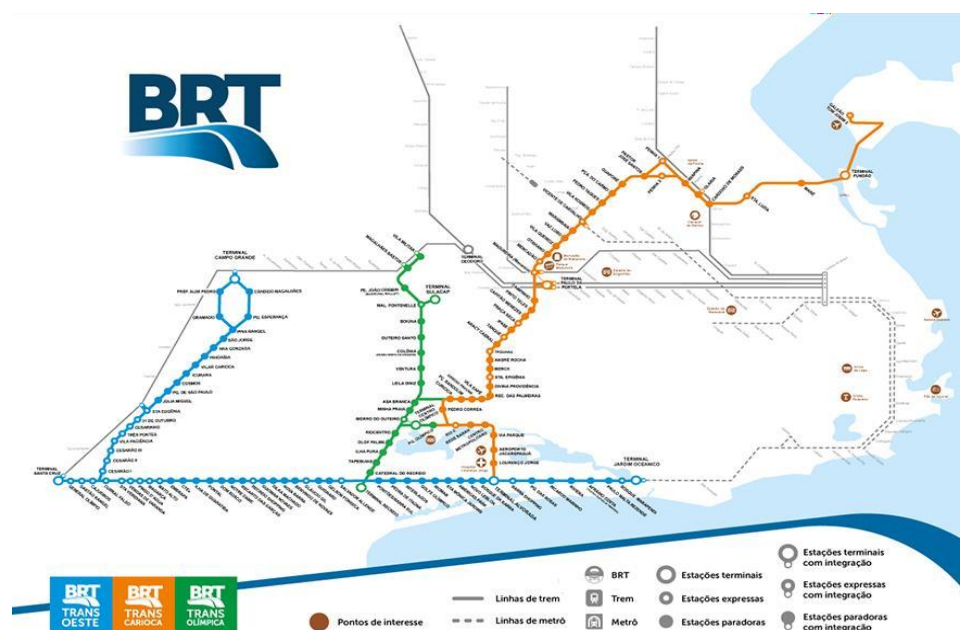
In order to improve its performance, Auto Viação Tijuca S.A. (Tijuquinha) entered into a partnership with Viação Normandy do Triângulo Ltda. (Normandy), and the Tijuquinha/Normandy group decided to seek, through innovation, a competitive advantage that would promote a reduction in its operating costs and bring an increase in the quality of services.

The Application Project will address the way innovation is perceived by urban passenger transport companies, highlight Knowledge Management and cite Schumpeter (1997), the sources and paths of innovation, and the barriers. It will present the economic scenario of the city and the State of Rio de Janeiro and the crisis that affects the country as a whole, in addition to describing the application of telemetry and the various benefits achieved with the use of this technology.

At the conclusion of the work, we will project the benefits of extending the technological solution applied in the Tijuquinha/Normandy partnership to the other companies of the BRT/RJ System of the City of Rio de Janeiro and the importance of metropolitan transport management in the coordination of mobility actions and in the dissemination of good practices, making urban transport companies viable and bringing improvements in the quality of life of the population.

Figure 1

Infographic of the BRT/RJ corridors and the interconnection with the train and subway modes



Source: BRT/RJ (2022).

The present study analyzes the use of telemetry in the articulated bus system of the BRT-RJ, as well as the difficulties and benefits that the implementation brought to the road passenger transport companies in the Metropolitan Region of Rio de Janeiro.

This study aims to analyze the feasibility and applicability of the use of telemetry in the BRT/RJ modal.

2 THEORETICAL FRAMEWORK

To use innovation in the best possible way, it is first necessary to understand where it was born in the business model and what are the fundamental steps to develop it in this organizational environment.

Based on the theories of economist Schumpeter (1997), considered "the father of innovation", the process of knowledge and innovation management, its sources, the barriers to be faced, the process of performance analysis and the direct and indirect results of innovation will be discussed.

2.1 INNOVATION

For Schumpeter (1997), innovation can be understood as the fundamental impulse that initiates and maintains the movement of the capitalist machine, from which derive "new consumer goods, new methods of production or transport, new markets, new forms of industrial organization that the capitalist company creates".

This phenomenon, which is dynamic and constant, non-linear, is a fundamental sociological factor in the reproduction of new patterns and influenced by several other factors. Innovation causes changes and transformations and takes place from the interaction between social actors to the processes of the organizational structure and the economic, political and social environments.

The socio-cultural environment in which the organization operates, that is, the environment where social, cultural and institutional transformations occur, in Schumpeter's view, is one of the important components of innovation. For Schumpeter (1997), it means making new combinations, that is, doing things differently, which encompasses:

- a) create a new good not yet familiar to consumers, or a new quality of a certain good;
- b) to introduce a new method of production, practically unknown within a certain branch of production, which does not need to derive from a scientific discovery;
- c) opening a new market, to which the product of a given industry has never had access before, regardless of whether or not this market has previously existed;
- d) discover a new source of raw material or semi-finished products, too, regardless of whether or not that source has existed previously, and
- e) reorganize any industry, with the creation or rupture of a monopoly position.

To innovate, it is not enough, therefore, for the organization to develop different behavior, but also to seek novelties that add value, in the sense of enabling leverage for future innovative processes.

According to Schumpeter (1997), innovation produces a continuous industrial mutation that constantly revolutionizes the economic structure from within, incessantly destroying the old and incessantly creating a new one.

The author calls this process Creative Destruction, in which there is a continuous search for the creation of something new, which destroys old rules and establishes new ones, which he considers an essential factor about capitalism.

Innovation, says Alter (2005, p. 155), when referring to Schumpeter's idea of Creative Destruction, rests on the simultaneous development of forces of destruction and creation, forming a permanent movement, a constant change that mobilizes a set of actors.

The encounter between organization and innovation, the author continues, corresponds to the relationship between established social practices and the forces of transformation, generating a movement of complex relations in permanent tension.

There are contexts in which the tendency to innovation is greater than in others, which makes it possible to infer that values, norms and social rules need to be taken into account

in order to think about this phenomenon, which fundamentally depends on a process of cultural acceptance.

Thus, it is necessary to view innovation as the result of a sum of variables (internal and external to the organizational group), responsible for the new directions of a company's development, and for the supply of the needs exposed in each specific context. For Freeman and Soete (1992, p. 19), innovations "make it possible to modify the entire quality of life for better or for worse and can involve not only greater quantities of the same goods, but also standards of goods and services that have never previously existed, except in our imagination".

Thus, innovation represents a creation, a movement that, according to Alter (2005), mobilizes a set of actors, enabling the transformation of social relations into new ones.

conducts. In the course of these relationships, meanings are generated, that is, the intentions, motives, and attitudes of the actors, giving rise to organizational practices.

These practices, which Dupuis (2007) characterizes as contextualized, contain a culture to the extent that they make sense to the actors.

In this perspective, innovative practices indicate cultural manifestations, enabling the organization to innovate based on the actions of its social actors.

2.2 KNOWLEDGE MANAGEMENT AND INNOVATION

Innovation studies have drawn on a wide range of disciplines, such as management, economics, geography, sociology, and psychology, as well as adopting different methods and definitions.

This diversity of research limits the accumulation of knowledge about innovation management and makes it difficult to define some measures of performance or success, which makes it difficult to translate it into managerial practices (TIDD, 2001).

The challenge of innovation management is to build organizations in which innovative behavior thrives, recognizing people as its main asset, since innovation is increasingly related to teamwork and creativity (TIDD, 2001). Knowledge management is responsible for creating ideas and concepts in the organizational context, which are incorporated into pioneering technologies, products, and services that meet the demands of customers and society. This new knowledge is disseminated to the entire organization and external environment, representing a process of continuous innovation that generates sustainable and lasting competitive advantage (NONAKA et al., 2000).

Despite the recognized importance of knowledge as a vital resource for organizational performance, there is little understanding of how organizations actually create and manage it dynamically.

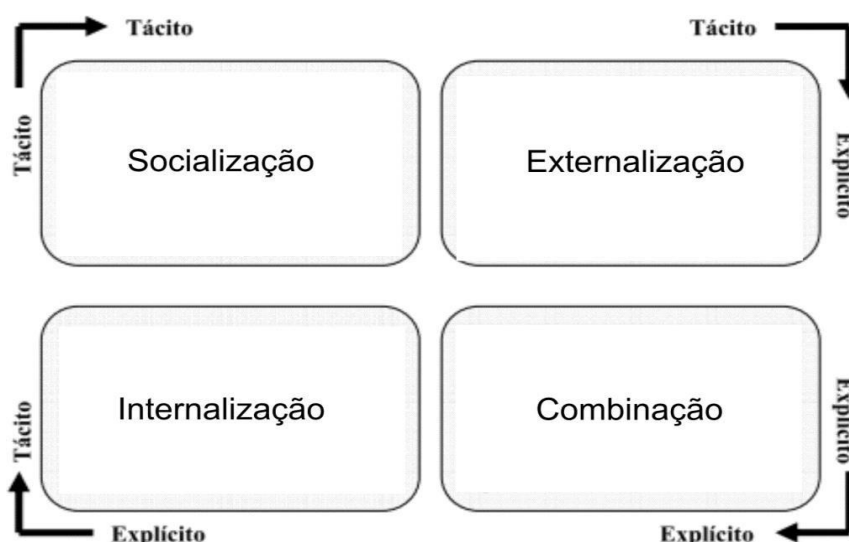
In a competitive environment in which the only certainty is uncertainty, the ability to create and use knowledge is the most important source of sustainable competitive advantage for companies, which are seen as a dynamic, evolved and almost autonomous system of production and application of knowledge (NONAKA; TAKEUCHI, 1997; NONAKA et al., 2000; SPENDER, 1996; ALAVI; LEIDNER, 2001).

There are two types of knowledge: tacit and explicit. Tacit knowledge is represented by the cognitive dimension, technical ability, know-how, experience, mental models, beliefs and values, and is available to people, and is difficult to be communicated and formalized in concrete means.

In turn, the explicit, because it is formal and systematic, is easily processed, shared, and stored in documents, manuals, databases, and other media. The Knowledge Spiral model – Socialization, Externalization, Combination and Internalization (SECI) – presents the conversion of knowledge from tacit to tacit (socialization), from tacit to explicit (externalization), from explicit to tacit (internalization) and from explicit to explicit (combination), as shown in Figure 2 (NONAKA, 1994; NONAKA et al., 2000).

Figure 2

SECI model of knowledge conversion



Source: Nonaka (1994) and Nonaka et al. (2000).

The SECI model can be understood as the organizational capacity to create knowledge, disseminate it in all areas and incorporate it into goods, services and systems

(Johannessen et al., 1999). It represents a dynamic process in which the organization creates, maintains and exploits knowledge (NONAKA et al., 2000).

In order to understand how organizations create knowledge dynamically, in addition to the SECI model, there are two other elements in interaction: the *ba* – a word of Japanese origin that represents the dynamic and shared organizational context in the processes of creation, dissemination and use of knowledge – and knowledge resources – inputs, outputs and moderate factors of the knowledge creation process (NONAKA; KONNO, 1998; NONAKA; TOYAMA, 2003; NONAKA et al., 2000).

Knowledge resources are stimulated and shared in *ba*, in which the tacit knowledge present in individuals is converted and amplified by the Knowledge Spiral through socialization, externalization, combination, and internalization. Leadership has the function of facilitating the process of knowledge creation (NONAKA et al., 2000).

Characterized by the dynamic interactions between the members of the organization and between these members and the environment in which they are inserted, the process of knowledge creation improves the interaction between individuals, organizations and society, to the extent that it expands the conversion from tacit to explicit knowledge. In the organizational environment, it is relevant to transform individual learning into collective learning and to create knowledge continuously (NONAKA, 1994; NONAKA et al., 2000).

Innovation management is the result of a kind of corporate project, translated into strategies and operations in order to create something that adds social value or wealth to organizations. The innovation process, which must be planned and managed, involves knowledge, information and creativity (TIDD et al., 2005).

A review by Tidd (2001) suggests that the complexity and uncertainty of the environment affect the degree, type, organization, and management of innovation, and that greater adjustment between these factors or greater coherence of the organizational configuration leads to better corporate performance. Innovation has two fundamental dimensions: novelty and feasibility (GARCIA; CALANTONE, 2002).

Novelty is related to knowledge, as it is the result of the creation of new ideas and concepts, that is, of people's creativity, evidencing the relevance of tacit knowledge and the SECI process of knowledge conversion (GRANT, 1996; NONAKA, 1994).

In turn, the feasibility of the ideas and concepts generated are more related to the Product Development Process (PDP). Innovation and process improvement play strategic roles and refer to corporate learning, both in the sense of knowledge acquisition and exploration.

In this way, the correspondences between the organization's structures, processes and culture, opportunities and characteristics of technological innovation, as well as the competitive and technological scenario in which the organization operates are explored (TIDD, 2001; TIDD et al., 2005).

2.3 TYPES OF INNOVATION

Innovation varies in its scope, execution time, and organizational and social impact. Categorization of any kind usually involves areas of duplication, in which the barriers between one category and another overlap. We will get an overview of the main types of innovation and a simplified classification. We must also take into account that categorizing innovation is not a science, and it can be positioned in different categories by companies.

The OECD - Oslo Manual provides a broad definition of what innovation is and its types.

According to the document:

The implementation of a new or significantly improved product (good or service), or a process, or a new marketing method, or a new organizational method in business practices, in the organization, in the workplace, or in external relations is what is called innovation. (OECD, 1990, p. 55)

- a) **PRODUCT INNOVATIONS** – Related to the provision of a new product/service, for example, a new insurance, a new line of financing, the service of a new medical specialty.
- b) **PROCESS INNOVATIONS** – Related to the modification of procedures prescribed for the elaboration/production of a product/service (back office) or procedures for user/customer service and service delivery (front office).
- c) **MARKET/MARKETING INNOVATIONS** – Related to the discovery of new markets, to the identification of niches in the same market, or even to the change in the organization's behavior in the market in which it operates.
- d) **ORGANIZATIONAL/MANAGERIAL INNOVATIONS** – Related to the introduction of new store formats, new planning techniques, process management, adoption of indicators, among others.

2.4 SCHUMPETER AND THE FIVE WAYS

Joseph Alois Schumpeter (1883-1950) was one of the most brilliant economists of the twentieth century. He is the father of the theory of "Creative Destruction", which states that

the capitalist system progresses by constantly revolutionizing its economic structure: new companies, new technologies and new products constantly replace old ones (Figure 3).

Figure 3

Schumpeter's Waves



Source: Schumpeter (1997).

According to Schumpeter (1997), there are five possible paths of innovation:

- Introduction of a new good or a new quality in an existing good.
- Introduction of a new production method.
- Opening of a new market.
- Conquest of a new source of supply of raw materials or semi-manufactured goods.
- Establishment of a new organization in any industry.

Innovation, for Schumpeter (1997), is "the fundamental impulse that initiates and maintains the movement of the capitalist machine". He reinforces that innovating means making new combinations:

Create a new good not yet familiar to consumers or a new quality of a certain good; to introduce a new method of production, practically unknown within a certain branch of production that does not need to derive from a scientific discovery; to open a new market to which the product of a given industry had never had access before, regardless of whether this source had existed or not before; reorganize any industry, such as the creation or rupture of a monopoly position. (SCHUMPETER, 1997).

Schumpeter (1997) states that innovation generates a continuous industrial mutation, which alters the bases of the economic structure because of Creative Destruction. It reinforces that it is the continuous search for the creation of something new, which destroys old rules and creates new ones, which is vital for capitalism.

Schumpeter (1997) argues that "market innovation" is an organizational strategy, as it is about winning customers through products with lower prices. Encouraging the continuous production of innovations is presented as a possibility of obtaining competitive advantage. According to the economist (SCHUMPETER, 1997):

The insertion of new practices in Brazilian organizations, such as corporate education, which involves, among other technologies, the modality of distance training, develops competencies that allow the acceptance and implementation of new social practices.

The author believes that this generates motivation in the search for differentiation, creation and implementation of organizational practices of organizational development, which, according to his beliefs, can be seen as the so-called "Creative Destruction", or even as "spontaneous and discontinuous changes implicit in the process of economic development" (SCHUMPETER, 1997).

2.5 THE SOURCES OF INNOVATION

Peter Drucker (2004) suggests seven types of sources of innovation, four of which are within organizations or sectors themselves. They are: process needs, unexpected occurrences, sectoral changes and inconsistencies. The other three that are outside of organizations and the industry are changes in perception, demographic shifts, and new knowledge. Please note:

- Process needs – It is innovation that is based on adjustments in processes.
- Unexpected occurrences – The unexpected is the source of opportunity for innovation.
- Sectoral and market changes – Drucker (2004) exemplifies with privatizations. They happen when social structures or markets change.
- Incongruities – These are inconsistencies. They happen when a product or service does not meet the expectations of its customers adequately and then, naturally, a change is necessary.

As for those outside organizations and/or the sector, it is worth mentioning:

- Changes in perception – They do not alter the facts, but they alter their meaning. Drucker (2004) exemplifies with the "computer".
- Demographic changes – This is the most reliable source for the author. These are the innovations created from the change in the total number of people, in age distribution, occupation, education and geographic location. This source is one of the most rewarding and least risky of entrepreneurial initiatives.

The main sources of innovation in companies are:

- Employees from different sectors within the company itself.
- Patent or know-how licenses.
- Research and Development Department of the company itself.
- Specialized publications in technical magazines.
- Fairs and exhibitions.
- Suppliers of machinery, equipment, materials, components/software.
- Research Institutes or Technology Centers.
- Trainings, conferences and lectures.
- Competitors.
- Other companies in the same economic group.
- Customers and end consumers.
- Universities and other institutes of higher education.
- Consulting firms or independent consultants.

2.6 OPEN INNOVATION

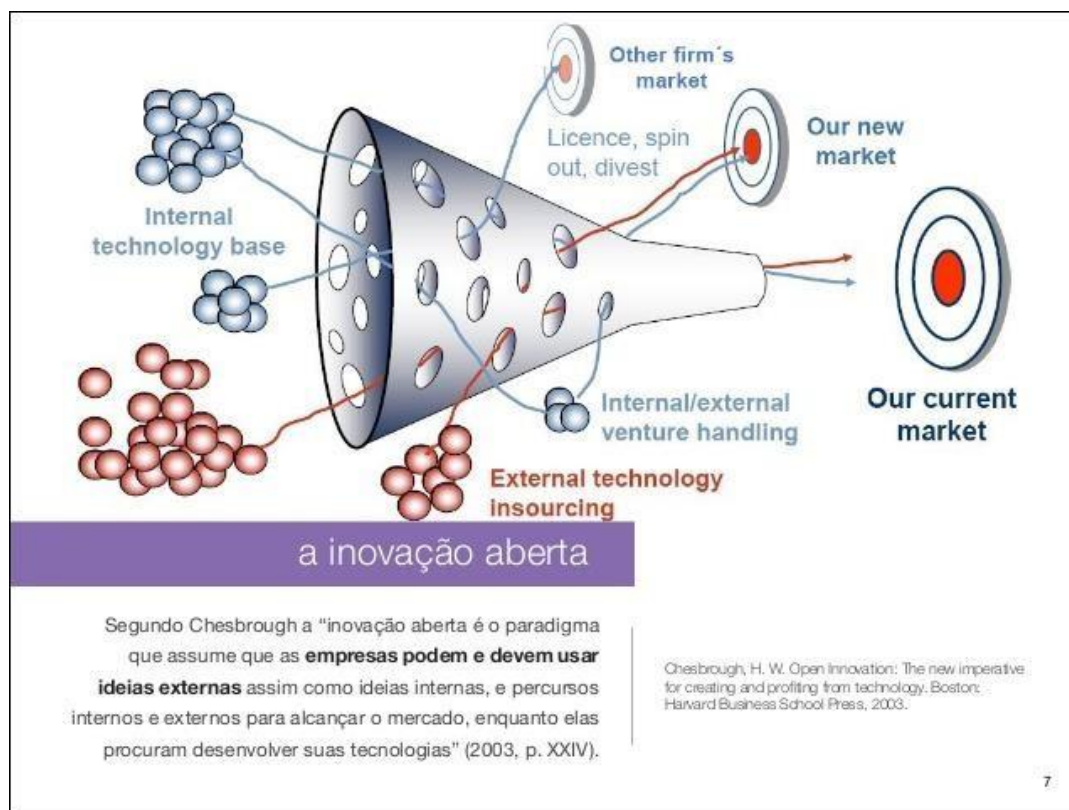
Chesbrough (2012) argues that there are two paradigms with regard to innovation: closed innovation and open innovation. The closed one is the one that focuses on internal Research and Development. This model of innovation was justified in industrial secrecy.

The open one is more current, arguing that organizations can create mechanisms for interaction with the external environment, for example: university laboratories, institutions focused on research, customers and suppliers. This paradigm is based on collaboration and uses the internet as fuel for this.

Chesbrough (2012) states that organizations that opt for the so-called open innovation are more likely to succeed in innovations (Figure 4).

Figure 4

Open innovation



Source: Chesbrough (2012).

Henry Chesbrough (2012) coined the term "Open Innovation", which argues that companies can and should use external ideas, as well as internal ones, and internal and external paths to reach the market, while developing their technologies. In this model, organizations can commercialize internal or external technologies and use internal or external resources in the execution of projects.

As a characteristic of open innovation processes, projects can be initiated by the company itself or by other external actors, as well as be incorporated or transferred to other organizations, at different stages of development.

Felin and Zenger (2014) evaluate open innovation as being capable of greater success in the face of environmental challenges, which demands a new managerial profile.

The principles of open innovation are:

- Not all of the best work with us. We need to count on the best inside and outside our company.
- Research and Development can create significant value. In-house R&D is needed to achieve some of that value.
- We are not obliged to generate research in order to profit from it.
- Building a better business model is more useful than getting to market first.

- If we make the best use of internal and external ideas, success will be ours.
- We have to produce revenue from the use of our patents by third parties, and we must buy third-party patents whenever it improves our business model.

2.7 BARRIERS TO INNOVATION

Each organization sees "innovation" in a particular way. Because of this, barriers exist and must be overcome.

As in the vast majority of times the time between the beginning of the process and the return on investment is medium or long term, the barriers are numerous and need to be identified and worked on. We can group them into three major groups:

- 1 - Of a technological nature.
- 2 - Of an economic and financial nature.
- 3° - Of human nature.

For Silva and Takeda (2005), norms, assumptions and values can be examples of barriers to innovation, so a behavioral and attitude change is necessary, especially with regard to human skills and the environment, so that it is flexible and entrepreneurial. They used a questionnaire to identify barriers to innovation and concluded that negative cultural orientation is the main one.

Kaasa and Vadi (2010) point out that culture can unify behaviors and people, as well as be a barrier between them. They add that "culture affects innovation because it shapes patterns of dealing with novelty, individual initiatives and collective actions, and understandings and behaviors in terms of risks as well as opportunities." (KAASA; VADI, 2010, p. 584).

Hernández-Mogollon et al. (2010) tested the role of cultural barriers in the relationship between open-mindedness and organizational innovation.

Regarding the evaluation of cultural barriers, they created five items from the reviewed literature, which dealt with resistance to change, training, lack of adjustment to the new culture, difficulties in assuming new patterns of behavior, and little satisfaction and/or integration of personnel.

In fact, the biggest barriers to innovation are within the organizations themselves, strongly alive in their organizational cultures and in their own work routines. The main ones are:

- Cultural barriers: prejudices, lack of cooperation, trust and team spirit among employees, resistance to change, a work environment that is not harmonious and cohesive, etc.
- Perceptual barriers: difficulty in distinguishing the essential from the accessory, tendency to overcomplicate or oversimplify problems, inability to view the issue from different perspectives, saturation, seeing what one expects (or wants) to see instead of reality, and lack of proper use of the various sensory stimuli.
- Emotional barriers: fear of making mistakes, fear of "ridicule", inability to tolerate ambiguity, preference for judging ideas instead of generating them, lack of interest and motivation, fear of being misunderstood, etc.
- Intellectual barriers: inadequate choice of mental processes, lack of knowledge, dissonance between tasks and skills, lack of clarity in communication, lack of commitment and critical and reflective capacity.

2.7.1 Internal

The most common internal barriers encountered in organizations are:

- Cultural restrictions.
- Investment limitations.
- Internal problems with the workforce.
- Inadequate processes.
- Inflexible infrastructure.
- Limited access to information.

2.7.2 External

The most common external ones are:

- Government and other legal restrictions.
- Economic instability.
- Inadequate technology.
- External problems with the workforce.

2.7.3 Management System Performance Analysis and Innovation

Organizations, due to market needs, seek a system to manage innovation, as well as seek perspectives for business sustainability, whether through products, processes, services, market conquest or organizational changes. After all, if they do not change, "they run the risk of being surpassed by others that do" say Bessant and Tidd (2009 In: RAI, 2015).

There is no way to evaluate the performance of an innovation process without the right indicators. According to Bes and Kotler (2011), "measures are essential, it is not possible to measure, it is not possible to manage and improve".

For Makkonen and van der Have (2013), in the journal RAI, there is no consensus on which indicator should be used to measure innovation, due to its complexity. The most used to evaluate the performance of an Innovation Management system are profitability, productivity, and market share.

In addition, the form of investigation or evaluation and the conclusion must also be well measured by the most correct instrument, as the information collected can make the organization direct its physical, financial and personnel efforts to a destination that leads to the "non-sustainability" of the business, or to a result that generates wrong decision-making, causing financial, motivational and loss of market damage.

In the text "Business Performance: a comparison between subjective and objective indicators", it is possible to understand that "Strategic Management often finds it difficult to obtain valid objective data for measuring business performance, as well as to define which performance indicators best represent the overall performance of companies." (GATTERMANN; SAMPAIO, 1999)

The authors also list some possibilities for using the most used indicators in the market to measure business performance, such as market share, Return on Assets (ROA), Return on Investment (ROI), profitability (profit on sales), growth, market performance, sales growth rate, product quality, size, relative success of new products, consumer satisfaction and overall performance (GATTERMANN; SAMPAIO, 1999, p. 2).

According to Tidd et al. (2008), we can use specific measurements to evaluate the internal workings of the innovation process, such as:

- Number of new ideas (product/service/process) generated at the beginning of the innovation system.
- Failure rate – in the development process, in the market.
- Number or percentage of extrapolation in development time and cost budget.
- Measuring customer satisfaction ratings – was that what the customer wanted?
- Time to market (average, compared to industry standards).
- Involvement of people/hour per innovation carried out.
- Average time from innovation process to launch.
- Continuous improvement measurements – suggestions/employee, number of problem-solving teams, accumulation of savings per worker, cumulative savings, etc.

2.7.4 Direct and Indirect Results of Innovation

In Salum et al. (2012), we can see that there is still a lot of discourse and little action in medium-sized companies when it comes to innovation.

The lack of knowledge of their role can contribute to companies still not prioritizing strategy and not organizing organizational goals for their growth and positioning in the market. Salum et al. (2012) explain that "it is necessary to face the theme as a new perception, treating innovation as a priority and also as an option for growth."

We highlight some results of Innovation Management, when the company seeks a position in the market, such as:

- Established and productive internal processes.
- Knowledge management as a way to organize ideas.
- Image of the company to its peers and customers.
- Internal and continuous improvements.
- More organized and dynamic indoor environment.
- Well-communicated and structured organizational culture.
- Cost reduction.
- Openness to new partnerships for innovation.

3 METHODOLOGY

In this chapter, the research methodology to be followed to analyze the innovation project will be presented and whether the objective of improving the performance of the company BRT Tijuca/Normandy, by implementing the system with Telemetry, has been meeting the company's expectations.

The research methodology, according to Castro (2002), is the space in which the necessary means to observe reality in a systematic and disciplined way must be outlined, in the sense of observing the facts, analyzing the relationships between them and, finally, responding to the research problem that represents, for the researcher, a gap in knowledge. Castro (2002) and Gil (1999) indicate three types of research: Exploratory, Descriptive and Explanatory.

The present project was based on a qualitative descriptive study, because, according to Perovano (2014), the descriptive process seeks to identify, record and analyze the characteristics, factors and/or variables that are related to the phenomenon studied. This type of research can be seen as a "case study" in which, after data collection, an analysis of the relationships between the responses is carried out for a subsequent projection of the expected effects on a company, product or production system.

Descriptive research can be:

- Documental.
- Field studies.
- Interviews.

It is important to emphasize that the researcher does not interfere in reality, he only observes the variables that, spontaneously, are linked to the phenomenon under study.

In descriptive research, the object of the investigation is partially known. The primary objective of research of this type is to describe the characteristics of a certain group or phenomenon, or to establish relationships between variables. It involves planning and standardized data collection techniques. Descriptive surveys are the most requested by organizations such as educational institutions, commercial companies, political parties, etc.

Qualitative research focuses on apprehending facts and phenomena, and not merely recording or describing them. It is focused on the perception of reality, and the most common type of this research in the social sciences is the Case Study. Quantitative research, on the other hand, expresses a strong concern with the measurement and establishment of relationships and determinations of some facts or phenomena of social reality. It is relevant to state that research can be, at the same time, quantitative and qualitative (TRIVINOS, 1987). In practice, the researcher, who develops an investigation based on statistics, intends to obtain objective results, fixing the result in the statistical data. However, this information could be used to advance a broader interpretation of the result.

According to the studies described, the methodological approach chosen to be used in the present study will allow us to portray the largest number of elements existing in the reality studied. However, to carry out the research in full, we used qualitative techniques with interviews.

The interview is an indirect observation. It is one of the most used techniques in social research and consists of interaction with the participant, formulating questions with the objective of obtaining data for the investigation.

Document analysis is an important technique in qualitative research, either complementing information obtained by other techniques, or unveiling new aspects of a theme or problems, according to Krippendorff cited in Lüdke and André (1986).

The strategy for collecting information was based on semi-structured interviews, as it arouses the interest and collaboration of the interviewee.

The semi-structured interview sought to bring perceptions and opinions about the company's decision to implement, as well as the vision of each manager and their

expectations about the innovation project. The first interviewee was the Legal and Administrative Manager of the company BRT Tijuca/Normandy, responsible for collecting the data, interviewing the managers of the areas involved and with the company that supplied the applied technology, M2M, in addition to being the interlocutor of the working group with the company. The complete interview questionnaire is presented in Appendix A of this study.

The interview was conducted through a structured questionnaire with the general data of the interviewees: company, name of the interviewee, position, date of the interview, time in the company and time in the position. In addition, the motivations for implementation, the stages of the implementation and the expected and obtained results were questioned.

To collect the information, the methodology of the interview survey was used, and applied by Cleber Reis, Legal and Administrative Manager of the BRT Tijuca/Normandy company and representative of the working group of the Application Project.

In this model, the researcher actively participates in the research situation, assuming, in a way, the role of a member of the group that is being observed.

We have a member who is a collaborator of the researched company, so the interaction and internal perception in this case study were faster, since it was possible to access internal documents, static data and percentage of return from the implementation.

The interview was conducted with Cleber Reis, Legal and Administrative Manager, Rosane Lucena, Operational Manager and Alvimar Queiroz, Maintenance Manager, all from the company BRT Tijuca/Normandy, and Flavio Mousinho, Operations Manager, and Alexandre Pereira, Operational Consultant of the company that provides the Telemetry system, M2M Solutions.

According to Marconi and Lakatos (2001), the questionnaire is a scientifically developed instrument, composed of a set of questions ordered according to a predetermined criterion, which must be answered without the presence of the interviewer and which aims to collect data from a group of correspondents. This instrument aims to capture the opinions, beliefs, feelings, interests, expectations and perceptions of the respondents in a uniform manner.

Based on this definition, we based our study on a questionnaire to collect detailed information on the implementation process, valid training, technical feasibility, benefits and financial results.

The interview was applied in a non-face-to-face manner, delivered by e-mail from 07/27 to 07/30/2018 to all managers, and doubts were clarified by telephone.

With the feedback of the interviews, by e-mail, the data were consolidated by the working group. The interpretation occurred taking into account the difficulties encountered by

each area involved with the relevance of the answers, thus demonstrating the feasibility of implementing the system in the company and, in the future, in others that operate the same transport system.

The employees of the company BRT Tijuca/Normandy are characterized by the length of time at home, coming from the base companies Auto Viação Tijuca S/A = Tijuquinha and Viação Normandy do Triângulo LTDA = Normandy. Cleber Reis, Legal and Administrative Manager, has been in the BRT system for a year and eight months, but in the group of companies for more than 8 years; Rosane Lucena, Operational Manager, has been in the group for 20 years and in the Tijuca/Normandy BRT for 2 and a half years; Alvimar Queiroz, Maintenance Manager, at BRT Tijuca/Normandy for 2 and a half years. All of them were comfortable with the possibility of innovation, a striking characteristic in the group's companies, and were concerned about the financial results of the project and how the implementation is linked to the customer. They talk about organizational data in a transparent way.

The company of Flavio Mousinho, Operations Manager and Alexandre Pereira, Operational Consultant, supplier of the Telemetry system, M2M Solutions, with 15 years of experience in the market, has consolidated itself as one of the main fleet monitoring companies in Brazil. It monitors more than 20 thousand vehicles in Brazil and abroad, with more than a thousand BRT buses in Rio de Janeiro, one of the most modern in the world. Because it is a company that thinks of innovation as a proposal for intelligent solutions, Alexandre was in tune with the company's expectations.

Table 1

Summary Table

Nature of the research	Research universe	Sample of the survey	Data collection	Interviewees
Qualitative descriptive research	Companies operating in the BRT system Tijuca/Normandy and the equipment supplier	Companies responsible for the implementation of the Telemetry Project	Semi-structured interviews	Managers responsible for the areas involved with the implementation of the Telemetry project.

Source: Adapted from Barbosa (2015, p.53).

4 DATA ANALYSIS AND DEVELOPMENT OF THE SOLUTION PROPOSAL

4.1 TELEMETRY

Telemetry: "tele" means "remotely" and "metria" means "measurement". It is a technological monitoring system used to command, measure or track something from a distance, through wireless communication (radio or satellite signals). Telemetry is currently

applied in many branches, such as agriculture, meteorology, water and sewage treatment system, energy monitoring, etc. For some time now, it has been helping to monitor and increase performance, such as in Formula 1 cars. In the late 80s, when Senna raced his McLaren, after practice he spent hours in the "motorhome" analyzing the data.

Transport companies are also investing in this technology, and today it is possible to know details about fuel consumption, wear and tear of parts, sudden acceleration and braking, intensity of curves and other driving details. In this way, companies are able to monitor and correct employee behaviors in various aspects.

The telemetry project is part of an internal campaign by MobiBrasil, called Conscious Driver – Do the Right One. The theme was adopted in September 2017, to stimulate individual changes in employees, with the aim of achieving results collectively.

MobiBrasil, an urban transport company in São Paulo, set a goal for diesel savings and awarded 80 drivers who managed to reach the determined amount. Fuel consumption was measured using telemetry technology, which was deployed on four of the company's lines in September 2017.

In addition to saving fuel, MobiBrasil stopped emitting 107.46 tons of CO₂ into the environment, just with the program implemented in these four lines for four months. The numbers were provided by the CEO of MobiBrasil Nieve Chaves, Jessica Marques, for *Diário do Transporte* (2017).

Another transport company, Viação Santa Brígida, which operates urban lines in the north, northwest, southeast and central regions of the City of São Paulo, invested in telemetry to improve the management of passenger transport fleets.

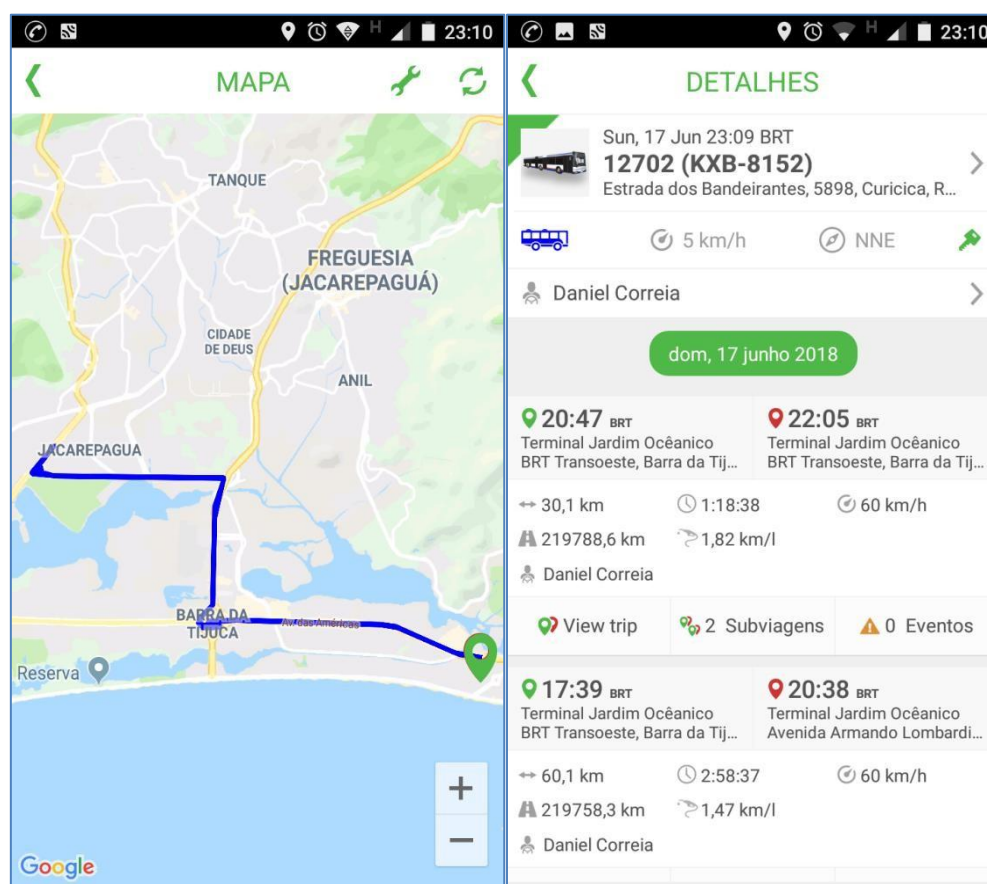
According to Fernando Cesar, maintenance manager at Viação Santa Brígida, the company already knew telemetry previously when participating in a project whose objective was to treat the technology intelligently. Using the concept of information transmission, the project allowed to aggregate the treatment of the data collected, understanding what to do with each result. "The items collected in the project were excessive speed, sudden acceleration, sudden braking, sudden turning, excessive rotation and driving outside the green lane," said Fernando Cesar.

There were two phases in this period. In the beginning, we sought to understand how telemetry technology would work in a situation where the driver operated the bus without knowing that he was being monitored. "In the next phase, already aware of the project, the driver acted with knowledge of which driving events were being analyzed."

4.2 THE MOST COMMON USE OF TELEMETRY

Telemetry is widely used abroad with significant results in cost and labor reduction. The reduction in costs happens in several ways:

- Identification of the driver and control of the working day.
- Speed in the dry and rain, providing a reduction in accidents and speeding fines and promoting the practice of defensive driving.
- Speeding violations with precision (direct from the speedometer) and support of audible warnings to drivers.
- Control of the economic range of RPM and speed, providing fuel savings and increasing the interval between corrective maintenance, in addition to reducing maintenance costs due to poor driving.
- Drivers' performance through ranking.
- Time of use of the vehicle in "toothless".
- Braking and sudden start.
- Improper clutch usage time.
- Real control of hours worked. Functionality widely used in machines or equipment that work at a standstill, such as compressors, generators, containers, cranes and munck trucks, among other machines at the customer's discretion.
- Special speed. This event log indicates speeding on an embedded fence, predetermined by the user.
- Arrival Notice. Through the boarding of points, the system identifies when the vehicle is close to the company, helping all yard logistics.
- ASO control. The system sends notices by e-mail 15 (fifteen) days before the exam is due.
- Control of National Driver's License (CNH). The system sends notices by e-mail 15 (fifteen) days before the expiration of the driver's license.
- Checkpoints and embarked fences. This functionality supports companies in quickly identifying the location of the vehicle when it is at work (for example: gas station, customer A, customer B, residence of employee A, etc.).

Figure 5*Trajectory and details of the trip*

Source: Google Maps, APP Mix/M2M (2022).

Telemetry also allows the elaboration of the ranking of drivers based on the analysis of the information on how they drive the vehicles, identifying those that are above or below the average values calculated, making it possible to establish measures that corroborate the better performance of these professionals and, consequently, a better use of the vehicles, resulting in lower operating and maintenance costs (Figure 5).

4.3 THE PRESENCE OF INNOVATION IN THE TIJUQUINHA GARAGE

Since its foundation, Tijuquinha has sought innovation incessantly. The company was one of the first to make use of indoor and outdoor filming technology, which began to be used in 1995, being mandatory in the sector only in 1999; also regarding the use of GPS for better distribution of vehicles along the lines, which happened in 2004, being the standard technology for the sector only in 2009.

It could not be different in the implementation of telemetry. Tijuquinha is the first in the world to implement this technology in articulated buses. The first attempt began in 2017, being successful in 2018. It will be nothing new if this technology becomes the standard for the industry in the coming years.

Telemetry imposes several challenges, including the need for a qualified team to treat the huge database that technology offers, so that they can be aggregated and transformed into useful information that enables the breaking of paradigms.

The main justifications for continuous innovation in the company are to increase its market share and improve the return on investment of its shareholders.

4.4 COST AND TIME FOR IMPLEMENTATION

The installation of the equipment is simple. The implementation time is one week, and the validation tests last at least three months. The company Auto Viação Tijuca S.A. finished the validation phase in May 2018.

Equipment was installed in 10 (ten) cars. Each vehicle has its equipment, and each driver has a unique key that links it to the vehicle at the time of operation. Maintenance has keys to perform the necessary tests, which allow the identification of the last professional who operated the vehicle.

The biggest difficulty in the testing phase was the engagement of the drivers themselves. But the transparency in the dissemination of the results made the advantages of the project discovered, and so the engagement occurred gradually.

During the validation period, at no cost, the equipment was loaned. After the signing of the commercial agreement, the equipment was implemented in the entire Tijuquinha/Normandy fleet.

The price of a telemetry service is between R\$ 140.00 to R\$ 200.00 per monitored vehicle.

4.4.1 Expected Results

- Evolution in management and control.
- Reduction of overtime and labor liabilities.
- Standardization of the way vehicles are driven.
- Development of driver awareness and training policies.
- Increased vehicle life, with the consequent reduction in vehicle downtime.
- Reduction in fuel consumption.
- Reduction in the number of fines.
- Reduction in the number of claims.
- Reduction of polluting gases.

4.5 THE BENEFITS

4.5.1 For Customers

Customers directly benefit from the telemetry system, as it monitors speeding, improper use of the brake, sharp curves, among other drivability events that can be used to monitor and guide the training of drivers in driving vehicles.

4.5.2 For managers

The main benefit for managers is to monitor, through remote control of the fleet, the management KPI's, in which the performance of drivers in relation to the goals established by the company is verified.

4.5.3 For entrepreneurs

The first benefit is in the reduction of costs. But it is not limited to this, as telemetry naturally brings a culture of meritocracy to all areas of the company.

4.6 THE RESULTS

The results are surprising, for example, the ease of remotely turning off the vehicle that is idling for a predetermined time of 10 minutes. It is very common for the driver to leave the vehicle on and leave it for various reasons, so when this occurs, the vehicle is turned off remotely, reducing its wear and tear and fuel consumption. Figure 6 lists some of the events that can be monitored by the smartphone app.

Figure 6

Events that can be selected to be followed

EVENTOS	EVENTOS
1 Evento(s) selecionado(s)	1 Evento(s) selecionado(s)
FM Temperature wire off ☐	M2M - Freio estacionamento ON ☐
Fora da faixa Verde ☐	M2M - Aumento do nível de combustível ☐
Freada Brusca ☐	M2M - Baixa Pressão do óleo ☐
Freio Estacionamento ON ☐	M2M - CAN: Brake Pedal Pressed ☐
Ignição OFF ☐	M2M - Excesso de Temperatura do Motor ☐
Ignição ON ☐	M2M - Freio Motor 1 ☐
In-cab road speed over speeding ☐	M2M - Freio Motor 2 ☐
In-cab road speed over speeding - EXCESSIV... ☐	M2M - Service Brake Air Pressure Circuit 1 ☐
In-cab road speed over speeding - EXCESSIV... ☐	M2M - Service Brake Air Pressure Circuit 2 ☐
Limpador ON ☐	Marcha Lenta ☐

Source: Google Maps, APP Mix/M2M (2022).

4.6.1 Reduction of accidents and fines

With telemetry, the entire road was mapped, and the driver is informed in advance of radars and stations. This reduced fines and accidents.

There was a 5% reduction in all types of accidents, in addition to a reduction in their severity. As for fines, there was a significant reduction of 98%.

4.6.2 Fuel and CO2 emission reduction

Drivers started to operate the vehicle correctly, within the green range (extra-economic range), thus reducing fuel consumption by 15% and, consequently, releasing less CO2 into the atmosphere.

4.6.3 Reduction in tire consumption

A better operation of the vehicle, with a reduction in sudden braking and greater use of the retarder brake to the detriment of the service brake, provided less heating of the wheels. Consequently, tires are saved more, promoting an increase of up to 5% in their useful life.

4.6.4 Less corrective maintenance

As the operation is done correctly and monitored, the tendency is for there to be less corrective maintenance. For example: wheel heating, coolant heating, pneumatic bellows displacement, etc.

4.6.5 Increase in average speed with less time inside the bus

With telemetry, you can monitor the downtime, which increases the average speed. Consequently, the customer will spend less time inside the bus.

4.7 THE CURRENT DIFFICULTIES IN CONTROLLING VEHICLE DATA IN REAL TIME

Currently, it is possible to monitor vehicles to:

- geolocation of vehicles (individual or group);
- address and date of each location;
- monitoring of events;
- distance traveled;
- speeding;
- custom reports;
- configuration of alerts;
- fences and virtual fines.

However, in the case of BRT, vehicles circulate in segregated lanes, with an independent system for applying fines and with entry and exit of passengers in their own (elevated) stations.

Thus, although the lanes are segregated, there are several intersections with the ordinary lanes, and with telemetry it is possible to check the places with the highest occurrence of events or accidents, especially in case of weather changes, to quickly warn the driver about the adversities that lie ahead.

The use of telemetry has already allowed the saving of fuel, rolling stock, shortened the maintenance time of vehicles, increased safety in transport and, above all, reduced the emission of polluting material.

5 FINAL CONSIDERATIONS

From our objective to demonstrate the importance of the search for innovative initiatives as a critical success factor for urban mobility companies and the benefits of implementing telemetry in the BRT/RJ modal, as well as the changes that the introduction of

a new technology can bring to the business model and how decisive the human factor is as a transforming agent. We seek to describe the process of implementing telemetry. To this end, we conducted a series of interviews with representatives of Tijuquinha and Normandy, who promoted this innovative initiative, in order to find out how its implementation took place, difficulties, risks and benefits generated.

The innovative initiative presented in this application project enabled the companies Tijuquinha and Normandy to obtain a significant cost reduction associated with improved quality, especially in vehicle driving, which was clearly perceived by their customers. These results established a competitive differential and allowed the companies to continue operating, despite the difficulties imposed by the economic crisis that we describe in this work.

The benefits of extending the innovative solution applied in the Tijuquinha and Normandy partnership to the other companies of the BRT/RJ System in the City of Rio de Janeiro are of paramount importance for the development of urban mobility in the State and even beyond our borders. If this initial one is extended to the other companies that operate BRT buses, there will be a general improvement in the quality of the companies and the system, through a lower number of breakdowns and consequent increase in the availability of vehicles. In this way, compliance with the BRT operator's schedule is guaranteed and, with that, a greater supply of seats, reducing overcrowding. There will also be a reduction in accidents, in addition to greater comfort for customers, with the improvement and standardization of bus driving. We cannot forget the benefits to the environment with the reduction of fuel consumption, CO₂ emissions and tire consumption.

For all of us who worked on the preparation of this Project, it was possible to perceive a clear evolution of our knowledge about the challenges of urban mobility in the metropolitan region, its history and evolution, to better understand its current infrastructure, in addition to the impact of the economic crisis on companies. It was also possible to develop our capacity for collective reflection on such a complex topic and of which we are part, influence and are influenced.

As we discussed in our theoretical framework, for Schumpeter (1997), innovation can be understood as the fundamental impulse that initiates and maintains the movement of the capitalist machine, from which arise "new consumer goods, new methods of production or transport, new markets, new forms of industrial organization that the capitalist company creates".

In this line of thought, the innovation presented still has several opportunities for development, and it is essential that there is continuity so that it is possible to explore its full

potential. This search for innovative initiatives should not be limited to Telemetry or be seen only as a technological solution. New technologies offer opportunities for much broader change than simply deploying systems and equipment. The incorporation of new technologies can change business models, introduce new habits and needs that were previously non-existent and that always depend on the human factor to be successful. The impacts of the development and deployment of new technologies on the behavior of people influenced by the change must be carefully managed to ensure the success of projects.

Currently, we have several technological solutions under development that may one day be applied to urban mobility solutions such as BRT. Just to name a few of them, we can list: battery or hybrid vehicles; autonomous vehicles, as already existing in subways in several cities around the world, for example, on Line 4 of the São Paulo Metro; new means of payment, eliminating current methods; new ticketing platforms with the increasing use of smartphones, the internet and its derivatives; applications of big data and artificial intelligence to evaluate demand behavior and define the best operational plan; Big Data and Artificial Intelligence applications for analyzing the operating pattern of assets (buses, trains, planes, escalators, etc.), which identify deviations from these standards and enable a scheduled maintenance action even before failure, increasing the safety, reliability, and availability of assets that are essential in urban mobility systems.

Still as an innovative initiative, it is necessary to continue in the search for solutions that enhance the strengths of each of the modes and companies, enable an integrated operation that meets the needs of the population at an adequate cost and that fulfills its historical role as a driving element for the growth of the City, without, however, making companies unviable. The creation of a Metropolitan Transport Authority, a legal entity endowed with administrative and financial autonomy to organize the issue of transport within the Metropolitan Region of Rio de Janeiro, may be one of the solutions to the urban mobility crisis that we are experiencing in our city. A metropolitan management of urban transport acting in the planning, regulation, coordination of mobility actions and the dissemination of good practices and innovative initiatives can make urban transport companies viable, bringing benefits to companies, government and contributing to the improvement of the quality of life of the population.

REFERENCES

A mil por hora. (2018). Disponível em: <https://onibusbrasil.com/caiiocesar95/3719958>

Alavi, M., & Leidner, D. E. (2001). Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, 25(1), 107–136.

Alma Carioca. (2014). Arquivo. Disponível em:
<https://almacarioca.files.wordpress.com/2014/02/fotolog7.jpg>

Alter, N. (2005). *L'innovation ordinaire*. Quadrige.

Amazon S3. (s.d.). Imagens. Disponível em:
https://s3.amazonaws.com/nycsubway.org/images/icon/title_world_br_riometro.jpg

Barbosa, A. C. Q. (Coord.). (2005). *Competências no Brasil: Um olhar sobre os modelos organizacionais de grandes empresas de Minas Gerais, Rio de Janeiro, Rio Grande do Sul e São Paulo*. Nig One – UFMG/CNPQ.

Bessant, J., & Tidd, J. (2009). *Inovação e empreendedorismo*. Bookman.

BRT Rio. (s.d.). Conheça o BRT. Disponível em: <http://www.brtrio.com/conheca>

BRT Rio. (2018, junho 23). Vandalismo nas estações. Disponível em:
<https://www.facebook.com/BRTRioOficial/photos/a.256866577785762.1073741828.254415668030853/1000694483402964/?type=3&theater>

Caged – Ministério do Trabalho e Emprego. (2017). Disponível em:
<http://caged.maisemprego.mte.gov.br/portalcaged/paginas/home/home.xhtml>

Caregnato, R. C. A., & Mutti, R. (2006). Pesquisa qualitativa: Análise de discurso versus análise de conteúdo. *Texto & Contexto Enfermagem*, 15(4), 679–684.

Castro, J. M. de. (2002). *Métodos e técnicas de pesquisa: Uma introdução* [Material eletrônico].

Chesbrough, H. (2012). *Inovação aberta: Como criar e lucrar com a tecnologia*. Bookman.

De Bes, F. T., & Kotler, P. (2011). *A bíblia da inovação*. Lua de Papel.

De Silva, S., & Takeda, J. (2005). Influence of culture on innovation barriers: The case of Sri Lankan food processing industry. *Journal of Applied Sciences*, 5(7), 1308–1315.

Diário do Transporte. (2016). Marcopolo anuncia venda de 40 ônibus para BRT do Rio de Janeiro. Disponível em: <https://diariodotransporte.com.br/2016/10/04/marcopolo-anuncia-venda-de-mais-40-onibus-para-brt-do-rio-de-janeiro>

Drucker, P. F. (2004). A disciplina da inovação. *Harvard Business Review*, 82(8).

Dupuis, J.-P. (2007). Entre as culturas latinas, anglo-saxã e nórdica: Os quebequenses em economia, negócios e administração. In J. F. Chanlat, R. Fachin, & T. Fischer (Orgs.), *Análise das organizações perspectivas latinas*. Editora UFRGS.

Dupuis, J.-P. (2008). *L'Analyse interculturelle en gestion: Décloisonner les approches classiques*. In E. Davel, J.-P. Dupuis, & J.-F. Chanlat (Orgs.), *Gestion en contexte interculturel: Approches, problématiques, pratiques et plongées*. Presses de l'Université Laval.

- Felin, T., & Zenger, T. R. (2014). Closed or open innovation? Problem solving and the governance choice. *Research Policy*, 43(5), 914–925.
- Freeman, C., & Soete, L. (1992). *New explorations in the economics of technical change*. Pinter.
- Garcia, F., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: A literature review. *Journal of Product Innovation Management*, 19, 110–132.
- Gattermann, M., & Sampaio, C. H. (1999). Performance empresarial: Uma comparação entre indicadores subjetivos e objetivos.
- Gil, A. C. (1999). *Métodos e técnicas de pesquisa social* (5ª ed.). Atlas.
- Globo G1. (2017). RJTV. Disponível em: <https://g1.globo.com/rio-de-janeiro/noticia/crise-fecha-quase-mil-lojas-do-comercio-de-rua-no-rio.ghtml>
- Globo G1. (2017). Disponível em: <https://g1.globo.com/economia/noticia/governo-reduz-de-1-para-05-projecao-de-alta-do-pib-em-2017.ghtml>
- Google Maps, App Mix/M2M. (2018). Screenshot. Mix Fleet Manager. Mix Telematics e M2M.
- Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(Winter special issue), 109–122.
- Hernández-Mogollon, et al. (2010). The role of cultural barriers in the relationship between open-mindedness and organizational innovation. *Journal of Organizational Change Management*, 23(4), 300–376.
- IndexMundi. (2018, junho 17). Petróleo bruto preço mensal – E.U. dólares por barril. Disponível em: <https://www.indexmundi.com/pt/pre%C3%A7os-de-mercado/?mercadoria=petr%C3%B3leo-bruto>
- IstoÉ. (2017). Disponível em: <https://istoe.com.br/um-ano-apos-euforia-olimpica-rio-de-janeiro-vive-marasmo>
- Johannessen, J. A., Olsen, B., & Olaisen, J. (1999). Aspects of innovation theory based on knowledge-management. *International Journal of Information Management*, 19(2), 121–139.
- Kaasa, A., & Vadi, M. (2010). How does culture contribute to innovation? Evidence from European countries. *Economics of Innovation and New Technology*, 19(7), 583–604.
- Krippendorff, K. (1986). Análise de conteúdo. In M. Lüdke & M. E. D. A. André (Orgs.), *Pesquisa em educação: Abordagens qualitativas*. EPU.
- Lakatos, E. M., & Marconi, M. A. (2001). *Fundamentos metodologia científica* (4ª ed.). Atlas.
- Makkonen, P., & van der Have, R. (2013). *RAI – Revista de Administração e Inovação*.
- Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, 5(1), 14–37.

- Nonaka, I., & Konno, N. (1998). The concept of “Ba”: Building a foundation for knowledge creation. *California Management Review*, 40(3), 40–54.
- Nonaka, I., & Toyama, R. (2003). The knowledge-creating theory revisited: Knowledge creation as a synthesizing process. *Knowledge Management Research and Practice*, 1, 2–10.
- Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long Range Planning*, 33, 5–34.
- Nonaka, I., & Takeuchi, H. (1997). *Criação de conhecimento na empresa*. Campus.
- O Dia. (2017, junho 23). BRT transporta menos gente do que o prometido e enfrenta velhos problemas. Disponível em: https://odia.ig.com.br/_conteudo/rio-de-janeiro/observatorio/2017-02-19/brt-transporta-menos-gente-do-que-o-prometido-e-enfrenta-velhos-problemas.html
- OCDE. (2018, junho 15). Manual de Oslo: Proposta de diretrizes para coleta e interpretação de dados sobre inovação tecnológica. http://www.finep.gov.br/images/a-finep/biblioteca/manual_de_oslo.pdf
- Ônibus Brasil. (2018, junho 23). Disponível em: <http://rodrigomattar.grandepremio.com.br/tag/auto-viacao-tijuca>
- Perovano, D. G. (2014). *Manual de metodologia científica para a segurança pública e defesa social*. Juruá.
- RAI – Revista de Administração e Inovação. (2014). *Revista de Administração e Inovação*, 11(3), 30–55.
- Railway Gazette. (s.d.). Disponível em: http://www.railwaygazette.com/uploads/pics/tn_br-rio_metro_line_4_train_in_station.jpg
- Rodrigues, A. E. M. (2016). *A costura da cidade*. Bazar do Tempo.
- Salum, F. A., et al. (2012). *Inovação nas médias empresas brasileiras: Um desafio para a competitividade*. Fundação Dom Cabral.
- Schumpeter, J. A. (1997). *Teoria do desenvolvimento econômico: Uma investigação sobre lucro, capital, crédito, juros e o ciclo econômico*. Nova Cultural.
- Silva, N., & Zanelli, J. C. *Cultura organizacional*. In J. C. Zanelli, J. E. Borges-Andrade, & A. V. B. Bastos, *Psicologia, organizações e trabalho no Brasil* (pp. 407–442). Artmed.
- Spender, J. C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, 17(Special Issue), 45–62.
- Tidd, J. (2001). Innovation management in context: Environment, organizational and performance. *International Journal of Management Reviews*, 3(3), 169–183.
- Tidd, J., Bessant, J., & Pavitt, K. (2005). *Managing innovation: Integrating technological, market and organizational change* (3rd ed.). John Wiley & Sons.

Tidd, J., Bessant, J., & Pavitt, K. (2008). *Gestão da inovação* (3ª ed.). Bookman.

Triviños, A. N. S. (1987). *Introdução à pesquisa em ciências sociais: A pesquisa qualitativa em educação*. Atlas, 91–115.

Viagens Vamos Nessa. (2016). VLT. Disponível em:
<https://www.viagensvamosnessa.com.br/2016/12/vlt-o-mais-novo-transporte-publico-do.html>

EVOLUTION OF MATHEMATICS AT CRU LOS SANTOS: QUANTITATIVE STUDY OF FOUR DECADES OF ACADEMIC ACTIVITY

EVOLUÇÃO DA MATEMÁTICA NO CRU LOS SANTOS: ESTUDO QUANTITATIVO DE QUATRO DÉCADAS DE ATIVIDADE ACADÊMICA

EVOLUCIÓN DE LA MATEMÁTICA EN EL CRU LOS SANTOS: ESTUDIO CUANTITATIVO DE CUATRO DÉCADAS DE ACTIVIDAD ACADÉMICA



<https://doi.org/10.56238/sevened2026.008-211>

Alcibiades Medina M.¹, Nohelys E. Díaz G.², Eliecer Cedeño³, Narciso Galástica⁴

ABSTRACT

This study analyzes the academic evolution of the School of Mathematics at the Los Santos Regional University Center (CRU) over forty years of institutional history. Through a quantitative and descriptive approach, various indicators related to academic activity are examined, such as student enrollment, graduates, academic offerings, faculty output, and participation in academic projects. Data were obtained from a graduate survey, institutional records, academic reports, and administrative documents corresponding to the study period. The results identify trends in enrollment growth, the strengthening of mathematics education, and the school's contribution to the academic development of the regional center. Furthermore, the analysis highlights the fundamental role of mathematics in scientific and professional training within the region. This work provides an institutional overview that contributes to understanding the historical evolution of mathematics education at the Los Santos CRU and offers insights for future academic planning.

Keywords: Mathematics. Higher Education. Academic Indicators. Institutional Evolution. Quantitative Analysis.

RESUMO

O presente estudo analisa a evolução acadêmica da Escola de Matemática do Centro Regional Universitário (C.R.U.) Los Santos ao longo de quarenta anos de trajetória institucional. Por meio de uma abordagem quantitativa e descritiva, examinam-se diversos indicadores relacionados à atividade acadêmica, tais como matrícula estudantil, formandos, oferta acadêmica, produção docente e participação em projetos acadêmicos. Os dados foram obtidos a partir de pesquisas com egressos, registros institucionais, relatórios acadêmicos e documentos administrativos correspondentes ao período de estudo. Os resultados permitem identificar tendências no crescimento da matrícula, no fortalecimento da formação matemática e na contribuição da escola para o desenvolvimento acadêmico do centro regional. Ademais, a análise evidencia o papel fundamental da matemática na formação científica e profissional dentro da região. Este trabalho oferece um panorama

¹ Universidad de Panamá. E-mail: profealcibiades184@gmail.com. Orcid: 0009-0008-6465-6697

² Universidad de Panamá. E-mail: nohelys.diaz16@gmail.com. Orcid: 0009-0006-3594-9947

³ Universidad de Panamá. E-mail: eliecer0918@gmail.com. Orcid: 0009-0000-5776-4915

⁴ Universidad de Panamá. E-mail: ngalastica06@gmail.com. Orcid: 0009-0009-8476-6807

institucional que contribui para compreender a evolução histórica do ensino de matemática no C.R.U. Los Santos e fornece elementos para o planejamento acadêmico futuro.

Palavras-chave: Matemática. Educação Superior. Indicadores Acadêmicos. Evolução Institucional. Análise Quantitativa.

RESUMEN

El presente estudio analiza la evolución académica de la Escuela de Matemática del Centro Regional Universitario (C.R.U.) Los Santos a lo largo de cuarenta años de trayectoria institucional. A través de un enfoque cuantitativo y descriptivo, se examinan diversos indicadores relacionados con la actividad académica, tales como matrícula estudiantil, egresados, oferta académica, producción docente y participación en proyectos académicos. Los datos fueron obtenidos a partir de encuesta a egresados, registros institucionales, informes académicos y documentos administrativos correspondientes al período de estudio. Los resultados permiten identificar tendencias en el crecimiento de la matrícula, el fortalecimiento de la formación matemática y la contribución de la escuela al desarrollo académico del centro regional. Asimismo, el análisis evidencia el papel fundamental de la matemática en la formación científica y profesional dentro de la región. Este trabajo ofrece una radiografía institucional que contribuye a comprender la evolución histórica de la enseñanza de la matemática en el C.R.U. Los Santos y aporta elementos para la planificación académica futura.

Palabras clave: Matemática. Educación Superior. Indicadores Académicos. Evolución Institucional. Análisis Cuantitativo.

1 INTRODUCTION

Mathematics education in Panama has been a subject of constant reflection due to the need to improve academic results in this area and foster a better understanding and application of mathematics in society. The School of Mathematics of the CRU Los Santos, began operations in 1983, according to an interview conducted by Magister Edwin Díaz Gálvez, first director of the CRU Los Santos and first professor of the school of mathematics in the University Extension of Las Tablas. "This mathematics school was opened with the purpose of training professionals in the field of mathematics and has played a fundamental role in strengthening mathematics education in the region," Diaz said. It has not only contributed to the training of mathematicians, but also has a direct impact on the teaching of mathematics at the local and national level. However, the presence of this school and its influence on mathematics education in the province of Los Santos and in Panama in general are still aspects that require further analysis. This study aims to reflect on the presence of the School of Mathematics in the province of Los Santos and its contribution to mathematics education in the country.

2 STATEMENT OF THE PROBLEM

Mathematics is a fundamental discipline for the scientific, technological and economic development of contemporary societies. In the field of higher education, mathematical training not only contributes to the strengthening of logical and analytical thinking, but also supports the development of multiple areas of knowledge and scientific innovation. In this context, the study of the evolution of the academic units dedicated to the teaching of mathematics allows us to understand the processes of professional training, the institutional dynamics and the impact of these structures on the academic development of universities.

Various studies have indicated that the analysis of academic indicators such as student enrollment, graduates, academic performance, and teacher participation is a key tool for evaluating the quality and functioning of university programs. In particular, academic performance and student participation are considered relevant indicators to understand the development and effectiveness of formative processes in mathematics (Wijaya et al., 2023).

Likewise, recent studies have shown that institutional, pedagogical, and contextual factors influence the dynamics of mathematics programs in higher education. For example, the literature indicates that the availability of specialized teachers, academic working conditions, and professional development opportunities significantly influence the consolidation and sustainability of mathematics areas in universities (Solis-Rodríguez, 2025).

In this sense, the historical and quantitative analysis of academic units allows us to identify trends in their growth, transformation or stagnation over time. According to research on university systems, the study of institutional indicators such as enrollment, graduation rates, and academic structure contributes to understanding how higher education institutions evolve and how they respond to social and educational demands (Taylor et al., 2019).

Despite the relevance of these analyses, in many Latin American university institutions there is still a limited systematization of historical information on the development of their schools or academic departments. This situation makes it difficult to understand the institutional trajectory, the identification of achievements and challenges, and the generation of inputs for academic planning and strategic decision-making.

In the case of the School of Mathematics of the Los Santos Regional University Center, its academic trajectory extends for approximately four decades of operation. During this period, the school has contributed to the training of professionals, the development of teaching activities and the strengthening of mathematics education in the region. However, the information regarding its institutional evolution such as the behavior of enrollment, the number of graduates, teacher participation and other academic indicators has not been systematized in a comprehensive way in scientific studies that allow analyzing its development over time.

Faced with this situation, the need arises to carry out a quantitative analysis that allows describing and understanding the evolution of the School of Mathematics of the C.R.U. Los Santos during his forty years of academic career. This analysis will allow the construction of an institutional x-ray based on data, contributing to the historical knowledge of the academic unit and providing relevant information for the planning and strengthening of the teaching of mathematics in the university context.

In this context, the following research questions are raised:

- How has the academic activity of the School of Mathematics of the CRU Los Santos evolved throughout its forty years of operation?
- What trends can be identified in institutional indicators such as student enrollment, number of graduates, and faculty development during this period?
- What aspects characterize the academic trajectory of the School of Mathematics of CRU Los Santos in terms of its institutional development?

3 JUSTIFICATION

The School of Mathematics of CRU Los Santos represents the main key player in the training of human resources in the field of mathematics in the region. The need to investigate

its impact lies in the fact that mathematics education is a fundamental pillar for the development of critical thinking, problem solving and decision-making in various areas of social, political and economic life. Through this study, we seek to understand how the training received in this school contributes to the quality of mathematics teaching at the educational levels of the province of Los Santos and Panama. In addition, it is intended to identify possible areas for improvement and promote the strengthening of the School of Mathematics, ensuring its role as a key actor in the country's educational process.

4 OBJECTIVES

4.1 GENERAL OBJECTIVE

□ To evaluate the academic evolution of the School of Mathematics of the C.R.U. Los Santos for forty years and its contribution to the improvement of mathematics education in Panama, through the study of institutional and academic indicators.

4.2 SPECIFIC OBJECTIVES

1. To analyze the impact of the training received at the School of Mathematics on graduates and their contribution in their respective fields of work.
2. To analyze the perception of graduates about the quality of academic training at the School of Mathematics of CRU Los Santos.
3. To explore how the presence of the School of Mathematics has influenced the development of mathematics education in the province of Los Santos.
4. Identify areas for improvement in the School of Mathematics to strengthen its impact on mathematics education at the regional and national levels.

5 THEORETICAL FRAMEWORK

1. The Role of Mathematics in the Development of a Region

Mathematics is more than an academic discipline; it is a fundamental tool for the social and economic progress of any community. As Lynn Arthur Steen (2001) points out, mathematical literacy is a basic need for citizens of the twenty-first century, who must be able to interpret data, understand statistical models, and make informed decisions in an increasingly quantitative world. The ability to apply logical thinking and problem-solving skills is crucial in sectors as diverse as technology, finance, and engineering (National Research Council, 2002). In the regional context, a solid background in mathematics equips professionals with the ability to innovate and contribute to the development of the local economy, boosting competitiveness and creating solutions to community challenges.

2. History and Evolution of Mathematics Education in C.R.U. The Saints

The C.R.U. School of Mathematics Los Santos has played a crucial role in the training of professionals in the region, adapting to educational and labor needs over time. Their curricula reflect a constant evolution, moving from teaching focused on theory to a more applied and problem-solving oriented one (Mathematical Society of Costa Rica, 2018). Analysis of founding documents and review of its historical curricula reveal how the school has responded to changes in the labor market and global trends in higher education, demonstrating its commitment to academic relevance and excellence. This study seeks, precisely, to x-ray the result of this effort through the performance of its graduates.

3. The Role of the Mathematics Graduate in Society

Mathematics graduates have a highly valued professional profile in various fields. Beyond teaching, which has historically been their main job opportunity, they are inserted in areas such as data analysis, finance, research, and information technology (American Mathematical Society, 2019). Their ability to model complex problems and critical thinking make them valuable assets to any organization. When evaluating the work of the School of Mathematics, it is essential to examine to what extent its graduates contribute to society with these skills and how their training aligns with the demands of the current labor market.

4. Mathematics education in higher education

Mathematics plays a fundamental role in academic and scientific training within higher education, due to its contribution to the development of logical, analytical and critical thinking. In this context, mathematics education is not only oriented to the transmission of disciplinary content, but also to the strengthening of cognitive competencies necessary for problem solving in various fields of knowledge. According to Artigue (2011), mathematics education has established itself as a field of research that analyzes the processes of teaching and learning mathematics, as well as the institutional and social factors that influence these processes.

Likewise, mathematical training at the university is linked to the preparation of professionals capable of facing the scientific and technological challenges of contemporary society. In this sense, Rico (2012) points out that research in mathematics education has contributed to understanding the complexity of training processes and to improving educational practices at different levels of the education system, including higher education.

5. Academic Indicators in Institutional Analysis

The analysis of academic indicators is an important tool for evaluating the functioning and development of higher education institutions. Variables such as student enrollment,

graduation rate, teaching staff, and academic offer allow us to identify trends in the evolution of educational programs and their impact on professional training.

According to Taylor, Marmolejo, and DeLuca (2019), the use of institutional indicators allows us to understand the performance and evolution of university institutions, facilitating decision-making and strategic planning. These indicators provide quantitative information that contributes to assessing the growth, sustainability and quality of academic programmes.

In the case of academic units dedicated to the teaching of mathematics, the analysis of these indicators allows identifying patterns in student training, teacher participation and the consolidation of study programs. In addition, these analyses facilitate the identification of strengths and areas for improvement in institutional development.

6. Contemporary Perspectives in Mathematics Education

Current research in mathematics education has broadened its focus to consider not only the cognitive aspects of learning, but also the social, cultural, and institutional dimensions that influence mathematics teaching. From this perspective, mathematics education is understood as a complex process that involves multiple actors and contexts.

Valero (2017) argues that the learning of mathematics should also be analyzed from a socio-political perspective, recognizing the role played by educational institutions in the construction of mathematical knowledge and in the formation of critical citizens. Similarly, Cantoral et al. (2013) highlight that mathematics education must be understood within a social and institutional framework that influences the production and transmission of mathematical knowledge.

In this context, the study of the historical evolution of mathematics schools or departments within universities allows us to understand how academic practices, institutional structures and dynamics of professional training in the field of mathematics have developed.

7. Institutional Studies and Academic Historical Analysis

The historical analysis of academic units is an important strategy for understanding the development of higher education institutions. This type of study allows us to identify transformations in the academic offer, changes in student enrollment and the growth of the teaching staff, as well as their impact on professional training.

In particular, studies based on quantitative indicators facilitate the construction of a comprehensive vision of institutional development, allowing the analysis of the evolution of academic activities over time. These analyses contribute to documenting the trajectory of the academic units and to generating relevant information for the planning and strengthening of educational programs.

In the case of the School of Mathematics of the Los Santos Regional University Center, the analysis of its evolution over forty years represents an opportunity to understand its contribution to the academic development of the regional center and to the strengthening of mathematical training in the region.

6 METHODOLOGY

This study followed a quantitative and descriptive approach, using a survey-type research methodology. A questionnaire was applied to graduates of the School of Mathematics of CRU Los Santos in order to obtain data on their perception of the quality of the training received, its impact on mathematics education and its contribution to society. The total population of graduates is 210; but despite the fact that the ideal sample of 137 graduates was not reached, for reasons such as: the lack of updating of contact information of the graduates, the low response rate in online surveys, and the limitations of time and budget, the sample was made up of a representative group of 75 graduates who have worked in different educational and professional areas. Data collection was carried out through an online form (Google Forms), which allowed answers to be obtained efficiently and safely. The results were analyzed quantitatively using descriptive statistical tools to identify trends and patterns in participants' responses.

Type of Research

The research was developed within the framework of a descriptive and exploratory research, since it sought to describe and analyze the current reality of the influence of the School of Mathematics in the province of Los Santos and at the national level, without intervention or manipulation of variables, and did not seek to generalize the results to the entire population of 210 graduates. Likewise, the study has a non-probabilistic approach, which is why the sample was not selected at random, but was based on the available graduates who met the participation criteria; and with a quantitative cut, since numerical data were collected, which allowed obtaining results on the impact of the training on graduates and their perception of educational quality.

7 ANALYSIS OF RESULTS

The Cru Los Santos School of Mathematics in real figures from 1983 to 2023

Table 1

Graduates

Género	Cantidad
Masculino	102
Femenino	108
Total	210

Table 2

Undergraduate projects

Tipo de trabajo	Cantidad
Tesis	52
Monografías	230
Total	282

Table 3

Thesis by area

Área	Cantidad
Matemática Pura	16
Matemática Aplicada	11
Matemática Educativa	25
Total	52

Table 4

Monographs by area

Área	Cantidad
Matemática Pura	0
Matemática Aplicada	0
Matemática Educativa	230
Total	230

The following results presented are based on a sample of 75 graduates who were surveyed online, after having validated the instrument to be applied using expert validation, therefore, the findings are applicable only to this group.

A. GENERAL INFORMATION

It presents an overview of the graduates of the School of Mathematics of the CRU Los Santos, analyzing various aspects such as gender, graduation generation, academic index, employment status, and areas of specialization. This analysis provides a comprehensive

understanding of the profile of the graduates, highlighting their academic and work trajectories, as well as their interests in continuing their education, both in the field of mathematics and in other areas.

Table 5

Gender of graduates

Género	Frecuencia
Masculino	35
Femenino	40
Total	75

Figure 1



Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

There is a greater female representation among the surveyed graduates, although the difference is not very significant, with 6.66% more women (53.33% vs. 46.67%). The results show a balanced gender distribution in the surveyed graduates of the School of Mathematics, with a slight female majority.

This suggests a good level of inclusion of both genders, which could be highlighted as a positive aspect in terms of diversity and equity in the institution.

Table 6

Generation to which it belongs according to the range of years

Año de Promoción	Frecuencia
1983-1993	2
1994-2004	18
2005-2015	26
2016-2023	26
Total	75

The data show a positive evolution in the number of graduates, especially between 1994 and 2015, with a stabilization in recent years. This reflects the strengthening of the School of Mathematics of CRU Los Santos and raises the importance of maintaining strategies to ensure sustainability and growth in future promotions.

Figure 2



Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

Table 7

Graduate's employment status as a teacher

Trabajo	Frecuencia
Sí	67
No	8
Total	75

Figure 3

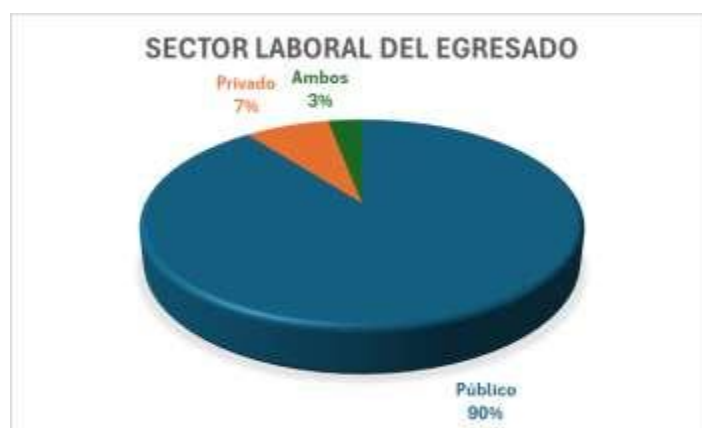


Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

Table 8*Graduates' Labor Sector*

Sector	Frecuencia
Público	60
Privado	5
Ambos	2
Total	67

The results show that most of the surveyed graduates of the School of Mathematics of the CRU Los Santos work as teachers. This reflects that the School of Mathematics contributes significantly to the strengthening of the education sector, particularly in areas where teaching mathematics is essential. This suggests that the training offered responds well to the labor demand of the education sector in the region.

Figure 4

Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

The results show a clear preference for the public sector among the surveyed graduates employed with 60 graduates (89.55%) working in the public sector, evidencing that most graduates find job opportunities in state institutions, such as public schools or government agencies.

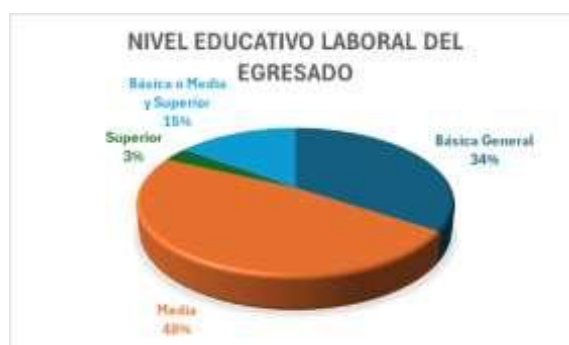
The public sector is the main employer of the surveyed graduates of the School of Mathematics, which reflects an alignment of academic training with the labor demand of this sector. This underscores the importance of public education as the predominant workplace for graduates in the region.

Table 9*Graduate's educational level*

Nivel educativo	Frecuencia
Básica General	23
Media	32
Superior	2
Básica o Media y Superior	10
Total	67

The results indicate that most of the surveyed graduates work as teachers at basic and secondary educational levels, with less presence in higher education.

Most of the surveyed graduates of the School of Mathematics of the CRU Los Santos contribute to the strengthening of basic and secondary education, with a lower presence in higher education. This suggests that the academic program responds mainly to the labor demand of the educational levels prior to university.

Figure 5

Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

Table 10*Specialization in Mathematics after graduation*

Realización de Estudios	Frecuencia
Sí	51
No	24
Total	75

Figure 6

Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

The results show that a significant proportion of the surveyed graduates seek to continue their academic training after graduation.

68% of the surveyed graduates who completed specialization studies show a significant commitment to continuous training, highlighting the importance of promoting opportunities for specialization and access to advanced programs. However, the 32% who do not suggest the need to identify barriers and promote academic development alternatives that the doctorate has a minimum representation. This shows considerable interest in professionalization, but also highlights the need to expand opportunities and support to reach more advanced levels of study, such as doctorates.

Table 11

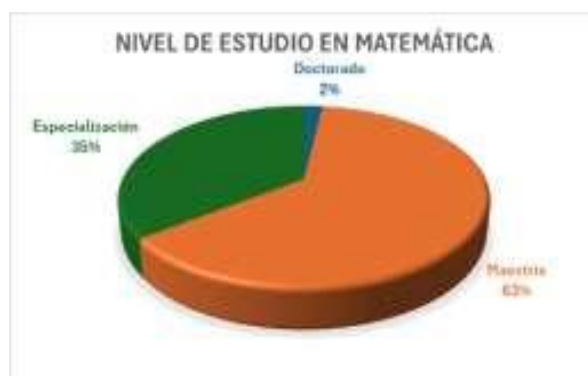
Level of studies in mathematics

Nivel	Frecuencia
Doctorado	1
Maestría	32
Especialización	18
Total	51

The data show that the surveyed graduates who have continued their academic training in Mathematics are mostly concentrated at master's levels with 32 graduates (62.75%) who have reached this level, being the most common. This suggests that the master's degree is perceived as an accessible and valuable option for professional development in Mathematics.

Most of the surveyed graduates who continue their academic training do so at master's or specialization levels, while

Figure 7



Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

B. IMPACT AND CONTRIBUTION OF THE SCHOOL OF MATHEMATICS

It addresses the impact and contribution of the School of Mathematics of CRU Los Santos in the training of its graduates and its influence in the educational and professional field. Key aspects such as skills development, job placement in the education sector and other related fields are examined, as well as opportunities for specialization and the role of graduates in the promotion of mathematics in the region. This analysis seeks to highlight how the school has strengthened both the educational quality and the professional profile of its graduates.

Table 12

Quality of the mathematical training received at the School of Mathematics of CRU Los Santos

Nivel de calidad	Frecuencia
Excelente	44
Buena	26
Aceptable	5
Regular	0
Deficiente	0
Total	75

Figure 8



Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

The majority of the graduates surveyed positively value the mathematical training received at the School of Mathematics of the CRU Los Santos, with an outstanding proportion of 58% considering the education as excellent. These results suggest that the school meets quality expectations

educational, although it is important to continue evaluating and improving areas that can increase the satisfaction of all students.

Table 13

Contribution of the School of Mathematics of CRU Los Santos in the professional development of the graduate

Nivel de contribución	Frecuencia
Mucho	56
Bastante	18
Poco	1
Nada	0
Total	75

Figure 9

Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

The results show a strong positive perception of the contribution of the School of Mathematics of CRU Los Santos in the professional development of its graduates with 74.6%, which indicates a strong correlation between the training received and professional success in the educational or work environment.

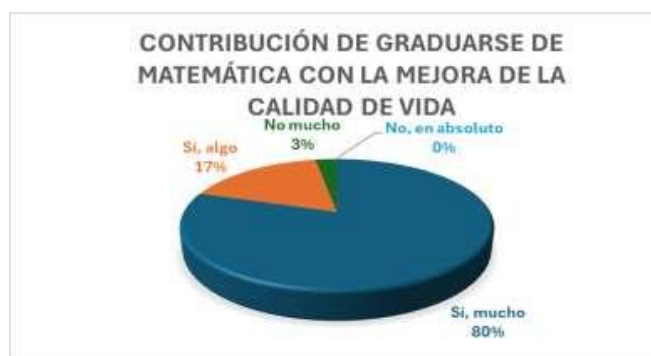
Most of the graduates surveyed perceive that the School of Mathematics has played a crucial role in their professional development, highlighting the effectiveness of the training in preparing them for the workplace. These results underscore the school's success in meeting the professional expectations and needs of its graduates.

Table 14

Contribution of graduating from the School of Mathematics of CRU Los Santos with the improvement of the quality of personal and family life

Nivel de contribución	Frecuencia
Sí, mucho	60
Sí, algo	13
No mucho	2
No, en absoluto	0
Total	75

Figure 10



Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

Most of the surveyed graduates perceive that training at the School of Mathematics of CRU Los Santos has had a significant positive impact on improving their personal and family quality of life. This highlights how education not only impacts professional development, but also has beneficial effects on the overall well-being of graduates.

C. APPLICATION OF KNOWLEDGE IN THE EDUCATIONAL AND LABOR FIELD

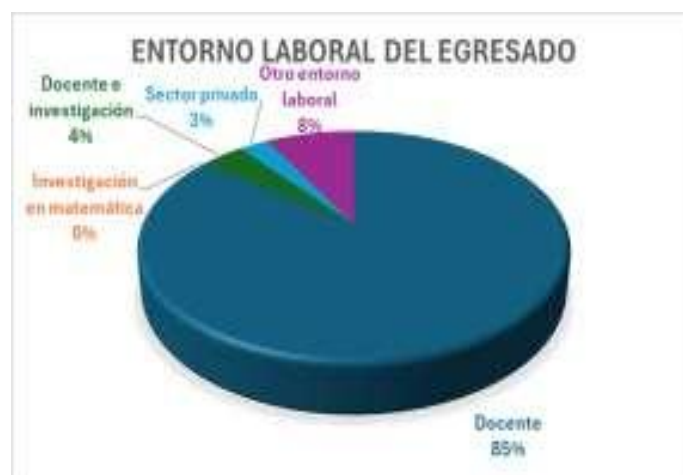
It focuses on the application of the knowledge acquired in the School of Mathematics of CRU Los Santos, analyzing how graduates have transferred and used their mathematical skills in the educational and labor field. The influence of training on the quality of teaching is explored, as well as its impact on professional development and the improvement of the quality of life of graduates. This analysis provides a vision of the effectiveness of the training received and its relevance in the daily practice of graduates.

Table 15

Type of work environment where the graduate works

Tipo de entorno	Frecuencia
Docente	64
Investigación en matemática	0
Docente e investigación	3
Sector privado	2
Otro entorno laboral	6
Total	75

Figure 11



Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

Most of the surveyed graduates of the School of Mathematics of the CRU Los Santos work in the educational field, mainly in teaching. This highlights the strong relationship between academic training and job opportunities in teaching, while participation in research and other job sectors is more limited.

Table 16

To the extent that he was present in the training at the School of Mathematics of the CRU Los Santos, "teaching how to teach mathematics"

Nivel de medida	Frecuencia
Siempre nos enseñaron	44
Algunas veces nos enseñaron	21
Muy poco nos enseñaron	6
Nunca nos enseñaron	1
Total	75

Most of the surveyed graduates consider that training in "teaching to teach mathematics" was significantly present in their education, highlighting that the School of Mathematics of CRU Los Santos has adequately integrated pedagogy into its curriculum. However, there is a small group that perceives that pedagogical teaching was not so constant or deep, which could be an area to be reinforced in the future.

Figure 12



Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

D. OPINION OF THE PRESENCE OF THE SCHOOL OF MATHEMATICS IN THE REGION

It focuses on the opinion of the graduates on the presence and impact of the School of Mathematics of the CRU Los Santos in the region. Through various questions, it is analyzed how graduates perceive the relevance of the institution in the educational and social field, as well as its contribution to local development. This analysis provides insight into the influence of the school in the community and its role in the training of trained professionals in the field of mathematics.

Table 17

Perception of the presence of the School of Mathematics of the CRU Los Santos in the province

Nivel de percepción	Frecuencia
Muy Positiva	52
Positiva	17
Neutra	5
Negativa	1
Total	75

Figure 13

Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

The general perception of the presence of the School of Mathematics of the CRU Los Santos in the province is mostly positive, with a strong assessment of its impact on the community. This data highlights the recognition of the school as a key institution in the training of professionals in the region.

Table 18

Perception of the improvement of mathematics education in the province of Los Santos, with the presence of the School of Mathematics

Nivel de percepción	Frecuencia
Si, de manera significativa	55
Si, en cierta medida	17
No mucho	3
No ha tenido impacto	0
Total	75

The results show a very positive perception about the impact of the School of Mathematics of the CRU Los Santos in the improvement of mathematics education in the province. 73.33% believe that the presence of the school has significantly improved mathematics education in the province, which underscores the great impact that the institution has on the quality of local education.

Most of the graduates perceive that the School of Mathematics of the CRU Los Santos has had a significant impact on the improvement of mathematics education in the province, highlighting its crucial role in the strengthening of mathematics teaching in the region. This highlights the importance of the institution in local educational development.

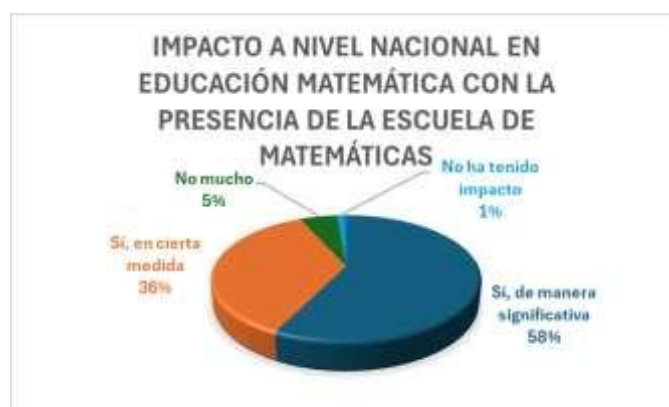
Figure 14

Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

Table 19

Impact at the national level on mathematics education that has been had with the presence of the Mathematics School of the CRU Los Santos

Nivel de impacto	Frecuencia
Sí, de manera significativa	43
Sí, en cierta medida	27
No mucho	4
No ha tenido impacto	1
Total	75

Figure 15

Source: Authors' elaboration based on the data obtained from the survey applied to graduates within the framework of this research.

The majority of the surveyed graduates perceive that the School of Mathematics of CRU Los Santos has had a significant or moderate impact on mathematics education at the national level, which highlights its relevance in the educational field beyond the province of

Los Santos. This data highlights the role of the school as an important actor in the improvement of mathematics teaching in the country.

8 DISCUSSION

The results obtained from the questionnaires applied to the graduates revealed that most of the participants consider that the academic training received at the School of Mathematics of the CRU Los Santos was highly satisfactory and contributed significantly to their professional development. A significant percentage of the graduates mentioned that the training received allowed them to work in different educational sectors, both in primary, secondary and higher education, and in applied areas of mathematics. In addition, many highlighted that the school has had a direct impact on the improvement of mathematics teaching in the province of Los Santos.

Regarding the perception of the school's presence in the region, the graduates agreed that the School of Mathematics of CRU Los Santos has been a key element in the promotion and development of mathematics in the province, contributing to the strengthening of mathematics education in Panama. However, opinions have also emerged that suggest the need to improve teaching resources and infrastructure to optimize teaching-learning processes.

9 CONCLUSIONS

The School of Mathematics of CRU Los Santos has proven to be an institution of great value for the training of professionals in the field of mathematics and has had a significant impact on mathematics education in the province of Los Santos and in Panama. The graduates of the school have been fundamental in the improvement of mathematics teaching in their respective fields of work. However, it was noted that there are areas for improvement, especially in the updating of study programs and in the expansion of continuing education, which would allow the institution to maintain its relevance in an ever-changing academic and professional world. In this sense, it is recommended that the School of Mathematics of CRU Los Santos strengthen and diversify its training programs and continue promoting the development of mathematics in Panama to continue contributing to the educational progress of the country. This study is a first step and we hope that future studies with greater resources will attempt to survey a larger and more representative sample of graduates.

REFERENCES

- Artigue, M. (2011). La educación matemática como campo de investigación y de formación. *Educación Matemática*, 23(2), 5–30. <https://www.redalyc.org/articulo.oa?id=40521119001>
- American Mathematical Society. (2019). Professional profiles of mathematics majors. <https://www.ams.org/profession/data/annual-survey>
- Cantoral, R. (2013). Teoría socioepistemológica de la matemática educativa: Estudios sobre construcción social del conocimiento. Gedisa. <https://books.google.com/books?id=mp9EAQAACAAJ>
- Díaz G., E. R. (2019). Centro regional universitario de Los Santos: Su historia objetiva y sus actores (1.^a ed.). Imprenta Universitaria.
- Flick, U. (2014). Diseño de investigación cualitativa (3.^a ed.). Ediciones Morata. <https://www.morata.es/libro/disenio-de-investigacion-cualitativa>
- Font, V., Planas, N., & Godino, J. D. (2010). Modelo del conocimiento didáctico-matemático del profesor: Implicaciones para la formación del profesorado. *Educación Matemática*, 22(3), 5–33. <https://www.redalyc.org/articulo.oa?id=40519174001>
- Gómez, L., & López, M. (2019). Metodología de la investigación: Un enfoque práctico y reflexivo. Editorial UOC. <https://www.editorialuoc.com/metodologia-de-la-investigacion>
- Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, M. P. (2014). Metodología de la investigación (6.^a ed.). McGraw-Hill Education.
- Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, M. P. (2019). Metodología de la investigación (7.^a ed.). McGraw-Hill Education.
- National Research Council. (2002). Mathematics education in the 21st century. The National Academies Press. <https://nap.nationalacademies.org>
- Rico, L. (2012). La investigación en educación matemática: Avances y perspectivas. *Educación Matemática*, 24(2), 5–29. <https://www.redalyc.org/articulo.oa?id=40525846001>
- Sociedad Matemática de Costa Rica. (2018). Historia de la educación matemática en Costa Rica: Un panorama. Editorial Universidad de Costa Rica.
- Solis-Rodríguez, M. (2025). Teacher well-being and its influence on teaching practices in higher education. *Education Sciences*, 15(8), 1073. <https://doi.org/10.3390/educsci15081073>
- Steen, L. A. (2001). Mathematics and democracy: The case for quantitative literacy. National Council on Education and the Disciplines. https://www.maa.org/external_archive/ql/mathanddemocracy.html
- Taylor, M., Marmolejo, F., & DeLuca, S. (2019). Indicators for higher education systems: Understanding institutional development and performance. arXiv. <https://arxiv.org/abs/1910.05470>

Trochim, W. M. K., & Donnelly, J. P. (2007). *Introducción a la investigación en ciencias sociales*. Pearson Educación.

Valero, P. (2017). La educación matemática crítica: Una visión sociopolítica del aprendizaje de las matemáticas. *Revista Latinoamericana de Investigación en Matemática Educativa*, 20(3), 331–357. <https://doi.org/10.12802/relime.17.2031>

Wijaya, T. T., Zhou, Y., & Ware, A. (2023). Student engagement and academic performance in mathematics education: A systematic review. *International Journal of Environmental Research and Public Health*, 20(5), 4518. <https://doi.org/10.3390/ijerph20054518>

REGULATION OF BRAZILIAN AIR TRANSPORTATION AND FUNDAMENTAL RIGHTS: LEGAL CHALLENGES IN THE TRANSPORTATION OF EMOTIONAL SUPPORT ANIMALS

REGULAÇÃO DO TRANSPORTE AÉREO BRASILEIRO E DIREITOS FUNDAMENTAIS: DESAFIOS JURÍDICOS DO TRANSPORTE DE ANIMAIS DE APOIO EMOCIONAL

REGULACIÓN DEL TRANSPORTE AÉREO BRASILEÑO Y DERECHOS FUNDAMENTALES: DESAFÍOS JURÍDICOS DEL TRANSPORTE DE ANIMALES DE APOYO EMOCIONAL



<https://doi.org/10.56238/sevened2026.008-212>

Ana Sheila dos Santos Gomes¹, Beatriz Barros Silva², Flávia da Silva Fernandes³, João Lopes Rodrigues⁴, Krícia Lavareda Mendes Gregório⁵, Laurentino de Sousa Santos⁶, Manuella Pimenta Loureiro⁷, Samia Tainar Marques da Silva⁸, Dimas Melo Gonçalves⁹

ABSTRACT

The growing recognition of mental health and psychological well-being has intensified legal debates regarding the institutional recognition of emotional support animals, particularly in regulated contexts such as air transportation. In this scenario, questions arise concerning the compatibility between passengers' fundamental rights, aviation safety requirements, and the regulatory norms governing the transport of animals on aircraft. This study aims to analyze the legal challenges related to the regulation of air transportation of emotional support animals in Brazil, considering its implications within the framework of fundamental rights and the normative organization of civil aviation. The research adopts a literature review methodology, based on the qualitative analysis of recent scientific studies addressing legal, social, and regulatory aspects related to the subject. The findings indicate that the social recognition of emotional support animals is closely linked to the psychological benefits associated with the human–animal relationship, while also revealing regulatory gaps that may generate conflicts among passengers, airlines, and regulatory authorities. It is concluded that the development of clearer and more balanced regulatory frameworks is essential to ensure legal certainty, protect fundamental rights, and maintain the proper organization of air transportation in light of contemporary social transformations.

¹ Universidade Nilton Lins. E-mail: ninhagomes127@gmail.com

² Universidade Nilton Lins. E-mail: bea.barros2005@gmail.com

³ Universidade Nilton Lins. E-mail: flaviafernandes058@gmail.com

⁴ Universidade Nilton Lins. E-mail: joaolopesrodrigues44@gmail.com

⁵ Universidade Nilton Lins. E-mail: kriciagregorio.dir@gmail.com

⁶ Universidade Nilton Lins. E-mail: laurentinosantos234@gmail.com

⁷ Universidade Nilton Lins. E-mail: manuploureiro12@gmail.com

⁸ Universidade Nilton Lins. E-mail: samiatainar81@gmail.com

⁹ Faculdade Santa Teresa. E-mail: dimasmelogoncalves@gmail.com

Keywords: Air Transportation. Civil Liability. Emotional Support Animals. Fundamental Rights. Air Transport Regulation.

RESUMO

A crescente valorização da saúde mental e do bem-estar psicológico tem impulsionado debates jurídicos relacionados ao reconhecimento institucional dos animais de apoio emocional, especialmente em contextos que envolvem serviços regulados, como o transporte aéreo. Nesse cenário, surgem questionamentos acerca da compatibilização entre os direitos fundamentais dos passageiros, a segurança operacional da aviação civil e as normas que disciplinam o transporte de animais em aeronaves. O presente estudo tem como objetivo analisar os desafios jurídicos relacionados à regulação do transporte aéreo de animais de apoio emocional no Brasil, considerando suas implicações no campo dos direitos fundamentais e da organização normativa da aviação civil. Para tanto, adotou-se como metodologia a revisão bibliográfica de literatura científica recente, com análise qualitativa de estudos que abordam aspectos jurídicos, sociais e regulatórios relacionados ao tema. Os resultados indicam que o reconhecimento social dos animais de apoio emocional está associado aos benefícios psicológicos decorrentes da relação humano-animal, mas também evidencia lacunas regulatórias que podem gerar conflitos entre passageiros, companhias aéreas e autoridades regulatórias. Conclui-se que a construção de marcos normativos mais claros e equilibrados constitui medida essencial para garantir segurança jurídica, proteção dos direitos fundamentais e adequada organização do transporte aéreo no contexto das transformações sociais contemporâneas.

Palavras-chave: Animais de Apoio Emocional. Direitos Fundamentais. Regulação do Transporte Aéreo. Responsabilidade Civil. Transporte Aéreo.

RESUMEN

El creciente reconocimiento de la salud mental y del bienestar psicológico ha intensificado los debates jurídicos relacionados con el reconocimiento institucional de los animales de apoyo emocional, especialmente en contextos regulados como el transporte aéreo. En este escenario surgen cuestionamientos acerca de la compatibilidad entre los derechos fundamentales de los pasajeros, los requisitos de seguridad de la aviación civil y las normas que regulan el transporte de animales en aeronaves. El presente estudio tiene como objetivo analizar los desafíos jurídicos relacionados con la regulación del transporte aéreo de animales de apoyo emocional en Brasil, considerando sus implicaciones en el ámbito de los derechos fundamentales y en la organización normativa de la aviación civil. Para ello se adoptó como metodología una revisión bibliográfica de literatura científica reciente, con análisis cualitativo de estudios que abordan aspectos jurídicos, sociales y regulatorios relacionados con el tema. Los resultados indican que el reconocimiento social de los animales de apoyo emocional está asociado a los beneficios psicológicos derivados de la relación humano-animal, pero también revela vacíos regulatorios que pueden generar conflictos entre pasajeros, compañías aéreas y autoridades regulatorias. Se concluye que la construcción de marcos normativos más claros y equilibrados constituye una medida esencial para garantizar seguridad jurídica, protección de los derechos fundamentales y adecuada organización del transporte aéreo frente a las transformaciones sociales contemporáneas.

Palabras clave: Animales de Apoyo Emocional. Derechos Fundamentales. Regulación del Transporte Aéreo. Responsabilidad Civil. Transporte Aéreo.

1 INTRODUCTION

The growing appreciation of mental health and quality of life has driven new legal discussions related to the protection of relevant social and affective bonds. In this context, the relationship between humans and companion animals began to receive greater attention in the scientific and legal fields, especially when these animals play an emotional support role for individuals in situations of psychological vulnerability.

The Constitution of the Federative Republic of Brazil establishes the dignity of the human person as the foundation of the Democratic Rule of Law, a principle that guides the interpretation and application of legal norms aimed at protecting the well-being and integrity of individuals, as provided by Brasil (1988). This constitutional foundation allows for a broader understanding of rights related to health and quality of life, including discussions involving the emotional support provided by companion animals.

In recent decades, the scientific literature has shown that the coexistence between humans and animals can produce positive impacts on people's psychological well-being. Recent studies show that interaction with pets can contribute to the reduction of symptoms related to stress, anxiety, and social isolation, favoring the emotional stability of individuals. In this sense, Brooks et al. (2023) highlight that the human-animal relationship can represent an important mechanism of psychological support, especially in contexts of emotional vulnerability. The expansion of this social recognition has driven the emergence of the category of so-called emotional support animals.

However, the institutional recognition of these animals has also provoked relevant legal debates, especially in sectors characterized by high normative regulation. Air transport is an emblematic example of this scenario, as it involves strict standards related to civil aviation safety, service organization and passenger protection. Younggren et al. (2020) highlight that the absence of standardized criteria for the evaluation and certification of emotional support animals can generate administrative and legal controversies, especially when these animals are transported in regulated collective environments.

In addition, the expansion of the presence of animals in different institutional spaces reflects broader cultural transformations related to the way contemporary society understands the relationship between humans and animals. Pallotta (2025) observes that the growing appreciation of the human-animal bond has influenced legal and political debates, stimulating discussions about the institutional recognition of certain forms of interaction between people and companion animals. This process highlights the emergence of new social demands that challenge traditional regulatory models, requiring legal responses capable of balancing individual rights, institutional security, and the organization of public and

private services.

In view of this scenario, the present study aims to analyze the legal challenges related to the regulation of the air transport of emotional support animals, considering the implications of this phenomenon in the scope of fundamental rights and the normative organization of civil aviation. It seeks to understand how the legal system can respond to emerging demands related to the transport of these animals, as well as to identify the main regulatory conflicts associated with the protection of passenger rights, the operational safety of air transport and animal welfare.

The expansion of discussions about emotional support animals is also related to the growth of social demands for institutional recognition of different forms of therapeutic support. In several countries, individuals facing psychological disorders or specific emotional conditions have started to resort to the help of companion animals as a form of support to maintain emotional balance. In this context, the scientific literature has pointed out that the presence of these animals can play a relevant role in the process of recovery and psychological stabilization of individuals. As indicated by Brooks et al. (2023), living with pets can contribute to reducing stress and anxiety levels, in addition to favoring the construction of affective bonds capable of strengthening emotional health.

However, the expansion of the social recognition of emotional support animals has also brought new regulatory challenges. The absence of uniform criteria for the identification and certification of these animals has provoked debates among regulatory authorities, service operators and users. Younggren et al. (2020) point out that the lack of standardized protocols for assessing the need for emotional support can generate divergent interpretations of the legitimacy of these demands. This scenario contributes to the emergence of administrative and legal conflicts, especially in sectors in which institutional functioning depends on strict operational standards.

In the field of air transport, these tensions are becoming even more evident. The civil aviation sector operates with high standards of safety and operational organization, which requires the adoption of clear rules for the transport of passengers and animals. Doughty (2023) observes that the growth in requests for the transport of emotional support animals on aircraft has exposed important gaps in the regulation of the sector, leading different authorities to review their institutional standards and policies. This process highlights the need to develop regulatory frameworks capable of reconciling the protection of passengers' rights with the operational requirements of air transport.

In addition to issues related to operational safety, the literature also points out that the transport of animals in aircraft can generate legal implications related to the civil liability of

airlines. Eulálio (2025) points out that conflicts involving damage or death of animals during transport have become increasingly frequent in the judicial sphere. This phenomenon shows that the transport of companion animals, including emotional support animals, has become part of broader legal debates related to consumer law, civil law, and animal law.

Given this panorama, it is necessary to deepen the legal analysis on the transport of emotional support animals in the context of civil aviation. Understanding the normative foundations and existing regulatory gaps can contribute to the development of legal solutions that are more appropriate to contemporary social transformations. Thus, the investigation proposed in this study seeks to understand the legal challenges related to the regulation of the air transport of these animals, analyzing the tensions between the protection of fundamental rights, the operational safety of air transport and the growing appreciation of animal welfare in contemporary society.

2 THEORETICAL FRAMEWORK

The contemporary legal debate about the transportation of emotional support animals has intensified in recent years, especially due to the expansion of discussions related to fundamental rights, animal welfare and regulatory transformations in the air transport sector. The social recognition of the bond between humans and companion animals has come to occupy a relevant space in academic and legal discussions, especially when this bond is related to mental health issues. In this scenario, recent scientific literature has sought to understand how legal systems can respond to the demands arising from the presence of emotional support animals in regulated environments, such as air transport.

One of the central aspects of the literature refers to the conceptual definition and recognition criteria of emotional support animals. Younggren et al. (2020) explain that these animals are distinguished from the so-called service animals because they do not necessarily receive specific training to perform certain tasks. Its main function is related to the emotional support offered to the tutor, especially in situations involving psychological or psychiatric disorders. The authors point out that the absence of uniform criteria for the evaluation and certification of these animals can generate distortions in the recognition of this type of therapeutic support, creating difficulties both for health professionals and for institutions responsible for regulating public and private services.

The literature also highlights the relevance of the relationship between humans and animals in the field of mental health and psychological well-being. Brooks et al. (2023) point out that living with pets is associated with a reduction in symptoms related to stress, anxiety, and social isolation. The authors note that, in many cases, the presence of an animal can

function as an important emotional support mechanism, contributing to the psychological stability of individuals in vulnerable situations. This therapeutic dimension has been used as a basis to justify the growing demand for institutional recognition of emotional support animals.

Despite these recognized benefits, the concept of emotional support animal still has uncertain legal contours. Pallotta (2025) argues that this category has a complex social and normative construction, being influenced by different cultural, institutional, and legal factors. According to the author, the expansion of the use of this concept in different regulatory contexts has generated debates about its limits and applications, especially when it involves the provision of public or private services. The absence of clear normative parameters can generate divergent interpretations and regulatory conflicts.

The discussion also involves the development of public policies and institutional mechanisms aimed at regulating these animals. Foltin et al. (2023) point out that different countries adopt different regulatory models for the recognition of assistance and emotional support animals. This regulatory diversity can cause practical difficulties for institutions responsible for providing services, especially in highly regulated sectors such as air transport. In this context, the authors highlight the need to develop clearer and more uniform criteria to guide administrative and legal decisions related to the topic.

These contributions demonstrate that the debate on emotional support animals goes beyond the field of health or psychology, reaching directly into the legal and regulatory domain. Recent literature has sought to understand how the law can balance the protection of individual rights, institutional security and the need to establish objective criteria for the recognition of this category of animals. Thus, the construction of a solid theoretical framework requires an integrated analysis of these different perspectives, allowing us to understand the conceptual and legal foundations that support the contemporary debate on the transport of emotional support animals.

The expansion of the debate on emotional support animals has also had direct repercussions in the field of air transport regulation. The presence of these animals on aircraft has generated relevant legal questions, especially with regard to the compatibility between the individual rights of passengers and the duties of airlines related to operational safety and the organization of the transport service. In this scenario, part of the specialized literature has analyzed the existing regulatory gaps and the legal conflicts that emerge from the absence of uniform regulation on the subject.

In this context, Doughty (2023) notes that the absence of clear criteria for the recognition of emotional support animals has contributed to a significant increase in conflicts

involving passengers and airlines. According to the author, during the last decade there has been a significant growth in the number of requests for the transport of these animals in aircraft, which has exposed regulatory weaknesses and led several legal systems to review their policies related to the subject. The lack of normative uniformity ends up producing legal uncertainty for both passengers and the companies responsible for providing the transport service.

The discussion also involves the interaction between aviation law rules and legislation aimed at the protection of people with disabilities or mental health conditions. Lanier (2021) analyzes how different regulatory systems began to revise their rules after the increase in cases involving passengers who sought to transport emotional support animals on aircraft. The author points out that the expansion of the recognition of these animals has generated tensions between the right of access to transport and the concerns of airlines with safety, hygiene and organization of the internal space of aircraft.

In addition, the growth in demand for transporting animals on commercial flights has also generated debates about the legitimacy of certain requests. Cummings (2023) highlights that the expansion of the category of emotional support animal has become the subject of criticism by regulatory authorities and airline operators, who point out difficulties in distinguishing legitimate cases from situations in which the classification is used inappropriately. For the author, the absence of standardized certification mechanisms can compromise the credibility of the institute itself and hinder the development of balanced regulatory policies.

Another relevant aspect discussed in the literature refers to civil liability arising from the transport of animals in aircraft. Eulálio (2025) analyzes cases involving damage or death of animals during air transport and highlights that such situations raise important debates about the liability of airlines. According to the author, the growing judicialization of conflicts involving animal transport demonstrates that the issue has gone beyond the administrative field and has become part of broader discussions related to consumer rights and animal rights.

In turn, Vallespin (2024) observes that the air transport of companion animals has undergone significant transformations in several countries, requiring adaptations in the operational and regulatory policies of airlines. The author points out that the growing social concern with animal welfare has influenced institutional changes in the aviation sector, which reinforces the need to develop clearer and more consistent regulatory models.

These analyses show that the transportation of emotional support animals in the context of civil aviation represents a changing legal field. The specialized literature has

pointed out that the absence of regulatory harmonization can generate conflicts between passengers, airlines and regulatory authorities. Thus, understanding the legal foundations of these disputes becomes essential to assess the regulatory challenges involved in the protection of fundamental rights and in the organization of contemporary air transport.

The discussion about the transport of emotional support animals also involves a broader dimension related to animal welfare and the social transformations that redefine the relationship between humans and animals in contemporary times. In recent decades, several studies have shown that pets play a relevant role in people's emotional and psychological lives, especially in contexts of vulnerability or treatment of mental disorders. This phenomenon has contributed to the broadening of the legal debate on the need to recognize certain forms of human-animal interaction as socially relevant and legally protected.

In this sense, Mota-Rojas et al. (2023) observe that contemporary discussions on animal welfare in Latin America have expanded significantly, incorporating legal, social, and ethical perspectives. The authors point out that the growing appreciation of animal protection has influenced different areas of law, including public policies, environmental legislation, and norms related to the protection of animals in institutional contexts. This movement has driven debates about the appropriate legal treatment of companion animals, especially when they are involved in transport or displacement situations.

The literature also highlights that social changes related to animal protection have produced relevant impacts on the formulation of regulatory policies. Pallotta (2025) argues that the concept of the emotional support animal has come to occupy significant space in institutional debates precisely because it reflects broader cultural transformations related to the way society understands the relationship between humans and animals. According to the author, this transformation has provoked pressures for greater legal recognition of this type of link, while requiring regulatory systems to develop clearer criteria for its application.

Another relevant aspect refers to the psychological and social implications of the coexistence between humans and animals. Brooks et al. (2023) highlight that recent studies show that the presence of companion animals can contribute to improving the emotional well-being and quality of life of their owners. This relationship has been especially relevant in mental health contexts, in which the emotional support provided by animals can help reduce symptoms associated with stress and anxiety. These factors have been used as a basis to justify the growing social demand for institutional recognition of emotional support animals.

However, the literature also emphasizes that the expansion of this recognition must be accompanied by appropriate regulatory mechanisms. Foltin et al. (2023) point out that public policies aimed at the recognition of assistance or emotional support animals need to establish

clear certification and evaluation criteria, in order to ensure legal certainty and avoid distortions in the use of these categories. The absence of objective parameters can compromise both the effectiveness of public policies and the credibility of norms aimed at protecting people who really need this type of support.

Thus, the scientific literature shows that the debate on the transport of emotional support animals involves multiple legal and social dimensions. On the one hand, there is a need to recognize the therapeutic and social benefits associated with human-animal coexistence. On the other hand, it is essential to develop regulatory frameworks capable of balancing the protection of fundamental rights, the safety of air transport and the guarantee of objective criteria for the recognition of these animals. The understanding of these different theoretical perspectives allows us to establish more solid bases for the analysis of the legal challenges involved in the regulation of the air transport of emotional support animals in the contemporary context.

3 METHODOLOGY

The present research is characterized as a qualitative study, with an exploratory and descriptive approach, developed through a bibliographic review of the recent scientific literature on the transport of emotional support animals and its legal developments in the field of air transport. The choice of this method is justified by the need to understand the theoretical, normative and regulatory foundations that structure the contemporary debate on the subject, allowing a critical analysis of the main academic contributions produced in recent years.

As for the technical procedures, the research was conducted through a bibliographic survey in scientific databases widely used in international and national academic production. Databases such as Scopus, Web of Science, PubMed, SciELO, and Google Scholar were prioritized, considering their relevance in the indexing of high-impact scientific journals. The search focused on scientific articles published in the last five years, with a preference for journals classified in strata A and B of the Qualis system, in order to ensure the quality and timeliness of the sources used in the development of the theoretical framework.

To identify relevant studies, descriptors related to the research object were used, such as emotional support animals, air transportation regulation, aviation law, animal welfare and fundamental rights. The combination of these terms allowed us to locate research that addresses both the concept of emotional support animals and the regulatory challenges related to the transportation of these animals on commercial aircraft. After conducting the searches, the publications were selected based on the reading of titles, abstracts and

keywords, prioritizing studies that had a direct relationship with the research problem.

The inclusion criteria adopted included scientific articles available in full text, preferably in PDF format, published in academic journals or recognized institutional repositories and that addressed legal, regulatory or social aspects related to emotional support animals or the transport of animals in aircraft. Publications that did not have a direct relationship with the topic investigated or that did not have a scientific character, such as opinion texts or materials without academic review, were excluded.

After the source selection stage, the studies were submitted to analytical and interpretative reading, seeking to identify the main concepts, theoretical arguments, and regulatory perspectives discussed by the authors. This stage allowed the systematization of the contributions of the recent literature and the organization of the elements that make up the theoretical framework of the study. The data analysis was carried out through a qualitative approach, with emphasis on the critical interpretation of the arguments presented in the selected articles, seeking to understand convergences, divergences and gaps in the scientific production on the subject.

The organization of the collected data occurred through the structuring of the information in analytical categories related to the main axes of discussion identified in the literature, such as the conceptual definition of emotional support animals, the impacts of the human-animal relationship in the field of mental health, the regulatory challenges in air transport and the legal implications arising from the absence of uniform standardization. This systematization made it possible to build a consistent theoretical basis for the analysis of the legal challenges involved in the regulation of the air transport of emotional support animals.

The literature review allowed us to identify relevant contributions that address different dimensions related to emotional support animals, including psychological, social, legal and regulatory aspects. The selected studies present complementary approaches, contributing to the understanding of the phenomenon from different theoretical and methodological perspectives. The following table presents the main authors used in the research so far, as well as the titles of the works analyzed and their respective years of publication.

Table 1

Authors used in the research

Author	Title	Year
Brooks et al.	The well-being of companion animal caregivers: a systematic review and research agenda	2023
Cummings	All dogs are emotional support animals: the need for clearer regulation	2023
Doughty	Failures in regulating emotional support animals	2023

Author	Title	Year
Eulalia	Liability of the airline in the event of death of an animal transported in the hold of the aircraft	2025
Foltin et al.	Current perspectives on implementing assistance and support animals in public policy	2023
Lanier	(Emotional support) peacocks on a plane: revising disability and aviation laws	2021
Mota-Rojas et al.	Controversial topics in animal welfare in Latin America	2023
Pallotta	Emotional support? Law, social control, and the human-animal bond	2025
Vallespin	The impact of transforming air transport for domestic animals	2024
Younggren et al.	Emotional support animal assessments: toward a standard model for mental health professionals	2020

Source: The authors.

The analysis of the studies presented in the table shows that the recent literature has been dedicated to investigating the phenomenon of emotional support animals from different perspectives, ranging from the psychological impacts of the human-animal relationship to the legal and regulatory challenges involved in the transport of these animals.

The contributions of these authors allow us to understand the complexity of the topic and provide a consistent theoretical basis for the discussion on the limits and possibilities of regulating the air transport of emotional support animals in the context of fundamental rights.

4 RESULTS AND DISCUSSIONS

The analysis of the selected studies allowed us to identify that the transport of emotional support animals represents an emerging field of legal debate, especially in the context of air transport regulation. The scientific literature analyzed shows that the growing appreciation of the bond between humans and companion animals has caused significant changes in social demands related to access to transportation services. In this scenario, the results of the literature review indicate that the presence of emotional support animals in aircraft is directly associated with the expansion of social recognition of their role in the psychological support of individuals facing mental health conditions.

Several studies point out that living with pets can have a positive impact on people's emotional health. Brooks et al. (2023) demonstrate that the presence of animals is associated with reduced levels of stress and anxiety, contributing to the improvement of the quality of life of tutors. The authors indicate that the human-animal relationship can function as an important emotional support mechanism, especially in contexts of psychological vulnerability. These results help explain why the demand for institutional recognition of emotional support animals has grown significantly in recent years.

In addition to the psychological dimension, the literature also highlights the need to establish clearer criteria for the recognition of these animals. Younggren et al. (2020) point out that the absence of standardized parameters for the evaluation and certification of emotional support animals has generated controversy in different institutional contexts. According to the authors, the lack of uniform procedures can make it difficult to distinguish between legitimate cases of emotional support and situations in which this classification is used inappropriately. This scenario contributes to the emergence of regulatory conflicts, especially in highly regulated sectors such as air transport.

The analysis of the studies also shows that the growth in demand for the transport of these animals has exposed relevant gaps in the regulation of the aviation sector. Doughty (2023) highlights that the significant increase in requests involving emotional support animals has led several regulatory authorities to reevaluate their air transport standards. The author notes that the absence of uniform criteria has caused legal uncertainty for both passengers and airlines, highlighting the need for the development of clearer and more consistent regulatory frameworks.

Another element identified in the literature refers to the difficulties faced by airlines in dealing with the increase in requests for transporting animals in the cabin. Lanier (2021) analyzes that the growth of this phenomenon has generated tensions between the right of access to transport and concerns related to the operational safety of aircraft. According to the author, companies in the airline industry began to face challenges related to the management of the internal space of aircraft, passenger safety, and the need to establish objective criteria to authorize or restrict the transport of these animals.

These results demonstrate that the legal debate on the transportation of emotional support animals involves multiple dimensions that go beyond the simple relationship between passenger and airline. The evidence identified in the literature indicates that the topic involves issues related to mental health, animal welfare, air transport regulation, and the protection of fundamental rights. In this sense, the analysis of academic contributions reveals that the absence of clear regulation can generate institutional conflicts and legal challenges that require balanced normative solutions.

The continuity of the literature analysis shows that the growth of social recognition of emotional support animals has produced direct impacts on contemporary regulatory debates. The expansion of this phenomenon began to challenge traditional legal models, especially in sectors in which institutional functioning depends on strict operational rules, as occurs in air transport. In this context, a significant part of recent scientific production has been dedicated to understanding the limits and implications of expanding the use of the category of emotional

support animal.

Cummings (2023) observes that the expansion of recognition of these animals occurred faster than the development of institutional mechanisms capable of adequately regulating their use. According to the author, the absence of clear procedures to prove the need for emotional support contributed to the increase in requests for transportation of these animals on commercial aircraft. This scenario has produced relevant debates about the legitimacy of certain demands and about the need to create more objective criteria for the evaluation of these requests.

In addition to regulatory issues, the literature also discusses the role of social transformations in expanding the presence of animals in different institutional spaces. Pallotta (2025) argues that the concept of the emotional support animal reflects cultural changes related to the way contemporary society understands the relationship between humans and animals. The author points out that the growing appreciation of companion animals has influenced legal and political debates, stimulating discussions about the institutional recognition of certain forms of human-animal bonding.

Another aspect identified in the studies refers to the institutional transformations that have been occurring in the air transport sector due to the growing concern with animal welfare. Vallespin (2024) points out that airlines and regulatory authorities have started to review their internal policies to deal with the increase in demand for the transport of companion animals. The author points out that this adaptation process involves operational and legal challenges, requiring the construction of regulatory models capable of balancing economic interests, operational safety, and social demands.

The literature also emphasizes the need to develop public policies capable of establishing clear criteria for the recognition of assistance and emotional support animals. Foltin et al. (2023) point out that the absence of uniform regulatory standards can generate practical difficulties for institutions responsible for providing services. The authors highlight that well-structured public policies can contribute to reducing institutional conflicts and increasing the predictability of administrative decisions related to the topic.

In the context of discussions on animal protection, Mota-Rojas et al. (2023) highlight that the growing appreciation of animal welfare has influenced the formulation of legal norms in different countries. The authors point out that the broadening of discussions on animal rights contributes to redefining the way legal systems treat companion animals, especially in contexts involving transportation, displacement, and the provision of services.

The literature also shows that the transportation of animals in aircraft can generate relevant legal implications related to the civil liability of airlines. Eulálio (2025) analyzes cases

involving damage or death of animals during air transport and observes that these conflicts have been increasingly judicialized. The author points out that the growing litigation involving the transportation of animals demonstrates the need to improve the regulatory and contractual rules that govern this type of service.

These results reinforce the idea that the transport of emotional support animals is a complex phenomenon that involves multiple legal, social and institutional dimensions. The literature analyzed indicates that the development of appropriate regulatory solutions requires the simultaneous recognition of the therapeutic benefits associated with emotional support animals and the operational requirements that characterize the air transport sector. In this context, the construction of balanced regulatory frameworks emerges as a fundamental element for the reduction of conflicts and for the protection of the fundamental rights involved in this issue.

The integrated analysis of the studies examined allows us to observe that the discussion about the transport of emotional support animals in air transport involves a complex interaction between legal, social and institutional factors. The results obtained in the literature review indicate that the expansion of this phenomenon is directly related to contemporary transformations in the way society understands the role of companion animals, especially in the context of mental health and emotional well-being.

In this sense, several authors point out that the relationship between humans and animals has acquired increasing social relevance, reflecting cultural and institutional changes that influence the formulation of public policies and legal norms. Pallotta (2025) argues that the social recognition of emotional support animals is associated with broader transformations in the understanding of the human-animal relationship, marked by the appreciation of well-being and the expansion of discussions on animal protection. This scenario contributes to new social demands being directed to regulatory systems, requiring institutional responses capable of dealing with this emerging reality.

At the same time, the literature also demonstrates that the expansion of the recognition of these animals must be accompanied by appropriate regulatory mechanisms. Younggren et al. (2020) highlight that the lack of uniform criteria for the evaluation and certification of emotional support animals can compromise the credibility of this therapeutic support instrument. According to the authors, the definition of clear professional parameters is essential to ensure that the recognition of these animals occurs in a responsible and evidence-based manner.

Another relevant element identified in the studies refers to the need to balance different legal interests involved in air transport. Doughty (2023) notes that the absence of uniform

regulation can generate conflicts between passengers seeking to transport emotional support animals and airlines responsible for the operational management of aircraft. The author points out that the safety of air transport and the organization of the service are essential factors that must be considered in the formulation of regulatory policies.

In addition, the literature shows that the growth of demands related to the transportation of animals has also caused institutional adaptations in the aviation sector. Vallespin (2024) notes that airlines and regulatory authorities have been pressured to review their operational policies to deal with the increased presence of animals on commercial flights. These changes reflect the need to develop regulatory models capable of reconciling operational safety, animal welfare and passenger rights.

The discussions analyzed also indicate that the expansion of the recognition of emotional support animals should consider the legal impacts arising from the transport of these animals. Eulálio (2025) highlights that conflicts involving damage or death of animals during air transport have generated increasing judicialization, highlighting the need to improve the rules that regulate this activity. This phenomenon reveals that the transport of animals in aircraft is not only an operational issue, but also a relevant topic for civil law, consumer law and animal law.

Thus, the results obtained in this research indicate that the transportation of emotional support animals represents a legal field in the process of consolidation. The literature analyzed demonstrates that the absence of clear and uniform regulation can generate institutional conflicts and legal uncertainty. On the other hand, the recognition of the therapeutic benefits associated with human-animal coexistence reinforces the importance of developing normative solutions capable of balancing the different interests involved, contributing to the construction of a fairer and more efficient regulatory system in the field of air transport.

The analysis of the literature used in this research allowed us to identify different theoretical and methodological approaches aimed at understanding the role of emotional support animals, as well as the legal and institutional challenges associated with their transport in aircraft.

The selected studies present relevant contributions ranging from aspects related to mental health and human well-being to discussions on air transport regulation, civil liability and public policies. The following table summarizes the main authors used in the development of the theoretical framework and the results of the research, highlighting the objectives of each study, the methods used and the main results presented.

Table 2*Synthesis of the studies used in the research*

Authors	Objective	Method	Main results
Brooks et al.	To investigate the impacts of the relationship between humans and pets on the psychological well-being of pet owners	Systematic review of the literature	It identified that living with animals can reduce stress, anxiety and social isolation
Cummings	Analyze regulatory challenges related to emotional support animal recognition	Legal analysis and literature review	It highlighted the need for clearer criteria for the recognition and certification of these animals
Doughty	Examine regulatory failures involving the transportation of emotional support animals in air transport	Normative analysis and legal study	Identified regulatory gaps that generate legal uncertainty for passengers and airlines
Eulalia	Assessing the civil liability of airlines in cases of animal death during transport	Jurisprudential and doctrinal analysis	Demonstrated the increase in litigation involving damage to animals transported in aircraft
Foltin et al.	Discuss the implementation of assistance and emotional support animals in public policies	Interdisciplinary literature review	He highlighted the need for clearer regulatory standards and institutional criteria
Lanier	Analyze legal conflicts between passenger rights and air transport rules	Legal analysis and case studies	He pointed out tensions between accessibility, operational safety and regulation of the airline sector
Mota-Rojas et al.	Investigate contemporary debates on animal welfare in Latin America	Interdisciplinary scientific review	It demonstrated the growth of discussions on animal protection and its influence on public policies
Pallotta	Examine the social and legal role of emotional support animals	Socio-legal analysis	It showed that the concept of emotional support animal reflects cultural and institutional transformations
Vallespin	Analyze the impacts of the air transport of companion animals on the policies of the airline industry	Analytical study and literature review	Identified operational and regulatory changes adopted by airlines
Younggren et al.	Propose professional criteria for evaluation of emotional support animals	Conceptual study and clinical analysis	It indicated the need for standardized protocols for the evaluation and certification of these animals

Source: The authors.

The synthesis presented in the table shows that the studies analyzed converge in the identification of regulatory challenges related to the recognition and transport of emotional support animals. At the same time, the results demonstrate that the scientific literature highlights the importance of balancing the therapeutic benefits associated with the human-animal relationship with the need to establish clear rules that ensure legal and operational certainty in air transport.

5 CONCLUSION

The present research aimed to analyze the legal challenges related to the regulation of the air transport of emotional support animals, considering the implications of this

phenomenon in the context of fundamental rights, civil aviation operational safety and animal welfare protection. From the review of recent scientific literature, it was possible to identify that the growing appreciation of the bond between humans and companion animals has produced new social demands that directly impact the way transport services are regulated and organized.

The results obtained show that the social recognition of emotional support animals is associated, above all, with the role that these animals play in the psychological support of individuals in situations of emotional vulnerability. The literature analyzed demonstrates that living with animals can contribute to the improvement of psychological well-being, strengthening the social perception that certain human-animal bonds have therapeutic relevance and deserve institutional recognition.

However, it was also possible to identify that the expansion of these demands has exposed relevant gaps in the regulatory systems that govern air transport. The absence of uniform normative criteria for the recognition and certification of emotional support animals has generated conflicts between passengers, airlines and regulatory authorities. This situation contributes to the formation of a scenario of legal uncertainty, in which administrative and judicial decisions come to depend on varying interpretations of the scope of the rights involved.

In addition, the results indicate that the transport of animals on aircraft involves multiple legal dimensions, including issues related to the safety of air transport, the civil liability of airlines and the protection of animal welfare. The interaction between these different elements highlights the need to build regulatory frameworks capable of balancing diverse interests, while ensuring the protection of passenger rights and the maintenance of aviation operational safety.

In this context, the research demonstrates that the development of clearer and more consistent rules for the transport of emotional support animals is an essential measure to reduce institutional conflicts and promote greater legal predictability. The definition of objective criteria for the recognition of these animals, combined with the elaboration of balanced regulatory policies, can contribute to the construction of a more efficient normative system that is compatible with contemporary social transformations.

It is concluded that the analyzed theme represents a legal field in the process of consolidation, in which there are still important regulatory gaps and interpretative challenges. The continuity of academic research on the subject can contribute to the improvement of legal discussions and to the development of normative solutions capable of harmonizing the fundamental rights of individuals with the operational requirements of air transport.

ACKNOWLEDGMENTS

The authors express their sincere gratitude to all those who, directly or indirectly, contributed to the realization of this study. They thank the teaching and research institutions that encourage scientific production and provide the necessary environment for the development of academic reflections aimed at building a more just and conscious society.

They also express recognition to the researchers whose work served as a basis for the elaboration of this research, contributing to the deepening of legal and social discussions related to the transport of emotional support animals and the protection of animal welfare.

In particular, the authors register their gratitude for the opportunity to dedicate this work to a theme that involves beings who, although they do not have a voice or direct means of expression, play a fundamental role in the lives and emotional balance of countless people. Talking about the protection and recognition of these animals represents not only an academic exercise, but also an ethical commitment to those who, even in silence, demonstrate their importance to society on a daily basis.

REFERENCES

Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Brasília, DF: Presidência da República. Disponível em: https://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm. Acesso em 10 mar. 2026.

Brooks, S. K., et al. (2023). The well-being of companion animal caregivers: A systematic review and research agenda. *Animals*. Disponível em: <https://www.mdpi.com/2076-2615/13/20/3294>. Acesso em 10 mar. 2026.

Cummings, L. (2023). All dogs are emotional support animals: The need for clearer regulation. *Marquette Benefits and Social Welfare Law Review*. Disponível em: <https://scholarship.law.marquette.edu/cgi/viewcontent.cgi?article=1106&context=benefits>. Acesso em 10 mar. 2026.

Doughty, J. (2023). Failures in regulating emotional support animals. *Journal of Air Law and Commerce*. Disponível em: <https://scholar.smu.edu/cgi/viewcontent.cgi?article=4235&context=jalc>. Acesso em 10 mar. 2026.

Eulálio, G. A. (2025). Responsabilidade da companhia aérea em caso de morte de animal transportado no bagageiro do avião. *Revista JRG de Estudos Jurídicos*. Disponível em: <https://revistajrg.com/index.php/portajrg/article/download/2731/2146>. Acesso em 10 mar. 2026.

Foltin, S., et al. (2023). Current perspectives on implementing assistance and support animals in public policy. *Veterinary Sciences*. Disponível em: <https://www.mdpi.com/2306-7381/10/1/62>. Acesso em 10 mar. 2026.

Lanier, T. (2021). (Emotional support) peacocks on a plane: Revising disability and aviation laws. *Indiana Journal of Law and Social Equality*. Disponível em: <https://www.repository.law.indiana.edu/cgi/viewcontent.cgi?article=1126&context=ijlse>. Acesso em 10 mar. 2026.

Mota-Rojas, D., et al. (2023). Controversial topics in animal welfare in Latin America. *Animals*. Disponível em: <https://www.mdpi.com/2076-2615/13/9/1463>. Acesso em 10 mar. 2026.

Pallotta, N. R. (2025). Emotional support? Law, social control, and the human–animal bond. *Societies*. Disponível em: <https://www.mdpi.com/2813-9372/2/4/40>. Acesso em 10 mar. 2026.

Vallespin, A. B. (2024). The impact of transforming air transport for domestic animals. *Theseus Research Repository*. Disponível em: https://www.theseus.fi/bitstream/10024/903226/2/Bosch%20Vallespin_Angels.pdf. Acesso em 10 mar. 2026.

Younggren, J. N., et al. (2020). Emotional support animal assessments: Toward a standard model for mental health professionals. *Professional Psychology: Research and Practice*. Disponível em: <https://pmc.ncbi.nlm.nih.gov/articles/PMC7517601/>. Acesso em 10 mar. 2026.

PACKAGING REGULATION AND CHOICES OF SUSTAINABLE MATERIALS: A CRITICAL DIALOGUE BETWEEN THE EUROPEAN PPWR AND BRAZILIAN DECREE NO. 12,688/2025, WITH EMPHASIS ON CARDBOARD AND CORRUGATED CARDBOARD

REGULAÇÃO DE EMBALAGENS E ESCOLHAS DE MATERIAIS SUSTENTÁVEIS: UM DIÁLOGO CRÍTICO ENTRE A PPWR EUROPEIA E O DECRETO BRASILEIRO Nº 12.688/2025, COM ÊNFASE EM PAPÉIS DE CARTÃO E PAPELÃO ONDULADO

REGULACIÓN DEL EMBALAJE Y ELECCIÓN DE MATERIALES SOSTENIBLES: UN DIÁLOGO CRÍTICO ENTRE LA PPWR EUROPEA Y EL DECRETO BRASILEÑO N.º 12.688/2025, CON ÉNFASIS EN EL CARTÓN Y EL CARTÓN ONDULADO



<https://doi.org/10.56238/sevened2026.008-213>

Leonardo Bezerra

ABSTRACT

Packaging regulation is at a historical turning point. In the European Union, Regulation (EU) 2025/40 – PPWR requires all packaging on the market to be economically recyclable by 2030, while harmonising design, labelling, prevention and substances of concern. In Brazil, Decree No. 12,688/2025 establishes the Reverse Logistics System for Plastic Packaging, with mandatory recovery targets (32% in 2026, scaling to 2040) and minimum post-consumer recycled (PCR) content thresholds, starting at 22% in 2026 for large companies. This paper provides a critical comparison of these frameworks and discusses technical-commercial implications for material selection, emphasising renewable, FSC chain-of-custody certified paperboard and corrugated board. We argue that cellulosic solutions, when designed for recycling (mono-material, contaminant-free and properly labelled), tend to reduce regulatory risk, compliance costs and reputational impacts while maintaining logistics performance. Decision-making should be guided by design-for-recycling criteria, auditable traceability and evidence (LCA), prioritising cellulose where technically feasible and, otherwise, polymers compatible with PCR targets and large-scale recycling.

Keywords: PPWR. Decree 12.688/2025. Sustainable Packaging. Paperboard. Corrugated Board. FSC. Reverse Logistics. Recycled Content.

RESUMO

A regulamentação de embalagens vive uma inflexão histórica. Na União Europeia, o Regulamento (UE) 2025/40 – PPWR torna obrigatória a reciclabilidade econômica de todas as embalagens até 2030, além de harmonizar requisitos de desenho, rotulagem, prevenção e substâncias de preocupação. No Brasil, o Decreto nº 12.688/2025 institui o Sistema de Logística Reversa de Embalagens de Plástico, com metas obrigatórias de recuperação (32% em 2026, com evolução até 2040) e percentuais mínimos de conteúdo reciclado pós-consumo (PCR), a partir de 22% em 2026 para grandes empresas. Este artigo compara

criticamente esses marcos e discute implicações técnico-comerciais na escolha de materiais, com ênfase em papéis de cartão e papelão ondulado de fonte renovável e cadeia de custódia certificada (FSC). Argumenta-se que soluções celulósicas, quando projetadas para reciclagem (mono-material, sem contaminantes e rotulagem adequada), tendem a reduzir riscos regulatórios, custos de conformidade e impactos reputacionais, preservando desempenho logístico. Conclui-se que a tomada de decisão deve ser orientada por critérios de projetar-para-reciclar, rastreabilidade auditável e evidências (ACV), privilegiando celulósicos onde tecnicamente viáveis e, nos demais casos, polímeros compatíveis com metas de PCR e reciclagem em escala.

Palavras-chave: PPWR. Decreto 12.688/2025. Embalagens Sustentáveis. Papelcartão. Papelão Ondulado. FSC. Logística Reversa. Conteúdo Reciclado.

RESUMEN

La normativa sobre envases está experimentando un punto de inflexión histórico. En la Unión Europea, el Reglamento (UE) 2025/40 – PPWR exige la reciclabilidad económica de todos los envases para 2030, además de armonizar los requisitos de diseño, etiquetado, prevención y sustancias preocupantes. En Brasil, el Decreto n.º 12.688/2025 establece el Sistema de Logística Inversa para Envases de Plástico, con objetivos de recuperación obligatorios (32 % en 2026, con evolución hasta 2040) y porcentajes mínimos de contenido reciclado posconsumo (PCR), a partir del 22 % en 2026 para las grandes empresas. Este artículo compara críticamente estos hitos y analiza las implicaciones técnicas y comerciales para la selección de materiales, con especial énfasis en el cartón y el cartón ondulado procedentes de fuentes renovables y con certificación de cadena de custodia (FSC). Se argumenta que las soluciones celulósicas, cuando se diseñan para el reciclaje (de un solo material, libres de contaminantes y con el etiquetado adecuado), tienden a reducir los riesgos regulatorios, los costos de cumplimiento y el impacto en la reputación, a la vez que preservan el rendimiento logístico. Se concluye que la toma de decisiones debe guiarse por criterios de diseño para el reciclaje, trazabilidad auditable y evidencia (ACV), priorizando los materiales celulósicos cuando sea técnicamente factible y, en otros casos, polímeros compatibles con el reciclaje de contenido reciclado (PCR) y los objetivos de reciclaje a gran escala.

Palabras clave: PPWR. Decreto 12.688/2025. Embalaje Sostenible. Cartón. Cartón Ondulado. FSC. Logística Inversa. Contenido Reciclado.

1 INTRODUCTION

The transition from the former Directive 94/62/EC to Regulation (EU) 2025/40 (PPWR) establishes a uniform regime for the European market, with the goal of making all packaging recyclable in an economically viable way by 2030 and with general application from August 2026 (EUROPEAN UNION, 2025; EUROPEAN COMMISSION, 2025). In Brazil, Decree No. 12,688/2025 inaugurates a specific framework for plastic packaging, with recovery and recycled content goals in the short term (BRASIL, 2025).

2 COMPARATIVE NORMATIVE FRAMEWORK

2.1 EUROPEAN UNION (PPWR)

The PPWR entered into force on 02/11/2025 and applies generally as of 08/12/2026. Pillars include: recyclability by design by 2030, prevention targets, harmonized labeling, and limits on substances of concern, such as restrictions on PFAS on food packaging (EUROPEAN UNION, 2025; PACKAGINGLAW.COM, 2025).

2.2 BRAZIL (DECREE NO. 12,688/2025)

The decree institutes the Reverse Logistics System for Plastic Packaging, prioritizes cooperatives and defines mandatory recovery and post-consumer recycled content (PCR) targets, starting at 22% in 2026 for large companies, with an expected evolution until 2040 (BRASIL, 2025; MARTINELLI ADVOGADOS, 2025). Also in 2026, SINIR+ opened related technical public consultations (SINIR+, 2026).

2.3 CONVERGENCES

Both regimes require design for recycling, document traceability, and integration with the collection and sorting infrastructure. The EU is moving towards recyclability performance grids and possible eco-modulation of rates, while Brazil imposes annual compliance with targets and proof via management entities (EUROPEAN COMMISSION, 2025; BRAZIL, 2025).

3 CELLULOSIC MATERIALS IN THE COMPLIANCE STRATEGY

3.1 RECYCLABILITY AND CIRCULARITY

Paperboard and corrugated cardboard, when specified as mono-material and without contaminants, are widely compatible with existing recycling streams, favoring compliance with the economic recyclability provided for in the PPWR (EUROPEAN COMMISSION,

2025). Manufacturers report additional benefits in mass optimization, logistical damage reduction, and renewable source communication (STORA ENSO, 2026).

3.2 FSC CHAIN OF CUSTODY

FSC certification (chain of custody) enables auditable traceability of the fiber from forest management to the final product, allowing robust claims on responsible origin and use of brands, which reduces greenwashing risks and meets due diligence expectations (FSC, 2026).

3.3 DESIGN BOUNDARIES AND CAUTIONS

Non-repulpable laminates, inks and incompatible adhesives can compromise the recyclability of the paper. The PPWR provides design criteria for recycling and performance grades that can penalize solutions with low recoverability (ERP GLOBAL, 2025).

4 CRITICAL COMPARISON: WHY CORRUGATED CARDBOARD REDUCES REGULATORY RISKS

- Adherence to 2030 (EU) recyclability: compatibility with existing streams, helping to meet recyclability criteria (EUROPEAN COMMISSION, 2025).
- Traceability from renewable sources: chain of custody (FSC) certifications provide documentary backing for responsible procurement (FSC, 2026).
- Substitution of problematic plastics: when technically feasible, cellulose-based materials avoid PCR targets applicable to plastics in Brazil and simplify evidence (BRASIL, 2025).
- Compliance and reputation costs: materials with high recyclability tend to reduce fees and image risks in EPR and regulatory harmonization regimes (EUROPEAN COMMISSION, 2025).

5 BUSINESS AND ENGINEERING IMPLICATIONS

- Specification governance: positive lists of inputs compatible with paper recycling and internal DfR criteria aligned with PPWR (ERP GLOBAL, 2025).
- Certified supply chain: require FSC CoC from converters, with records of claims and audits (FSC, 2026).
- LCA and data: LCA-supported decisions and primary supplier data on mass, avoided damage, and logistics (STORA ENSO, 2026).
- Integration with LR (Brazil): for lines that maintain polymers, plan PCR and proofs for targets in 2026 and beyond (BRASIL, 2025).

6 FINAL CONSIDERATIONS

The convergence between PPWR and Brazilian Decree No. 12,688/2025 reinforces the centrality of verifiable circularity as a criterion for competitiveness. In scenarios where function allows, paperboard and corrugated paper designed for recycling and with certified chain of custody tend to offer the most robust combination of regulatory compliance, performance and ESG storytelling; when not, polymeric solutions compatible with PCR and recycling at scale should be prioritized.

REFERENCES

- Brasil. (2025). Decreto nº 12.688, de 21 de outubro de 2025. Institui o Sistema de Logística Reversa de Embalagens de Plástico. Disponível em: https://www.planalto.gov.br/ccivil_03/_Ato2023-2026/2025/Decreto/D12688.htm. Acesso em: 12 mar. 2026.
- European Commission. (2025). Packaging waste – Environment. Disponível em: https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste_en. Acesso em: 12 mar. 2026.
- ERP Global. (2025). PPWR – Packaging and Packaging Waste Regulation (overview e cronograma). Disponível em: <https://erp-recycling.org/wp-content/uploads/2025/05/PPWR-Packaging-and-Packaging-Waste-Regulation-EN-final.pdf>. Acesso em: 12 mar. 2026.
- FSC – Forest Stewardship Council. (2026). Chain of custody certification. Disponível em: <https://fsc.org/en/chain-of-custody>. Acesso em: 12 mar. 2026.
- Martinelli Advogados. (2025, outubro 24). Novo marco regulatório para logística reversa de embalagens plásticas no Brasil. Disponível em: <https://www.martinelli.adv.br/novo-marco-regulatorio-para-logistica-reversa-de-embalagens-plasticas-no-brasil/>. Acesso em: 12 mar. 2026.
- Packaginglaw.com. (2025, janeiro 23). The new EU packaging and packaging waste regulation – Highlights and challenges ahead. Disponível em: <https://www.packaginglaw.com/special-focus/new-eu-packaging-and-packaging-waste-regulation-highlights-and-challenges-ahead>. Acesso em: 12 mar. 2026.
- SINIR+. (2026). Sistema nacional de informações sobre a gestão de resíduos sólidos – Consultas públicas e orientações. Disponível em: <https://sinir.gov.br/>. Acesso em: 12 mar. 2026.
- União Europeia. (2025). Regulamento (UE) 2025/40 do Parlamento Europeu e do Conselho, de 19 de dezembro de 2024, relativo a embalagens e resíduos de embalagens (PPWR). EUR-Lex, 22 jan. 2025. Disponível em: <https://eur-lex.europa.eu/eli/reg/2025/40/oj/eng>. Acesso em: 12 mar. 2026.

Stora Enso. (2026). Sustainability expertise for corrugated packaging solutions. Disponível em: <https://www.storaenso.com/en/products/corrugated-packaging-solutions/sustainability>. Acesso em: 12 mar. 2026.

MIGRATION AND TERRITORIAL DYNAMICS IN BORDER REGIONS: CULTURE, REGIONAL DEVELOPMENT, AND PUBLIC POLICIES

MIGRAÇÃO E DINÂMICAS TERRITORIAIS EM REGIÕES DE FRONTEIRA: CULTURA, DESENVOLVIMENTO REGIONAL E POLÍTICAS PÚBLICAS

MIGRACIÓN Y DINÁMICA TERRITORIAL EN LAS REGIONES FRONTERIZAS: CULTURA, DESARROLLO REGIONAL Y POLÍTICAS PÚBLICAS



<https://doi.org/10.56238/sevened2026.008-214>

Rosalina Alves Nantes¹, Rosemeire Ferrarezi Valiante²

ABSTRACT

This article examines the theoretical contributions that connect migration, border, culture, regional development and public policy, with emphasis on the territorial dynamics produced in border regions. The study adopts a qualitative bibliographic approach based on the analytical reading of classic and contemporary works in sociology, geography, political science and development studies. The central argument is that migratory flows cannot be understood in isolation, since they are linked to the social production of territory, the negotiation of identities, the circulation of cultural practices and the institutional strategies of regulation and planning. By reviewing authors such as Sayad, Castles and Miller, Portes, Raffestin, Foucher, Grimson, Haesbaert, Boisier, Sen, Perroux and Furtado, the text shows that the border goes beyond a geopolitical limit and becomes a relational space marked by mobility, cooperation, conflict and the recomposition of belonging. The discussion also highlights that regional development, when approached from a territorial perspective, requires public policies that are sensitive to the sociocultural specificities of border spaces. It concludes that an interdisciplinary approach broadens the analytical capacity of migration studies and provides stronger foundations for understanding inequality, interdependence and development possibilities in border contexts.

Keywords: Migration. Border. Territoriality. Regional Development. Public Policy.

RESUMO

Este artigo analisa as contribuições teóricas que articulam migração, fronteira, cultura, desenvolvimento regional e políticas públicas, com ênfase nas dinâmicas territoriais produzidas em regiões fronteiriças. A pesquisa é de natureza qualitativa e bibliográfica, baseada na leitura analítica de obras clássicas e contemporâneas da sociologia, da geografia, da ciência política e dos estudos do desenvolvimento. O argumento central sustenta que os fluxos migratórios não podem ser compreendidos de forma isolada, porque se vinculam à produção social do território, à negociação de identidades, à circulação de

¹ Dr. in Regional Development and Environment. Universidade Federal de Rondônia (UNIR).

E-mail: rnantes@unir.br Orcid: <https://orcid.org/0000-0001-8347-7856>

Lattes: <https://lattes.cnpq.br/9798065739676651>

² Doctoral student in Regional Development and Environment. Universidade Federal de Rondônia (UNIR).

E-mail: rosevaliante@unir.br Lattes: <https://lattes.cnpq.br/8931538056779528>

práticas culturais e às estratégias institucionais de regulação e planejamento. Ao revisar autores como Sayad, Castles e Miller, Portes, Raffestin, Foucher, Grimson, Haesbaert, Boisier, Sen, Perroux e Furtado, o texto demonstra que a fronteira ultrapassa a condição de limite geopolítico e se afirma como espaço relacional, marcado por mobilidade, cooperação, conflito e recomposição de pertencimentos. A discussão também evidencia que o desenvolvimento regional, quando pensado a partir do território, requer políticas públicas sensíveis às especificidades socioculturais dos espaços de fronteira. Conclui-se que a abordagem interdisciplinar amplia a capacidade analítica do estudo da migração e oferece bases mais consistentes para a compreensão das desigualdades, das interdependências e das possibilidades de desenvolvimento em contextos fronteiriços.

Palavras-chave: Migração. Fronteira. Territorialidade. Desenvolvimento Regional. Políticas Públicas.

RESUMEN

Este artículo analiza las contribuciones teóricas que articulan migración, fronteras, cultura, desarrollo regional y políticas públicas, con énfasis en las dinámicas territoriales que se producen en las regiones fronterizas. La investigación es de naturaleza cualitativa y bibliográfica, basada en una lectura analítica de obras clásicas y contemporáneas de sociología, geografía, ciencia política y estudios del desarrollo. El argumento central sostiene que los flujos migratorios no pueden entenderse de forma aislada, ya que están vinculados a la producción social del territorio, la negociación de identidades, la circulación de prácticas culturales y las estrategias institucionales de regulación y planificación. Mediante la revisión de autores como Sayad, Castles y Miller, Portes, Raffestin, Foucher, Grimson, Haesbaert, Boisier, Sen, Perroux y Furtado, el texto demuestra que la frontera trasciende la condición de límite geopolítico y se afirma como un espacio relacional, marcado por la movilidad, la cooperación, el conflicto y la recomposición de la pertenencia. El análisis también subraya que el desarrollo regional, concebido desde la perspectiva del territorio, requiere políticas públicas sensibles a las especificidades socioculturales de las zonas fronterizas. Se concluye que el enfoque interdisciplinario amplía la capacidad analítica de los estudios sobre migración y ofrece una base más sólida para comprender las desigualdades, las interdependencias y las posibilidades de desarrollo en contextos fronterizos.

Palabras clave: Migración. Frontera. Territorialidad. Desarrollo Regional. Políticas Públicas.

1 INTRODUCTION

Migratory processes occupy a central place in contemporary social sciences, especially when examined in territories crossed by intense circulation of people, goods, norms and symbols. In border regions, migration cannot be reduced to the simple displacement of individuals between different political units. It involves labor relations, family networks, disputes for recognition, cultural negotiations, and state control mechanisms that, together, reconfigure the social space.

The analytical relevance of borders stems from the fact that these territories condense different scales of interaction. In them, macroeconomic and national political decisions coexist with daily practices of mobility, commerce, kinship, and belonging. For this reason, the study of migration in border contexts requires an interdisciplinary approach, capable of articulating contributions from sociology, geography, anthropology, regional economics and political science.

From this perspective, migration is understood as a complex historical and social phenomenon. It is not just an individual response to economic incentives, but a process shaped by structural inequalities, collective trajectories, social networks, and institutions. At the same time, the border is no longer seen only as a line of separation between States and is now understood as a relational space, in which territorialities, identities and development strategies are produced.

The objective of this article is to analyze, in a bibliographic key, the theoretical contributions that articulate migration, border, culture, regional development and public policies. It seeks to demonstrate that the understanding of border dynamics depends on the integrated reading of these fields, as migratory flows alter the organization of the territory, tension identity categories and demand specific institutional responses. As a research problem, it is asked how social relations in border regions develop when human mobility, territoriality, regional development and public action are simultaneously considered.

In addition to this introduction, the text presents the methodology used, discusses the main theoretical contributions on migration, border, culture and regional development, examines the implications of these perspectives for public policies and, finally, synthesizes the analytical contributions of the study. The review was restructured to reduce conceptual repetition, strengthen argumentative cohesion, and adapt the writing to the academic standard expected in scientific journals.

2 METHODOLOGY

The research is characterized as qualitative, bibliographic in nature and with analytical-interpretative purpose. The corpus was composed of books and reference articles in the fields of migration studies, political geography, culture, regional development and public policies. Priority was given to classic and contemporary works that offer consolidated categories to interpret human mobility, borders, territoriality, cultural identities and territorial planning.

The literature review was organized into three complementary procedures. The first consisted of the selection of authors with recognized theoretical relevance to the theme, such as Sayad, Castles and Miller, Portes, Raffestin, Foucher, Grimson, Haesbaert, Boisier, Sen, Perroux and Furtado. The second involved the analytical reading of the works, with the identification of central concepts, convergences, tensions and possibilities of interdisciplinary articulation. The third corresponded to interpretative systematization, focusing on the construction of an analytical axis capable of relating migration, border, culture, regional development and public policies.

From the methodological point of view, the review did not seek to exhaust all the available production on the subject, but to select consistent contributions to the construction of an integrated theoretical framework. The inclusion criterion favored texts that explain migratory processes beyond economism, define the border as a social and political category, problematize culture in contexts of mobility and treat regional development as a territorially situated process.

The analysis of the material was based on comparative and interpretative reading. Instead of presenting authors in isolation, we sought to highlight how their formulations complement or oppose each other. This procedure allows us to understand that migration in border regions should be read as a multidimensional phenomenon, whose explanation requires dialogue between economic structures, sociocultural practices, social networks and forms of state regulation.

3 MIGRATION, BORDER AND CULTURE: THEORETICAL BASES OF ANALYSIS

In the field of migration studies, Abdelmalek Sayad occupies a central position by demonstrating that migration cannot be reduced to statistics of entry and exit or to strictly individual choices. For the author, it is a total social fact, that is, a process that simultaneously mobilizes economic, political, legal, symbolic and affective dimensions. Its formulation shifts the analysis of the migrant as a labor force to the social condition produced by emigration and immigration. By insisting that all immigration refers to emigration, Sayad shows that the

phenomenon must be understood from the historical relations between the society of origin and the society of destination.

This reading broadens the understanding of the effects of migration on forms of belonging. The migrant does not completely abandon the social universe of origin nor does he integrate fully and immediately into the new space. On the contrary, their experience is marked by ambivalence, disengagement, and continuous negotiation. In analytical terms, this perspective is decisive for border contexts, in which the daily circulation between territories tends to intensify multiple bonds, overlapping loyalties, and complex forms of social insertion.

Stephen Castles and Mark J. Miller contribute to this discussion by situating migrations on the scale of globalization. In his approach, the contemporary intensification of displacements stems from economic, political, and technological transformations that increase the interdependence between regions. The authors demonstrate that migratory flows have diversified, feminized, politicized and come to involve countries of origin, transit and destination simultaneously. Such a perspective allows us to understand that migration is constitutive of the global order, and not an exceptional or residual phenomenon.

Alejandro Portes' contribution complements this picture by highlighting the role of migratory networks. By emphasizing family, community, and economic ties that connect migrants, former migrants, and non-migrants, the author shows how mobility tends to acquire social continuity. Networks reduce costs, share information, enable occupational insertion and create solidarity mechanisms. In border spaces, this logic is particularly relevant, as territorial proximity favors lasting relationships, commercial circuits, and circulation strategies that do not end with the formal passage through a checkpoint.

An important consequence of this approach is the overcoming of readings that rigidly separate economic causes and cultural effects of migration. When displacement is seen only as a rational decision oriented by income, there is a tendency to make invisible the way in which the labor market itself is structured by state policies, ethnic hierarchies, community networks and social representations of the foreigner. The literature reviewed suggests, on the contrary, that the economic insertion of the migrant is already mediated by cultural and territorial markers.

Also for this reason, the border should not be treated only as an object of geopolitics, but as a category of experience. The crossing can take on very different meanings depending on the mobility regime, the subject's social profile, the available documentation, the language, the gender, the occupational position and the density of social networks on both sides of the state boundary. In many situations, the social distance between groups that share the same

border territory is greater than the physical distance that separates them. This observation helps to understand why cooperation and conflict coexist in the same spaces.

In border territories, everyday life tends to produce specific forms of social pragmatism. Families distribute their members among different cities, workers build commuting routines, merchants organize informal and formal supply circuits, students cross the international line to access services and opportunities. These movements do not nullify the presence of the state, but show that social life often operates through arrangements that combine legality, custom, and practical adaptation to the conditions of the territory.

From a cultural point of view, the border offers particularly favorable conditions for the observation of situational identities. Subjects can activate national, local, ethnic, linguistic or religious belongings according to the circumstance. This plasticity does not mean the absence of identity, but the permanent reorganization of repertoires. Hall helps to understand this process by rejecting the idea of cultural essence, while Canclini demonstrates that social practices in contact contexts produce combinations that cannot be described in terms of purity or simple assimilation.

If migration needs to be understood as an expanded social process, the same is true for the border. Claude Raffestin proposes a relational reading of territory, understood as the result of mediations and power relations. In this key, the border is not a simple natural datum or neutral cartographic layout; it expresses political operations of delimitation, control and organization of space. Michel Foucher, in turn, deepens the geopolitical dimension of state borders by emphasizing their strategic function in the affirmation of sovereignty, in the production of national identities and in the management of differences.

The articulation between Raffestin and Foucher allows us to distinguish two complementary movements. On the one hand, the border is a political institution, associated with state authority, legal regulation, and territorial surveillance. On the other hand, it is socially constructed and continuously reinterpreted by the subjects who cross it. For this reason, border regions cannot be defined only by state norms; It is necessary to observe the practices that are developed in them, the circuits of circulation and the social uses of space.

Alejandro Grimson reinforces this inflection by treating the border as a complex social and cultural space. His approach is particularly relevant to Latin America, where international lines coexist with historical neighborhood relations, economic exchange, bilingualism, kinship, and daily circulation. The border, in this sense, does not only separate; it also connects, mixes, and produces contact situations in which identities are negotiated. The author draws attention to the fact that the border experience combines asymmetries of power with dense forms of interaction.

This perspective converges with Rogério Haesbaert's notion of multiterritoriality. Instead of supposing that mobility dissolves territorial bonds, the author shows that subjects and groups can maintain simultaneous insertions in different scales and spaces. The migrant can work on one side of the border, reside on another, preserve family ties in a third place, and participate in transnational symbolic circuits. Territoriality thus becomes plural and procedural. This category is especially fruitful for interpreting regions in which social life is organized by multiple belongings and recurrent mobility.

On the cultural level, Stuart Hall contributes by understanding identities as historical, relational and discursive constructions, and not as fixed essences. Migration, in this context, does not cause a mere loss of identity, but processes of repositioning and reinterpreting belongings. Néstor García Canclini expands this discussion with the notion of cultural hybridization, which allows us to understand how practices, codes, and references recombine in situations of unequal contact. In border regions, the coexistence of different national norms, languages, markets and traditions produces hybrid repertoires and specific forms of sociability.

The notion of diaspora, systematized by William Safran, also illuminates the relationship between migration and culture by highlighting the permanence of symbolic links with the land of origin, even after spatial dispersion. Although later literature expanded and criticized its model, the category remains useful for thinking about collective memories, transnational networks, and identities sustained by origin narratives. In summary, cultural and migratory studies converge by showing that mobility and border do not eliminate belonging; they reorganize it on multiple bases, often tense, but socially productive.

This debate is close to Homi Bhabha's formulations about the in-betweens of culture. Although his work is not specifically dedicated to international borders, it contributes to thinking about spaces of enunciation in which difference is produced by translation, negotiation and ambivalence. In migratory contexts, such a contribution allows us to understand that culture does not remain intact, but neither does it disappear. It is re-inscribed in new relations of power and communication.

For this reason, the category of territoriality cannot be dissociated from symbolic processes. The territory is appropriated materially, but also narrated, remembered and represented. Migrants construct affective maps of space, define places of safety and risk, attribute meanings to institutions and create circuits of sociability. In border regions, these maps tend to cross formal national boundaries, composing a vivid geography that often does not coincide with state cartography.

Another relevant point is that cross-border circulation can intensify both integration and stigmatization. If, on the one hand, spatial proximity favors economic exchanges, kinship and cultural familiarity, on the other hand, it can produce discourses that associate certain groups with illegality, unfair competition or threat to public order. The literature on migration shows that control policies often operate by selective classifications, differentiating legitimate and illegitimate mobilities according to economic, racial and national criteria.

In summary, the theoretical basis discussed in this section allows us to understand that migration, border and culture form an inseparable analytical triangle. Mobility transforms the territory; the territory conditions the experience of mobility; and culture mediates the meanings attributed to this process. Any analysis that intends to interpret border regions rigorously must therefore simultaneously consider these three dimensions.

4 REGIONAL DEVELOPMENT AND PUBLIC POLICIES IN BORDER CONTEXTS

In the field of regional development, classical approaches show that the economic space is marked by persistent inequalities. François Perroux, when formulating the theory of growth poles, demonstrates that economic expansion tends to be concentrated in activities and places capable of radiating effects on other productive units. Celso Furtado, in turn, shows that development is not to be confused with simple growth of the product, as it depends on structural transformations and the overcoming of historical patterns of dependence and underdevelopment. These contributions remain relevant for the analysis of border regions, in which investments, infrastructure, and trade flows tend to produce uneven effects between neighboring locations.

Contemporary formulations expand this discussion by incorporating territorial, institutional and social dimensions. Sergio Boisier understands territorial development as a process built by the capacity for coordination between actors, by the mobilization of endogenous resources and by the formation of synergistic capital. From this perspective, the territory is not a mere physical support of the economy, but a space for collective action. Michael Storper and Georges Benko, in different ways, reinforce the idea that regional dynamics depend on articulations between the productive base, institutions, networks and knowledge.

Amartya Sen's approach adds a substantive criterion to the debate by defining development as the expansion of freedoms. Centrality no longer falls exclusively on economic indicators and starts to include effective capacities for social participation, access to rights, education, health, security, and mobility. Applied to border regions, this reading suggests that development should be evaluated based on the concrete opportunities available to

populations that live with intense circulation, institutional asymmetries and frequent precariousness in the provision of public services.

When articulated with migration studies, these perspectives show that migration is not only a consequence of uneven development, but also an element that reconfigures regional economies. Migrants expand markets, produce trade networks, introduce cultural repertoires, redistribute labor force and change patterns of consumption and occupation of the territory. At the same time, they may face document barriers, discrimination, labor segmentation, and unequal access to social policies. For this reason, the relationship between migration and regional development is ambivalent: it contains dynamic potential, but it also reveals and reproduces inequalities.

Celso Furtado's reading is particularly useful to avoid linear interpretations of development. By drawing attention to historical structures of dependence, productive heterogeneity and concentration of income, the author shows that the territory does not respond homogeneously to economic stimuli. In border areas, this warning is fundamental, because proximity to another country does not guarantee, by itself, virtuous integration or equitable distribution of the benefits generated by circulation.

Similarly, the idea of the growth pole in Perroux needs to be read critically when applied to frontier contexts. Certain cities can concentrate services, credit, logistics infrastructure and business opportunities, radiating dynamism to their surroundings. However, polarization can also deepen dependencies and empty neighboring localities. Regional development, in this context, requires coordination mechanisms capable of distributing capacities and preventing spatial asymmetries from becoming lasting exclusion.

Boisier adds to this debate a decisive emphasis on territorial governance. Development is no longer conceived as an automatic effect of the market or exogenous investment and starts to depend on the articulation between public, private and collective actors. In border regions, this means recognizing that municipalities, national bodies, community entities and even institutions from the neighboring country can participate, formally or informally, in the management of common problems. Cooperation, in this case, is not only desirable; it is usually a condition of effectiveness.

Sen's approach to capabilities further broadens the normative horizon of the analysis. By shifting attention to what people are actually capable of doing and being, the author offers a valuable criterion for evaluating policies in border territories. It is not enough to register growth in trade or increase in the flow of goods; It is necessary to verify whether the local population has real means to access education, health, income, legal protection and social participation in dignified conditions.

Public policies assume, in this scenario, a decisive role. In border regions, state planning needs to consider that the population served does not always coincide with the formal limits of national citizenship. Health, education, assistance, security, document regularization, urban mobility and economic inspection services are strained by continuous cross-border flows. Public management thus faces the challenge of reconciling sovereignty, rights, inter-institutional cooperation and local specificities.

This finding requires abandoning policies formulated from homogeneous models of territory. Borders are spaces in which social life often goes beyond the traditional administrative cut. The presence of transnational families, commuting workers, circulating students, and informal commercial networks demands flexible instruments, coordination between scales of government, and cooperation mechanisms with entities located on the other side of the international line. Without this recognition, state action tends to produce gaps in care and low effectiveness.

In addition, public policies aimed at regional development need to incorporate the cultural dimension of the border. Actions that ignore linguistic repertoires, local forms of sociability, historically consolidated economic practices, and specific migratory experiences tend to fail to implement. The recognition of cultural diversity is not ancillary; it conditions the ability to formulate legitimate policies, adhering to the territory and guided by social inclusion.

In analytical terms, the border can be understood as a privileged laboratory for observing the relationship between State, territory and mobility. In these contexts, the formulation of public policies clearly reveals the tensions between control and shelter, social protection and surveillance, economic development and the reproduction of inequalities. Therefore, the reviewed literature suggests that planning in border regions should combine fine territorial reading, attention to migratory social networks, and commitment to rights.

In many border areas, the provision of public services is crossed by administrative ambiguities. People living in constant circulation may depend on equipment located in another jurisdiction, while local governments face difficulties in planning policies based on fluctuating populations. This affects the production of statistics, the financing of policies, and the definition of institutional responsibilities. The reviewed literature suggests that such problems are not marginal, but structural for territorial management.

Migration policies, social policies and regional development policies should not, therefore, be formulated in isolation. Document regularization influences access to work and social protection; the design of the infrastructure affects commercial circuits and everyday mobility; cultural and educational programs can favor integration and reduce conflicts; Intergovernmental cooperation mechanisms expand the capacity to respond to shared

demands. In frontier contexts, institutional fragmentation tends to generate inefficiency and deepen vulnerabilities.

There is also a symbolic dimension of public policy that deserves attention. By naming certain groups as a problem, risk or threat, the State produces classification effects that impact social trajectories and belongings. On the other hand, policies that recognize cultural plurality and the legitimacy of mobilities can favor inclusion, institutional trust and civic participation. The quality of public action depends, therefore, not only on material resources, but also on the categories through which the territory and its population are understood.

In a propositional key, the literature examined points to the need for territorialized policies. This means formulating actions based on localized diagnoses, attentive to the concrete flows of people, to the effective economic circuits and to the cultural forms that organize daily life. The frontier demands situated planning, capable of combining multi-scale coordination, production of qualified information, institutional strengthening and social participation. Without this, public intervention runs the risk of reproducing abstractions that have little dialogue with lived reality.

5 ANALYTICAL ARTICULATION OF REFERENCES

The integrated reading of the authors examined allows us to sustain four central propositions. The first is that migration must be treated as a structural and relational process. Sayad, Castles, and Miller and Portes show, through different paths, that population displacements result from inequalities, state policies, social networks, and global transformations. This combination prevents simplified explanations and reaffirms the need for interdisciplinary approaches.

The second proposition is that the border does not operate only as a geopolitical limit. Raffestin, Foucher, Grimson and Haesbaert show that the border space condenses power, circulation, territorialization and multiple belongings. In this sense, the border is not a neutral scenario for migration; it actively participates in the production of the social, economic and cultural dynamics it intends to regulate.

The third proposition is that culture cannot be treated as a residual variable. Hall, Canclini and Safran allow us to understand that mobility and territorial contact produce procedural identities, hybrid forms of belonging and lasting transnational bonds. In border regions, culture organizes daily practices, mediates conflicts, guides economic strategies and influences the institutional reception of migrant groups.

The fourth proposition is that regional development, when thought of in a territorial key, depends on the articulation between economy, institutions, rights and recognition of

sociocultural diversity. Perroux, Furtado, Boisier and Sen converge in the criticism of the reduction of development to economic growth and reinforce that the territory must be considered in its materiality, in its institutional density and in its capacity to produce inclusion.

These four propositions, when put together, offer a robust theoretical basis for empirical studies on border regions. They allow us to examine both the economic and social insertion of migrant groups and the ways in which public policies can respond to contexts of intense mobility. More than listing authors, the review demonstrates that the articulation between migration, border, culture, and regional development produces a coherent interpretative field to analyze territories marked by interdependence, inequality, and social innovation.

The articulation proposed in this article also helps to reposition the very notion of region. Far from designating only a delimited portion of space, the region appears as the result of interactions, flows and institutions. In frontier areas, this definition becomes even more evident, as regional life is often organized by cross-cutting connections that cross the international line and defy rigid administrative classifications.

Another analytical gain is to recognize that mobility does not necessarily represent territorial disorganization. Although public discourses often associate circulation with lack of control, the literature shows that migrants build relatively stable patterns of displacement, work, residence, and sociability. Migratory networks and multiple territorialities produce their own forms of ordering, although not always recognized by the state apparatus. The problem, in this case, is not the absence of order, but the coexistence of distinct orders.

This observation is important for future empirical research because it guides the choice of indicators and categories of analysis. Instead of measuring only formal inputs and outputs or aggregate volumes of trade, it is necessary to observe daily practices of circulation, differential access to rights, density of social networks, cultural repertoires in interaction, and local institutional capacity. Theory, in this sense, does not only work as an interpretative framework, but as a tool to define what should be observed in the territory.

Finally, the integration between the references examined allows us to overcome frequent dichotomies in the public debate: legal/illegal, national/foreign, center/periphery, tradition/modernity, growth/development. Such oppositions, when taken rigidly, obscure the complexity of border experiences. The literature reviewed here indicates that the relevant social phenomena occur precisely in the zones of contact, mediation, and overlap. It is in this analytical space that the frontier reveals its greatest explanatory power.

Although the bibliographic focus of this article is predominantly theoretical, it has direct implications for the reading of concrete situations in twin cities, migratory corridors and areas

of cross-border integration. In such contexts, the territory usually operates simultaneously as a space of opportunity and restriction. The proximity between markets, services and family networks can facilitate social reproduction; However, the difference between legislation, state capacities and citizenship regimes also creates areas of uncertainty. The theory helps to interpret this ambivalence without reducing it to an anomaly.

In many cases, the border experience produces a temporality of its own. Daily life is organized by customs opening hours, exchange rate variations, different school calendars, asymmetric health policies, and frequent changes in the intensity of inspection. These elements interfere in the economic and family life of the local populations. The border, therefore, does not act only on space; it regulates social times, rhythms of circulation and expectations of permanence or return.

This temporal dimension reinforces the importance of social networks. In scenarios of regulatory instability, they are often the ones who guarantee reliable information, logistical support, and adaptation mechanisms. The analytical value of the concept of migratory network lies precisely in showing that individual action is mediated by relational structures. The decision to migrate, stay, circulate, or return does not stem solely from economic calculation, but from shared expectations, reciprocal obligations, and collectively constructed repertoires of trust.

The urban dimension of the border regions is also noteworthy. Many migratory dynamics materialize in specific neighborhoods, commercial centers, popular markets, religious spaces, associations and public facilities. The border territory is not just an abstract extension; It is expressed in concrete urban forms, often marked by segregation, centralization of services and differentiated appropriations of space. The territorial reading of regional development needs to incorporate these intra-urban cuts, as it is in them that inequalities and institutional capacities become visible.

From a cultural point of view, border circulation can favor bilingualism, hybrid food repertoires, shared festivals, juxtaposed religious calendars, and new forms of symbolic consumption. Such processes do not cancel conflicts; on the contrary, they often coexist with moral disputes, prejudices and national or ethnic hierarchies. Culture, therefore, should be understood less as a static stock of traditions and more as a field for negotiation, classification and production of social legitimacy.

The literature on regional development also suggests that territorial competitiveness cannot be analyzed without considering social cohesion and institutional density. Territories that have cooperative networks, administrative capacity, information production and coordination mechanisms tend to respond better to external shocks and turn circulation into

opportunity. In border areas, this observation is even more relevant, because exchange rate volatility, regulatory changes, and political crises can rapidly alter mobility and trade patterns.

When the relationship between migration and public policies is observed from this perspective, it becomes evident that the challenge is not only to expand the supply of services, but to design institutional arrangements compatible with populations on the move. Registration, financing, planning, and evaluation are often based on stable residents and clearly defined jurisdictions. However, the border produces situations in which the daily use of services goes beyond these categories. Territorial governance therefore needs to develop instruments that are more sensitive to circulation and interdependence.

Ultimately, the contribution of this review lies in demonstrating that the analysis of border regions gains density when migration, culture, territory, development and public policies are treated as mutually constitutive dimensions. This formulation does not eliminate the need for specific empirical approaches, but it offers criteria for constructing them in a more rigorous way. By shifting the debate from partial explanations to an integrated framework, the article seeks to strengthen the conceptual basis of future research and expand the dialogue between different fields of knowledge.

6 FINAL CONSIDERATIONS

The literature review shows that migratory processes, when observed in border regions, require reading that goes beyond sectoral or monocausal approaches. Migration proved to be inseparable from power relations, social networks, identity negotiations, production of territory and state action. Thus, human mobility cannot be treated only as physical displacement or the border as a simple line of separation between sovereignties.

The analysis also showed that the border is a relational space, in which control, circulation, cooperation and conflict coexist. In these territories, identities are continuously redefined, territorialities become multiple, and regional development depends on institutional capacities capable of recognizing the complexity of local social life. The literature examined thus reinforces that the border territory is not an analytical periphery, but a privileged place to understand contemporary transformations.

In terms of regional development, it was found that approaches focused only on economic growth are insufficient to interpret contexts marked by institutional asymmetries and intense population mobility. Development, understood as structural transformation, territorial coordination and expansion of freedoms, requires public policies that are sensitive to the concrete social circuits of the border. This includes attention to rights, access to services, cooperation across government scales, and recognition of cultural diversity.

It is concluded, therefore, that the articulation between migration, border, culture, regional development and public policies constitutes a consistent theoretical axis for the analysis of border regions. By reducing conceptual repetitions and reorganizing the argument, this version of the text reinforces the study's contribution to the interdisciplinary debate and offers a more cohesive basis for future empirical investigations on migrant territorialities, governance, and development in border spaces.

REFERENCES

- Benko, G. (1996). *Geografia econômica mundial*. São Paulo: Hucitec.
- Bhabha, H. K. (1994). *The location of culture*. London: Routledge.
- Boisier, S. (1999). El desarrollo territorial a partir de la construcción de capital sinérgico. *Revista CEPAL*, 69, 105–121.
- Brandão, C. A. (2012). *Território e desenvolvimento: As múltiplas escalas entre o local e o global*. Campinas: Editora da Unicamp.
- Canclini, N. G. (1997). *Culturas híbridas: Estratégias para entrar e sair da modernidade*. São Paulo: EDUSP.
- Castles, S., & Miller, M. J. (2009). *The age of migration: International population movements in the modern world* (4. ed.). London: Macmillan.
- Evans, P. (2002). Collective capabilities, culture, and Amartya Sen's development as freedom. *Studies in Comparative International Development*, 37(2), 54–60.
- Foucher, M. (1988). *Fronts et frontières: Un tour du monde géopolitique*. Paris: Fayard.
- Furtado, C. (1961). *Desenvolvimento e subdesenvolvimento*. Rio de Janeiro: Fundo de Cultura.
- Furtado, C. (1959). *Formação econômica do Brasil*. Rio de Janeiro: Fundo de Cultura.
- Grimson, A. (2011). *Los límites de la cultura: Crítica de las teorías de la identidad*. Buenos Aires: Siglo XXI Editores.
- Haesbaert, R. (2004). *O mito da desterritorialização: Do “fim dos territórios” à multiterritorialidade*. Rio de Janeiro: Bertrand Brasil.
- Hall, S. (2003). *A identidade cultural na pós-modernidade* (8. ed.). Rio de Janeiro: DP&A.
- Perroux, F. (1961). *L'économie du XXe siècle*. Paris: Presses Universitaires de France.
- Perroux, F. (1955). Note sur la notion de pôle de croissance. *Économie appliquée*, 8, 307–320.
- Portes, A. (Ed.). (1995). *The economic sociology of immigration: Essays on networks, ethnicity, and entrepreneurship*. New York: Russell Sage Foundation.

- Portes, A. (1995). Economic sociology and the sociology of immigration: A conceptual overview. In A. Portes (Ed.), *The economic sociology of immigration: Essays on networks, ethnicity, and entrepreneurship* (pp. 1–41). New York: Russell Sage Foundation.
- Raffestin, C. (1980). *Pour une géographie du pouvoir*. Paris: Librairies Techniques.
- Safran, W. (1991). Diasporas in modern societies: Myths of homeland and return. *Diaspora: A Journal of Transnational Studies*, 1(1), 83–99.
- Sayad, A. (1998). *A imigração ou os paradoxos da alteridade*. São Paulo: EDUSP.
- Sayad, A. (1999). *La double absence: Des illusions de l'émigré aux souffrances de l'immigré*. Paris: Seuil.
- Sen, A. (2000). *Desenvolvimento como liberdade*. São Paulo: Companhia das Letras.
- Storper, M. (1997). *The regional world: Territorial development in a global economy*. New York: Guilford Press.

BETWEEN SIMPLICITY AND TECHNICAL DIFFICULTIES: PERCEPTIONS OF TECHNOLOGIES FOR MONITORING PUBLIC CONTRACT MANAGEMENT

ENTRE A SIMPLICIDADE E AS DIFICULDADES TÉCNICAS: PERCEPÇÕES SOBRE TECNOLOGIAS DE MONITORAMENTO DE GESTÃO DE CONTRATOS PÚBLICOS

ENTRE LA SIMPLICIDAD Y LAS DIFICULTADES TÉCNICAS: PERCEPCIONES SOBRE TECNOLOGÍAS DE MONITOREO DE LA GESTIÓN DE CONTRATOS PÚBLICOS



<https://doi.org/10.56238/sevened2026.008-215>

Carla Sabrina dos Santos Souza, Reinaldo Azevedo Barbosa, Roberto Miranda Pimentel Fully

ABSTRACT

The study analyzed the perceptions of assistants and monitors regarding the usability of digital technologies applied to the monitoring of public contract management within the Ministry of Development and Social Assistance, Family and Fight Against Hunger (MDS) and the Department of Support and Shelter Entities Working with Alcohol and Drugs (DEPAD). The research employed statistical textual analysis using the IRaMuTeQ software, processing a corpus composed of 46 respondents and 148 context units, totaling 5,000 lexical occurrences. The results confirmed that the simplicity and clarity of KoboToolbox fostered positive usability perceptions, whereas technical failures of uMov.me generated dissatisfaction and compromised effectiveness. Furthermore, the analysis revealed differences between profiles: assistants prioritized subjective evaluations, while monitors emphasized technical and institutional aspects, validating the four proposed hypotheses. It is concluded that technological adoption in public contract monitoring depends on the interaction between design factors, technical performance, and functional profile, requiring differentiated training and investments in platform stability.

Keywords: Usability. Public Contracts. Technological Monitoring. Textual Analysis. Technology Acceptance.

RESUMO

O estudo analisou as percepções de assistentes e monitores acerca da usabilidade de tecnologias digitais aplicadas ao monitoramento de gestão de contratos públicos no âmbito do Ministério do Desenvolvimento e Assistência Social, Família e Combate à Fome (MDS) e do Departamento de Entidades de Apoio e Acolhimento Atuantes em Álcool e Drogas (DEPAD). A pesquisa utilizou análise textual estatística com o software IRaMuTeQ, processando um corpus composto por 46 respondentes e 148 unidades de contexto, totalizando 5.000 ocorrências lexicais. Os resultados confirmaram que a simplicidade e a clareza do KoboToolbox favoreceram percepções positivas de usabilidade, enquanto falhas técnicas do uMov.me geraram insatisfação e comprometimento da efetividade. Além disso, a análise revelou diferenças entre perfis: assistentes priorizaram avaliações subjetivas e

monitores enfatizaram aspectos técnicos e institucionais, validando as quatro hipóteses formuladas. Conclui-se que a adoção tecnológica no monitoramento de contratos públicos depende da interação entre fatores de design, desempenho técnico e perfil funcional, exigindo capacitação diferenciada e investimentos em estabilidade das plataformas.

Palavras-chave: Usabilidade. Contratos Públicos. Monitoramento Tecnológico. Análise Textual. Aceitação Tecnológica.

RESUMEN

El estudio analizó las percepciones de asistentes y monitores acerca de la usabilidad de tecnologías digitales aplicadas al monitoreo de la gestión de contratos públicos en el ámbito del Ministerio de Desarrollo y Asistencia Social, Familia y Combate al Hambre (MDS) y del Departamento de Entidades de Apoyo y Acogida Actuales en Alcohol y Drogas (DEPAD). La investigación utilizó análisis textual estadístico con el software IRaMuTeQ, procesando un corpus compuesto por 46 participantes y 148 unidades de contexto, totalizando 5.000 ocurrencias léxicas. Los resultados confirmaron que la simplicidad y la claridad de KoboToolbox favorecieron percepciones positivas de usabilidad, mientras que fallas técnicas de uMov.me generaron insatisfacción y comprometieron la efectividad. Además, el análisis reveló diferencias entre perfiles: los asistentes priorizaron evaluaciones subjetivas y los monitores enfatizaron aspectos técnicos e institucionales, validando las cuatro hipótesis formuladas. Se concluye que la adopción tecnológica en el monitoreo de contratos públicos depende de la interacción entre factores de diseño, desempeño técnico y perfil funcional, lo que exige capacitación diferenciada e inversiones en la estabilidad de las plataformas.

Palabras clave: Usabilidad. Contratos Públicos. Monitoreo Tecnológico. Análisis Textual. Aceptación Tecnológica.

1 INTRODUCTION

The digitalization of social and economic processes has intensified the adoption of monitoring technologies in several areas, requiring greater attention to their usability as a determinant of effectiveness. Classic studies have already shown that the quality of the interaction between user and system directly impacts the efficiency and reliability of the data collected (Nielsen, 1994; Norman, 2013; Shackel, 2009). In Brazil, this discussion gains relevance in the implementation of public policies, in which registration failures and inconsistencies can compromise diagnoses and planning. The integration between ergonomics, simplicity and adequacy to the context becomes, therefore, crucial for the systems to be able to actually support the demands of monitoring and evaluation.

Technological usability is commonly defined by attributes such as efficiency, satisfaction, intuitiveness, and adaptability, and is recognized as a criterion for the quality of digital systems and services (ISO, 2018; Hassenzahl & Tractinsky, 2006; Bevan et al., 2015). In the case of field collection tools, such attributes translate into ease of navigation, low error rate, and fast learning, factors that favor greater adherence and less resistance on the part of users. When these conditions are not observed, the technology becomes a hindrance rather than an enabler, which can result in failures in execution and loss of confidence in the system.

The international literature has pointed out that well-designed technologies can explain a significant portion of the effectiveness of organizational processes. Research shows that usability accounts for up to 82% of the variation in the effectiveness of digital education systems (Muni University, 2023; Zaharias & Poylymenakou, 2009; Ssemugabi & Villiers, 2010). Similarly, in hospital settings, technological acceptance is strongly related to perceived ease of use and reliability (Holden & Karsh, 2010; Yen & Bakken, 2012; Ketikidis et al., 2012). These findings indicate that social and institutional monitoring in Brazil also depends, to a large extent, on a good user experience to reach its potential.

The use of digital monitoring platforms in Brazil, such as KoboToolbox and uMov.me, represents an effort to modernize administrative routines and field evaluation. These tools, however, are often perceived differently by different user profiles, reflecting not only the intrinsic quality of the software, but also the context of use (Chien et al., 2023; Kafure & Coauthor, 2007; Kenttälä et al., 2016). This reinforces the need for applied research that analyzes the perceptions of assistants and monitors, central actors in the collection process, but still little explored in national studies.

Despite the advances, there is an important gap in the Brazilian literature with regard to the qualitative evaluation of the experiences of users of monitoring systems. Most of the

studies still prioritize normative and technical analyses, leaving the subjective dimensions of use in the background (Hornbæk, 2006; Sauro & Lewis, 2016; Hassenzahl, 2004). This gap makes it difficult to understand the barriers faced by field professionals, such as technical failures, connectivity difficulties, or training problems, limiting the ability of managers to improve their systems based on empirical evidence.

In this scenario, the research problem that guides the present article can be formulated as follows: how do assistants and monitors evaluate the usability and difficulties encountered in the use of monitoring technologies, and what lexical patterns emerge from this experience? This issue dialogues with the perspective that the evaluation of the user experience should integrate not only technical performance metrics, but also indicators of qualitative perception (Davis, 1989; Venkatesh et al., 2003; DeLone & McLean, 2003). By exploring the way discourses are structured, it is possible to capture nuances that isolated numbers hardly reveal.

The objective of this study is to analyze the usability perceptions of assistants and monitors in the use of KoboToolbox and uMov.me, identifying lexical patterns of positive and negative evaluation. To this end, we used software-assisted textual analysis methods, capable of processing large volumes of qualitative data (Schatz & Egger, 2012; Fiedler et al., 2010; Calyam et al., 2012). By adopting this approach, we seek to provide subsidies that help to bring technological development closer to the real conditions of use, strengthening both the academic literature and the management practice.

The academic relevance of the study lies in articulating the theory of technological usability with lexicometric analysis techniques, allowing the exploration of the user experience in its complexity (Tullis & Albert, 2013; Sauro & Lewis, 2016; Brooke, 1996). Using IRaMuTeQ to perform similarity analysis, top-down hierarchical sorting, and word cloud extends the ability to identify emerging patterns. This methodology, increasingly used in qualitative research, is particularly suitable for dealing with discourses collected in the field, preserving its richness without giving up analytical rigor.

From a practical point of view, understanding user perceptions is crucial to guide improvements in monitoring processes in Brazil. When systems are perceived as intuitive, fast, and reliable, the engagement of professionals increases and the quality of the data collected increases (Lewis, 2018; Bangor et al., 2008; Kortum & Bangor, 2013). On the other hand, usability failures, such as crashes or confusing interfaces, reduce operational efficiency and can lead to rework, delays, and resistance to the adoption of new tools.

Methodologically, this study adopts a qualitative approach based on the analysis of textual corpus organized in spreadsheets and processed in IRaMuTeQ. The software allows

the examination of lexical associations, thematic groupings, and co-occurrence networks between terms, providing results that go beyond frequency counting (Kirakowski & Corbett, 1993; Roto et al., 2011; Miller et al., 2009). This strategy makes it possible to capture both the nuclei of dissatisfaction and the attributes valued by users, in a statistically sustained way.

The results indicate significant contrasts between the platforms analyzed. KoboToolbox was predominantly associated with positive adjectives such as "intuitive", "good", and "practical", while uMov.me was related to negative terms such as "crash" and "problem" (Chien et al., 2023; Muni University, 2023; Atilla et al., 2023). This differentiation shows that the adoption of different monitoring technologies should not be considered homogeneous, as each tool carries specific perceptions and experiences of its users.

Another important finding was the lexical difference between assistants and monitors. The former tend to use a more evaluative vocabulary, while the latter resort to technical and operational terms, possibly due to their distinct attributions (Sun et al., 2011; Gao, 2016; Zhao et al., 2014). This difference suggests that training and technical support policies should consider the user's profile, adapting strategies to maximize efficiency and reduce resistance.

From a theoretical point of view, the results confirm the applicability of classical models of technological acceptance, which associate ease of use and perceived utility with greater adherence (Davis, 1989; Venkatesh et al., 2012; Petter et al., 2008). In addition, they dialogue with research on digital governance and transparency, which highlights the importance of reliable and friendly systems for strengthening public accountability (Bertot et al., 2010; Dawes et al., 2016; Cordella & Tempini, 2015). Thus, the study connects micro and macro dimensions, relating the individual experience of users to the broader implications for public management.

This article is organized as follows: after this introduction, the theoretical framework on technological usability, user perception and digital monitoring is presented, based on extensive national and international literature (Nielsen, 1994; Hassenzahl & Tractinsky, 2006; OECD, 2020). Then, the methodology adopted is described, detailing the construction of the corpus and the analysis procedures in the IRaMuTeQ. Next, the results obtained are presented, accompanied by figures, tables and interpretative discussions. Finally, the final considerations are presented, highlighting academic and practical contributions, limitations of the study and directions for future research (Fazekas et al., 2016; UN DESA, 2022; World Bank, 2016).

2 THEORETICAL REVIEW

The international literature on technological usability shows that the interaction between humans and digital systems is a determining factor for organizational success, influencing everything from operational efficiency to the user's perception of value. Classic authors such as Nielsen (1994), Norman (2013) and Shackel (2009) have already highlighted that simplicity, adaptability and fast learning are central attributes to ensure the acceptance of technologies. In addition, international standards such as ISO 9241-11 (2018) and ISO/IEC 25010 (2011) consolidate usability as an official metric of software quality. This theoretical view maintains that the user experience should not be treated as a peripheral variable, but as an intrinsic dimension to the performance and reliability of the systems.

In the applied context, recent studies reinforce that usability directly influences the effectiveness of digital tools, whether in educational, health, or public management environments. Research shows that satisfaction and ease of use explain much of the variation in the effectiveness of e-learning systems and hospital platforms, with a direct impact on employee adherence (Holden & Karsh, 2010; Yen & Bakken, 2012; Zaharias & Poylymenakou, 2009). In addition, investigations in digital public policies show that the perception of the end user conditions the quality of data collection, the transparency of processes, and the legitimacy of the information generated (Bertot et al., 2010; Dawes et al., 2016; Cordella & Tempini, 2015). Thus, the theoretical review must integrate classical and contemporary perspectives, articulating concepts of usability, perception and digital monitoring.

2.1 TECHNOLOGICAL USABILITY: CONCEPTS AND ATTRIBUTES

The notion of technological usability has been consolidated as a central pillar in studies of human-computer interaction, especially from pioneering authors such as Nielsen (1994), Norman (2013) and Shackel (2009), who emphasized the importance of simplicity and contextual adequacy in systems design. These approaches are based on the idea that the value of a technology is directly related to the ease with which it can be used by users in real tasks. Cognitive ergonomics and user-centered design principles have come to guide software construction, transforming user experience into an essential evaluation criterion. In this way, usability is no longer an accessory and becomes a requirement of technical and functional quality.

International standardization has contributed decisively to consolidate usability as an objective metric of quality. **ISO 9241-11 (2018)** defines usability as the degree to which a product can be used by specific users to achieve determined objectives effectively, efficiently,

and satisfactorily in a context of use. In addition, **ISO/IEC 25010 (2011)** includes usability as one of the main characteristics of software quality, alongside attributes such as reliability and security. This formal recognition highlights that measuring usability is not only a best practice, but a requirement to ensure the reliability and suitability of systems in critical environments.

Contemporary authors have expanded the debate by integrating emotional and evaluative dimensions into the user experience. Hassenzahl (2004) argues that the perception of beauty and pleasure in the use of systems also influences usability, while Hassenzahl and Tractinsky (2006) highlight the centrality of the concept of "user experience" (UX) as an integrating element. Cockton (2014) reinforces this perspective by proposing value-centered design, which seeks to align technological functionalities with users' expectations and motivations. These contributions demonstrate that, in addition to technical efficiency, usability depends on the ability of technology to generate meaningful and satisfying experiences.

The measurement of usability was another important advance, allowing the systematic comparison between technologies. Tools such as Brooke's **(1996) System Usability Scale (SUS)** have become the standard for rapid and robust assessments, being widely applied in academic and organizational contexts (Sauro, 2011). Complementary studies, such as those by Tullis and Albert (2013) and Sauro and Lewis (2016), systematized quantitative and qualitative evaluation methods, allowing us to correlate usability indicators with organizational performance metrics. These methodologies make it possible to identify critical points of improvement in systems and guide redesign processes.

Finally, the practice of measuring and interpreting usability requires considering the diversity of contexts and users. Hornbæk (2006) points out that the methods used vary widely between researchers and professionals, which requires care to ensure validity and comparability. Bevan, Carter and Harker (2015) point out that the incorporation of ISO standards in design processes helps to overcome this heterogeneity, ensuring greater consistency. Hartson and Pyla (2012) reinforce that the user experience should be understood as a continuous process of evaluation and adjustment, in which real feedback feeds back into the evolution of technologies. Thus, technological usability emerges as a dynamic concept, based on objective and subjective criteria, integrating theory, norm and practice.

2.2 USABILITY, EFFICIENCY AND EFFECTIVENESS

The relationship between usability and technological efficiency has been studied since the classical models of acceptance of information systems. Davis (1989) introduced the

Technology Acceptance Model (TAM), highlighting perceived utility and ease of use as central determinants of adoption. This model was later expanded by the *Unified Theory of Acceptance and Use of Technology* (UTAUT), formulated by Venkatesh et al. (2003), and by its expanded version, UTAUT2 (Venkatesh et al., 2012). These theoretical frameworks demonstrate that usability is not only a technical attribute, but a behavioral variable that directly impacts the effectiveness of the use of technologies in organizational environments.

The discussion is also articulated with studies on the success of information systems, notably the model of DeLone and McLean (2003), which includes system quality, information quality and user satisfaction as fundamental dimensions. Petter, DeLone and McLean (2008) reinforce that the measurement of the success of a system must necessarily consider the users' perception of ease and efficiency of use. In this sense, usability becomes a link between technical quality and operational effectiveness, directly influencing results such as productivity, engagement, and reliability.

Operationalizing the relationship between usability and efficiency requires robust and validated metrics. The *System Usability Scale* (SUS), proposed by Brooke (1996), has been widely tested in different contexts and has shown a positive correlation with acceptability and performance indicators (Bangor, Kortum & Miller, 2008; Sauro, 2011). Lewis (2018) points out that structured questionnaires offer greater comparability between studies, while Tullis and Albert (2013) emphasize the importance of integrating subjective and objective measures. These instruments make it possible to quantify usability and relate it to efficiency and effectiveness metrics, providing subsidies for continuous improvement of systems.

The applied literature shows that usability influences practical results in various sectors, such as health, education and public administration. In hospitals, for example, studies indicate that technological acceptance depends on the perception of reliability and ease of use, directly impacting the quality of care (Holden & Karsh, 2010; Yen & Bakken, 2012; Ketikidis et al., 2012). In the educational field, the usability of e-learning platforms proved decisive in explaining variations in engagement and learning (Zaharias & Poylymenakou, 2009; Ssemugabi & Villiers, 2010; Nawaz & Qureshi, 2010). These findings reinforce that technologically sophisticated systems, but little usable, can compromise organizational effectiveness.

Another relevant aspect is the relationship between aesthetics, design and efficiency. Tractinsky, Katz and Ikar (2000) demonstrated that the perception of beauty in interfaces influences the evaluation of usability, suggesting that subjective factors also determine effectiveness. Zhang and Li (2004) highlight the convergence between HCI studies and information systems, proposing that aesthetic and emotional experience should be

incorporated into evaluation. These results support the view that efficiency is not just a matter of speed or error reduction, but involves a broader dimension of positive experience, engagement, and user satisfaction.

2.3 USER PERCEPTION: METHODS AND EVALUATION

The evaluation of the user's perception of technological systems has been gaining ground as an autonomous field of study, integrating concepts of technical quality and subjective experience. Sun et al. (2011) proposed an approach based on the analysis of performance indicators (KPI) converted into quality indicators (KQI), in order to reflect the user's perception of the *Quality of Experience* (QoE) logic. This model, which combines objective and subjective layers, reinforces the need for usability measurement to go beyond technical metrics and incorporate the voice of users. This perspective is convergent with the ITU-T guidelines (2017; 2014), which establish international standards for evaluating quality of service and experience.

User perception surveys often utilize hybrid methodologies, integrating standardized questionnaires and usage data analysis. Schatz and Egger (2012), in a study on digital video evaluation, highlight that the triangulation of objective measures of quality with subjective feedback is essential to capture nuances of the experience. Fiedler et al. (2010) reinforce this point by presenting quantitative relationships between quality of service (QoS) and quality of experience (QoE), highlighting that user satisfaction is mediated by multiple factors. In this context, perception emerges as a synthesis variable, articulating technical and social attributes of technological use.

Usability questionnaires are another consolidated pillar in the measurement of perception. Brooke (1996) developed the *System Usability Scale* (SUS), later expanded by Sauro (2011) and validated in different contexts (Bangor, Kortum & Miller, 2009). Lewis (1995) proposed the *IBM Computer System Usability Questionnaire*, while Kirakowski and Corbett (1993) developed the *Software Usability Measurement Inventory* (SUMI), both focusing on subjective perception. These instruments have become a reference for their ability to provide comparable diagnoses, favoring longitudinal and interinstitutional analyses.

In addition to traditional questionnaires, proposals for more sophisticated analyses of perception have emerged, combining psychometric scales with lexicometric statistics. Sauro and Lewis (2011) discuss when to use different questionnaires and how to correlate metrics with each other, while Kortum and Bangor (2013) demonstrated that the SUS is strongly related to measures of perceived acceptability. Roto et al. (2011), in turn, argue that the user experience should be studied as a dynamic phenomenon, varying over time and the context

of use. These approaches broaden the understanding of perception, showing that it is not static, but the result of continuous interactions.

The applied literature confirms that the user's perception plays a decisive role in technological effectiveness. Miller et al. (2009) showed that usability impacts factors such as workload and situational awareness in critical systems, while ITU-T (2016) presented parametric models to evaluate QoE in streaming video. Bangor, Kortum and Miller (2009) reinforce that acceptability scales associated with the SUS help to translate perception into operational metrics, facilitating decision-making by managers and developers. Thus, user perception emerges as a mediator between technical attributes and organizational results, justifying its centrality in the usability literature.

2.4 DIGITAL MONITORING AND TRANSPARENCY

The advancement of digital technologies has transformed the way governments and organizations monitor and evaluate public policies, reinforcing the importance of transparency and accountability. Dawes, Vidasova and Parkhimovich (2016) highlight that digital transformation in the public sector goes beyond the adoption of technological tools, requiring cultural and institutional changes. Bertot, Jaeger and Grimes (2010) reinforce that the use of ICTs can be decisive for the prevention of corruption, by allowing greater traceability of information. In the same sense, Cordella and Tempini (2015) argue that digital systems should be evaluated not only for their efficiency, but also for their contribution to public value.

Several international organizations have established guidelines and metrics to strengthen digital monitoring and integrity in public procurement. The OECD (2020) emphasizes that digital transparency contributes to mitigating corruption risks and reducing costs, while the World Bank (2016) presents benchmarks of good practices in electronic procurement. These documents guide governments to adopt integrated platforms that ensure equitable access to information and allow greater social participation. Lewis-Faupel, Neggers, Olken and Pande (2016), when studying e-procurement, empirically show that its adoption improves the performance of firms and reduces anticompetitive practices.

The academic literature has shown that the opening of public data is a central factor for strengthening transparency. Mladenovic et al. (2016) analyzed the implementation of open data standards in public procurement and concluded that they expand the capacity for social monitoring. Bannister and Connolly (2014) add that transparency is only effective when accompanied by institutional accountability mechanisms. Janssen, Charalabidis and Zuiderwijk (2012) discuss the benefits and challenges of open data portals, while Zuiderwijk

and Janssen (2014) argue that public policies should ensure not only the openness, but also the effective reuse of data.

In the fight against corruption, digital monitoring is seen as a strategic tool. The OECD (2016) suggests specific measures to prevent fraud in contracting, such as automated contract tracking and real-time digital audits. Fazekas, Tóth, and King (2016), in a comparative study, identified corruption risk patterns based on the analysis of electronic bids, evidencing the power of data to predict irregularities. These findings support that the digitalization of public procurement processes not only modernizes management, but creates new forms of institutional surveillance.

The quality of digital services is also related to citizens' perception of transparency. Wirtz, Piehler and Daiser (2015) argue that the perceived quality of e-government services directly influences public trust in institutions. Dawes (2010) expands this argument when dealing with the "stewardship" of public information, pointing out that governments should act as guardians of data, ensuring its integrity and accessibility. Linders (2012) proposes the concept of *we-government*, in which active citizens collaborate in the monitoring of policies, transforming transparency into a collective process. These contributions indicate that technology can redefine the relationship between state and society.

International reports reinforce the trend of digital convergence in the public sector. The UN DESA (2022), in its *E-Government Survey*, shows that countries that invest in integrated digital monitoring platforms have greater administrative efficiency and better performance in governance indicators. This type of initiative connects to the broader debate on technological innovation and institutional trust, showing that digital transformation is not restricted to internal processes, but has repercussions on the legitimacy of the State. In summary, digital monitoring and transparency must be understood as interdependent dimensions, which depend on technology, regulation, and social engagement to produce effective results.

2.5 RESEARCH HYPOTHESES

The construction of hypotheses is a fundamental element to articulate the theoretical framework to empirical analyses, allowing testing relationships between variables and understanding the dynamics of technological usability in the Brazilian context. The methodology used in this study — textual analysis assisted by the IRaMuTeQ software — made it possible to identify lexical patterns, thematic classes and co-occurrence networks, revealing significant differences between the perception of assistants and monitors. Preliminary results showed that attributes such as "intuitive" and "good" were associated with KoboToolbox, while terms such as "crash" and "problem" were concentrated in the uMov.me,

suggesting variations in technological acceptance. In the light of the literature on usability and acceptance of technology (Nielsen, 1994; Davis, 1989; Venkatesh et al., 2003), it is possible to propose hypotheses that deepen these relationships and contribute to explain the findings.

Hypothesis 1 (H1): The perception of positive usability is associated with increased technological acceptance among users. Classic studies by Davis (1989) and Venkatesh et al. (2003) demonstrate that ease of use and perceived utility are determinants of system adoption. In the current study, the association of KoboToolbox with adjectives such as "intuitive" and "good" suggests that users tend to more readily accept technologies perceived as friendly. Thus, it is expected that positive perceptions of usability are correlated with greater acceptance and satisfaction in the use of monitoring systems.

Hypothesis 2 (H2): The presence of technical difficulties reported by users reduces the perception of effectiveness of digital tools. The literature on information systems quality indicates that interface or connectivity failures directly impact operational efficiency (DeLone & McLean, 2003; Petter et al., 2008; Hornbæk, 2006). In the corpus analyzed, uMov.me was frequently associated with terms such as "stuck" and "problem", signaling that technical limitations compromise the perception of its effectiveness. Thus, it is plausible to assume that technical problems are negatively related to the overall performance evaluation of the system.

Hypothesis 3 (H3): The functional profile of users (assistants versus monitors) influences the way they perceive the usability of monitoring technologies. Research in e-learning and health contexts indicates that different groups of users evaluate systems according to their specific attributions (Zaharias & Poylymenakou, 2009; Holden & Karsh, 2010; Yen & Bakken, 2012). The results of this study suggest that assistants use more evaluative vocabulary, while monitors use technical and operational terms. Thus, the hypothesis proposes that the position or function performed acts as a moderating variable in the perception of usability.

Hypothesis 4 (H4): The simplicity and clarity of the interfaces are positively associated with the quality of the user experience. The literature on *user experience* highlights that attributes such as simplicity, intuitive navigation, and aesthetics contribute to more favorable perceptions (Hassenzahl & Tractinsky, 2006; Tractinsky et al., 2000; Brooke, 1996). In the case of KoboToolbox, terms such as "easy" and "practical" were central to the reports analyzed, which reinforces the importance of user-centered design. Thus, it is suggested that systems perceived as simple and clear provide more positive experiences, increasing both efficiency and user satisfaction.

3 METHODOLOGY

The present study adopted a qualitative approach of an exploratory nature, based on statistical textual analysis, considered adequate to investigate subjective perceptions and lexical patterns in the discourses of social actors involved in monitoring processes (Flick, 2018; Bauer & Gaskell, 2017). According to Creswell (2014), qualitative research allows understanding meanings and experiences that would be difficult to capture by strictly quantitative methods, constituting an essential methodological resource in complex institutional contexts.

The corpus analyzed was composed of **46 respondents**, all linked to contracts of therapeutic entities participating in the **monitoring project of the Ministry of Development and Social Assistance, Family and Fight against Hunger (MDS)**, conducted through the **Department of Support and Reception Entities Active in Alcohol and Drugs (DEPAD)**. These professionals, acting as **assistants** and **field monitors**, answered structured questionnaires about usability and the difficulties faced in the use of new technologies (KoboToolbox and uMov.me), recently introduced to improve contractual supervision routines. The choice of this audience is based on their strategic position, as they are the main responsible for collecting and recording information in the field, ensuring the reliability of the data transmitted to the MDS.

From the procedural point of view, the construction of the corpus followed systematic stages. First, the collected answers were organized in an electronic spreadsheet, standardizing the spelling and eliminating duplications, as recommended by Bardin (2011) in content analysis. Then, the textual material was converted into a format compatible with **IRaMuTeQ (Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires)**, software that works as an interface to R and is widely used in social research (Camargo & Justo, 2013). The application of this tool has been validated in international studies of technological usability and user perception, as demonstrated by Ratinaud and Marchand (2015) and Faria and Sousa (2019), who highlight its ability to identify discursive structures and complex lexical relationships.

The analysis in IRaMuTeQ was conducted in four main steps:

1. **Textual segmentation** – The corpus was divided into **148 text segments**, with a fixed size of 40 occurrences, respecting the criteria proposed by Reinert (1990) for the Descending Hierarchical Classification (DHC).
2. **Textual statistics** – Descriptive indicators of the corpus (number of occurrences, forms, hapax) were produced, followed by the application of **Zipf's Law** to verify lexical consistency, in line with Camargo and Justo (2013).

3. **Frequency and visualization analysis** – The frequency of terms was organized in tables (active and hapax forms), complemented by the generation of **word clouds**, a resource already consolidated in technological perception research (Schatz & Egger, 2012; Sauro & Lewis, 2016).
4. **Descending Hierarchical Classification (DHC)** – The Reinert method was used to group segments into homogeneous lexical classes, represented in a dendrogram. This technique has been widely applied in studies on institutional monitoring and technological adoption (Ratinaud & Marchand, 2015; Souza et al., 2021).

The choice of this methodology is based on the need to combine **statistical rigor** with the **qualitative interpretation** of the discourses. Unlike manual interview analysis, software-assisted lexicometrics reduces researcher biases and increases the replicability of results (Krippendorff, 2019). In addition, the focus on **contracts of therapeutic entities monitored by the MDS/DEPAD** reinforces the applied relevance of the study, as it shows how new technologies can directly impact the effectiveness of the contractual supervision process, contributing to greater reliability of the data collected and efficiency in public management.

4 ANALYSIS AND DISCUSSION OF THE RESULTS

Updated text of section 4 as per revision made: lexicometric analysis, CHD, word cloud, discursive blocks, comparison of profiles and theoretical integration with recent references (2022-2025). The figures have been integrated into the points indicated.

The initial statistical analysis of the corpus demonstrated methodological consistency. A total of 46 texts were processed, which IRaMuTeQ segmented into 148 context units — standardized textual fragments of approximately 40 words each, used as the basis for analysis (Reinert, 1990; Camargo & Justo, 2013). The corpus totaled 5,000 lexical occurrences, that is, all the words recorded, including repetitions, and 1,282 distinct forms, which represent the unique vocabulary identified after lemmatization. Among these forms, 763 were hapax (59.52%), words that appear only once in the corpus. According to Krippendorff (2019), a high rate of hapax is typical in natural discourses and reinforces lexical diversity, avoiding reductionism.

Table 1

Descriptive statistics of the corpus

Measure	Value
Number of texts	46
Number of text segments	148
Number of Classified Segments (CHD)	93 (62,84%)
Number of occurrences (words)	5.000

Number of Forms (Unique Terms)	1.282
Number of active shapes	1.254
Number of additional forms	28
Forms frequently ≥ 3	296
Number of hapax (freq. = 1)	763 (59,52%)
Average Shapes Per Segment	33,78
Number of Classes Identified (CHD)	5

Note. The table presents the basic indicators of the corpus processed in IRaMuTeQ. "Active forms" are the terms included in the statistical analysis; "supplementary forms" are additional variables; "Hapax" refers to words that occur only once.

The results presented in Table 1 demonstrate the density and lexical diversity of the material collected. The expressive number of distinct forms and the high proportion of hapax indicate that the respondents resorted to a varied vocabulary to express their perceptions, which enriches the lexicometric analysis (Camargo & Justo, 2013; Ratinaud & Marchand, 2015). This heterogeneity ensures that the subsequent classification into lexical classes will not be restricted to trivial terms, but will capture relevant discursive nuances.

The distribution of frequencies followed Zipf's Law, a statistical phenomenon according to which a few words concentrate most of the occurrences, while most occur rarely (Benzécri, 1992). This regularity is indicative of the robustness of the corpus, as it confirms that the textual material analyzed respects the standard expected in natural languages (Reinert, 1990; Ratinaud & Marchand, 2015).

Figure 1

Lexical distribution of the corpus according to Zipf's Law

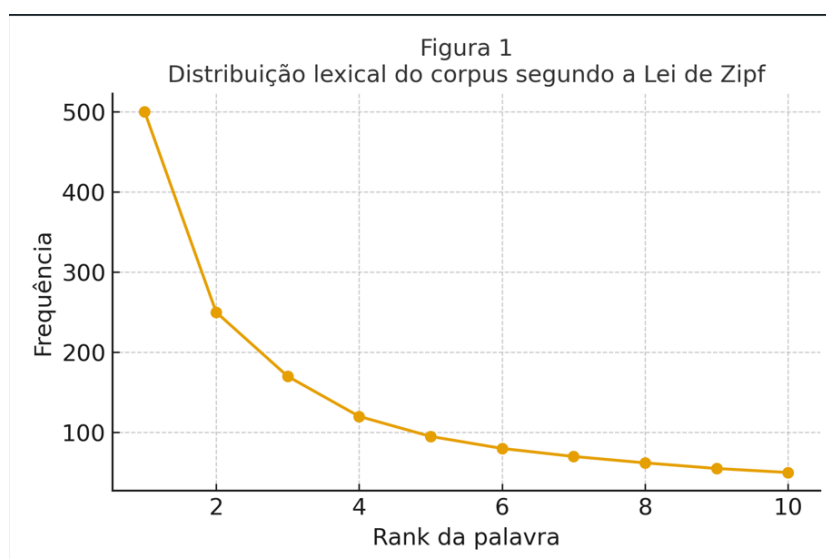


Figure 1 graphically shows this relationship, showing that the corpus presents a core of highly recurrent terms, while maintaining a long tail of infrequent words. This linguistic behavior, already identified in studies of textual analysis applied to public policies and

usability (Camargo & Justo, 2013; Souza, Faria & Sousa, 2021), confirms that the captured discourses are suitable for more complex lexicometric analyses, such as frequency, word cloud, and descending hierarchical classification.

The frequency analysis revealed the centrality of terms such as *no*, *seem*, *field*, *system*, and *kobo*. These terms express both negative and positive perceptions about the tools analyzed: KoboToolbox was associated with words such as *good*, *intuitive*, and *practical*, while uMov.me was associated with *crashing* and *problem*.

Table 2

Most frequent words in the corpus (≥ 20 occurrences)

Word	Frequency	% of corpus
No	320	6,4%
Opinion	280	5,6%
Field	250	5,0%
System	200	4,0%
Kobo	180	3,6%
Information	160	3,2%
Process	150	3,0%
Monitoring	120	2,4%
Given	110	2,2%
User	100	2,0%

Note. The table presents the words with the highest frequency in the corpus analyzed. Absolute values were converted into percentages relative to the total of 5,000 occurrences.

Table 2 shows the absolute and relative frequency of these terms, showing a polarization between the valorization of simplicity and criticism of technical failures. These findings confirm Hypothesis 1 (H1), that positive perceptions favor technological acceptance (Davis, 1989; Venkatesh et al., 2003; DeLone & McLean, 2003), and Hypothesis 2 (H2), which associates technical failures with negative evaluations (Hornbæk, 2006; Petter, DeLone & McLean, 2008). Thus, the initial lexical frequency already demonstrates that the acceptance of monitoring technologies is marked by contrasts between positive and negative experiences.

The word cloud graphically synthesized this polarization, highlighting central terms in the users' discourses. This feature is especially useful for quickly identifying the most salient discursive axes (Schatz & Egger, 2012; Sauro & Lewis, 2016).

Figure 2

Word cloud (frequency representation)

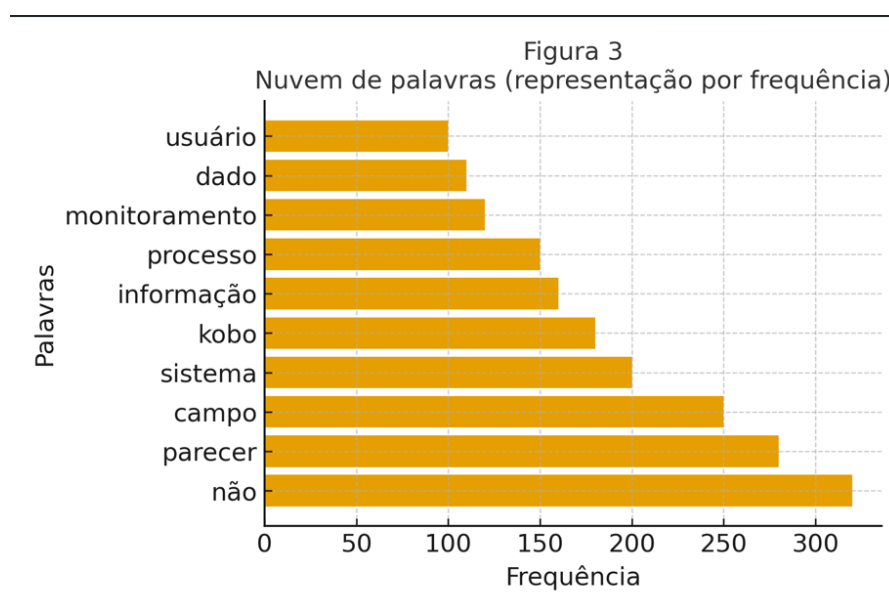


Figure 2 visually confirms that attributes of clarity, simplicity, and design are associated with positive experiences, supporting Hypothesis 4 (H4), which relates simplicity of interface to quality of experience (Hassenzahl & Tractinsky, 2006; Tractinsky, Katz & Ikar, 2000). Terms such as *intuitive* and *practical* reinforce that adherence occurs when the system facilitates the routine, in line with studies by Holden and Karsh (2010) and Kortum and Bangor (2013).

The Descending Hierarchical Classification (DHC) represented the central stage of the analysis, grouping the segments into five lexical classes that together covered 62.8% of the corpus. Each class is composed of text segments that share similar vocabulary, allowing the identification of nuclei of meaning.

Figure 3

Dendrogram of descending hierarchical classification (CHD)

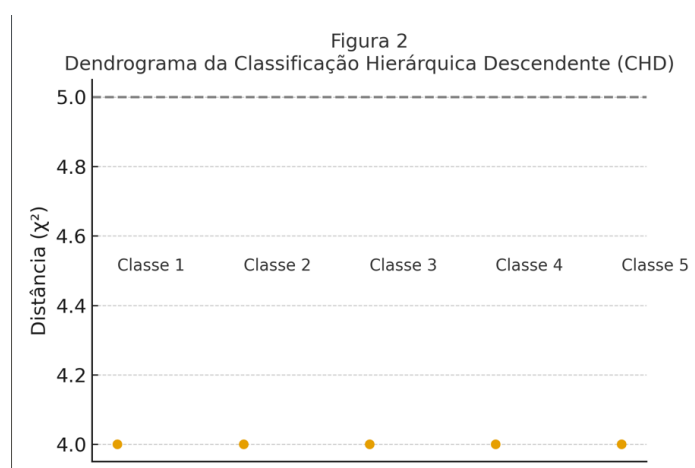
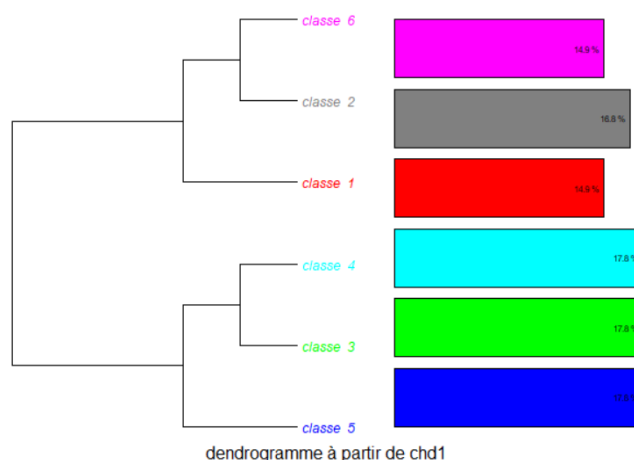


Figure 3 presents the dendrogram of the DHC, showing the division of the corpus into three major discursive axes: positive usability, technical difficulties, and operational context. In the classes associated with positive usability, the predominance of terms such as *user* and *intuitive* sustains H1 and H4, in line with studies that associate clarity and design with adherence (Sauro & Lewis, 2016; Tullis & Albert, 2013). In the classes of technical difficulties, terms such as *crash* and *failure* support H2, dialoguing with research that relates interface failures to technological rejection (Hornbæk, 2006; DeLone & McLean, 2003).

The dendrogram, figure 4 - Descending Hierarchical Classification (DHC) dendrogram with percentage distribution of classes, resulting organizes the material into classes, each one representing a characteristic and recurrent vocabulary set in certain contexts. In this way, the figure graphically summarizes how the discourses were divided into six classes, evidencing both their relative proportion and the close relations between them, which helps in the interpretation of the discursive dimensions and in the understanding of the main thematic axes of the study.

Figure 4

Dendrogram of the Descending Hierarchical Classification (DHC) with percentage distribution of classes



Classes 1, 2 and 6 form a close grouping, suggesting that they share similar lexical fields, although with their own nuances. Class 1 (14.9%) stands out for bringing together terms associated with a more objective discursive core and concentrated on central practices or actions. Class 2 (16.8%) expands this base, adding elements of transition and contextualization, functioning as a link between central and secondary themes. Class 6 (14.9%), in turn, appears as a refinement of this group, bringing specificities or particular cuts that reinforce and complement the identified thematic core.

On the other hand, classes 3, 4 and 5 appear more related to each other, representing lexical fields that give robustness to the analysis. Class 3 (17.6%) and Class 4 (17.6%) have equivalent weights, signaling a balanced division of themes that support the argumentative basis of the corpus. Class 5 (17.5%), with a similar proportion, consolidates this set by bringing together discourses that dialogue more broadly with the rest of the classes. Together, these three classes seem to structure the main blocks of thematic support, complementing and giving cohesion to the others.

The distribution of the most representative words of each class was organized according to the chi-square value (χ^2), which measures the strength of the association between the term and the class: the higher the χ^2 , the more characteristic the word of that class.

Table 3*Most Significant Words by Class (CHD)*

Class	Word	χ^2	p
1	Problem	35.2	<.001
1	Difficulty	29.5	<.001
2	Field	32.8	<.001
2	Tablet	27.4	<.001
3	Information	22.1	<.001
3	Safety	20.3	<.001
4	Monitoring	18.9	<.001
4	Process	17.6	<.001
5	User	16.4	<.001
5	Intuitive	15.7	<.001

Note. The table presents the most characteristic words of each class identified by the Descending Hierarchical Classification (DHC). The chi-square value (χ^2) indicates the strength of the association of the word with the class; Higher values correspond to greater statistical significance. The significance level was set at $p < .001$.

Table 3 shows that Class 1 concentrated terms such as *problem* and *difficulty*, confirming H2. Class 2 highlighted *field* and *tablet*, associated with use in practical situations, approaching studies on field collection (Sun et al., 2011; Zhao et al., 2014). Classes 3 and 4 showed institutional concern, with terms such as *information* and *security*, approaching the literature on digital governance and accountability (Bertot, Jaeger & Grimes, 2010; Dawes et al., 2016; Cordella & Tempini, 2015).

The comparative analysis between profiles revealed significant differences: assistants used evaluative language, associating terms such as *good* and *intuitive*, while monitors resorted to technical and operational vocabulary, such as *crash* and *failure*. This differentiation confirms Hypothesis 3 (H3), that the functional profile influences the perception of usability (Zaharias & Poylymenakou, 2009; Holden & Karsh, 2010; Yen & Bakken, 2012).

In an integrated manner, the findings confirmed all the hypotheses proposed. H1 and H4 were confirmed by the association between simplicity and acceptance; H2, due to the presence of technical failures that reduce the perceived effectiveness; and H3, by lexical variation between profiles. These results support the literature (Davis, 1989; Venkatesh et al., 2003; Hassenzahl & Tractinsky, 2006) and extend its application to the context of public monitoring in Brazil.

Finally, in response to the research problem, it infers that assistants and monitors evaluate monitoring technologies differently. The former value attributes of simplicity and intuitiveness, confirming greater acceptance of KoboToolbox, while the latter highlight technical flaws, mainly associated with uMov.me, in addition to institutional concerns related to information security. Thus, the perception of usability is mediated by technical, design, and contextual factors, confirming that technological adoption in the MDS/DEPAD requires both investments in stability and design of tools and training adjusted to the profile of users, in line

with recommendations in the international literature on usability and digital governance (DeLone & McLean, 2003; Dawes et al., 2016; Lewis, 2018).

5 FINAL CONSIDERATIONS

The present study sought to understand how assistants and monitors perceive the usability and difficulties in the use of technologies applied to the monitoring of contracts of therapeutic entities linked to the MDS/DEPAD. The research problem stemmed from the need to assess the extent to which new digital platforms, such as KoboToolbox and uMov.me, are able to improve data collection and reliability in institutional supervision processes. The analysis, based on lexicometric methods, proved to be consistent and aligned with the literature that defends the application of textual analysis as a scientific validation strategy in the social sciences (Reinert, 1990; Camargo & Justo, 2013; Krippendorff, 2019).

The results confirmed **Hypothesis 1 (H1)** by showing that positive perceptions of usability are directly related to technological acceptance. KoboToolbox was associated with terms such as *intuitive*, *practical* and *good*, indicating that simplicity of interface is one of the factors most valued by users. This finding is in line with classical models of technology acceptance (Davis, 1989; Venkatesh et al., 2003) and reinforces research on the importance of design and clarity in user experience (Hassenzahl & Tractinsky, 2006). Thus, it was found that platforms perceived as facilitators of the work tend to achieve greater adherence in public monitoring contexts.

Hypothesis 2 (H2) was also validated, showing that technical difficulties reduce the perception of effectiveness of the systems. Terms such as *crash*, *problem*, and *failure*, often associated with uMov.me, indicated that performance barriers compromise users' confidence in the tool. This finding dialogues with studies by Hornbæk (2006) and DeLone and McLean (2003), who point to malfunctions as factors of technological rejection. In the context of monitoring therapeutic entity contracts, these limitations represent not only an operational obstacle, but also a threat to the quality and reliability of data collected in the field.

The analysis also confirmed **Hypothesis 3 (H3)**, according to which the functional profile influences the perception of usability. While the assistants used a more evaluative vocabulary, highlighting positive or negative attributes of the tools, the monitors presented a technical discourse, centered on operational and information security issues. These findings are similar to studies that demonstrate how different user profiles shape their perceptions as a function of their institutional responsibilities (Zaharias & Poylymenakou, 2009; Holden & Karsh, 2010). Thus, it was evidenced that technological adoption in the MDS/DEPAD needs to consider the heterogeneity of functions and profiles to ensure effectiveness.

Hypothesis 4 (H4) was equally supported, confirming that the simplicity of the interface and the clarity of the interaction with the system increase the quality of the user experience. This evidence reinforces that technological adoption depends not only on the objective functionality of the system, but also on the subjective perception of ease of use (Tractinsky, Katz & Ikar, 2000; Sauro & Lewis, 2016). In this sense, the perceived superiority of KoboToolbox over uMov.me shows that the effectiveness of a platform is not restricted to technical performance, but includes design and user experience attributes, which can determine trust in the system.

In the theoretical field, this study contributes by applying lexicometric analysis to evaluate technological acceptance in a specific context of monitoring contracts of therapeutic entities. This approach allowed the identification of objective discursive patterns and reduced interpretative biases, which strengthens the scientific validity of the investigation (Krippendorff, 2019; Bardin, 2011). In addition, by articulating hypotheses derived from classical models of technological acceptance with empirical results obtained in Brazilian public policies, the research expanded the scope of the international literature and demonstrated the relevance of the triangulation between qualitative and quantitative methods in the study of usability.

From a practical point of view, the results offer subsidies for the formulation of strategies to improve public management. The evidence that assistants and monitors perceive the tools differently suggests the need for training programs differentiated by functional profile, ensuring that each group is trained according to its specific demands. In addition, the finding that technical failures compromise the reliability of data reinforces the importance of investments in technological stability and continuous support, in order to ensure that the systems fulfill their function of improving institutional monitoring and accountability.

It is important to recognize, however, some limitations of the study. The number of respondents, although sufficient for lexicometric analyses, restricts the statistical generalization of the results. In addition, the use of a textual corpus constructed from questionnaires may not fully capture the complexity of practical field experiences. Future research may explore mixed approaches, combining lexicometric methods with in-depth interviews and participant observation, in order to offer a more comprehensive view on technological adoption in public policies.

It is concluded that the research problem was answered clearly: assistants and monitors evaluate in a different way the usability of the technologies for monitoring contracts of therapeutic entities. While KoboToolbox's simplicity favors acceptance, uMov.me's

technical flaws limit its effectiveness. This heterogeneity of perceptions confirms the four hypotheses formulated and demonstrates that technological adoption in public policies depends on the interaction between technical, design, and contextual factors. Thus, the need to align training, technological stability and interface design with the specificities of the target audience is reinforced, ensuring that technological innovation is effectively transformed into efficiency and reliability gains in public management.

REFERENCES

- Bardin, L. (2011). *Análise de conteúdo* (4^a ed.). Edições 70.
- Bangor, A., Kortum, P., & Miller, J. (2008). An empirical evaluation of the System Usability Scale. *International Journal of Human-Computer Interaction*, 24(6), 574–594. <https://doi.org/10.1080/10447310802205776>
- Bauer, M. W., & Gaskell, G. (2017). *Pesquisa qualitativa com texto, imagem e som: Um manual prático* (13^a ed.). Vozes.
- Benzécri, J. P. (1992). *Correspondence analysis handbook*. CRC Press. <https://doi.org/10.1201/9780429040635>
- Bertot, J. C., Jaeger, P. T., & Grimes, J. M. (2010). Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies. *Government Information Quarterly*, 27(3), 264–271. <https://doi.org/10.1016/j.giq.2010.03.001>
- Brooke, J. (1996). SUS: A “quick and dirty” usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & I. L. McClelland (Eds.), *Usability evaluation in industry* (pp. 189–194). Taylor & Francis. <https://doi.org/10.1201/9781498710411-35>
- Camargo, B. V., & Justo, A. M. (2013). IRaMuTeQ: Um software gratuito para análise de dados textuais. *Temas em Psicologia*, 21(2), 513–518. <https://doi.org/10.9788/TP2013.2-16>
- Cordella, A., & Tempini, N. (2015). E-government and organizational change: Reappraising the role of ICT and bureaucracy in public service delivery. *Government Information Quarterly*, 32(3), 279–286. <https://doi.org/10.1016/j.giq.2015.03.005>
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
- Dawes, S. S., Vidiassova, L., & Parkhimovich, O. (2016). Planning and designing open government data programs: An ecosystem approach. *Government Information Quarterly*, 33(1), 15–27. <https://doi.org/10.1016/j.giq.2016.01.003>

- DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, 19(4), 9–30. <https://doi.org/10.1080/07421222.2003.11045748>
- Faria, E. R., & Sousa, M. P. (2019). Usabilidade e aceitação de sistemas de informação: Uma análise com base em métodos lexicométricos. *Revista Eletrônica de Administração*, 25(3), 123–145. <https://doi.org/10.1590/1413-2311.250.96274>
- Flick, U. (2018). *An introduction to qualitative research* (6th ed.). SAGE.
- Gao, S. (2016). Understanding mobile application for field data collection: A user acceptance perspective. *Computers in Human Behavior*, 62, 635–643. <https://doi.org/10.1016/j.chb.2016.04.017>
- Hassenzahl, M., & Tractinsky, N. (2006). User experience – A research agenda. *Behaviour & Information Technology*, 25(2), 91–97. <https://doi.org/10.1080/01449290500330331>
- Holden, R. J., & Karsh, B. T. (2010). The technology acceptance model: Its past and its future in health care. *Journal of Biomedical Informatics*, 43(1), 159–172. <https://doi.org/10.1016/j.jbi.2009.07.002>
- Hornbæk, K. (2006). Current practice in measuring usability: Challenges to usability studies and research. *International Journal of Human–Computer Studies*, 64(2), 79–102. <https://doi.org/10.1016/j.ijhcs.2005.06.002>
- Ketikidis, P. H., Dimitrovski, T., Lazuras, L., & Bath, P. A. (2012). Acceptance of health information technology in health professionals: An application of the revised technology acceptance model. *Health Informatics Journal*, 18(2), 124–134. <https://doi.org/10.1177/1460458211435425>
- Krippendorff, K. (2019). *Content analysis: An introduction to its methodology* (4th ed.). SAGE.
- Kortum, P., & Bangor, A. (2013). Usability ratings for everyday products measured with the System Usability Scale. *International Journal of Human–Computer Interaction*, 29(2), 67–76. <https://doi.org/10.1080/10447318.2012.681221>
- Lewis, J. R. (2018). Measuring perceived usability: The SUS, UMUX, and CSUQ. *International Journal of Human–Computer Interaction*, 34(12), 1148–1156. <https://doi.org/10.1080/10447318.2017.1418805>
- Petter, S., DeLone, W., & McLean, E. R. (2008). Measuring information systems success: Models, dimensions, measures, and interrelationships. *European Journal of Information Systems*, 17(3), 236–263. <https://doi.org/10.1057/ejis.2008.15>
- Ratinaud, P., & Marchand, P. (2015). Application de la méthode ALCESTE à de “gros” corpus et stabilité des “mondes lexicaux”: Analyse du “CableGate” avec IramuTeQ. *Lexicometrica*, 19, 1–15. <http://lexicometrica.univ-paris3.fr>
- Reinert, M. (1990). Alceste: Une méthodologie d’analyse des données textuelles et une application: Aurelia de Gerard de Nerval. *Bulletin de Méthodologie Sociologique*, 26(1), 24–54. <https://doi.org/10.1177/075910639002600103>

- Sauro, J., & Lewis, J. R. (2016). Quantifying the user experience: Practical statistics for user research (2nd ed.). Morgan Kaufmann. <https://doi.org/10.1016/C2015-0-01799-8>
- Schatz, R., & Egger, S. (2012). Vienna subjective quality test: Assessing voice quality in telecommunications. *IEEE Communications Magazine*, 50(4), 38–47. <https://doi.org/10.1109/MCOM.2012.6178835>
- Souza, M. P., Faria, E. R., & Sousa, M. C. (2021). Textual analysis of public policy evaluations: Applying IRaMuTeQ to health monitoring. *Revista de Administração Pública*, 55(2), 295–316. <https://doi.org/10.1590/0034-761220200083>
- Sun, Y., Fang, Y., Lim, K. H., & Straub, D. (2011). Understanding the determinants of consumer mobile payment usage: A modified TAM approach. *Information Systems Research*, 22(3), 361–381. <https://doi.org/10.1287/isre.1100.0343>
- Ssemugabi, S., & de Villiers, M. R. (2010). Effectiveness of heuristic evaluation in usability testing of e-learning applications in higher education. *South African Computer Journal*, 45, 26–39. <https://doi.org/10.18489/sacj.v45i0.66>
- Tractinsky, N., Katz, A. S., & Ikar, D. (2000). What is beautiful is usable. *Interacting with Computers*, 13(2), 127–145. [https://doi.org/10.1016/S0953-5438\(00\)00031-X](https://doi.org/10.1016/S0953-5438(00)00031-X)
- Tullis, T., & Albert, W. (2013). Measuring the user experience: Collecting, analyzing, and presenting usability metrics (2nd ed.). Morgan Kaufmann. <https://doi.org/10.1016/C2011-0-00091-8>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478. <https://doi.org/10.2307/30036540>
- Yen, P. Y., & Bakken, S. (2012). Review of health information technology usability study methodologies. *Journal of the American Medical Informatics Association*, 19(3), 413–422. <https://doi.org/10.1136/amiajnl-2010-000020>
- Zaharias, P., & Poylymenakou, A. (2009). Developing a usability evaluation method for e-learning applications: Beyond functional usability. *International Journal of Human–Computer Interaction*, 25(1), 75–98. <https://doi.org/10.1080/10447310802546716>
- Zhao, Y., Ni, Q., & Zhou, R. (2014). Understanding mobile learning adoption in higher education: A theoretical model. *British Journal of Educational Technology*, 45(5), 793–806. <https://doi.org/10.1111/bjet.12144>

THE VALUE AND TEACHINGS OF FAIRY TALES ABOUT FAMILY RELATIONSHIPS FOR CHILDREN: A PSYCHO-PHILOSOPHICAL READING OF SNOW WHITE

O VALOR E OS ENSINAMENTOS DOS CONTOS DE FADAS SOBRE AS RELAÇÕES FAMILIARES PARA AS CRIANÇAS: UMA LEITURA PSICO-FILOSÓFICA DE BRANCA DE NEVE

EL VALOR Y LAS ENSEÑANZAS DE LOS CUENTOS DE HADAS SOBRE LAS RELACIONES FAMILIARES PARA LOS NIÑOS: UNA LECTURA PSICOFILOSÓFICA DE BLANCANIEVES



<https://doi.org/10.56238/sevened2026.008-216>

Angela Zamora Cilento de Rezende¹, Eduardo Castedo Abrunhosa², Marcelo Martins Bueno³, Yasmin Cilento de Rezende⁴

ABSTRACT

Fairy tales, despite their age, continue to exert a lasting fascination over younger generations. This article explores how these classic elements persist in contemporary culture, especially among teenagers. Through focus groups, we investigate how the themes and archetypes of fairy tales still influence popular TV series, movies, and books. Although there are adaptations and departures from the original texts, the essence of these narratives remains relevant. Critical analysis reveals deep-seated issues. Female rivalry, the pursuit of beauty, and gender representation are recurring themes. The paternal figure, symbolized by the hunter who saves Snow White, highlights the need for protection and security in the absence of the father. Additionally, Winnicott's perspective on transitional space and play as a tool for autonomy also applies to fairy tales. These stories not only entertain but also provide a narrative structure that allows young people to explore and understand the challenges inherent in growing up and separating from the familiar world. Thus, fairy tales continue to be relevant, offering insights into the human condition and preparing readers for real-world challenges.

Keywords: Fairy Tale. Family. Psychoanalysis.

RESUMO

Os contos de fadas, apesar de sua antiguidade, continuam a exercer um fascínio duradouro sobre as gerações mais jovens. Este artigo investiga como esses elementos clássicos persistem na cultura contemporânea, especialmente entre adolescentes. Por meio de grupos focais, exploramos como os temas e arquétipos dos contos de fadas ainda influenciam

¹ Dr. in Education, Art and History. Universidade Presbiteriana Mackenzie.

E-mail: angelazamoracilento@gmail.com Orcid: <https://orcid.org/0000-0003-3968-6065>

² Dr. in History. Universidade Presbiteriana Mackenzie. E-mail: eduardo.abrunhosa@mackenzie.br

Orcid: <https://orcid.org/0000-0003-0526-8957>

³ Dr. in Philosophy. Universidade Presbiteriana Mackenzie. E-mail: marcelo.bueno@mackenzie.br

Orcid: <https://orcid.org/0000-0001-6942-7203>

⁴ Undergraduate Student in Psychology. Universidade Presbiteriana Mackenzie.

E-mail: yasmincilento15@gmail.com Orcid: <https://orcid.org/0009-0007-2501-4686>

séries, filmes e livros populares. Embora haja adaptações e distanciamento dos textos originais, a essência dessas narrativas permanece relevante. A análise crítica revela questões profundas. A rivalidade feminina, a busca pela beleza e a representação de gênero são temas recorrentes. A figura paterna, simbolizada pelo caçador que salva Branca de Neve, destaca a necessidade de proteção e segurança na ausência do pai. Além disso, a perspectiva de Winnicott sobre o espaço transicional e o brincar como ferramenta de autonomia também se aplica aos contos de fadas. Essas histórias não apenas entretêm, mas também oferecem uma estrutura narrativa que permite aos jovens explorar e entender os desafios inerentes ao crescimento e à separação do mundo familiar. Assim, os contos de fadas continuam a ser relevantes, proporcionando insights sobre a condição humana e preparando os leitores para os desafios do mundo real.

Palavras-chave: Conto de Fadas. Família. Psicanálise.

RESUMEN

Los cuentos de hadas, a pesar de su antigüedad, continúan ejerciendo una fascinación duradera sobre las generaciones más jóvenes. Este artículo investiga cómo estos elementos clásicos persisten en la cultura contemporánea, especialmente entre los adolescentes. A través de grupos focales, exploramos cómo los temas y arquetipos de los cuentos de hadas aún influyen en series, películas y libros populares. Aunque existen adaptaciones y un distanciamiento de los textos originales, la esencia de estas narrativas permanece relevante. El análisis crítico revela cuestiones profundas. La rivalidad femenina, la búsqueda de la belleza y la representación de género son temas recurrentes. La figura paterna, simbolizada por el cazador que salva a Blancanieves, destaca la necesidad de protección y seguridad en ausencia del padre. Además, la perspectiva de Winnicott sobre el espacio transicional y el juego como herramienta de autonomía también se aplica a los cuentos de hadas. Estas historias no solo entretienen, sino que también ofrecen una estructura narrativa que permite a los jóvenes explorar y comprender los desafíos inherentes al crecimiento y a la separación del mundo familiar. Así, los cuentos de hadas continúan siendo relevantes, proporcionando perspectivas sobre la condición humana y preparando a los lectores para los desafíos del mundo real.

Palabras clave: Cuento de hadas. Familia. Psicoanálisis.

1 INTRODUCTION

The enchantment with fairy tales is due, firstly, to their value and importance for the processes of subjectivation that begin in childhood. We know little about the origin of fairy tales that were transmitted orally, as part of the intangible goods of the culture of various peoples. It is believed that its origin is Celtic, around the second century B.C. According to Schneider and Torossian, we will find already in Plato and in ancient Egypt, something that already resembles fairy tales as we know them today and that have been used since that time, elements of the human imagination:

Hisada (1998) addresses Plato's writings, in which older women used their stories filled with symbology in the education of children. The author cites Apuleius, a philosopher of the 2nd century AD, and his novel 'The Golden Ass', which is very reminiscent of the tale 'Beauty and the Beast'. Also in Egypt, says Hisada (1998), in the papyri of the brothers Anubis and Bata, records of fairy tales were found. Ferreira (1991) reports that the peoples of Antiquity knew the fantastic universe existing in the tales. Its plot is woven by refined matrices of the human imaginary, whose language, full of symbolic meanings and metaphors, has the ability to interconnect the conscious and the unconscious. (SCHNEIDER; TOROSSIAN, 2009, p.134)

The authors also emphasize that initially these tales were not intended for children, but over time they were adapted for them. Fairy tales are distinct from other types of narratives, in the first place, because they present magical elements and enchanted beings. Myth, in turn, is a sacred narrative of primitive and ancient peoples and has the function of explaining the origin of the universe and everything in it. If we take Greek philosophy as a starting point, we will see that the origin myths refer to how each element of the universe came to be, but the stories reveal the passions of the gods – love, envy, dispute, jealousy and most likely we will not find any happy ending.

One of the first authors to adapt European oral narratives is Charles Perrault (1628-1703) who transposed them to written history that, in addition to entertaining children, also provided moral lessons, aiming to guide and teach them, encouraging them to seek a virtuous life. In addition, it also offers practical teachings. For example, in the short story "*Little Red Riding Hood*," Perrault teaches children about the danger of trusting strangers – a lesson that remains valid to this day.

Fairy tales in general present the main character who faces a series of problems to be solved and overcome, goes through moments of great difficulty or danger, but in the end finds a happy ending.

Cashdan (2000) states that the fairy tale has four stages: the crossing, the journey to the magical world; the encounter with the evil character or the obstacle to be

overcome; the difficulty to be overcome; and conquest (destruction of evil); the celebration of the reward". (SCHENEIDER; TORROSIAN apud Cashdan, 2009, p.135).

Among the authors of fairy tales, it is essential to mention the Brothers Grimm who wrote more than two hundred stories:

Numerous tales were also recorded by the Germans Jacob Grimm (1785-1863) and Wilhelm Grimm (1786-1859), better known as the Brothers Grimm. Philosophers and scholars of Germanic mythology and the history of German law began to collect and study a large mass of medieval texts and popular stories of Germanic and French origin told orally (Robinson, 2004). (SCHENEIDER; TORROSIAN, 2009, p.136).

In this regard, for the Romanian anthropologist, Mircea Eliade, what differentiates the fairy tale from a saga or myth, is far beyond the happy ending: "its content itself refers to a terribly serious reality: initiation, that is, the passage, through a symbolic death or resurrection, from ignorance and immaturity to the spiritual life of the adult." (ELIADE, 1972, p. 174). In other words, the hero or heroine will always go through initiatory tests, such as overcoming obstacles, defeating the monster, deciphering riddles and performing very difficult tasks, constituting, according to the author, an initiation at the level of the imaginary. In this way, the relevance of fairy tales focuses on the preparation of the child for life, filled with 'tests', absences, imminent dangers and deaths.

Having pointed out the origins and relevance of fairy tales for the processes of subjectivation, we will dwell, first, on some aspects of Walter Benjamin's philosophy regarding the importance of narratives and, in particular, that of fairy tales.

2 WALTER BENJAMIN AND THE VALUE OF NARRATIVE AND FAIRY TALES

Walter Benjamin wrote *The Narrator* in 1936. This work presents a diversity of ideas about the art of narrative that find great correspondence with the other key ideas of his work. The first of them refers to the art of narrative with history. Now, when you tell a story, you talk about something that has already happened. History is, by definition, melancholic, because its object, the past, is absent by definition. From his Jewish ancestry, Benjamin inherits the idea that history always has a truth to offer, occupying a relevant place in the whole of his philosophy.

For the thinker, the art of narrating goes back to the manual work of medieval artisans that harmonized with the rhythm and an experience of time, qualitatively different from what we have now. The best narratives, according to him, are the ones that are least different from those oral ones that were told during the work - the art of narrating would be linked to

handicraft and manual work, in which the rhythm of the work would provide the conditions for certain stories to be told. The intonation and the narrative itself were intertwined with the threads woven by the artisan's hands, in an inseparable articulation between gesture and word. The narrator has human life as his subject and establishes an artisanal relationship with it.

Storytelling has always been the art of telling them again, and it is lost when the stories are no longer preserved. It is lost because no one else spins or weaves while listening to the story. The more the listener forgets himself, the more deeply what is heard is engraved on him. When the rhythm takes hold of him, he listens to the stories in such a way that he spontaneously acquires the gift of narrating them. (BENJAMIN, 1985, p.205)

Corroborating what we said earlier, for Walter Benjamin, it is narratives that provide a deeper knowledge about life, are able to transmit 'advice' and truths and offer a way out of the most difficult situations. Silva explains to us:

Etymologically, for experience, the word Walter Benjamin uses is *Erfahrung*. Its root is "fahr" which means to travel. In Old German, "fahr" is to cross a region, during a journey, through unknown places. And the Latin word for experience has as its root "per" (experience): to leave a perimeter, to leave the condition of what is already known, of what has already been lived, to expand experiences, events and repercussions of these new events in our lives. And from "per" also comes the word *periculum*: crossing a region, during a trip, where dangers can assault us. And, for these dangers, there is the word that is associated with *periculum*, which is *oportunos* – originating from *portus*, which means exit. So, the experiences that happen to us during a journey into the unknown, on a journey, are experiences that broaden our identity, our knowledge, our sensitivity, our condition in the world. Now, at present, with the contraction of time, experience has been abolished. Experience was something that was transmitted from generation to generation, in the sense that: communicable narratives were made as exemplary models of teachings for generations to come. (SILVA apud Matos, p. 159)

The practice of telling and listening to stories are activities as old as man himself. In this sense, orality has always been present in the genesis of all literature and especially in children's literature. According to Benjamin, the fairy tale is the first counselor of humanity, it offers comfort and help through the advice poured out of manifest and latent conflicts. In terms of narrative, for the thinker, he surpasses myth:

The fairy tale taught humanity many centuries ago, and continues to teach children today, that the most advisable thing is to face the forces of the mythical world with cunning and arrogance. The liberating spell of the fairy tale does not stage nature as a mythical entity, but indicates its complicity with the liberated man. The adult only perceives this complicity occasionally, that is, when he is happy; For the child, it

appears for the first time in the fairy tale and provokes in him a feeling of happiness. (BENJAMIN, 1985, p.215)

In this way, we will find in Benjamin not only the value of narratives through the concept of *Erfahrung*, in the construction of subjectivity, but of the primacy of the fairy tale over myth – he transmits an experience from which one can extract 'advice' for life. In fairy tales, although there are spells and magic potions that make use of elements of nature, in Benjamin's philosophy, nature is a friend and ally of man, because man and nature are works of the same creator and lament the loss of the initial paradisiacal state.

In addition, the central characters of fairy tales find happiness precisely because they have remained virtuous, even though they live miserably. They are persevering to the point of making good prevail over evil and obtain redemption, unlike what happens in myth.

Walter Benjamin highlights the fundamental importance of orality in the fairy tale tradition, a practice that he considers essential for maintaining the relevance and vitality of these stories over time. According to the German thinker, the oral transmission of fairy tales allows these narratives not only to survive, but also to transform, adapting to the cultural, social, and historical changes of each era. Through orality, stories are shaped by the collective experiences, values, and needs of each generation, ensuring that they continue to be a source of wisdom and moral guidance.

And, among the written narratives, the best are those that are least distinguished from the oral histories told by the numerous anonymous narrators. Between these, there are two groups, which interpenetrate each other in multiple ways. The figure of the narrator only becomes fully tangible if we keep these two groups in mind. (BENJAMIN, 1985, p.198)

Regarding *Erfahrung's concept*, we ask ourselves the following question: Could it be that in the contemporary world, dominated by digital technologies and social networks, are these fairy tales that are appropriated by the entertainment industry, even if they make very interesting reinterpretations, capable of providing children with this collective experience? Or is she being reduced to a mere experience – '*Erlebnis*', an inauthentic experience?

The great difference between these two concepts focuses on the idea that *Erfahrung's* concept presents the idea of a community, in which the subject is perfectly integrated, enabling him to sediment learning over time. Benjamin points out that modernity has been showing a decline in this experience, as the subject is isolated in an increasingly fragmented society.

The result was the predominance of an attitude of disorientation thanks to the fragmented character of impressions: discontinuous experience or perception, which is opposed to experience (*Erfahrung*) characterized by the attachment to personal memory and reflection: In the modern world, all psychic energies have to be concentrated in immediate consciousness, in order to intercept the shocks of everyday life, which involves the impoverishment of other instances, such as memory, and with this the 'modern hero' loses all contact with tradition, becoming a victim of amnesia (ROUANET, 1993, p. 64). (LIMA; MAGALHÃES, 2010, p.148)

Walter Benjamin's reflections on the decline of experience, in this sense, take up this question: even though fairy tales undergo adaptations and rereadings, is it still possible to make meaningful the child's approach to these tales, presented through the most diverse dynamics and media? It seems to us that, although these media offer new ways of telling these stories, they also have the merit of fixing these narratives in a way that arouses interest so that they can be read later. However, the fluidity and adaptability of oral tradition can be severely compromised in the light of Benjamin's ideas.

3 THE VALUE AND TEACHINGS OF FAIRY TALES

Walter Benjamin discusses the importance of narratives as the possibility of carrying out an experience lived and shared collectively over time. In his work, he differentiates "*Erfahrung*" from "*Erlebnis*," which refers to individual, momentary and isolated experiences, typical of modernity. Traditional storytelling is a form of "*Erfahrung*" because it transmits the accumulated knowledge and practical wisdom of generations. These stories are not just accounts of events, but carriers of deep meanings that help shape the collective understanding of the world and human relationships.

He also states that the fairy tale is the greatest counselor of children. It is in him that the true narrator is found, without a doubt he knows how to give good advice and propitiates the child that it is through courage, which is a kind of confrontation with the forces of the world of myth, that fear is lost; And then this child gets a taste of the feeling of being happy. The fairy tale passed on teachings to humanity: the kindness and friendly relationship of man with nature are present, according to Benjamin: "the character of the animal that rescues a child shows that nature prefers to associate itself with man than with myth". (BENJAMIN, 1985, p.215).

The mythical characters exist in the narrative to save human life, they are beings: just, wise, kind and consoling of humanity. The fairy tale manages to show man the path to be followed through the courage of choice and humanization from the advice that permeates it. In it, the "voice of nature" stands out, in which there is a reconciliation of man with her, showing how part of it and they as friends show the elective affinity between souls who are

good and their tendency to help each other. It is not uncommon in these tales to see animals helping the heroes in their journey. As with myths (observing their differences), fairy tales provide models for human conduct, as we follow in the footsteps of Benjamin's philosophy.

Both in Benjamin and in psychoanalysis, narratives always have a utility that can be translated as a moral teaching, a practical suggestion or a norm of life.

Fairy tales come with this purpose, as they address issues that refer to conscious and unconscious conflicts experienced during life and especially during childhood, facilitating the emotional and psychological maturation of the human being. 'Fairy stories speak to our conscious and our unconscious, as they easily coexist in our unconscious.' (BETTELHEIM, 2007, p.242)

However, for Mircea Eliade, in contemporary times, fairy tales will become entertainment, and with the cultural industry, entertainment. However, its structure retains its value and its initiatory character:

Although in the West the marvellous tale has long since become a literature of amusement (for children and peasants) or of evasion (for the inhabitants of the cities), it still presents the structure of an infinitely serious and responsible adventure, for it is reduced, in short, to an initiatory plot: in it we always find the initiatory tests (fights against the monster, seemingly insurmountable obstacles, puzzles to be solved, impossible tasks, etc.) the descent into hell or the ascension to Heaven (or - what comes to the same - death and resurrection) and marriage to the Princess. It is true, as Jan de Vries rightly pointed out, that the story always concludes with a *happy ending*. (ELIADE, 1972, p. 173)

In view of the previous considerations, we will seek to understand the relevance of fairy tales for the formation of the *psyche* through the psychoanalysis of these narratives and, especially, of the tale of Snow White, which we will discuss below. Following the thoughts of Walter Benjamin, in addition to the issues already addressed, we can observe in his work reflections on specific themes that stand out for the depth of his cultural and historical analysis. A striking example of this is his interpretation of the short story "Sleeping Beauty".

Benjamin reflects on how "*Sleeping Beauty*" can be interpreted as a metaphor for power dynamics and the passage of time in monarchical societies. The sleeping princess's long wait symbolizes stagnation or a transitional period in monarchies, in which power is suspended, awaiting a significant change, often represented by the arrival of a new ruler. This interpretation suggests that the tale goes beyond a simple fantasy story, also functioning as an allegory of the political and social realities of its time.

By analyzing fairy tales such as "*Sleeping Beauty*," Benjamin points out how these narratives reflect a society's anxieties and hopes, often related to shifts in power and

uncertainty about the future. Thus, the tale can be read as a commentary on the cyclical nature of history, in which periods of inactivity and expectation are followed by moments of renewal and transformation.

Fairy tales are filled with symbols and metaphors that carry deep meanings, allowing for multiple interpretations and analyses. Each story offers a rich tapestry of symbolic elements that reflect psychological, cultural, and social aspects.

In addition, some professionals use fairy tales in the clinical context, both in the treatment of adults and children, to help understand and express feelings, anguish, and emotions that are often difficult to understand on their own. This practice is especially common in children who find themselves in situations of vulnerability or illness, as they tend to identify their pain and frustration with the adversities faced by the characters in the stories. This identification facilitates the openness to talk about their own problems, as they recognize themselves in the narratives of the tales.

Reading or narrating fairy tales is considered a powerful tool to provoke deep reflections, even when the child is alone in his room, whether during the day or at night. By recalling history, you can feel more comforted, finding relief and understanding in the midst of your own challenges.

History, in addition to its reflective value, is seen as one of the transitional tools that can enrich the therapeutic work, as highlighted by Hisada Hilst, when addressing the encounter that occurs, during the analytic session, between the patient and his analyst. It is in this meeting space, known as potential space, that the process of illusion manifests itself, influencing the formation of human subjectivity. The use of stories in the analytical context has the power to improve the patient's communicative pattern, promoting a more effective way of expressing and understanding their emotions.

According to Caldin, the pleasure generated by reading fairy tales produces joy, and this joy has a therapeutic effect. This effect is particularly significant because children feel a deep relief and satisfaction when they see that, at the end of the story, everything ends well. In this way, fairy tales not only entertain but also play a crucial role in the emotional healing and psychological empowerment of children.

Tales and stories are, therefore, an excellent transitional medium, acting as a kind of therapeutic play. According to the theory presented by Winnicott, it is through playful action that the individual is able to favor human maturation, emphasizing, with this, the importance of emotional and psychological development.

In this way, the use of stories in a clinical context not only enriches the therapeutic experience but also plays a crucial role in the healing process and the patient's personal growth.

Winnicott, when discussing the importance of play in psychoanalysis, states:

I can now restate what I am trying to convey. I wish to draw attention away from the sequence of psychoanalysis, psychotherapy, play material, play, and propose all this again, in reverse. In other words, it is play that is universal and that is proper to health: play facilitates growth and, therefore, health; play leads to group relationships; Playing can be a form of communication in psychotherapy; Finally, psychoanalysis was developed as a highly specialized form of play, in the service of communication with oneself and with others. (WINNICOTT, 1975, p.70).

The child begins to engage with the stories by adding details, characters, or even remembering events that the narrator may have left out. These narratives are essential for children to build their identity, better understand family dynamics, and, in addition, develop a significant affective bond with those who are telling the story.

The analysis of fairy tales proposed by Bruno Bettelheim in *"The Psychoanalysis of Fairy Tales"* and Winnicott's reflection in *"Playing and Reality"* on the relationship between mother and baby offer a rich and complementary perspective on human emotional and psychological development, especially in childhood.

By connecting the ideas of Bettelheim and Winnicott, we can see how the tale of "Snow White" can be interpreted as a narrative that addresses the breakdown and transformation of the mother-child relationship. The stepmother symbolizes the negative aspect of the maternal figure, which threatens the development of the child's autonomy. However, it is through overcoming the challenges presented by this threatening figure that Snow White, like the child, manages to reach emotional maturity, a theme that we will address below.

4 THE PSYCHOANALYSIS OF FAIRY TALES: ANALYSIS OF SNOW WHITE

In the story of Snow White, according to the Brothers Grimm, it is possible to notice the queen's happiness at being pregnant. She was in the castle sewing something near the window watching the snowflakes fall softly, when suddenly she pricked her finger with a needle. When she saw her blood flow and mix with the snow, she found the image beautiful and wished that her daughter had skin as white as snow, lips as red as blood and hair as black as the wood of the window. After giving birth to a girl named Snow White, the queen passed away: "Some time later, she had a daughter, who was white as snow, red as blood, and had hair as black as ebony. They named her Snow White, but when she was born, the queen died." (GRIMM, p.1)

After the birth of his heiress and the death of the queen, the King after a year, remarries. The new queen was beautiful and extremely vain. So she couldn't bear the thought of anyone being more beautiful than her. In possession of a magic mirror, the queen asked him: "Who was the most beautiful woman in the country?" And he always replied that he was the queen. However, time passed and Snow White, with each passing day, became more beautiful. Once, when Snow White was already a beautiful girl, the mirror answered the usual question, stating that Snow White was the most beautiful woman.

The queen's vanity and the idea of not being the most graceful in the kingdom made her ask the huntsman to take the girl to the forest and kill her, also demanding that he bring her liver and lungs so that the cooks could prepare them for her dinner:

The queen swallowed, turned yellow and green with envy. Every time she looked at Snow White after that, she hated her so much that her blood even boiled in her chest. Envy and pride grew like weeds within the queen's heart until she could not have a moment of quiet, neither night nor day. Finally, he sent for a hunter and said:
- Disappear with this girl in front of me. I want you to take it to the bottom of the forest and kill it. To prove that you really did it, bring me her lungs and liver. (GRIMM, p. 01)

The hunter, however, was not brave enough to kill the princess because of her beauty (he either took pity on her or imagined that the animals of the forest themselves would soon do this job). Snow White fled through the forest at night, very frightened and afraid of the dangerous and hungry animals. After walking for hours, he saw a small house. So, she went in and noticed that everything was small, organized and clean, she looked at the table where there was a white tablecloth, seven plates, forks, knives and mugs, she ate and drank a little of each plate and mug, she looked for a place to take a nap, one bed was too small, another was too wide, one was cramped until she found a perfect one to sleep in.

The dwarfs arrived from work in the mine and noticed that someone had entered their house: the chairs were messy, the dishes were missing food, some mugs were empty, and their beds were unmade. Until one of them realized that there was someone lying on his bed, when they got close they found Snow White so beautiful that they did not have the courage to wake her:

"God in heaven!" they cried, 'God in heaven! What a beautiful girl!' They were so amazed at her that they didn't even wake her up, but they let her continue sleeping in the bed. The seventh dwarf slept with his companions, an hour with each one, and then the night was over." (GRIMM, p. 06)

The dwarfs woke up early as usual and asked the girl what her name was, she replied, apologized and told her story. Compassionate, the dwarves allowed her to stay, as long as she kept the house clean, washed the dishes, and prepared dinner.

The dwarfs said, "If you take care of our house, cook for us, make the beds, wash, sew, and darn our clothes, and keep everything neat and tidy at all times, you can stay with us, and you will never lack anything." - Good! - said Snow White - I would love it... And that's how she took care of the house. Every morning they went out to the mountain to pan for gold and silver, and every night they came home and she had to have made dinner. But she spent all day alone, and the kind dwarfs thought it good to warn: "Be very careful with your stepmother. She'll soon find out that you're here. Don't let anyone in, ever. (GRIMM, p. 07)

Days later, the queen went to the mirror to ask again who the most beautiful woman was, firmly believing that the mirror would give her the answer she expected. The mirror then betrays Snow White. She had been tricked by the hunter. Faced with this, he decides to kill her personally. First, she dresses like a peasant girl and sells Snow White a beautiful bodice. This one, as soon as she put it on, ran out of air, almost suffocated to death and, luckily, the dwarves arrived in time to save her. The second attempt was the sale of a hair comb that, when placed, would cause the princess to fall into a deep sleep, again the dwarves saved her. In the last attempt, the stepmother poisoned an apple – and as soon as Snow White bit it, she fell to the ground as if she were dead.

The dwarves, when they found her fallen, imagined her dead. They then placed her in a glass coffin so that everyone who walked by could see her beauty. One day, a prince approached the coffin, came across the princess and decided to take her, because he had been amazed and enchanted by such beauty. She wanted to pay the dwarfs to keep her. His sudden passion also did not let him move away from the princess. Moved, the dwarves allowed him to take her, as they found no solution to the situation. As the coffin moved, the piece of apple that was stuck in Snow White's throat came loose and she awoke.

The prince told her what had happened and confessed his love to her and immediately asked her to marry him. Snow White accepted the proposal, as she had also fallen in love with the prince.

Snow White's stepmother was invited to the wedding. After getting ready for the ceremony, he stopped in front of the mirror and asked again if she was still the most beautiful: the mirror replied that the most beautiful was the new queen.

Lady Queen, you are the most beautiful one that is here, but the young queen is a thousand times more beautiful than all the beautiful ones out there. Hearing this, the evil one cursed and cursed. She was so horrified that she didn't know what to do. At

first he did not want to go to the wedding, but he could not resist the curiosity of seeing the young queen. The moment she entered the hall, she recognized Snow White and was so terrified that she couldn't even move. But they had already ordered two iron slippers to be put on the coals. Someone took them out with tongs and placed them in front of her, who was forced to put on her red-hot shoes and dance until she fell dead. (GRIMM, p. 12)

For Walter Benjamin, fairy tales can show man the path to be followed through courage, choice and humanization from the advice that permeates him. In it stands out the "voice of nature" in which there is a reconciliation of man with her, showing him as part of it, and they as friends, evidencing the elective affinity between souls that are good, and their tendency to help each other. It is not uncommon in these tales to see animals helping the heroes in their journey. As with myths (observing their differences), fairy tales provide models for human conduct, as we follow in the footsteps of Benjamin's philosophy.

Both in Benjamin and in psychoanalysis, narratives always have a utility that can be translated as a moral teaching, a practical suggestion or a norm of life.

Fairy tales come with this purpose, as they address issues that refer to conscious and unconscious conflicts experienced during life and especially during childhood, facilitating the emotional and psychological maturation of the human being. 'Fairy stories speak to our conscious and our unconscious, as they easily coexist in our unconscious.' (BETTELHEIM, 2007, p.242)

The analysis we intend to make about the tale of *Snow White* is not exhausted in the space available for this article. We aim to present some key ideas that focus on family relationships, in the light of the work *The Psychoanalysis of Fairy Tales* by Bruno Bettelheim. Thus, Bettelheim's analysis of "*Snow White*" can be enriched by Winnicott's understanding of the importance of play and transitional space in the formation of identity. Both perspectives underline the complexity of family relationships and the importance of distancing and symbolic elaboration for healthy emotional development. Ultimately, fairy tales, such as the one in "*Snow White*," not only entertain but also offer a narrative structure that allows the child to explore and understand the challenges inherent in growing up and separating from the family world.

The challenges inherent to growing up and separating from the family world, addressed by both Bruno Bettelheim and Winnicott, are central to understanding children's emotional development. In "*The Psychoanalysis of Fairy Tales*", the author argues that tales like "*Snow White*" are not just entertainment stories, but symbolic narratives that help the child to face and elaborate the emotional conflicts that arise as he grows up and distances himself from the family nucleus.

In this tale, the stepmother represents an archetypal challenge: the confrontation with a maternal figure who not only ceases to be protective, but who becomes a direct threat to the child's development. This conflict symbolizes the painful but necessary process of separation of the child from the mother, a process that is both psychological and emotional. The stepmother, in trying to eliminate Snow White, personifies the difficulties that the child faces when trying to establish her own identity, independent of maternal expectations and influences.

Winnicott, in *"Playing and Reality"*, offers a complementary perspective when discussing the concept of transitional space, which is the psychological environment in which the child learns to exist separately from the mother, developing a sense of *autonomous self*. According to Winnicott, this space is crucial for the child to be able to begin to explore the outside world, while still feeling safe within the structure of their family world. Playing is a central activity in this process, as it allows the child to experience independence in a safe and controlled way, creating a balance between dependence on maternal care and the need for autonomy. It is worth highlighting at this point, the stepmother's magic mirror: a powerful symbol of vanity and narcissism. The mirror not only reflects the stepmother's obsession with her own beauty, but also functions as a device that feeds her insecurity and cruelty, as she finds herself constantly threatened by Snow White's youth and purity. These two elements, vanity and narcissism, also adulterate the healthy relationship between parents and children.

When we connect Bettelheim's and Winnicott's ideas, we can see that the challenges of growth and separation are represented in fairy tales as critical phases of child development. The distancing from the maternal figure, whether represented by the mother or a stepmother, requires the child to face fears, insecurities and, eventually, discover new ways of existing in the world.

Another metaphorical representation of this growth that we can highlight takes place in the space of the forest. This represents the child's inner world, a space where he must confront the unknown and his own weaknesses in order to emerge stronger and more independent. The forest, where Snow White takes refuge, can be seen as the transitional space described by Winnicott, in which the character is removed from maternal protection and under the imminent threat of her stepmother. It is in this scenario that the child will discover himself and build his identity.

This process of isolation and self-knowledge, although painful, is essential for emotional growth, reflecting the need for separation from the maternal figure so that the child can fully develop. It is also worth mentioning the figure of the hunter, which carries an equally deep symbolism, in which his figure represents danger and salvation. It represents the

possibility of moral choice, showing that even in a world full of evil, there is room for compassion and a change of heart. This act of mercy also allows the narrative to continue, leading Snow White to face new challenges and eventually find her own identity and strength.

Therefore, the huntsman in "Snow White" can be seen as an embodiment of human duality—the ability to harm or protect, to blindly obey cruel orders or to act in accordance with higher moral principles. It serves as a catalyst for Snow White's journey, pushing her into the woods, where true transformation and growth can happen.

For Bettelheim, fairy tales provide the child with a symbolic script to deal with these challenges. They show that while separation and growth can be painful and daunting, they are also necessary for the development of a solid and resilient identity. For Winnicott, the process of playing offers a means by which the child can smooth the transition between dependence on the mother and the discovery of himself, as a separate individual.

Therefore, both Bettelheim and Winnicott underline the importance of addressing these challenges of growth and separation, recognizing that they are key steps in healthy emotional and psychological development. Fairy tales, by dramatizing these internal struggles, allow children to symbolically experience these difficult transitions, preparing them for the real challenges they will face as they grow up to become independent adults. Thus, the tale of "Snow White", like many others, uses these symbols to explore universal themes such as the conflict between good and evil, envy, ephemeral beauty, and the inevitability of change.

4 FINAL CONSIDERATIONS

First of all, it is necessary to emphasize that the article has the merit of deepening the interfaces between philosophy and psychology within the academic sphere through the fairy tale. Second, because fairy tales, understood as oral narrative, with *Erfahrung*, contribute significantly to the processes of subjectivation.

In this way, we intend to contribute to our studies on psychoanalysis in an attempt to offer possibilities for qualitative changes to occur in the relationships between parents and children, making them healthier. Thus, we intend to contribute to the advancement of an interdisciplinary modality of studies, as it recovers the dialogue of various areas of knowledge, making this production significant, as it demanded research from us, a necessary condition for the continuation of our studies.

We emphasize that fairy tales play a fundamental role in the subjective formation of children, providing not only entertainment, but also learning and emotional development. Their origin dates back to ancient times, being transmitted orally through various cultures

before being adapted and recorded by writers such as Charles Perrault and the Brothers Grimm. Initially intended for an adult audience, these tales have been modified over time to meet children's needs, introducing moral lessons and narratives structured in challenges, overcoming, and happy endings.

In addition to their playful character, fairy tales represent a process of symbolic initiation, as pointed out by Mircea Eliade, preparing the child to face real-life challenges. They connect the conscious and the unconscious, allowing little ones to develop emotional resilience and better understand the world around them. Thus, the relevance of these narratives goes beyond simple enchantment, becoming a valuable means for the psychological, cultural and philosophical development of humanity.

From Walter Benjamin's reflections, it becomes evident that fairy tales have an essential narrative value, functioning as transmitters of experience and knowledge throughout the generations. Their traditional orality allowed these stories to be molded to the needs and values of different times, providing not only entertainment, but also fundamental advice and teachings for the construction of subjectivity. However, Benjamin points out that modernity brought with it a rupture in the transmission of this experience (*Erfahrung*), replacing it with fragmented and superficial experiences (*Erlebnis*). The advancement of digital media and the entertainment industry, although it has contributed to the diffusion and reinvention of fairy tales, also raises the question of whether these new forms of narrative still preserve the richness and depth of oral versions.

Thus, the challenge of today's society is to find a balance between innovation and tradition, ensuring that stories continue to play their formative role in childhood. Despite the changes in the way tales are told, their power to convey values and assist in children's emotional development remains, as long as there is an effort to preserve their narrative essence and their connection to the human experience.

From the above, it is evident that fairy tales have a significant value both in cultural transmission and in the psychological and emotional formation of the individual. As presented by Walter Benjamin, these narratives are more than simple stories; They carry profound teachings, transmitted over generations, helping to build the collective experience and understand the world. In addition, the psychoanalytic analysis of authors such as Bettelheim and Winnicott demonstrates how these stories help in the emotional maturation of children, allowing them to face fears, internal conflicts, and life challenges in a symbolic and transformative way. Even in the face of modernization and the influence of the cultural industry, fairy tales maintain their initiatory structure and therapeutic potential, serving as a

valuable tool for the development of human subjectivity and for the understanding of interpersonal relationships.

The psychoanalytic analysis of "Snow White" allows us to understand that fairy tales are not only playful narratives, but also symbolic representations of the emotional and psychological challenges faced in child development. From the contributions of Bruno Bettelheim and Donald Winnicott, it can be seen that this tale approaches, in a metaphorical way, the separation of the maternal figure, the construction of identity and the emotional maturation of the child.

The stepmother represents the necessary break between the child and maternal protection, while the forest symbolizes the transitional space in which the process of self-discovery takes place. In addition, Snow White's journey illustrates the challenges of growing up and seeking autonomy, showing how facing adversity is fundamental for the formation of an independent *self*.

Fairy tales, therefore, play an essential role in the child *psyche*, helping the child to elaborate their fears, insecurities and desires through symbolic identification. At the end of the narrative, the outcome of Snow White reaffirms the overcoming of challenges and the achievement of maturity, demonstrating that the journey of growth, although full of difficulties, leads to development and independence. In this way, "Snow White" remains a timeless example of the structuring function of fairy tales in the emotional and psychological construction of the individual.

REFERENCES

- Benjamin, W. (1985). O narrador. In Obras escolhidas (Vol. 1). Brasiliense.
- Bettelheim, B. (1980). A psicanálise dos contos de fadas. Paz e Terra.
- Eliade, M. (1972). Mito e realidade. Editora Perspectiva.
- Falconi, I. M. (2015). Contos de fadas: Origem e contribuições para o desenvolvimento da criança. Recuperado em 2 de dezembro de 2024, de <https://unifafibe.com.br/revistasonline/arquivos/cadernodeeducacao/sumario/35/06042015200330.pdf>
- Flick, U. (2009). Introdução à pesquisa qualitativa (3ª ed.). Artmed.
- Grimm, I. (n.d.). Branca de Neve. Recuperado em 2 de dezembro de 2024, de https://www.grimmstories.com/pt/grimm_contos/branca_de_neve
- Lima, F. G. G., & Magalhães, S. M. C. (2010). Modernidade e declínio da experiência em Walter Benjamin. Acta Scientiarum: Human and Social Sciences, 32(2). Recuperado em 8 de dezembro de 2024, de <https://www.redalyc.org/pdf/3073/307325336004.pdf>

Schneider, R. E. F., & Torrosina, S. D. (2009). Contos de fadas: De sua origem à clínica contemporânea. *Psicologia em Revista*, 15(2), 132–148. Recuperado em 2 de dezembro de 2024, de <https://periodicos.pucminas.br/index.php/psicologiaemrevista/article/view/P.1678-9563.2009v15n2p132/873>

Winnicott, D. W. (1975). *O brincar e a realidade*.

Silva, C. A. (2011). A questão da experiência em Marx, Benjamin e Adorno e suas implicações. *Revista Aurora*, 5(9). Recuperado em 2 de dezembro de 2024, de <https://revistas.marilia.unesp.br/index.php/aurora/article/view/1711>

AUTO SOLDERING: AUTOMATION OF THE SOLDERING PROCESS FOR TRANSFORMER COIL TERMINALS

AUTO SOLDERING: AUTOMAÇÃO DO PROCESSO DE SOLDAGEM DOS TERMINAIS DAS BOBINAS APLICADAS A TRANSFORMADORES

AUTO SOLDERING: AUTOMATIZACIÓN DEL PROCESO DE SOLDADURA DE TERMINALES DE BOBINAS APLICADAS A TRANSFORMADORES



<https://doi.org/10.56238/sevened2026.008-217>

Alexandre Holanda Damasceno¹, Léo Fernando Castelhana Bruno², Maria de Lourdes Santos de Lima³, Victor Abreu dos Santos⁴, Luis Felipe Trindade Natário⁵

ABSTRACT

This article describes the development of the AUTO SOLDERING project, the result of an PD&I initiative conceived and executed by B&Z International in the industrial context, with its scientific production coordinated by IITA. The project is aimed at the design and implementation of an automated tin immersion soldering system applied to transformer coil terminals used in cell phone chargers. The initiative stems from the need to replace the manual and semi-automatic process currently employed, which exposes operators to health and safety risks and presents instabilities regarding repeatability, reproducibility and control of critical parameters. The proposed solution is based on an integrated hardware and software prototype capable of automating the stages of insertion, handling, fluxing, immersion soldering and transfer of the product to the subsequent stage. The system includes control of essential variables (time, depth and immersion angle) and continuous monitoring of temperature, weld volume and cycle time. As a differential, it uses embedded intelligence for real-time decision-making, aiming at operational stability and quality standardization. Additionally, it allows the collection and availability of productive data for integration into the CMES system through XML files, supporting performance indicators and traceability. The development considers ergonomics, occupational safety and compliance with NR-12. As expected results, the elimination of operator exposure to the process, increased efficiency and availability, improved quality and greater control of production indicators stand out, characterizing incremental process innovation applied to the industrial context.

Keywords: Industrial Automation. Dip Soldering. Electronic Transformers. Occupational Safety. Process Control.

¹ Master's degree in Engineering. Instituto de Inovação e Tecnologia da Amazônia (IITA).
E-mail: alexandre@iita.org.br

² Dr. in Business Administration. Califórnia American Universit. Instituto de Inovação e Tecnologia da Amazônia (IITA). E-mail: leo.bruno@iita-am.org

³ Master's student in Electrical Engineering. Universidade Federal do Amazonas (UFAM), B&Z International.
E-mail: maria.lima@bezinternational.com

⁴ Graduated in Mechanical Engineering. Instituto Federal do Amazonas (IFAM). B&Z International.
E-mail: victor.abreu@bezinternational.com

⁵ Graduated in Electrical Engineering. Nilton Lins. B&Z International.
E-mail: luis.natario@bezinternational.com

RESUMO

O presente artigo descreve o desenvolvimento do projeto AUTO SOLDERING, fruto de uma iniciativa de PD&I concebida e executada pela B&Z International no contexto industrial, tendo sua produção científica coordenada pelo IITA. O projeto é voltado à concepção e implementação de um sistema automatizado de soldagem por imersão em estanho aplicado aos terminais de bobinas de transformadores utilizados em carregadores de telefones celulares. A iniciativa decorre da necessidade de substituir o processo manual e semiautomático atualmente empregado, que expõe operadores a riscos de saúde e segurança e apresenta instabilidades quanto à repetibilidade, reprodutibilidade e controle de parâmetros críticos. A solução proposta baseia-se em um protótipo integrado de hardware e software capaz de automatizar as etapas de inserção, manuseio, limpeza em fluxo, soldagem por imersão e transferência do produto à etapa subsequente. O sistema contempla controle de variáveis essenciais (tempo, profundidade e ângulo de imersão) e monitoramento contínuo de temperatura, volume de solda e tempo de ciclo. Como diferencial, utiliza inteligência embarcada para tomada de decisão em tempo real, visando estabilidade operacional e padronização da qualidade. Adicionalmente, permite coleta e disponibilização de dados produtivos para integração ao sistema CMES por meio de arquivos XML, suportando indicadores de desempenho e rastreabilidade. O desenvolvimento considera ergonomia, segurança ocupacional e conformidade com a NR-12. Como resultados esperados, destacam-se a eliminação da exposição do operador ao processo, aumento de eficiência e disponibilidade, melhoria da qualidade e maior controle dos indicadores produtivos, caracterizando inovação incremental de processo aplicada ao contexto industrial.

Palavras-chave: Automação Industrial. Soldagem por Imersão. Transformadores Eletrônicos. Segurança do Trabalho. Controle de Processos.

RESUMEN

Este artículo describe el desarrollo del proyecto AUTO SOLDERING, resultado de una iniciativa de PD&I concebida y ejecutada por B&Z International en el contexto industrial, cuya producción científica está coordinada por el IITA. El proyecto tiene como objetivo el diseño e implementación de un sistema automatizado de soldadura por inmersión de estaño aplicado a los terminales de bobina de transformador utilizados en cargadores de teléfonos móviles. La iniciativa surge de la necesidad de sustituir el proceso manual y semiautomático actualmente empleado, que expone a los operadores a riesgos para la salud y la seguridad y presenta inestabilidades en cuanto a repetibilidad, reproducibilidad y control de parámetros críticos. La solución propuesta se basa en un prototipo integrado de hardware y software capaz de automatizar las etapas de inserción, manejo, limpieza de flujos, soldadura por inmersión y transferencia del producto a la siguiente etapa. El sistema incluye el control de variables esenciales (tiempo, profundidad y ángulo de inmersión) y monitorización continua de la temperatura, el volumen de soldadura y el tiempo de ciclo. Como diferencial, utiliza inteligencia integrada para la toma de decisiones en tiempo real, con el objetivo de lograr la estabilidad operativa y la estandarización de calidad. Además, permite la recopilación y disponibilidad de datos productivos para su integración en el sistema CMES mediante archivos XML, apoyando indicadores de rendimiento y trazabilidad. El desarrollo tiene en cuenta la ergonomía, la seguridad laboral y el cumplimiento de la normativa NR-12. Como resultados esperados, destacan la eliminación de la exposición del operador al proceso, el aumento de la eficiencia y disponibilidad, la mejora de la calidad y un mayor control de los indicadores de producción, caracterizando la innovación incremental de procesos aplicada al contexto industrial.

Palabras clave: Automatización Industrial. Soldadura por Inmersión. Transformadores Electrónicos. Seguridad Laboral. Control de Procesos.

1 INTRODUCTION

The search for efficiency and safety in electronic manufacturing processes has driven the transition from manual methods to intelligent automation systems. This article presents the development of the AUTO SOLDERING project, whose objective is the design and implementation of an automated system for the immersion soldering of transformer coil terminals. The initiative is based on the need to replace manual and semi-automatic processes that, in addition to exposing operators to occupational risks, present technical instability. According to Rosário (2005), automation is essential in processes that require high repeatability, as active systems are capable of acting with optimal efficiency when processing information from the environment in real time.

Although the techniques of joining materials are ancestral, their technological evolution has allowed systemic integration in several global industrial segments, consolidating itself as a critical stage in sectors such as the two-wheeled pole, white goods, electronics and portable appliances. According to Rosário (2005), the evolution of these processes is driven by the need for precision and structural integrity, where automation acts as the link between conventional metallurgy and advanced manufacturing. As Groover (2011) points out, welding and other joining processes are fundamental in the assembly of complex products, requiring strict parameter control to ensure final quality in high-productivity environments.

The implementation of automation introduces a disruptive paradigm in production models, simultaneously boosting operational efficiency and the qualitative reliability of the final product. In addition to increasing production, the technological transition in critical processes acts as a fundamental agent in promoting the safety and health of the operator, by mitigating exposure to unhealthy environments or ergonomic risks. According to Rosário (2005), automation allows the active system to perform dangerous or exhausting tasks with precision superior to human accuracy, ensuring that the physical integrity of the worker is preserved without prejudice to throughput. In this sense, Groover (2011) reinforces that automation does not only aim to replace manual effort, but to create a work environment where control technology absorbs risk variables, resulting in a more humane, stable and safe industrial process.

This article aims to highlight the transition from the manufacturing model of an industrial welding process to the automated system, evaluating the effectiveness of the mitigation of production anomalies, as well as the increase in efficiency and quality as well as the reduction of risks to the health and physical integrity of the operator. As highlighted by Rosário (2005) and Groover (2011), this transition is essential to convert rigid systems into intelligent and safe manufacturing cells.

To achieve this central objective, the following specific objectives were established: technical survey through the realization of a detailed diagnosis of the current process and the identification of the root causes of its critical problems; proposal of a solution by exposing the architecture of the developed automated model, detailing its embedded intelligence and control mechanisms; comparative analysis with the execution of a quali-quantitative study between the manual and automated models, validating the performance gains and compliance with safety standards.

2 THEORETICAL FRAMEWORK

The theoretical framework of a study consists of a critical and systematized analysis of the literature pertinent to the theme, with the objective of providing the theoretical contextualization of the research and delimiting its fundamental concepts. The following topics present the main conceptual constructs that support and guide the development of this work.

2.1 INDUSTRY 4.0

Industry as it is known today is the result of numerous transformations over the decades, transformations resulting from revolutions, studies and technological evolution and modernity of societies. For Boettcher (2015), Industry 4.0 is the result of industrial revolutions and great technological advances.

2.1.1 First Industrial Revolution – Industry 1.0

The earliest forms of civilization produced goods strictly according to their immediate needs, through predominantly manual processes, characterized by artisanal production. With demographic growth, the need to settle in permanent housing and social organization in villages and small groups, a significant change in human behavior began, which resulted in the emergence of new demands and increased consumption.

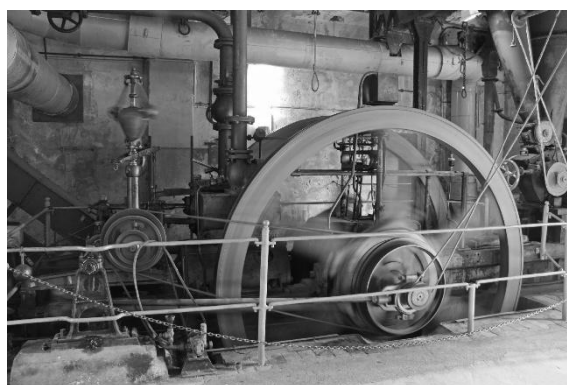
The migration of the population from the countryside to urban centers intensified this process, promoting transformations in the market with the aim of stimulating consumption. In this context, new services and activities aimed at the urban population have emerged, such as cinemas, clothing stores and the sale of low-cost electronics. The growing demand for consumer goods required the reformulation of production processes, since artisanal production was no longer able to meet large-scale production while maintaining the standardization of products. Thus, factories emerged as an alternative to boost the retail market, with the adoption of organized labor in industrialized processes.

According to Cavalcante and Silva (2011), in addition to being more agile, production began to occur on a larger scale, contributing to the transformation of social culture through the consolidation of capitalism, whose main objective is to obtain profits.

According to Boettcher (2015), this revolution began in England between the end of the eighteenth century and the beginning of the nineteenth century, later extending to other countries, such as the United States, France, Belgium, Russia, Germany, and the Netherlands. The main characteristic of the First Industrial Revolution was the improvement of the steam engine, initially applied to the textile industry and later expanded to several other production processes.

Figure 1

Depiction of the First Industrial Revolution and the Steam Engine



Source: The Electric Sector (2010).

2.1.2 Second Industrial Revolution – Industry 2.0

Boettcher (2015) states that the main factor that promoted the emergence of new revolutions was the evolution of technologies, as they provided growth and modernization and a significant increase in profits. Around 1870, the Second Industrial Revolution emerged, driven by technological demand.

This transition was marked by the discovery of electricity, transformation of iron into steel, operationalization and modernization of means of transport, advancement of communication systems, development of the chemical industry, etc. The main characteristics of this revolution were the search for greater profits, specialization of work and application of production (SILVA; GASPARIN, 2013).

Fordism begins, the name for mass production, with the objective of rationalizing production through technical innovations, stimulating a new chain of mass production VS mass consumption, with Henry Ford as a precursor in 1914 (BOETTCHER, 2015).

Figure 2*Henry Ford - Fordismo*

Source: Business Insider (2012).

2.1.3 Third Industrial Revolution – Industry 3.0

In addition to the technological boost, there was also a renewal in the economic, political and social process, with great dynamism and high complexity in the twentieth and twenty-first centuries, according to Silva et al. (2012).

Also called the Third Revolution, Technical-Scientific and Informational, it was formed through processes of technological innovation, which are marked by advances in the fields of information technology, robotics, telecommunications, transportation, biotechnology, chemistry and nanotechnology (BOETTCHER, 2015).

Industry 3.0 has presented several outstanding characteristics, among which the use of multiple energy sources, the growing use of computer and automation resources, as well as the increase in environmental awareness, stand out. It was also observed the intensification of the replacement of human labor by increasingly modern machines, which contributed to the increase in structural unemployment. At the same time, there was the expansion of labor rights, the advance of the globalization process, the emergence of new industrial powers and the massification of technological products (SILVA et al., 2002).

2.1.4 Fourth Industrial Revolution – Industry 4.0

The concept of Industry 4.0 gained international visibility in 2011, when it was officially presented in Germany during the Hannover Messe. According to Kagermann et al. (2013), this initiative emerged as a strategic response to the need to increase the competitiveness of the German manufacturing sector in the face of technological transformations and the global economic scenario.

The following year, in 2012, those responsible for the development of the project, under the coordination of Siegfried Dais, representative of Robert Bosch GmbH, and Henning Kagermann, linked to acatech, prepared a document with guidelines and recommendations sent to the German Federal Government. This report served as the basis for the planning

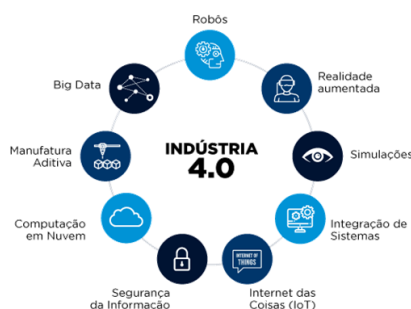
and implementation of the new industrial model. In 2013, still at the Hannover Fair, the final version of the Industry 4.0 concept was consolidated and released (Silveira, 2017).

This new industrial paradigm is associated with the intensification of digitalization and automation processes in manufacturing, promoting increasingly integrated and intelligent production environments (Oesterreich; Teuteberg, 2016). As Silveira (2017) points out, the essence of Industry 4.0 lies in the ability to interconnect machines, systems, and productive resources, allowing the formation of autonomous networks capable of making decisions and optimizing processes without constant human intervention.

From this perspective, Zawadzki and Zywicki (2016) state that Industry 4.0 represents the convergence of recent technological advances with a new vision of production, in which cyber-physical systems connect the physical to the virtual environment, enabling automated, intelligent and highly adaptable operations.

Figure 3

Top Industry Technologies



Source: Tecnicon (2022).

2.1.5 Industry 4.0 in Brazil

In the Brazilian context, Industry 4.0 is still in the early stages of development when compared to more industrially advanced countries, such as Germany, the United States, and Japan. According to Hahn (2017), this technological delay is mainly evidenced by the low replacement of traditional production lines by automated systems, whose adoption rate remains lower than that observed in developed economies.

Despite this scenario, the national industry shows efforts to insert itself in this new productive paradigm. According to the National Confederation of Industry (CNI, 2016), initiatives aimed at Industry 4.0 in Brazil initially focus on product improvement and the development of new business models, seeking greater efficiency and competitiveness.

Zancul (2016) points out that, although many Brazilian industries have already incorporated some level of automation, digital manufacturing has not yet been fully achieved. The author points out that Industry 4.0 is based on two fundamental dimensions, integrated

processes and innovative products, in which Brazil still has limitations, reflected in the reduced number of competitive sectors on a global scale.

In addition, it is observed that several national companies are still in the process of transition to the Third Industrial Revolution, living with different levels of technological maturity. However, as Santos (2017) points out, there is the possibility of accelerating this process through the direct adoption of technologies associated with Industry 4.0, especially by small and medium-sized companies, which can obtain significant gains in productivity and competitiveness.

In this sense, the implementation of Industry 4.0 in Brazil must consider the particularities of the national reality, allowing the adaptation of concepts and the overcoming of traditional stages of industrial development. However, the dissemination of this model still faces obstacles, such as the lack of technical knowledge and resistance to the adoption of new technologies, factors that hinder the consolidation of this new industrial revolution in the country (Hahn, 2017).

2.2 ERGONOMICS

The term Ergonomics was first used in 1857 by Wojciech Jastrzębowski, being derived from the Greek words *ergon* (work) and *nomos* (rules or laws). Ergonomics has its origin in the studies of Work Physiology, focusing on the identification of the causes of work fatigue and the proposition of solutions aimed at mitigating or eliminating it (Pinto, 2009).

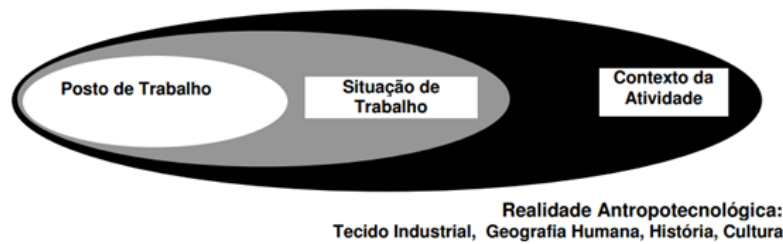
According to Wisner (1982), ergonomics can be defined as the set of scientific knowledge related to the human being and necessary for the design of tools, machines, systems and devices that can be used with maximum comfort, safety and efficiency.

Ergonomics is directly related to the health and safety of the worker, through the adequacy of processes and working conditions, seeking to ensure the highest possible level of comfort and well-being. This concern began to gain greater relevance from the changes in the way workers were perceived within organizations, especially throughout the different industrial revolutions. As Chiavenato (2002) points out, "the more industrialized the society, the more numerous and complex the organizations become, which begin to exert a deep and lasting impact on the lives and quality of life of individuals".

In this context, ergonomics addresses aspects such as lighting, posture, limb and spine positioning, repetitive movements, load handling capacity, temperature, and other physical and organizational factors, which are essential to ensure that the work environment is considered adequate, safe, and healthy.

Figure 4

Types of Ergonomics



Source: Federal Technological University of Paraná Londrina Campus (2019).

2.3 WELDING

Welding is a process of permanent joining of materials, predominantly metallic, carried out by means of heating and/or pressure, with or without the addition of filler material. In electrical and electronic applications, welding plays a critical role by directly impacting electrical conductivity, mechanical integrity, and product reliability throughout the life cycle.

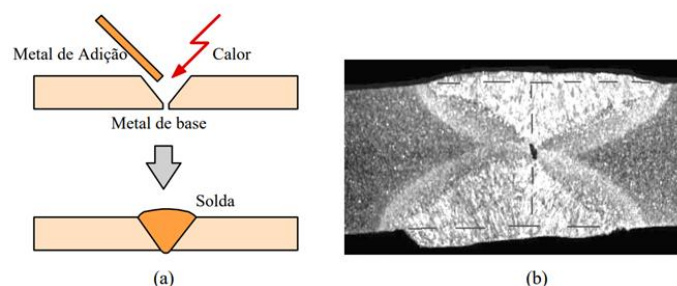
From the point of view of technological classification, welding processes can be organized into different groups, depending on the form of heat generation and the joining mechanism:

- Fusion welding: the base metal is fused, with or without filler metal, and the joint is formed after solidification of the metal bath. It is widely used in industry for its versatility and productivity.
- Solid state (pressure) welding: the union occurs without significant melting of the base metal, typically by the application of pressure, and there may be auxiliary heating. It stands out for its high-strength joints and for reducing metallurgical effects associated with melting.
- Resistance welding: heat is generated by the passage of electric current in the region of contact between the parts, combined with pressure. It is common in serial and highly repeatable applications.
- Concentrated energy welding: uses highly concentrated sources (e.g., laser or electron beam), allowing high precision, low thermally affected zone, and strict control of deformations.
- Gas welding (oxygen): uses the heat from the combustion of gases, and is traditionally applied in maintenance, repair and light welding operations.
- Brazing and soft welding: joining processes in which the base metal is not melted; The union occurs by melting the addition metal, with a melting point lower than that of the base metal. Brazing usually takes place above 450 °C, and soft welding below this value.

Historically, welding has accompanied the evolution of metallurgical techniques for centuries, with records of processes such as brazing and forging in different civilizations. Industrial consolidation intensified with the development of controllable energy sources and the use of electric arcs and combustible gases, increasing the precision and reliability of joining processes, especially after the great industrial demands of the twentieth century.

In this early stage of development, welding had limited application, being employed mainly in emergency repairs. Only after the First World War did this process begin to be used more widely and systematically, consolidating itself as an important method of industrial manufacturing. Currently, there are more than fifty distinct welding processes with application in the industrial sector, making it the main means of permanent joining of metals. The relevance of this process is evidenced by its presence in several segments of the industry and by the direct influence that weldability requirements exert on the development of new types of steels and other metal alloys.

In the present work, the focus is on tin immersion (tin bath) soldering, applied to metal terminals of miniaturized transformers. In this method, the previously prepared terminals, including the fluxing step, are immersed in liquid metal alloy for a controlled time, promoting proper wetting and joint formation after solidification. As it is a process that is highly sensitive to variables such as time, depth, and immersion angle, in addition to temperature and bath conditions, automation becomes a determining factor to ensure stability, repeatability, and reduction of defects in the production process.

Figure 5*Welding process*

Source: Federal University of Espírito Santo (2009).

2.4 AUTOMATION

It is essential to distinguish automation from automation. While the first refers strictly to the mechanization of repetitive movements, characterized as a "blind action" because it lacks the processing of variables, automation is defined as a set of cyber-physical techniques. It enables the creation of active systems capable of processing information from the environment in real time to act with optimal efficiency. In short, automation provides intelligence to the process, allowing the system to make data-driven decisions.

In this context, modern industrial automation operates through computer systems that process signals from various measuring instruments on the factory floor. By confronting this data with optimal parameters (setpoints), the system performs complex mathematical operations in order to generate instantaneous correction signals. As stated by Groover (2011), automation is the technology by which a process or procedure is carried out without human assistance, being executed through an instruction program combined with a control system.

According to Rosário (2005), industrial automation can be categorized into three main types, according to its versatility and production volume:

- **Fixed Automation:** It is characterized by operational rigidity, with little or no adaptability to changes. It is aimed at very high-volume processes and standardized models, where the sequence of operations is fixed by the configuration of the equipment. An example of this is the large-scale SMD insertion processes, where there is no internal variation or change of setup, and the lines are segregated by models due to the impossibility of changing to different processes.
- **Flexible Automation:** It is an evolution of programmable automation, being directed to medium production volumes. Its main feature is the ability to process different product models without wasting time with extensive tool changes or reprogramming, allowing for a varied and simultaneous production mix.

- **Programmable Automation:** It is used in production processes that have high product variability and lower production volumes. In this case, the sequence of operations is controlled by software, and can be changed to different product configurations, although it requires a setup time for the reprogramming and replacement of physical devices.

The evolution of manufacturing systems has been driven by the transition from mass markets to niche markets, where product variability becomes a competitive differentiator. According to Rosário (2005), the need for automation arises not only to increase productivity, but to ensure integrity and repeatability in scenarios where human error is enhanced by the diversity of models and processes.

In contexts of high variability, automation is no longer purely mechanical and becomes a tool for managing complexity. Rosário (2005) argues that fixed automation, although efficient for large volumes, becomes obsolete in the face of the need for customization, since "it is directed to production processes with little or no adaptability to changes" (Rosário, 2005, p. 11).

The implementation of flexible and programmable systems is justified by the ability to process different product configurations with minimal physical intervention. As the author points out:

"Flexible automation is an extension of programmable automation. [...] A flexible automation system is one capable of producing a variety of products (or parts) with reduced setup times, allowing the production of different models on the same assembly line." (Rosário, 2005).

Thus, the variability of products requires automation to be equipped with intelligent control systems and embedded software capable of recognizing and adjusting parameters autonomously. This transition to flexible automation minimizes losses from batch changes (setups) and reduces the incidence of critical failures, such as electrical insulation or structural integrity, which tend to occur more frequently when the process relies solely on memory and operator manual action in the face of multiple models.

In short, automation in high-variability environments is not just a technical choice, but a strategic necessity to enable throughput and regulatory compliance in modern production systems.

3 METHODOLOGY

The present research is characterized as applied and technological, as it is oriented to the solution of a real manufacturing problem and involves the development and evaluation of a prototype of industrial automation. As for the objectives, this is a descriptive and explanatory study, as it describes the immersion welding process currently used and explains the effects of automation on critical safety, stability, and performance variables (GIL, 2019).

Regarding the approach, a mixed design (qualitative-quantitative) is adopted, integrating qualitative evidence (mapping of occupational risks and compliance with safety requirements) and quantitative evidence (cycle time measurements, productivity indicators and quality metrics), a strategy recommended when seeking a more comprehensive understanding of the phenomenon by combining different types of data (CRESWELL; CLARK PLAN, 2017).

As a technical procedure, the work is configured as a case study in an industrial environment, suitable when investigating contemporary phenomena in the real context and intending to understand "how" and "why" process changes produce certain effects (YIN, 2018). The validation of prototype performance follows a comparative before-after logic (semi-automatic process versus automated prototype), incorporating chronoanalysis/study of times for estimates and comparison of standard time and cycle time (BARNES, 1977).

The evaluation of the performance of the automated system is carried out through a direct comparison between the semi-automatic process and the automated model, considering operational and productive indicators extracted from the equipment's own control system. The analysis includes variables such as cycle time, process stability, incidence of defects and operational availability, data that are automatically collected by the on-board software and made available for monitoring through the CMES system. To consolidate the overall performance of the equipment, the Overall Equipment Effectiveness (OEE) indicator is adopted, widely used in the industry for the integrated measurement of availability, performance and quality (NAKAJIMA, 1988).

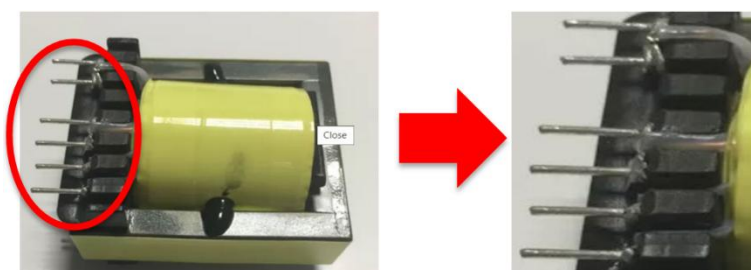
3.1 DIAGNOSIS OF THE NON-AUTOMATED PROCESS

The production process under study is a fundamental stage in the manufacture of cell phone chargers, focusing specifically on the welding of the terminals of a critical component: the transformer. This operation is technically called immersion welding, or "tin bath", and consists of submitting the terminals to the metal in a liquid state to promote the metallurgical union. To ensure joint quality and integrity, strict control of fluid temperature, immersion height accuracy, and alloy purity is imperative, as the presence of contaminants compromises conductive properties and process adhesion.

The current method for welding the terminals is based on a semi-automatic system with a high dependence on manual intervention and low ergonomic efficiency. The operational flow begins with the preparation of the fixing rod, which requires the manual application of adhesive tapes (double-sided and crepe) to support the components. After positioning the transformers with the pins vertically oriented, the terminals are subjected to fluxing, a process that requires frequent renewal of the chemical input every two tray cycles to ensure adequate deoxidation of the surfaces.

Figure 6

Comparative analysis of the morphology of the terminals: (A) Pre-welded in natura state and (B) Metal interface after the immersion tinning process



Source: RD&I Technical Report – B&Z International (2022).

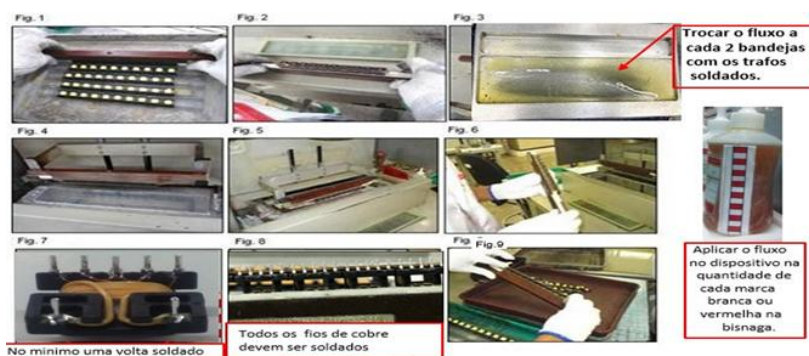
The critical welding step takes place by means of manual activation, after coupling the rod to the traction device. The process requires two consecutive immersion cycles in the molten tin alloy, with tightly established contact times of between 2.2 and 2.6 seconds. The second dip presents an additional technical complexity, as it must selectively target the Tex-E yarn. At the end of the immersion, a detailed visual inspection is carried out to validate the integrity of the welding and certify the absence of thermal degradation in the insulators or fasteners.

This flow is characterized by constant setup maintenance, requiring the replacement of the masking tape every 15 or 20 cycles, a frequency that varies according to the temperature and saturation of the flow. In the event of anomalies in the primary welding, the

components are segregated to a rework line with adjusted parameters, immersion times between 1.0 and 2.0 seconds and temperatures between 350°C and 370°C. The persistence of failures after this intervention results in definitive disposal (scrap), evidencing a manufacturing model with a high incidence of human manipulation and latent productivity bottlenecks.

Figure 7

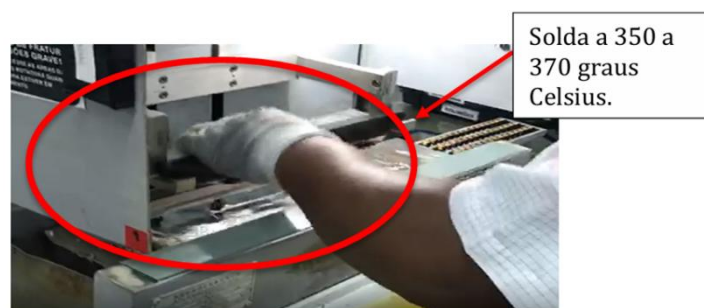
Flow of transformer assembly activity on dip rulers.



Source: RD&I Technical Report – B&Z International (2022).

Figure 8

Process of immersion of the transformers in the solder bath



Source: RD&I Technical Report – B&Z International (2022).

The analysis of this scenario reveals a matrix of critical risks to the physical integrity and occupational health of operators in the long term. The preponderant risk factor lies in the inhalation of metallic fumes composed of ultrafine particles (0.01 to 1µm) that, due to their small size, cross the barriers of the respiratory system. The toxicity of these effluents is potentiated by elements such as hexavalent chromium Cr(VI), manganese and nickel. According to Nederman technical data, continuous exposure to these agents is associated with severe pathologies, including systemic neoplasms, neurological damage, occupational asthma and other lung diseases.

In addition to the chemical risk, manual operation imposes immediate physical dangers, since the welding crucible operates at constant temperatures between 350°C and

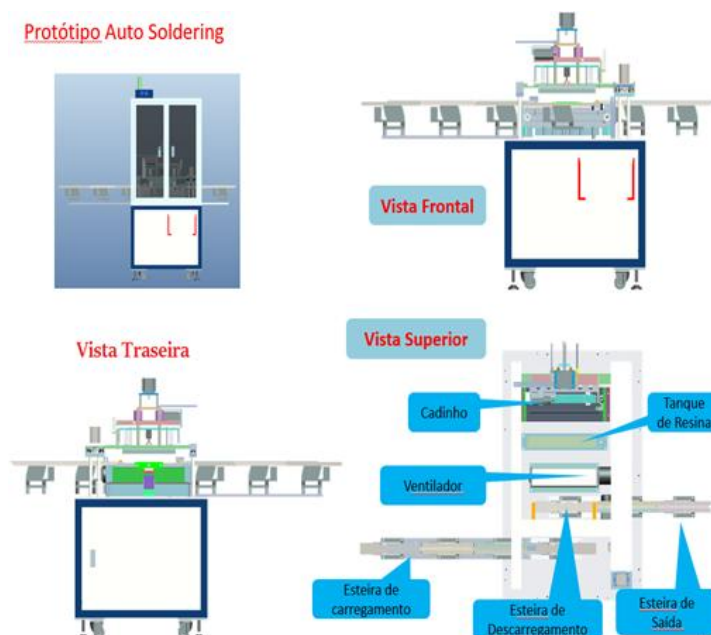
370°C. This condition subjects the worker to intense thermal radiation, resulting in acute discomfort and early fatigue, factors that exponentially increase the probability of accidents and serious burns during the handling of the dipstick. From the perspective of production efficiency, the current model suffers from chronic instabilities in the repeatability and reproducibility of the process, since the control of fundamental variables, such as immersion time, depth and angle of attack, depends exclusively on the dexterity and physical resistance of the operator. The absence of digital records and the dependence on analog methods for monitoring make it difficult to manage performance and favor handling errors that compromise the final quality of the product. In view of this scenario, the automation of the process via the AUTO SOLDERING project presents itself as an imperative measure to ensure the biosafety and technical stability required by modern manufacturing.

The diagnosis of the current process revealed critical instabilities in the repeatability and reproducibility of the welding, mainly due to the manual variation of the immersion time and angle. In addition, the direct exposure of operators to metal fumes and high temperatures was identified, reinforcing the need for an automated solution in compliance with NR-12 and ergonomics standards.

3.2 DETAILING OF THE AUTOMATED MODEL WITH EMBEDDED INTELLIGENCE AND CONTROL MECHANISMS

The proposed solution consists of a prototype of integral automation with embedded software, designed to manage the production cadence through real-time monitoring. The transition to the fully automated model eliminates the need for direct operator intervention in critical steps, substantially reducing the risks of occupational diseases and accidents. The technological scope of the system includes:

- **Product Life Cycle Automation:** The prototype performs the automatic insertion, handling and transport of transformers through customized pick and place systems, ensuring continuous production online.
- **Intelligent Treatment and Welding:** Includes automatic cleaning of terminals in flux tanks and immersion welding with strict control of bath height, angle and depth.
- **Safety and Biosecurity:** Implementation of an independent exhaust system to capture metal fumes at the source and compliance with NR-12 for operation in a zero-risk environment.
- **Digital Integration (Smart Manufacturing):** Collection of production indexes and equipment status for export via XML files, allowing direct integration with the company's CMES system.

Figure 9*Concept of the prototype*

Source: RD&I Technical Report – B&Z International (2022).

The prototype was conceived from digital modeling elaborated in the SolidWorks software. In the construction phase, the mechanical structure was initially assembled and then the manipulation, transport, control and power devices were integrated, including sensors, actuators, PLC, pneumatic cylinders, among other components necessary for the operation of the system.

Figure 10*Module development*

Source: RD&I Technical Report – B&Z International (2022).

The storage and control system of the flux and solder in the respective tanks was developed independently, depending on the technical particularities of each application. The resin-coated flow tank is intended for cleaning terminals, made of titanium alloy, and has been subjected to use and reliability tests.

Figure 11

Welding tank

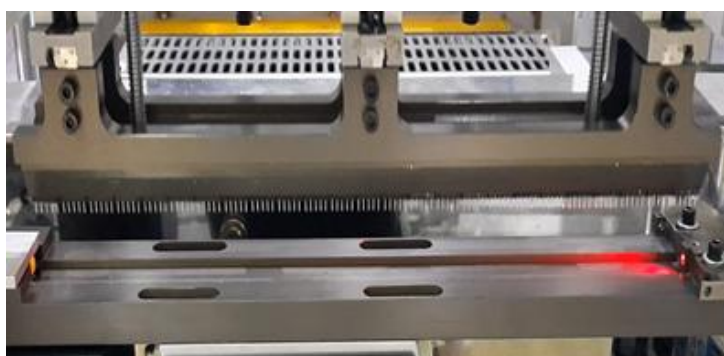


Source: RD&I Technical Report – B&Z International (2022).

The main purpose of the use of solder flux is to facilitate the welding process, promoting the removal of oxides and impurities, in addition to improving the wettability of the metal surface. According to Frank et al. (1981), the welding flux can be composed of a non-reactive mixture, containing activators with at least one halogen atom, destabilizing components and acidic surfactants, such as polybasic carboxylic acids, their hydroxylated derivatives, acetoacids or combinations of these agents, whose function is to optimize the performance of the process.

Figure 12

Flow circulation tank (fluxer)



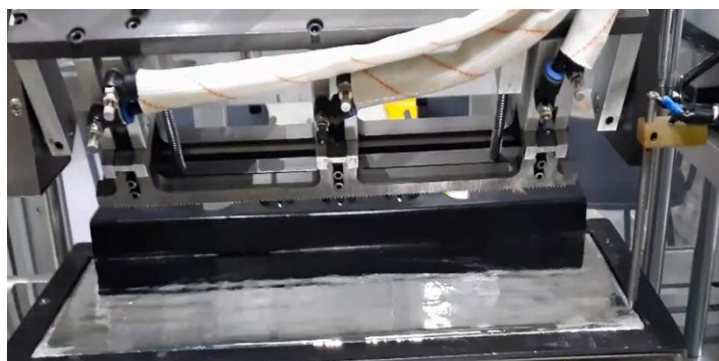
Source: RD&I Technical Report – B&Z International (2022).

To ensure that the chemical compound was kept in optimal operating conditions, especially in terms of temperature, wave height and applied volume, a system with a recirculation pump was designed, responsible for regulating the formation of the wave during

the cleaning process. Such a solution avoids the alteration of the viscosity of the flow, preventing its paste-like consistency, and allows the controlled adjustment of the operating parameters, ensuring stability and quality to the developed cleaning system.

Figure 13

Weld volume level sensor

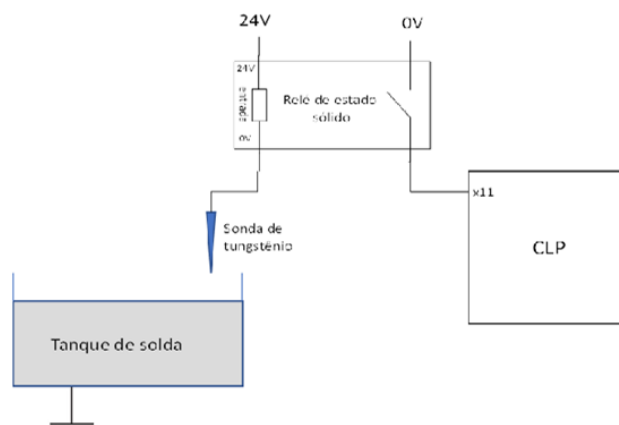


Source: RD&I Technical Report – B&Z International (2022).

One of the main solutions used in the system was the welding wave height sensor, developed from research carried out, a system was established (described in figure 14) that starts when the tungsten probe touches the surface of the liquid weld, this potential of 0V is transferred to the input of the solid state relay, which results in energization of the coil. At this moment, the contact of the solid-state relay switches, transferring the potential of 0V to the x11 terminal of the PLC. When the PLC detects the signal in x11, its internal program reads the height on the Z-axis encoder. The height read on the encoder is the weld level used as a reference in the welding process.

Figure 14

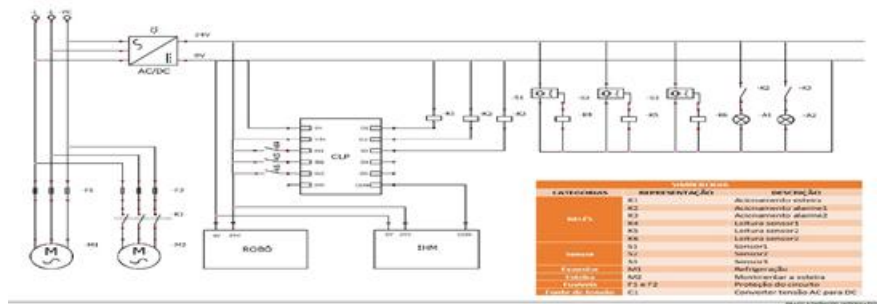
Level control functional diagram



Source: RD&I Technical Report – B&Z International (2022).

Figure 15

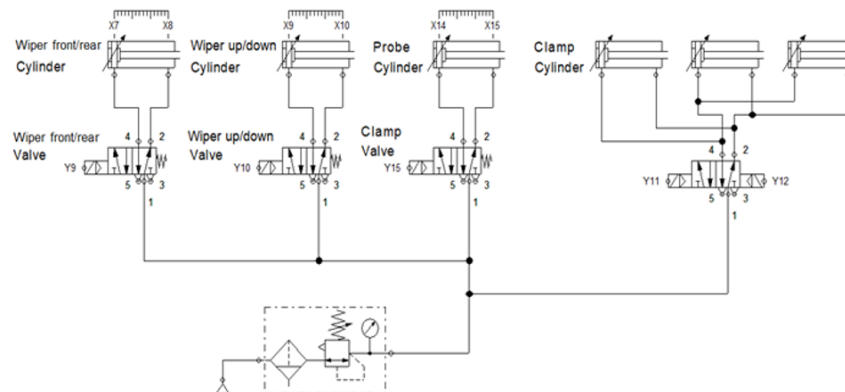
Electrical diagram



Source: RD&I Technical Report – B&Z International (2022).

Figure 16

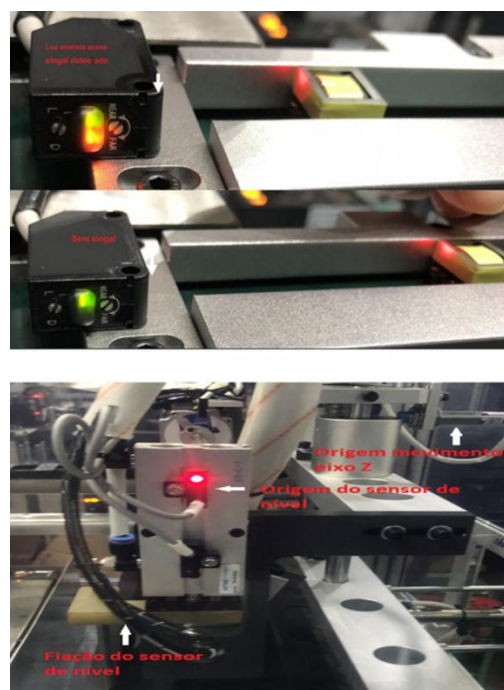
Pneumatic diagram



Source: RD&I Technical Report – B&Z International (2022).

Figure 17

Prototype sensors



Source: RD&I Technical Report – B&Z International (2022).

3.2.1 Software Architecture

The core of the system was developed in the C and C++ languages, using an architecture that processes field variables in milliseconds. The innovative differential lies in the implementation of an Artificial Intelligence that performs autonomous decision-making on the depth of immersion.

Through mathematical calculations processed by the computer, the system checks the volume of material available in the tanks and dynamically adjusts the position of the robotic arm. This mechanism automatically compensates for tin and flux consumption, ensuring that the level of contact with the terminals remains constant regardless of the amount of material in the crucible. In addition, the software calculates and makes available OEE, monitoring temperature, speed and defect indexes, demonstrating them in an intuitive human-machine interface (HMI) for technical supervision.

3.2.2 Incremental Innovation and Industrial Customization

Due to the lack of "off-the-shelf" solutions for the manufacture of miniaturized transformers, a market restricted to proprietary designs, the project represents an incremental process innovation. The equipment was designed with interchangeable accessories, allowing flexibility for future product design adjustments, aligning the robustness of fixed automation with the versatility of flexible automation, as recommended by Rosário (2005).

Table 1

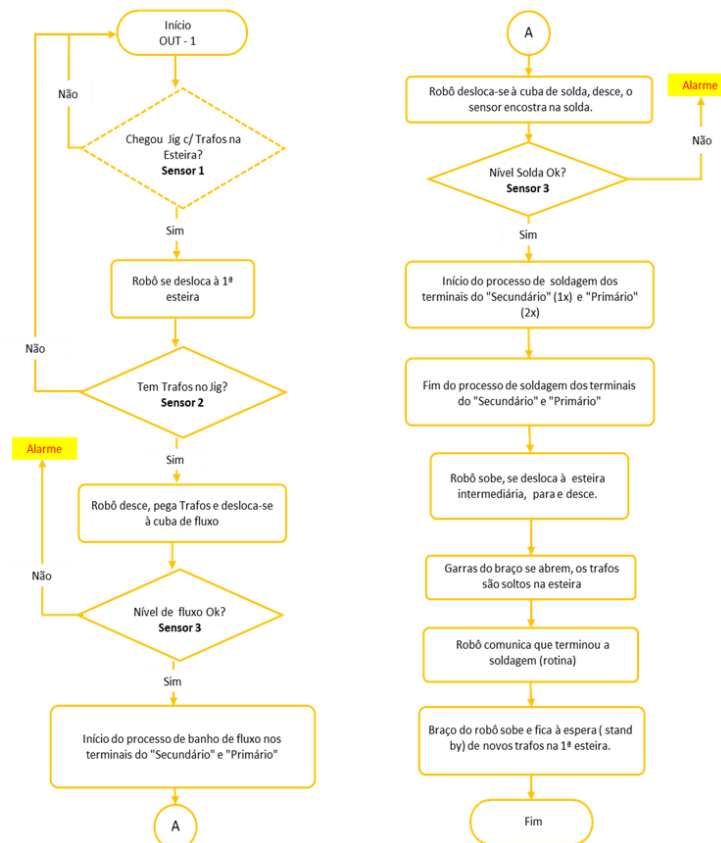
Technical knowledge matrix

Knowledge Component	Application in the AUTO SOLDERING Project
Artificial Intelligence (AI)	Dynamic calculation of immersion based on tank volume and level.
C/C++ and Ladder Language	Synchronization of cyber-physical systems and test variables.
Ultrasound Technology	Control of production parameters for metallurgical precision of the weld.
System Integration	Management of transport, welding and segregation in reduced space.

Source: Authors (2026).

Figure 18

Prototype operation flow

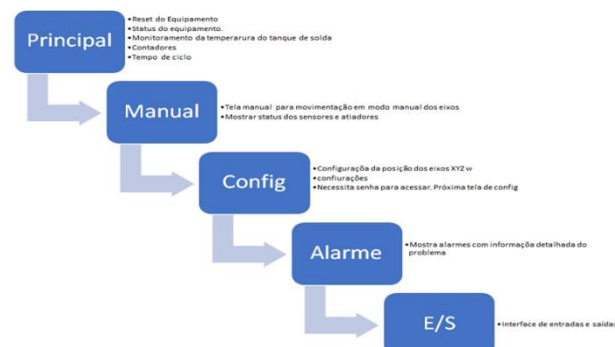


Source: RD&I Technical Report – B&Z International (2022).

The Human Machine Interface (HMI) used in the system was the WEINVIEW MT6071iP model. The programming was carried out in the EasyBuilder Pro software, in which the application files were developed, the operating parameters were defined and the communication devices were configured. The integration with the PLC used in the application was established through the parameterization of communication protocols, allowing the monitoring and management of movements and system functions in real time.

Figure 19

Interface requirements



Source: RD&I Technical Report – B&Z International (2022).

Based on the previously established requirements, the graphical interfaces of the system were elaborated, using the resources of the Drawing Tools library of EasyBuilder Pro. In this stage, elements such as buttons, light indicators, text fields, labels, images and tables were inserted and configured, organized in the project files in the extensions ".exob" and ".cxob", which make up the visual and functional structure of the HMI.

3.2.3 Negative Scope and Restrictions

To ensure the focus on the central objective of safety and welding quality, the project delimits that the following functionalities will not be contemplated: automatic identification of product change via code reading; direct integration with ERP (maintaining only the provision of data to the CMES via XML); and purely cosmetic or mechanical quality inspections outside the scope of the welded joint.

3.3 METHODOLOGY FOR THE QUALI-QUANTITATIVE STUDY BETWEEN THE MODELS

For the validation of the technological transition, this research adopts a mixed methodological approach, based on a quali-quantitative study that confronts the current scenario (semi-automatic) with the developed prototype (AUTO SOLDERING). The objective is to measure the impact of automation on the mitigation of occupational risks and the increase of production efficiency.

3.3.1 Qualitative Procedures (Health and Safety)

Qualitative analysis focuses on the assessment of biosafety and regulatory compliance. The methodology consists of mapping the risks of exposure to metal fumes and thermal irradiation (350°C - 370°C), based on the particle toxicity parameters (0.01-1µm) described in Nederman's technical literature. The effectiveness of the prototype is validated by the complete elimination of human interaction at the welding point, replacing manual handling with pick and place systems and independent exhaust, aiming to achieve the goal of zero accidents and absences.

3.3.2 Quantitative Procedures (Performance and Reliability)

The quantitative aspect uses chronoanalysis and comparison of operational indicators to evaluate productivity and quality between the semi-automatic process and the automated model (BARNES, 1977). The data collection follows the following criteria:

Evaluation of the stability and operational repeatability of the process by monitoring the critical parameters (time, depth and immersion angle), comparing the variation observed

in the manual model with the variation obtained in the automated system. While the manual model depends on the operator's skill, the automated model uses embedded intelligence (ANI), implemented in C/C++, to calculate and adjust the depth and angle of immersion in real time, compensating for variations in the process throughout the production cycle.

Overall Equipment Effectiveness (OEE): Automatic data collection via software, integrating cycle time, availability, and defect rate information directly into the company's CMES system via XML files.

Technical Parameters: Comparative monitoring of thermal stability and immersion time (set at 2.2s ~ 2.6s), evaluating the percentage of scrap reduction after rework.

3.3.3 Innovation Validation Framework

Given that there are no standardized "off-the-shelf" solutions for the specific design of the company's transformers, the development methodology follows the concept of incremental innovation. Validation occurs by verifying the system's ability to automatically adjust to the volume of molten tin and the cleanliness of the terminals, ensuring that the immersion soldering technology achieves the levels of precision required by high-scale manufacturing.

4 RESULTS AND DISCUSSIONS

The implementation of the AUTO SOLDERING project resulted in the development of a functional prototype of an automated tin immersion soldering station applied to the terminals of transformer coils used in mobile phone chargers. The results obtained were evaluated from the perspectives of occupational health and safety, process stability, production efficiency and welding quality, according to the objectives established in the project's work plan.

From the point of view of biosafety, the main evidence of the result was the total elimination of the operator's direct interaction with the weld bath, which operates at temperatures between 350 °C and 370 °C. The automated system integrated pick and place mechanisms, dedicated metal fume exhaust and enclosure as per the requirements of NR-12, completely mitigating the risks associated with inhaling ultrafine particles (0.01–1 µm) containing elements such as hexavalent chromium, manganese and nickel. In this way, the projected indicators of zero work accidents, zero absences and zero occurrence of occupational diseases became technically achievable, significantly surpassing the scenario of the semi-automatic process previously used.

Figure 22

Production data

Resultados Produção 2993 peças				
1ª Indutância	Teste Func.	Hipot	Tex-E	total ok
15 und	0 und	01 und	35 und	2942
			FPY	98,30%

51 peças em análise

Back Panel

Source: RD&I Technical Report – B&Z International (2022).

The integral automation of the cycle, insertion, cleaning, welding and transfer of the components, allowed continuous operation in an online regime, meeting the critical requirement of production time of approximately 2.86 seconds per part, through the collective welding of multiple transformers simultaneously.

Figure 23

Production performance report

RELATÓRIO OQC - Transformador							
MODELO:				ULC			
CÓDIGO:				FM 0201IH ULC		Qty de Amostra: 2942 pcs	
LINHA/FORNECEDOR				LINHA PILOTO (PROJETO AUT. DE SOLDA)		Qty Amostra: 160 pcs	
DATA: 05/04/2021				RESPONSÁVEL: CARLOS - ENGENHARIA		Índice NOK: 2,5% EMC acima do espec	
PEÇA	HIPOT	TESTE FUNC.	EMC (-70 ~ 40mV)	PEÇA	HIPOT	TESTE FUNC.	EMC (-70 ~ 40mV)
NUM.	STATUS	STATUS	VALOR MEDIDO	NUM.	STATUS	STATUS	VALOR MEDIDO
1	OK	OK	0	81	OK	OK	-30
2	OK	OK	-30	82	OK	OK	70
3	OK	OK	-60	83	OK	OK	0
4	OK	OK	10	84	OK	OK	0
5	OK	OK	40	85	OK	OK	-60

Source: RD&I Technical Report – B&Z International (2022).

The quality of the final product also showed significant gains. Reduced manual handling minimized thermal damage to insulators, weld wetting failures, and defects associated with rework. As a consequence, the project projects an improvement in welding quality of around 30%, directly reflecting on the reduction of scrap and the increase in the reliability of the component delivered to the subsequent stages of the production line. In addition, the automatic collection of production data enabled the continuous monitoring of indicators such as OEE, cycle time, stoppages and defect rates, allowing integration with the company's CMES system through XML files.

From the perspective of industrial innovation, the results confirm the character of incremental process innovation of the AUTO SOLDERING project. The lack of standardized "off-the-shelf" solutions for the automated welding of miniaturized transformers required the development of a customized solution, with interchangeable accessories and flexible architecture. This characteristic ensures the adaptability of the system to future variations in

product design, reconciling the robustness of fixed automation with the versatility of flexible automation, as recommended in the classic literature of industrial automation.

5 CONCLUSION

The development of the AUTO SOLDERING project has proven to be a technically and industrially viable solution for the automation of the tin immersion soldering process of transformer coil terminals applied to the manufacture of mobile phone chargers. The transition from the semi-automatic model to a fully automated system showed significant gains in occupational safety, process stability, production efficiency and quality of the final product.

The results obtained confirm that the elimination of human intervention in the critical stages of the process not only effectively reduces the risks of accidents and occupational diseases, but also contributes to the standardization of welding, ensuring high levels of repeatability and reproducibility. The use of embedded intelligence for real-time decision making proved to be fundamental for the dynamic control of process variables, automatically compensating for variations in weld volume and flux, and ensuring the metallurgical integrity of the welded joints.

In addition, the ability to collect and make available productive data in real time positions the AUTO SOLDERING system in line with the principles of industry 4.0, by allowing integration with corporate manufacturing systems and management based on performance indicators. This characteristic expands the potential of the equipment not only as an operational solution, but as a strategic tool to support industrial decision-making.

Finally, it is concluded that the project represents an applied incremental innovation, capable of raising the technological level of the production process without the need for complex restructuring of the industrial plant. The solution developed contributes to the modernization of electronic manufacturing, promoting a safer, more efficient and sustainable work environment, in addition to serving as a reference for future applications of intelligent automation in critical industrial processes.

ACKNOWLEDGMENTS

The authors would like to thank B&Z International for the design and execution of the RD&I project that served as the basis for this study, carried out in partnership with a company from the Manaus Industrial Complex. The support for the technical analysis, theoretical

systematization and preparation of this scientific publication was provided by the Institute of Innovation and Technology of the Amazon (IITA).

REFERENCES

- Barnes, R. M. (1977). Estudo de movimentos e de tempos: projeto e medida do trabalho (6ª ed.). São Paulo: Edgard Blücher.
- Boettcher, M. (2015). Revolução industrial: um pouco de história da indústria 1.0 até a indústria 4.0. LinkedIn. Disponível em: <https://pt.linkedin.com/pulse/revolu%C3%A7%C3%A3o-industrial-um-pouco-dhist%C3%B3ria-da-10-at%C3%A9-boettcher>
- Brasil. Ministério do Trabalho e Emprego. (s.d.). Norma regulamentadora nº 12 (NR-12): segurança no trabalho em máquinas e equipamentos. Brasília, DF.
- Cavalcante, Z. V., & Silva, M. L. S. da. (2011). A importância da revolução industrial no mundo da tecnologia. In Encontro Internacional de Produção Científica (7.). Maringá. Disponível em: https://www.unicesumar.edu.br/epcc-2011/wpcontent/uploads/sites/86/2016/07/zedequias_vieira_cavalcante2.pdf
- Chiavenato, I. (2002). Introdução à teoria geral da administração (6ª ed.). Rio de Janeiro: Campus.
- Confederação Nacional da Indústria (CNI). (2016). Desafios para indústria 4.0 no Brasil. Brasília: CNI.
- Creswell, J. W., & Plano Clark, V. L. (2017). Pesquisa de métodos mistos (3ª ed.). Porto Alegre: Penso.
- Frank, R. et al. (1981). Soldering flux (U.S. Patent No. 4,278,479). Washington, DC: U.S. Patent and Trademark Office.
- Gil, A. C. (2019). Como elaborar projetos de pesquisa (6ª ed.). São Paulo: Atlas.
- Groover, M. P. (2011). Automação industrial e sistemas de manufatura (3ª ed.). São Paulo: Pearson.
- Jastrzębowski, W. B. (1857). An outline of ergonomics, or the science of work based upon the truths drawn from the science of nature.
- Kagermann, H. et al. (2013). Recommendations for implementing the strategic initiative Industrie 4.0.
- Oesterreich, T. D., & Teuteberg, F. (2016). Understanding the implications of digitization and automation in the context of industry 4.0: a triangulation approach and elements of a research agenda for the construction industry. Computers in Industry.
- O Setor Elétrico. (s.d.). Da máquina a vapor aos softwares de automação. Disponível em: <https://www.osetoreletrico.com.br/da-maquina-a-vapor-aos-softwares-de-automacao/>

- Nakajima, S. (1988). Introduction to TPM: total productive maintenance. Cambridge: Productivity Press.
- Nederman. (s.d.). Catálogo técnico de soluções para extração de fumos de solda.
- Pinto, A. R. (2009). Ergonomia aplicada ao trabalho. São Paulo: Blucher.
- Rosário, J. M. (2005). Princípios de mecatrônica. São Paulo: Pearson Prentice Hall.
- Sakurai, R., & Zuchi, J. D. (s.d.). As revoluções industriais até a indústria 4.0. INFA – Revista de Inovação, Tecnologia e Sustentabilidade. <https://doi.org/10.31510/infa.v15i2.386>
- Santos, M., Manhães, A. M., & Lima, A. R. (2018). Indústria 4.0: desafios e oportunidades para o Brasil. In Simpósio de Engenharia de Produção de Sergipe (X SIMPROD). São Cristóvão, SE.
- Silva, D. B. da et al. (2012). O reflexo da terceira revolução industrial na sociedade. In Encontro Nacional de Engenharia de Produção (22.). Curitiba: ABEPRO. Disponível em: http://www.abepro.org.br/biblioteca/enegep2002_tr82_0267.pdf
- Silva, M. C. A. da, & Gasparin, J. L. (2015). A segunda revolução industrial e suas influências sobre a educação escolar brasileira. Disponível em: http://www.histedbr.fe.unicamp.br/acer_histedbr/seminario/seminario7/TRABALHOS/M/Marcia%20CA%20Silva%20e%20%20Joao%20L%20Gasparin2.pdf
- Silveira, C. B. (2017). O que é a indústria 4.0 e como ela vai impactar o mundo. Citisystems. Disponível em: <https://www.citisystems.com.br/industria-4-0/>
- Wisner, A. (1982). Ergonomie (2ª ed.). Paris: Presses Universitaires de France.
- Yin, R. K. (2018). Estudo de caso: planejamento e métodos (6ª ed.). Porto Alegre: Bookman.
- Zancul, E. de S. (2016). O Brasil está pronto para a indústria 4.0? Exame. Disponível em: <https://exame.abril.com.br/tecnologia/o-brasil-esta-pronto-para-a-industria-4-0/>
- Zawadzki, P., & Żywicki, K. (2016). Smart product design and production control for effective mass customization in the industry 4.0 concept. Management and Production Engineering Review.

RESPONSIBLE MANAGEMENT AND SUSTAINABLE HUMAN REINTEGRATION

GESTÃO RESPONSÁVEL E REINTEGRAÇÃO HUMANA SUSTENTÁVEL

GESTIÓN RESPONSABLE Y REINTEGRACIÓN HUMANA SOSTENIBLE



<https://doi.org/10.56238/sevened2026.008-218>

**Fernanda Caroline Conrado¹, Kevin Gonçalves Calbusch², Rafael Ávila Lopes³,
Geovani Broering⁴, Renato Rodrigues⁵**

ABSTRACT

The homeless population represents one of the most complex social phenomena in contemporary societies, resulting from structural processes of social exclusion, economic inequality and the weakening of family and community ties. This article analyzes the Lages Recupera Program, a municipal public policy aimed at sheltering, assisted transition and socioeconomic reintegration of the homeless population in the city of Lages, Santa Catarina, Brazil. The study adopts a qualitative approach based on literature review, normative analysis and a case study of a municipal public policy. The theoretical framework incorporates contributions from Lenio Streck, Pedro Serrano, Paulo Freire, Moacir Gadotti, José Carlos Libâneo, Selma Garrido Pimenta and Slavoj Žižek, as well as institutional data from IBGE and IPEA. The findings indicate that integrated public policies combining assisted housing, psychosocial support, professional training and productive inclusion have greater potential to reduce homelessness and promote human dignity. The study concludes that the Lages Recupera Program represents an important instrument for sustainable human development aligned with the Brazilian Constitution of 1988, human rights principles and the Sustainable Development Goals of the United Nations 2030 Agenda.

Keywords: Public Policies. Homelessness. Human Rights. Social Inclusion. Sustainable Development.

RESUMO

A população em situação de rua constitui um dos fenômenos sociais mais complexos das sociedades contemporâneas, resultante de processos estruturais de exclusão social, desigualdade econômica e fragilização de vínculos familiares e comunitários. O presente artigo analisa o Programa Lages Recupera, política pública municipal voltada ao acolhimento, transição assistida e reinserção socioeconômica da população em situação de

¹ Master's Student in Law and Sustainable Development. UNIFACVEST.
E-mail: fernanda.aluno@unifacvest.edu.br

² Master's Student in Law and Sustainable Development. UNIFACVEST.
E-mail: kevin_kalbusch@hotmail.com

³ Master's Student in Law and Sustainable Development. UNIFACVEST.
E-mail: riovacasgordas@hotmail.com

⁴ Dr. in Law. Dr. in Humanity, Universidade Veiga de Almeida (UVA). E-mail: reitoria@unifacvest.edu.br
Lattes: <http://lattes.cnpq.br/5211119375617252>

⁵ Dr. in Law, Universidade Veiga de Almeida (UVA). E-mail: prpe@unifacvest.edu.br
Lattes: <http://lattes.cnpq.br/6556757529380415>

rua no município de Lages, Santa Catarina. O estudo adota abordagem qualitativa, fundamentada em revisão bibliográfica, análise normativa e estudo de caso de política pública municipal. A pesquisa mobiliza referenciais teóricos de Lenio Streck, Pedro Serrano, Paulo Freire, Moacir Gadotti, José Carlos Libâneo, Selma Garrido Pimenta e Slavoj Žižek, além de dados institucionais do IBGE e do IPEA. Os resultados indicam que políticas públicas integradas que combinam moradia assistida, acompanhamento psicossocial, qualificação profissional e inclusão produtiva apresentam maior potencial de redução da população em situação de rua e promoção da dignidade humana. Conclui-se que o Programa Lages Recupera constitui instrumento relevante de desenvolvimento humano sustentável, alinhado à Constituição de 1988, aos direitos humanos e aos Objetivos de Desenvolvimento Sustentável da Agenda 2030.

Palavras-chave: Políticas Públicas. População em Situação de Rua. Direitos Humanos. Inclusão Social. Desenvolvimento Sustentável.

RESUMEN

La población sin hogar constituye uno de los fenómenos sociales más complejos de las sociedades contemporáneas, resultado de procesos estructurales de exclusión social, desigualdad económica y debilitamiento de los lazos familiares y comunitarios. Este artículo analiza el Programa Lages Recupera, una política pública municipal orientada a la acogida, la transición asistida y la reintegración socioeconómica de la población sin hogar en el municipio de Lages, Santa Catarina. El estudio adopta un enfoque cualitativo, basado en una revisión bibliográfica, un análisis normativo y un estudio de caso de política pública municipal. La investigación se fundamenta en los marcos teóricos de Lenio Streck, Pedro Serrano, Paulo Freire, Moacir Gadotti, José Carlos Libâneo, Selma Garrido Pimenta y Slavoj Žižek, además de datos institucionales del IBGE y el IPEA. Los resultados indican que las políticas públicas integradas que combinan vivienda asistida, apoyo psicossocial, formación profesional e inclusión productiva tienen un mayor potencial para reducir la población sin hogar y promover la dignidad humana. Se concluye que el Programa Lages Recupera constituye un instrumento relevante para el desarrollo humano sostenible, en consonancia con la Constitución de 1988, los derechos humanos y los Objetivos de Desarrollo Sostenible de la Agenda 2030.

Palabras clave: Políticas Públicas. Población Sin Hogar. Derechos Humanos. Inclusión Social. Desarrollo Sostenible.

1 INTRODUCTION

The homeless population is a multifactorial social phenomenon that reflects the deep socioeconomic inequalities present in contemporary societies. This phenomenon results from the combination of structural factors such as unemployment, job insecurity, chemical dependency, mental disorders, rupture of family ties and absence of effective housing policies.

In Brazil, recent data indicate significant growth in this population in recent decades. Surveys based on the Unified Registry indicate that the number of homeless people in the country exceeds 260 thousand individuals, revealing a trend of expansion of this population group in several urban regions.

In the state of Santa Catarina, the situation is also worsening. Recent studies indicate that the number of people living on the streets went from 5,678 in 2021 to approximately 9,989 in 2023, representing a growth of about 76% in two years.

In the municipality of Lages, located in the Serra Catarinense, estimates point to approximately 397 homeless people, placing the municipality among the ten with the highest absolute number in the state.

The scenario becomes even more critical due to the climatic conditions of the region, characterized by harsh winters, often with temperatures close to or below 0°C. In these circumstances, the absence of shelter and adequate public policies significantly increases the risks of illness and mortality of the homeless population.

The 1988 Constitution of the Federative Republic of Brazil, often referred to as the Citizen Constitution, established a model of State committed to the promotion of human dignity, social justice and the reduction of inequalities. In this sense, the realization of social rights requires the implementation of structured public policies capable of guaranteeing housing, health, social assistance and productive inclusion.

This article aims to analyze the Lages Recupera Program, a municipal public policy aimed at the social reintegration of the homeless population, evaluating its legal, social and institutional foundation.

2 METHODOLOGY

The present research is characterized as a qualitative study of exploratory and descriptive nature, based on bibliographic, documentary and normative analysis.

The investigation was structured in three main stages: Bibliographic review, involving classic works in the areas of constitutional law, public policies and education.

Documentary and normative analysis, with examination of the Federal Constitution of 1988, Decree No. 7,053/2009 (National Policy for the Homeless Population) and institutional documents produced by public agencies such as IBGE and IPEA.

This is a case study, centered on the analysis of the proposal of the Lages Recupera Program as a municipal public policy aimed at the socioeconomic reintegration of the homeless population.

The approach adopted allows us to understand the phenomenon of homelessness in its social and institutional complexity, articulating legal, economic and educational dimensions.

3 THEORETICAL FOUNDATION

3.1 1988 CONSTITUTION AND THE EFFECTIVENESS OF FUNDAMENTAL RIGHTS

The Brazilian Constitution of 1988 established a new legal paradigm based on the centrality of the dignity of the human person and the guarantee of social rights.

In this sense, Lenio Streck points out that the Constitution has a normative and directing character:

The Constitution is not a letter of intent. It establishes normative commitments that bind the State and society, imposing the realization of fundamental rights as a condition for the legitimacy of the democratic State itself. (Streck, 2017, p. 89)

Public policies aimed at the homeless population must be understood as instruments of constitutional implementation.

Pedro Serrano complements this perspective by stating that the effectiveness of fundamental rights depends on the concrete action of the State in reducing social inequalities.

3.2 EDUCATION, SOCIAL EMANCIPATION AND INCLUSION

The social reintegration of the homeless population requires public policies that promote autonomy and human emancipation.

The thinker and educator, Paulo Freire states: "Education does not transform the world. Education changes people. People transform the world." (Freire, 1996, p. 67).

Freire's perspective emphasizes that educational processes must contribute to the reconstruction of autonomy and human dignity.

Moacir Gadotti reinforces this view by highlighting the transformative role of education: "Education committed to human emancipation needs to be linked to the construction of a more just, democratic and solidary society." (Gadotti, 2003, p. 54).

Public policies for social inclusion must articulate education, work and citizenship.

3.3 SOCIAL EXCLUSION AND CONTEMPORARY CRITICISM

Extreme social exclusion can also be analyzed in the light of contemporary critical theory.

Slavoj Žižek observes that: "The most profound violence in contemporary societies is not only visible violence, but that which manifests itself in the social structures that produce exclusion and invisibility." (Žižek, 2014, p. 22).

The perspective shows that homelessness cannot be understood only as an individual problem, but as a result of exclusionary social structures.

4 THE LAGES RECUPERA PROGRAM

The Lages Recupera Program proposes a municipal public policy structured in three central axes:

- housing reception;
- psychosocial recovery;
- socioeconomic reintegration;

4.1 HOUSE OF THE NEW BEGINNING

The Casa do Recomeço is an assisted transition center for the reception of the homeless population.

The program adopts principles inspired by the international model Housing First⁶, which establishes housing as an initial condition for social reintegration.

4.2 PSYCHOSOCIAL RECOVERY CENTER

The program provides care by a multidisciplinary team composed of psychologists, social workers and occupational therapists.

The objective is to promote emotional recovery, strengthen autonomy and rebuild social bonds.

⁶ The Housing First model is a public policy approach that originated in the United States in the 1990s, especially from the experiences developed by Sam Tsemberis, which proposes the immediate offer of permanent housing to homeless people as a starting point in the process of social reintegration. Unlike traditional models of care, which condition access to housing to the prior overcoming of problems such as chemical dependency or unemployment, Housing First is based on the assumption that housing stability is a fundamental condition for individuals to be able to later face other social vulnerabilities, such as mental health, professional qualification, and insertion in the labor market. International studies indicate that this approach presents high rates of permanence in housing and improvement of the living conditions of the beneficiaries (TSSEMBERIS, 2010).

4.3 SCHOOL OF MOUNTAIN CRAFTS

Another strategic axis of the program consists of professional training focused on the regional economy.

The timber sector, traditional in the Lages region, is a relevant opportunity for income generation and productive inclusion through the circular economy.

5 EXPECTED OUTCOMES AND IMPACTS

Among the main results expected from the program are:

- a 40% reduction in the homeless population in 24 months;
- insertion of 60% of the beneficiaries in the labor market;
- reduction of hospital admissions associated with exposure to cold;
- strengthening urban social cohesion.

6 FINAL CONSIDERATIONS

The homeless population is one of the greatest social challenges faced by Brazilian cities. This is a structural phenomenon that requires integrated and sustainable public policies.

The analysis carried out demonstrates that the Lages Recupera Program has a consistent legal, social and institutional foundation, aligned with the principles of the 1988 Constitution, human rights and the Sustainable Development Goals of the 2030 Agenda.

By articulating decent housing, psychosocial monitoring, professional qualification and productive inclusion, the program establishes an innovative model of social reintegration and promotion of human dignity.

REFERENCES

Brasil. (1988). Constituição da República Federativa do Brasil de 1988.

Brasil. (2009). Decreto nº 7.053/2009.

Freire, P. (1996). Pedagogia da autonomia. Paz e Terra.

Gadotti, M. (2003). Pedagogia da práxis. Cortez.

Instituto Brasileiro de Geografia e Estatística (IBGE). (2023). Síntese de indicadores sociais: uma análise das condições de vida da população brasileira. IBGE.

Instituto de Pesquisa Econômica Aplicada (IPEA). (2023). Estimativa da população em situação de rua no Brasil (2012-2022). Ipea.

Pimenta, S. G. (2012). Formação de professores. Cortez.

Rodrigues, R., & Gonçalves, J. C. (2023). Procedimentos de metodologia científica (11. ed.). Papervest.

Serrano, P. E. A. P. (2016). Autoritarismo e golpes na América Latina. Alameda.

Streck, L. L. (2017). Jurisdição constitucional e hermenêutica. Forense.

Tsemberis, S. (2010). Housing First: the pathways model to end homelessness for people with mental illness and addiction. Hazelden.

Žižek, S. (2014). Violência. Boitempo.

Postone, M. (2014). Tempo, trabalho e dominação social. Boitempo.

WELFARE IN PUBLIC POLICIES
ASSISTENCIALISMO NAS POLÍTICAS PÚBLICAS
EL BIENESTAR EN LAS POLÍTICAS PÚBLICAS



<https://doi.org/10.56238/sevened2026.008-219>

Hildeberto Pedro Paixão¹, Alexandra Aparecida Borges de Souza², Geovani Broering³, Renato Rodrigues⁴

ABSTRACT

This article analyzes the phenomenon of welfare assistance within the context of Brazilian public policies, discussing its relationship with social assistance, the role of the State, and its social and economic impacts. The study begins by distinguishing between welfare assistance and social assistance, highlighting that the former has an emergency and palliative character, whereas social assistance constitutes a right guaranteed by the 1988 Brazilian Constitution and is part of the social security system. The research is exploratory and bibliographical in nature, based on theoretical contributions from sociology, political economy, and social theory, as well as the analysis of public policies implemented in Brazil, such as conditional cash transfer programs and the Unified Health System. Institutional data and local experiences in social policy are also discussed, including references to the municipality of Lages, Santa Catarina. The results indicate that although income transfer programs contribute to reducing poverty and social vulnerability, their effectiveness depends on their articulation with structural policies related to economic development, education, and productive inclusion. It is concluded that public policies based on social rights can play an important role in promoting citizenship and reducing social inequalities.

Keywords: Welfare Assistance. Public Policies. Social Assistance. Social Inequality. Citizenship.

RESUMO

O presente artigo analisa o fenômeno do assistencialismo no contexto das políticas públicas brasileiras, discutindo sua relação com a assistência social, o papel do Estado e seus impactos sociais e econômicos. Parte-se da distinção conceitual entre assistencialismo e assistência social, destacando que o primeiro possui caráter emergencial e paliativo, enquanto a assistência social constitui direito garantido pela Constituição Federal de 1988 e integra o sistema de seguridade social. A pesquisa possui natureza exploratória e bibliográfica, fundamentada em autores das áreas da sociologia, economia política e teoria social, além da análise de políticas públicas implementadas no Brasil, como programas de

¹ Master's student in Law and Sustainable Development. UNIFACVEST. E-mail: hildebertopaixao@bol.com.br

² Master's student in Law and Sustainable Development. UNIFACVEST. E-mail: alexandra.souza@udesc.br

³ Dr. in Law. Dr. in Humanity. Universidade Veiga de Almeida (UVA). E-mail: reitoria@unifacvest.edu.br
 Lattes: <http://lattes.cnpq.br/5211119375617252>

⁴ Dr. in Law. Universidade Veiga de Almeida (UVA). E-mail: prpe@unifacvest.edu.br
 Lattes: <http://lattes.cnpq.br/6556757529380415>

transferência de renda e o Sistema Único de Saúde. Também são discutidos dados institucionais e experiências de políticas sociais em âmbito municipal, com referência ao município de Lages (SC). Os resultados indicam que, embora programas de transferência de renda contribuam para a redução da pobreza e da vulnerabilidade social, sua eficácia depende da articulação com políticas estruturais de desenvolvimento econômico, educação e inclusão produtiva. As políticas públicas baseadas em direitos sociais podem desempenhar papel relevante na promoção da cidadania e na redução das desigualdades sociais.

Palavras-chave: Assistencialismo. Políticas Públicas. Assistência Social. Desigualdade Social. Cidadania.

RESUMEN

Este artículo analiza el fenómeno de la asistencia social en el contexto de las políticas públicas brasileñas, discutiendo su relación con la asistencia social, el papel del Estado y sus impactos socioeconómicos. Comienza con la distinción conceptual entre asistencia social y asistencia social, destacando que la primera tiene un carácter de emergencia y paliativo, mientras que la asistencia social constituye un derecho garantizado por la Constitución Federal de 1988 y forma parte del sistema de seguridad social. La investigación es de carácter exploratorio y bibliográfico, basada en autores de los campos de la sociología, la economía política y la teoría social, además del análisis de políticas públicas implementadas en Brasil, como los programas de transferencia de ingresos y el Sistema Único de Salud. También se discuten datos institucionales y experiencias de políticas sociales a nivel municipal, con referencia al municipio de Lages (SC). Los resultados indican que, si bien los programas de transferencia de ingresos contribuyen a la reducción de la pobreza y la vulnerabilidad social, su efectividad depende de su articulación con políticas estructurales de desarrollo económico, educación e inclusión productiva. Las políticas públicas basadas en derechos sociales pueden desempeñar un papel relevante en la promoción de la ciudadanía y la reducción de las desigualdades sociales.

Palabras clave: Asistencia Social. Políticas Públicas. Desigualdad Social. Ciudadanía.

1 INTRODUCTION

The debate about welfare in Brazilian public policies has acquired increasing relevance in the field of social, legal and economic sciences, especially in view of the expansion of income transfer and social protection programs in recent decades. Such policies are often aimed at socially vulnerable groups, such as homeless people, unemployed individuals, and families without access to formal income, seeking to reduce conditions of poverty, inequality, and social exclusion.

It is essential to understand the distinctions between social assistance and assistance. While social assistance is a right guaranteed by the Federal Constitution of 1988 and is part of the Brazilian social security system, welfare is usually associated with specific aid practices that do not necessarily address the structural causes of social inequality. The distinction has been widely debated in the academic literature, especially with regard to the effects of these policies on the promotion of citizenship, the expansion of access to rights, and the construction of more equitable conditions for social development.

The expansion of public income transfer policies, although recognized for their ability to reduce extreme levels of poverty and expand access to basic rights, also raises criticisms related to the possibility of generating social dependence or discouraging productive insertion. In this sense, part of the literature argues that such programs should be articulated with broader strategies for economic inclusion, professional qualification, and strengthening of the autonomy of individuals, avoiding that they are merely palliative mechanisms in confronting structural inequalities.

This article aims to analyze the phenomenon of welfare in the context of Brazilian public policies, discussing its limits and potentialities in confronting social inequalities. It seeks to examine the relationship between social assistance, state action and the social and economic impacts of these policies, also considering the criticisms directed at welfare practices and their possible effects on the reproduction of historical structures of dependence and social exclusion.

The debate raises the hypothesis that public policies for income transfer in Brazil should not be understood exclusively as welfare practices. When structured as State policies and articulated with broader strategies for social inclusion, professional qualification, and economic development, such policies can contribute significantly to the reduction of social inequalities, to the expansion of access to fundamental rights, and to the strengthening of the human capacities of individuals.

The discussion becomes particularly relevant in a scenario marked by deep social inequalities and the growing demand for social protection mechanisms. In this sense, the

proposed reflection dialogues with theoretical contributions that problematize the limits of practices based exclusively on immediate care, highlighting the need for public policies guided by the promotion of autonomy, citizenship and social participation.

Paulo Freire's thought contributes to understanding that overcoming conditions of oppression and social exclusion is not achieved only through the granting of material benefits, but requires processes of awareness and social transformation. As the author points out:

The assistentialist practice, when disconnected from processes of awareness and social emancipation, tends to reinforce the dependence of the subjects. The liberation of individuals is not achieved by the simple granting of benefits, but by the creation of conditions that allow the oppressed to understand and transform the social reality in which they live. (Freire, 1996, p. 67).

Understanding the role of public policies in confronting poverty and promoting citizenship becomes fundamental to assess whether such initiatives contribute to the construction of emancipatory processes or end up reproducing, albeit indirectly, historical structures of inequality and social exclusion.

1.1 METHODOLOGY

The present research is characterized as an exploratory and bibliographic study, based on the analysis of classic and contemporary works in the areas of law, economics, sociology and political philosophy.

The method adopted consists of a literature review, with interpretative analysis of authors who discuss social inequality, public policies and the role of the State. The theoretical approach allows us to understand assistentialism from different analytical perspectives.

According to José Carlos Libâneo:

Bibliographic research is a fundamental stage of scientific production, as it allows the researcher to situate his object of study within a broader field of theoretical and conceptual debates. By analyzing different authors, the researcher identifies convergences, divergences, and gaps that contribute to the advancement of scientific knowledge. (Libâneo, 2013, p. 52).

The readings of references support the article with theoretical analysis and statistical data, institutional reports on social assistance programs in Brazil, especially those related to income transfer policies and social protection systems.

1.2 LITERATURE REVIEW

The analysis of Brazilian public policies demonstrates that social protection programs cannot be understood only from the perspective of welfare. Unlike specific care practices, many of these policies are structured as social rights institutionally guaranteed by the State.

The most relevant examples are the Bolsa Família Program, considered one of the main income transfer policies implemented in the country in recent decades. Studies carried out by the Institute of Applied Economic Research (IPEA) indicate that programs of this nature produce significant effects on poverty reduction and local economic dynamism. "Income transfer programs have an important multiplier effect on the economy, as the resources destined to low-income families quickly return to the economic circuit through consumption." (IPEA, 2013, p. 31).

The programs have a relevant social impact, especially when associated with education, economy and health policies. The conditionalities linked to school attendance and health monitoring demonstrate that the policy seeks to act on structural factors related to poverty. "The Bolsa Família Program is part of a broader strategy to combat poverty that articulates income transfer with access to essential public services." (Campello; Falcão, 2014, p. 54).

Another example of structuring public policy in Brazil is the Unified Health System (SUS), established by the Federal Constitution of 1988 and based on the principles of universality, integrality and equity. "The Unified Health System is one of the most important social achievements of the 1988 Constitution." (Paim, 2015, p. 37).

The SUS expands access to health and also plays an important role in economic development, by moving the health industrial complex and encouraging scientific production. "The Unified Health System should not be understood only as public spending, but as a strategic investment for national development." (Campos, 2007, p. 112).

The analysis of Brazilian public policies shows that social protection programs can play an important role in reducing social inequalities and promoting citizenship, as long as they are structured as social rights and articulated with broader strategies for economic and social development.

2 WELFARE

The concept of welfare refers to social practices aimed at offering immediate help to individuals or groups in situations of social vulnerability, especially those affected by poverty, unemployment or social exclusion. Although such actions can alleviate urgent needs, they

are often palliative, as they do not address the structural causes that produce social inequalities.

Historically, welfare has been associated with practices of charity or social paternalism. As Boschi (1984) observes, these actions are often related to the philanthropic tradition and the logic of punctual help, which does not necessarily promote lasting processes of social inclusion. In this sense, Paiva and Ouriques argue that: "[...] in Brazil, the logic of crumbs sets the tone for social policies, marked by fragmented actions and incapable of promoting structural changes in the living conditions of the poorest population." (Paiva; Ouriques, 2006, p. 173).

However, it is necessary to differentiate traditional welfare from contemporary public policies of social protection. From the Federal Constitution of 1988, several policies began to be structured as social rights guaranteed by the State, integrating the Brazilian social security system.

Income transfer programs have gained relevance as instruments to combat poverty. Among them, the Bolsa Família Program stands out, widely analyzed by researchers and international organizations. Studies indicate that programs of this nature have a relevant impact on reducing poverty and stimulating the local economy.

Research by the Institute of Applied Economic Research (IPEA) shows that the resources transferred to low-income families quickly return to the economic circuit through consumption. "Income transfer programs have an important multiplier effect on the economy, as the resources destined to low-income families quickly return to the economic circuit through consumption." (IPEA, 2013, p. 31).

The economic impact is very important and social dimension policies are significantly added, especially when associated with public education and health services. In this sense, the Unified Health System (SUS) is one of the main pillars of Brazilian social policy.

The Federal Constitution establishes that: "Health is a right of all and a duty of the State, guaranteed through social and economic policies aimed at reducing the risk of disease and other health problems and universal and equal access to actions and services." (Brasil, 1988, p. 118).

According to Paim (2015), the SUS represents one of the most important social achievements of the Brazilian redemocratization, by guaranteeing universal access to health services.

The Unified Health System is one of the greatest social achievements of the 1988 Constitution, as it instituted a health care model based on the principles of universality, comprehensiveness and equity. It is a structuring public policy that significantly

expanded the population's access to health services and consolidated health as a right of citizenship and responsibility of the State. In this sense, the SUS represents not only a system of service provision, but also a civilizing project committed to the reduction of social inequalities and the promotion of social justice in Brazil. (Paim, 2015, p. 32).

The system also has an economic impact parallel to the social one in a relevant way by mobilizing a broad productive complex linked to the health area. Demonstrated by Campos 2007:

The Brazilian public health system should not only be understood as a social policy to serve the population, but also as an important inducer of economic development. The SUS mobilizes complex production chains that involve pharmaceutical industries, medical equipment, specialized services and scientific production. Thus, the public health system constitutes a relevant component of the national economy, articulating social policies and development policies. (Campos, 2007, p. 115).

Research by Rego and Pinzani (2013) also indicates that income transfer programs do not produce generalized social dependence. On the contrary, they can contribute to expanding the autonomy of beneficiary families and strengthening social participation.

Contrary to the argument often used by critics of cash transfer policies, our empirical research demonstrates that the beneficiaries of these programs do not tend to be accommodating or permanently dependent on the state. On the contrary, income transfer programs can contribute to expanding the autonomy of individuals and strengthening their capacity for social participation, to the extent that they provide minimum conditions of material security necessary for the exercise of citizenship. (Rego; Pinzani, 2013, p. 147)

Relevant aspects of the expansion of autonomy refer to the so-called social conditionalities, such as the requirement of school attendance and monitoring of children's health. According to Campello and Falcão (2014), such mechanisms seek to act on structural factors related to the reproduction of poverty.

The conditionalities associated with income transfer programs do not have a punitive character, but constitute instruments of articulation between different public policies. By requiring school attendance and monitoring of children's health, these programs seek to act on structural factors responsible for the intergenerational reproduction of poverty, simultaneously promoting social inclusion, expanding opportunities and strengthening the human capital of beneficiary families. (Campello; Falcão, 2014, p. 63).

Public policies for income transfer can function as instruments of social protection and promotion of citizenship, especially when articulated with broader strategies for economic development and social inclusion.

2.1 SOCIAL ASSISTANCE AS A PUBLIC POLICY

Social assistance is one of the policies that is part of Brazilian social security, along with health and social security. Unlike welfare, this policy is based on principles of universality, social protection and guarantee of rights.

The regulation occurred with the creation of the Organic Law of Social Assistance – LOAS (Law No. 8,742/1993), later complemented by the implementation of the Unified Social Assistance System (SUAS), responsible for the decentralized organization of social assistance services in the country.

According to the Ministry of Social Development: "The Unified Social Assistance System organizes, in a decentralized and participatory way, the services, programs and benefits of social assistance in Brazil." (Brazil, 2005, p. 12).

This institutional structure represents an important advance in the consolidation of Brazilian social policies, by replacing welfare practices with public policies based on social rights.

2.2 CASE STUDY: PUBLIC POLICIES OF SOCIAL ASSISTANCE IN LAGES (SC)

In the local context, the municipality of Lages, in Santa Catarina, has relevant experiences in the implementation of public social assistance policies aimed at the population in vulnerable situations.

The municipality is part of the national network of the Unified Social Assistance System (SUAS), with Social Assistance Reference Centers (CRAS) and Specialized Social Assistance Reference Centers (CREAS), responsible for serving families at social risk.

Among the actions developed are family monitoring programs, access to social benefits, inclusion in income transfer programs and referral to education, health and professional training services.

These initiatives demonstrate the importance of municipal action in the implementation of social policies provided for in federal legislation. In the case of Lages, the social assistance programs seek not only to offer emergency support, but also to promote processes of social inclusion and strengthening the autonomy of the families served.

The local experience shows that structured public policies articulated with territorial services can contribute to reducing situations of social vulnerability and expanding the population's access to fundamental rights.

3 FINAL CONSIDERATIONS

The analysis developed in this article shows that welfare is a complex phenomenon, located at the intersection between social policies, economics and political culture. Public policies of income transfer and social protection in Brazil play an important role in tackling extreme poverty and reducing social inequalities. Programs such as Bolsa Família and universal systems such as the Unified Health System (SUS) should be understood not only from the perspective of welfare, but as institutional instruments to guarantee social rights provided for in the Federal Constitution of 1988.

National and international research highlights that such policies have contributed significantly to the reduction of poverty and inequality in Brazil, expanding the population's access to essential health, education, and social protection services.

Studies by international organizations, such as the World Bank and public policy research centers, indicate that conditional cash transfer programs, such as Bolsa Família, have relevant impacts on improving the living conditions of families in vulnerable situations, especially when associated with conditionalities related to education and health.

[...] these programs contribute to the reduction of extreme poverty, the increase in school attendance and the improvement of child health indicators, in addition to having a reduced or statistically insignificant impact on the reduction of labor supply among adult beneficiaries (World Bank, 2019).

The initiatives should be interpreted as components of a broader strategy for social protection and human development.

Authors such as Amartya Sen (2010) and Celso Furtado (2004) emphasize that development should be understood as the expansion of human capacities and social opportunities. Overcoming structural inequalities requires public policies that integrate economic growth, education, health, and productive inclusion. In the legal field, Lenio Streck (2014) and Pedro Serrano (2016) highlight that the Brazilian Constitution instituted a State model committed to the realization of social rights and the promotion of material equality. On the other hand, the critical reflection of Slavoj Žižek (2011) warns of the risk of policies that only alleviate the symptoms of inequalities without addressing their structural causes, which reinforces the need for social assistance policies to be articulated with strategies for economic development and productive inclusion.

The analysis of the public policies implemented in the municipality of Lages, in Santa Catarina, highlights the importance of local action in the consolidation of the Brazilian social protection system. Municipal social assistance, structured through the Social Assistance Reference Centers (CRAS) and actions linked to the Unified Social Assistance System (SUAS), serves thousands of families in vulnerable situations, offering both immediate benefits and services aimed at strengthening family and community bonds and social inclusion. This case study demonstrates that the effectiveness of public policies depends on the articulation between the Union, states and municipalities, as well as on the performance of local institutions in the implementation of social protection actions.

The emancipatory perspective proposed by Paulo Freire (1996) shows that overcoming poverty and social exclusion depends not only on distributive policies, but also on processes of awareness, social participation and strengthening of citizenship. The contemporary challenge of Brazilian public policies is to consolidate a social protection model capable of balancing immediate assistance and long-term development. The articulation between income transfer, universal access to health, quality education, professional qualification and generation of economic opportunities is fundamental to promote the social emancipation of the population. Public policies such as Bolsa Família and SUS should be understood as pillars of a social development project that seeks to reduce historical inequalities, expand human capacities, and strengthen social justice, inclusion, and democracy in Brazil.

REFERENCES

- Barrientos, A., & Rawlings, L. (2004). Social assistance in developing countries. World Bank.
- Boschi, C. C. (1984). O assistencialismo na Capitania do Ouro. *Revista de História*, (116), 25–41.
- Boschi, R. R. (1984). Elites industriais e democracia: hegemonia burguesa e mudança política no Brasil. Graal.
- Bourdieu, P. (1998). O poder simbólico. Bertrand Brasil.
- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Senado Federal.
- Brasil. (1993). Lei nº 8.742, de 7 de dezembro de 1993: Dispõe sobre a organização da assistência social e dá outras providências (Lei Orgânica da Assistência Social – LOAS). Presidência da República.
- Brasil. Ministério do Desenvolvimento Social. (2005). Política Nacional de Assistência Social (PNAS). MDS.

- Brasil. Ministério do Desenvolvimento e Assistência Social. (2025). Cadastro Único para Programas Sociais: dados e relatórios nacionais. MDS.
- Campello, T., & Falcão, T. (2014). O Brasil sem miséria. Ministério do Desenvolvimento Social.
- Campello, T., & Falcão, T. (2014). Bolsa Família: uma década de inclusão e cidadania. Ipea.
- Campos, G. W. S. (2007). Saúde pública e saúde coletiva: campo e núcleo de saberes e práticas. *Ciência & Saúde Coletiva*, 12(2), 305–317.
- Chauí, M. (2000). Convite à filosofia. Ática.
- Draibe, S. M. (2003). A política social no período FHC e o sistema brasileiro de proteção social. *Tempo Social*, 15(2), 63–101.
- Freire, P. (1996). Pedagogia da autonomia: saberes necessários à prática educativa. Paz e Terra.
- Freire, P. (2019). Pedagogia do oprimido (78. ed.). Paz e Terra.
- Furtado, C. (2004). Formação econômica do Brasil. Companhia das Letras.
- Instituto Brasileiro de Geografia e Estatística (IBGE). (2023). Censo demográfico 2022: resultados da população e domicílios. IBGE.
- Instituto de Pesquisa Econômica Aplicada (IPEA). (2013). Programas de transferência de renda no Brasil: impactos e desafios. Ipea.
- Instituto de Pesquisa Econômica Aplicada (IPEA). (2022). Programas de transferência de renda e mercado de trabalho no Brasil. Ipea.
- Libâneo, J. C. (2013). Didática. Cortez.
- Medeiros, F. C., Matos, A. C. V., Pagnussat, E., & Oliveira, M. I. F. F. (2020). Entre a benesse e o direito: as políticas de atendimento à população em situação de rua na América Latina. *Psicologia em Estudo*, 25(2), 1–17. <https://doi.org/10.4025/psicoestud.v25i0.45025>
- Neri, M. (2017). A nova classe média: o lado brilhante dos pobres. FGV.
- Paim, J. S. (2015). O que é o SUS. Fiocruz.
- Paiva, B. C., & Ouriques, N. D. (2006). Uma perspectiva latino-americana para as políticas sociais: quão distante está o horizonte? *Revista Katálisis*, 9(2), 166–175.
- Rego, W. L., & Pinzani, A. (2013). Vozes do Bolsa Família: autonomia, dinheiro e cidadania. Editora Unesp.
- Rodrigues, R., & Gonçalves, J. C. (2023). Procedimentos de metodologia científica (11. ed.). Papervest.
- Sen, A. (2010). Desenvolvimento como liberdade. Companhia das Letras.

- Serrano, P. E. A. P. (2018). Autoritarismo e golpes na América Latina: breve ensaio sobre jurisdição e exceção. Alameda.
- Souza, J. (2017). A elite do atraso: da escravidão à Lava Jato. Leya.
- Standing, G. (2017). Renda básica: como podemos fazer acontecer. Autonomia Literária.
- Streck, L. L. (2014). Hermenêutica jurídica e(m) crise: uma exploração hermenêutica da construção do direito. Livraria do Advogado.
- Suplicy, E. M. (2006). Renda de cidadania: a saída é pela porta (3. ed.). Cortez.
- World Bank. (2019). Conditional cash transfers and labor supply in Brazil. World Bank.
- Žižek, S. (2011). Primeiro como tragédia, depois como farsa. Boitempo.
- Žižek, S. (2015). Problemas no paraíso: do fim da história ao fim do capitalismo. Boitempo.

TECHNICAL-ENERGY PERFORMANCE, OVERSIZING, AND SIMULTANEITY IN A RESIDENTIAL SOLAR POWER PLANT WITH ENPHASE MICROINVERTERS AND TRINA 705 W MODULES: A CASE STUDY IN FORTALEZA/CE

DESEMPENHO TÉCNICO-ENERGÉTICO, OVERSIZING E SIMULTANEIDADE EM UMA USINA SOLAR RESIDENCIAL COM MICROINVERSORES ENPHASE E MÓDULOS TRINA 705 W: ESTUDO DE CASO EM FORTALEZA/CE

DESEMPEÑO TÉCNICO-ENERGÉTICO, SOBREDIMENSIONAMIENTO Y SIMULTANEIDAD EN UNA PLANTA SOLAR RESIDENCIAL CON MICROINVERSORES ENPHASE Y MÓDULOS TRINA DE 705 W: ESTUDIO DE CASO EN FORTALEZA/CE



<https://doi.org/10.56238/sevened2026.008-220>

Maicom Aparecido Mortol¹, Rickardo Léo Ramos Gomes²

ABSTRACT

Photovoltaic distributed generation has become established in Brazil as a relevant alternative for the energy transition, especially after the enactment of Law No. 14,300/2022, which redefined the rules of the Electric Energy Compensation System. In this context, it is important to evaluate not only the total energy generated by residential systems, but also the degree of simultaneity between generation and consumption, as well as sizing decisions (DC/AC ratio), which influence local energy use and the export of surplus energy. This study aims to analyze the technical-energy performance of a residential solar power plant with a decentralized architecture based on microinverters and high-power modules, installed in Fortaleza/CE, using real data at 15-minute intervals. The research is applied in nature, with a qualitative-quantitative approach and a case study procedure. Data from 10/19/2025 to 02/23/2026 were analyzed (generation, consumption, export, and import). The system consists of 12 Trina 705 Wp modules (8.46 kWp in direct current) and 12 Enphase IQ8P microinverters (5.7 kW in alternating current), with a DC/AC ratio of 1.48. The results indicated total generation of 5,444.03 kWh and a capacity factor of 31.34%, with occasional clipping during periods of higher irradiance (maximum observed power of 5.676 kW; 9.65% of intervals ≥ 5.6 kW). The estimated self-consumed energy was 579.11 kWh, resulting in a self-consumption rate of 10.64% and a self-sufficiency rate of 47.44%. It is concluded that the system presented consistent performance and that simultaneity is a central variable for interpreting energy utilization in residential settings, especially in projects with intentional surplus for compensation.

Keywords: Distributed Generation. Microinverters. Energy Performance. Oversizing. Simultaneity.

¹ MBA in Renewable Energy Management. Postgraduate in Computer Networks. Universidade Federal de São Carlos (UFSCAR). E-mail: mmortol@solarbr.com.br Orcid: <https://orcid.org/0009-0006-9362-4665>

² Dr. in Biological Sciences. Universidade Federal do Ceará.

E-mail: rickardolrg@yahoo.com.br Orcid: <https://orcid.org/0000-0001-6101-9571>

RESUMO

A geração distribuída fotovoltaica consolidou-se no Brasil como alternativa relevante para a transição energética, especialmente após a promulgação da Lei nº 14.300/2022, que redefiniu regras do Sistema de Compensação de Energia Elétrica. Nesse contexto, torna-se importante avaliar não apenas a energia total gerada por sistemas residenciais, mas também o grau de simultaneidade entre geração e consumo e as decisões de dimensionamento (razão DC/AC), que influenciam o aproveitamento local e a exportação de excedentes. Este trabalho tem como objetivo analisar o desempenho técnico-energético de uma usina solar residencial com arquitetura descentralizada baseada em microinversores e módulos de alta potência, instalada em Fortaleza/CE, utilizando dados reais em intervalos de 15 minutos. A pesquisa é aplicada, com abordagem qualitativa e procedimento de estudo de caso. Foram analisados dados de 19/10/2025 a 23/02/2026 (geração, consumo, exportação e importação). O sistema é composto por 12 módulos Trina de 705 Wp (8,46 kWp em corrente contínua) e 12 microinversores Enphase IQ8P (5,7 kW em corrente alternada), com razão DC/AC de 1,48. Os resultados indicaram geração total de 5.444,03 kWh e fator de capacidade de 31,34%, com clipping pontual no período de maior irradiância (potência máxima observada de 5,676 kW; 9,65% dos intervalos $\geq 5,6$ kW). A energia autoconsumida estimada foi de 579,11 kWh, resultando em taxa de autoconsumo de 10,64% e taxa de autossuficiência de 47,44%. Conclui-se que o sistema apresentou desempenho consistente e que a simultaneidade é variável central para interpretação do aproveitamento energético em residências, especialmente em projetos com excedente intencional para compensação.

Palavras-chave: Geração Distribuída. Microinversores. Desempenho Energético. Oversizing. Simultaneidade.

RESUMEN

La generación distribuida fotovoltaica se ha consolidado en Brasil como una alternativa relevante para la transición energética, especialmente tras la promulgación de la Ley n.º 14.300/2022, que redefinió las reglas del Sistema de Compensación de Energía Eléctrica. En este contexto, es importante evaluar no solo la energía total generada por los sistemas residenciales, sino también el grado de simultaneidad entre generación y consumo, así como las decisiones de dimensionamiento (relación DC/AC), que influyen en el aprovechamiento local y la exportación de excedentes. Este trabajo tiene como objetivo analizar el desempeño técnico-energético de una planta solar residencial con arquitectura descentralizada basada en microinversores y módulos de alta potencia, instalada en Fortaleza/CE, utilizando datos reales en intervalos de 15 minutos. La investigación es de carácter aplicado, con enfoque cualitativo-cuantitativo y procedimiento de estudio de caso. Se analizaron datos del 19/10/2025 al 23/02/2026 (generación, consumo, exportación e importación). El sistema está compuesto por 12 módulos Trina de 705 Wp (8,46 kWp en corriente continua) y 12 microinversores Enphase IQ8P (5,7 kW en corriente alterna), con una relación DC/AC de 1,48. Los resultados indicaron una generación total de 5.444,03 kWh y un factor de capacidad del 31,34%, con clipping puntual en los períodos de mayor irradiancia (potencia máxima observada de 5,676 kW; 9,65% de los intervalos $\geq 5,6$ kW). La energía autoconsumida estimada fue de 579,11 kWh, resultando en una tasa de autoconsumo del 10,64% y una tasa de autosuficiencia del 47,44%. Se concluye que el sistema presentó un desempeño consistente y que la simultaneidad es una variable central para la interpretación del aprovechamiento energético en residencias, especialmente en proyectos con excedente intencional para compensación.

Palabras clave: Generación Distribuida. Microinversores. Desempeño Energético. Sobredimensionamiento. Simultaneidad.

1 INTRODUCTION

Photovoltaic distributed generation has become one of the most relevant vectors of the energy transition in Brazil, contributing to the diversification of the energy matrix and the reduction of emissions associated with electricity production (Tolmasquim, 2003; REN21, 2024). In recent years, the fall in costs of modules, inverters, and fastening structures, combined with the greater availability of financing and the maturation of supply chains, has contributed significantly to the expansion of solar PV on a global scale (IEA, 2024; IEA-PVPS, 2024), accelerating adoption in niches such as residential rooftop systems. At the same time, normative and legal changes have redefined the form of compensation for surpluses, directly influencing the economic viability of the projects.

With Law No. 14,300/2022, which established the Legal Framework for Distributed Microgeneration and Minigeneration, new rules were established for the electricity compensation system in Brazil (Brasil, 2022; Santos; Figueira; Florian, 2024)., the logic of economic return has become more sensitive to consumption behavior simultaneous to generation, especially in systems with high exports to the grid. In this scenario, indicators such as the self-consumption rate and the self-sufficiency rate gain importance in the evaluation of the energy performance of photovoltaic systems connected to the grid (Villalva; Gazoli, 2012), as they describe how much of the energy generated is effectively used at the production site. In addition, sizing decisions, especially the DC/AC ratio, should be evaluated in conjunction with the consumer's hourly load curve, since the increase in the DC arrangement can increase the annual energy generated, but also intensify clipping episodes at peak times.

In parallel with regulatory evolution, there has been significant progress in power electronics applied to solar energy, especially in the development of more efficient inverters and decentralized conversion architectures (Pinho; Galdino, 2004). The architecture with microinverters, in which each photovoltaic module has a dedicated converter, has been adopted in scenarios that demand detailed monitoring, greater tolerance to shading, and expansion flexibility. Still, the technological choice must be supported by evidence in real operation, especially in tropical regions, where irradiance, temperature, and cloudiness regimes influence the performance of the system.

In view of the above, this work has as its general objective to analyze the technical-energy performance of a residential photovoltaic solar plant with Enphase microinverters and Trina 705 Wp high power modules, installed in Fortaleza/CE, from real monitoring data at 15-minute intervals. As specific objectives, it is sought: (i) to discuss conversion architectures applicable to residential distributed generation; (ii) present fundamentals related to DC/AC

sizing and the clipping phenomenon; (iii) calculate technical performance and concurrency indicators; and (iv) report the main results observed in the analyzed period of operation, including monthly consolidation and analysis of hourly curves.

As for the structure, the work is organized into five sections: introduction; methodology; theoretical foundation; experience report in the implementation of the plant and final considerations.

2 METHODOLOGY

This research has an applied nature and a qualitative-quantitative approach, combining numerical analysis of data with technical interpretation of the results (Marconi; Lakatos, 2021). The methodological procedure adopted is the case study, appropriate to the investigation of contemporary phenomena in their real context (Yin, 2015).

The database was obtained by export from the Enphase monitoring platform (CSV file), with records at 15-minute intervals. The following fields were used: date/time, energy produced (Wh), energy consumed (Wh), energy exported (Wh) and energy imported (Wh). The period analyzed comprises 10/19/2025 to 02/23/2026.

The study unit is located in Fortaleza/CE and has a single-phase electrical connection (220V). The photovoltaic array consists of 12 Trina TSM-705NEG21C.20 modules (705 Wp each), totaling 8.46 kWp in direct current, associated with 12 Enphase IQ8P-72-2-BR microinverters, totaling 5.7 kW in alternating current, resulting in a DC/AC ratio of 1.48. The generation measurement is carried out after the microinverters (AC generation), by means of a dedicated current transformer, ensuring representativeness of the energy effectively converted and made available in the installation.

The data processing included: (i) daily and monthly consolidation; (ii) construction of average hourly curves of generation and consumption; (iii) calculation of performance indicators; and (iv) clipping analysis by evaluation of the average power at each 15-minute interval. For the indicators, the following operational definitions were adopted: self-consumed energy in each interval as the minimum between energy produced and energy consumed; self-consumption rate as the ratio of self-consumed energy to total energy generated; self-sufficiency rate as the ratio between self-consumed energy and total consumption; and capacity factor as the ratio of power generated to theoretical power if the system operated continuously at rated AC power over the period.

Table 1 presents the main parameters of the system and indicators calculated in the period analyzed.

Table 1

System parameters and calculated indicators

Parameter/Indicator	Value
Installation location	Fortaleza/CE
Period analyzed	19/10/2025 to 23/02/2026
Installed power (DC)	8.46 kWp
Rated Power (AC)	5.7 kW
DC/AC ratio	1,48
Total generation (kWh)	5.444,03
Total consumption (kWh)	1.220,61
Total Export (kWh)	4.864,92
Total import (kWh)	641,50
Estimated self-consumed energy (kWh)	579,11
Self-consumption rate	10,64%
Self-sufficiency rate	47,44%
Capacity Factor (AC)	31,34%

Source: Prepared by the author based on the Enphase report (2026).

For the construction of the theoretical framework of this study, authors who contributed significantly to the development of knowledge related to photovoltaic solar energy and distributed generation in Brazil were considered. In chronological order, Tolmasquim (2003) stands out, for the contextualization of renewable sources in national energy planning; Pinho and Galdino (2004), for the engineering fundamentals applied to photovoltaic systems; Villalva and Gazoli (2012), for the technical approach to energy conversion and integration of photovoltaic systems into the electricity grid; Nascimento and Benevides (2018), for discussions related to residential application and systems monitoring; and Santos, Figueira and Florian (2024), who analyze recent regulatory impacts and the relevance of energy simultaneity in the context after Law No. 14,300/2022.

3 THEORETICAL FOUNDATION

The theoretical foundation was organized into five topics: (i) distributed generation and regulatory framework; (ii) conversion architectures into residential photovoltaic systems; (iii) high-power photovoltaic modules; (iv) technical performance indicators; and (v) DC/AC scaling, clipping, and concurrency.

3.1 DISTRIBUTED GENERATION AND REGULATORY FRAMEWORK

The regulation of distributed generation in Brazil had as its starting point ANEEL Normative Resolution No. 482/2012 (ANEEL, 2012), which established conditions for the connection of microgeneration and minigeneration to the grid and the credit compensation mechanism.

Subsequently, the Legal Framework (Law No. 14,300/2022) consolidated rules and transitions, establishing criteria for the gradual collection of tariff components associated with the use of the network by new connections. This new arrangement makes the technical evaluation and design of the project even more dependent on the consumption profile and the level of export of surpluses.

In practical terms, residential projects can pursue two strategies: maximize local self-consumption (reducing exports) or size surplus to form energy credits to be offset in future periods and/or in other linked consumer units.

The choice affects energy indicators and the interpretation of efficiency: a low self-consumption rate may be a consequence of an intentional surplus strategy, and not necessarily of design flaws.

3.2 ARCHITECTURES AND ENERGY CONVERSION SYSTEMS IN RESIDENTIAL SOLAR POWER PLANTS

The technical configuration of residential solar plants, in turn, brings decisions that are closely linked to the performance of the system, especially in relation to energy conversion architectures. As Santos, Figueira, and Florian (2024) discuss, the choice between a central inverter, a string inverter, or a microinverter is not a matter of overall generation efficiency, but also of how the system deals with shading, localized failures, and the new regulatory requirements that emerged after Law No. 14,300/22. The comparative analysis of these architectures, therefore, is important to understand how different technological solutions adjust to the practical conditions of operation in photovoltaic systems connected to the grid.

In residential applications, Tomich Junior (2021) notes that string inverters dominate the market due to their ease of installation and lower initial price, but microinverters are becoming popular because they allow for optimized performance of each module and more detailed monitoring. This variety of options demonstrates that the system needs to be adapted to the particularities of each facility, such as available space, consumption pattern, and environmental conditions, which directly impact energy performance over time.

When dealing with solar energy for residential use, Nascimento and Benevides (2018) emphasize that, in order for the photovoltaic system to operate efficiently and reliably, it is crucial to implement energy monitoring and management strategies. Within this technological spectrum, systems with microinverters, such as Enphase, offer an alternative among the various options on the market, enabling a more detailed control of generation and the rapid detection of losses or failures. Therefore, when the Enphase system is positioned compared

to other well-established solutions, it enriches the understanding of the different technological options that can be utilized in residential solar plants.

The DC/AC conversion stage is central to the quality of supply and the overall performance of the photovoltaic system (Pine; Galdino, 2004; Villalva; Gazoli, 2012). In string inverters, modules connected in series share the same operating point, which can lead to *mismatch* losses. On the other hand, the topology with microinverters performs tracking of the maximum power point (MPPT) in each module, reducing losses due to *mismatch* and partial shading (Villalva; Gazoli, 2012).

Additionally, microinverters favor granular monitoring and predictive maintenance. For operational management purposes, access to data by module allows the identification of anomalies (e.g. localized dirt, premature degradation or connection failures), reducing diagnostic time. However, designs with microinverters must consider the nominal AC power limitation per unit and the combined effect of the DC array on clipping behavior.

3.3 HIGH POWER MODULES AND WEATHER CONDITIONS

High-power modules, such as the Trina Vertex N family, utilize advanced technologies such as *n-type* cells and TOPCon architectures for increased efficiency (IEA-PVPS, 2024; TRINA SOLAR, 2024). On residential rooftops, the main benefit is higher power density, allowing higher installed powers to be achieved in limited areas. However, field performance depends on climatic variables: operating temperature, roof ventilation, albedo, and cloudiness all influence instantaneous power.

In coastal regions with a hot climate, such as Fortaleza, high temperatures can reduce the instantaneous yield of the module in relation to the standard test (STC). Still, the high annual irradiance and the greater amount of sunshine hours can sustain high annual energy production, making the place favorable to photovoltaic generation.

3.4 TECHNICAL PERFORMANCE INDICATORS

The performance analysis of grid-connected photovoltaic systems often uses consolidated energy assessment indicators (Dobos, 2014; IEC 61724-1, 2021). The specific generation (kWh/kWp) is useful for comparing different projects in different locations. The capacity factor (FC) describes the degree of utilization of the rated power over time, being influenced by irradiance, temperature, and system losses. The self-consumption rate, on the other hand, measures the fraction of energy generated that is instantly used on site, while the self-sufficiency rate expresses how much of the total consumption is supplied by self-generation.

In operational terms, simultaneity can be analyzed by hourly curves: in homes, it is common for consumption peaks to occur in the early morning and at night, when generation is low or non-existent. Thus, load displacement strategies (e.g., use of pumps, heating, recharging of vehicles or household appliances during the day) tend to increase self-consumption and reduce exports, which becomes more relevant under rules of charging for the use of the network.

3.5 DC/AC RATIO, *OVERSIZING* AND *CLIPPING*

The dimensioning of the DC/AC ratio is a relevant design decision for optimizing annual energy generation (Dobos, 2014; Villalva; Gazoli, 2012). When the DC array is higher than AC capacity, there is potential power gain at times of lower irradiance, but also greater likelihood of clipping at peaks. The intensity of the clipping depends on the local irradiance, temperature, and array profile. Thus, the evaluation should quantify the frequency of saturation and compare it with the benefit of additional production at other times.

3.6 EXPERIENCE REPORT ON THE IMPLEMENTATION OF A RESIDENTIAL SOLAR PLANT

This section describes, in the form of an experience report, the main results of the operation of the plant installed in Fortaleza/CE, based on real data obtained from the monitoring platform. The system has a generation surplus in relation to local consumption, resulting in high exports and, consequently, the formation of credits for compensation. The interpretation of the indicators is carried out considering this strategy.

In the period analyzed, the total energy generated was 5,444.03 kWh, while the total consumption recorded was 1,220.61 kWh. Exports totaled 4,864.92 kWh and imports 641.50 kWh. The estimated self-consumed energy was 579.11 kWh, which resulted in a self-consumption rate of 10.64% and a self-sufficiency rate of 47.44%.

The average daily generation was 42.87 kWh/day. Considering the nominal power of 5.7 kW, the capacity factor in the period was 31.34%. These values reflect the favorable conditions of solar resources and the sizing strategy adopted.

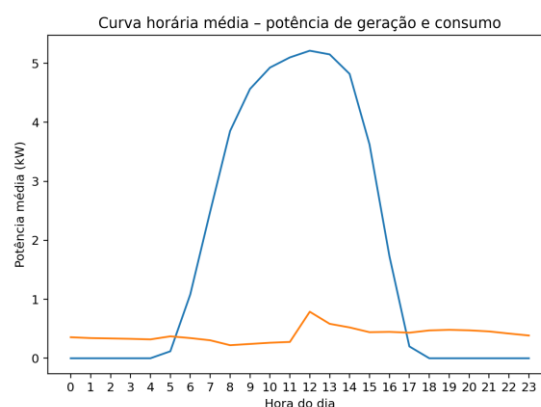
To evaluate *clipping*, the average power was calculated at each 15-minute interval. The maximum power observed was 5.676 kW, very close to the nominal limit of the system. The frequency of intervals with power equal to or greater than 5.6 kW was 9.65%, indicating point saturation concentrated at the top of the daily curve. From a practical point of view, this behavior is expected in projects with *oversizing* and can be interpreted as evidence that the

inverter was used close to the limit part of the time, without, however, eliminating the generation gain at times of intermediate irradiance.

The day with the highest generation was 01/08/2026, with a daily production of 50.25 kWh. This result is useful for illustrating typical behavior under favorable conditions, including the plateau associated with the conversion threshold. Figures 1, 2, 3, 4 and 5 illustrate all the calculations developed.

Figure 1

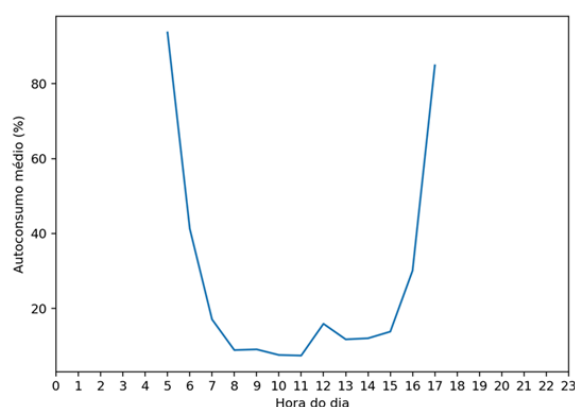
Average hourly curve of generation and consumption power



Source: Prepared by the author from the Enphase report (2026).

Figure 2

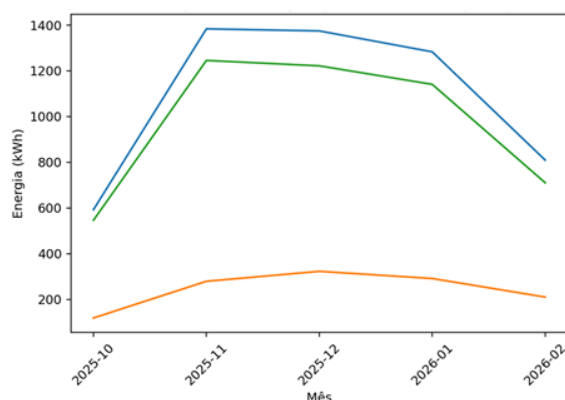
Average hourly rate of self-consumption



Source: Prepared by the author from the Enphase report (2026).

Figure 3

Monthly consolidation of generation, consumption and exports



Source: Prepared by the author from the Enphase report (2026).

Figure 4

Generation power distribution (15-minute intervals)



Source: Prepared by the author from the Enphase report (2026).

Figure 5

Generation profile on the day of highest production



Source: Prepared by the author from the Enphase report (2026).

Table 2 shows the monthly energy consolidation (kWh) in the period analyzed.

Table 2

Monthly Energy Consolidation

Month	Generation	Consumption	Export	Import
2025-10	592,69	118,31	546,24	71,87
2025-11	1383,89	278,88	1245,52	140,51
2025-12	1374,71	322,5	1221,92	169,7
2026-01	1283,29	291,07	1140,9	148,69
2026-02	809,46	209,85	710,35	110,73

Source: Prepared by the author from the Enphase report (2026).

The hourly analysis indicates that self-consumption is maximized in the periods of lower irradiance (morning and late afternoon), when generation approaches consumption. In the central period of the day, the surplus is expressive, resulting in high exports. This result is consistent with the project's strategy: the plant was sized to generate more than local consumption, allowing compensation for the surplus in another consumer unit, in addition to reducing dependence on grid energy at times of solar availability.

In terms of regulatory interpretation, the scenario reinforces that residential projects should be analyzed considering: (i) load profile; (ii) compensation policy; (iii) possibility of consumption management; and (iv) tariff structure. In the case analyzed, high exports are desired from the point of view of energy credit, but it reduces the rate of local self-consumption, which does not represent, in itself, low technical performance.

4 FINAL CONSIDERATIONS

The present work evaluated the technical-energy performance of a residential photovoltaic plant with microinverters and high-power modules, using real data at 15-minute intervals. The approach allowed calculating performance indicators, analyzing hourly curves and quantifying clipping, providing practical evidence for sizing decisions in residential distributed generation.

In the period analyzed, the system presented a total generation of 5,444.03 kWh and a capacity factor of 31.34%, indicating high performance by residential standards. The DC/AC ratio of 1.48 was technically adequate to the local conditions, with punctual and non-dominant clipping. The local self-consumption rate was 10.64% and the self-sufficiency rate was 47.44%, values influenced by the strategy of intentional surplus.

The results show that the simultaneity between generation and consumption should be interpreted in the light of the project's objective and regulatory rules. When the purpose includes compensation in other consumer units, high exports are part of the strategy. Even

so, in contexts of higher charges for network use, increasing self-consumption by load and/or storage management can become relevant for economic optimization.

As limitations, it is noteworthy that the analyzed period does not include a complete annual cycle, which restricts conclusions about annual seasonality. In addition, local measurements of irradiance and module temperature were not incorporated, which makes it impossible to calculate indicators such as Performance Ratio. As future works, it is recommended: (i) to extend the horizon to 12 months; (ii) integrate meteorological data; (iii) evaluate tariff and economic scenarios; (iv) simulate load displacement strategies; and (v) analyze impacts of possible insertion of storage.

REFERENCES

Agência Nacional de Energia Elétrica (ANEEL). (2022). Micro e minigeração distribuída (geração distribuída). <https://www.gov.br/aneel/pt-br/assuntos/geracao-distribuida>

Agência Nacional de Energia Elétrica (ANEEL). (2024). Relatórios e indicadores de micro e minigeração distribuída no Brasil. <https://www.gov.br/aneel/pt-br/centrais-de-conteudos/relatorios-e-indicadores/micro-e-minigeracao-distribuida>

Brasil. (2022). Lei nº 14.300, de 6 de janeiro de 2022: Institui o marco legal da microgeração e minigeração distribuída, o Sistema de Compensação de Energia Elétrica (SCEE) e o Programa de Energia Renovável Social (PERS). https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2022/lei/l14300.htm

Dobos, A. P. (2014). PVWatts version 5 manual. National Renewable Energy Laboratory (NREL). <https://pvwatts.nrel.gov/downloads/pvwatts5.pdf>

Enphase Energy. (2024a). IQ8P microinverter (IQ8P-72-2-BR): Ficha técnica. <https://enphase.com/pt-br/download/iq8p-microinverter-ficha-tecnica>

Enphase Energy. (2024b). IQ8P microinverter (IQ8P-72-2-BR): Manual do usuário. <https://enphase.com/pt-br/download/iq8p-microinverter-manual-do-usuario>

Enphase Energy. (2025–2026). Relatório personalizado de monitoramento (CSV): 5942717_personalizado_relatorio [Arquivo de dados].

International Electrotechnical Commission (IEC). (2021). IEC 61724-1:2021 — Photovoltaic system performance — Part 1: Monitoring.

International Energy Agency (IEA). (2024). World energy outlook 2024.

International Energy Agency Photovoltaic Power Systems Programme (IEA-PVPS). (2024). Trends in photovoltaic applications 2024. <https://iea-pvps.org/wp-content/uploads/2024/10/IEA-PVPS-Task-1-Trends-Report-2024.pdf>

Marconi, M. de A., & Lakatos, E. M. (2021). Fundamentos de metodologia científica (9ª ed.). Atlas.

- Nascimento, E. S., & Benevides, J. C. M. (2018). Uso da energia solar em residências. *Revista Científica Multidisciplinar Núcleo do Conhecimento*, 3(11), 117–124. <https://www.nucleodoconhecimento.com.br/engenharia-civil/uso-da-energia-solar>
- Pinho, J. T., & Galdino, M. A. (Orgs.). (2004). *Manual de engenharia para sistemas fotovoltaicos*. CRESESB.
- REN21. (2024). *Renewables 2024 global status report*. <https://www.ren21.net/gsr-2024/>
- Santos, W. C. do, Figueira, R. G., & Florian, F. (2024). Energia solar e seus impactos em projeto fotovoltaico conectado à rede após a Lei 14.300/22. *RECIMA21 - Revista Científica Multidisciplinar*, 5(5). <https://doi.org/10.47820/recima21.v5i5.5202>
- Tolmasquim, M. T. (2003). *Fontes renováveis de energia no Brasil*. Interciência.
- Tomich Junior, Á. R. (2021). *Energia fotovoltaica residencial (Trabalho de Conclusão de Curso)*. Faculdade Pitágoras.
- Trina Solar. (2024). Datasheet: TSM-NEG21C.20 (695–720 W). https://static.trinasolar.com/sites/default/files/Datasheet_NEG21C.20.pdf
- Villalva, M. G., & Gazoli, J. R. (2012). *Energia solar fotovoltaica: Conceitos e aplicações*. Érica.
- Yin, R. K. (2015). *Estudo de caso: Planejamento e métodos* (5ª ed.). Bookman.

AI GOVERNANCE IN HUMAN RESOURCES: TRANSPARENCY, COMPLIANCE, AND FAIRNESS IN AUTOMATED PROCESSES

GOVERNANÇA DE IA EM RECURSOS HUMANOS: TRANSPARÊNCIA, CONFORMIDADE E EQUIDADE EM PROCESSOS AUTOMATIZADOS

GOBERNANZA DE IA EN RECURSOS HUMANOS: TRANSPARENCIA, CUMPLIMIENTO Y EQUIDAD EN PROCESOS AUTOMATIZADOS



<https://doi.org/10.56238/sevened2026.008-221>

Denilson Albano Portácio¹, Francisca Elsa Silva Franklin², Francisco José Lopes Cajado³, Ilcimar Gomes Vieira Costa⁴, Irene Mendes Fontes⁵, Juliana Alves Coelho⁶, Maria Antônia do Socorro Rabelo Araujo⁷, Ricardo Cesar de Oliveira-Borges⁸, Rickardo Léo Ramos Gomes⁹, Roberto Augusto Caracas Neto¹⁰, Walter Junior Silva Sousa¹¹

ABSTRACT

The adoption of artificial intelligence in companies is changing human resource management practices. This is evident in practices such as recruitment, performance evaluation, and talent management. This creates a new context in which technology influences decisions and management strategies within organizations. The discussion of technological governance is crucial, especially in Human Resources. This debate is even more important given the growing need to ensure transparency in automated processes. It is essential to ensure strict compliance with regulatory standards and respect for principles of fairness in the workplace, making ethical management of these technologies essential. A qualitative approach was adopted to investigate the governance of artificial intelligence in Human Resources. This

¹ Master's degree in Letters. Universidade Federal do Ceará (UFC). E-mail: denilsonap@seduc.ce.gov.br
Orcid: <https://orcid.org/0000-0001-7481-2077>

² Specialization in Geography Teaching. UniAteneu. E-mail: elsafranklinaraujo@gmail.com
Orcid: <https://orcid.org/0009-0007-1971-8935>

³ Dr. in Agricultural Biotechnology. RENORBio/UFC. E-mail: lopesbio@yahoo.com.br
Orcid: <https://orcid.org/0000-0002-8824-9251>

⁴ Postgraduate Degree in Clinical and Institutional Psychopedagogy. Universidade Estadual Vale do Acaraú. E-mail: ilcimar@seduc.ce.gov.br Orcid: <https://orcid.org/0009-0008-2180-2420>

⁵ Postgraduate certificate in Criminal Law. Centro Universitário UniAteneu. E-mail: irenefontesrc@gmail.com
Orcid: <https://orcid.org/0009-0002-3152-6649>

⁶ Specialist in People Management. FBUNI. E-mail: juliana.alves41@yahoo.com.br
Orcid: <https://orcid.org/0009-0007-3416-9911>

⁷ Master's degree in Business Administration. Universidade Federal do Ceará (UFC). E-mail: socorro.rabelo2008@gmail.com Orcid: <https://orcid.org/0009-0000-8828-472X>

⁸ Postdoctoral in Geography. Universidade Federal do Ceará (UFC). E-mail: admricardocesar@gmail.com
Orcid: <https://orcid.org/0009-0001-2522-8103>

⁹ Dr. in Biological Sciences. Universidade Federal do Ceará. E-mail: rickardolrg@yahoo.com.br Orcid: <https://orcid.org/0000-0001-6101-9571>

¹⁰ Doctoral student in Intellectual Property and Innovation. INPI. E-mail: robertocaracas2000@gmail.com
Orcid: <https://orcid.org/0000-0001-8484-411X>

¹¹ MBA in Labor and Social Security Management. BSSP. E-mail: walterrsousa@gmail.com
Lattes: <https://lattes.cnpq.br/5031383678885182>

method analyzes institutional relationships, norms, and organizational practices beyond numerical indicators. Bibliographic research was the main methodological strategy, allowing the analysis of books, journal articles, and scientific studies on the topic. This study aims to analyze the foundations and practices of artificial intelligence governance in Human Resources, focusing on transparency, compliance, and fairness in automated management processes. The research showed that artificial intelligence in human resource management is very beneficial, as it improves organizational analysis and supports data-driven decision-making. The application of this technology requires careful governance structures that ensure transparency, compliance with standards, and seek to reduce possible algorithmic biases in information processing. This is essential to ensure that the adopted practices are fair and responsible. Supervision, auditing, and institutional accountability are essential to ensure that automated systems promote a more equitable organization aligned with modern human resource management standards. These tools are essential to ensure that guidelines and procedures are aligned with ethical principles and workplace demands, promoting more equitable organizational development.

Keywords: Artificial Intelligence. Governance. Transparency. Human Resources.

RESUMO

A adoção de inteligência artificial nas empresas está mudando profundamente as práticas de gestão de pessoas. Isso se destaca em práticas como seleção de pessoal, avaliação de desempenho e gestão de talentos. Isso cria um novo contexto em que a tecnologia influencia as decisões e estratégias de gestão de pessoas nas organizações. A discussão sobre governança tecnológica é crucial, especialmente em Recursos Humanos. Esse debate é ainda mais importante diante da crescente necessidade de garantir a transparência em processos automatizados. É fundamental garantir o cumprimento rigoroso das normas regulatórias e o respeito aos princípios de equidade no trabalho, tornando essencial um gerenciamento ético dessas tecnologias. Adotou-se uma abordagem qualitativa para investigar a governança da inteligência artificial em Recursos Humanos. Esse método analisa relações institucionais, normas e práticas organizacionais além dos indicadores numéricos. A pesquisa bibliográfica foi a principal estratégia metodológica, permitindo a análise de livros, artigos em periódicos e estudos científicos sobre o tema. Este estudo visa analisar fundamentos e práticas de governança da inteligência artificial em Recursos Humanos, focando em transparência, conformidade e equidade em processos automatizados de gestão. A pesquisa mostrou que a inteligência artificial na gestão de recursos humanos é muito benéfica, pois melhora a análise das empresas e auxilia decisões baseadas em dados. A aplicação dessa tecnologia exige estruturas de governança cuidadosas, que garantam transparência, conformidade com normas e busquem reduzir possíveis vieses algorítmicos no tratamento das informações. Isso é essencial para que as práticas adotadas sejam justas e responsáveis. A supervisão, auditoria e responsabilização institucional são essenciais para assegurar que sistemas automatizados promovam uma organização mais justa e alinhada aos padrões modernos de gestão de recursos humanos. Essas ferramentas são essenciais para garantir que as diretrizes e procedimentos estejam alinhados aos princípios éticos e às demandas do ambiente de trabalho, promovendo um desenvolvimento organizacional mais justo.

Palavras-chave: Inteligência Artificial. Governança. Transparência. Recursos Humanos.

RESUMEN

La adopción de la inteligencia artificial en las empresas está cambiando las prácticas de gestión de recursos humanos. Esto se destaca en prácticas como la selección de personal, la evaluación del desempeño y la gestión del talento. Esto crea un nuevo contexto en el que la tecnología influye en las decisiones y estrategias de gestión dentro de las organizaciones. La discusión sobre la gobernanza tecnológica es crucial, especialmente en Recursos Humanos. Este debate es aún más importante ante la creciente necesidad de garantizar la transparencia en los procesos automatizados. Es fundamental asegurar el cumplimiento riguroso de las normas regulatorias y el respeto a los principios de equidad en el trabajo, haciendo esencial una gestión ética de estas tecnologías. Se adoptó un enfoque cualitativo para investigar la gobernanza de la inteligencia artificial en Recursos Humanos. Este método analiza las relaciones institucionales, normas y prácticas organizacionales más allá de los indicadores numéricos. La investigación bibliográfica fue la principal estrategia metodológica, permitiendo el análisis de libros, artículos en revistas y estudios científicos sobre el tema. Este estudio tiene como objetivo analizar los fundamentos y prácticas de gobernanza de la inteligencia artificial en Recursos Humanos, enfocándose en la transparencia, el cumplimiento y la equidad en los procesos automatizados de gestión. La investigación mostró que la inteligencia artificial en la gestión de recursos humanos es muy beneficiosa, ya que mejora el análisis de las organizaciones y apoya la toma de decisiones basada en datos. La aplicación de esta tecnología requiere estructuras de gobernanza cuidadosas que garanticen la transparencia, el cumplimiento de normas y busquen reducir posibles sesgos algorítmicos en el tratamiento de la información. Esto es esencial para asegurar que las prácticas adoptadas sean justas y responsables. La supervisión, auditoría y responsabilidad institucional son esenciales para asegurar que los sistemas automatizados promuevan una organización más equitativa y alineada con los estándares modernos de gestión de recursos humanos. Estas herramientas son esenciales para garantizar que las directrices y procedimientos estén alineados con los principios éticos y las demandas del entorno laboral, promoviendo un desarrollo organizacional más justo.

Palabras clave: Inteligencia Artificial. Gobernanza. Transparencia. Recursos Humanos.

1 INTRODUCTION

The introduction of artificial intelligence systems in companies has significantly changed the way decisions are organized and made in people management. Processes that were previously fully managed by Human Resources professionals, such as recruitment, selection, performance evaluation, and career planning, now have tools based on algorithms. In this context, the growing presence of data-driven technologies requires careful reflection on the criteria that guide these decisions, as well as on the institutional mechanisms necessary to ensure transparency, organizational accountability, and respect for the rules that regulate the use of data and automated systems (Appolinário; Hedler; Ferneda, 2025).

At the same time, the development of these technologies intensifies the academic and institutional discussion on the governance of artificial intelligence. The implementation of automatic systems in organizational processes raises concerns about the explanation of algorithms, compliance with relevant legislation, and the need to avoid discrimination arising from biases in data or predictive models. In this sense, it is crucial to investigate how organizations can implement governance practices that can balance technological innovation, institutional accountability, and principles of equity in the workplace.

To carry out this investigation, a qualitative approach was used, considering that the theme in question concerns the interpretation of phenomena related to the governance of artificial intelligence in the area of Human Resources. This type of method enables the analysis of institutional relations, norms and organizational practices that are not limited to mere numerical indicators. Regarding the methodology, bibliographic research was the chosen strategy, which is widely recognized in scientific elaboration, since it allows the thorough examination of academic books, articles from specialized journals and published research on the subject in question.

The general objective of this work is to analyze the fundamentals and governance practices of artificial intelligence in the area of Human Resources, focusing on the promotion of transparency, regulatory compliance and equity in automated people management processes. To achieve this purpose, three specific objectives were established: to examine how artificial intelligence systems are being applied in recruitment, selection, performance evaluation, and talent management processes; investigate the transparency and regulatory compliance mechanisms necessary for the responsible use of artificial intelligence in Human Resources; and assess the risks of biases, discrimination, and inequalities arising from decision-making automation in people management practices.

To make clear and well-defined the analytical path that was built throughout the text, the article was structured in four main sections. The first section of the work is the introduction,

in which the research theme is presented with caution, the problem that will be explored throughout the work is defined and the objectives that will guide the development of the study are clarified. This introduction is vital, as it defines the premises that the reader will use to understand all the content that will follow. The methodology, which is the protagonist of the second part of this work, has as its main objective to describe in detail the chosen approach and also to list the various procedures used in the construction of the analysis carried out. This section aims to elucidate how methodological choices have shaped the development of the research. Then, in the third section of the work, the theoretical foundation is presented, which is intended to discuss the main academic references that are significantly connected to the use of artificial intelligence in people management, in addition to addressing the issue of technological governance and the risks involved in the automation of decision-making processes. Therefore, this discussion is crucial to unravel the implications and effects of these technologies in the organizational environment. Finally, in the last part of the text, the final considerations are made, where the main aspects and elements discussed and analyzed throughout the construction of the text are recalled. In addition, some possible directions and trajectories are pointed out so that future research on the subject can be carried out, thus expanding the investigations that may result from the results and conclusions reached.

2 METHODOLOGY

This work used a qualitative approach, considering that the proposal of the study consists of the interpretation of phenomena related to the governance of artificial intelligence in the Human Resources sector. Qualitative research is widely used in current scientific research, as it enables the understanding of complex social processes and examines meanings, institutional relations and normative structures that guide certain practices in organizations. Gil (2021) argues that this strategy is beneficial for the analysis of phenomena that cannot be quantified and is especially suitable when the researcher's goal is to understand interpretations, perceptions, and institutional dynamics in specific contexts.

In the area of applied social sciences, qualitative research is a common tool to explore phenomena related to regulation, institutional governance, and technological changes that impact organizations. This enables an analysis of how regulations, ethical principles and organizational structures are interconnected in the creation of new management practices. As Rattner (1979) argues, scientific research needs methodological procedures that are capable of deciphering, in a systematic way, the social reality, connecting epistemological foundations and analytical strategies that enable the understanding of the complex phenomena that manifest themselves in contemporary societies.

Regarding the research process that was chosen for this work, it was decided to adopt bibliographic research, which is a widely recognized and established method in the production of scientific knowledge. This approach is often used in several areas of knowledge, as it allows an in-depth and grounded analysis based on already published sources, contributing to the construction of a solid theoretical framework. Bibliographic research is a methodology that is characterized by the careful and organized analysis of materials that have already been previously published. This type of investigation allows the researcher to have the opportunity to examine various perspectives, both theoretical and empirical, in relation to a specific theme. In this way, bibliographic research is an essential tool for deepening the knowledge and understanding of the different existing approaches on the subject in question. According to Gil (2021), this type of procedure is considered one of the essential foundations of scientific research, since it allows the collection, interpretation, and systematization of knowledge that has already been prepared by the academic community. This approach is fundamental, as it favors the performance of analyses that are solidly based on the available technical and specialized literature. Thus, the use of this procedure not only adds value to the study, but also supports the development of new investigations that are based on previous studies carried out in the area.

The bibliographic research developed here was based on more than fifteen scientific sources, most of which are books and academic articles that deal with the subjects of technological governance, artificial intelligence and people management. The choice of these sources aimed to cover the various analytical perspectives that can be found in the specialized literature, aiming at the construction of a solid panorama on the issue under investigation. As stated by Rodrigues and Neubert (2023), the careful choice of scientific references enables the organization of existing knowledge about a given object of investigation, which allows for critical analysis and a systematization of the academic debate.

3 THEORETICAL FOUNDATION

To theoretically support this work, three analytical axes were outlined that enable an articulation between the different layers that make up the governance of artificial intelligence in people management. The first subtopic, 3.1 Artificial Intelligence at the Service of Strategic People Management, brings to light the integration of intelligent systems in key functions of the Human Resources sector, particularly in the areas of recruitment, selection, performance evaluation and analysis of organizational data. Principle 3.2, entitled Transparency, Compliance, and Corporate Responsibility in the Use of AI, comes next and discusses governance in technology, with an emphasis on data protection, system audits, and

compliance with regulatory frameworks. Finally, item 3.3 Equity, Organizational Justice and Risks of Discrimination in Automated Processes brings to light the ethical issues involved in decision automation, addressing the dangers of algorithmic biases and institutional initiatives to foster a fairer and more equitable organizational practice.

3.1 APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN STRATEGIC PEOPLE MANAGEMENT

The integration of artificial intelligence systems in Human Resources functions has significantly transformed the way companies perform tasks related to people management. AI, which was previously limited to operational functions such as organizing data or automating administrative tasks, is now present in strategic processes that encompass recruitment, selection, performance evaluation, and talent management. In this sense, tools that use algorithms and data analysis are capable of recognizing patterns of conduct in the professional environment, assisting in decision-making within organizations, and optimizing the efficiency of internal processes (Dantas, 2025; Lima et al., 2025).

This reflects the evolution from a traditional people management model to a data-driven approach. There are people analytics platforms that make it possible to integrate multiple sources of information on performance, turnover, and skills development. The systematic collection of this information allows decisions about career planning, talent retention, and organizational development to be made more informedly. Ribeiro (2024) explains that, by adopting these tools, the Human Resources professional is no longer just a people manager to become a strategic partner of the organization, collaborating in decisions that are supported by evidence and analytical data.

Another use of artificial intelligence occurs in recruitment and selection processes, where automated systems screen resumes, map profiles that align with the requirements of the vacancies, and assist in digital interviews mediated by algorithms. They increase the processing capacity of large volumes of data and speed up the initial screening steps. Market reports indicate that companies are increasing the adoption of these technologies to make selection processes more efficient and to improve the quality of talent management decisions (Gartner, 2024). In this sense, Table 1 summarizes some of the main uses of artificial intelligence in strategic people management.

Table 1

Applications of Artificial Intelligence in Strategic Human Resource Management

AI Application in HR	Description	Organizational Contribution
Automated Resume Screening	AI systems analyze large volumes of resumes to identify candidates whose profiles match job requirements.	Reduces time in initial recruitment stages and improves candidate filtering efficiency.
AI-Assisted Digital Interviews	Intelligent platforms analyze verbal responses, facial expressions, and communication patterns during virtual interviews.	Supports decision-making in candidate evaluation and standardizes assessment processes.
People Analytics	Advanced data analytics applied to workforce data to identify trends related to performance, engagement, and turnover.	Enhances strategic workforce planning and supports data-driven HR decisions.
Performance Monitoring Systems	AI-based tools track employee performance indicators and behavioral patterns in organizational environments.	Enables continuous feedback processes and supports talent development strategies.

Source: Adapted from Dantas (2025); Gartner (2024); Lima et al. (2025); Ribeiro (2024).

Chart 1 illustrates several applications of artificial intelligence in Human Resources, highlighting how these tools have supported people management processes in a more structured and data-driven way. Among the most notable functions, we can mention the automatic screening of resumes, digital interviews with the support of artificial intelligence, the use of People Analytics, and performance monitoring systems. They make it possible to analyze large volumes of data, identify important patterns, and support decision-making within the organization. Therefore, there is a decrease in time in the initial phases of recruitment, greater uniformity in the evaluation of candidates, better strategic planning of the workforce, and constant monitoring of employee performance, which results in more efficient talent development and management processes in companies.

The growing adoption of these tools reinforces the consolidation of a data-driven Human Resources model supported by sophisticated digital technologies. In this context, artificial intelligence plays an important role in assisting in strategic people management decisions, making the operation more efficient and improving talent assessment and development processes. Simultaneously, as Lima et al. (2025) point out, the adoption of these technologies must be carefully considered in relation to governance, transparency, and regulatory compliance, particularly when it comes to automated decisions that can shape careers and opportunities within organizations.

3.2 TRANSPARENCY, COMPLIANCE, AND CORPORATE RESPONSIBILITY IN THE USE OF AI

The introduction and integration of artificial intelligence in organizational contexts has stimulated a significant increase in discussions about technological governance. This

phenomenon is particularly relevant at the moment when these advanced systems begin to exert influence on decisions involving the administration and management of human resources (Appolinário; Hedler; Ferneda, 2025). The impact brought by this technology sparks a growing interest in understanding how governance guidelines and practices should adapt to deal with these new dynamics that affect the way organizations manage their employees. In the field of Human Resources, the implementation of algorithms in activities involving candidate selection, as well as the evaluation and management of talents, requires the existence of organizational structures that ensure transparency in procedures, promote accountability in actions, and ensure that there is alignment with essential ethical foundations. This need becomes even more relevant considering the complexity and importance of decisions that directly impact the professional lives of the individuals involved. According to the analysis carried out by Schmidt, Huttenlocher, and Kissinger in 2023, the evolution of artificial intelligence within organizations has generated the need to develop adequate control mechanisms. These mechanisms are essential to understand more deeply how automated systems operate, in addition to enabling a careful evaluation of the consequences that these technologies can have, both for society in general and for the specific institutions involved.

Therefore, the governance of artificial intelligence goes beyond the technology itself, also encompassing compliance with regulatory frameworks and standards on data protection and corporate responsibility. According to Gabriel (2022), the growing presence of intelligent systems in organizations requires these institutions to establish, through internal policies, well-defined criteria on how data will be collected, processed, and used, especially when this information guides decisions that impact employees' careers. Transparency in algorithmic processes is thus an important requirement for automated decisions to be understood, justified and audited when necessary.

In addition, the adoption of artificial intelligence tools in business activities requires institutional structures that are intended for the supervision and control of these technologies. Digital ethics committees, systems audits, and accountability protocols are some of the tools that organizations around the world are adopting to balance technological innovation and institutional responsibility. As highlighted by Dias and Ferreira (2023), the use of artificial intelligence in compliance-related activities can expand the capacity for monitoring and analyzing risks, as long as there are adequate governance and human supervision structures. To illustrate, Exhibit 2 presents some of the principles and mechanisms that are often associated with the responsible governance of artificial intelligence in organizational contexts.

Table 2*Governance Mechanisms for Responsible AI Use in Organizational Contexts*

Governance Dimension	Description	Organizational Objective
Data Protection Compliance	Implementation of policies ensuring that personal and organizational data are collected, processed, and stored according to legal and regulatory standards.	Ensure alignment with data protection laws and safeguard individual rights.
Algorithmic Transparency	Adoption of documentation and reporting practices that allow stakeholders to understand how AI systems operate and influence decisions.	Promote clarity and accountability in automated decision-making processes.
AI System Auditing	Periodic evaluation of AI systems to identify operational risks, biases, or inconsistencies in automated outcomes.	Strengthen reliability and support responsible technological oversight.
Human Oversight Mechanisms	Establishment of qualified supervision to review and validate decisions generated by AI systems.	Maintain accountability and prevent unjustified automated outcomes.

Source: Adapted from Dias and Ferreira (2023); Gabriel (2022); Schmidt, Huttenlocher, and Kissinger (2023); Franco, Pinheiro and Del Lhano (2025).

These governance mechanisms are becoming increasingly common in organizations, as they seek to reconcile technological innovation with institutional responsibility. According to Franco, Pinheiro and Del Lhano (2025), the adoption of artificial intelligence in corporate governance must be accompanied by the definition of ethical and regulatory standards that ensure the responsible use of these technologies. With regard to Human Resources, this architecture ensures that decisions mediated by algorithms are made transparently, in compliance with legislation and in line with the principles of equity that govern modern people management.

3.3 EQUITY, ORGANIZATIONAL JUSTICE, AND RISKS OF DISCRIMINATION IN AUTOMATED PROCESSES

The growing adoption of artificial intelligence in people management routines has sparked relevant and important debates about equity and justice in organizations. These questions touch on several points about what artificial intelligence tools can mean for the relationships and treatment of employees in the workplace, including equal opportunities, the way decisions are made within organizations, among others. When it comes to automated decision systems applied to recruitment, performance evaluation, and talent management, we are already entering a territory where these systems are beginning to directly impact professional careers and the opportunities that open up within the corporate environment. Therefore, these systems play a central role in the way careers are built and in the opportunities for ascension and development that workers find in their professional routines. In this sense, investigations and studies of the specialized literature point out that algorithms

fed by large data sets are capable of reproducing historical patterns of inequality. This becomes even more evident when the data used reflect the asymmetries that already exist in the social and institutional organizations of society (Kim, 2018).

Therefore, it is essential to consider the ethical and legal issues surrounding the use of data-driven technologies in the context of work. Research on algorithm-based decisions shows that predictive models can generate discrimination even in the absence of a clear intention to do so. This is why the variables that the systems use can capture statistical correlations that are linked to gender, race, age, or other sensitive characteristics. According to Ferrari, Becker, and Wolkart (2018), it is crucial to have regulatory and institutional mechanisms that ensure that decision-making automation does not compromise the principles of equality and justice in its application.

In view of this, it is essential to discuss how strategies will be implemented to reduce algorithmic biases and ensure constant supervision of the systems that support organizational decisions. People management, as discussed in recent literature, should include regular audits of predictive models, constant validations of databases, and monitoring of the effects of automated decisions. These actions help to detect distortions and prevent something from having a discriminatory effect within the company. In the context presented, Chart 3 lists some of the main risks of using artificial intelligence in people management processes, as well as strategies to mitigate their consequences.

Table 3

Risks of Algorithmic Bias and Mitigation Strategies in AI-Driven Human Resource Processes

Risk Dimension	Description	Mitigation Strategy
Historical Data Bias	AI systems trained with historical organizational data may replicate past patterns of inequality in hiring or promotion decisions.	Periodic review of datasets and removal of variables that indirectly reproduce discriminatory patterns.
Algorithmic Decision Opacity	Automated decision systems may operate as opaque models, making it difficult to understand the criteria used in evaluations.	Implementation of explainable AI methods and documentation of decision criteria.
Discriminatory Outcomes in Recruitment	Automated screening tools may unintentionally disadvantage certain demographic groups due to biased correlations in data.	Continuous validation of recruitment algorithms and human oversight in selection processes.
Lack of Impact Monitoring	Organizations may fail to evaluate the long-term consequences of algorithmic decisions on diversity and inclusion.	Establishment of monitoring frameworks to assess diversity indicators and organizational fairness outcomes.

Source: Adapted from Araújo et al. (2022); Kim (2018); Ferrari, Becker and Wolkart (2018); Silva, Matins and Laranjeira (2023).

Especially when automated systems begin to integrate into decision-making routines in people management, the implementation of supervision and control strategies becomes

essential. Araújo et al. (2022) draw attention to the protection of fundamental rights in relation to the use of personal data in labor contexts, especially when it comes to digital technologies that affect evaluations and professional opportunities. Similarly, Silva, Matins, and Laranjeira (2023) highlight that the introduction of technological tools in selection processes can make organizations' operations more efficient, but it is crucial that there are institutional mechanisms in place to monitor their consequences and ensure that organizational practices are in compliance with the principles of diversity, inclusion, and justice in the workplace.

4 FINAL CONSIDERATIONS

The increasing integration of artificial intelligence tools in the different practices within organizations is promoting a significant transformation in the way people management is carried out. This transformation is reflected, in a special way, in activities that involve the selection of professionals, the evaluation of employee performance, and the development of talents. Thus, we can see that the use of these technological systems is redefining the usual strategies and procedures in this field. Within this scenario, the conversation about technological governance has become an increasingly relevant and evident issue in the Human Resources area. This is especially due to the growing demand for ensuring not only transparency in operations, but also compliance with established rules and regulations, in addition to ensuring that there are fair and equitable criteria in all processes that are carried out in an automated way. The implementation of tools that use algorithms has the effect of significantly expanding the analytical capacity of institutions, enabling decisions that are based on robust and reliable data. However, this adoption also brings with it a series of new challenges for companies, which are directly associated with the responsibility that these organizations have towards society, in addition to issues related to the maintenance and promotion of principles of equity within the professional environment. These challenges need to be carefully considered so that the use of these resources does not compromise fundamental values in the workplace.

Based on this context, the present study had the general goal of analyzing the fundamentals and governance practices of artificial intelligence in Human Resources, prioritizing transparency, compliance with standards and equity in automated people management processes. The objectives initially proposed were achieved, according to the results obtained in the theoretical research carried out. The first specific goal made it possible to analyze the main ways in which artificial intelligence can be used in recruitment, selection, performance evaluation, and talent management processes. The second objective allowed us to explore the institutional mechanisms that ensure transparency and regulatory

compliance in the use of these technologies. Finally, the third objective helped to assess the risks of algorithmic biases and disparities generated by automation in decision-making in people management.

The analysis proposed in the theoretical foundation showed that the adoption of intelligent systems in Human Resources reflects a progressive change from traditional operating models to those based on data. Tools such as people analysis platforms, automated systems for screening resumes, and digital solutions for performance monitoring increase the ability of organizations to handle large amounts of information and make strategic decisions. The study also showed that the adoption of these technologies requires governance structures that ensure transparency in algorithmic processes, respect for data protection standards, and institutional supervision and auditing mechanisms. In addition, the importance of continuous monitoring of the effects that automated systems produce was emphasized, especially with regard to the prevention of biases and the promotion of organizational practices that are compatible with the principles of diversity and fairness in the workplace.

Throughout the research, it was reached the definition of three interconnected dimensions that enable a better understanding of the governance of artificial intelligence in people management, namely: transparency, regulatory compliance and equity in automated processes, which constitute the main contribution of this study to the academic debate. Thus, the study provides a framework that makes it possible to interpret the organizational, ethical, and normative consequences that emerge from the adoption of algorithmic systems in people management practices. This enriches the debate around the responsible use of these technologies at work, pointing out that the implementation of data-driven tools must be supported by institutional mechanisms that ensure supervision, accountability, and fairness in the criteria of decisions that impact careers and the dynamics of organizations.

In light of the issues discussed, it is noted that the research agenda in artificial intelligence in people management continues to expand and lacks new empirical investigations. Future studies may investigate, for example, how different organizations establish technological governance mechanisms to monitor automated decision systems. Studies that are dedicated to the comparative analysis between national and international regulatory frameworks on artificial intelligence at work are also very pertinent. Research that investigates how decision-making automation really affects indicators of diversity, inclusion, and professional mobility can help to better understand the effects of these technologies on the dynamics of labor relations.

REFERENCES

- Appolinário, D. G., Hedler, H. C., & Ferneda, E. (2025). Desafios do uso da inteligência artificial na gestão de recursos humanos: Uma revisão sistemática. *Boletim de Conjuntura (BOCA)*, 21(63), 293–315. <https://doi.org/10.5281/zenodo.15313087>
- Araújo, A. R. de, et al. (2022). O uso de dados pessoais e inteligência artificial na relação de trabalho: Proteção, discriminação, violência e assédio digital. Ministério Público do Trabalho.
- Dantas, A. N. de J. (2025). O uso da inteligência artificial na gestão organizacional: Uma revisão da literatura. *Revista Caderno Pedagógico*, 22(7), 1–12.
- Dias, C. C., & Ferreira, R. V. (2023). O uso da inteligência artificial na atividade de compliance: Riscos e benefícios. *Revista Científica do CPJM*, 2(8). <https://doi.org/10.55689/rcpjm.2023.08.011>
- Ferrari, I., Becker, D., & Wolkart, E. N. (2018). Arbitrium ex machina: Panorama, riscos e a necessidade de regulação das decisões informadas por algoritmos. *Revista dos Tribunais*, 995.
- Franco, B. D., Pinheiro, C. da R., & Del Llano, L. A. (2025). A integração da inteligência artificial na governança corporativa: Enfoque ético e regulatório. *Revista de Direito, Governança e Novas Tecnologias*, 10(2), 22–44.
- Gabriel, M. (2022). *Inteligência artificial: Do zero ao metaverso*. Atlas.
- Gartner. (2024). *Artificial intelligence in HR: Trends and predictions*.
- Gil, A. C. (2021). *Como elaborar projetos de pesquisa* (6ª ed.). Atlas.
- Kim, P. (2018). Big data and artificial intelligence: New challenges for workplace equality. *University of Louisville Law Review*. <https://ssrn.com/abstract=3296521>
- Lima, A. de O. de, Machado, A. M. S. G., Silva, F. B. B. da, & Parente, T. C. (2025). Aplicações e desafios da inteligência artificial no setor de recursos humanos. *Revista Foco*, 18(9), e9640. <https://doi.org/10.54751/revistafoco.v18n9-017>
- Rattner, H. (1979). *Pesquisa científica: Suas bases epistemológicas e metodológicas*. Editora Nacional.
- Ribeiro, C. S. M. (2024). *Inteligência artificial em recursos humanos: Tendências e competências para o futuro* (Tese de doutorado). ISCAP.
- Rodrigues, R. S., & Neubert, P. da S. (2023). *Introdução à pesquisa bibliográfica*. Editora da UFSC. <https://doi.org/10.5007/978-65-5805-082-7>
- Schmidt, E., Huttenlocher, D., & Kissinger, H. A. (2023). *A era da IA e nosso futuro como humanos* (V. Schreiner, Trad.). Alta Books.
- Silva, C. G. L., Martins, G., & Laranjeira, C. (2023). Análise dos impactos da tecnologia nos processos seletivos das organizações contemporâneas. *Revista Científica Multidisciplinar Viabile*, 2(2).

ENERGY TRANSITION, LEGAL CERTAINTY, AND THE NEW ENVIRONMENTAL LICENSING FRAMEWORK: PERSPECTIVES FOR THE GREEN HYDROGEN AND AMMONIA INDUSTRY IN BRAZIL

TRANSIÇÃO ENERGÉTICA, SEGURANÇA JURÍDICA E NOVO MARCO DO LICENCIAMENTO AMBIENTAL: PERSPECTIVAS PARA A INDÚSTRIA DE HIDROGÊNIO E AMÔNIA VERDE NO BRASIL

TRANSICIÓN ENERGÉTICA, SEGURIDAD JURÍDICA Y EL NUEVO MARCO DEL LICENCIAMIENTO AMBIENTAL: PERSPECTIVAS PARA LA INDUSTRIA DEL HIDRÓGENO Y AMONÍACO VERDE EN BRASIL



<https://doi.org/10.56238/sevened2026.008-222>

Tadeu Dote Sá¹, Givanildo Ximenes Santana², João Guilherme de Oliveira Duarte³, Rickardo Léo Ramos Gomes⁴

ABSTRACT

The energy transition has redefined regulatory and economic priorities in the international scenario, especially with regard to the consolidation of new production chains linked to low-emission sources. In this context, the debate on Brazilian environmental licensing gains strategic relevance in light of the expansion of the green hydrogen and ammonia industry. The research was developed using a qualitative approach, and two research methods were applied: bibliographic research and documentary research. The general objective of this study is to analyze the impacts of the new Brazilian environmental licensing framework on legal certainty and the consolidation of the green hydrogen and ammonia industry within the context of the energy transition, identifying regulatory challenges and institutional opportunities for the sustainable development of the sector. It is concluded that the new environmental licensing framework, by seeking to provide greater predictability and rationality to administrative procedures, may directly influence legal certainty and the investment environment in the green hydrogen and ammonia sector. The consolidation of this industry in Brazil will depend on the institutional capacity to harmonize economic development, energy transition, and environmental protection, ensuring regulatory stability and trust as the basis for sustainable growth.

Keywords: Energy Transition. Environmental Licensing. Legal Certainty. Green Hydrogen.

¹ Dr. in Regional Development. The University of Barcelona. E-mail: tadeu@geosol-br.com
Orcid: <https://orcid.org/0009-0005-5575-6328>

² Dr. in Genetics, Conservation, and Evolutionary Biology. National Institute of Amazonian Research.
E-mail: gxsantana@petrobras.com.br Orcid: <https://orcid.org/0000-0001-8337-1082>

³ MBA in Renewable Energy Management. IEL/FBUNI. E-mail: joaoguidu-arte@gmail.com
Orcid: <https://orcid.org/0009-0004-5055-7824>

⁴ Dr. in Biological Sciences. Universidade Federal do Ceará.
E-mail: rickardolrg@yahoo.com.br Orcid: <https://orcid.org/0000-0001-6101-9571>

RESUMO

A transição energética tem redefinido prioridades regulatórias e econômicas no cenário internacional, especialmente no que se refere à consolidação de novas cadeias produtivas vinculadas a fontes de baixa emissão. Nesse contexto, o debate sobre o licenciamento ambiental brasileiro ganha relevância estratégica diante da expansão da indústria de hidrogênio e amônia verde. A pesquisa foi elaborada com uma abordagem qualitativa e foram utilizados dois métodos de pesquisa: a pesquisa bibliográfica e a pesquisa documental. O objetivo geral desta pesquisa é analisar os impactos do novo marco do licenciamento ambiental brasileiro sobre a segurança jurídica e a consolidação da indústria de hidrogênio e amônia verde no contexto da transição energética, identificando desafios regulatórios e oportunidades institucionais para o desenvolvimento sustentável do setor. Conclui-se que o novo marco do licenciamento ambiental, ao buscar conferir maior previsibilidade e racionalidade aos procedimentos administrativos, pode influenciar diretamente a segurança jurídica e o ambiente de investimentos no setor de hidrogênio e amônia verde. A consolidação dessa indústria no Brasil dependerá da capacidade institucional de harmonizar desenvolvimento econômico, transição energética e proteção ambiental, garantindo estabilidade normativa e confiança regulatória como bases para um crescimento sustentável.

Palavras-chave: Transição Energética. Licenciamento Ambiental. Segurança Jurídica. Hidrogênio Verde.

RESUMEN

La transición energética ha redefinido las prioridades regulatorias y económicas en el escenario internacional, especialmente en lo que respecta a la consolidación de nuevas cadenas productivas vinculadas a fuentes de baja emisión. En este contexto, el debate sobre el licenciamiento ambiental brasileño adquiere relevancia estratégica ante la expansión de la industria del hidrógeno y amoníaco verde. La investigación fue elaborada con un enfoque cualitativo y se utilizaron dos métodos de investigación: la investigación bibliográfica y la investigación documental. El objetivo general de esta investigación es analizar los impactos del nuevo marco del licenciamiento ambiental brasileño sobre la seguridad jurídica y la consolidación de la industria del hidrógeno y amoníaco verde en el contexto de la transición energética, identificando desafíos regulatorios y oportunidades institucionales para el desarrollo sostenible del sector. Se concluye que el nuevo marco del licenciamiento ambiental, al buscar otorgar mayor previsibilidad y racionalidad a los procedimientos administrativos, puede influir directamente en la seguridad jurídica y en el entorno de inversiones en el sector del hidrógeno y amoníaco verde. La consolidación de esta industria en Brasil dependerá de la capacidad institucional para armonizar el desarrollo económico, la transición energética y la protección ambiental, garantizando estabilidad normativa y confianza regulatoria como bases para un crecimiento sostenible.

Palabras clave: Transición Energética. Licenciamiento Ambiental. Seguridad Jurídica. Hidrógeno Verde.

1 INTRODUCTION

The energy transition has consolidated itself as one of the main axes of reorganization of contemporary economies, requiring normative responses from States capable of reconciling economic growth, technological innovation, and socio-environmental responsibility. In Brazil, this movement takes on its own contours due to the strategic relevance of renewable sources in the electricity matrix and the country's growing insertion in global low-emission energy chains. In this scenario, the debate on environmental licensing assumes centrality, as it constitutes a structuring instrument of environmental policy and conditions the implementation of large-scale enterprises.

The growing green hydrogen and ammonia industry is accelerating this debate. These energy vectors have been considered as strategic options for the decarbonization of industrial sectors and to increase the competitiveness in the international scenario of countries that have a vast supply of renewable energy. However, the construction of factories, the exploitation of natural resources and the need for an appropriate logistics infrastructure bring regulatory challenges that need clear and stable legal frameworks. Legal certainty, in this sense, is crucial to attract investments and for the development of an integrated production chain.

The new environmental licensing framework, called the General Environmental Licensing Law – LGLA, Law No. 15,190, of August 8, 2025, and which came into force on February 4, 2026 (Brasil, 2025), is part of this environment of institutional transformations. By proposing adjustments in administrative procedures and in the distribution of competences, it seeks to provide greater predictability to state decisions. At the same time, it raises debates about the preservation of environmental principles and the maintenance of adequate control standards. The analysis of this normative reconfiguration becomes, therefore, relevant to understand its effects on the energy transition and on Brazil's position in the international market for green hydrogen and ammonia.

The investigation was conducted with a qualitative focus and employed two types of research: bibliographic and documentary. This research aims, in general, to investigate how the new framework of Brazilian environmental licensing influences the legal certainty and the strengthening of the hydrogen and green ammonia industry within the energy transition, while seeking to identify both the regulatory challenges and the institutional opportunities that can promote sustainable development for the sector. The specific objectives outlined are: To analyze the evolution of the rules on environmental licensing in Brazil in comparison with the principles of legal certainty aimed at renewable energy projects; Investigate the main regulatory and environmental obstacles to the implementation of hydrogen and green

ammonia projects in Brazil; and, finally, to assess how the new legal framework for environmental licensing can affect the attraction of investments, international competitiveness and the consolidation of the hydrogen and green ammonia production chain in Brazil.

The article is divided into four interconnected sections. The Introduction brings the context and the outline of the research problem, placing the reader at the center of the current discussion on energy transition and legal certainty. The Methodology details the theoretical options and the steps followed, ensuring that the research has transparency and scientific rigor. The Theoretical Foundation establishes the analytical axes that support the research, connecting environmental licensing, the regulatory aspects of the hydrogen and green ammonia industry, and the new legal framework, to provide a solid basis for the reflections and conclusions that follow.

2 METHODOLOGY

The research was elaborated with a qualitative approach, which is appropriate for the analysis of legal phenomena that are complex and socially situated. According to Creswell (2014), qualitative research makes it possible to explore meanings, interpretations, and processes within an institution that cannot be quantified. The aforementioned perspective is of special relevance in environmental licensing, since it encompasses the understanding of norms, administrative practices, regulatory conflicts and institutional arrangements that organize the actions of the State and economic agents. By valuing interpretation, qualitative analysis helps in the investigation of how the new legal framework impacts legal certainty and the structuring of the green hydrogen and ammonia industry in Brazil.

Two research methods were used: bibliographic research and documentary research. According to Köche (2011), the detailed description of the methodological procedures guarantees the relationship of scientific rigor and the consonance between what is intended and the techniques used. Bibliographic research is a fundamental stage in academic production, as it enables the recognition of the state of the art, the mapping of different theoretical currents and the placement of the research problem within a broader scientific debate. As Batista and Kumada (2021) point out, its various configurations allow the organization and interpretation of already consolidated contributions, serving as a consistent basis for critical analysis and reasoned propositions.

The bibliographic research, which supported the study in question, was based on 15 scientific sources, including books, academic articles and reports published in specialized journals. This set of resources made it possible to analyze both the theoretical foundations of

environmental licensing and the recent discussions on the new legal framework and the energy transition. The diversity of sources ensured a broad understanding of the theme, with the combination of doctrinal perspectives, institutional analyses and positions of the productive sector, which makes the research even more solid from a scientific point of view.

The documentary research, in turn, was supported by the analysis of institutional documents relevant to the understanding of the regulatory and economic context of the sector. According to Piana (2009), documentary research makes it possible to access records produced by official bodies and specialized entities, contributing to the analytical reconstruction of public policies and normative processes. In this sense, the IEA report was examined. *Ammonia Technology Roadmap: Towards More Sustainable Nitrogen* (2021), the IPEA study *Institutional Constraints on the Execution of Investments in Economic Infrastructure in Brazil: Environmental Licensing* (2017), as well as the new regulatory framework for Brazilian environmental licensing, instituted by Law No. 15,190, of August 8, 2025, which provides for environmental licensing and regulates item IV of paragraph 1 of article 225 of the Federal Constitution. These documents offer technical, institutional, and legal subsidies for the analysis of Brazil's insertion in the global green hydrogen and ammonia market, as well as for the understanding of the regulatory challenges inherent to environmental licensing in the context of the energy transition.

3 THEORETICAL FOUNDATION

The theoretical foundation was arranged in an organized way in three axes that are interrelated, aiming to ensure a logical coherence in the analysis that is presented. In the first segment, 3.1 Environmental Licensing, Legal Security and Energy Transition in Brazil, the conceptual and normative elucidation that underlies the discussion is made, aligning environmental principles with legal certainty in the process of transformation of the energy matrix. The second, 3.2 Regulatory and Environmental Aspects of the Green Hydrogen and Ammonia Industry, investigates the technical and legal aspects of these projects in function of territorial and environmental constraints. Finally, item 3.3 New Framework for Environmental Licensing and Environment of investments for Clean Energy makes a critical analysis of recent changes in legislation and their impacts on the predictability of standards, the reduction of legal risks and Brazil's competitiveness in the global market for low-emission energy.

3. 1 ENVIRONMENTAL LICENSING, LEGAL CERTAINTY AND ENERGY TRANSITION IN BRAZIL

Environmental licensing in Brazil has evolved in parallel with the consolidation of Environmental Law as an autonomous and properly structured branch since the 1988 Constitution. According to Antunes (2023), licensing is the most important instrument of the National Environmental Policy, making the principles of legality, prevention, and precaution real. Its normative evolution in recent decades shows a constant effort to reconcile environmental preservation and economic growth, especially in strategic sectors, such as renewable energy. Legal certainty, in this context, gains relevance, as the predictability of rules and the stability of administrative decisions are factors that impact the viability of large enterprises.

The inclusion of the climate variable in the licensing process enriches this discussion and accentuates the urgency of normative coherence. Feldmann (2025) argues that the explicit inclusion of climate impacts in the licensing process not only complies with international environmental commitments, but also strengthens legal certainty by reducing the possibilities of interpretative uncertainty. By incorporating objective criteria regarding emissions and energy transition, the State provides more defined parameters for investors and society, preventing contradictory decisions and prolonged disputes. In this way, regulatory stability is no longer just a market request, but becomes a fundamental component of contemporary environmental governance.

In the current context of constitutionalism focused on environmental issues, the environmental licensing process has been understood in a broader way, not being restricted to a simple administrative procedure. Instead, it is seen as an important legal instrument that plays a key role in the organization and implementation of the National Environmental Policy. This perspective highlights the relevance of licensing for environmental protection and the sustainable management of natural resources, evidencing its structuring function within the normative framework that aims at the conservation of the environment. Within this perspective, the authors Coelho, Silva, and Serafim (2023) argue that the institute in question needs to be understood under the aegis of the constitutional principles that promote the protection of the environment. This is necessary to ensure that there is an appropriate balance between economic progress and the preservation of ecology.

Thus, the interpretation must consider the importance of harmonizing these two aspects. This perception highlights that the validity of the licensing process is directly related to attention to criteria that are technical, legal and also institutional. These criteria play a

fundamental role, as they are capable of providing greater stability and security in the decisions that are made in the administrative sphere.

Thus, strict compliance with these criteria is essential to ensure that licensing is considered legitimate and reliable, thus avoiding uncertainties and wear and tear in possible future decisions. In the current scenario of the energy transition, which seeks sustainable alternatives and the expansion of new production chains, including the production of hydrogen and green ammonia, the analysis presented here clearly highlights the strategic role that environmental licensing plays.

This licensing becomes essential to intermediate, in a balanced way, the attraction of investments and the protection of the fundamental right of all citizens to an environment that is ecologically balanced and healthy. Thus, this mediation function is crucial to ensure that economic development occurs in harmony with environmental preservation.

According to the institutional perspective, the Ipea study (2017) points out that obstacles in the licensing process are one of the main factors that prevent investments in economic infrastructure in Brazil. The slowness of the processes, the duplicity of competences and the lack of a stable interpretation are indicated as factors that increase costs and increase legal risks.

Particularly in projects linked to the energy transition, such as those focused on the production of hydrogen and green ammonia, such issues become strategic. To harmonize environmental protection, legal certainty and expansion of renewable energies in Brazil, it is crucial to create a stable, coherent and technically grounded regulatory environment.

3. 2 REGULATORY AND ENVIRONMENTAL ASPECTS OF THE GREEN HYDROGEN AND AMMONIA INDUSTRY

The development of the green hydrogen and ammonia industry in Brazil goes beyond the mere availability of renewable sources, involving a cohesive set of technical, socio-environmental and regulatory constraints. According to Ronceros et al. (2025), the generation of green hydrogen requires a significant availability of renewable electricity, an appropriate infrastructure for electrolysis, and well-defined regulatory frameworks on the legal status of the fuel. The lack of clear normative definitions on classification, authorisation and administrative powers tends to increase investor uncertainty and make it difficult to implement large-scale projects.

In technological and environmental terms, green ammonia is positioned as a key element for the storage and transport of hydrogen, especially in logistics chains destined for export. According to Duarte et al. (2025), although ammonia as a hydrogen carrier brings

logistical benefits, it entails challenges in terms of emission control, operational safety, and the need to adjust industrial plants to current environmental regulations. In light of an international perspective, the IEA report (2021) emphasizes that the decarbonization of ammonia production depends on technological updating, integration with renewable energy sources, and stable public policies, elements that directly influence the structure of the environmental licensing of these operations.

In order to systematize the main regulatory and environmental obstacles identified in the literature, Table 1 is presented.

Table 1

Main regulatory and environmental obstacles to the implementation of green hydrogen and ammonia projects in Brazil

Dimension	Obstacles identified	References
Regulatory	Absence of a consolidated regulatory framework and clear definition of administrative competencies	Ronceros et al. (2025)
Technological and industrial	Need for plant modernization and integration with renewable sources	IEA (2021); Duarte et al. (2025)
Environmental	Requirements related to emission control and operational safety	Duarte et al. (2025); IEA (2021)
Infrastructure and natural resources	Dependence on stable renewable energy, intensive use of water and adequacy of logistics and port infrastructure	Ronceros et al. (2025); Kaleem, Zaman and Rajakaruna (2024)

Source: Based on Duarte et al. (2025), IEA (2021), Kaleem, Zaman and Rajakaruna (2024) and Ronceros et al. (2025).

The territorial dimension also deserves attention, especially regarding the use of water resources and the installation of industrial complexes in coastal areas close to organized ports. Kaleem, Zaman, and Rajakaruna (2024) emphasize that the expansion of green hydrogen depends on reliable energy infrastructure and distribution systems adapted to new demands, including in decentralized applications. In the Brazilian context, this reality implies making water use grants, connection to the electricity grid and environmental licenses compatible, in an institutional arrangement that still seeks greater coordination between the federative entities.

3.3 NEW FRAMEWORK FOR ENVIRONMENTAL LICENSING AND ENVIRONMENTAL INVESTMENTS FOR CLEAN ENERGY

The new legal framework for environmental licensing is part of a broader process of restructuring the institutional bases of environmental policy in Brazil. According to Christian (2025), the Senate's approval of the new framework was an attempt to standardize

procedures and bring more clarity to the phases of the licensing process. The aforementioned regulatory reorganization is related to the search for regulatory predictability, especially in areas that require high capital and technology investments, such as the production of green hydrogen and ammonia, whose consolidation depends on consistent and technically grounded administrative decisions.

From a dogmatic perspective, Farias (2025, p. 26) recalls that environmental licensing is a preventive instrument aimed at making economic activity compatible with environmental protection. The legislative update, in this sense, cannot be understood only as a measure of procedural simplification, but as a redefinition of the legal guidelines that guide state action. Kassmayer (2025) problematizes precisely this point when inquiring about the concrete effects of the new framework on administrative practice, highlighting that the reduction of interpretative uncertainties can contribute to mitigating legal risks, as long as the technical and constitutional parameters that structure the environmental system are preserved. In order to systematize the main effects of the new legal framework on the environment of investments in clean energy, Table 2 is presented.

Table 2

Reflections of the new environmental licensing framework on the environment of investments in hydrogen and green ammonia

Aspect analyzed	Legislative change or identified effect	Expected impact on investments and competitiveness	References
Regulatory predictability	Standardization of procedures and definition of clearer steps	Reduced uncertainties and greater legal certainty for large-scale projects	Christian (2025); Nigris (2025)
Legal risks	Search for objective criteria and delimitation of competencies	Litigation mitigation and increased institutional trust	Kassmayer (2025); Farias (2025)
Economic environment	Positive signal to the productive sector and industry	Expansion of investments and strengthening of the clean energy chain	Barollo and Seixas (2025)
International insertion	Regulatory compliance with environmental governance standards	Brazil's greater competitiveness in the global hydrogen and green ammonia market	Christian (2025); Nigris (2025)

Source: Source: Based on Christian (2025), Barollo and Seixas (2025), Kassmayer (2025), Farias (2025) and Nigris (2025).

The economic repercussion of the legislative changes has also been emphasized by representatives of the productive sector. Barollo and Seixas (2025) report that industrial entities evaluate the approval of the project as a measure capable of expanding investments and favoring sustainable development. In a similar vein, Nigris (2025) points out that the new framework seeks to establish more objective criteria for the classification of enterprises, which tends to positively impact the perception of legal certainty in the business environment. In the

specific case of the hydrogen and green ammonia production chain, such a scenario can influence Brazil's international competitiveness, especially in the face of the growing global demand for low-emission fuels.

4 FINAL CONSIDERATIONS

The energy transition places the Brazilian State in front of the challenge of harmonizing economic growth, technological innovation, and environmental conservation, all in an increasingly complex regulatory environment. In this sense, the new environmental licensing framework is crucial, especially when considering the strengthening of the green hydrogen and ammonia industry as a means of positioning itself on the international scene and transforming Brazil's energy matrix. The investigation carried out in this study sought to understand how this new normative arrangement can impact legal certainty and the investment climate in Brazil.

The study managed to achieve all the goals and objectives that were proposed at the beginning. It was possible to carry out a detailed study on the evolution of the rules that govern environmental licensing in Brazil and its relationship with the principles of legal certainty applicable to renewable energy projects. This connection is crucial to understand how guidelines and regulations have evolved over time, demonstrating the need to ensure not only the protection of the environment, but also the stability and legal predictability for enterprises in the sector. Thorough studies were also conducted on the regulatory hurdles and environmental issues surrounding the implementation of green hydrogen and ammonia projects. In addition, a thorough analysis was carried out on how the new legal framework can impact the ability to attract investments, international competitiveness, and the consolidation of the production chain of these sustainable fuels.

The results showed that regulatory stability and clarity in procedures are crucial factors for reducing legal risks in industries that depend heavily on capital and technology. It was shown that the lack of firm definitions, the overlapping of attributions and interpretative doubts tend to impair the predictability of regulation. It was also found that legislative adjustments, guided by technical criteria and respecting environmental constitutional principles, can help create a more consistent and reliable institutional environment.

The investigation also revealed that the expansion of the hydrogen and green ammonia industry in Brazil depends on a consistent articulation between energy policy, natural resource management and environmental governance. Environmental licensing, far from representing a mere bureaucratic obstacle, is an instrument for the organization of the territory and mediation between public and private interests. When structured in a balanced

way, it can favor the country's insertion in the global market for low-emission energy, without removing the requirements of environmental control and responsibility.

As a future agenda, it is recommended the development of empirical studies aimed at the analysis of concrete cases of licensing of hydrogen and green ammonia projects, focusing on the practical application of the General Environmental Licensing Law. Comparative research that examines regulatory experiences in other countries and investigations that evaluate the regional socioeconomic impacts resulting from the installation of these projects are also relevant.

REFERENCES

- Antunes, P. de B. (2023). *Direito ambiental* (23^a ed.). Barueri/SP: Atlas.
- Barollo, A., & Seixas, B. (2025). Aprovação do PL do licenciamento ambiental vai ampliar investimentos e promover desenvolvimento sustentável, avaliam CNI e Findes. Vitória: FINDES.
- Batista, L. dos S., & Kumada, K. M. O. (2021). Análise metodológica sobre as diferentes configurações da pesquisa bibliográfica. *Revista Brasileira de Iniciação Científica (RBIC)*.
- Brasil. (2025). Lei nº 15.190, de 8 de agosto de 2025. Brasília: Câmara dos Deputados. Disponível em: <https://www2.camara.leg.br/legin/fed/lei/2025/lei-15190-8-agosto-2025-797833-normaatualizada-pl.pdf>
- Coelho, S. O. P., Silva, T. D. O., & Serafim, D. H. A. (2023). Licenciamento ambiental na ótica do constitucionalismo contemporâneo: potenciais do instrumento para um papel estrutural na Política Nacional de Meio Ambiente. *Veredas do Direito*, 20. Disponível em: <http://www.domhelder.edu.br/revista/index.php/veredas/article/view/2548>
- Christian, H. (2025). Senado aprova novo marco legal do licenciamento ambiental. Brasília: Rádio Senado. Disponível em: <https://www12.senado.leg.br/radio/1/noticia/2025/05/21/senado-aprova-novo-marco-legal-do-licenciamento-ambiental>
- Creswell, J. W. (2014). *Investigação qualitativa & projeto de pesquisa* (3^a ed.). São Paulo: Editora Penso.
- Duarte, I. F. et al. (2025). A contribuição da amônia verde para a economia de hidrogênio: potencial, aplicações e desafios. *Anais do Congresso Científico do International Brazil Energy Meeting - iBEM25*.
- Farias, T. (2025). *Aspectos gerais do licenciamento ambiental* (10^a ed.). São Paulo: Ed. JusPodivm.
- Feldmann, P. M. (2025). A inclusão da variante climática no licenciamento ambiental como garantia da segurança jurídica. *Revista DELOS*, 18(63). <https://dx.doi.org/10.55905/rdelosv18.n63-005>

- IEA. (2021). Ammonia technology roadmap: Towards more sustainable nitrogen. Disponível em: <https://www.iea.org/reports/ammonia-technology-roadmap>
- IPEA – Instituto de Pesquisa Econômica Aplicada. (2017). Condicionantes institucionais à execução dos investimentos em infraestrutura econômica no Brasil: Licenciamento ambiental. Brasília/Rio de Janeiro: Ipea.
- Kaleem, A., Zaman, A., & Rajakaruna, S. (2024). Hydrogen at home: the current and future landscape of green hydrogen in residential settings. *Sustainable Energy Technologies and Assessments*, 72.
- Kassmayer, K. (2025). Novo marco legal do licenciamento ambiental. E agora? São Paulo: Consultor Jurídico. Disponível em: <https://www.conjur.com.br/2025-jul-29/licenciamento-ambiental-e-agora/>
- Köche, J. C. (2011). Fundamentos de metodologia científica: teoria da ciência e iniciação à pesquisa. Petrópolis, Rio de Janeiro: Vozes.
- Nigris, G. de. (2025). Entenda o novo marco do licenciamento ambiental. São Paulo: Revista Exame. Disponível em: https://exame.com/colunistas/instituto-millennium/entenda-o-novo-marco-do-licenciamento-ambiental/?utm_source=copiaecola&utm_medium=compartilhamento
- Piana, M. C. (2009). A construção da pesquisa documental. São Paulo: Editora UNESP; São Paulo: Cultura Acadêmica.
- Ronceros, N. G., Santos, G. S., Oliveira, R. D., & Oliveira, L. C. da S. (2025). O hidrogênio verde no Brasil: aspectos técnicos e regulamentares na produção do combustível do futuro. *Aracê*, 7(7). <https://dx.doi.org/10.56238/arev7n7-165>

BETWEEN STRATEGY AND PRACTICE: LEADERSHIP AND THE CONSTRUCTION OF ORGANIZATIONAL GROWTH IN BUSINESS CONTEXTS

ENTRE ESTRATÉGIA E PRÁTICA: LIDERANÇA E CONSTRUÇÃO DO CRESCIMENTO ORGANIZACIONAL EM CONTEXTOS EMPRESARIAIS

ENTRE ESTRATEGIA Y PRÁCTICA: LIDERAZGO Y LA CONSTRUCCIÓN DEL CRECIMIENTO ORGANIZACIONAL EN CONTEXTOS EMPRESARIALES



<https://doi.org/10.56238/sevened2026.008-223>

Plinio Alexandre dos Santos Caetano¹, Ana Flávia Faria Paiva², Grazielle Martins Fraga Nascimento³

ABSTRACT

Leadership has become a central dimension in understanding strategic implementation processes within organizations operating in environments marked by competitiveness, constant change, and the ongoing need for adaptation. This chapter examines how business leaders from medium- and large-sized companies perceive their role in conducting organizational growth strategies, considering the articulation between people, processes, and results. The study adopted a mixed-methods approach and was developed through a survey based on a structured questionnaire applied to 16 leaders holding strategic positions across different organizational sectors. The findings indicate that leadership is recognized as a structuring element of strategic execution, particularly regarding clarity in goal definition, encouragement of collaboration, and systematic monitoring of organizational performance. Participants' narratives further reveal that leaders perceive themselves as mediators between planning and practice, responsible for aligning teams, fostering autonomy, and sustaining adaptation processes. It is concluded that leadership performs an integrative role in organizational growth processes, contributing to strategic effectiveness in complex organizational contexts.

Keywords: Organizational Leadership. Organizational Growth. Strategy Implementation. Organizational Climate. Leadership and Management.

RESUMO

A liderança tem se consolidado como dimensão central na compreensão dos processos de implementação estratégica em organizações inseridas em ambientes marcados por competitividade, mudança e necessidade contínua de adaptação. Neste capítulo, analisa-se como líderes empresariais de empresas de médio e grande porte percebem sua atuação na

¹ Dr. in Territorial Development and Environment. Instituto Federal de Educação, Ciência e Tecnologia de São Paulo (IFSP). Instituto Federal de Educação, Ciência e Tecnologia de Minas Gerais (IFMG).

E-mail: plinio@ifsp.edu.br Orcid: <https://orcid.org/0000-0003-1405-7553>

² Specialization Student in Management. Instituto Federal de Minas Gerais (IFMG).

E-mail: ana.ffpaiva1@gmail.com Orcid: <https://orcid.org/0009-0001-9957-28472>

³ Specialization Student in Management. Instituto Federal de Minas Gerais (IFMG).

E-mail: grazie_le_m@hotmail.com Orcid: <https://orcid.org/0009-0000-2883-02313>

condução de estratégias de crescimento organizacional, considerando a articulação entre pessoas, processos e resultados. A investigação, de abordagem quali-quantitativa, foi desenvolvida por meio de survey com aplicação de questionário estruturado a 16 líderes com atuação estratégica em diferentes setores organizacionais. Os resultados indicam que a liderança é reconhecida como elemento estruturante da execução estratégica, especialmente no que se refere à clareza na definição de objetivos, ao estímulo à colaboração e ao acompanhamento sistemático do desempenho organizacional. As narrativas dos participantes revelam ainda que os líderes se percebem como mediadores entre planejamento e prática, responsáveis por alinhar equipes, favorecer autonomia e sustentar processos de adaptação. Conclui-se que a liderança exerce função integradora nos processos de crescimento organizacional, contribuindo para a efetividade estratégica em contextos organizacionais complexos.

Palavras-chave: Liderança Organizacional. Crescimento Organizacional. Implementação Estratégica. Clima Organizacional. Liderança e Gestão.

RESUMEN

El liderazgo se ha consolidado como una dimensión central en la comprensión de los procesos de implementación estratégica en organizaciones insertas en entornos marcados por la competitividad, el cambio y la necesidad continua de adaptación. En este capítulo se analiza cómo los líderes empresariales de empresas medianas y grandes perciben su actuación en la conducción de estrategias de crecimiento organizacional, considerando la articulación entre personas, procesos y resultados. La investigación, con un enfoque cualitativo-cuantitativo, fue desarrollada mediante una encuesta con la aplicación de un cuestionario estructurado a 16 líderes con actuación estratégica en diferentes sectores organizacionales. Los resultados indican que el liderazgo es reconocido como un elemento estructurante de la ejecución estratégica, especialmente en lo que respecta a la claridad en la definición de objetivos, el fomento de la colaboración y el seguimiento sistemático del desempeño organizacional. Las narrativas de los participantes también revelan que los líderes se perciben como mediadores entre la planificación y la práctica, responsables de alinear equipos, promover la autonomía y sostener procesos de adaptación. Se concluye que el liderazgo desempeña una función integradora en los procesos de crecimiento organizacional, contribuyendo a la efectividad estratégica en contextos organizacionales complejos.

Palabras clave: Liderazgo Organizacional. Crecimiento Organizacional. Implementación Estratégica. Clima Organizacional. Liderazgo y Gestión.

1 INTRODUCTION

Contemporary organizations are inserted in environments marked by accelerated transformations, high competitiveness and permanent need for adaptation. Technological changes, economic reconfigurations, new forms of work organization and growing demands for innovation make strategic decisions cease to be punctual events and become continuous processes of interpretation and response to the environment. In this scenario, organizational growth does not only mean expanding operations or results, but developing internal capacity for coordination, learning, and adaptation.

Organizational expansion, especially in medium and highly complex business contexts, requires more than formal planning instruments. Although strategic plans, indicators and goals remain central to contemporary management, their effectiveness depends on the way they are appropriated in the organizational routine. Between planning and practice there is a relational space in which decisions need to be translated, priorities need to be negotiated, and people need to be mobilized. It is precisely in this space that leadership plays a decisive role.

Recent literature has shown that leadership cannot be understood only as a hierarchical exercise of authority. It is a social process of influence, construction of meaning and institutional mediation, through which leaders articulate expectations, guide behaviors and produce conditions for the execution of collective objectives. In complex organizational environments, leadership begins to operate as a link between strategic rationality and human dynamics, connecting organizational goals to daily work practices.

Such an understanding becomes even more relevant when analyzing strategies aimed at organizational growth. Processes of expansion, innovation, competitive repositioning and increase in production capacity imply internal changes that often require redefinition of roles, reorganization of decision-making flows and strengthening of the capacity for coordination between different areas. In these circumstances, leadership ceases to be just a supervisory function to assume a role of sustaining the conditions that make strategic implementation possible.

Bernardes and Ferreira (2023) highlight that organizational growth results from the articulation between institutional context, organizational competencies, and leadership's capacity for strategic action. Such a perspective shifts the debate on growth as a simple consequence of technical decisions to understand it as a process dependent on the way the organization mobilizes its human and symbolic resources. Growth, in this sense, also involves consolidating forms of leadership capable of producing alignment and direction.

At the same time, recent studies have shown that leadership styles directly influence

the quality of work relationships and the organizational climate, affecting levels of trust, engagement, and willingness to change. Poubel, Sincorá and Brandão (2022) show that transformational leadership favors well-being at work and expands the capacity for collective mobilization, especially in contexts that require continuous learning and adaptation.

The relationship between leadership and strategic implementation is also expressed in the way leaders communicate objectives, build legitimacy, and distribute responsibilities. Organizations often have clear guidelines at the formal level, but they face difficulties when these guidelines need to be incorporated into routines, intermediate decisions, and collective behaviors. The distance between formulation and execution remains one of the main challenges of contemporary strategic management.

A significant part of these difficulties stems from factors that go beyond the technical design of the strategy. Cultural resistance, insufficient communication, decision-making ambiguities and lack of coordination between organizational areas become recurrent obstacles to the implementation of growth initiatives. In these cases, leadership assumes a mediating role, capable of reducing uncertainties and producing coherence between strategic direction and organizational action.

From this perspective, understanding leadership also implies analyzing its relational dimension. Leaders not only set priorities, but produce environments of trust, influence perceptions of legitimacy, and organize shared meanings about change and performance. The daily performance of leadership becomes, therefore, a decisive component for sustaining lasting strategic processes.

Mata, Ferreira, and Bastos Filho (2024) demonstrate that situational leadership contributes to the formation of more responsive organizational environments, by adapting behaviors to the concrete needs of teams and contextual challenges. This flexibility becomes especially relevant in growth scenarios, in which different sectors and hierarchical levels respond unevenly to organizational transformations.

People development is also part of this debate as an inseparable dimension of strategic leadership. Martins et al. (2024) point out that the leader's mindset directly influences the organizational capacity for learning, innovation, and adaptation. Growth-oriented leaders tend to value mistakes as a possibility for development, strengthening organizational cultures that are more open to experimentation and the collective construction of solutions.

In addition, Oliveira et al. (2022) highlight that leadership directly interferes with emotional health and organizational climate, demonstrating that practices based on listening, communicational clarity, and professional recognition contribute to more stable and

cooperative environments. In contexts of strategic implementation, such elements cease to be ancillary and become part of the very conditions of viability of the strategy.

It is in this set of relationships that the purpose of this chapter is situated: to understand how leadership acts in the implementation of organizational growth strategies from the perception of business leaders inserted in medium and large companies. More than identifying isolated practices, it seeks to interpret how these professionals mean their performance in processes of coordination, adaptation and construction of results.

The analytical path is based on the understanding that leadership does not act in isolation, but in permanent interaction with organizational climate, institutional culture, decision-making processes, and governance practices. Thus, organizational growth is approached as a multidimensional phenomenon, in which people, structures, and strategies are dynamically articulated.

Methodologically, the study adopts a qualitative-quantitative approach, articulating data obtained by survey with interpretative analysis of the perceptions expressed by the participants. This combination allows you to simultaneously examine general trends and meanings attributed by leaders themselves to the experience of conducting strategic processes in complex organizational environments.

2 ORGANIZATIONAL LEADERSHIP: CONCEPTS AND APPROACHES

2.1 LEADERSHIP IN THE CONTEMPORARY ORGANIZATIONAL CONTEXT

Leadership is understood as a process of intentional influence that aims to guide individuals and teams towards common goals. In the organizational environment, leading means going beyond the occupation of a formal position, involving the ability to inspire, coordinate efforts and promote collective engagement. According to Oliveira et al. (2022), the leader's performance has a direct impact on the organizational climate and on the emotional health of employees, demonstrating that effective leadership is related not only to operational results, but also to people's well-being and the quality of work relationships.

In the current context, marked by constant transformations and high competitiveness, leadership assumes an essentially strategic character. Leaders become central agents in the conduct of organizations, acting as mediators between planning and execution. Bernardes and Ferreira (2023) highlight that organizational growth depends on the articulation between context, internal competencies, and roles played by leaders, showing that strategic decisions only materialize when there is leadership capable of aligning people and processes with institutional goals.

In addition, the literature points out that leadership involves a set of technical and

behavioral competencies that are indispensable to organizational performance. Clear communication, decision-making skills, conflict management, and people development are fundamental attributes for the leader to exert a positive influence on his team. In this sense, Martins et al. (2024) argue that the leader's mindset – whether fixed or growth – directly interferes in the way he faces challenges, leads changes and stimulates organizational learning, reinforcing the idea that leading is also a process of cultural construction.

Finally, it is understood that leadership does not manifest itself in a single or static way, but as an adaptive practice to the demands of the environment. Different leadership styles have different impacts on team engagement, satisfaction, and productivity. Mata et al. (2024) demonstrate that situational leadership, by adapting behaviors to the needs of the subordinates, contributes to the construction of a more favorable organizational climate. Similarly, Poubel et al. (2022) point out that transformational leadership approaches favor the implementation of strategies and the achievement of better institutional results. Thus, understanding the fundamentals of leadership becomes an indispensable condition to analyze its role in the implementation of organizational growth strategies.

2.2 LEADERSHIP STYLES AND THEIR IMPACTS

Leadership styles represent different ways in which leaders exert influence on their teams and drive organizational processes. The specialized literature shows that there is no single leadership model capable of meeting all situations, and it is necessary to consider the context, the characteristics of the subordinates and the strategic objectives of the organization. In this sense, Mata et al. (2024) state that situational leadership stands out for its flexibility, allowing the leader to adapt his behavior to the specific needs of the team, favoring a more productive and collaborative organizational climate.

Among the most discussed styles in the field of management, transformational leadership has received special attention for its positive impact on organizational performance. According to Poubel et al. (2022), transformational leaders are able to inspire their subordinates, stimulate the development of competencies, and promote greater engagement with institutional objectives. This leadership style contributes to the creation of more innovative work environments and to overcoming organizational challenges, and is especially relevant in contexts of implementing growth strategies.

Another relevant aspect concerns the influence of behavioral and cognitive factors on leadership practice. Martins et al. (2024) highlight that the leader's mindset plays a decisive role in the way he leads his team and faces adverse situations. Leaders with a growth mindset tend to see mistakes as learning opportunities, encouraging autonomy and innovation. On

the other hand, leaders with a fixed mindset have greater resistance to change and less openness to development, which can compromise the effectiveness of organizational strategies.

In addition to the impacts on performance and results, leadership styles also directly influence the well-being and emotional health of employees. Oliveira et al. (2022) show that leadership based on clear communication, emotional support, and professional recognition contributes to the improvement of the organizational climate and the reduction of stress factors at work. Thus, understanding the different leadership styles and their effects becomes essential to analyze how leaders can act more effectively in leading teams and implementing organizational growth strategies.

3 LEADERSHIP AND ORGANIZATIONAL CLIMATE

3.1 LEADERSHIP AS A DETERMINING FACTOR OF THE ORGANIZATIONAL CLIMATE

Organizational climate refers to the set of perceptions shared by employees about the work environment, management practices, and interpersonal relationships established in the organization. This climate directly influences aspects such as team motivation, productivity, satisfaction, and commitment. Several studies point out that leadership plays a central role in the formation and maintenance of this environment, since the leader's behavior defines patterns of communication, recognition, and interaction within the organization (Oliveira et al., 2022).

The way leaders lead their teams directly impacts the quality of work relationships and the level of employee engagement. Mata et al. (2024) highlight that situational leadership, by adapting its style to the needs of the subordinates, favors the creation of a healthier and more productive organizational climate. When the leader demonstrates support, clarity in guidelines and openness to dialogue, he tends to promote greater trust and cooperation among team members, fundamental elements for the achievement of institutional objectives.

In addition, the organizational climate is closely related to the ability of organizations to implement changes and strategies. Environments characterized by poor communication, frequent conflicts, and low employee participation tend to hinder the execution of strategic plans. In this sense, Poubel et al. (2022) state that transformational leadership practices contribute to building a more favorable climate for innovation and development, strengthening the alignment between people and organizational goals.

Another relevant factor concerns the influence of the leader's mindset in building the organizational climate. Martins et al. (2024) argue that leaders with a growth mindset encourage continuous learning, value collaboration, and encourage employee autonomy,

which results in more positive and development-oriented environments. Thus, it is evident that leadership not only interferes in individual and collective performance, but also constitutes a determining element for the creation of an organizational climate capable of sustaining processes of change and growth.

3.2 MINDSET, CULTURE AND PEOPLE DEVELOPMENT

The concept of mindset has been widely discussed as a fundamental element to understand the behavior of leaders and their influence on teams. According to Martins et al. (2024), mindset can be understood as the set of beliefs and attitudes that guide the way an individual interprets challenges, learns from mistakes, and positions himself in the face of change. In the organizational context, leaders with a growth mindset tend to encourage continuous learning, innovation, and collaboration, creating favorable conditions for the development of people and the strengthening of organizational culture.

Organizational culture, in turn, is built from shared values, practices, and behaviors, and is strongly influenced by the performance of leaders. When the leader adopts a posture open to dialogue, feedback, and constant improvement, he contributes to the formation of more participatory and development-oriented environments. In this sense, Oliveira et al. (2022) emphasize that leaders who value emotional support, recognition, and transparent communication favor the creation of a healthier organizational climate, positively impacting team engagement and performance.

People development is another aspect directly related to the mindset and culture promoted by leaders. Organizations that invest in the training of their employees and encourage autonomy tend to have a greater capacity for adaptation and innovation. Poubel et al. (2022) show that transformational leadership practices encourage the professional and personal growth of individuals, strengthening commitment to strategic objectives and expanding organizational capacity to respond to challenges and opportunities.

Thus, it is understood that the alignment between growth mindset, organizational culture, and people development is essential for the effectiveness of leadership. Mata et al. (2024) demonstrate that leaders who are able to adjust their style to the needs of the team and promote continuous learning environments contribute to building more resilient organizations that are prepared to implement strategies. Thus, the role of the leader goes beyond the coordination of tasks, becoming a central agent in the formation of a culture that values human development as the basis for organizational growth.

4 ORGANIZATIONAL GROWTH STRATEGIES

4.1 CONCEPTS OF ORGANIZATIONAL STRATEGY

Organizational strategy can be understood as the set of guidelines and planned actions that guide the organization in the pursuit of its long-term objectives. It is a continuous process of defining goals, allocating resources, and choosing paths that allow the company to position itself competitively in the market. In the contemporary business environment, marked by uncertainties and constant changes, strategy plays a fundamental role in ensuring the sustainability and growth of organizations.

Traditionally, strategy is conceived as a process involving two complementary dimensions: formulation and implementation. Formulation concerns the definition of organizational plans, goals, and policies, while implementation refers to the transformation of these plans into concrete actions. Bernardes and Ferreira (2023) highlight that organizational growth does not depend only on the development of good strategies, but mainly on the organization's ability to articulate them with its internal competencies and with the effective performance of leaders, responsible for conducting the strategic execution process.

In addition, organizational strategy is directly related to the ability of companies to adapt to the context in which they are inserted. Technological changes, competitive pressures, and transformations in consumer behavior require organizations to respond quickly and flexibly. In this sense, strategy should be understood as a dynamic process and not just as a static plan. Poubel et al. (2022) argue that organizations that are able to align strategies with effective leadership practices are more likely to achieve consistent and sustainable results.

Another relevant aspect refers to the role of people in the strategic process. The execution of any strategy depends fundamentally on the engagement and coordinated action of employees. Therefore, organizational strategy cannot be dissociated from human and cultural factors. Mata et al. (2024) point out that strategic success is strongly conditioned by the ability of leaders to mobilize teams, promote internal alignment, and create environments conducive to innovation and performance. Thus, understanding the concepts of organizational strategy is essential to analyze how leadership acts as a key element in the implementation of growth strategies.

4.2 THE STRATEGIC IMPLEMENTATION PROCESS

Strategic implementation corresponds to the set of actions and decisions necessary to transform plans and guidelines into concrete results. While strategic formulation defines "what to do", implementation answers the "how to" question, involving the coordination of

people, processes, and resources. Several studies indicate that most of the difficulties faced by organizations are not in the elaboration of strategies, but in their effective execution, evidencing the complexity of this process.

The strategic implementation process requires alignment between different organizational levels and clarity in communicating objectives. Bernardes and Ferreira (2023) emphasize that organizational growth depends on the ability of leaders to articulate strategies with internal competencies and to promote coherence between strategic decisions and daily practices. Without this alignment, even well-structured strategies tend to lose effectiveness, resulting in poor performance and wasted resources.

Another determining factor for the successful implementation of strategies is the engagement of teams. Strategic execution involves changes in behavior, adoption of new practices, and overcoming internal resistance. In this sense, Poubel et al. (2022) highlight that transformational leadership styles favor employee commitment, stimulating cooperation and willingness to face organizational challenges. Leaders who communicate clearly, offer support, and value the development of people contribute significantly to the effectiveness of the strategic process.

In addition, strategic implementation is directly related to the organizational climate and the ability of leaders to adapt. Mata et al. (2024) state that situational leadership, by adjusting behaviors to the team's needs and context, creates more favorable conditions for the execution of strategies. Martins et al. (2024) add that leaders with a growth mindset tend to see difficulties as learning opportunities, favoring innovation and problem-solving. Thus, strategic implementation reveals itself to be an essentially human and relational process, in which leadership plays a decisive role in achieving organizational results.

4.3 LEADERSHIP AND ORGANIZATIONAL GROWTH

Organizational growth is one of the main strategic objectives of companies and involves processes of expansion, innovation, increased competitiveness and continuous improvement of performance. However, the simple planning of actions aimed at growth does not guarantee their effectiveness. The literature has shown that the success of expansion strategies depends decisively on the ability of leaders to lead people and processes towards organizational objectives. In this sense, leadership is a central element in the articulation between planning and strategic execution.

Bernardes and Ferreira (2023) highlight that organizational growth results from the interaction between three fundamental dimensions: the institutional context, organizational competencies, and the role played by leaders. According to the authors, effective leaders are

able to interpret external demands, mobilize internal resources, and promote decisions aligned with the needs of the environment. Thus, growth should not be understood only as a consequence of good strategies, but as a result of leadership practices that favor learning, innovation, and organizational adaptation.

The relationship between leadership and growth is also evident in the ability of leaders to create environments conducive to strategic execution. Poubel et al. (2022) argue that transformational leadership has a direct impact on institutional performance by stimulating employee engagement, motivation, and development. Leaders who communicate a clear vision, inspire confidence, and encourage active team participation significantly increase the chances of success of strategic growth-oriented initiatives.

Another relevant aspect refers to the influence of the organizational climate on the expansion process of companies. Mata et al. (2024) demonstrate that situational leadership, by adapting behaviors to the characteristics of the subordinates and the demands of the context, contributes to the formation of more collaborative and productive environments. Such environments favor the implementation of changes, the overcoming of internal resistance, and the alignment of teams around strategic goals, indispensable factors for sustainable organizational growth.

In addition to the organizational climate, the mindset of leaders plays a decisive role in driving growth. Martins et al. (2024) state that leaders with a growth mindset tend to value continuous learning, innovation, and people development, essential characteristics in organizational expansion processes. On the other hand, leaders with a fixed mindset may have greater difficulty in dealing with uncertainties and transformations, limiting the organization's ability to take advantage of growth opportunities.

The well-being and emotional health of teams also relate directly to the ability of organizations to grow consistently. Oliveira et al. (2022) point out that leaders who offer support, recognition, and transparent communication contribute to the creation of psychologically healthy environments, reducing stress levels and increasing employee commitment. More engaged and emotionally balanced teams tend to perform better, which is positively reflected in the organization's strategic results.

In addition, organizational governance and compliance practices influence the growth process by establishing ethical and management standards that strengthen internal and external trust. Paz, Azevedo, and Sousa (2023) show that organizational environments structured on principles of compliance and transparency favor safer decisions that are aligned with strategic objectives. In this context, leadership plays a fundamental role in promoting an organizational culture based on integrity, responsibility, and results-orientation.

In view of these considerations, it is observed that leadership acts as an integrating axis between strategy, people and results, constituting a decisive factor for organizational growth. Leaders' ability to communicate vision, mobilize teams, adapt to dynamic contexts, and foster innovation-friendly environments is essential for organizations to be able to transform strategic intentions into effective performance. Thus, understanding the relationship between leadership and organizational growth becomes indispensable to analyze how leadership practices influence the implementation of strategies and the sustainability of business development.

5 LEADERSHIP, GOVERNANCE AND ORGANIZATIONAL ENVIRONMENTS

5.1 ETHICS, GOVERNANCE AND COMPLIANCE

The effectiveness of organizational strategies is directly related to the governance environment in which the organization is inserted. Management practices based on ethics, transparency and regulatory compliance are essential pillars for institutional credibility and for the sustainability of business growth. In this context, corporate governance and compliance emerge as mechanisms that guide strategic decisions and reduce organizational risks, strengthening the trust of internal and external stakeholders (Paz, Azevedo & Sousa, 2023).

Compliance can be understood as the set of procedures and controls aimed at ensuring that the organization acts in accordance with laws, standards, and ethical principles. More than a control instrument, compliance represents a strategic element that contributes to the improvement of decision-making processes and the construction of an integral organizational culture. Paz, Azevedo, and Sousa (2023) show that companies that adopt consistent compliance practices tend to have greater managerial maturity and better alignment between organizational objectives and professional conduct.

In this scenario, leadership plays a decisive role in promoting ethical values and consolidating governance practices. The way leaders lead their teams and make decisions directly influences organizational behavior and the perception of legitimacy of strategic actions. Bernardes and Ferreira (2023) highlight that sustainable organizational growth depends on the ability of leaders to integrate governance principles into daily practices, ensuring coherence between discourse and action.

In addition, organizational environments guided by ethics and transparency tend to favor the implementation of growth strategies. Leaders who value integrity, respect for standards, and social responsibility contribute to the creation of relationships of trust, an indispensable factor for team engagement and the effective execution of strategies. Thus,

the articulation between ethics, governance, and compliance is a fundamental component for leadership to be able to exercise its role legitimately and effectively, promoting an organizational environment conducive to development and sustainable growth.

5.2 THEORETICAL SYNTHESIS AND CONCEPTUAL MODEL

The theoretical review shows that leadership is a central element for the effectiveness of organizational strategies and, consequently, for the growth of companies. The different authors analyzed demonstrate that strategic implementation is not limited to technical or formal aspects of planning, but depends fundamentally on the performance of leaders in conducting people, processes and decisions. Bernardes and Ferreira (2023) reinforce that organizational growth results from the articulation between context, internal competencies, and leadership practices, confirming that the execution of strategies is directly associated with the ability of leaders to mobilize resources and align collective efforts.

Studies on leadership styles and organizational climate reveal that the leader's behavior decisively influences team engagement and the work environment. Mata et al. (2024) show that situational leadership favors adaptation to the demands of the context and the needs of employees, creating more appropriate conditions for the execution of strategies. In a complementary way, Poubel et al. (2022) highlight that transformational leadership practices stimulate motivation, learning, and commitment, essential elements for organizations to be able to transform strategic plans into effective results.

Another relevant aspect refers to the influence of the *leader's mindset* and organizational culture on the growth process. Martins et al. (2024) demonstrate that leaders with a growth mindset tend to promote more innovative, collaborative, and people-development-oriented environments, which expands the organizational capacity for adaptation and expansion. Oliveira et al. (2022) add that emotional support, clear communication, and professional recognition contribute to the construction of healthier organizational climates, favoring collective performance and the implementation of strategic changes.

The integration of these elements allows the construction of a conceptual model that guides the present study. From the literature analyzed, it is understood that leadership directly influences the organizational climate, team engagement and the quality of decision-making processes, factors that, in turn, impact the effectiveness of strategic implementation. Thus, a model is proposed in which the performance of leadership, mediated by communication, people management, ethics, and governance practices (Paz, Azevedo, & Sousa, 2023), contributes to the creation of favorable organizational environments and to the alignment of

teams, resulting in the successful implementation of organizational growth strategies.

Thus, the theoretical synthesis maintains that organizational growth should be understood as a multidimensional phenomenon, in which leadership, climate, culture, and governance act interdependently. This understanding underpins the methodological path adopted in the research and guides the analysis of the data collected, allowing us to examine how leadership practices, in the perception of business leaders, influence the implementation of strategies and the performance of organizations. The conceptual proposal constructed here does not intend to end the debate, but to offer an interpretative key capable of articulating leadership, organizational environment and strategic execution in business contexts marked by increasing complexity.

6 METHODOLOGY

To empirically understand how business leaders interpret their performance in the implementation of growth strategies, an investigative path of applied nature was adopted, with a qualitative-quantitative approach and an exploratory-descriptive design. The choice of this methodological design is justified by the need to understand, in depth, the perceptions of business leaders about the role of leadership in the implementation of organizational growth strategies. According to Gil (2019), exploratory research is indicated when greater familiarity with the investigated problem is sought, while descriptive studies allow the identification and analysis of characteristics of a certain phenomenon or social group.

As for the technical procedures, the survey method was adopted, with the application of a structured questionnaire composed of closed questions on a Likert scale and open questions, applied from December 2025 to January 2026. According to Creswell and Creswell (2021), the use of mixed instruments enables the collection of numerical and qualitative data, expanding the understanding of the investigated object. The research universe was made up of business leaders working in medium and large companies, and the sample was defined by accessibility and convenience, including professionals who perform strategic management functions in different organizational sectors.

Data collection took place electronically, by sending the questionnaire to previously invited participants. Quantitative data were treated by means of descriptive statistics, with analysis of frequencies and means of the answers obtained. The qualitative data, from the open questions, were examined based on content analysis, according to the procedures proposed by Bardin (2016), allowing the categorization and interpretation of the respondents' perceptions about leadership practices and their relationship with strategic implementation.

With regard to ethical aspects, the research strictly observed the guidelines

established for studies involving human beings. The project was submitted to the Research Ethics Committee (CEP) of the Federal Institute of Education, Science and Technology of Minas Gerais (IFMG), and was duly approved before the start of data collection, according to CAAE process: 92484425.5.0000.0293. All participants received information about the objectives of the study, guaranteed anonymity and confidentiality of the answers, expressing agreement through the Informed Consent Form (ICF).

Thus, the methodological path adopted allowed the obtaining of consistent information aligned with the proposed objectives, making it possible to analyze quantitative and qualitative data in an integrated way. The combination of these techniques favored the understanding of the investigated phenomenon from multiple perspectives, offering subsidies for the discussion about the role of leadership in the implementation of organizational growth strategies.

7 RESULTS AND DISCUSSIONS

7.1 CHARACTERIZATION OF THE PARTICIPANTS

The initial reading of the data allows us to observe that the study participants are mostly inserted in organizational contexts of high decision-making complexity, which gives interpretative density to the perceptions presented below, with a predominance of professionals with more than six years of leadership experience (62.5%). There is an age concentration between 31 and 40 years old (56.3%), in addition to the majority of activities in the industrial sector (68.8%) and in large companies (81.3%).

This profile indicates insertion in structured organizational contexts, with greater strategic complexity and formalization of decision-making processes, which gives consistency to the perceptions analyzed.

Table 1

Characterization of the study participants

Variable	Category	Frequency	Percentage
Time leadership in	1 to 3 years	4	25,0%
	4 to 6 years	2	12,5%
	More than 6 years	10	62,5%
Age group	Under 30 years old	1	6,2%
	31 to 40 years old	9	56,3%
	41 to 50 years old	5	31,3%
	Over 50 years old	1	6,2%

Gender	Women	5	31,3%
	Male	11	68,8%
Company Area	Industry	11	68,8%
	Services	3	18,8%
	Technology	2	12,5%
Company size	Medium	3	18,8%
	Large	13	81,3%

The data presented in Table 1 show that the participants have consolidated experience in strategic functions, which reinforces the validity of subsequent analyses about the implementation of organizational growth strategies. Although the sample is small, the profile of the participants indicates high strategic experience, which reinforces the interpretative quality of the data.

7.2 CORRESPONDENCE OF THE ANALYZED ASSERTIONS

The organization of the assertions used in the data collection instrument favors the integrated reading of the dimensions investigated, which is why Table 2 systematizes the correspondence between the analytical codes used and their respective statements.

Table 2

Correspondence between codes and assertions used in the research data collection instrument

Code	Assertive
P1	Clear definition of objectives and expectations for the team
P2	Actively encourages the exchange of ideas and collaboration within the team
P3	The leader demonstrates trust and transparency in his or her interactions with the team
P4	My company's leaders handle change and uncertainty well
P5	Leaders encourage team autonomy and decision-making
P6	Leadership fosters a collaborative environment
P7	Leaders constantly seek professional improvement
P8	Leadership actively contributes to the implementation of growth strategies
P9	The results obtained are often analyzed and adjusted as necessary
P10	Strategic decisions are based on data and performance indicators

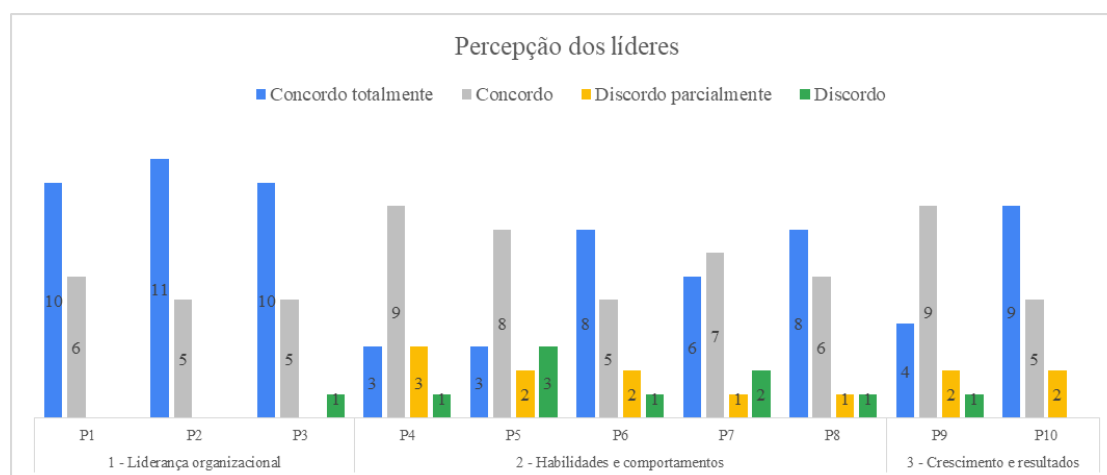
It should be highlighted, in addition to Table 1, that all the statements used the four-point Likert scale, namely, disagree, partially disagree, agree and totally agree.

7.3 QUANTITATIVE ANALYSIS OF LEADERS' PERCEPTIONS

The reading of the quantitative data reveals a consistent pattern of agreement around dimensions considered central to the performance of leadership in organizational growth processes.

Figure 1

Leaders' perception of leadership practices and their influence on organizational growth



Source: Survey data (2026).

Figure 1 shows a consistent pattern of agreement in the assertions related to the communication of strategic objectives, trust in interactions, and the active role of leadership in the execution of strategies (P1, P2, and P3). This result reinforces the theoretical perspective that leadership acts as an articulating element between strategic formulation and implementation, as pointed out by Bernardes and Ferreira (2023), when they argue that organizational growth depends on the ability of leaders to align internal competencies and strategic direction. The high agreement in these dimensions, then, suggests that the participants recognize leadership as a central mechanism for coordinating and mobilizing teams around organizational goals.

On the other hand, the greater dispersion observed in the assertions related to change management (P4), incentive to autonomy (P5), work environment (P6), continuous development (P7) and leadership behavior (P8) indicates that, although there is a general positive perception, these dimensions still present different levels of consolidation in the organizational contexts analyzed. This result dialogues with Mata, Ferreira, and Bastos Filho (2024), who argue that the effectiveness of leadership depends on the ability to adapt situationally to the characteristics of teams and the environment. Thus, the presence of partial disagreements may reflect structural and cultural challenges that hinder the transposition of more participatory leadership practices oriented to human development.

Regarding the assertions related to the analysis of results and data-based decision-making (P9 and P10), a high degree of agreement is again observed, suggesting that leaders perceive continuous monitoring and the use of indicators as indispensable components for organizational growth. This finding converges with the literature on strategic leadership, which emphasizes the need for evidence-based decisions and continuous evaluation

processes to sustain organizational competitiveness (Bernardes and Ferreira, 2023). In addition, this orientation towards metrics can be interpreted as a reflection of the expansion of governance and accountability practices discussed by Paz, Azevedo, and Sousa (2023).

The integrated analysis of quantitative data allows us to understand leadership as a multifaceted phenomenon, simultaneously guided by relational dimensions — such as communication, trust, and collaboration — and by technical aspects related to performance and strategic control. This combination is close to the characteristics of transformational leadership described by Poubel, Sincorá, and Brandão (2022), in which the leader exerts influence both through inspiration and engagement and through the ability to drive results. Thus, the data suggest that the organizational growth perceived by the participants emerges from the articulation between socio-emotional competencies and results-oriented management practices, reinforcing the centrality of leadership as an integrating element of strategic processes.

7.4 QUALITATIVE ANALYSIS OF LEADERS' PERCEPTIONS

The analysis of the open-ended responses allowed the researchers to deepen the quantitative results by evidencing interpretative dimensions that help to understand how leaders signify their role in strategic implementation, in such a way that, more than confirming trends observed in the assertions, the qualitative reports reveal relational and contextual processes that support the execution of organizational strategies, demonstrating that leadership is perceived as a dynamic and situated practice, and not just as a formal function.

First, the understanding of leadership as a mediation between planning and execution is highlighted. Participants describe the leader as responsible for translating strategic guidelines into concrete operational actions, establishing priorities and monitoring performance indicators. This perception converges with Bernardes and Ferreira (2023), when they emphasize that organizational growth depends on the ability of leaders to articulate internal competencies and transform strategic intentions into effective results. In this way, qualitative data reinforce the idea that leadership acts as a bridge between the strategic and operational dimensions, giving coherence to the implementation process.

A second interpretative axis refers to the role of communication as a structuring element of strategic leadership. The narratives indicate that clarity in the definition of goals, alignment between teams, and transparency of information are essential conditions for collective engagement and for the reduction of ambiguities during the execution of strategies. This finding dialogues with Oliveira et al. (2022), who associate open communication practices with building trust and strengthening the organizational climate, indicating that

communication is not only a management tool, but a central component of the exercise of leadership.

The third axis evidenced is related to the development of people and the promotion of autonomy. The answers indicate that leaders recognize organizational growth as a process dependent on continuous training and encouraging the active participation of employees. This perspective is close to the discussions of Poubel, Sincorá and Brandão (2022) on transformational leadership, in which human development and motivation constitute the basis for innovation and sustainable performance. At the same time, the narratives reveal that the consolidation of these practices faces cultural and structural barriers, which helps to explain the variability observed in the quantitative responses associated with autonomy and the collaborative environment.

Finally, the participants demonstrate that they understand organizational growth as a dynamic phenomenon, marked by continuous processes of evaluation, adaptation and integration between areas. This view reinforces the conception of situational leadership defended by Mata, Ferreira, and Bastos Filho (2024), according to which the effectiveness of leadership depends on the ability to adapt to the context and emerging demands. Thus, the qualitative analysis confirms that leaders perceive their performance as an integrating element between strategy and performance, showing that organizational growth is the result of collective processes mediated by the strategic action of leadership.

7.5 SUMMARY OF ANALYSES

The triangulation between quantitative and qualitative data shows high internal coherence of the findings and reinforces the analytical robustness of the study, allowing us to understand strategic implementation as a multidimensional process, in which technical and human factors are interdependently articulated. The results indicate that the effectiveness of growth strategies is not restricted to the formal formulation of plans, but depends fundamentally on the role of leadership as an integrating agent between people, processes, and organizational objectives, corroborating the perspective presented by Bernardes and Ferreira (2023).

Integrated analysis demonstrates that strategic clarity and structured communication emerge as central pillars of execution. Both quantitative data and qualitative narratives indicate that leaders capable of making objectives explicit, aligning expectations, and promoting transparency favor greater team engagement and reduce operational ambiguities. Such evidence converges with Oliveira et al. (2022), when they indicate that consistent communication practices contribute to the construction of environments of trust and to the

strengthening of the organizational climate, essential elements for the successful implementation of strategic changes.

In addition, the results show that behavioral competencies of leadership — such as adaptability, encouragement of autonomy and development of people — exert a direct influence on the effectiveness of strategic implementation. This perception is close to discussions about transformational and situational leadership, in which organizational performance is understood as the result of the combination of results-orientation and sensitivity to the team's needs (Poubel et al., 2022; Mata et al., 2024). The variability observed in some assertions suggests that these competencies are still conditioned by cultural and structural factors present in the organizations analyzed.

Another relevant aspect refers to the association between sustainable growth and continuous monitoring practices. The valorization of indicator analysis and data-based decision-making reveals a growing orientation towards more strategic management models aligned with the logic of governance and accountability, as discussed by Paz, Azevedo, and Sousa (2023). In this context, leadership plays a central role in balancing relational and analytical dimensions, articulating organizational performance and learning.

In summary, the findings reinforce that leadership maturity directly influences the organizational capacity to adapt and respond to dynamic contexts, configuring itself as a key element for the generation of value and for the sustainability of business growth. Thus, the integration of empirical data contributes to broaden the understanding of the role of strategic leadership in medium and large companies, showing that organizational growth is the result of collective processes mediated by the conscious and adaptive performance of leaders.

8 FINAL CONSIDERATIONS

Throughout this chapter, we sought to understand leadership as a constitutive dimension of the processes of strategic implementation in organizations inserted in contexts marked by demands for growth, adaptation and competitiveness. More than examining individual attributes of leaders, the analysis allowed us to observe leadership as a relational practice that articulates decisions, expectations and forms of coordination within organizations.

The data analyzed indicate that leadership is perceived by the participants as a structuring element of the strategic dynamics, especially because it acts in the space where institutional guidelines need to be translated into concrete work practices. In this sense, leadership does not appear only as an instance of supervision, but as a permanent mediation between strategic formulation and organizational capacity for execution.

The convergence between quantitative and qualitative data shows that clarity in the communication of objectives, building trust, encouraging collaboration, and systematic monitoring of results are dimensions particularly valued by the leaders investigated. These elements reveal that strategic implementation, far from depending exclusively on technical planning instruments, requires continuous processes of alignment and internal legitimation.

The recurrent presence of communication in the answers obtained reinforces the understanding that organizational strategies become effective when they manage to produce shared intelligibility. Clear objectives, explicit priorities, and consistent information flows reduce ambiguities and strengthen the collective capacity for action, making leadership a central operator of organizational coherence.

At the same time, the qualitative analysis shows that leaders attribute great importance to the ability to reduce resistance, sustain adaptation processes and stimulate autonomy in teams. Such a perception broadens the understanding of leadership beyond formal command, bringing it closer to an action aimed at creating favorable conditions for strategic changes to be incorporated into the organizational routine.

This relational dimension becomes particularly important in contexts of organizational growth, in which transformations often generate tensions between stability and change. Growing implies reorganizing practices, redefining priorities, and expanding internal capacities, processes that are difficult to sustain without leaders capable of interpreting the context and producing institutional cohesion.

The findings also suggest that organizational growth is not perceived by participants as a purely technical or linear phenomenon. On the contrary, it emerges as a dynamic process, dependent on the organizational capacity to learn, adjust decisions, and integrate different areas around common goals. Leadership, in this scenario, appears as an element that favors circulation between different levels of the organization.

From a theoretical perspective, the results reinforce contemporary approaches that understand leadership as an integrating variable between people, processes and results. By dialoguing with studies on strategic leadership, transformational leadership, organizational climate, and people development, the chapter broadens the understanding that strategic effectiveness depends heavily on human and cultural factors.

The approximation between empirical data and the literature shows that effective leadership practices are not restricted to decision-making, but include the ability to listen, contextually read, build trust, and sustain collaborative environments. These competencies become especially relevant in organizations operating under increasing demands for innovation and adaptation.

From an organizational point of view, the results suggest that sustainable growth strategies require continuous investments in leadership development. It is not enough to have formal management instruments; It is necessary to strengthen skills related to communication, change management, people development, and strategic reading of organizational environments.

The relevance of practices guided by systematic monitoring of results is also evidenced. The valorization of indicators and the continuous analysis of performance reveals that the leaders investigated recognize the importance of decisions supported by evidence, bringing leadership and governance closer together in more consistent decision-making processes.

Even so, it should be recognized that the results presented are the result of a specific cut, constructed from a small number of participants and convenience sampling. Although such a configuration does not compromise the interpretative power of the analysis, it recommends caution regarding generalizations to other organizational contexts.

Another aspect to be considered refers to the fact that the perceptions analyzed derive exclusively from the view of the leaders themselves, which naturally favors certain interpretations of the organizational dynamics. Incorporating other voices—especially employees and middle managers—can significantly broaden the understanding of the relationships between leadership and strategic implementation.

In this sense, future investigations may explore comparisons between different economic sectors, different organizational sizes and varied institutional contexts, allowing us to observe how leadership practices are configured in environments marked by specific challenges of growth and transformation.

In summary, the analysis developed in this chapter reinforces that leadership occupies a central position in organizational growth processes because it acts as a mediation between strategy, people, and institutional capacity for adaptation. More than an individual attribute, leadership proves to be a decisive social practice for the production of organizational coherence and for the sustenance of development trajectories in complex business contexts.

REFERENCES

Bardin, L. (2016). *Análise de conteúdo*. Edições 70.

Bernardes, M. E. B., & Ferreira, V. A. (2023). Crescimento organizacional: um estudo da relação prática entre contexto, competências organizacionais e lideranças. *Revista de Administração Mackenzie (RAM)*, 24(4), 1–28. <https://doi.org/10.1590/1678-6971/eRAMG230253.pt>

Creswell, J. W., & Creswell, J. D. (2021). Projeto de pesquisa: métodos qualitativo, quantitativo e misto (5ª ed.). Penso.

Gil, A. C. (2019). Métodos e técnicas de pesquisa social (7ª ed.). Atlas.

Martins, A. P., Gonçalves, M. M., Lima, O. C. S., Costa, J. C., Melo, W. F. M., Madeira, M. A., & Miranda, T. N. (2024). Entre desafios e oportunidades: o impacto dos mindsets na liderança. *Revista Ibero-Americana de Humanidades, Ciências e Educação (REASE)*, 10(8), 822–830. <https://doi.org/10.51891/rease.v10i8.15161>

Mata, D. M. S., Ferreira, F. S., & Bastos Filho, R. A. (2024). Liderança situacional e clima organizacional: uma análise à luz das teorias de Hersey e Blanchard. *Revista de Gestão e Secretariado (GeSec)*, 15(8), 1–20. <https://doi.org/10.7769/gesec.v15i8.4154>

Oliveira, P. T., Ferreira, P. T., & Costa, D. H. (2022). Liderança e o impacto da saúde mental no clima organizacional. *e-Acadêmica*, 3(2), e2932173. <http://dx.doi.org/10.52076/eacad-v3i2.173>

Paz, M. F., Azevedo, S. U., & Sousa, H. A. (2023). Compliance: um estudo sobre o perfil requerido pelas empresas brasileiras versus as qualificações do profissional da área. *Advances in Scientific and Applied Accounting (ASAA)*, 16(1), 201–217. <https://doi.org/10.14392/asaa.2022160107>

Poubel, L., Sincorá, L. A., & Brandão, M. M. (2022). Liderança transformacional e bem-estar no trabalho em instituições de ensino: uma proposta teórico-metodológica e reflexões para uma agenda de pesquisa. *Revista de Carreiras e Pessoas (RECaPe)*, 12(2), 240–258. <http://dx.doi.org/10.23925/recape.v12i2.48902>

THE CONTRIBUTIONS OF LANDSCAPE TO THE URBAN AND ENVIRONMENTAL PLANNING PROCESS AND TO THE INTEGRATED MANAGEMENT OF THE HYDROGRAPHIC BASIN

AS CONTRIBUIÇÕES DA PAISAGEM NO PROCESSO DE PLANEJAMENTO URBANO E AMBIENTAL E NA GESTÃO INTEGRADA DA BACIA HIDROGRÁFICA

LAS CONTRIBUCIONES DEL PAISAJE AL PROCESO DE PLANIFICACIÓN URBANA Y AMBIENTAL Y A LA GESTIÓN INTEGRADA DE LA CUENCA HIDROGRÁFICA



<https://doi.org/10.56238/sevened2026.008-224>

Elizabeth de Fátima Correia¹, Nilo Nunes², Laís Samira Correia Nunes³, Manuel Enrique Gamero Guandique⁴

ABSTRACT

In the current scenario of environmental manipulation and landscape interventions, the adoption of a new paradigm for urban and environmental planning becomes urgent, raising the question of how landscape planning, design, and architecture can contribute to the urban and environmental planning of the watershed. The objectives consist of investigating the theoretical and methodological concepts applied in landscape planning, design, and architecture; contributing to urban and environmental planning, using the watershed as the basis of this process; identifying proposals, experiences, and projects carried out on this theme; and contributing to broadening conceptual reflection and deepening the debate on integrated landscape management. The methodology was exploratory, involving the collection and compilation of documents and texts; reading, studying, and analyzing the selected material; and textual organization. It was concluded that landscape planning, design, and architecture contribute to the urban and environmental planning of the hydrographic basin through the application of environmental solutions such as connectivity, biodiversity, water governance, strengthening urban resilience, and the interaction of nature with people, as living, adaptive, and sustainable solutions to the urban and environmental challenges of contemporary cities.

¹ Doctoral student in Environmental Sciences. Universidade Estadual Paulista (UNESP). E-mail: elizabeth.correia@unesp.br Orcid: <https://orcid.org/0000-0001-6542-200X> Lattes: <https://lattes.cnpq.br/5180677956134006>

² Doctoral student in Environmental Sciences. Universidade Estadual Paulista (UNESP). E-mail: nilo.nunes@unesp.br Orcid: <https://orcid.org/0000-0001-8618-0222> Lattes: <https://lattes.cnpq.br/0954606558006772>

³ Dr. in Biological Sciences. Universidade Santa Cecília (UNISANTA). E-mail: laisnunes@unisanta.br Orcid: <https://orcid.org/0000-0002-4857-7656> Lattes: <https://lattes.cnpq.br/7621713529589524>

⁴ Dr. in Agronomy. Universidade Estadual Paulista (UNESP). E-mail: enrique.gamero@unesp.br Orcid: <https://orcid.org/0000-0001-9738-0932> Lattes: <https://lattes.cnpq.br/7970443137108970>

Keywords: Landscape Architecture. Urban Drainage. Landscape Ecology. Green Infrastructure. Nature-Based Solutions.

RESUMO

No cenário atual da degradação ambiental e das intervenções na paisagem, torna-se urgente a adoção de um novo paradigma para o planejamento urbano e ambiental, suscitando o questionamento de como o planejamento, o projeto e a arquitetura da paisagem podem contribuir para o planejamento urbano e ambiental da bacia hidrográfica. Os objetivos consistem em investigar os conceitos teóricos e metodológicos aplicados no planejamento, no projeto e na arquitetura da paisagem; contribuir para o planejamento urbano e ambiental, tendo a bacia hidrográfica como base desse processo; identificar propostas, experiências e projetos realizados com essa temática; e, contribuir para ampliar a reflexão conceitual e o aprofundamento do debate sobre a gestão integrada da paisagem. A metodologia foi exploratória, com o levantamento e compilação de documentos e textos; na leitura, estudos e análise do material selecionado; e, na organização textual. Concluiu-se que o planejamento, projeto e arquitetura da paisagem contribuem para o planejamento urbano e ambiental da bacia hidrográfica, através da aplicação de soluções ambientais, como a conectividade, a biodiversidade, a governança das águas, o fortalecimento da resiliência urbana e a interação da natureza com as pessoas, como soluções vivas, adaptativas e sustentáveis, para os desafios urbanos e ambientais das cidades contemporâneas.

Palavras-chave: Arquitetura da Paisagem. Drenagem Urbana. Ecologia da Paisagem. Infraestrutura Verde. Soluções Baseadas na Natureza.

RESUMEN

En el contexto actual de degradación ambiental e intervenciones paisajísticas, la adopción de un nuevo paradigma para la planificación urbana y ambiental se vuelve urgente, lo que plantea la cuestión de cómo la planificación, el diseño y la arquitectura del paisaje pueden contribuir a la planificación urbana y ambiental de la cuenca hidrográfica. Los objetivos consisten en investigar los conceptos teóricos y metodológicos aplicados en la planificación, el diseño y la arquitectura del paisaje; contribuir a la planificación urbana y ambiental, utilizando la cuenca hidrográfica como base de este proceso; identificar propuestas, experiencias y proyectos realizados sobre este tema; y contribuir a ampliar la reflexión conceptual y profundizar el debate sobre la gestión integrada del paisaje. La metodología empleada fue exploratoria e incluyó la recopilación y compilación de documentos y textos; la lectura, el estudio y el análisis del material seleccionado; y la organización textual. Se concluyó que la planificación, el diseño y la arquitectura del paisaje contribuyen a la planificación urbana y ambiental de la cuenca hidrográfica mediante la aplicación de soluciones ambientales como la conectividad, la biodiversidad, la gobernanza del agua, el fortalecimiento de la resiliencia urbana y la interacción de la naturaleza con las personas, como soluciones vivas, adaptativas y sostenibles a los desafíos urbanos y ambientales de las ciudades contemporáneas.

Palabras clave: Arquitectura Paisajística. Drenaje Urbano. Ecología Del Paisaje. Infraestructura Verde. Soluciones Basadas en la Naturaleza.

1 INTRODUCTION

In the current scenario, in the Anthropocene era, anthropogenic actions are increasingly intense and accelerated (Magalhães, 2023), resulting in profound transformations in the landscape and the environment. These transformations lead to the loss of biodiversity, environmental degradation, destruction of ecosystems, fragmentation of the landscape, interruption of ecological flows and climate change (Olivo; Meneguetti, 2023). As a consequence, there is also an increase in the impermeabilization of urban soil, water pollution and extreme weather events.

From the second half of the twentieth century, with the advance of industrialization and urbanization, technical and technological development intensified interventions on the landscape. Such interventions, called gray infrastructure, consist of engineering works, which, through artificially constructed structures, control natural processes through technique, conducting urban waters through impermeable pipes and galleries, making the systems of nature invisible in the daily life of the contemporary city (Lima; Ragonha; Schenk, 2023). As a result, the impacts resulting from this process cause the rupture, reduction and alteration of natural processes, in addition to the loss of the role of water in the urban landscape (Baptista; Cardoso, 2013).

In Brazil, the practice of gray infrastructure was adopted from 1889 (Silveira, 1998), and has continued to the present day. Despite scientific and technological advances, as well as the creation of instruments for territorial planning of environmental policy, it is observed that a technocratic vision of the city persists, conceived as a technical object aimed at urban regulation. This model of urban planning, based on principles and methods aimed mainly at regulatory efficiency, privileges socioeconomic processes (Brasil, 2002a) to the detriment of the integration of the landscape system with the environmental planning of Brazilian cities.

Thus, therefore, urbanization has generated a series of impacts on water bodies, causing the loss of their potential and multiple uses, the reduction of the quality and quantity of available water, in addition to the increase in organic load and pollutants. It is noteworthy that the channeling of urban rivers did not solve problems such as floods, pollution and contamination; on the contrary, it has aggravated the degradation of ecosystem functions, biodiversity and the landscape. In this context, the intensification of urbanization has increased concerns and stimulated the search for sustainable solutions aimed at the well-being of the population, the improvement of water quality, the increase of urban and climate resilience, urban drainage, the valorization of the natural environment and the river landscape (Silveira; Rodrigues; Dornelles, 2025).

Therefore, it is urgent to adopt a new paradigm for urban and environmental planning, related to the insertion of multidisciplinary in the complexity of the landscape. In this scenario, the river basin takes the lead in the process of planning, territorial planning, and integrated landscape management, incorporating both water management and its governance (Sant'Anna, 2020). Hydrographic basins contain environmental structures of extreme relevance in the cultural landscape of Brazilian cities, being considered as the synthesis of the territories interconnected to them (Lourenço *et al.*, 2015).

After World War II, regional planning proposals based on the urban landscape emerged, which began to guide territorial planning, with the watershed as a priority in this process (Sant'Anna, 2020). However, this perspective requires the integration of environmental agendas into political, social, economic and scientific discussions and decisions, with a view to formulating public policies for sustainable urban development.

In view of the above, the problem that this study proposes to investigate raises the following question: "How can landscape planning, design and architecture contribute to urban and environmental planning, with the watershed as the basis of the planning process, territorial planning and integrated landscape management?". Thus, this work aims to: investigate the theoretical and methodological concepts applied in landscape planning, design and architecture; contribute to urban and environmental planning, with the hydrographic basin as the basis of this process; identify proposals, experiences and projects carried out with this theme; and, to contribute to broaden the conceptual reflection and the deepening of the debate on integrated landscape management.

2 THEORETICAL FOUNDATION

2.1 ENVIRONMENTAL PLANNING IN BRAZILIAN LEGISLATION

In Brazil, from the middle of the twentieth century, the intense process of urbanization generated numerous socio-environmental impacts. In 1960, the urbanization rate was 45.52%; however, in 2022, the Brazilian population living in urban areas jumped to 87.40% (IBGE, 2022). This unbridled urbanization has caused numerous impacts in cities, such as socioeconomic inequality (Brasil, 2002a), environmental racism and social and climate injustice.

Between 1980 and 2000, Law No. 6,938/1981 was enacted, creating the National Environmental Policy (PNMA) (Brasil, 1981); and, in 1988, the Federal Constitution (FC) (Brasil, 1988), contemplating the fundamental principles of environmental legislation. In the context of the hydrographic basin, Law No. 9,433/1997 created the National Water Resources Policy (PNRH) (Brasil, 1997), which in addition to directing the management of this national

heritage, also influenced urban and regional management, since the hydrographic basins encompass the territories: national, state and municipal (Ferrão, 2018). In this way, the hydrographic basins are considered as the unit of integrated landscape management, as they integrate in their territories, the waters, the soil, the flora, the fauna, the natural resources, the cultural heritage, the people and the anthropic actions on these landscapes.

It is in this scenario that the City Statute was born, as a way of responding in a purposeful way to the challenges of reconstructing urban, redistributive and inclusive planning, under new principles, methods, conceptions and tools. Thus, the City Statute created by Law No. 10,257/2001, regulated articles 182 and 183 of the 1988 Federal Constitution, and established the general guidelines of urban policy, aiming at the full development of the city's social functions, the guarantee of the right to a sustainable city and the democratization of urban management (Brasil, 2002a). According to the City Statute, the municipality is responsible for urban policy, which has the Master Plan (PD) as its basic instrument.

Federal Decree No. 4,297/2002, through ecological-economic zoning, established the parameters of municipal environmental zoning (ZA), as a beacon of urban, rural and environmental territorial planning, and should consider the proposals of civil society and public agents, programs and projects that use natural resources, seeking the full maintenance of ecosystem services and ecological conservation, making use, protection and control compatible, as a way to achieve sustainable development (Brasil, 2002b).

The Brazilian Forest Code, updated by Law No. 12,651/2012 (Brasil, 2012), regulated by CONAMA Resolution No. 369/2006 (CONAMA, 2006), established the parameters for intervention and suppression of vegetation in the immediate surroundings of rivers, called Permanent Preservation Areas (APPs), constituting an important instrument of territorial planning of Brazilian environmental policy (Souza; 2015).

Consequently, municipal environmental planning and management are of fundamental importance in the contemporary context, considering popular participation, the promotion of the sense of belonging, of experience, of the identity of people and communities in relation to the place (Piroli, 2024), incorporating the multidisciplinary of landscape complexity in the process of planning, territorial planning and sustainable management of the city.

2.2 INTEGRATED LANDSCAPE MANAGEMENT IN THE ENVIRONMENTAL PLANNING PROCESS

In the environmental planning process, landscape systems must be contemplated (Sant'Anna, 2020). In this context, the hydrographic basin is considered the territorial unit of

planning and integrated management. Water governance and integrated landscape management should be part of public policies, with a view to sustainable urban development.

The articulation of water governance is a key element for the implementation of sustainable, participatory and integrated management of water resources. Of particular note is the guarantee of access to quality water for all, the promotion of sustainable use of water, the mitigation of the impacts of climate change, the guarantee of water security, social justice, transparency and citizen participation in decision-making processes in Brazilian municipalities (Empinotti; Jacobi; Fracalanza, 2016; Nicollier; Kiperstok; Bernardes, 2023).

Water governance has become relevant to the Brazilian public administration due to the frequent and intense water crises in the country (ANA, 2019; OECD, 2015). These facts show that water crises are the result of poor public management of water resources and areas that impact water; such as, land use and occupation, environment and basic sanitation (GWP, 2000; Tundisi, 2013; Pahl-Wostl, 2017).

One of the biggest challenges in water governance is the more effective participation of municipalities in the implementation of water resources management policy (OECD, 2015). For Nicollier, Kiperstok and Bernardes (2023), one of the possible factors is the lack of control of the municipal administration over water, and the municipalities have their participation in the National Water Resources Management System, indirectly, through the River Basin Committees. Thus, the importance of expanding spaces for social and political participation in the management of water resources in Brazil is emphasized.

Another relevant aspect is the complex relationship that the landscape and water governance establish between themselves, as these involve multiple actors, interests and scales of intervention (Ribeiro *et al.*, 2013).

Integrated landscape management includes the river basin, through various approaches, such as: land use, basic sanitation, environmental health, biodiversity, culture and sustainable urban development (Cerezini; Hanai, 2017; Xavier, 2025).

3 METHODOLOGY

From the point of view of the objectives, the research is characterized as exploratory. According to Prodanov and Freitas (2017), exploratory research allows the study of the theme from different angles and aspects, first involving the survey and compilation of documents and bibliography; then, the reading, studies and analysis of the selected material; and, finally, the textual organization compatible with the objectives of the research. From the point of view of technical procedures, the research is bibliographical. For Gil (2022), bibliographic research is based on material already published, including printed material, such as books, magazines,

newspapers, theses, dissertations and annals of scientific events, as well as material made available on the Internet.

4 RESULTS

Hydrographic basins comprise environmental structures of extreme relevance in the cultural landscape of Brazilian cities. These structures are shaped through natural processes throughout the planet's evolution (Piroli, 2024); Thus, the hydrographic basins are part of the set of natural and anthropic environmental factors; and, they are related to geomorphological aspects, which influence the way waters move and are distributed in the river basin (Sant'Anna, 2020).

Consequently, designing the urban landscape from its waters constitutes a challenge and an opportunity to reincorporate its social, environmental, cultural, economic and political value. The mutant and intertwined landscapes constitute the synthesis of the territories interconnected to them (Lourenço *et al.*, 2015).

The integrated planning, management and management of the watershed require the adoption of sustainable socio-environmental practices, and public policies aimed at expanding water availability, reducing conflicts and critical hydrological events, promoting water conservation as a socio-environmental value, as well as the protection and recovery of ecosystems, aiming at maintaining adequate environments for all (Piroli, 2024).

In the case of water governance, the landscape must be in the context of the interaction between the use of water resources, preservation and environmental conservation. In this way, integrated landscape management, including quality of life, well-being of people and ecosystems, is connected to water governance (Fernandes *et al.*, 2015).

4.1 THE COMPLEXITY OF THE RIVER BASIN AND THE ROLE OF THE LANDSCAPE IN PLANNING, TERRITORIAL PLANNING AND INTEGRATED MANAGEMENT

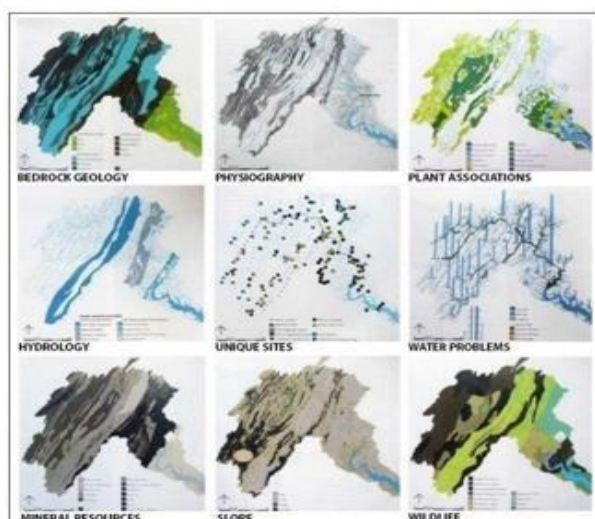
In the twenty-first century, environmental planning, by incorporating the complexity of increasingly urbanized territories, is associated with other areas of knowledge, which study and intervene in the territory. In this sense, considering the hydrographic basin as the basis of landscape planning, in a regional cut, it includes relief and geography. In turn, the river corridors drain the surface waters of the hydrographic basin, through the relief and vegetation that accompanies the banks of the rivers (riparian forests), where it is possible to identify and describe the natural resources contained in this territory in an integrated way (Sant'Anna, 2020).

From this point of view, the planning, design and architecture of the landscape must incorporate its physiographic regions, composed of natural elements, relief, geomorphology, soil types, water resources, vegetation, etc., in their different scales in studies, analyses, discussions and propositions in the context of the hydrographic basin, (McHarg, 2000).

McHarg (2000) in studies carried out in the Potomac watershed, in Canada, sought to enhance the relationships between uses and preservation. In this way, he defined the climate as a fundamental factor in the relationship with the physiography of the territory; and, the study and analysis of geomorphology to define the physiographic regions. These physiographic regions were analyzed and organized on thematic maps, based on hydrological conditions, soil, vegetation, fauna, mineral resources, landscape landmarks (natural sites and cultural manifestations) and slope (Figure 1); also, the aptitudes for agriculture, forestry, urbanization, leisure and recreation (Figure 2). Then, these maps were superimposed, generating a synthesis of guiding trends for the different types of land uses, the natural determinants, the analysis of the impacts of the occupation of unsuitable areas, the scale of compatibility with the type of land use and occupation, and the potential of the areas of the watershed (Figure 3).

Figure 1

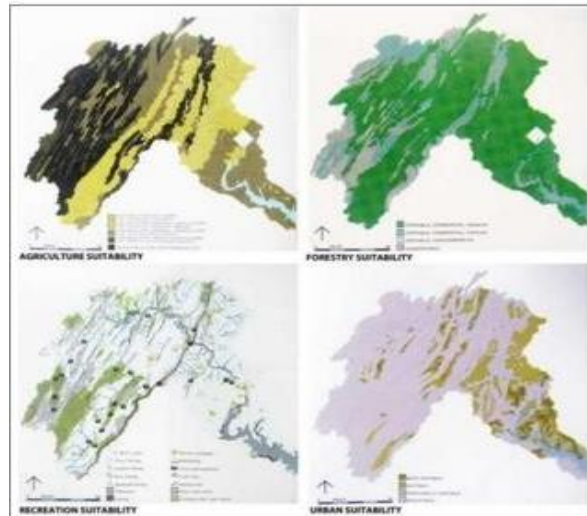
Studies for the Potomac River basin, through maps related to geology, physiography, landscape landmarks, hydrology, vegetation, water problems, mineral resources, slope and fauna



Source: McHarg (1997, p.140-145).

Figure 2

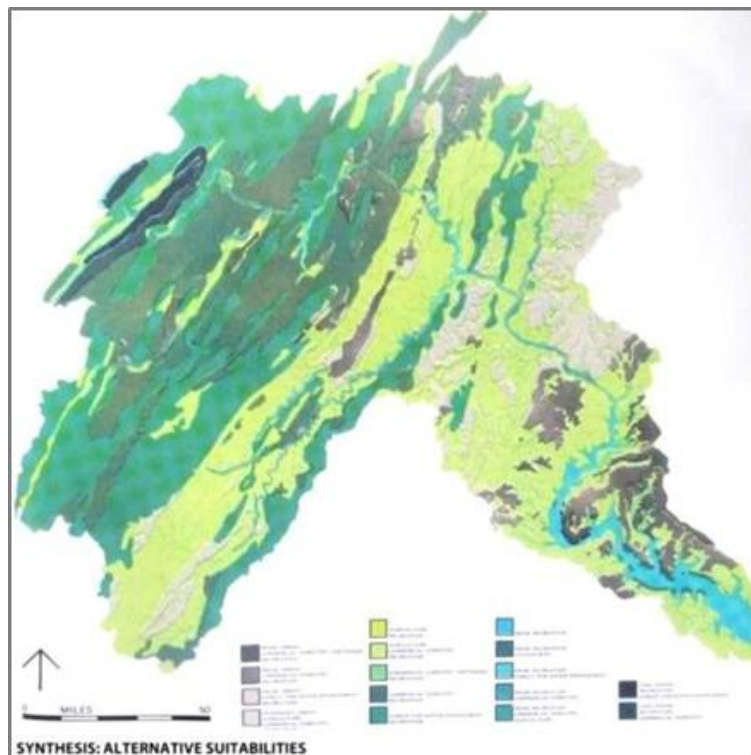
Studies for the Potomac River basin, through overlapping maps of the surveys carried out, indicating the suitability of the territory for agriculture, forestry, recreation and urban use



Source: McHarg (1997, p.140-145).

Figure 3

Studies for the Potomac River basin, presenting the synthesis of alternatives and trends



Source: McHarg (1997, p.321-333).

Thus, Ian McHarg developed a process of planning, design, and landscape architecture, encompassing the complexity of the territory and the role of the cultural landscape in territorial planning, thus contributing to the design of studies that enable decision-making based on modeling for future scenarios, as well as for proposals for the

formulation of legislation, regulation and public policies, aiming at current contemporary urgencies (Sant'Anna, 2020). The foundation of resilience as an environmental paradigm is close to ecological planning, as prescribed by McHarg (Olivo; Meneguetti, 2023).

Therefore, the application of the general principles of ecology such as connectivity, resilience and biodiversity, in the territorial coverage of the hydrographic basin, can be used as tools for the planning, design and architecture of the landscape (Olivo; Meneguetti, 2023; Pellegrino *et al.*, 2006).

4.2 LANDSCAPE PLANNING, DESIGN, AND ARCHITECTURE

After the Second World War, proposals for regional planning began to emerge from the landscape of the cities, guiding territorial planning; and, having the hydrographic basin as a priority in this process (Sant'Anna, 2020).

McHarg (2000), in his book *Design with Nature*, released in 1969, defined the landscape as a means and method, incorporating the principles of ecology in landscape planning (Lima; Ragonha; Schenk, 2023; Meneguetti, 2009), the multi-scalarity of planning as the basis of the work, as well as proposing adaptive strategies for low-impact urban development (Sant'Anna, 2020). Thus, the methodology proposed by McHarg (2000) was based on the superimposition of thematic maps, allowing the crossing of data from the natural support (geological, geomorphological, hydrological, vegetation, etc.), from existing ecological processes (ecosystems, land use, and urban and regional development) (Souza, 2015), as well as historical, cultural, and aesthetic factors, introducing subjectivity into the experiential perspective experienced in the territory (Lima; Ragonha; Schenk, 2023), in order to contribute to decision-making in urban and regional planning.

In this regard, the Mchargian methodology allowed the application in different contexts and scales, such as watershed planning, incorporating the broader systems of the territories; and, in the project, through local scales related to environmental experience and perception (Ragonha, 2019), recognizing the place as the product of natural and social systems and values (Lima; Ragonha; Schenk, 2023). Thus, the work of McHarg (2000) constitutes an important legacy for the planning, design and architecture of the landscape, as well as a fundamental instrument for the development of sustainable environmental and urban solutions for the contemporary city (Hough, 1988; Lima; Ragonha; Schenk, 2023; Olivo, Meneguetti, 2023; Pellegrino *et al.*, 2006; Sant'Anna, 2020; Souza, 2015; Spirn, 1995; Weiss, 2024).

Therefore, for the planning, design, and architecture of the landscape, an integrated and interdependent understanding is necessary (Weiss, 2024), as well as its practices require

a strategy of territorial multiscaling, in order to identify the diversity of the cultural and/or natural landscape (Schenk, 2008). Thus, in urban and regional planning, the landscape corresponds to the broad territories, such as the hydrographic basin, which is the unit of territorial planning and management; in the landscape project, the scale is local, linked to the functioning of the system, but not subordinated to it; and, in landscape architecture, the scale of planning is articulated with the design of the local scale, considering the experiential perspective of the people of the place, so that planning and design decisions are always connected to the context and to the various existing perceptions (Lima; Ragonha; Schenk, 2023; Weiss, 2008).

In this way, reflections on the relationship between man and nature and the multiscale of the landscape are intertwined by objectivities and subjectivities. Thus, the objectivities of the landscape occur through the physiognomy and natural dynamics, such as, for example, the hydrological cycle, geomorphology, the tidal cycle (in coastal cities), winds, relief and vegetation; and the subjectivities, present in the places (historical, paleontological and archaeological sites), in the cultural manifestations and their meanings, and in the appropriations and perceptions. From this understanding, nature becomes an integral and guiding element of the process of planning, design, and landscape architecture, bringing human processes closer to natural processes (Olivo; Meneguetti, 2023), incorporating adaptive strategies committed to the characteristics of the place (Sant'Anna, 2020).

In view of this, landscape architecture and ecology come together, providing the promotion of diverse territories and new meanings (Olivo, Meneguetti, 2023). Thus, McHarg (2000), based on landscape ecology, elaborated the theoretical and practical foundations of landscape planning, design and architecture, influenced by anthropology, archaeology, biology, geology and ecology, based on the premise of nature as a fundamental element in the experience of the place, in physical and biological evolution, in adaptation and adjustment, also contributing to biodiversity, geography and territorial management (Spirn, 1995).

For Forman (1995), the landscape corresponds to a set of ecosystems, which interact and repeat themselves in space, distributing themselves spatially, in a heterogeneous way. Meneguetti (2007) emphasizes that landscape ecology represents a new look at landscape planning, through a more ecological approach and spatial solutions, as a way to balance anthropic interventions with biophysical support and its possibility of absorbing impacts. In this way, Forman and Gordon (1986) approach landscape ecology as a theoretical-methodological framework related to structure, function, and dynamics/change.

In this context, the landscape can be understood as a mosaic of matrices, spots or fragments and corridors, and must be analyzed from its structure, through the arrangement in spatial patterns of its elements, acting on the functioning and changes of the landscape. It is from this perspective that landscape ecology unites ecology and landscape architecture, as a methodological approach (Gobster; Xiang, 2012), recognizing the interdependence of design, ecology and society (Grose, 2014), using the general principles of ecology, such as connectivity, green corridors, resilience and biodiversity, as tools for landscape planning, design and architecture (Pellegrino *et al.*; 2006). Thus, "[...] the spatial component is the key to Landscape Ecology" (Souza, 2015, p.56).

Therefore, while landscape represents the connection between human and natural processes, landscape ecology represents the central point of the dialogue between the two processes, applying, for example, to the environmental planning of watersheds (Darmstadt; Olson; Forman, 1996; Forman, 1995; 2004; 2008; Meneguetti, 2009; Pellegrino *et al.*, 2006; Tardin, 2018; Weiss, 2024). From this perspective, two contemporary instruments stand out: nature-based solutions (NbS) and green infrastructure (McHarg, 2000).

4.3 NATURE-BASED SOLUTIONS AND ECOSYSTEM SERVICES OF RIVER BASINS

Urbanization impacts the surface climate of urban areas, alters the land surface, and contributes to climate change, becoming sources of greenhouse gas (GHG) emissions. Mosisa *et al.* (2025) highlight that, in 2015, urban areas accounted for 61.8% of GHG emissions; and, by 2100, this number should exceed 80%. The authors also warn that in Brazil there has been a 62% reduction in ecosystem services.

From this perspective, NBS emerge as important mitigators of these effects, because by recognizing nature in their processes, as fundamental elements in the construction of cities (Devecchi *et al.*, 2021), they become essential for the creation of resilient and sustainable urban ecosystems (Mosisa *et al.*, 2025).

In the process of regional, urban and environmental planning, NBS propose integration and take into account the complexity of river basins and urban ecosystems. In this sense, NBS, with a focus on landscapes, are aligned with the 2030 SDGs, as they constitute living and adaptive solutions, inspired and supported by nature and with the involvement of people, (Evers *et al.*, 2022; Olivo; Meneguetti, 2023; Puskas; Abunnasr; Naalbandian, 2021; Spirn, 1998; McHarg, 2000; Mosisa *et al.*, 2025).

Olivo and Meneguetti (2023) point out that in the context of watershed ecosystem services, NBS seek to accelerate multiple services and benefits, valuing perception and experimentation, promoting a more holistic culture, as well as the incorporation and

understanding of nature with people. For Evers *et al.* (2022), ecosystem services (Chart 1) are the central element of NBS, promoting a series of positive impacts for climate adaptation and resilience.

Table 1

Contributions of ecosystem services in river basins

Services Provision	Food	Managed agrosystems, marine and freshwater systems, forests, and urban horticultures that provide food.
	Raw material	Woods, biofuels and vegetable oils, derived from native and cultivated plant species.
	Water	Vegetation and forests control the flow, store and purify the water. They influence the amount of water available locally.
Services Regulation	Local climate and Air Quality	Trees and green spaces reduce the temperature in cities. Forests influence the hydrological cycle, stimulating rainfall and removing pollutants from the atmosphere.
	Kidnapping of Carbon	Trees and plants remove carbon dioxide from the atmosphere, acting as carbon stores.
	Moderation of Extreme events	Ecosystems can act in the prevention of natural disasters. Plants stabilize slopes and mangroves filter river waters.
Cultural services	Recreation and health	Green spaces contribute to the socialization and welcoming of people. Also for physical and mental health.
	Tourism	Ecosystems and biodiversity are sources of socio-environmental benefits and income generation.
	Experience spiritual and sensory	Nature and biodiversity are common to the main cultures and traditional knowledge, giving a sense of belonging.
Services Support	Habitats for Species	Ecosystems provide essential habitats for the life cycle of many terrestrial and aquatic species.
	Maintenance of the Diversity Genetics	Genetic diversity provides the basis for well-adapted locally adapted crops and a gene <i>pool</i> for the development of agroecology, especially in food and animal production.

Source: Adapted from WRI Brasil (2022).

However, whether the contributions of watershed ecosystem services can actually maximize benefits as an adaptation strategy will depend on the approach and scale of the landscape. The protection, restoration and management of urban ecosystems are considered to ensure the integrity and connectivity of these ecosystems, which undoubtedly constitute the key to the maintenance of biodiversity and the resilience of the solutions themselves. This will minimize climate impacts, such as floods, droughts, and fires (Evers *et al.*, 2022; Mosisa *et al.*, 2025). The authors emphasize that the solutions can be implemented at different scales, and compose a network of NbS combined with gray infrastructures. To this end, NBS planning must count on the participation of local populations, as well as traditional communities, in order to identify priority areas, obstacles and facilitators for their implementation.

NBS within the scope of the watershed can include, for example: urban afforestation; preservation, conservation, recovery of riparian forest and springs; water-linked green area

systems (Devecchi *et al.*, 2021), restoration of native vegetation in PPAs, ecological corridors, green infrastructure, urban drainage and urban parks and linear parks on urban riverfronts (Evers *et al.*, 2022).

4.4 GREEN INFRASTRUCTURE IN THE CONTEXT OF ENVIRONMENTAL PLANNING OF THE RIVER BASIN

Green infrastructure incorporates a series of connected green spaces, impacting different scales and in different modes, characterizing itself as an adaptive project (Olivo; Meneguetti, 2023). However, it is essential that green infrastructure incorporates people's perceptions and interactions with landscapes, in addition to physical-territorial aspects (Mell, 2010).

Thus, in the context of the environmental planning of the river basin, green infrastructure incorporates the principles related to multi-scalarity, connectivity, interdisciplinarity, multifunctionality, integration, and social participation (Sant'Anna, 2020).

According to the author, in the principle of multiscale and interdisciplinarity, when designing with nature, it becomes essential to analyze the spatial and temporal scale of the regional scale of the hydrographic basin, as the unit of planning, design and architecture of the landscape; Multifunctionality, related to adaptation and climate change, aims to articulate the different mosaics contained in the landscape, which from the integration of these processes and in the performance of their multiple functions, can guarantee resilience and ecological integrity from the performance of the ecosystem services of the hydrographic basin. In the principle of connectivity, the relationships between spatial structure, functions, interactions, activities and ecological processes of the landscape, make up a green system, interconnecting the ecosystems and the natural and anthropic landscapes of the watershed. The purpose of integration is to promote the relationship between green infrastructure and other urban infrastructures. Finally, the principle of social participation can be considered the core for the success and maintenance of the territory. The importance of the participation of different agents and social actors is highlighted, involving communities in the collaborative process of urban and environmental planning.

In this way, green infrastructure, from the perspective of the urban landscape, assumes the function of urban infrastructure, covering, in addition to environmental functions, leisure, culture, education, recreation equipment, among other essential uses of urban open spaces (Souza, 2015), which are part of the hydrographic basin. It is emphasized that green spaces, an integral part of urban infrastructure, are articulated with the urban fabric, the road system, buildings, and urban open spaces (Pellegrino *et al.*, 2006). It is emphasized,

therefore, that in the process of planning, design, and landscape architecture, it is necessary to understand the relationship, the contribution of urban infrastructure in the design of the landscape, and the collaboration of green infrastructure within the context of the watershed.

Green infrastructure, when applied to urban drainage, acts to control land use and reserve (Souza, 2015), mitigating the impacts on river systems, whether in waste load and/or erosive processes, as well as ensuring the flow of runoff in river basins, soil permeability, and recharge of the water table and aquifers. Among the water management practices with low-impact interventions are: urban green corridors (*greenways*), constructed *wetlands*, reforestation of slopes and green streets (Sant'Anna, 2020; Pellegrino *et al.*, 2006), and the protection and recovery of springs. Connected to other green spaces in the city, urban parks and linear parks play a fundamental role in people's well-being and quality of life, while preserving and connecting natural areas, with significant benefits to biodiversity (Benedict; McMahon, 2002).

It is noteworthy that green infrastructure can cost 50% less than equivalent grey infrastructure, providing an additional 28% value, benefiting pollution reduction, carbon capture, adaptation, and urban and climate resilience (Evers *et al.*, 2022).

4.5 LANDSCAPE ARCHITECTURE: A NEW PARADIGM FOR ENVIRONMENTAL DESIGN

In the context of a new environmental paradigm, landscape architecture is one where the scale of planning is articulated with the design on the local scale and the experiential perspective of the people of the place. This concept has emerged recurrently in the literature, revealing transdisciplinarity based on the foundations of the plastic instance, theoretical training, practical experimentation and complex worldviews (Olivo; Meneguetti, 2023). Therefore, this new environmental paradigm is an evolving model, aimed at the conception of unprecedented solutions (Ndubisi, 2002), correlating with other paradigms such as resilience, connectivity, accessibility, cultural standards, appearance performance, multiscalarity, integration, biodiversity, multifunctionality, ecological aesthetics, redundancy and modularization, sustainability and complex thinking (Olivo; Meneguetti, 2023). Thus, it is important to emphasize that the understanding of the ecosystem processes of the landscape presupposes the proposition of a flexible and participatory social structure.

Several landscape architecture projects and proposals have been carried out around the world, considering urban rivers, aquatic ecosystems and watersheds as central elements of planning. These initiatives seek to integrate ecological, social, and cultural aspects, promoting the multifunctionality of free spaces and strengthening urban resilience. By addressing connectivity, biodiversity, water management and governance, and the

interaction of nature with people, these projects highlight the practical application of contemporary paradigms of landscape architecture, consolidating living, adaptive, and sustainable solutions to current urban and environmental challenges, contextualized in the spatial and temporal scale of the watershed.

The 2011 Habin Qunli Park project includes the green infrastructure for the management of urban waters in the Chinese city of Hardim and a walkable waterfront for the surrounding population. In this proposal, the concepts of connectivity and biodiversity are physically and functionally interconnected between different scales, relating them to integration, accessibility and multi-scalarity (Olivo; Meneguetti, 2023), characterizing itself as resilient, in the context of the contemporary sustainable city. Following the concept of Habin Qunli Park, Tanner Springs Park, in Portland, from 2010, works on the environmental process of the invisibility of urban waters, acting on a bioretention network as a complementary and ecological action in urban rainwater drainage, that is, a large rain garden (Cormier; Pellegrino, 2008).

In the case of Crissy Field Park, implemented in San Francisco (USA) in 2001, the concept of multifunctionality is combined with the biotic, abiotic, functional and cultural functions of urban open spaces (Hansen; Paulet, 2014), promoting social cohesion and the security of socio-ecological systems, with the reestablishment of tidal marsh and coastal dunes, and the juxtaposition and integration between people, wild fauna and flora. In this way, the park project works on the concept of diversity, recognizing the hybrid landscape in the human and ecosystem dimensions. Thus, biodiversity, the basis of the sustainability paradigm, considers both the diversity of biotic and abiotic factors and social, physical, and economic diversity, as an effective strategy for urban resilience (Olivo; Meneguetti, 2023). As for Downsview Park, implemented in Toronto, Canada, in 1999, diversity is present in the concept of the project, through topography, considering the circulation of matter and energy (Corner, 2016) and the constitution of a mobility system.

The Pirapora River Park, in Maranguape, Ceará, Brazil was one of the projects selected by the call for proposals "NbS Accelerator in Cities" (WRI Brasil, 2022). Its proposal is based on the nature-based infrastructural system, based on the infrastructure of nature, infrastructure of care, infrastructure of local socio-biodiversity and the infrastructure of the immaterial, all with the purpose of generating better urban conditions, better housing conditions, reduction of pollution and environmental degradation, valorization of green areas, income generation and strengthening of community-based tourism, in order to contribute to the fight against climate change and the achievement of the 2030 SDGs (WRI Brasil, 2024). In this sense, the Pirapora River Park project represents the environmental paradigm of

landscape architecture, in which resilience incorporated into the other paradigms of environmental design, reads, interprets and incorporates the reality of the landscape, thus introducing the possibilities of change, as opportunities for living and adaptive solutions, supported and inspired by the focus of nature with people (Evers *et al.*, 2022; Olivo; Meneguetti, 2023; Pellegrino *et al.*, 2006; Puskas; Abunnasr; Naalbandian, 2021; Sant'Anna, 2020; Spirn, 1998; McHarg, 2000; Mosisa *et al.*, 2025), presenting alternative scenarios and sustainable guiding trends for the watershed (McHarg, 1997; Olivo; Meneguetti, 2023).

5 CONCLUSIONS

Considering the national scenario of concerns with the various aspects of environmental degradation; and, the effort of the academic and scientific community, as well as the various sectors of civil society, new perspectives for urban and environmental planning emerge and, consequently, the formulation of public policies, from the complexity of the landscape to mitigate the effects of climate change and strengthen resilience.

Watersheds are understood as environmental structures of extreme relevance for landscape management and water governance, recognizing them as essential for the quality of life of people and ecosystems. The importance of understanding the ecosystem processes of the landscape is emphasized, through a flexible and participatory social structure.

It is identified in the principles and tools for planning, design and architecture of the landscape, connectivity, integration, interdisciplinarity, multidisciplinary, multiscale, multifunctionality, adaptability, sustainability, water security, analysis of ecological processes, green corridors, resilience, accessibility, environmental conservation and biodiversity, preservation, recovery and ecological restoration, objectivities and subjectivities, manifestations cultural and their meanings, cultural patterns, social and climate justice, transparency, social participation and inclusion, landscape diversity and complexity; and, nature-based solutions and green infrastructure.

NBS aligned with the 2030 SDGs are living and adaptive solutions, which contribute to the multiple ecosystem services and benefits of the river basin; and, they promote climate adaptation and resilience. In turn, green infrastructure acts in the river basin, at different scales and in different ways, through the principles and tools already mentioned. The importance of popular participation in NBS is emphasized; and, of people's perceptions and interactions with landscapes and in green infrastructure proposals.

The practical application of the environmental paradigms of landscape architecture as central elements of planning, territorial planning and integrated management of the landscape of the river basins is highlighted. The integration of design, ecology and society

promotes the multifunctionality of open spaces, strengthens urban resilience, multi-scalarity, connectivity and biodiversity. Water governance and management must interact with nature and people, as living, adaptive, and sustainable solutions.

It is concluded that the objectives of the study were achieved. However, the subject is not exhausted, because, due to its breadth, it may be the object of multiple approaches. Therefore, it is recommended to continue the studies, with the deepening of the conceptual reflection and the debate on the integrated management of the landscape.

REFERENCES

- Agência Nacional de Águas e Saneamento Básico (ANA). (2019). Plano nacional de segurança hídrica (PNSH). ANA/MDR.
- Baptista, M. B., & Cardoso, A. S. (2013). Rios e cidades: uma longa e sinuosa história. *Revista da Universidade Federal de Minas Gerais*, 20(2), 124–153.
- Benedict, M., & McMahon, E. (2002). Green infrastructure: Smart conservation for the 21st century. The Conservation Fund.
- Brasil. (1981). Lei nº 6.938, de 31 de agosto de 1981: Dispõe sobre a Política Nacional do Meio Ambiente, seus fins e mecanismos de formulação e aplicação, e dá outras providências.
- Brasil. (1988). Constituição da República Federativa do Brasil. Saraiva.
- Brasil. (1997). Lei nº 9.433, de 8 de janeiro de 1997: Institui a Política Nacional de Recursos Hídricos, cria o Sistema Nacional de Gerenciamento de Recursos Hídricos.
- Brasil. (2002a). Estatuto da Cidade: guia para implementação pelos municípios e cidades (2. ed.). Câmara dos Deputados.
- Brasil. (2002b). Decreto nº 4.297, de 10 de julho de 2002: Regulamenta o art. 9º, inciso II, da Lei nº 6.938, de 31 de agosto de 1981, estabelecendo critérios para o Zoneamento Ecológico-Econômico do Brasil – ZEE, e dá outras providências.
- Brasil. (2012). Lei nº 12.651, de 25 de maio de 2012: Dispõe sobre a proteção da vegetação nativa.
- Cerezini, M. T., & Hanai, F. Y. (2017). Gestão sustentável e integrada da água em bacias hidrográficas: 20 anos da lei das águas no Brasil. *Caminhos de Geografia*, 18(64), 159–168.
- Conselho Nacional do Meio Ambiente (CONAMA). (2006). Resolução nº 369, de 28 de março de 2006: Dispõe sobre os casos excepcionais que possibilitam intervenção ou supressão de vegetação em Área de Preservação Permanente (APP).
- Cormier, N. S., & Pellegrino, P. R. M. (2008). Infraestrutura verde: uma estratégia paisagística para a água urbana. *Paisagem e Ambiente*, (25), 127–145.

- Corner, J. (2016). The ecological imagination: Life in the city and public realm. In F. R. Steiner, G. F. Thompson, & A. Carbonell (Eds.), *Nature and cities: The ecological imperative in urban design and planning* (pp. 3–29). Lincoln Institute of Land Policy.
- Devecchi, A. M., Chirmici, A. C., Simonetti, C., & Corrêa, T. B. (2020). Desenhando cidades com soluções baseadas na natureza. *Parcerias Estratégicas*, 217–233.
- Dramstad, W., Olson, J., & Forman, R. (1996). *Landscape ecology principles in landscape architecture and land use planning*. Island Press.
- Empinotti, V. L., Jacobi, P. R., & Fracalanza, A. P. (2016). Transparência e a governança das águas. *Estudos Avançados*, 30(88), 63–75.
- Evers, H., Incau, B., Caccia, L., & Corrêa, F. (2022). Soluções baseadas na natureza para adaptação em cidades: o que são e por que implementá-las. WRI Brasil.
- Fernandes, D. T., Curado, M. J., & Rodrigo, M. A. I. A. (2015). A paisagem na gestão integrada dos recursos hídricos. In *Anais do II Congresso Ibérico de Restauración Fluvial* (pp. 450–455).
- Ferrão, A. M. A. (2018). Parques patrimoniais (agrários, fluviais, geoparques): o território das águas. *Terrae Didactica*, 14(1), 39–48.
- Forman, R. T. T. (1995). *Land mosaics: The ecology of landscapes and regions*. Cambridge University Press.
- Forman, R. T. T. (2004). *Mosaico territorial para la region metropolitana de Barcelona*. Gustavo Gili.
- Forman, R. T. T. (2008). *Urban regions: Ecology and planning beyond the city*. Cambridge University Press.
- Forman, R. T. T., & Godron, M. (1986). *Landscape ecology*. John Wiley & Sons.
- Forman, R. T. T., & Wilson, E. O. (2018). *Land mosaics*. Cambridge University Press.
- Gil, A. C. (2022). *Como elaborar projetos de pesquisa*. Grupo GEN.
- Global Water Partnership (GWP). (2000). *Integrated water resources management (TAC Background Paper No. 4)*.
- Gobster, P. H., & Xiang, W. N. (2012). What do we mean by landscape? *Landscape and Urban Planning*, 106(3), 219–220.
- Grose, M. J. (2014). Grapes and futures in working between ecology and design for constructed ecologies. *Landscape and Urban Planning*, 132, 69–78.
- Hansen, R., & Pauleit, S. (2014). From multifunctionality to multiple ecosystem services? *AMBIO*, 43(4), 516–529.
- Hough, M. (1998). *Cities and natural processes*. Routledge.
- Instituto Brasileiro de Geografia e Estatística (IBGE). (2022). *Censo demográfico*.

- Lima, M. C. P. B., Ragonha, J., & Schenk, L. B. M. (2023). A paisagem no planejamento e projeto do território. *Arquitextos*, 23(274.04).
- Lourenço, I. B., Veról, A. P., Marcelo, G. M., & Britto, A. L. N. P. (2015). Rios urbanos e paisagens multifuncionais. *Paisagem e Ambiente*, (36), 91–115.
- Magalhães, C. (2023). Preservar paisagens no antropoceno. *Revista Jatobá*, 5.
- McHarg, I. L. (2000). *Proyectar com la naturaleza*. Gustavo Gili.
- McHarg, I. L. (1997). Ecology and design. In G. E. Thompson & F. R. Steiner (Eds.), *Ecological design* (pp. 140–145). John Wiley & Sons.
- Mell, I. (2010). *Green infrastructure: concepts, perceptions and its use in spatial planning* (PhD thesis). University of Newcastle.
- Meneguetti, K. S. (2009). *Cidade-jardim, cidade sustentável*. Eduem.
- Mosisa, G. B., Bejadi, B., Dalle, G., & Tassie, N. (2025). Nature-based solutions to combat global change in urban ecosystem. *Urban Climate*, 61.
- Nicollier, V., Kiperstok, A., & Bernardes, M. E. C. (2023). A governança das águas no Brasil. *Estudos Avançados*, 37(109), 279–302.
- Ndubisi, F. (2002). *Ecological planning: a historical and comparative synthesis*. Johns Hopkins University Press.
- Organisation for Economic Co-operation and Development (OECD). (2015). *Governança dos recursos hídricos no Brasil*. OECD Publishing.
- Olivo, C., & Meneguetti, K. (2023). A duna e a floresta. *Paisagem e Ambiente*, 34(51), e200549.
- Pahl-Wostl, C. (2017). An evolutionary perspective on water governance. *Water Resources Management*, 31, 2917–2932.
- Pellegrino, P. R. M., Guedes, P. P., Pirillo, F. C., & Fernandez, S. A. (2006). A paisagem da borda. In L. M. S. A. Costa (Org.), *Rios e paisagens urbanas e cidades brasileiras* (pp. 57–76). PROURB.
- Pirolí, E. L. (2024). *Bacias hidrográficas e segurança hídrica*. ANAP.
- Prodanov, C. C., & Freitas, E. C. (2013). *Metodologia do trabalho científico* (2. ed.). Feevale.
- Puskas, N., Abunnasr, Y., & Naalbandian, S. (2020). Assessing participation in nature-based solutions. *Landscape and Urban Planning*, 210.
- Ragonha, J. (2019). *Planejar com a paisagem* (Dissertação de mestrado). Universidade de São Paulo.
- Sant'Anna, C. G. (2020). *A infraestrutura verde e sua contribuição para o desenho da paisagem da cidade* (Tese de doutorado). Universidade de Brasília.

- Schenk, L. (2008). *Arquitetura da paisagem* (Tese de doutorado). Universidade de São Paulo.
- Silveira, A. L. L. (1998). Hidrologia urbana no Brasil. In B. Braga, C. Tucci, & M. Tozzi, *Drenagem urbana* (pp. 7–25). ABRH.
- Silveira, G. B., Rodrigues, L. H. R., & Dornelles, F. (2025). Uso de soluções baseadas na natureza. *urbe. Revista Brasileira de Gestão Urbana*, 17, e20240012.
- Souza, C. B. (2015). *APPs fluviais e sistemas de espaços livres* (Dissertação de mestrado). Universidade de São Paulo.
- Spirn, A. W. (1998). *O jardim de granito*. Edusp.
- Tardin, R. (2018). *Análise, ordenação e projeto da paisagem*. Rio Books/UFRJ.
- Tundisi, J. G. (2013). Governança da água. *Revista UFMG*, 20(2), 222–235.
- Weiss, R. (2024). Planejamento da paisagem. In M. Enokibara, G. B. Paquotto, & S. M. Benini (Orgs.), *Paisagem: métodos e técnicas de análise e intervenção* (pp. 235–260). ANAP.
- Xavier, D. (2025). *Gestão integrada de bacias hidrográficas*. Ecopédia.

CITIZEN REFLECTIONS BASED ON THE APPROACH TO CHILD SUPPORT IN "VALE TUDO" (2025)

REFLEXÕES CIDADÃS A PARTIR DA ABORDAGEM SOBRE PENSÃO ALIMENTÍCIA EM "VALE TUDO" (2025)

REFLEXIONES CIUDADANAS A PARTIR DEL ENFOQUE DE LA PENSIÓN ALIMENTICIA EN "VALE TUDO" (2025)



<https://doi.org/10.56238/sevened2026.008-225>

Alessandra Helen Alves Claudino¹, Gabriela Caroline Alves Claudino²

ABSTRACT

The social merchandising contained in the May 13, 2025 episode of the telenovela "Vale Tudo," which addressed the request for alimony by the character Lucimar (Ingrid Gaigher), proved to be a strong motivator for women in similar situations to claim a right widely specified in the country, but with little publicized access to it. In this sense, this study aims to evaluate the framing of the episode in question based on its repercussions in national and Minas Gerais media, with the objective of drawing a parallel on how a telenovela can impact society. Furthermore, secondarily, it sought to relate the cited episode to the concept of Digital Governance, in order to make evident that the digitization of state services, accompanied by rights.

Keywords: Soap Opera. Citizenship. Framing. Digital Government. An Emancipated Spectator.

RESUMO

O *merchandising* social contido no capítulo de 13 de maio de 2025 da novela "Vale Tudo", em que foi abordado o pedido de pensão alimentícia pela personagem Lucimar (Ingrid Gaigher), se revelou como forte propulsor de mulheres em situações parecidas, no sentido de reivindicar um direito amplamente mencionado no país, mas com o modo de acesso pouco divulgado. Nesse sentido, pretende-se avaliar os enquadramentos do trecho em questão a partir da repercussão na mídia nacional e mineira, com o objetivo de traçar um paralelo sobre como a telenovela pode ter impacto na sociedade. Além disso, de forma secundária, buscou-se relacionar o capítulo citado com o conceito de Governança Digital, de modo a tornar evidente que a digitalização de serviços do Estado, acompanhado de esclarecimentos, pode garantir ao cidadão um acesso mais autônomo e rápido aos seus direitos.

Palavras-chave: Telenovela. Cidadania. Enquadramentos. Governo Digital. Espectador Emancipado.

¹ Specialist in Civil and Administrative Law. Universidade Estadual de Minas Gerais (UEMG).

² Master's Student in Social Communication. Universidade Federal de Minas Gerais (UFMG).

RESUMEN

El mercadeo social contenido en el episodio del 13 de mayo de 2025 de la telenovela "Vale Tudo", que abordó la solicitud de pensión alimenticia del personaje Lucimar (Ingrid Gaigher), demostró ser un fuerte motivador para que las mujeres en situaciones similares reclamaran un derecho ampliamente reconocido en el país, pero con escaso acceso público al mismo. En este sentido, este estudio busca evaluar el encuadre del episodio en cuestión con base en sus repercusiones en los medios nacionales y de Minas Gerais, con el objetivo de establecer un paralelismo sobre cómo una telenovela puede impactar a la sociedad. Además, secundariamente, buscó relacionar el episodio citado con el concepto de Gobernanza Digital, para evidenciar que la digitalización de los servicios estatales, acompañada de derechos.

Palabras clave: Telenovela. Ciudadanía. Encuadre. Gobierno Digital. Un Espectador Emancipado.

1 INTRODUCTION

The article seeks to make an approximation between Jacques Rancière's (2009) theory about the emancipated spectator, and the educational potential of soap operas. In this sense, it was sought to analyze how the approach to child support by the soap opera *Vale Tudo* (2025), contributed to the promotion of citizenship and emancipation of viewers. The debate included the debureaucratization of the State via Digital Governance, which aims to expand and make more efficient the population's access to public services.

Considering the idea developed by Goffman that framings influence the perception of reality and action of the subjects (MENDONÇA, SIMÕES, 2012), in order to operationalize the investigation, the intention is to verify which framings are triggered by the soap opera and by three communication vehicles to address the subject of alimony. The approaches of the online news portals G1, Correio Braziliense and O Tempo will be taken as a basis. As a theoretical apparatus, the perspective of the emancipated spectator will be considered (RANCIÈRE, 2009), in order to trace reflections on political issues and representativeness and visibility raised by the central point.

In this way, the topic in question is relevant since the exhibition of the chapter of the soap opera in which the character Lucimar requests child support via the Public Defender's Office App mobilized women across Brazil to also claim this right. Considering that the soap opera, despite being an important cultural product in Brazil, is still permeated by the stereotype of being banal and irrelevant, the repercussion of the subject of child support, raised by the soap opera *Vale Tudo*, actually reveals the strength of this audiovisual product as a cultural, pedagogical vehicle and promotion of citizenship.

2 THEORETICAL FRAMEWORK

2.1 CULTURE AND PEDAGOGY THROUGH SOAP OPERAS

The history of Brazilian television is permeated by soap operas, which have been part of the national culture for more than seventy years. Some titles are highlighted in the teledramaturgy, such as "Vale Tudo", from Rede Globo, whose first version dates from 1988. Due to the social relevance of the soap opera, in 2025 the *remake* was carried out, with the update of themes addressed and striking characters.

The new version of "Vale Tudo" is an example of how the soap opera can have a social impact through the themes it addresses. After the airing of the chapter in which the character Lucimar (Ingrid Gagher) learns (and at the same time teaches the public) how to download the Public Defender's Office application to apply for child support, support requests have grown in Brazil.

From this perspective, according to Sodré (2006), politics involves the sphere of power and the visible, and that/who appears in the public scene exerts influence. In this sense, the media acts in the formation of beliefs to the extent that it exerts forms of power, and it is necessary to pay attention to the relationships established between individuals and the media, so that they do not lose critical capacity and are only manipulated (SODRÉ, 2009).

Thus, when thinking about the case of the soap opera, what is shown gains visibility and exerts influences on the public. When the soap opera uses *social merchandising*, that is, it addresses and discusses latent social issues, the sphere of power (often political power) is accentuated. In the case discussed in the present work, it is clear that the treatment of the subject of alimony has become a point of discussion, given that it is related, among other topics, to a right in the sphere of the family, which is connected with latent issues in the present time, such as gender roles in society, the position of women and single motherhood.

Furthermore, borrowing Green's (2010) discussion about the power of the figure of the citizen as spectator, when thinking about the relationship between the soap opera and the public, it is expected that it is a passive way, however the gaze is also a form of participation. What is transmitted by the soap opera and seen by the viewers generates a network of influences that can lead to action, even if in the private sphere of individuals. As in the case of alimony, whether or not to make the request is a personal decision, but it generates impacts in the private sphere of the subjects, and also in the social sphere, when there is a significant number of people who manage to achieve their rights and thus pass this awareness on.

In this case, political power emerges from the soap opera to the public, which receives it in various ways, whether through the television screen, social networks and news. Therefore, understanding the dynamics of the relationships between soap operas and audiences is important, considering that the condition of being a spectator is not wrong, bad or apathetic, but rather constitutes a way of interacting with the world, and the soap opera can pass on knowledge and generate different forms of social engagement.

2.2 THE SOAP OPERA "VALE TUDO" OF 2025

The telenovela "Vale Tudo", with the first version in 1988, was produced by Rede Globo and was written by Gilberto Braga, Aguinaldo Silva and Leonor Bassères, and in 2025 it was adapted by Manoela Dias. The main themes addressed were the duality of honesty/corruption, ethical issues, inequalities, and other current social issues.

The most recent version rescued the central arc: the plot revolved around the characters Raquel Accioli (Taís Araújo), a woman full of values and ethics, Maria de Fátima (Bella Campos), daughter of Raquel, an unscrupulous young woman who does everything to

get out of the socioeconomic situation in which she was born, and Odete Roitman (Débora Bloch), a villain who represents the elite, and that embodies pride and different intolerances.

The story is triggered by the clash between Raquel and Fátima, when the young woman sells her grandfather's house, and uses the money to settle in Rio de Janeiro. Raquel goes after Fatima, and when she discovers that she has been deceived, she has to fight for her own survival in a strange city. With the help of friends he meets in Vila Isabel, he manages to create a business, and also meets Ivan Meirelles (Renato Góes), with whom he falls in love.

Meanwhile, Maria de Fátima, with the help of her boyfriend César (Cauã Reymond), tries to conquer space in different elite environments, until they reach the heir of the TCA airline, Afonso Roitman (Humberto Carrão), who is Odete's son. Getting closer to the villain, Fatima gets a deal: to separate Raquel from Ivan, and thus have support to marry Afonso. With this premise, the soap opera follows the course, including the supporting core that acts in the development of varied plots, which discuss themes that go beyond the fictional scope, and dialogue with social issues.

Therefore, it should be noted that in 2025 the soap opera updated some characters and themes worked. Heleninha (Paola Oliveira) has bipolar behavior and alcoholism addressed as diseases that need treatment, with empathy being demonstrated by some characters, and passages of treatment with the therapist; Laís (Lorena Lima) and Cecilia (Maeve Jinkings) are openly a couple and adopt a child; Poliana, who in the first version was just a shy and closeted man, now stands out when she discovers she is asexual and goes through a process of self-worth; Lucimar (Ingrid Gaigher) has her own story, being a woman who fights for her son's survival and conquest of independence.

Thus, in the 2025 version of the soap opera it is possible to identify important changes in the treatment of social issues. As Martins (2021) points out, time is not linear, but acts in a connection between past, present, and future. In this sense, the soap opera as a cultural product present in Brazilian daily life acts in the propagation of ideas and values that are constantly updated and that dialogue with the three times, and can create for certain groups the power of resistance, having a strong power of influence and transformation in the public.

From the new version of Lucimar in "Vale Tudo" the plot of alimony was developed, which yielded important social repercussions. This point will be analyzed below, considering possible contributions of the approach to the subject to the promotion of citizenship, in view of the framing given to the issue by the soap opera and by the journalistic coverage, pointing to the emancipation of the spectator.

2.3 DEBATES ON CITIZENSHIP FROM THE TELENOVELA "VALE TUDO", 2025: THE CASE OF ALIMONY

Social *merchandising* has already become a brand in Brazilian soap operas. From this practice, the soap opera addresses social themes, which can provoke off-screen discussions, generating an impact on viewers. This was the case of the May 13, 2025, chapter of the soap opera "Vale Tudo", in which the request for child support by the character Lucimar (Ingrid Gaigher) was addressed. After the scene was shown, thousands of requests for child support by women were registered in Brazil, reigniting the debate on current issues, such as solo motherhood, gender inequality and the right to child support as a way to guarantee resources for child rearing, which is a responsibility of both parents.

In the original version of "Vale Tudo", from 1988, the character Lucimar (Maria Gladys) worked as a day laborer, and was known for always betting on the Jogo do Bicho and meddling in the lives of neighbors, contributing to the gossip in Vila Isabel. A member of the comic core and on the side of the D/E class of the soap opera, only at the end of the story did she stand out, when she became rich after betting on the Jogo do Bicho the number of Odete Roitman's grave, embodying the superb characteristics of the villain. In the 2025 remake, the character gained a more complex plot. Lucimar is presented as a young woman, and even with dreams of ascending socially and being recognized as a singer, she works as a day laborer to support her son, Jorginho (Rafael Fuchs), the result of her relationship with her ex-husband Vasco (Thiago Martins).

Over the weeks, scenes are shown in which Lucimar asks Vasco to contribute to Jorginho's pension. Always with some excuse, Vasco excuses himself from the obligation, until Lucimar decides to make the formal request for child support for his son, given that he needs to pay for housing, food, education and leisure for the child.

In the plot, Lucimar has the help of Daniela (Jessica Marques), who is a law student and her friend, to be able to make the procedures for child support. Initially, Daniela explains to Lucimar how to proceed, but it takes a while for the character to actually decide to make the request, as she is afraid that Vasco will be arrested, which could lead Jorginho to believe that she harmed his father. In the meantime, the soap opera addresses fear and misinformation as the main reasons for women not to apply for child support, and highlights the view that permeates society, that men and women can have different behaviors and responsibilities in raising children.

In the chapter where Lucimar decides to apply for alimony, the step-by-step guide on how to proceed in the Public Defender's Office application is shown. This approach generated

repercussions on the networks, and also in the media, as the fact that after the exhibition of the scene increased exponentially the requests for child support in Brazil gained notoriety.

In this way, the soap opera gained prominence as a means of guiding a current and necessary debate, which even led to transformations in reality, in view of the identification and engagement generated in the public.

Taking as a parallel the thinking developed by Butler (2018), about the performativity of bodies considered deviant, and gender issues, there is a discussion about bodies considered worthy of appearance. Thus, thinking about the representation that the soap opera "Vale Tudo" makes of a poor woman, with an undervalued profession (day laborer), and who has problems in being able to access basic rights, such as the pension, breaks hegemonic patterns and raises current debates.

In line with the fact that collective acts are political performances that claim visibility and recognition for marginalized bodies (BUTLER, 2018), the soap opera as a cultural object of broad (collective) reach, by bringing certain thematic and body approaches, becomes a space for performances that can bring visibility and recognition to certain groups in society. With this, the relevance of the approach to child support by the soap opera "Vale Tudo" is highlighted as a way to connect vulnerable people within this theme, who can learn together and achieve rights.

Thus, in order to better understand how the theme of alimony was addressed by the soap opera, and how it had repercussions in the media, the methodological paths pertinent to the intended analysis, and the possible social discussions provided, will be dealt with below.

3 METHODOLOGY

3.1 FRAMING AND EMANCIPATED SPECTATOR

To assist in the process of understanding the positions of the soap opera "Vale Tudo", 2025, on the subject of alimony, as well as the news portals on the repercussions of the subject, the framing approach is appropriate.

Gregory Bateson developed, in the field of psychology, the notion of framing to understand some pathologies, and established that every framing is metacommunicative and allows the identification of ways of interpreting and organizing experiences and messages. Erving Goffman expanded the idea of framing, placing it as a way to guide the perception that individuals have about the world, having the possibility of answering the question "what is happening here?". Thus, it establishes the concept of frame as referring to the principles of

organization of social frameworks and participation of individuals in them, and proposes that the framework guides the positioning of subjects, "*footing*" (MENDONÇA, SIMÕES, 2012).

In the case of the analysis of the approach of the soap opera "Vale Tudo" on the subject of alimony, and the journalistic coverage made by the online portals G1, Correio Braziliense and O Tempo on the repercussions of the soap opera, the framing aspect of the analysis of the interactive situation will be adopted. Such a conception helps to understand the relationship between the way in which the process of describing the situation places it in certain perspectives, and creates certain interpretative keys, frames of meaning (MENDONÇA, SIMÕES, 2012).

With this, the framings allow us to investigate the perspective/framework in which a certain content is presented. This perspective is productive for the analysis of televisual objects, such as soap operas, in view of the need for a more critical view of the transmitted contents.

In order to support the analysis of the framings, the notion of emancipated spectator, developed by Rancière (2009), will also be taken as a basis. From the author's perspective, the spectator is not merely passive, and seeing, knowing and acting are interconnected, so that the spectator can be active and also the holder of knowledge.

Thus, political artistic practices invite the spectator to appropriate knowledge from their own knowledge and experiences. In the approximation and breaking of hierarchies between the objects of knowledge and the public, it is possible to have emancipation and transformation from what is learned.

From this perspective, the forms of representation and framing proposed by the soap opera can lead the viewer to varied paths. Considering the topic of social *merchandising* present in the plots, the emancipation of the spectator can occur through the identification of a portrayed reality, or with the criticality raised about a certain current subject. With this idea, this article seeks to understand, to a certain extent, how the public appropriated the issue of alimony.

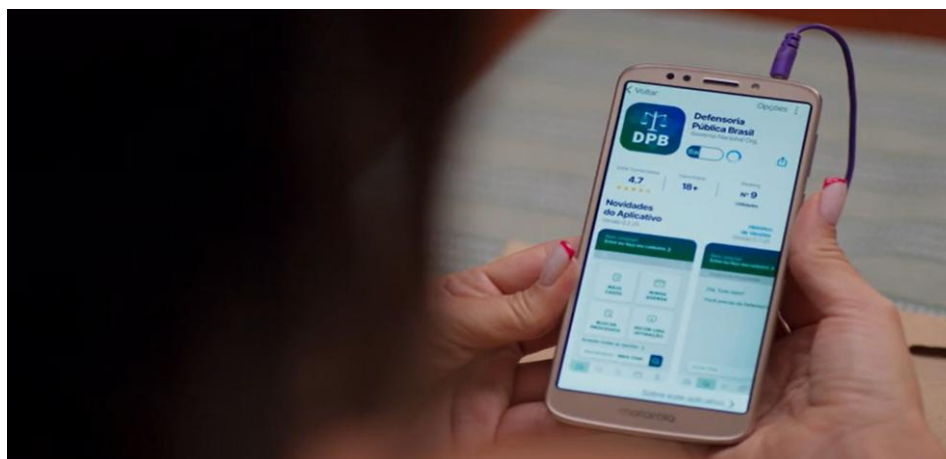
3.2 FRAMEWORKS ON CHILD SUPPORT IN THE SOAP OPERA "VALE TUDO" (2025) AND IN NEWS PORTALS

The scene of the request for child support by the character Lucimar, in "Vale Tudo", 2025, aired in the episode of May 13, 2025, and lasted less than 4 minutes (41'00" to 43'54"). After eight years, Lucimar decides to apply for child support for Jorginho, and turns to her friend Daniela. The scene is quick, but presents the path to be followed in the Public Defender's Office application to start the action.

Lucimar goes to Daniela's house, and is instructed to download the Public Defender's Office application. The process is quick, and soon she opens the app and starts reading the guidelines.

Figure 1

Lucimar downloads the Public Defender's Office application on her cell phone



Source: Frame from the soap opera "Vale Tudo", 2025. (Chapter 13/05/2025, scene 42' 30").

In the scene, all the initial screens of the application are shown to the public, so that it is possible to read the content and see how the procedure begins.

Figure 2

Lucimar has Daniela's help to carry out the initial procedures of the pension request



Source: Frame from the soap opera "Vale Tudo", 2025. (Chapter 13/05/2025, scene 42' 47").

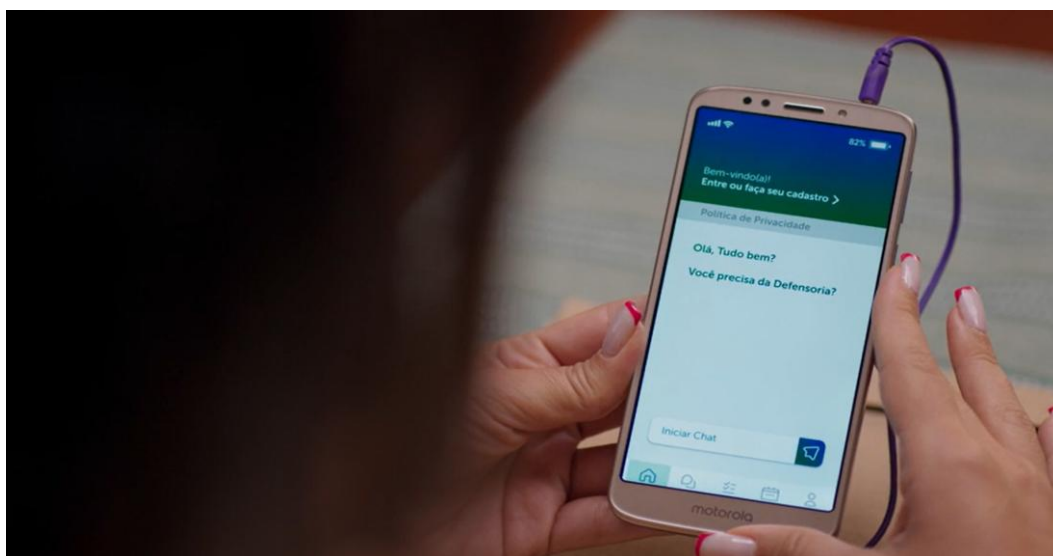
After entering the Public Defender's Office application, Lucimar says that after eight years, she will finally take her ex-husband to court. Daniela corrects this statement, and says that it is not a process of putting the ex in court, but of formalizing the custody of the child.

Lucimar reflects that this description is better, as it doesn't seem like she's ending her ex-husband's life.

Such a picture created by the soap opera brings the pedagogical and critical sense to the public about the patriarchal values of society. This moment of reflection on the meaning given to the request for alimony places it as a right, not as part of a process of revenge against the ex-partner. In this way, the process of the woman, in these cases, being considered the executioner of the ex-husband, a reason that leads to the perpetuation of patrimonial violence and female overload in the care of children, in addition to leading to the withdrawal, or lack of encouragement to file the request for alimony.

Figure 3

Home page of the Public Defender's Office application

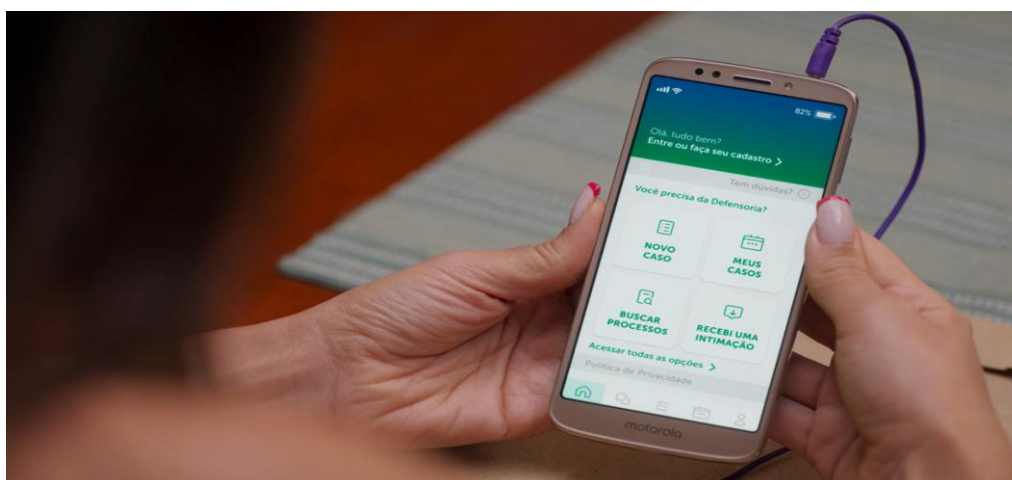


Source: Frame from the soap opera "Vale Tudo", 2025. (Chapter 13/05/2025, scene 42' 52").

Lucimar remains in the app, and reads the initial messages that appear: "do you have questions?", then "privacy policy". She responds to the information she reads in an ironic way, showing that she is a little nervous. Daniela tells her not to worry, because the app is easy to understand and she will be able to place the order. In this context, possible points of identification with the public are passed: being a layman and being nervous or insecure to make the request does not prevent the action from being carried out. The procedure is placed as simple, and easily accessible to everyone.

Figure 4

How to start service from the Public Defender's Office application

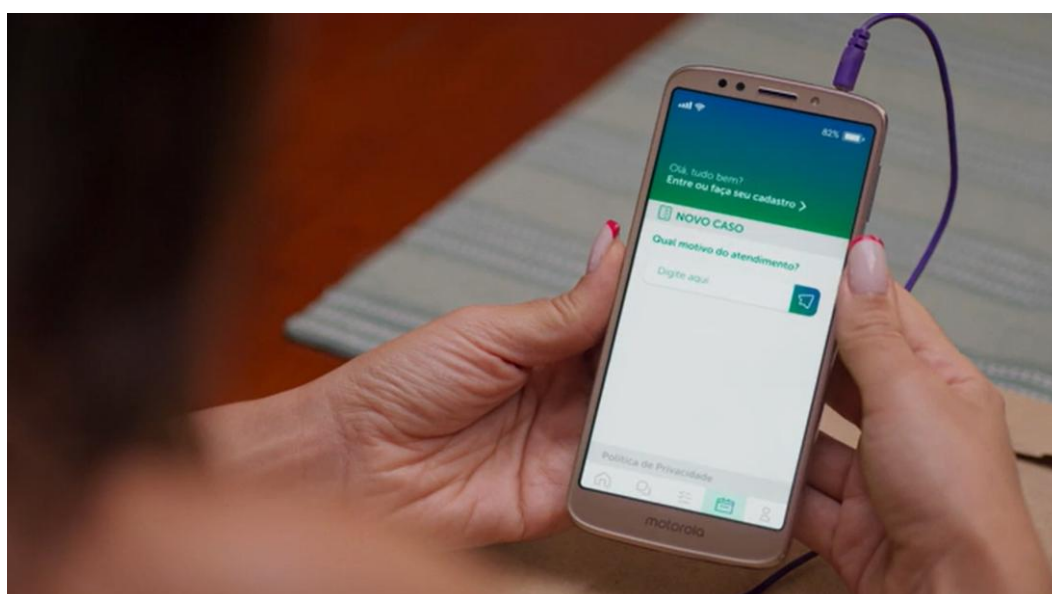


Source: Frame from the soap opera "Vale Tudo", 2025. (Chapter 13/05/2025, scene 43' 02").

Finally, Lucimar starts a "new application" in the application, and searches for "alimony".

Figure 5

How to search for the type of service in the Public Defender's Office application



Source: Frame from the soap opera "Vale Tudo", 2025. (Chapter 13/05/2025, scene 43' 20").

Daniela explains to Lucimar that at this first moment, the application is made online, with the submission of documents. Afterwards, she and Vasco will be called for a conversation.

Thus, the soap opera places the request for child support as a simple and practical procedure, available for access by anyone interested. From this picture of meaning passed by the plot, the repercussion of the scene in the public was immediate, generating an increase

in requests for child support by women throughout Brazil. The case gained notoriety on social networks, with a manifestation of the actress who played the character Lucimar, and was also reported in several media outlets, gaining a bias that goes beyond the field of mere entertainment, but dialoguing with the citizenry.

To understand how the media framed the repercussion of the soap opera "Vale Tudo" in relation to the chapter in which the request for child support is addressed, the online news portals G1 were selected, as it belongs to Grupo Globo, from the same broadcaster that produced the soap opera, in order to understand how the broadcaster wanted to reflect on the issue; *Correio Braziliense*, with national circulation, and *O Tempo*, with Minas Gerais circulation, to verify a possible geographical cut for dealing with the subject.

On May 20, seven days after the episode in question aired, the G1 portal published an article in the "Pop e Arte" column, with the following headline: "Scene from 'Vale Tudo' raises requests for child support; see step by step how to ask". The title itself suggests, on the one hand, the promotion of the soap opera, and on the other, the continuity of the pedagogical tone on the theme.

The article highlights data from the Public Defender's Office of Rio de Janeiro, which shows an increase in the number of accesses to the agency's application after the exhibition of the scene in which the character Lucimar learns and teaches the public how to access the system and make the initial procedures for the request for child support. Below, the concept of alimony, who is entitled to it, how it is for the specific case of children of divorced parents, and how the request is made, highlighting the necessary documents, are addressed. The article uses arguments of authority, with a video in which a lawyer explains how to apply for alimony, and an explanation by the Deputy Public Defender General, Emmanuela Saboya, saying that the alimony meets general demands for the upbringing and subsistence of children.

In this way, the article on the G1 portal implicitly emphasizes the power of the soap opera "Vale Tudo" in dealing with the issue of alimony, and continues the pedagogical focus, teaching the public about the right to alimony and how to achieve it. The intention went further, with a special program of *Profissão Repórter* to address the subject, bringing the soap opera as a backdrop to deal with the public's identification with the theme, marking a position of commitment to the promotion of citizenship before the audience.

The portal of the newspaper *O Tempo*, in turn, brought, on May 28, the headline "Scene from the soap opera 'Vale Tudo' raises requests for child support and ignites debate". From a brief context of the soap opera, the article features a video about child support, and broadly addresses the context of Minas Gerais, with the position of the Public Defender's

Office of Minas Gerais on the number of pension requests in the state, and the fact that there is still no application in the region. The focus also falls on the discussion of what alimony is, teaching the procedures for the request, and emphasizing, based on authoritative arguments from legal and psychology professionals, the obstacles for women throughout Brazil to claim the right. Finally, they highlight the impacts of soap operas and art on the public, with high potential to transform reality.

In addition to bringing the discussion closer regionally, the portal of the newspaper O Tempo also dialogues with the pedagogical bias, and uses a guiding discourse to the public, highlighting the social implications of the issue of child support, acting in an awareness-raising tone that ranges from the importance of the soap opera for society, to the need for people to seek their rights.

Finally, Correio Braziliense presents, on May 17, 2025, the headline "Ingrid Gaigher: Lucimar from 'Vale Tudo' inspires 270 thousand women in one hour". In a milder tone, the article contextualizes the soap opera and the repercussion of the case in the Public Defender's Office, but mainly contemplates the career of the actress who plays the character Lucimar, and her positions on the effects of the soap opera. In this case, there is no pedagogical tone, as the article does not explain what alimony is, nor does it teach the public how to use the law.

Thus, Correio Braziliense frames the issue in a subtle way as it highlights the career of actress Ingrid Gaigher and the success she achieved with the scene of the soap opera "Vale Tudo", but without problematizing the issue of child support socially. The debate on citizenship is little worked on, since the greatest support of the text in this sense is the approach to the numbers of the Public Defender's Office, which sounds more like curiosity than a way of understanding a communicative phenomenon with effects on practical life. Despite being emptied of critical engagement, the article still reflects on the soap opera as a vehicle, albeit indirect, for promoting social discussions.

Consequently, in the exchange between the soap opera and the public, and also with the appropriation of the repercussions of this relationship by journalistic vehicles, there is the dimension of the emancipation of the public. As evidenced by the increase in requests for alimony after the screening of the scene starring Lucimar, there were concrete effects of the content of the soap opera "Vale Tudo" on the viewers, who appropriated the theme in question in an emancipatory way.

In addition, Lucimar's representation highlights a body and a reality that are not in the hegemonic sphere, bringing representation to marginalized groups, which also highlights

current emerging discussions, such as the position of women in society and gender inequalities.

As expressed by the media coverage, the social *merchandising* made by "Vale Tudo" about alimony generated great repercussion in the viewers, highlighting the power of teledramaturgy in engaging with social issues, with direct effects on the lives of the affected subjects.

3.3 CITIZEN REFLECTIONS

From the scene of the request for child support via the Public Defender's Office application, the disclosure not only of a right, but also of a government strategy for the alleged improvement in access to services by citizens, which is the issue of digital governance, is also highlighted. In recent decades, there has been an exponential growth of information technologies, and consequent implementation in everyday life. What once seemed remote, today constitutes the basis of various human activities, so that contemporary society lives a true relationship of symbiosis with digital devices.

Over the years, in addition to permeating private and economic relations, technological solutions have also advanced towards public administration, allowing the debureaucratization of various State processes. According to Albuquerque and Costa (2025), the advancement of Information and Communication Technologies (ICT) has given rise to a new form of governance, called electronic government, which allows online access to public information, as well as to various government services.

For Jardim (2000), electronic government (e-Gov) is a resource through which the State uses technology to offer society better access to information and government services, so that it raises the quality of the activities it develops, while increasing social participation in democratic processes.

In relation to the Brazilian government, ICTs have been present since the beginning of the new century, always aiming at simplifying actions, improving service to the public and efficiency in the use of collective resources. On its own page, the Ministry of Management and Innovation in Public Services outlines the timeline that demonstrates how the State transitioned from electronic to digital in the period between the years 2000 and 2022.

As mentioned, since the 2000s, various services of the State have been offered from digital supports, and under the focus of the present work, those provided by the Public Defender's Office stand out, an institution that aims to guarantee free legal assistance and defense to people who do not have the resources to pay for the expenses of a lawyer.

It so happens that Brazil is a country crossed by multiple inequalities, so that there is

a real paradox between the expansion of the availability of public services through digital means, and the real access to such activities by the Brazilian citizen, who faces physical/material barriers, as well as impediments related to digital literacy. In this sense, Cavalcante, Ota and Oliveira (2024) converge, when relating public ethics to the digital governance system: "... The digital divide is not just an infrastructure problem. It also manifests itself in the absence of digital skills to use tools in a meaningful way." Thus, it is possible to conclude that one of the biggest challenges of e-Gov in the country goes beyond the implementation barrier, reaching the aspect of de facto democratic access.

Thus, it is important to highlight the May 13, 2025 chapter of the soap opera "Vale Tudo", particularly the scene where the character Lucimar requests child support for her son (41'00" to 43'54"). In the scene, Lucimar details the step-by-step process to apply for alimony through the Public Defender's Office application, making the entire procedure not only didactic, but also emptying viewers of possible fears about the meaning of the action.

For the reasons explained and considering the reach and repercussion of the work in Brazilian society, the scene that lasted just under 4 minutes ended up contributing to the democratization of access to the Public Defender's Office service, as well demonstrated by the numerous reports of the time that pointed to the growth in demand for child support services in several capitals of Brazil, Just after the exhibition of the plot in prime time on Brazilian television.

Therefore, what seemed to be an isolated scene of a popular cultural production in the country, proved to be a strong driver of awareness and social mobilization. Thus, the serial ended up settling, albeit in isolation, a scenario of exclusion, where due to lack of basic information, the citizen stops using public resources, even those already available digitally (which in theory mean greater autonomy and better access for the citizen).

In its own way, the May 13, 2025 chapter of the soap opera "Vale Tudo", reinforced the objectives and importance of e-Gov in Brazil, expanding social knowledge and, consequently, popular interest in its use.

4 CONCLUSION

The present work sought to show how soap operas can play an emancipatory role in viewers from the social impacts it can generate. In this sense, the approach to child support in the soap opera "Vale Tudo" (2025) confirmed this power, given that it led thousands of women in Brazil to apply for child support after the exhibition of the chapter in which the character Lucimar claims this right for her child.

By incorporating *social merchandising* as a narrative tool, the soap opera contributed to making visible an urgent social demand, enabling the public to identify with the character Lucimar and promoting awareness about rights that are often neglected. According to the notion of the emancipated spectator, developed by Jacques Rancière (2009), it is perceived that the spectators not only passively watched the soap opera, but acted from it, mobilizing knowledge, experiences and practices to transform part of the reality in which they are inserted.

In addition, the framing triggered by the soap opera "Vale Tudo" and by the online news portals G1, O Tempo and Correio Braziliense show, for the most part, the pedagogical bias when dealing with the issue of child support. Thus, different reflections are raised on the issue, which in line with the experiences and expectations of the spectators lead to repercussions such as those generated by the soap opera analyzed.

It is important to note that the scene of the request for child support via the Public Defender's Office application is also relevant for highlighting the issue of Digital Governance, a state management strategy that in general aims to improve access to services by citizens.

Finally, the work points to the relevance of teledramaturgy as a space for the construction and dissemination of representations and knowledge, and as a privileged vehicle for the promotion of representativeness and citizenship.

REFERENCES

- Albuquerque, M. R. de, & Costa, L. (2025). Transformação digital no setor público: tendências e implicações. *Revista de Gestão e Secretariado*, 16(3), e4771. <https://doi.org/10.7769/gesec.v16i3.4771>
- Brasil. (2019). Governo digital: do eletrônico ao digital. Brasília: Governo Federal. Disponível em: <https://www.gov.br/governodigital/pt-br/estrategia-de-governanca-digital/do-eletronico-ao-digital>
- Butler, J. (2018). *Corpos em aliança e a política das ruas*. Rio de Janeiro: Civilização Brasileira.
- Cavalcante, A. F., Ota, K. da C., & Oliveira, V. J. de. (2024). Governança digital e ética pública: construindo confiança em um mundo de algoritmos. *Revista Políticas Públicas & Cidades*, 13(2), e1445. <https://doi.org/10.23900/2359-1552v13n2-392-2024>
- Green, J. (2010). *The eyes of the people* (Cap. 2). New York: OUP.
- Goffman, E. (2012). *Os quadros da experiência social*. Petrópolis: Vozes.
- G1. (2025, maio 20). *Cena de Vale Tudo faz subir pedidos de pensão alimentícia; veja passo a passo de como pedir*. Disponível em: <https://g1.globo.com/pop-arte/noticia/2025/05/20/cena-de-vale-tudo-faz-subir-pedidos-de-pensao-alimenticia-veja-passo-a-passo-de-como-pedir.ghtml>

- G1. (2025, junho 12). Cena de Vale Tudo faz disparar buscas por pedidos de pensão alimentícia no aplicativo da Defensoria; entenda. Disponível em: <https://g1.globo.com/profissao-reporter/noticia/2025/06/12/cena-de-vale-tudo-faz-disparar-buscas-por-pedidos-de-pensao-alimenticia-no-aplicativo-da-defensoria-entenda.ghtml>
- Jardim, J. M. (2000). Capacidade governativa, informação e governo eletrônico. DataGramaZero – Revista de Ciência da Informação, 1(5). Disponível em: <https://share.google/5KZ1Oo0GF80CaLYRY>
- Lopes, M. I. V. de. (2014). Memória e identidade na telenovela brasileira. In Anais do 23º Encontro Anual da Compós. Campinas: Galoá. Disponível em: <https://proceedings.science/compos/compos-2014/trabalhos/memoria-e-identidade-na-telenovela-brasileira?lang=pt-br>
- Martins, L. M. (2021). Performances do tempo espiralar, poéticas do corpo-tela. Editora Cobogó.
- Mendonça, R., & Simões, P. G. (2012). Enquadramento: diferentes operacionalizações analíticas de um conceito. Revista Brasileira de Ciências Sociais, 27, 187–201.
- O Tempo. (2025, maio 28). Cena da novela Vale Tudo eleva pedidos por pensão alimentícia e acende debate. Disponível em: <https://www.otempo.com.br/interessa/2025/5/28/cena-da-novela-vale-tudo-eleva-pedidos-por-pensao-alimenticia-e-acende-debate>
- Rancière, J. (2009). O espectador emancipado. London: Espectador Emancipado.
- Selvatti, P. (2025, maio 17). Ingrid Gaigher: Lucimar de “Vale tudo” inspira 270 mil mulheres em uma hora. Correio Braziliense. Disponível em: <https://www.correiobraziliense.com.br/diversao-e-arte/2025/05/7147951-ingrid-gaigher-lucimar-de-vale-tudo-inspira-270-mil-mulheres-em-uma-hora.html>
- Sodré, M. (2006). As estratégias sensíveis: afeto, mídia e política. Mauad.
- Sodré, M. (2009). Antropológica do espelho: uma teoria da comunicação linear e em rede. Petrópolis (RJ): Vozes.
- Vale tudo. (1988–1989). Novela de Gilberto Braga, Aguinaldo Silva e Leonor Bassères. Direção: Dennis Carvalho e Paulo Ubiratan. Produção: TV Globo.
- Vale tudo. (2025). Novela de Manuela Dias. Direção artística: Paulo Silvestrini. Produção: TV Globo.

CONFLICT, MIMETIC RIVALRY AND NONVIOLENCE: FRIENDSHIP AS AN ETHICAL HORIZON OF COEXISTENCE

CONFLITO, RIVALIDADE MIMÉTICA E NÃO VIOLÊNCIA: A AMIZADE COMO HORIZONTE ÉTICO DA CONVIVÊNCIA

CONFLICTO, RIVALIDAD MIMÉTICA Y NO VIOLENCIA: LA AMISTAD COMO HORIZONTE ÉTICO DE LA CONVIVENCIA



<https://doi.org/10.56238/sevened2026.008-226>

Antonio Coêlho Soares Junior¹, Joaquim Ribeiro de Souza Junior², Mariana Maria Pereira³

ABSTRACT

This article examines, from a philosophical perspective, the status of conflict in human relations and investigates to what extent nonviolence can interrupt the mimetic logic that turns difference into hostility. It begins from the hypothesis that conflict belongs to the relational condition of the human being and therefore cannot simply be eliminated from social life. The problem emerges when conflict is captured by violent reciprocity and rivalry, producing forms of enmity that degrade the bond with the other. Based on bibliographical research with a qualitative and theoretical-conceptual approach, the text brings into dialogue Jean-Marie Muller, René Girard, Georg Simmel, Zygmunt Bauman, Norberto Bobbio, José Maria da Silva Rosa, and Leo Tolstoy. It argues that nonviolence does not mean passivity, but an ethical practice of resisting violence without reproducing it. The article concludes that friendship may be understood as an ethical horizon of coexistence, since it allows one to think relations shaped by responsibility, recognition, and the refusal of revenge.

Keywords: Conflict. Imitative Desire. Nonviolence. Peace. Relational Ethics. Responsibility.

RESUMO

Este artigo examina, em perspectiva filosófica, o estatuto do conflito nas relações humanas e investiga em que medida a não violência pode interromper a lógica mimética que converte diferença em hostilidade. Parte-se da hipótese de que o conflito integra a condição relacional do ser humano e, por isso, não pode ser simplesmente eliminado da vida social. O problema surge quando ele é capturado pela reciprocidade violenta e pela rivalidade, produzindo formas de inimizade que degradam o vínculo com o outro. Com base em pesquisa bibliográfica, de abordagem qualitativa e caráter teórico-conceitual, o texto articula contribuições de Jean-Marie Muller, René Girard, Georg Simmel, Zygmunt Bauman,

¹ Dr. in Law. Università degli Studi Roma Tre. E-mail: antonio.coelho@ufma.br

Orcid: <https://orcid.org/my-orcid?orcid=0000-0003-3408-9915> Lattes: <http://lattes.cnpq.br/9061637440474333>

² Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).

E-mail: joaquimjunior33@gmail.com Orcid: <https://orcid.org/0000-0003-3488-5508>

Lattes: <https://lattes.cnpq.br/3574109956957619>

³ Postgraduate in Civil and Civil Procedural Law. Legale Educacional. E-mail: mariana.mariap98@gmail.com

Lattes: <https://lattes.cnpq.br/594350504279284>

Norberto Bobbio, José Maria da Silva Rosa e Liev Tolstói. Sustenta-se que a não violência não significa passividade, mas uma prática ética de resistência à violência sem sua reprodução. Conclui-se que a amizade pode ser compreendida como horizonte ético da convivência, na medida em que permite pensar relações marcadas por responsabilidade, reconhecimento e recusa da vingança.

Palavras-chave: Amizade. Conflito. Ética Relacional. Mimese. Não Violência.

RESUMEN

Este artículo analiza, desde una perspectiva filosófica, el estatuto del conflicto en las relaciones humanas e investiga en qué medida la no violencia puede interrumpir la lógica mimética que transforma la diferencia en hostilidad. Se parte de la hipótesis de que el conflicto forma parte de la condición relacional del ser humano y, por lo tanto, no puede ser simplemente eliminado de la vida social, aunque pueda ser orientado de manera no violenta. Mediante una investigación bibliográfica de enfoque cualitativo y carácter teórico-conceptual, el texto examina cómo la dinámica del deseo imitativo y de la reciprocidad hostil contribuye a la formación de rivalidades, así como a la estabilización de formas de enemistad que degradan el vínculo con el otro. Sobre esta base, se argumenta que la no violencia no equivale a pasividad, sino que constituye una práctica ética y racional de resistencia a la violencia que se niega a reproducirla. El estudio propone, finalmente, comprender la amistad como un horizonte ético de convivencia, capaz de preservar el disenso sin convertir al otro en enemigo y de ofrecer un marco normativo orientado por la responsabilidad y el reconocimiento mutuo.

Palabras clave: Convivencia. Deseo Imitativo. Ética Relacional. Paz. Responsabilidad.

1 INTRODUCTION

Human existence takes place within social relations. As a relational being, the individual is constituted in the interaction with others, in bonds that both enable cooperation and recognition and produce tensions, disputes and antagonisms. From this perspective, conflict should not be understood as an accidental element of life in society, but as a constitutive dimension of human experience and of the dynamics of society itself.

Based on this assumption, this article investigates, in a philosophical key, how conflict, although inherent to interpersonal relationships, can be conducted without becoming violence. The central hypothesis is that violence does not stem from conflict as such, but from the capture of conflict by mimetic rivalry and hostile reciprocity.

On the other hand, it is argued that nonviolence constitutes a rational and ethical practice of interrupting this circuit, making friendship thinkable not as private affection or simple cordiality, but as a normative form of relationship capable of preserving dissent without degrading the other into an enemy.

To develop this hypothesis, the article is structured in three moments. In the first, conflict is examined as a component of social relations, based mainly on the contributions of Jean-Marie Muller and Georg Simmel, highlighting its constitutive character for human coexistence. Then, it is analyzed how conflict can become rivalry and violence when crossed by mimetic desire and reciprocity, in dialogue with René Girard's theory.

Finally, nonviolence is discussed as a practice of resistance to hostility and as a possibility of ethical reorientation of relationships, with friendship as a normative horizon, with the support of Muller, José Maria da Silva Rosa, Leo Tolstoy, Zygmunt Bauman and Norberto Bobbio.

Methodologically, this is a bibliographic research, with a qualitative approach and a theoretical-conceptual character. The analysis articulates contributions from philosophy, social theory, and the anthropology of violence to defend a precise thesis: the decisive philosophical problem is not to eliminate conflict, but to prevent it from stabilizing in the form of violent rivalry. In this framework, friendship ceases to appear as a moral ideal external to the conflict and is understood as an ethical effect of the refusal of bad reciprocity.

2 RIVALRY

2.1 IN THE BEGINNING, THE CONFLICT

In Jean-Marie Muller's studies on violence and non-violence, the human condition is understood from the point of view of the relationship. The individual is not self-sufficient: he is formed in the encounter with other people, in experiences of proximity, dependence,

divergence and cooperation. For this reason, coexistence is not a peripheral datum of existence, but the space in which humanity itself is concretized.

It is precisely in this relational terrain that the conflict appears. The presence of the other can arouse adherence, but also friction, dispute and resistance. Competing interests, incompatible expectations, and divergent projects make conflict a recurrent feature of collective life, which is why Muller treats it as a structural element of human relations, and not as an occasional anomaly.

The reading of Georg Simmel reinforces this understanding by associating society with the intertwining of reciprocal interactions. For the sociologist, the social emerges both from movements of approximation and from impulses of opposition; collaboration, competition, agreement and antagonism coexist in the same relational fabric. Society, therefore, is not formed in spite of these tensions, but also through them:

Just as the universe needs 'love and hate', that is, forces of attraction and forces of repulsion, in order to have any form, so society, in order to achieve a certain configuration, needs proportional amounts of harmony and disharmony, association and competition, favorable and unfavorable tendencies (SIMMEL, 1983, p. 124).

The successive actions and reactions between individuals shape the concrete form of social life. The way in which subjects intervene in each other — whether in the key of defense, attack, cooperation, competition or search for prestige — conditions the type of bond that is established. From this point of view, society is not the result of homogeneous relations, but of varied compositions, often crossed by tensions:

Society exists wherever various individuals interact. [...] make man find himself in a state of coexistence with other men, with actions in favor of them, together with them, against them, in correlation of circumstances with them (SIMMEL, 1983, p. 59).

In Simmel, conflict is not just a symptom of rupture; it can also operate as a modality of sociation. This ambivalence prevents treating it as an exclusively negative reality. At the same time that it expresses dissociation, conflict is part of the field of interpersonal relationships and participates in social cohesion itself, albeit in a paradoxical way.

This formulation makes it clearer that human coexistence includes clashes between individual purposes. When desires, pretensions and interests collide, a dispute is established in which each agent starts to directly affect the other. It is at this moment that reciprocity thickens and the conflict ceases to be a simple divergence to take the form of relational opposition.

Among the factors that intensify this dynamic, desire occupies a decisive position. When the relationship is crossed by impulses of appropriation and comparison, the conflict can degenerate into rivalry, inaugurating a circuit of hostility. It is at this point that René Girard's reflection becomes central to understanding the passage from dissent to violent antagonism.

2.2 RECIPROCITY AND VIOLENCE: THE PERPETUAL DOUBLE IMITATION

Girard starts from the idea that human desire is neither spontaneous nor entirely autonomous. It is desired from a mediator, from a model whose will begins to guide the will of the subject. Mimicry, in this sense, is not a simple external imitation of behavior, but a deep structure of desire, and it is precisely for this reason that rivalry always becomes possible:

Man desires intensely, but he does not know exactly what, for it is the being he desires, a being of which he feels deprived and of which some other seems to him to be endowed. The subject expects this other to tell him what it is necessary to desire in order to acquire this being. [...] it is through its own desire that the model assigns to the subject the supremely desirable object (GIRARD, 1990, p. 184).

The mimetic model can be an admired person, a social group or any reference invested with prestige. Without this mediation, desire does not acquire precise direction. The problem arises when the same figure who guides the aspiration starts to block his satisfaction, becoming a reference into an obstacle and, later, a rival.

By stating that society transforms into a model what it honors, Girard draws attention to the heteronomous character of desire. The subject believes he desires freely, but his will is crossed by socially shared values and hierarchies. In this logic, the object matters less for its intrinsic qualities than for the value conferred by others.

When two wills converge mimetically, interpersonal conflict gains intensity. The other ceases to be just a distinct presence and starts to represent concrete resistance to the subject's project. Opposition, then, is no longer limited to the plane of ideas: it affects the very constitution of the relation.

Envy plays a decisive role in this process. The good possessed by the other comes to be perceived as a sign of one's own lack, and greed shifts the object's attention to the position occupied by the rival. Desire, therefore, takes on a competitive form and feeds new possibilities of conflict.

It is not only the disputed object that gives rise to rivalry. What ignites the antagonism is the fact that he has been invested with value by the other. The rival becomes an obstacle

precisely because he confirms, with his own desire, the importance of what he intends to achieve.

In the mimetic climb, imitator and model enter into reciprocal mirroring. Each one starts to react to the other, and the initial convergence of desires becomes a mutual barrier. At this stage, the relationship becomes autonomous in relation to the object and tends to revolve around the opposition itself:

Imitation reappears from the one who strives to deny it. When one of the two partners drops the torch of mimicry, in short, the other takes it not to renew the bond that is being broken, but to finish the rupture by reduplicating it mimetically (GIRARD, 2012, p. 55).

In a similar key, Hobbes identifies competition as one of the sources of human conflict. The search for goods, security and recognition produces distrust and confrontation, especially when agents perceive themselves to be threatened in their interests. The result can be open enmity and a willingness to war.

When this occurs, the adversaries progressively stop aiming at the object in dispute and concentrate on each other. The rival becomes the true center of the relationship, and mimesis no longer organizes only desire, but also violence itself. The opposition is fueled by an increasingly hostile reciprocity:

It is imagined that at first there is the object, then the desires that converge independently to this object, and finally violence, a fortuitous, accidental consequence of this convergence. [...] Violence becomes more and more manifest: it is no longer the intrinsic value of the object that provokes conflict, exciting rival greed, but it is violence itself that values the objects, inventing pretexts to unleash itself more easily (GIRARD, 1990, p. 182).

The mimetic theory thus allows us to locate the genesis of violence in the relational dynamics of desire. Violence does not appear as an accident external to the human bond, but as a possible unfolding of competitive imitation, when reciprocity closes in on itself and transforms the other into a threat.

Poor reciprocity translates precisely this passage. Small gestures of hostility can trigger equivalent responses, establishing a logic of aggressive mirroring. As the boundary between ordinary interaction and violent escalation is narrow, conflict can be quickly contaminated by the reproduction of aggression.

It is in this horizon that Girard mobilizes the anthropological sense of scandal as an obstacle and trap. Scandal fixes the subject on the rival, captures his attention and imprisons him in the mimetic relationship. Instead of dissolving conflict, it intensifies and reproduces it.

The reading of João Cezar de Castro Rocha helps to make this mechanism explicit by showing that the scandalous hurts the other precisely because he exhibits success, superiority or prestige. Provocation does not only act on the moral plane; it reorganizes the perception of the subject and reinforces the centrality of the rival in the economy of desire.

When society naturalizes counterviolence as a legitimate response, it becomes more difficult to perceive how much this reaction only renews the destructive spiral. The social legitimization of retaliation conceals the mimetic character of violence and contributes to perpetuating it.

If conflict structurally accompanies life in common, the decisive question is to prevent it from becoming the predominant form of bond. Recognizing its inevitability is not equivalent to naturalizing violence. On the contrary: precisely because conflict is constitutive, it becomes philosophically necessary to distinguish between opposition, rivalry and destruction, so that common life is not organized under the empire of counterviolence.

Therefore, the peaceful relationship does not depend on the elimination of the other as a potential adversary, but on the effort not to turn him into an enemy. In the face of opposition, the ethical requirement is to contain hostility and reject the logic of fear, threat and revenge.

Girard's contribution, at this point, is to demonstrate that rivalry is not born only from objective differences of interest, but from the way in which subjects learn to desire one from the other. By revealing the imitative dimension of conflict, his theory helps to understand why violence can spread so quickly in human relationships.

3 NONVIOLENCE

Moved by desire and inscribed in mimetic relationships, human beings can become antagonists of one another. The similarity of claims and interests, far from ensuring harmony, often intensifies competition. It is in this context that it becomes necessary to think about how conflict can be faced without reproducing violence.

For Jean-Marie Muller, an effectively human coexistence is not achieved only by abstract tolerance of differences. It requires ethical work on one's own relationship, including the tendency to look to the other for a competitive mirror. Nonviolence is born, in this context, as a practice of rupture with hostile reciprocity.

Human coexistence may aspire to peace, but it is still conflictive. Muller's observation is decisive because it dispels two symmetrical illusions: that it would be possible to abolish conflict and that all tension inevitably leads to violence. Between these extremes, nonviolence presents itself as a way of governing dissent.

When the subject responds to aggression by reproducing it, he prolongs the violence suffered and helps to stabilize his circuit. The retaliatory gesture, even when it presents itself as a justified reaction, re-inscribes the individual in the same logic that it intends to combat and amplifies the imbalance of the relationship:

Any violence is a process of homicide, of annihilation. Perhaps the process will not go all the way, but the desire to eliminate the adversary, to drive him away, to exclude him, to reduce him to silence, to suppress him, will become stronger than the will to come to terms with him. From insult to humiliation, from torture to homicide, there are multiple forms of violence and multiple forms of death (MULLER, 2007, p. 30).

René Girard states that "the violence of the nonviolent, which we all believe to be, is never the work of particularly 'aggressive' individuals, nor is it the result of an instinct of aggression"; it is rather the desire to return the violence of the other, the desire to avenge the hostile attitude of another. The French author also points out that even the most violent beings believe that they are only returning a violent action, or reacting to the violence of another person (GIRARD, 2012, p. 54).

From this perspective, Muller distinguishes between aggressiveness and violence. Aggressiveness corresponds to an energy of affirmation and resistance that is characteristic of the human condition; Violence, on the contrary, consists in its destructive deformation. Nonviolence does not suppress the power of action, but seeks to orient it towards forms of confrontation that do not annihilate the other:

Passivity is a much more widespread attitude than violence. Men's capacity for resignation is considerably greater than their capacity for revolt. [...] it is necessary to point out that nonviolence is in greater opposition to passivity and resignation than to violence (MULLER, 2007, p. 23).

Therefore, conflict can take on a constructive or destructive aspect. Nonviolent practice presupposes a willingness to face tension, and not to run away from it. Being nonviolent is not equivalent to submitting to the power of the adversary, but to sustaining the firmness of the confrontation without adhering to its violent grammar.

In Muller, nonviolence also appears as a rational choice and an exercise in self-control. Interrupting the chain of violence requires self-examination, containment of the impulses of revenge and awareness of the way in which the subject can become an agent of propagation of the evil he denounces.

Hence the importance of limiting one's own desires. By recognizing that rivalry feeds on the unlimited expansion of individual pretensions, the subject makes room for another

relational economy, less oriented by dispute and more attentive to the ethical effects of his actions on others.

José Maria da Silva Rosa, when addressing non-violence as a horizon of coexistence, also emphasizes the need to refuse violence as the ordinary language of human relations. For the author, peace does not result from the mere absence of confrontation, but from the construction of modes of bonding capable of interrupting violent excess:

José Maria da Silva Rosa argues, in similar terms, that the urgency of nonviolence stems less from its abstract value as an ideal than from the constant, manifest or latent presence of forms of violence that cross human coexistence and feed the temptation to respond to evil through the logic of retaliation (ROSA, 2001, p. 12).

Breaking bad reciprocity implies, therefore, disobeying the call for violence. It is a matter of cutting the imitative chain before it becomes contagious, refusing to return the aggression received to the other. This refusal does not eliminate the conflict, but modifies its trajectory.

When the individual decides not to reproduce the violence of his rival, he prevents the cruelty of others from fully determining his own conduct. The refusal of violent imitation thus functions as a gesture of ethical freedom and as a condition for reconfiguring the relationship:

The strategy of nonviolent action aims to break the mimicry by which each of the two rivals imitates the violence of the other, returning aggression for aggression, fracture for fracture, eye for eye, tooth for tooth. The very principle of nonviolent action consists of refusing to let oneself be carried away by this spiral of endless violence (MULLER, 2007, p. 148).

In *The Kingdom of God Is Within You*, Tolstoy argues that violence cannot be justified even under the argument of self-defense, because the violent response, even when presented as protection, reaffirms the same logic that it intends to condemn. His radical critique reinforces the demand not to return evil in the form of new evil.

Commenting on Gandhi, Muller observes that human truth is realized in the bond with the other and that violence corrupts precisely this bond. For this reason, nonviolent action is not a simple denial of force, but a defense of the relationship in its proper dignity. In this key, resorting to violence means degrading humanity itself. The recovery of the human thus passes through a practice of resistance that preserves the otherness of the other and prevents the conflict from becoming reciprocal annulment.

In commenting on Gandhi, Muller argues that truth, love, and nonviolence should not be thought of as independent values or combinable only occasionally; for him, there is

a deep ethical unity between these terms, incompatible with any attempt to legitimize violence in the name of love or truth (MULLER, 2007, p. 201).

Together, these formulations allow us to understand nonviolence as an active posture of responsibility, self-restraint and recognition. More than an abstract ideal, it operates as an ethical technique for deactivating rivalry: it disallows aggressive symmetry, interrupts the circulation of retaliation, and restores to conflict a regime in which the other can still be faced without being annulled.

4 FRIENDSHIP

When the individual disposes himself for the good of the other, he assumes responsibility for the relationship and starts to act, in Muller's terms, as a true artisan of peace. Friendship, in this context, is not reduced to private affection; it designates a form of ethical presence that sustains and reorients human bonds.

Reading Simmel, Zygmunt Bauman observes that friendship and enmity function as poles of the same relational matrix. Between these extremes, the other forms of social interaction are distributed. The quality of bonds, therefore, depends on the practices by which the subjects build cooperation or nurture antagonism.

If the rivalry exacerbates the conflict and pushes it into the impasse of violence, the decision not to respond to the adversary in the same terms opens up another possibility of relationship. Friendship arises, then, not as naïve sentimentality, but as an ethical orientation contrary to the fabrication of enemies.

Girard helps to perceive the procedural character of this degradation. Relationships do not break down all at once; They deteriorate by small displacements, repeated offenses and symmetrical responses, until no one recognizes himself as responsible for the wear and tear produced.

When the subjects are exempt from being responsible for coexistence, the rivalitarian machinery gains strength. Enmity does not appear spontaneously: it is constructed by practices of confrontation, by dispositions of suspicion and by a pragmatics of struggle that organizes the other as a threat.

In the opposite direction, friendship is produced by a pragmatics of cooperation. It requires responsibility, ethical initiative and care with the bond, without depending on the certainty of equivalent return. Therefore, friendship is less an affective reward than a relational practice:

While the expectation of friendship is not necessary to make friends, the expectation of enmity is indispensable to make enemies. Thus the opposition between friends and enemies is between doing and suffering, between being the subject or object of action. It is an opposition between advancing and retreating, between initiative and vigilance, between dominating and being dominated, between acting and reacting (BAUMAN, 1999, p. 63).

Norberto Bobbio, when reflecting on serenity, also approaches this ethic of nonviolence. Serenity, for him, is not indifference or weakness, but a willingness to refuse revenge and to contain the temptation to respond to evil with another evil.

The serene subject is, in this sense, the one who resists violence without making it an instrument of personal affirmation. Their attitude is not guided by competition or by the need to prevail over the other, but by the preservation of the relationship on non-destructive bases:

The serene is, on the contrary, the one who 'lets the other be what he is', even when the other is the arrogant, the insolent, the arrogant. He does not contact others for the purpose of competing, of creating conflict, and ultimately of winning. It is completely out of the spirit of competition, competition, rivalry, and therefore, also victory (BOBBIO, 2002, p. 40).

Opting for non-violence and cultivating serenity is, therefore, an ethical response to the rivalry and violence that permeate social relations. In the midst of the fragility and instability of contemporary bonds, this choice preserves the possibility of reciprocal recognition. Friendship can thus be understood as a practical horizon of a coexistence in which conflict does not disappear, but ceases to be organized by the logic of hostility.

5 CONCLUSION

The path developed in this article allows us to affirm that conflict belongs to the very fabric of social life and, for this reason, cannot be abolished without also erasing something of the human relational condition. The philosophical task, therefore, does not consist in imagining a frictionless coexistence, but in thinking about the conditions under which dissent can fail to converge towards destruction.

The analysis showed that the critical point of the transition from conflict to violence is found in mimetic rivalry and hostile reciprocity. When the subjects start to desire from the rival and respond to him according to the logic of aggressive mirroring, the other ceases to be an interlocutor or circumstantial adversary and starts to occupy the position of an obstacle to be neutralized. It is in this displacement that the conflict loses its own ambivalence and becomes fixed in the form of violence.

Against this mechanism, nonviolence was understood as an active practice of ethical and political regulation of conflict. Its meaning is not that of passivity, accommodation or refusal to act; rather, it is a deliberate intervention on the logic of destructive reciprocity. By refusing retaliation and limiting the mimetic expansion of desire, nonviolence preserves the possibility of confrontation without consenting to the symbolic or material annihilation of the other.

In this framework, friendship appears less as a spontaneous feeling than as a normative horizon of coexistence. It does not eliminate difference, dissent, or asymmetry, but it prevents such elements from being immediately translated into enmity. Thought of in this way, friendship designates a form of relationship in which otherness is sustained without surrender to hostility, and in which peace does not mean the absence of conflict, but the refusal of the violent degradation of the bond.

The central contribution of the article is to show that conflict, rivalry, non-violence and friendship make up interdependent moments of the same relational dynamic. Distinguishing conflict from violence and friendship from mere concord allows us to formulate a more precise philosophical thesis: peace only becomes intelligible when it ceases to be understood as the suppression of tensions and starts to be thought of as an ethical practice of containing bad reciprocity.

REFERENCES

- Bauman, Z. (1999). *Modernidade e ambivalência*. Rio de Janeiro: Jorge Zahar.
- Bobbio, N. (2002). *Elogio da serenidade e outros escritos morais* (M. A. Nogueira, Trad.). São Paulo: Editora UNESP.
- Girard, R. (2012). *Aquele por quem o escândalo vem* (C. Nougué, Trad.). São Paulo: É Realizações.
- Girard, R. (1990). *A violência e o sagrado* (M. C. Gambini, Trad.). São Paulo: Editora Universidade Estadual Paulista.
- Girard, R. (2011). *O sacrifício* (M. M. G. Lamelo, Trad.). São Paulo: É Realizações.
- Hobbes, T. (2014). *Leviatã* (R. D'Angina, Trad.). São Paulo: Martin Claret.
- Muller, J.-M. (2007). *O princípio da não-violência: uma trajetória filosófica* (I. Polegato, Trad.). São Paulo: Palas Athena.
- Rocha, J. C. de C. (2017). *Culturas shakespearianas: teoria mimética e os desafios da mimesis em circunstâncias não hegemônicas*. São Paulo: É Realizações.

Rosa, J. M. da S. (2001). A não-violência como horizonte de convivência. In *Poiética do mundo: homenagem a Joaquim Cerqueira Gonçalves* (pp. 807–819). Lisboa: Edições Colibri.

Simmel, G. (1983). *Georg Simmel: sociologia* (E. de M. Filho, Org. & Trad.). São Paulo: Ática.

Tólstoi, L. (1994). *O reino de Deus está em vós* (C. Portocarrero, Trad.). Rio de Janeiro: Rosa dos Tempos.

POST-TRAUMATIC STRESS DISORDER: UNDERSTANDING, IMPACTS, AND COPING STRATEGIES FROM ACADEMIC AND COMMUNITY PERSPECTIVES

TRANSTORNO DO ESTRESSE PÓS-TRAUMÁTICO: COMPREENSÃO, IMPACTOS E ESTRATÉGIAS DE ENFRENTAMENTO EM PERSPECTIVA ACADÊMICA E COMUNITÁRIA

TRASTORNO DE ESTRÉS POSTRAUMÁTICO: COMPRENSIÓN, IMPACTOS Y ESTRATEGIAS DE AFRONTAMIENTO DESDE UNA PERSPECTIVA ACADÉMICA Y COMUNITARIA



<https://doi.org/10.56238/sevened2026.008-227>

Felipe Vieira Barbosa¹, Marina Sias Leal², Rosane Pinheiro Krüger Feijó³

ABSTRACT

Post-Traumatic Stress Disorder (PTSD) is a psychological condition resulting from exposure to traumatic events that leads to persistent cognitive, emotional, and behavioral changes, compromising the individual's quality of life. Although trauma has been studied since Ancient Greece, the current understanding, focused on emotional and memory aspects, was consolidated in the 20th century, culminating in its current classification in the DSM-5-TR within trauma- and stressor-related disorders. The disorder shows a high prevalence among women, survivors of sexual violence, and rescue professionals, presenting neurobiological alterations that impair memory consolidation and functions such as attention. This study, linked to the Academic League of Psychology and Health (LAPS) at the Catholic University of Pelotas, aimed to analyze PTSD through a bibliographic and cultural review, combining theoretical foundations with extension practices. The methodology included the study of theoretical and audiovisual references, as well as a community action in the Laranjal neighborhood, in Pelotas, consisting of mapping service areas and distributing informational materials. The results indicate that the activity allowed for a deeper understanding of diagnostic criteria and promoted community support, bringing academic knowledge closer to society. It is concluded that the increase in global tragedies raises the risk of developing the disorder, making interdisciplinary initiatives essential for disseminating qualified information and strengthening coping strategies.

Keywords: Post-Traumatic Stress Disorder. DSM-5-TR. Mental Health. University Extension. Psychology.

RESUMO

O Transtorno de Estresse Pós-Traumático (TEPT) é uma condição psicológica decorrente da exposição a eventos traumáticos que gera alterações cognitivas, emocionais e comportamentais persistentes, comprometendo a qualidade de vida do indivíduo. Embora o trauma seja estudado desde a Grécia Antiga, a compreensão atual, focada em aspectos

¹ Psychology Student. Universidade Católica de Pelotas. E-mail: felipe.barbosa@sou.ucpel.edu.br

² Psychology Student. Universidade Católica de Pelotas. E-mail: marina.leal@sou.ucpel.edu.br

³ Professor. Universidade Católica de Pelotas. E-mail: rosane.feijo@ucpel.edu.br

emocionais e de memória, consolidou-se no século XX, culminando na classificação atual do DSM-5-TR dentro dos transtornos relacionados a trauma e estressores. O transtorno apresenta prevalência elevada em mulheres, sobreviventes de violência sexual e profissionais de resgate, manifestando alterações neurobiológicas que prejudicam a consolidação da memória e funções como a atenção. Este trabalho, vinculado à Liga Acadêmica de Psicologia e Saúde (LAPS) da Universidade Católica de Pelotas, objetivou analisar o TEPT por meio de uma revisão bibliográfica e cultural, unindo fundamentos teóricos à prática extensionista. A metodologia incluiu o estudo de referenciais teóricos e audiovisuais, além de uma ação comunitária no bairro Laranjal, em Pelotas, que consistiu no mapeamento de zonas de atendimento e distribuição de materiais informativos. Os resultados indicam que a atividade permitiu a compreensão aprofundada dos critérios diagnósticos e promoveu o acolhimento da população, aproximando o conhecimento acadêmico da sociedade. Conclui-se que o aumento de tragédias globais eleva o risco de desenvolvimento da doença, tornando iniciativas interdisciplinares essenciais para a disseminação de informações qualificadas e o fortalecimento de estratégias de enfrentamento.

Palavras-chave: Transtorno de Estresse Pós-Traumático. DSM-5-TR. Saúde Mental. Extensão Universitária. Psicologia.

RESUMEN

El Trastorno de Estrés Postraumático (TEPT) es una condición psicológica derivada de la exposición a eventos traumáticos que genera alteraciones cognitivas, emocionales y conductuales persistentes, comprometiendo la calidad de vida del individuo. Aunque el trauma ha sido estudiado desde la Antigua Grecia, la comprensión actual, centrada en aspectos emocionales y de memoria, se consolidó en el siglo XX, culminando en su clasificación actual en el DSM-5-TR dentro de los trastornos relacionados con trauma y factores de estrés. El trastorno presenta una alta prevalencia en mujeres, sobrevivientes de violencia sexual y profesionales de rescate, manifestando alteraciones neurobiológicas que afectan la consolidación de la memoria y funciones como la atención. Este trabajo, vinculado a la Liga Académica de Psicología y Salud (LAPS) de la Universidad Católica de Pelotas, tuvo como objetivo analizar el TEPT a través de una revisión bibliográfica y cultural, integrando fundamentos teóricos con la práctica extensionista. La metodología incluyó el estudio de referencias teóricas y audiovisuales, además de una acción comunitaria en el barrio Laranjal, en Pelotas, que consistió en el mapeo de zonas de atención y la distribución de materiales informativos. Los resultados indican que la actividad permitió una comprensión más profunda de los criterios diagnósticos y promovió la acogida de la población, acercando el conocimiento académico a la sociedad. Se concluye que el aumento de las tragedias globales incrementa el riesgo de desarrollar el trastorno, haciendo que las iniciativas interdisciplinarias sean esenciales para la difusión de información cualificada y el fortalecimiento de estrategias de afrontamiento.

Palabras clave: Trastorno de Estrés Postraumático. DSM-5-TR. Salud Mental. Extensión Universitaria. Psicología.

1 INTRODUCTION

Post-Traumatic Stress Disorder (PTSD) is a psychological condition related to exposure to traumatic events that causes persistent cognitive, emotional, and behavioral changes, compromising the quality of life of individuals. Trauma has been studied since the times of Ancient Greece and, over the centuries, several explanations and epistemologies have been suggested. The current concept, mainly linked to emotional and memory, only began to be considered by thinkers of the twentieth century. Officially recognized in the DSM-III in 1980 and updated in subsequent editions, PTSD is currently classified among trauma-related disorders and stressors (APA, 2022). Over the years, it has undergone significant revisions in its diagnostic criteria, reflecting advances in the understanding of the disease and its clinical manifestations.

Studies indicate higher prevalence in women, survivors of sexual violence, war and rescue professionals (SBARDELLOTO; SCHAEFER; FAIR; KRISTENSEN, 2011). Research in neuropsychology highlights that PTSD not only alters emotional responses, but also interferes with memory consolidation processes, enhancing the intrusive recollection of traumatic events and compromising cognitive functions such as attention and working memory. These neurobiological alterations have direct implications for rehabilitation and the development of more effective therapeutic interventions (SBARDELLOTO; SCHAEFER; FAIR; KRISTENSEN, 2011).

The discussion on the topic is fundamental not only for clinical practice, but also for the development of public policies and mental health care strategies. This study aimed to investigate PTSD based on a literature and cultural review, to explore the evolution of diagnostic criteria throughout the editions of the DSM, to analyze its prevalence in different contexts and to discuss the implications of these changes for clinical practice and mental health policies, uniting theoretical foundations, artistic productions and extension practices, aiming to disseminate knowledge about the disorder inside and outside the university.

2 METHODOLOGY

The study was developed within the scope of the Academic League of Psychology and Health (LAPS) of the Catholic University of Pelotas. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR), national and international scientific articles, audiovisual materials (films and online videos) and the book "The body keeps the marks (VAN DER KOLK, 2021)" were used as a theoretical basis. The process involved: (1) preliminary study of the references; (2) holding an oral seminar for the members of the league; (3) dialogical discussion among the participants; and (4) extension action with the production of a mapping

of appropriate service zones in the city of Pelotas and distribution of informative posters to the community of the Laranjal neighborhood, at the local Basic Health Unit.

3 REPORTS AND IMPACTS GENERATED

The activity allowed for an in-depth understanding of the diagnostic criteria, symptoms, prevalence, and therapeutic interventions for PTSD. The use of cinematographic works made it possible to exemplify in an accessible way the impacts of trauma on daily life, while the collective discussion generated critical reflections among the participants of the league. The community action in the Laranjal neighborhood demonstrated social impact by bringing academic knowledge closer to the population, promoting awareness about mental health, welcoming, and care possibilities. For the students involved, the experience contributed significantly to their academic training, strengthening research skills, oral exposition, teamwork and demystifying previously established concepts about the disorder.

4 CONSIDERATIONS

Post-Traumatic Stress Disorder is deeply marked in the psyche of those who experience it. The number of tragedies on a global scale that occur frequently increases the risk of developing the disease both for those who are affected by them and for the emergency professionals who work in the affected places. The work achieved its objective of articulating theory, practice and university extension in the study of PTSD. The experience proved to be relevant both for the training of students and for the community, highlighting the importance of disseminating qualified information about mental health in urban spaces and with accessible language. It is evident, therefore, that interdisciplinary and extension initiatives favor the construction of bridges between the university and society, in addition to expanding the collective understanding of the impact of traumas, their manifestations and the available coping strategies.

REFERENCES

- American Psychiatric Association. (2022). DSM-5-TR: Manual diagnóstico e estatístico de transtornos mentais (5ª ed. rev.). Artmed.
- Sbardellotto, G., Schaefer, L. S., Justo, A. R., & Kristensen, C. H. (2011). Transtorno de estresse pós-traumático: Evolução dos critérios diagnósticos e prevalência. *Psico-USF*, 16(1), 67–73.
- Van der Kolk, B. (2021). O corpo guarda as marcas: Cérebro, mente e corpo na cura do trauma (2ª ed.). Arqueiro.

Lopes, H. L., et al. (2024). Como o trauma contribui para o desenvolvimento do transtorno de estresse pós-traumático. *Revista Ibero-Americana de Humanidades, Ciências e Educação*, 10(11).

Gomes, R. M. (2012). Mulheres vítimas de violência doméstica e transtorno de estresse pós-traumático: Um enfoque cognitivo comportamental. *Revista de Psicologia da IMED*, 4(2), 672–680.

Neria, Y., DiGrande, L., & Adams, B. G. (2011). Posttraumatic stress disorder following the September 11, 2001, terrorist attacks: A review of the literature among highly exposed populations. *American Psychologist*, 66(6), 429–446.

Meshulam-Werebe, D., Andrade, M. G. O., & Delouya, D. (2003). Transtorno de estresse pós-traumático: O enfoque psicanalítico. *Brazilian Journal of Psychiatry*, 25(Suppl. 1), 46–50.

Rede D'Or São Luiz. (n.d.). Tratamento do estresse pós-traumático (TEPT): O que é, sintomas, tratamentos e causas. Recuperado em 15 agosto, 2025, de <https://www.rededorsaoluiz.com.br/doencas/tratamento-do-estresse-pos-traumatico>

PLANETARY HEALTH IN THE AMAZON: IMPACTS OF CLIMATE CHANGE AND MULTIPROFESSIONAL RESPONSES TO GLOBAL HEALTH CHALLENGES

SAÚDE PLANETÁRIA NA AMAZÔNIA: IMPACTOS DAS MUDANÇAS CLIMÁTICAS E RESPOSTAS MULTIPROFISSIONAIS PARA OS DESAFIOS DA SAÚDE GLOBAL

SALUD PLANETARIA EN LA AMAZONÍA: IMPACTOS DEL CAMBIO CLIMÁTICO Y RESPUESTAS MULTIPROFESIONALES A LOS DESAFÍOS DE LA SALUD GLOBAL



<https://doi.org/10.56238/sevened2026.008-228>

Patrícia dos Santos Moutinho Coelho¹, Mariana Elizabeth Lopes de Sales², Vânia Cristina Ribeiro Brilhante,³ Adriana Almeida dos Santos⁴, Leidiane Braz de Sousa⁵, Amanda Emanuele dos Santos Correa⁶, Patrícia Gabrielly da Silva Pires⁷, Valdemar Mendes de Moraes Filho⁸, Leidson Frank Santana Cardoso⁹, Priscila Bezerra de Lima¹⁰, Kátia Lamara de Araújo Santos¹¹, Jander Marcus Cirino Lopes¹², Suane e Silva Duarte Souto¹³, Iolene Mara Cardoso de Matos¹⁴, Amanda Martins Araújo¹⁵,

¹ Doctoral student in Sustainable Development. Universidade Federal do Pará (UFPA).

E-mail: profpatriciamoutinho26@gmail.com Orcid: 0000-0001-6641-6787

² Master's degree in Risk and Natural Disaster Management in the Amazon. Universidade Federal do Pará (UFPA). E-mail: marydts.sespa@gmail.com Orcid: 0000-0001-8655-2364

³ Dr. in Tropical Medicine. Universidade Federal do Pará (UFPA). E-mail: vrbrilhante@hotmail.com Orcid: <https://orcid.org/0009-0005-4014-808X>

⁴ Pharmacy. Centro Universitário Planalto do Distrito Federal (UNIPLAN). E-mail: adri.neto.eron@gmail.com

⁵ Master's student in Biosciences. Universidade Federal do Oeste do Pará (UFOPA). E-mail: leidybraz@hotmail.com

⁶ Master's degree in Health Sciences. Universidade do Estado do Pará (UEPA). Universidade Federal do Oeste do Pará (UFOPA). FASERRA/Biocursos. Hospital Israelita Albert Einstein. E-mail: amanda.emanuele95@gmail.com

⁷ Doctoral student in Society, Nature and Development. Universidade Federal do Pará (UFPA). Universidade Federal do Oeste do Pará (UFOPA). E-mail: kpi_mcc@hotmail.com Orcid: <https://orcid.org/0000-0002-4541-611X>

⁸ Pharmacist. Centro Universitário Leonardo da Vinci (UNIASSELVI). E-mail: Valdemar.morais11@gmail.com

⁹ Pharmacist. Uniesamaz. E-mail: frank_cardozoz@yahoo.com.br

¹⁰ Master's degree in Health Sciences. Universidade Federal do Oeste do Pará (UFOPA). E-mail: priscila.lima@live.com Orcid: <https://orcid.org/0000-0003-0858-076X>

¹¹ Bachelor's in Law. Centro Universitário Metropolitano da Amazônia (UNIFAMAZ). E-mail: katia-lamara@hotmail.com Orcid: <https://orcid.org/0009-0006-6765-5476>

¹² Master's degree in Society, Environment and Quality of Life. Instituto Esperança de Ensino Superior (IESPES). Faveni. E-mail: jander.lopes@yahoo.com.br Orcid: <https://orcid.org/0009-0002-1819-5910>

¹³ Graduated in Pharmacy. Instituto Esperança de Ensino Superior (IESPES). E-mail: farma.suaneduarte@gmail.com Orcid: <https://orcid.org/0009-0006-1481-5026>

¹⁴ Nurse. Centro Universitário Planalto do Distrito Federal (UNIPLAN). E-mail: iolenemaramatos916000@gmail.com

¹⁵ Postgraduate certificate in Clinical Analysis. Postgraduate certificate in Clinical Microbiology and Microbiological Quality Control. Instituto Esperança de Ensino Superior (IESPES). E-mail: amandhamartins27@gmail.com Orcid: <https://orcid.org/0009-0008-1224-3399>

Eduardo Silva Rodrigues¹⁶, Jhennifer Stefany Teles Gonçalves¹⁷, Rafaela Balot de Souza¹⁸, Anna Monise Rigon Von Heimburg¹⁹, Tassyane Martins Bezerra²⁰, Grazielle Queiroz Mazete Maran²¹, Jean-Claude Martins de Andrade²², Vanessa Silva Bermond²³, Rosana Pereira Medina Freitas²⁴, Lucas de Souza Victor²⁵, Neide Garcia Ribeiro²⁶

ABSTRACT

Climate change represents one of the greatest contemporary challenges to global health, directly affecting environmental, social, and epidemiological dynamics in various regions of the planet. The Amazon stands out in this scenario due to its ecological relevance and its influence on the global climate balance. This chapter aims to analyze the impacts of climate change in the Amazon and to discuss the role of multiprofessional teams in building integrated responses to global health challenges. This is a qualitative study, developed through an integrative review of the scientific literature, with searches conducted in international databases such as PubMed, Scopus, Web of Science, SciELO, and the Virtual Health Library, including publications from 2016 to 2025. The results show that phenomena such as deforestation, wildfires, and air pollution have contributed to an increase in respiratory, cardiovascular, and infectious diseases, in addition to expanding social vulnerabilities among indigenous and riverside communities. In this context, the importance of multiprofessional action is highlighted, involving physicians, nurses, pharmacists, physiotherapists, nutritionists, dentists, and public health professionals in epidemiological surveillance, health promotion, and the implementation of comprehensive care strategies. It is concluded that the preservation of the Amazon and the integration between environmental and health policies are essential to address the challenges of planetary health, strengthen resilient health systems, and promote better living conditions for current and future populations.

Keywords: Planetary Health. Climate Change. Amazon. Multiprofessional Team. Global Health.

RESUMO

As mudanças climáticas representam um dos maiores desafios contemporâneos para a saúde global, afetando diretamente a dinâmica ambiental, social e epidemiológica em diversas regiões do planeta. A Amazônia destaca-se nesse cenário devido à sua relevância ecológica e à sua influência sobre o equilíbrio climático mundial. Este capítulo tem como objetivo analisar os impactos das mudanças climáticas na Amazônia e discutir o papel das equipes multiprofissionais na construção de respostas integradas para os desafios da saúde global. Trata-se de um estudo de abordagem qualitativa, desenvolvido por meio de revisão integrativa da literatura científica, com busca realizada em bases de dados internacionais como PubMed, Scopus, Web of Science, SciELO e Biblioteca Virtual em Saúde, contemplando publicações entre 2016 e 2025. Os resultados evidenciam que fenômenos

¹⁶ Postgraduate certificate in Traumatology and Orthopedics. AFYA Centro Universitário de Ji-Paraná. E-mail: eduardorodrigues.fisio9@gmail.com

¹⁷ Physiotherapy Student. AFYA Centro Universitário de Ji-Paraná. E-mail: jhenniferstefanytg@gmail.com

¹⁸ Physiotherapy Student. AFYA Centro Universitário de Ji-Paraná. E-mail: rafaelabalot9@gmail.com

¹⁹ Physiotherapy Student. AFYA Centro Universitário de Ji-Paraná. E-mail: moniseanna0@gmail.com

²⁰ Postgraduate certificate in Orthopedic Physiotherapy and Chiropractic. AFYA Centro Universitário de Ji-Paraná. E-mail: tassyaneemb@gmail.com

²¹ Physiotherapy Student. AFYA Centro Universitário de Ji-Paraná. E-mail: graziellequeiroz4@gmail.com

²² Physiotherapy Student. AFYA Centro Universitário de Ji-Paraná. E-mail: jeanjejejp@gmail.com

²³ Physiotherapy Student. AFYA Centro Universitário de Ji-Paraná. E-mail: vanessasilvabermond@gmail.com

²⁴ Physiotherapy Student. AFYA Centro Universitário de Ji-Paraná. E-mail: rosanamedina.jpja@gmail.com

²⁵ Physiotherapy Student. AFYA Centro Universitário de Ji-Paraná. E-mail: lucasvictor2120@gmail.com

²⁶ Master's degree in Cardiorespiratory Physiotherapy. AFYA Centro Universitário de Ji-Paraná. E-mail: neide.ribeiro@afya.com.br

como desmatamento, queimadas e poluição atmosférica têm contribuído para o aumento de doenças respiratórias, cardiovasculares e infecciosas, além de ampliarem vulnerabilidades sociais em comunidades indígenas e ribeirinhas. Nesse contexto, destaca-se a importância da atuação multiprofissional envolvendo médicos, enfermeiros, farmacêuticos, fisioterapeutas, nutricionistas, cirurgiões-dentistas e profissionais da saúde coletiva na vigilância epidemiológica, na promoção da saúde e na implementação de estratégias de cuidado integral. Conclui-se que a preservação da Amazônia e a integração entre políticas ambientais e sanitárias são fundamentais para enfrentar os desafios da saúde planetária, fortalecer sistemas de saúde resilientes e promover melhores condições de vida para as populações atuais e futuras.

Palavras-chave: Saúde Planetária. Mudanças Climáticas. Amazônia. Equipe Multiprofissional. Saúde Global.

RESUMEN

El cambio climático representa uno de los mayores desafíos contemporáneos para la salud global, afectando directamente la dinámica ambiental, social y epidemiológica en diversas regiones del planeta. La Amazonía se destaca en este escenario debido a su relevancia ecológica y su influencia sobre el equilibrio climático mundial. Este capítulo tiene como objetivo analizar los impactos del cambio climático en la Amazonía y discutir el papel de los equipos multiprofesionales en la construcción de respuestas integradas a los desafíos de la salud global. Se trata de un estudio de enfoque cualitativo, desarrollado mediante una revisión integradora de la literatura científica, con búsqueda realizada en bases de datos internacionales como PubMed, Scopus, Web of Science, SciELO y la Biblioteca Virtual en Salud, incluyendo publicaciones entre 2016 y 2025. Los resultados evidencian que fenómenos como la deforestación, los incendios forestales y la contaminación atmosférica han contribuido al aumento de enfermedades respiratorias, cardiovasculares e infecciosas, además de ampliar las vulnerabilidades sociales en comunidades indígenas y ribereñas. En este contexto, se destaca la importancia de la actuación multiprofesional que involucra a médicos, enfermeros, farmacéuticos, fisioterapeutas, nutricionistas, odontólogos y profesionales de la salud pública en la vigilancia epidemiológica, la promoción de la salud y la implementación de estrategias de atención integral. Se concluye que la preservación de la Amazonía y la integración entre políticas ambientales y sanitarias son fundamentales para enfrentar los desafíos de la salud planetaria, fortalecer sistemas de salud resilientes y promover mejores condiciones de vida para las poblaciones actuales y futuras.

Palabras clave: Salud Planetaria. Cambio Climático. Amazonía. Equipo Multiprofesional. Salud Global.

1 INTRODUCTION

In recent decades, climate change has emerged as one of the greatest global challenges for public health, directly influencing the occurrence of diseases, food security, air quality, and the living conditions of populations. In the context of planetary health, the debate on environmental impacts on human health has become central to understanding how climate phenomena, environmental degradation, and changes in ecosystems affect health systems in different regions of the world. In this scenario, the Brazilian Amazon assumes a strategic position, not only for its ecological and climatic importance, but also for its decisive role in the dynamics of global health (WATTS et al., 2019; NOBRE et al., 2016).

The Amazon is home to the largest tropical forest on the planet and exerts a significant influence on the world's climate balance. However, processes such as deforestation, fires, agricultural expansion and changes in land use have intensified the emission of air pollutants and altered the environmental cycles of the region. These transformations contribute to the increase in air pollution, exposure to fine particulate matter, and the occurrence of extreme weather events, factors that directly impact the health of populations in the Amazon and other regions of the planet (MARLIER et al., 2020; BUTT et al., 2021).

The effects of these environmental changes are reflected in the increase in respiratory, cardiovascular and infectious diseases, as well as problems related to food insecurity, malnutrition and population displacement. Recent studies show that smoke from fires in the Amazon is associated with increased hospitalizations for respiratory diseases and increased premature mortality in different population groups (YE et al., 2021; COBELO et al., 2023). These impacts make it evident that the climate crisis is not only an environmental issue, but also a central public health problem.

Given this scenario, the integrated action of multiprofessional health teams is essential to face the challenges associated with climate change. Doctors play a fundamental role in the diagnosis and treatment of diseases related to environmental exposure, while nurses work in epidemiological surveillance, clinical follow-up and health promotion in communities. Pharmacists contribute to the safe management of medications and to the therapeutic follow-up of patients with chronic diseases aggravated by environmental factors, while physiotherapists participate in the rehabilitation of individuals affected by respiratory and cardiovascular diseases associated with air pollution (SHEEHAN et al., 2023; ROCHA-SILVA et al., 2025).

In addition, nutritionists play an essential role in assessing and managing the nutritional consequences related to environmental change and food insecurity, especially in vulnerable populations. Dentists also contribute to the promotion of integral health,

considering that environmental and socioeconomic changes can influence oral health conditions and systemic diseases. At the same time, professionals from the social sciences, public health, and epidemiology collaborate to understand the social determinants of health and develop community intervention strategies in the face of climate impacts (SANTOS et al., 2025; SILVA et al., 2025).

The multiprofessional approach becomes even more relevant when considering the vulnerability of indigenous communities, riverside dwellers and traditional populations in the Amazon, who face additional challenges related to access to health services, environmental exposure and changes in lifestyles. Studies indicate that these populations are among the most affected by climate and environmental transformations, which reinforces the need for integrated and culturally sensitive care strategies (PRIST et al., 2023; HACÓN et al., 2020).

In this context, the concept of planetary health emerges as a fundamental approach to understanding the interdependence between natural systems and human health. Planetary health proposes an integrated vision that recognizes that the well-being of populations depends on the preservation of ecosystems and environmental sustainability. Thus, multiprofessional action in health becomes a central element in the construction of effective responses to the challenges imposed by climate change, especially in strategic regions such as the Amazon (WATTS et al., 2019).

Given this reality, understanding the impacts of climate change in the Amazon and its implications for global health becomes essential to guide public policies, prevention strategies, and comprehensive care actions. Thus, this chapter aims to analyze the effects of climate change on the health of Amazonian populations and discuss the role of multiprofessional teams in the construction of integrated responses to contemporary global health challenges.

2 LITERATURE REVIEW

2.1 CLIMATE CHANGE AND PLANETARY HEALTH IN THE GLOBAL CONTEXT

Climate change has been recognized as one of the greatest contemporary challenges to global health, directly influencing the environmental determinants of human health. The concept of planetary health emerges in this scenario as an interdisciplinary approach that seeks to understand the interdependence between natural systems and human well-being. The scientific literature points out that climate change, environmental degradation, and biodiversity loss have the potential to intensify health crises in different regions of the planet, mainly affecting vulnerable populations (WATTS et al., 2019).

Global studies indicate that the increase in the planet's average temperature, the intensification of extreme weather events, and changes in precipitation patterns have contributed to the increase in infectious, respiratory, and cardiovascular diseases. In addition, these phenomena influence the availability of natural resources, directly impacting food security and access to drinking water. In this context, planetary health proposes an integrated vision that recognizes that the preservation of ecosystems is essential to ensure adequate health conditions and quality of life for human populations (NOBRE et al., 2016).

Another relevant aspect refers to the fact that the impacts of climate change on health are not evenly distributed. Developing countries and regions with greater socio-environmental vulnerability tend to suffer more intense effects from these transformations. Thus, understanding the effects of climate on health requires a multidisciplinary approach that considers environmental, social, and economic factors, in addition to the integrated work of professionals from different areas of health.

2.2 AMAZON AND CLIMATE CHANGE: ENVIRONMENTAL AND HEALTH IMPLICATIONS

The Amazon plays a central role in the regulation of the global climate, being responsible for important ecological processes that influence the planet's environmental balance. However, the advance of deforestation, fires and changes in land use has significantly altered the natural cycles of the region, contributing to the intensification of climate change. These environmental transformations have direct impacts on the health of populations living in the Amazon region and in other parts of the world (MARLIER et al., 2020).

Scientific research shows that fires in the Amazon release large amounts of fine particles and polluting gases into the atmosphere, contributing to the deterioration of air quality. Prolonged exposure to these pollutants is associated with an increase in respiratory, cardiovascular, and inflammatory diseases. Studies show that the periods of intensification of fires are related to the increase in hospitalizations for respiratory diseases in several regions of Brazil (BUTT et al., 2021; COBELO et al., 2023).

In addition, environmental degradation can favor the emergence and reemergence of infectious diseases, since changes in ecosystems modify the dynamics of vectors and natural reservoirs of pathogens. Thus, the relationship between environmental changes and human health becomes increasingly evident, reinforcing the need for integrated prevention and epidemiological surveillance strategies.

2.3 AIR POLLUTION AND IMPACTS ON THE HEALTH OF AMAZONIAN POPULATIONS

Air pollution associated with fires represents one of the main risk factors for the health of populations in the Amazon. The fine particles released during wildfires can penetrate deep into the respiratory system, triggering inflammatory processes and aggravating pre-existing diseases. Studies indicate that exposure to air pollution from fires is related to an increase in cases of asthma, bronchitis, cardiovascular diseases, and premature mortality (YE et al., 2021).

Research carried out in different regions of Brazil shows that periods of intensification of fires are associated with a significant increase in hospital admissions due to respiratory diseases. Children, the elderly, and individuals with chronic diseases are more vulnerable to the effects of air pollution. In addition, prolonged exposure to smoke can affect the immune system, increasing the risk of respiratory infections and aggravating pre-existing clinical conditions (ROCHA-SILVA et al., 2025).

Another important aspect refers to the economic and social impact associated with air pollution. The increase in hospital admissions and demands for health services generates significant costs for health systems and directly affects the quality of life of exposed populations. Thus, the control of fires and environmental preservation become fundamental strategies for the promotion of public health.

2.4 VULNERABILITY OF AMAZONIAN POPULATIONS TO CLIMATE CHANGE

Populations living in the Amazon, especially indigenous and riverine communities, are highly vulnerable to the impacts of climate change. These communities rely directly on natural resources for their livelihoods and have limited access to health services and basic infrastructure. Changes in climate and biodiversity can affect the availability of food, water, and natural resources essential for maintaining their ways of life (SANTOS et al., 2025).

Recent studies show that environmental degradation and the advance of economic activities on traditional territories have contributed to the increase in infectious diseases, nutritional problems, and socio-environmental conflicts. In addition, prolonged exposure to pollution from fires increases the risk of respiratory and cardiovascular diseases in these populations (PRIST et al., 2023).

The vulnerability of these communities requires specific health intervention strategies that consider cultural, social and environmental aspects. In this context, the performance of multiprofessional teams becomes essential to develop actions for health promotion, disease prevention, and strengthening epidemiological surveillance in Amazonian territories.

2.5 THE ROLE OF THE MULTIPROFESSIONAL TEAM IN THE FACE OF CLIMATE IMPACTS ON HEALTH

The complexity of the impacts of climate change on health requires articulated responses between different areas of knowledge. Multiprofessional action becomes essential to face the health challenges associated with environmental transformations. Doctors play an essential role in the diagnosis and treatment of diseases related to environmental exposure, while nurses work in epidemiological surveillance, clinical follow-up, and health promotion in communities (SHEEHAN et al., 2023).

Pharmacists contribute to the therapeutic follow-up of patients with chronic diseases aggravated by environmental pollution, ensuring the rational use of medicines. Physiotherapists work in the rehabilitation of patients with respiratory and cardiovascular diseases, helping in functional recovery and improving quality of life. Nutritionists play an important role in the nutritional assessment of vulnerable populations, especially in contexts of food insecurity associated with environmental changes.

In addition to these professionals, dental surgeons, collective health professionals, and specialists in the social sciences also play relevant roles in the promotion of integral health. The integration of these areas allows the development of more effective strategies to address the impacts of climate change on public health.

2.6 GLOBAL STRATEGIES AND PUBLIC POLICIES TO ADDRESS CLIMATE IMPACTS ON HEALTH

The growing scientific evidence on the health impacts of climate change has driven the development of global strategies to address this challenge. International organizations have emphasized the need to integrate environmental and health policies to reduce the negative effects of climate change on human populations (WATTS et al., 2019).

In the Brazilian context, initiatives aimed at protecting the Amazon and reducing fires have been recognized as essential strategies to mitigate climate impacts and protect the health of populations. The preservation of Amazonian ecosystems contributes not only to the maintenance of biodiversity, but also to the reduction of air pollution and the improvement of the living conditions of local communities (VIANA, 2020).

In addition, public policies aimed at environmental health and epidemiological surveillance are essential to monitor the health impacts of climate change. The implementation of intersectoral strategies, involving professionals from different areas of health and public management, is an essential element to face the contemporary challenges of global health.

3 METHODOLOGY

3.1 STUDY DESIGN

This chapter was developed from a qualitative approach of a theoretical-analytical nature, structured through an integrative review of the scientific literature. This methodological design was chosen because it allows a critical and systematic analysis of the available evidence on the relationships between climate change, environmental degradation in the Amazon, and its impacts on global health, as well as on the role of multiprofessional teams in the construction of health responses in this scenario. The integrative review makes it possible to bring together different types of scientific studies, allowing a comprehensive and interdisciplinary view of the investigated phenomenon.

The adoption of this method is also justified by the complexity of the topic addressed, which involves multiple environmental, social, and epidemiological determinants. In this way, the analysis of the scientific literature allowed us to understand how climate change in the Amazon affects health systems and demands integrated responses from professionals from different areas, including doctors, nurses, pharmacists, physiotherapists, nutritionists, dental surgeons, and specialists in public health and social sciences.

3.2 SEARCH STRATEGY AND DATABASES

The bibliographic search was carried out in international scientific databases recognized for their relevance in the production of knowledge in public health, climate change and planetary health. The following databases were consulted:

- PubMed/MEDLINE
- Scopus
- Web of Science
- SciELO
- Virtual Health Library (VHL/LILACS)
- Google Scholar

These databases were selected because they bring together extensive scientific production in the areas of environmental epidemiology, global health, climate change, and public health.

To identify the studies, descriptors in Portuguese and English combined by Boolean operators (AND/OR) were used. Among the main terms used are:

- Climate change
- Planetary Health
- Amazon

- climate change
- planetary health
- Amazon rainforest
- environmental health
- Global Health
- wildfire smoke
- air pollution and health

The combination of these descriptors made it possible to identify studies that addressed the impacts of climate change on human health, with an emphasis on Amazonian populations and the challenges faced by health systems.

3.3 ANALYSIS PERIOD

Studies published mainly between **2016 and 2025 were considered**, a period that concentrates important advances in scientific production on planetary health, the impacts of climate change on health, and environmental degradation in the Amazon. Classic works and relevant international reports were also included when considered fundamental for the understanding of the phenomenon investigated.

Inclusion and exclusion criteria

The studies included in the review met the following criteria:

- scientific articles published in peer-reviewed journals
- studies that addressed climate change and human health
- research related to environmental impacts in the Amazon
- Studies on air pollution, fires and health
- Publications that discuss planetary health or global health
- Articles available in Portuguese, English or Spanish

The following were excluded from the analysis:

- Duplicate studies among the databases consulted
- publications that were not directly related to the theme
- exclusively technical or environmental studies unrelated to human health
- works without access to the full text.

3.4 SELECTION AND ORGANIZATION OF EVIDENCE

After applying the search strategy and eligibility criteria, the selected studies were submitted to full reading and critical analysis. At the end of the process, **twenty relevant scientific publications made up the analytical corpus of this chapter**, including scientific

articles, systematic reviews, and international reports widely cited in the literature on climate change and health.

The evidence extracted was organized through thematic analysis, allowing the structuring of the scientific discussion into analytical categories related to:

- Climate Change and Planetary Health
- environmental impacts in the Amazon
- Air pollution and respiratory diseases
- Vulnerability of Amazonian populations
- Role of the multiprofessional team in responding to climate impacts
- global strategies to address the climate crisis.

This thematic organization made it possible to integrate different scientific perspectives and build a comprehensive analysis on the impacts of climate change on health and the challenges for health systems.

3.5 SCIENTIFIC RIGOR AND VALIDITY OF THE ANALYSIS

Methodological rigor was ensured by the selection of studies from internationally recognized scientific bases, by the prioritization of recent evidence, and by the critical analysis of the publications included. The diversity of the sources analyzed made it possible to contemplate different disciplinary approaches, including epidemiology, public health, medicine, nursing, environmental sciences, and global health.

In addition, the triangulation of evidence allowed us to understand the investigated phenomenon from multiple scientific perspectives, strengthening the analytical consistency of the study and contributing to the construction of an interdisciplinary approach aligned with the concept of planetary health.

3.6 ETHICAL ASPECTS

As this is a study based exclusively on secondary data from the scientific literature and institutional documents, there was no direct participation of human beings. Thus, the research does not require consideration by the Research Ethics Committee. All sources used were duly cited throughout the chapter, ensuring academic integrity, methodological transparency and respect for the ethical principles of scientific production.

4 RESULTS AND DISCUSSION

The analysis of the selected scientific evidence demonstrates that climate change has produced significant impacts on the health of populations, especially in environmentally

sensitive regions such as the Amazon. The studies analyzed indicate that phenomena associated with environmental degradation, such as deforestation, fires, and changes in land use, have contributed to the increase in air pollution and the intensification of extreme weather events, factors that directly influence the occurrence of respiratory, cardiovascular, and infectious diseases (MARLIER et al., 2020; BUTT et al., 2021). These results reinforce the understanding that environmental transformations in the Amazon have repercussions that go beyond regional boundaries, affecting health systems on a global scale.

Among the main impacts identified, the increase in air pollution resulting from forest fires stands out. The fine particles released during these events, especially fine particulate matter (PM_{2.5}), have a high capacity to penetrate the human respiratory system, and can trigger pulmonary inflammation and aggravate chronic respiratory diseases. Epidemiological studies demonstrate that long-term exposure to these particles is associated with increased hospitalizations for respiratory and cardiovascular diseases, as well as increased premature mortality in exposed populations (YE et al., 2021; COBELO et al., 2023). This scenario shows that environmental degradation in the Amazon is not only an ecological problem, but also an important determinant of public health.

Another relevant result refers to the relationship between fire events and the overload of health systems. During periods of intensification of fires, there is a significant increase in the demand for hospital services related to the treatment of acute respiratory diseases and exacerbations of chronic diseases. Research indicates that children, the elderly, and individuals with cardiovascular or respiratory diseases are more vulnerable to the effects of air pollution, which contributes to the increase in hospital admission rates in these groups (ROCHA-SILVA et al., 2025). In this way, the impacts of climate change are also manifested in the response capacity of health systems in the face of environmental emergencies.

The results also point out that climate change influences the epidemiological dynamics of several infectious diseases. Changes in temperature and precipitation patterns can modify the geographic distribution of vectors and pathogens, favoring the emergence or reemergence of infectious diseases. This phenomenon has been observed in different tropical regions, in which environmental changes create favorable conditions for the proliferation of vectors and natural reservoirs of infectious agents (WATTS et al., 2019). In this context, the Amazon becomes an important scenario for observing the interactions between climate, environment and health.

The vulnerability of Amazonian populations is also a central aspect identified in the literature. Indigenous communities, riverside communities, and traditional populations are more exposed to the effects of climate change due to their direct dependence on natural

resources and limited access to health services. Studies indicate that these populations face additional challenges related to food insecurity, environmental pollution, and exposure to emerging infectious diseases (SANTOS et al., 2025; PRIST et al., 2023). These factors increase health inequalities and reinforce the need for intervention strategies that consider the sociocultural specificities of these communities.

In this complex scenario, the performance of multiprofessional teams emerges as an essential element to face the health challenges associated with climate change. Physicians play a central role in the diagnosis and treatment of diseases related to environmental exposure, while nurses work in epidemiological surveillance, clinical monitoring, and health education in communities. Pharmacists contribute to the safe therapeutic management of patients with chronic diseases aggravated by environmental factors, while physiotherapists participate in the rehabilitation of individuals affected by respiratory and cardiovascular diseases associated with air pollution (SHEEHAN et al., 2023).

In addition, nutritionists play an important role in assessing and managing the nutritional consequences associated with climate change, especially in contexts of food insecurity. Dentists also participate in the promotion of integral health, considering that environmental and socioeconomic factors can influence oral health conditions and systemic diseases. At the same time, professionals from the public health and social sciences contribute to the analysis of the social determinants of health and to the development of public policies aimed at protecting vulnerable populations.

The discussion of the results also highlights the need for integrated public policies that articulate environmental, health and social actions. The preservation of Amazonian ecosystems represents a fundamental strategy not only for the protection of biodiversity, but also for the promotion of global health. The scientific literature points out that reducing deforestation and controlling fires can contribute significantly to improving air quality and reducing diseases associated with air pollution (VIANA, 2020).

In addition, global initiatives aimed at planetary health have emphasized the importance of integrating environmental policies and health systems to address the challenges posed by climate change. This approach recognizes that human health is directly dependent on the preservation of natural systems and environmental sustainability. Thus, multiprofessional action in health becomes essential to develop strategies for prevention, surveillance, and comprehensive care in the face of climate impacts.

In general, the results analyzed indicate that climate change in the Amazon has profound implications for the health of local populations and for global health. The intensification of extreme weather events, the increase in air pollution, and the social

vulnerability of Amazonian populations are challenges that require integrated responses between science, public policies, and multiprofessional action. Thus, the construction of coping strategies based on collaboration between different areas of knowledge represents an essential step to promote health and sustainability in a context of global climate change.

5 CONCLUSION

The evidence analyzed in this chapter demonstrates that climate change constitutes one of the main contemporary challenges to global health, especially in environmentally strategic regions such as the Amazon. The advance of deforestation, the intensification of fires, and changes in environmental cycles have caused significant impacts on air quality, ecosystem dynamics, and the living conditions of Amazonian populations. These processes directly contribute to the increase in respiratory, cardiovascular, and infectious diseases, in addition to expanding existing social and health vulnerabilities.

The results discussed throughout the chapter indicate that the environmental impacts observed in the Amazon have repercussions that go beyond regional limits, influencing global climate systems and affecting the health of populations in different parts of the world. The relationship between environmental degradation, air pollution, and increased disease burden shows that the climate crisis must also be understood as a health crisis, requiring articulated responses between different sectors of society and science.

In this context, the concept of planetary health presents itself as an essential approach to understand the interdependence between the preservation of ecosystems and the promotion of human health. The protection of the Amazon rainforest is not only an environmental issue, but also a fundamental strategy for reducing health risks and building more resilient health systems in the face of climate change.

The complexity of the challenges presented reinforces the importance of the integrated performance of multiprofessional health teams. Doctors, nurses, pharmacists, physiotherapists, nutritionists, dentists, collective health professionals, and social science specialists play complementary roles in disease prevention, epidemiological surveillance, clinical care, and health promotion in vulnerable territories. The articulation between these different areas of knowledge allows the development of more comprehensive care and intervention strategies, strengthening the capacity of health systems to respond to the impacts of climate change.

In addition, it is essential to strengthen public policies that integrate environmental, health, and social actions, promoting the conservation of Amazonian ecosystems and the protection of populations that directly depend on these territories. Investments in

environmental surveillance, scientific research, health education, and strengthening primary care represent important ways to face the challenges posed by the climate crisis.

Thus, it is concluded that the preservation of the Amazon and the confrontation of climate change are central elements for the promotion of global health. The construction of effective responses to this scenario depends on the integration between science, public policies, and multiprofessional action, recognizing that human health is deeply connected to environmental sustainability and the balance of the planet's natural systems.

REFERENCES

- Butt, E. W., et al. (2021). Large air quality and human health impacts due to Amazonian fires. *GeoHealth*, 5(8).
- Cobelo, I., et al. (2023). Wildfire events and health risks in Brazil. *Environmental Research*, 220.
- Hacón, S., et al. (2020). Health in the Amazon: Environmental and social determinants. United Nations Sustainable Development Solutions Network.
- Marlier, M., et al. (2020). How do Brazilian fires affect air pollution and public health? *GeoHealth*, 4.
- Nobre, C. A., et al. (2016). Land-use and climate change risks in the Amazon and implications for global climate. *Proceedings of the National Academy of Sciences*, 113(39).
- Prist, P. R., et al. (2023). Protecting Indigenous territories reduces pollution exposure and health risks in the Amazon. *Communications Earth & Environment*, 4.
- Rocha-Silva, R., et al. (2025). Wildfires and their effects on respiratory health in Brazil. *Research, Society and Development*, 14(2).
- Santos, A., et al. (2025). Impacts of climate change on Indigenous peoples located in the Amazon biome. *Revista Gestão Social e Ambiental*, 19.
- Sheehan, D., et al. (2023). Protected areas affect particulate matter and respiratory hospitalizations in Brazil. *Environmental Health*, 22.
- Silva, J., et al. (2025). Climate injustice and fires in the Amazon: One Health perspective. *Revista Brasileira de Estudos de População*, 42.
- Viana, V. (2020). Climate justice, deforestation and global health. Springer Nature.
- Watts, N., et al. (2019). The Lancet Countdown on health and climate change: Ensuring that the health of a child born today is not defined by a changing climate. *The Lancet*, 394.
- Ye, T., et al. (2021). Risk and burden of hospital admissions associated with wildfire-related PM_{2.5} in Brazil. *The Lancet Planetary Health*, 5.

COMPUTATIONAL MODELING OF THE DOCK CHANNEL IN BELÉM, PARÁ, FOR THE IMPLEMENTATION OF URBAN IMPROVEMENTS PRIOR TO COP30

MODELAGEM COMPUTACIONAL DO CANAL DA DOCA EM BELÉM-PA PARA IMPLANTAÇÃO DE MELHORIA URBANA PRÉVIA À COP30

MODELIZACIÓN COMPUTACIONAL DEL CANAL DEL MUELLE EN BELÉM-PA PARA LA IMPLANTACIÓN DE MEJORAS URBANÍSTICAS PREVIAS A LA COP30



<https://doi.org/10.56238/sevened2026.008-229>

Marco Valério de Albuquerque Vinagre¹, Luan da Silva Freitas², Roberto Fontes de Sousa³, Rodrigo Lauria Fonseca⁴, Edilaine Cristina Pamplona Menezes⁵, Marly Sanches Cardoso⁶, Larissa Mourão Pantoja⁷

ABSTRACT

The implementation of the New Doca Linear Park in the Armas basin, in Belém-PA, in the Amazon, for urban improvement before 30th UN Conference of the Parties on Climate Change (COP30), was based on a hydrological-hydrodynamic study using the computational code Storm Water Management Model–SWMM. This study formulated ways to prevent overflows in the Doca Channel, due to intense rainfall, low elevation of the terrain (between 0 and 8m), high impermeability, and high tidal levels. The hydraulic behavior of the basin was realistically simulated under the effect of rainfall with a 50- year return period, with 172 mm of precipitation in 24 hours, under the effect of a high tide of 3.02m, indicating the need of floodgates. It is concluded that there is susceptibility to tidal flooding for terrains with elevations below 3.02m. The occupied capacity of the Doca channel reached 97%, suggesting the use of booster pumps to prevent overflows, with the operational

¹ Dr. in Natural Resources Engineering of the Amazon. Universidade da Amazônia (UNAMA).

E-mail: valeriovinagre@gmail.com Orcid: <https://orcid.org/0000-0002-7650-9204>

Lattes: <http://lattes.cnpq.br/8044094535697705>

² Doctoral student in Urban Development and Environment. Universidade da Amazônia (UNAMA).

E-mail: freitasluan52@gmail.com Orcid: <https://orcid.org/0000-0003-0186-695X>

Lattes: <https://lattes.cnpq.br/2515137074404173>

³ Doctoral student in Architecture and Urbanism. Universidade de São Paulo (USP).

E-mail: fontes2@gmail.com Orcid: <https://orcid.org/0009-0004-8459-0462>

Lattes: <http://lattes.cnpq.br/0584412115660517>

⁴ Doctoral student in Urban Development and Environment. Universidade da Amazônia (UNAMA).

E-mail: rodrigolauriafonseca@gmail.com Orcid: <https://orcid.org/0009-0007-6120-5244>

Lattes: <http://lattes.cnpq.br/6072236533521159>

⁵ Master's degree in Civil Engineering. Universidade Federal do Pará (UFPA). E-mail:

edilainecristina@gmail.com

Orcid: <https://orcid.org/0000-0003-3574-3085> Lattes: <http://lattes.cnpq.br/3009334989716730>

⁶ Doctoral student in Urban Development and Environment. Universidade da Amazônia (UNAMA).

E-mail: lysanches2009@gmail.com Orcid: <https://orcid.org/0000-0002-3958-2584>

Lattes: <https://lattes.cnpq.br/3846600562555588>

⁷ Doctoral student in Urban Development and Environment. Universidade da Amazônia (UNAMA).

E-mail: Larissa.m.pantoja@hotmail.com Orcid: <https://orcid.org/0000-0002-7023-2742>

Lattes: <https://lattes.cnpq.br/6539028576094741>

recommendation to limit the occupied capacity to 85%. The Environmental Protection Agency Network Evaluation Tool (EPANET) software was used to study the installation of 4 electric pumps, with an individual flow rate of $0.4 \text{ m}^3/\text{s}$ and a pumping head of 7.2 m, activated by automation when the channel capacity reaches 85% (level of 2.00 m) and deactivated when it reaches 51% (level of 1.20 m). Thus, the computational simulation with SWMM and the assistance of EPANET allowed the study of engineering solutions for a extremely relevant problem that is preventing flooding in Belém-PA.

Keywords: Flooding. Urbanization. SWMM. Armas Basin. Amazon.

RESUMO

A implantação do Parque Linear Nova Doca, na bacia do Armas, em Belém-PA, na Amazônia, para melhoria urbana previamente à realização da 30ª Conferência das Partes da ONU sobre Mudanças Climáticas (COP30), teve por base o estudo hidrológico- hidrodinâmico com uso do código computacional livre Storm Water Management Model– SWMM. Esse estudo formulou modos de combater e prevenir transbordos no Canal da Doca, devido precipitações pluviométricas intensas, baixas cotas altimétricas do terreno (entre 0 e 8m), muito impermeabilizado, e elevado nível de marés. Foi simulado realisticamente o comportamento hidráulico da bacia sob o efeito de chuva de período de retorno de 50 anos, com precipitação de 172 mm em 24 horas, sob o efeito da preamar de 3,02m, indicando necessidade do uso de comportas. Conclui-se que há suscetibilidade de alagamento por maré para terrenos com cotas inferiores a 3,02m. A capacidade ocupada do canal da Doca atingiu 97%, sugestivo para uso de eletrobombas de recalque para prevenção de transbordos, com o indicativo operacional de limitar a capacidade ocupada a 85%. Utilizou-se o software Environmental Protection Agency Network Evaluation Tool (EPANET), para estudar a instalação de 4 eletrobombas, com vazão individual de $0,4 \text{ m}^3/\text{s}$ e altura de recalque 7,2mca, acionadas por automação, quando a capacidade do canal atingir 85% (nível de 2,00m) e desligadas quando atingir 51% (nível de 1,20m). Assim, a simulação computacional com o SWMM e assistência do EPANET permitiu estudar soluções e engenharia para um problema extremamente relevante para o combate e a prevenção de alagamentos em Belém-PA.

Palavras-chave: Alagamentos. Urbanização. SWMM. Bacia do Armas. Amazônia.

RESUMEN

La implantación del Parque Linear Nova Doca, en la cuenca del Armas, en Belém-PA, en la Amazonia, para la mejora urbana previa a la celebración de la 30.ª Conferencia de las Partes de la ONU sobre el Cambio Climático (COP30), se basó en el estudio hidrológico-hidrodinámico con el uso del código informático libre Storm Water Management Model (SWMM). Este estudio formuló formas de combatir y prevenir desbordamientos en el Canal da Doca, debido a las intensas precipitaciones pluviométricas, las bajas cotas altimétricas del terreno (entre 0 y 8 m), muy impermeabilizado, y el elevado nivel de las mareas. Se simuló de forma realista el comportamiento hidráulico de la cuenca bajo el efecto de una lluvia con un período de retorno de 50 años, con una precipitación de 172 mm en 24 horas, bajo el efecto de una marea alta de 3,02 m, lo que indica la necesidad de utilizar compuertas. Se concluye que existe susceptibilidad de inundación por mareas en terrenos con cotas inferiores a 3,02 m. La capacidad ocupada del canal del muelle alcanzó el 97 %, lo que sugiere el uso de bombas eléctricas de recalque para evitar desbordamientos, con la indicación operativa de limitar la capacidad ocupada al 85 %. Se utilizó el software Environmental Protection Agency Network Evaluation Tool (EPANET) para estudiar la instalación de 4 bombas eléctricas, con un caudal individual de $0,4 \text{ m}^3/\text{s}$ y una altura de bombeo de 7,2 mca, accionadas por automatización, cuando la capacidad del canal alcance el 85 % (nivel de 2,00 m) y se apaguen cuando alcance el 51 % (nivel de 1,20 m). Así, la simulación computacional con el SWMM y la asistencia del EPANET permitió estudiar

soluciones e ingeniería para un problema extremadamente relevante para el combate y la prevención de inundaciones en Belém-PA.

Palabras clave: Inundaciones. Urbanización. SWMM. Cuenca del Armas. Amazonas.

1 INTRODUCTION

The city of Belém, capital of the State of Pará, located in the Brazilian Amazon, hosted the mega-event of the 30th UN Conference of the Parties on Climate Change (COP30) in 2025. During the preparatory phase, the city received investments to improve its infrastructure and solve important structural problems, including the urban flooding of the Igarapé das Armas basin, where the Nova Doca Linear Park was implemented, based on the hydrological-hydrodynamic study presented below.

The drainage of the Doca channel, in Belém-PA, represents an important urban challenge in the Amazon, due to its overflows that occur due to high tides and/or heavy rains.

The solution studied for the Armas basin, for the implementation of the Nova Doca Linear Park, was developed based on the hydrological-hydrodynamic computational modeling of this basin, using the SWMM software, including the occurrence of intense rainfall simultaneous to high tides, focusing on recurrent flooding in the Dock Channel, in order to assist in the decisions of projects and works for the implementation of this important work.

The city of Belém-PA has elevation levels between 0 and 16 m (Belém, 2020) and receives intense rainfall, decisive factors for the occurrence of important urban flooding.

Thus, the guiding question of the present research is to verify if it is possible to develop a hydrological-hydrodynamic computational model to formulate adequate components to prevent and combat flooding of the Doca channel in Belém-PA.

It is justified that this issue is crucial, as the functionality of the drainage system of the Canal da Doca stands out for the importance of not flooding Avenida Visconde de Souza Franco, avoiding losses and damages to the city and its inhabitants, especially when there is intense rainfall associated with high tide levels in Guajará Bay.

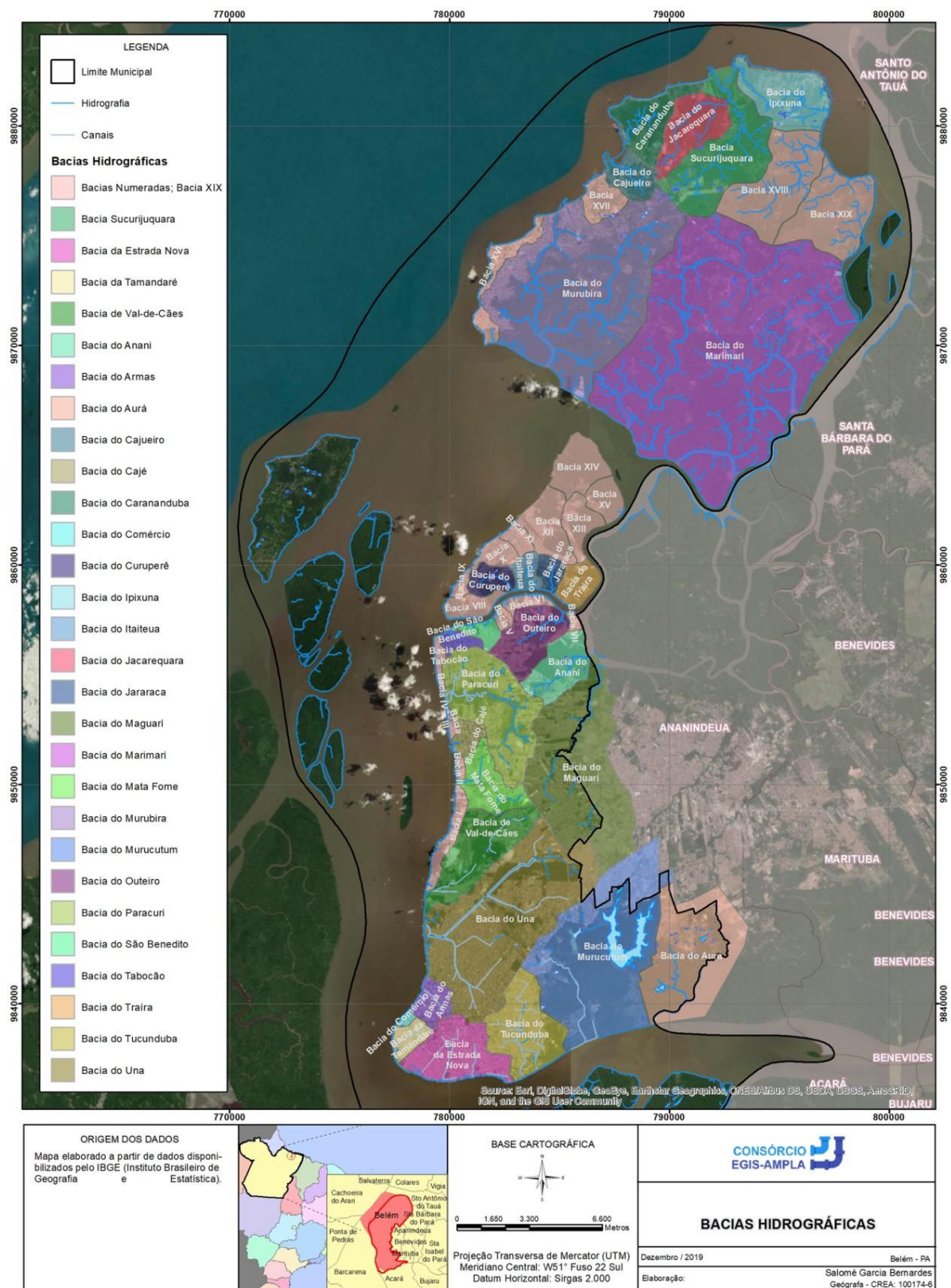
2 THEORETICAL FRAMEWORK

2.1 HYDROGRAPHIC BASINS OF BELÉM-PA

Figure 1 below presents the map of hydrographic basins of Belém-PA.

Figure 1

Map of basins in Belém/PA



Source: Belém (2020).

Figure 2 shows the map of hydrographic basins of the city of Belém-PA, including the Armas Basin.

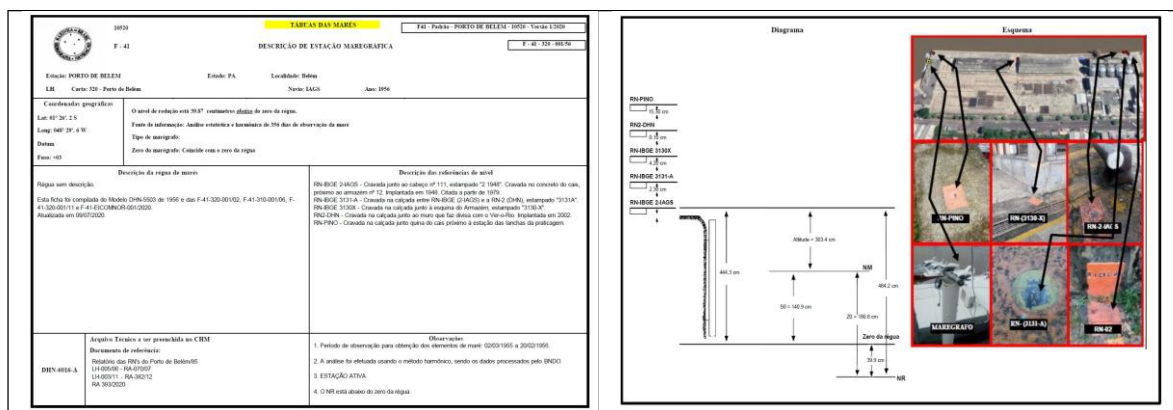
2.2 ALTIMETRY OF THE CHN AND IBGE

The Hydrography and Navigation Center of the Brazilian Navy collects and disseminates information from the Tide Gauge Station of the Port of Belém-PA, with the tide tables of this Port.

Figure 2 shows information regarding the Tide Gauge Station of the Port of Belém-PA.

Figure 2

Information from the Tide Gauge Station of the Port of Belém-PA



Source: CHN (2025).

Figure 2 presents information from the Tide Gauge Station of the Port of Belém-PA, in which the measurement of the tide level is carried out by the reduction level methodology, and not by the Brazilian Altimetric Datum, of the IBGE.

2.3 BRAZILIAN ALTIMETRIC DATUM

According to IBGE (2009), the relationship between the Vertical Datum of the Brazilian Geodetic System (Imbituba and Santana) and the Reduction Levels and Hydrographic "Zeros" on the Brazilian Coast is obtained using the IBGE's Geodetic Database (BDG), which provides geodetic information to be used in engineering projects, mapping and scientific studies.

The most frequently requested information is the altitudes of the vertical stations (Level References, RRNN) of the Brazilian Geodetic System (SGB), for use in studies in which the unevenness or slope are important, such as in the implementation of urban drainage systems in coastal cities, which suffer tidal effect. The altitudes of the SGB originate from two particular values of the mean sea level (NMM), called Datum de Imbituba and Datum de Santana.

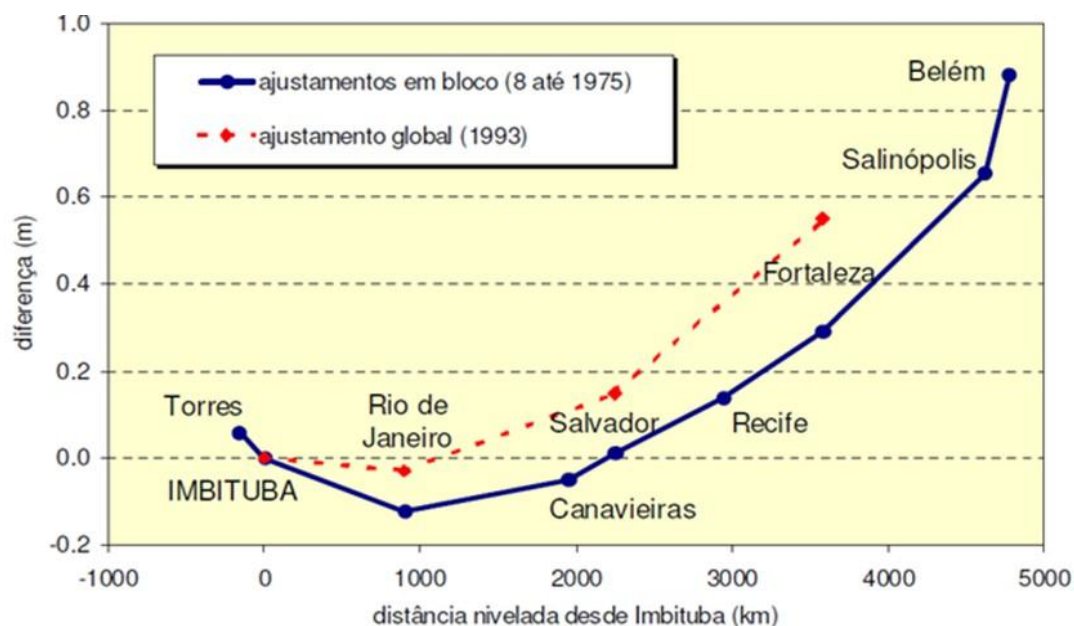
The first was defined from sea level observations of the Port of Imbituba (SC) between the years 1949 and 1957. To define the Datum of Santana (AP), observations made in 1957 and 1958 were used (Alencar, 1990; Femar, 2000; Light; Guimarães, 2003). The most

common source of information on tide levels on the Brazilian coast is the Tide Table (MT), published annually by the Brazilian Navy's Hydrography and Navigation Center (CHN) (CHN, 2025).

Figure 3 shows the differences between the altitudes of the RRNN of the IBGE Brazilian Altimetric Datum, referred to Imbituba, and their heights in relation to the local NMM.

Figure 3

Differences in altitudes of RRNN of SGB in relation to local NMM



Source: IBGE (2009); Alencar (1990).

Figure 3 summarizes the global adjustment of the RAAP geometric leveling data, completed in 1993, which produced altitudes of a significantly higher number of RRNNs than the manual adjustments made periodically between 1948 and 1975 (Alencar, 1990; Light; Guimarães, 2003).

Thus, the port of Belém has a tide gauge reading +0.8808m above the IBGE level (Alencar, 1990) for the terrain, and the positive sign indicates that the plane of the mean sea level recorded by the observations of the local Tide Gauge is higher than that determined in Imbituba, and transported by the leveling.

2.4 SIMULATION USING SWMM

The free computer code *Storm Water Management Model* (SWMM), Urban Drainage Management Model (in Portuguese), is a hydrological-hydrodynamic computer modeling software, developed by the United States Environmental Protection Agency (USEPA) in 1971 (SWMM, 2012). For Garcia (2005) it is the most widely used application worldwide for urban

drainage simulation. It is a physical, distributed, discrete temporal simulation model, where a hydrographic basin is represented by a series of elements such as sub-basins, junctions, conduits, in order to enable the continuous simulation of hydrological-hydrodynamic events and processes (Beling, 2013).

This model has many uses, being able to describe various hydrological processes such as surface runoff, infiltration, groundwater contribution, flow propagation, surface accumulation, and water quality propagation (Shinma, 2011).

3 METHODOLOGY

The hydrological-hydrodynamic computational model of the Armas Basin elaborated using the free software SWMM had the following methodological procedures:

I) Preparation of the tide curve and the precipitation time series; II) Identification and quantification of the components of the basin (sub-basins, nodes and conduits), with their physical characteristics (shape, type and use of soil, slope, sections, extensions, elevations, roughness), based on existing topographic surveys, geographical maps and other available maps; III) Feeding of the model prepared in the SWMM; IV) Execution and analysis of the results obtained.

3.1 LOCUS OF RESEARCH

The research had as its locus the Doca canal, in the city of Belém-PA. The images of the research site are presented below.

Figure 4 shows the Nova Doca Linear Park implanted in the Armas basin in Belém-PA.

Figure 4

Nova Doca Linear Park implemented for COP30 in Belém-PA

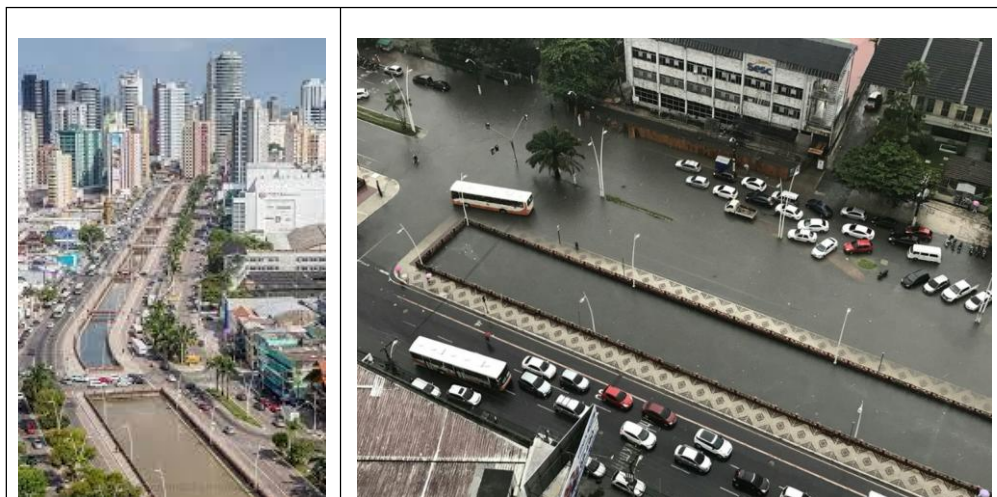


Source: Government of the State of Pará (2025).

Figure 5 below shows an image of the Dock Channel with overflow and flooding due to high tide and heavy rain.

Figure 5

Overflow of the Dock Channel due to high tide and rain on 03/17/2022



Source: <https://g1.globo.com/pa/para/noticia/vias-ficam-alagadas-e-canais-transbordam-apos-chuva-1-hour-fort-in-belem.ghtml>

It is observed in Figure 2 overflow and flooding in the Doca channel under the effect of intense rain and high tide level in its outlet in Guajará Bay. It is a very urbanized and waterproofed area.

Figure 6 shows the floodgates of the Canal da Doca, on Av. Visconde de Souza

Franco, essential to its functionality.

Figure 6

Dock Channel Gates

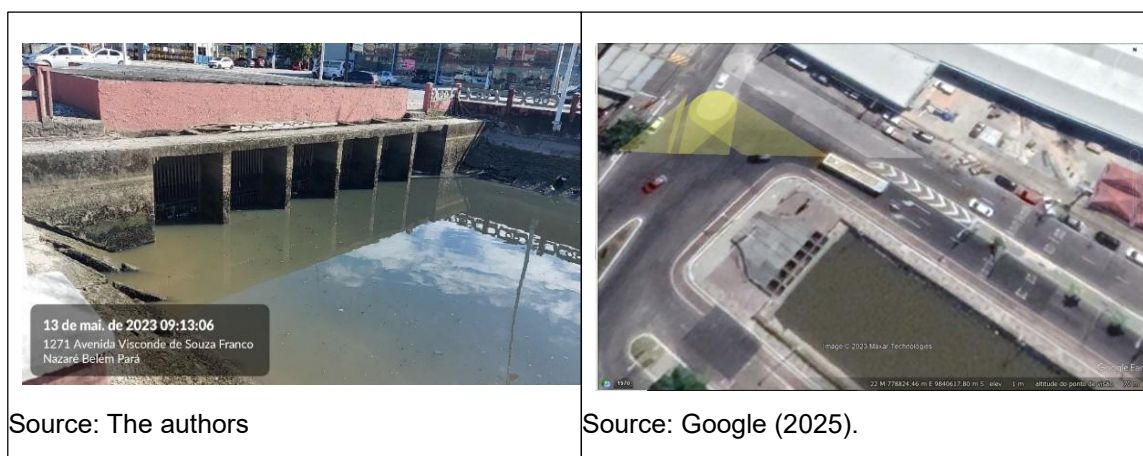


Figure 6 shows the floodgates of the Canal da Doca, in its outlet. The canal has sides covered in concrete, in a very urbanized urban area.

4 RESULTS AND DISCUSSIONS

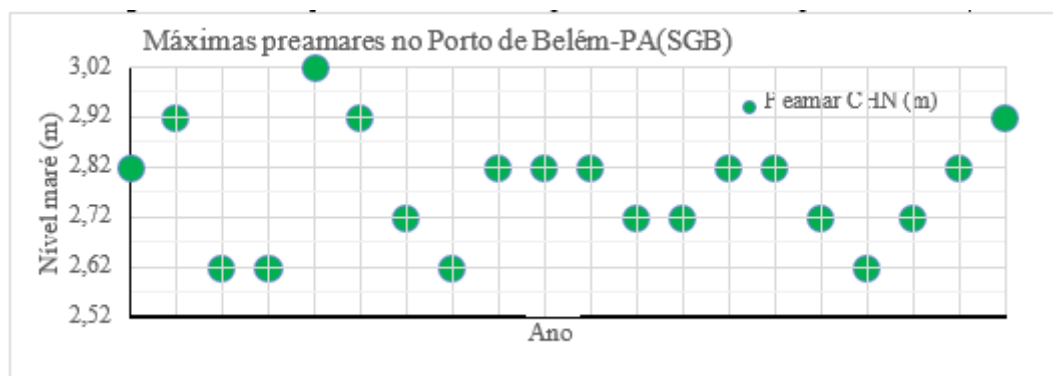
4.1 RESULTS

4.1.1 Tidal curve and precipitation time series

Figure 7 shows the levels of maximum preamares measured in the tide gauge of the Brazilian Navy (CHN) for the port of Belém-PA, transposed to the ground level according to the Brazilian Altimetric Datum of the IBGE.

Figure 7

High tides reported by the Brazilian Navy for Belém-PA



Source: The authors.

Figure 4 shows the levels of the annual preamares maximums informed by the CHN and referenced to the IBGE's Brazilian Altimetric Datum. The maximum preamar, with an

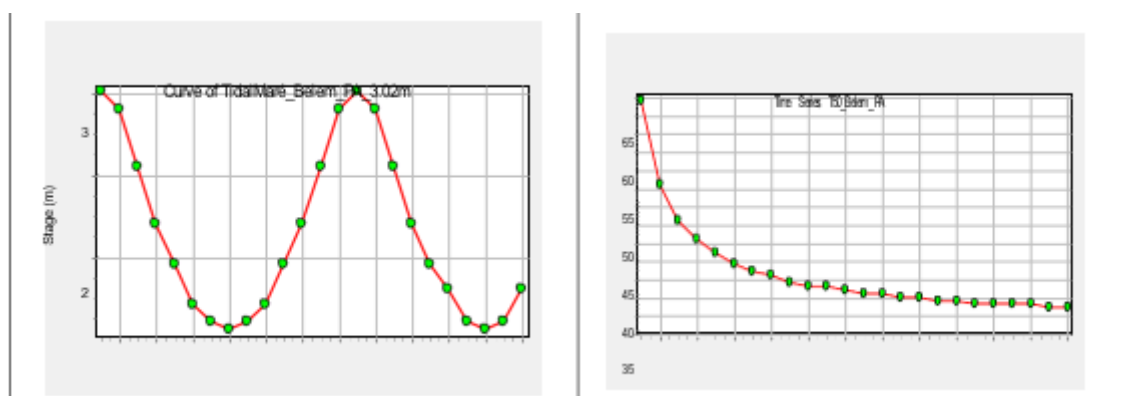
elevation of 3.02 m, occurred only in 2010. Based on the above, the maximum annual preamar with an elevation of 3.02m was adopted for this study. In this way, land with an elevation of more than 3.02m is not susceptible to tidal flooding.

Regarding the time series of rainfall of the 50-year return period for Belém-PA, used for the design of urban macro-drainage works, it was obtained based on Souza *et al.* (2012), with total rainfall of 172 mm and duration of 24 hours, using the methodology of hourly disaggregation of rainfall for the 24-hour event studied.

Figure 8 shows the tide curve with a 3.02m high tide and the rainfall time series, both used in the modeling.

Figure 8

Tidal curve and precipitation time series used in the simulation



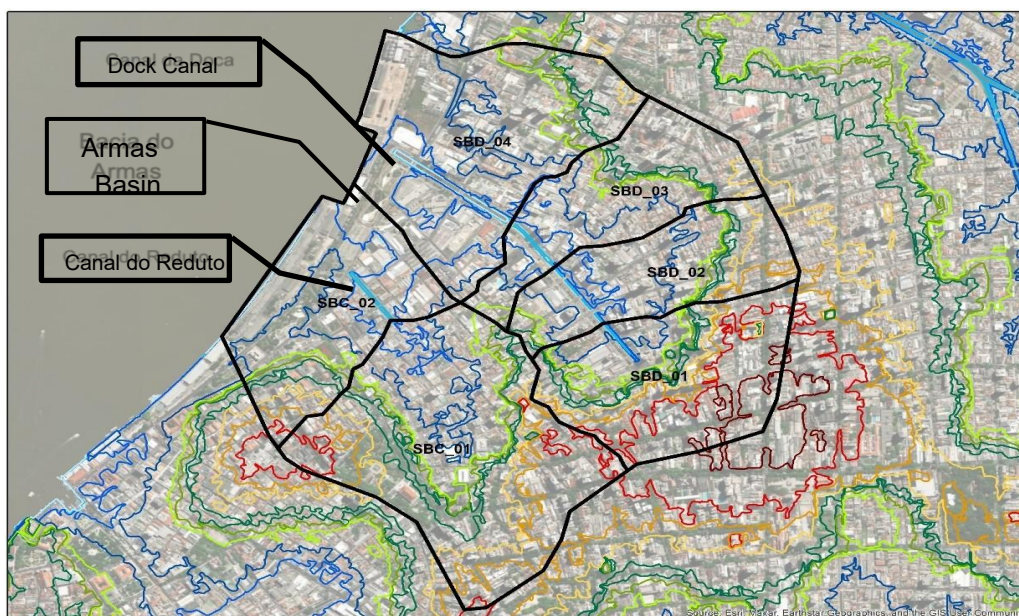
Source: The authors, based on data from CHN (2025).

Figure 8 shows the tide curve of a maximum tide of 3.02m and the rainfall time series with a return period of fifty years T50 used in the simulation.

4.1.2 Armas Basin Information

The Armas basin has an area of 2.8km² with great waterproofing, low altitude (0.8m), high rainfall, tidal influence and for these reasons it has frequent urban flooding. It includes two sub-basins, Doca (area of 1.7 km²) and Reduto (area of 1.1 km²), which are interconnected by an existing pluvial gallery on Rua da Municipalidade. The Canal da Doca, with a length of 1.1 km, is located at Av. Visconde de Souza Franco and Reduto, with a length of 0.3 km, is located at Av. General Magalhães. Both are lined in concrete and equipped with floodgates implanted in the 1960s (Belém, 2020).

Figure 9 shows the Armas Basin with its Doca and Reduto channels.

Figure 9*Armas Basin*

Source: The authors, using the free software QGIS (2025).

Figure 9 shows the Armas Basin, which includes the Doca sub-basin with its four sub-basins and the Reduto sub-basin with its two sub-basins.

Table 1 lists sub-basins, areas, channels and extensions of the Armas basin.

Table 1*Sub-basins and channels of the Armas basin*

Sub-basin	Area (ha)	Exutory	Channel	Top width (m)	Span (m)	<i>n</i>
SBD_01	44,36	PD_01	Dock	10	189,10	0,013
SBD_02	33,14	PD_02	Dock	10	251,60	0,013
SBD_03	35,04	PD_09	Dock	10	180,00	0,013
SBD_04	62,42	PD_12	Dock	20	479,10	0,013
Sum	174,96				1.099,80	
SBC_01	73,00	PC_01	Redoubt	10		
SBC_02	40,21	PC_03	Redoubt	10	278,00	0,013
Sum	113,21					
SUM	288,17				1.377,80	

Source: The authors.

Table 1 shows the Armas basin including the Doca and Reduto canals, which are interconnected by a pluvial gallery on Rua da Municipalidade.

4.1.3 Feeding of the model prepared in the SWMM

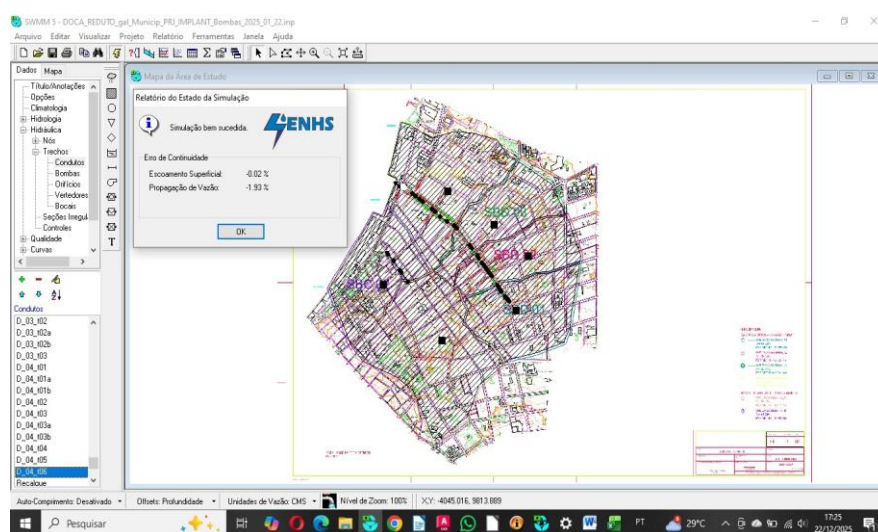
The collected information was inserted into the hydrological-hydrodynamic model of the Armas basin, enabling the execution of the simulation.

4.1.4 Implementation and analysis of the results obtained

Figure 10 below shows the result of the simulation of the Una basin under the effect of rainfall with a recurrence period of 50 years and a pre-tide of 3.02 m.

Figure 10

Result of simulation of the Armas basin in Belém-PA



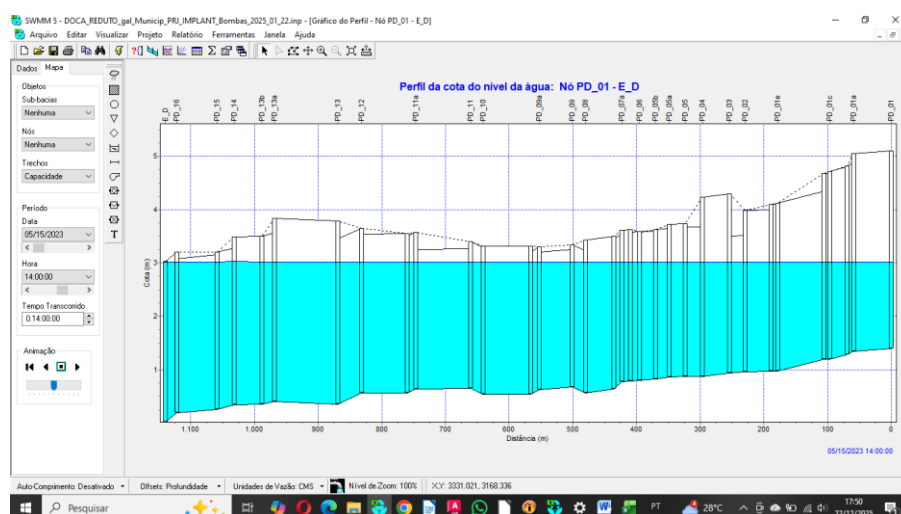
Source: The authors.

Figure 10 shows the successful result of the simulation of the Armas basin with SWMM, with very small errors, of -0.10% for surface runoff and -1.93% for flow propagation.

Figure 11 shows the Dock Channel at the moment of maximum water depth.

Figure 11

Profile of the Dock channel at the moment of maximum water depth



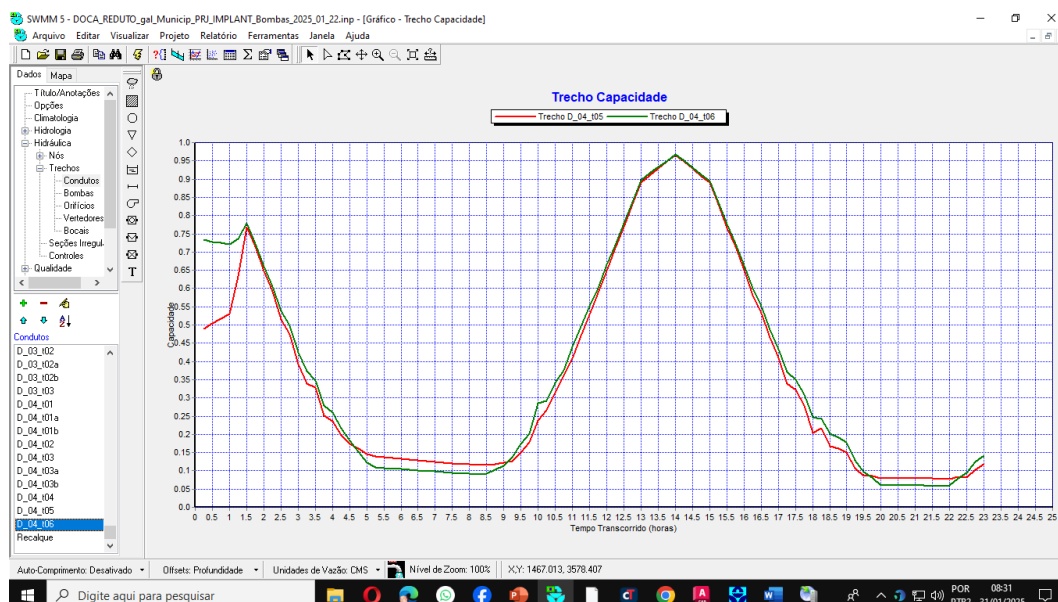
Source: The authors.

Figure 11 shows that the land near the floodgates presents a risk of flooding.

The analysis of the flow with the aid of the computational model elaborated in the SWMM results in the fact that the most critical stretch for overflow and flooding is the final stretch of the Doca channel, as shown in Figure 12.

Figure 12

Time series of the capacity of the final stretch of the Doca canal

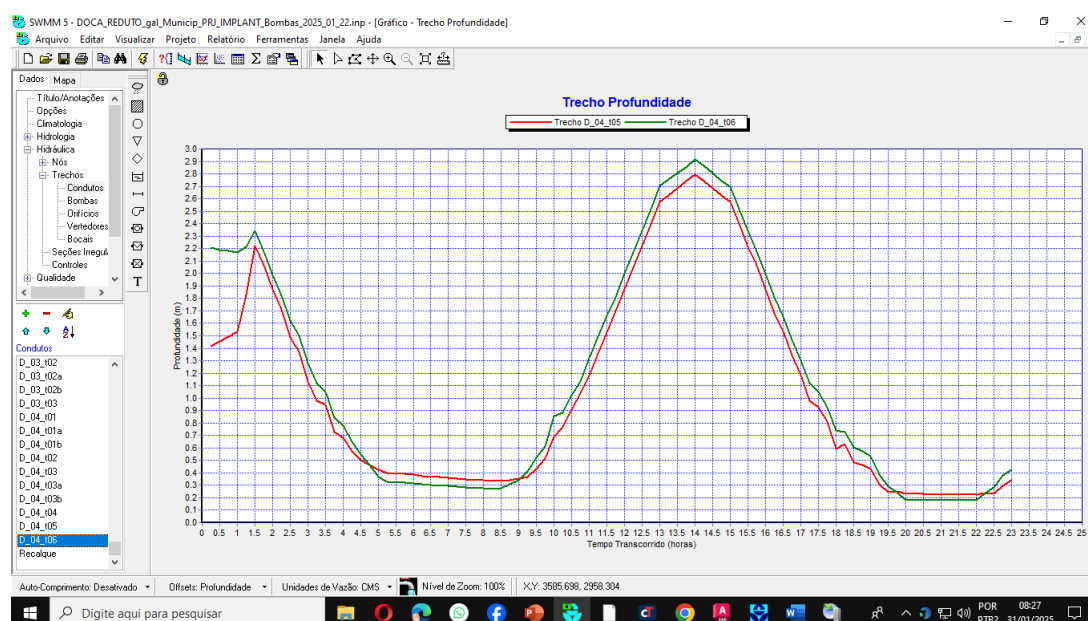


Source: The authors.

Figure 13 shows that the moment of greatest occupied capacity of the channel, from 85% to 97%, occurs in the interval from 12:45 to 15:15 hours after the beginning of the event.

Figure 13

Time series of depths in the final stretch of the Doca channel



Source: The authors.

Figure 14 shows the time series of the flow in the final stretch of the Doca channel.

Figure 14

Time series of the flow in the final stretch of the Doca channel



Source: The authors.

Figure 14 shows that at the moment of maximum occupied capacity of the Dock channel, of 96%, the flow is 4 m³.s⁻¹. As the usual value of 85% is exceeded, the use of booster electric pumps to prevent overflows and flooding is being studied. For this, we opted for the use of the free computational code *Environmental Protection Agency Network Evaluation Tool* (EPANET), also developed by USEPA, and suitable for the study of hydraulic

flows in pressurized conduits. In order to reduce the capacity used in these stretches to up to 85%, in this interval of higher risk of overflow, the insertion of four units of submersible electric pumps was studied, for settlement heights of 7.2mca and individual flows of 0.4m³/s. As an operating rule, they must be activated when the water depth in the section of the lift reaches 2.00m (85% of the capacity of the section) and turned off when it reaches 1.20m (51%), in order to reduce the capacity used in the channel to below 85%, preventing overflows.

Figure 15 shows the proposed location for the Rainwater Pumping Station of the Armas basin (EEAPA), at the confluence of Av. General Magalhães with Rua de Belém, at the end of the Reduto canal, which is connected to the Doca canal by the gallery of Rua Municipalidade.

Figure 15

Proposed location for EEAPA



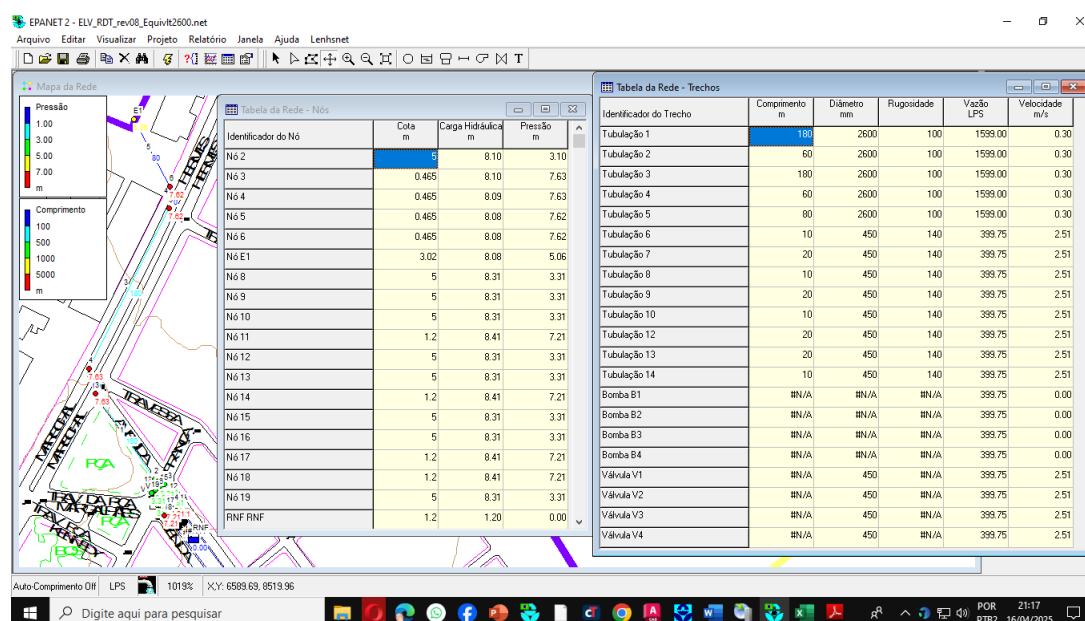
Source: Google Earth (2025).

Figure 15 shows the proposed location of the Armas Basin Rainwater Pumping Station (EEAPA), whose flow will be pumped to the Reduto discharge gallery, located after the floodgates of this channel.

Figure 16 shows the result of the EEAPA simulation in EPANET.

Figure 16

Result of the EEAPA simulation on EPANET



Source: The authors.

Figure 16 shows the result of the EEAPA simulation in EPANET, considering the use of the drainage gallery of the Reduto channel for the flow of pumped water.

Figure 17 shows the discharge section of the Reduto gallery in Guajará Bay.

Figure 17

Reduto Gallery



Source: The authors.

Figure 14 shows the image of the drainage gallery of the Reduto channel, in concrete,

with dimensions height 1.60m, width 3.40m and altimetric level of the bottom slab of 0.465m.

4.2 DISCUSSION

The computational modeling of hydrological-hydrodynamic events in urban drainage basins is extremely useful for urban management, especially for preventing and combating flooding, by demonstrating quantitatively that the association of high rainfall, topography, tidal rise and intense waterproofing can result in the occurrence of overflows and flooding.

5 CONCLUSION

The successful implementation of the Nova Doca Linear Park, in the Armas basin, in Belém-PA as an improvement of urban infrastructure before COP30, was based on the hydrological-hydrodynamic study prepared using a computational model in the SWMM described here.

The constraints of the urban flooding problem were the low elevation of the terrain, which is very waterproofed, the high level of the tides, which suggest the usefulness of the use of floodgates and finally the benefit of the use of electric pumps for rainwater settlement, to prevent overflows and flooding.

The study proved to be very useful, realistically simulating the hydraulic behavior of the basin when subjected to rainfall with a return period of 50 years, precipitation of 172 mm in 24 hours, concomitantly with the maximum known preamar, which occurred in 2010. An important conclusion was the indication of susceptibility to tidal flooding for land with elevation below 3.02m, with bas at the level of the maximum tide, which occurred in 2010,

The computational model resulted in reaching 97% of the capacity in the Dock channel, strongly suggesting the need to use electric pumps to prevent overflows, with the operational indication of maintaining the occupied capacity of the channel at a maximum of 85%.

The implementation of the Armas Rainwater Pumping Station (EEAPA) is an important equipment to prevent/combat overflows and flooding in the Dock Channel (and Reduto), acting at times of high water levels, together with the measures related to altimetric levels and operationalization of the floodgates. In this way, the Armas basin, as explained above, will be equipped with adequate mechanisms to prevent and combat overflows and flooding.

For the implementation of this EEAPA, with the objective of reducing the used capacity of the channel to below 85%, preventing overflows, the installation of four submersible electric pumps in parallel was studied using the EPANET software, and each unit can pump flow rates of 0.4m³/s to settlement heights of 7.2mca. The pumps must be activated when the water depth in the pumping station catchment reaches 2.00m and turned off when it reaches 1.20m,

by automation.

Thus, the computer simulation with SWMM and EPANET allowed to study an extremely relevant problem for the fight and prevention of flooding in Belém-PA and the formulation of appropriate engineering solutions.

ACKNOWLEDGMENTS

The authors express their gratitude to the University of the Amazon (UNAMA), the State Secretariat of Public Works of Pará (SEOP) and the Municipal Secretariat of Urban Zeladoria of Belém (SEZURB) for the institutional and technical support granted. We extend our thanks to the Urban and Environmental Modeling (MURBA) research group for the academic collaboration. Finally, we thank the Coordination for the Improvement of Higher Education Personnel (CAPES) for the support granted through scholarships, a fundamental resource for the development and feasibility of this research.

REFERENCES

- Alencar, J. C. M. (1990). Datum altimétrico brasileiro. *Cadernos de Geociências*, 5, 69–73.
- Belém (PA). (2020). Lei Municipal nº 9.656, de 30 de dezembro de 2020: Institui a Política Municipal de Saneamento Básico do Município de Belém, o Plano Municipal de Saneamento Básico (PMSB), e o Plano de Gestão Integrada de Resíduos Sólidos (PGIRS), em atenção ao disposto no Art. 9º da Lei Federal nº 11.445/2007, com as atualizações trazidas pela Lei nº 14.026/2020, o Novo Marco do Saneamento Básico. Belém. Recuperado em 26 novembro, 2025, de <https://encurtador.com.br/kLOI>
- Beling, F. A. (2013). Calibração automática de parâmetros do modelo SWMM utilizando o algoritmo PEST para simulação hidrológica em bacia urbana (Dissertação de mestrado). Universidade Federal de Santa Maria (UFSM), Santa Maria, RS.
- Centro de Hidrografia e Navegação da Marinha (CHN). (2025). Tábua das marés: descrição de estação maregráfica. Marinha do Brasil. Recuperado em 25 dezembro, 2025, de https://www.marinha.mil.br/chm/sites/www.marinha.mil.br/chm/files/dados_de_mare/105_20_-_porto_de_belem_f-41_padrao_v1-2020_0.pdf
- Fundação de Estudos do Mar (FEMAR). (2000). Catálogo de estações maregráficas brasileiras. Recuperado em 23 setembro, 2024, de <http://www.femar.com.br>
- Garcia, J. I. B. (2005). Monitoramento hidrológico e modelagem da drenagem urbana da bacia hidrográfica do Arroio Cancela (Dissertação de mestrado). Universidade Federal de Santa Maria, Santa Maria, RS.
- Instituto Brasileiro de Geografia e Estatística (IBGE). (2009). Esclarecimento sobre a relação entre o datum vertical do SGB Imbituba e Santana e os níveis de redução e zeros hidrográficos no litoral brasileiro. Recuperado em 2 dezembro, 2025, de <https://www.ibge.gov.br/geociencias/metodos-e-outros-documentos-de->

referencia/outros-documentos-tecnicos-geo/16393-esclarecimento-sobre-a-relacao-entre-o-datum-vertical-do-sgb-imbituba-e-santana-e-os-niveis-de-reducao-e-zeros-hidrograficos-no-litoral-brasileiro.html

Luz, R. T., & Guimarães, V. M. (2003). Dez anos de monitoramento do nível do mar no IBGE. Em Colóquio Brasileiro de Ciências Geodésicas (3., 2003, Curitiba). Anais [...]. UFPR. Recuperado em 20 setembro, 2024, de <https://artigos.ibge.gov.br/artigos-home/geodesia/2004-2000/3089-dez-anos-de-monitoramento-do-nivel-do-mar-no-ibge.html>

QGIS Development Team. (n.d.). QGIS Geographic Information System: Open source geospatial foundation project. Recuperado em 25 dezembro, 2025, de <http://qgis.org>

Shinma, T. A. (2011). Calibração multiobjetivo do SWMM aplicada à transformação chuva-vazão (Dissertação de mestrado). Escola de Engenharia de São Carlos, Universidade de São Paulo, São Carlos.

Souza, R. O. R. M., et al. (2012). Equações de chuvas intensas para o Estado do Pará. Revista Brasileira de Engenharia Agrícola e Ambiental, 16(9), 999–1005.

Storm Water Management Model (SWMM). (2012). EPA SWMM 5.0: Modelo de gestão de drenagem urbana (Tradução de Laboratório de Eficiência Energética e Hidráulica em Saneamento). UFPB. Recuperado em 25 março, 2025, de www.lenhs.ct.ufpb.br/html/downloads/swmm/SWMM_2012.pdf

THE 'RECOMEÇAR LAGES' PROGRAMME: AN INTEGRATED MUNICIPAL POLICY FOR PEOPLE LIVING ON THE STREETS

PROGRAMA RECOMEÇAR LAGES: POLÍTICA MUNICIPAL INTEGRADA PARA A POPULAÇÃO EM SITUAÇÃO DE RUA

PROGRAMA RECOMENZAR LAGES: POLÍTICA MUNICIPAL INTEGRADA PARA LA POBLACIÓN EN SITUACIÓN DE CALLE



<https://doi.org/10.56238/sevened2026.008-230>

Kleberson de Oliveira¹, Joshua Pinto Farias de Almeida², Geovani Broering³, Renato Rodrigues⁴

ABSTRACT

The homeless population represents one of the most complex social challenges in contemporary cities, involving structural factors such as poverty, unemployment, breakdown of family ties, substance abuse, and insufficient housing policies. This article analyzes the proposal of the Recomeçar Lages Program, a municipal public policy aimed at the social reintegration of the homeless population in the municipality of Lages, Santa Catarina. The study adopts a qualitative approach, with normative analysis, literature review, and a local public policy case study. The program is analyzed in light of the fundamental rights established in the 1988 Federal Constitution, the National Policy for the Homeless Population, and the Sustainable Development Goals of the United Nations 2030 Agenda. The theoretical framework articulates contributions from Lenio Streck, Pedro Serrano, Paulo Freire, Selma Garrido Pimenta, and Slavoj Žižek, in addition to institutional data produced by IBGE and IPEA. It is concluded that integrated public policies combining assisted housing, professional qualification, access to healthcare, and productive inclusion present greater potential to reduce homelessness and promote human dignity. The Recomeçar Lages Program demonstrates legal, institutional, and financial feasibility, constituting a relevant instrument for inclusive sustainable development at the municipal level.

Keywords: Public Policies. Homeless Population. Human Rights. Sustainable Development. Social Inclusion.

RESUMO

A população em situação de rua constitui um dos desafios sociais mais complexos das cidades contemporâneas, envolvendo fatores estruturais como pobreza, desemprego, ruptura de vínculos familiares, dependência química e insuficiência de políticas

¹ Master's student in Law and Sustainable Development. Centro Universitário UNIFACVEST. E-mail: oliveerklebermestrado@gmail.com

² Master's student in Law and Sustainable Development. Centro Universitário UNIFACVEST. E-mail: adv.joshuaalmeida@outlook.com

³ Dr. in Law. Centro Universitário UNIFACVEST. E-mail: reitoria@unifacvest.edu.br Lattes: <http://lattes.cnpq.br/5211119375617252>

⁴ Dr. in Law. Centro Universitário UNIFACVEST. E-mail: prpe@unifacvest.edu.br Lattes: <http://lattes.cnpq.br/6556757529380415>

habitacionais. O presente artigo analisa a proposta do Programa Recomeçar Lages, política pública municipal voltada à reinserção social da população em situação de rua no município de Lages, Santa Catarina. O estudo utiliza abordagem qualitativa, com análise normativa, revisão bibliográfica e estudo de política pública local. O programa é analisado à luz dos direitos fundamentais previstos na Constituição Federal de 1988, da Política Nacional para a População em Situação de Rua e dos Objetivos de Desenvolvimento Sustentável da Agenda 2030 da Organização das Nações Unidas. A fundamentação teórica articula contribuições de Lenio Streck, Pedro Serrano, Paulo Freire, Selma Garrido Pimenta e Slavoj Žižek, além de dados institucionais produzidos pelo IBGE e pelo IPEA. Conclui-se que políticas públicas integradas que combinam moradia assistida, qualificação profissional, acesso à saúde e inclusão produtiva apresentam maior potencial de redução da população em situação de rua e promoção da dignidade humana. O Programa Recomeçar Lages demonstra viabilidade jurídica, institucional e financeira, constituindo instrumento relevante para o desenvolvimento sustentável inclusivo em âmbito municipal.

Palavras-chave: Políticas Públicas. População em Situação de Rua. Direitos Humanos. Desenvolvimento Sustentável. Inclusão Social.

RESUMEN

La población en situación de calle constituye uno de los desafíos sociales más complejos de las ciudades contemporáneas, involucrando factores estructurales como la pobreza, el desempleo, la ruptura de vínculos familiares, la dependencia química y la insuficiencia de políticas habitacionales. El presente artículo analiza la propuesta del Programa Recomeçar Lages, una política pública municipal orientada a la reinserción social de la población en situación de calle en el municipio de Lages, Santa Catarina. El estudio adopta un enfoque cualitativo, con análisis normativo, revisión bibliográfica y estudio de política pública local. El programa es analizado a la luz de los derechos fundamentales establecidos en la Constitución Federal de 1988, de la Política Nacional para la Población en Situación de Calle y de los Objetivos de Desarrollo Sostenible de la Agenda 2030 de las Naciones Unidas. El marco teórico articula contribuciones de Lenio Streck, Pedro Serrano, Paulo Freire, Selma Garrido Pimenta y Slavoj Žižek, además de datos institucionales producidos por el IBGE y el IPEA. Se concluye que las políticas públicas integradas que combinan vivienda asistida, capacitación profesional, acceso a la salud e inclusión productiva presentan un mayor potencial para reducir la población en situación de calle y promover la dignidad humana. El Programa Recomeçar Lages demuestra viabilidad jurídica, institucional y financiera, constituyendo un instrumento relevante para el desarrollo sostenible inclusivo a nivel municipal.

Palabras clave: Políticas Públicas. Población en Situación de Calle. Derechos Humanos. Desarrollo Sostenible. Inclusión Social.

1 INTRODUCTION

The homeless population represents a complex and multifactorial social phenomenon, which reflects structural inequalities present in contemporary societies. This phenomenon involves factors such as extreme poverty, unemployment, fragility of family networks, chemical dependency, mental disorders, and insufficient housing and social inclusion policies.

In Brazil, studies produced by the Institute of Applied Economic Research indicate significant growth in this population group in recent decades. Recent estimates indicate that the country has more than 220 thousand people living on the streets, concentrated mainly in urban centers (IPEA, 2023). This scenario highlights the need for structured public policies that go beyond merely welfare approaches.

The Federal Constitution of 1988 instituted a model of State committed to the dignity of the human person and to the realization of social rights. In this sense, social assistance, health, housing and work are fundamental rights whose realization depends on the articulated action of the public power.

From a legal point of view, authors such as Lenio Streck highlight that the Brazilian Constitution has a guiding character, guiding state action in the promotion of fundamental rights and the reduction of social inequalities, as (Streck, 2017).

The Constitution cannot be understood as a mere letter of intent or symbolic document devoid of normative efficacy. In a Democratic State of Law, the Constitution assumes a leading character, establishing normative commitments that bind the public powers to the realization of fundamental rights. This means that state action must be guided by the realization of these rights, especially those related to the dignity of the human person, material equality and the reduction of social inequalities. Constitutional interpretation, therefore, must be carried out in a way that is committed to the effectiveness of rights and the transformation of social reality. (Streck, 2017, p. 94)

Thus, public policies aimed at the homeless population must be understood as instruments of constitutional implementation.

In the field of critical theory, Slavoj Žižek argues that extreme social exclusion reveals structural contradictions in the contemporary socioeconomic system, requiring institutional responses capable of guaranteeing minimum conditions of human dignity (Žižek, 2014).

The most fundamental violence present in contemporary societies is not only that visible in individual actions or direct conflicts, but that which manifests itself silently in the social and economic structures that organize collective life. It is a systemic violence that produces inequality, exclusion and social invisibility, particularly affecting those who are pushed to the margins of society. In these cases, extreme poverty and

exclusion cannot be interpreted as mere individual failures, but as the result of structures that continuously reproduce relations of inequality. (Žižek, 2014, p. 22).

This article aims to analyze the proposal of the Recomeçar Lages Program, a municipal policy aimed at the social reintegration of the homeless population in the municipality of Lages, Santa Catarina. The analysis seeks to understand the legal, institutional and social feasibility of the program, as well as its relationship with the principles of sustainable development and human rights.

2 PUBLIC POLICIES

2.1 LEGAL BASIS AND HUMAN RIGHTS

The implementation of public policies aimed at the homeless population is supported by several constitutional and normative provisions. The Federal Constitution of 1988 establishes, in its article 1, that the dignity of the human person constitutes the foundation of the Brazilian State, while article 6 recognizes social rights such as education, health, work, housing and social assistance.

Pedro Serrano's studies emphasize that the effectiveness of fundamental rights depends on the concrete action of the State in the formulation of public policies capable of reducing inequalities and promoting social inclusion (Serrano, 2016).

In a Democratic State of Law, fundamental rights cannot be understood only as formal declarations inscribed in the Constitution. The effectiveness of these rights requires the concrete action of the State through public policies that guarantee material conditions for their exercise. The 1988 Constitution instituted a model of State committed to the promotion of human dignity, the reduction of social inequalities and the construction of a more just and solidary society. Thus, it is up to the public authorities to formulate and implement policies that ensure social inclusion, access to essential services and protection of groups in vulnerable situations, under penalty of emptying the constitutional project itself. (Serrano, 2016, p. 78).

The infra-constitutional issues include the Organic Law of Social Assistance (Law No. 8,742/1993), the Unified Social Assistance System (SUAS) and Decree No. 7,053/2009, which instituted the National Policy for the Homeless Population. These instruments establish guidelines for ensuring social protection, productive inclusion, and access to essential public services.

The program dialogues with the principles of the United Nations 2030 Agenda, especially with the Sustainable Development Goals related to the eradication of poverty, reduction of inequalities and promotion of sustainable cities.

2.2 EDUCATION, SOCIAL INCLUSION AND EMANCIPATION

The social reintegration of the homeless population requires policies that go beyond welfare and promote autonomy and social emancipation.

Brazilian educator Paulo Freire argues that education is a fundamental instrument of liberation and social transformation, enabling historically marginalized individuals to regain their autonomy and participation in social life (Freire, 1996).

Education does not transform the world alone, but neither does the world transform without it. Educational practice, when guided by democratic and emancipatory principles, allows subjects to critically understand the reality in which they are inserted and develop the ability to intervene in it. In this sense, educating does not only mean transmitting knowledge, but promoting a process of awareness through which men and women recognize their historical and social condition, strengthening their autonomy and their participation in the construction of a more just and egalitarian society. (Freire, 1996, p. 67).

In a complementary way, Selma Garrido Pimenta points out that training processes aimed at social inclusion must consider the life trajectories of the subjects, valuing experiences and promoting integral human development (Pimenta, 2012).

Public policies aimed at the homeless population need to articulate professional training, productive inclusion and access to basic social rights.

2.3 STRUCTURE OF THE RECOMEÇAR LAGES PROGRAM

The Recomeçar Lages Program proposes an integrated municipal policy structured in five main axes:

a. Social approach and registration

It provides for the performance of a multidisciplinary team responsible for identifying and registering beneficiaries, carrying out psychosocial assessment and preparing an Individual Care Plan (PIA). The objective is to ensure that all beneficiaries are included in existing public policies.

b. Assisted living

Inspired by the international model Housing First, the program establishes housing as the starting point of social reintegration. The proposal provides:

- emergency shelter;
- assisted transitional housing;
- referral to permanent housing.

International experiences show that assisted housing policies have more effective results in reducing the homeless population.

c. Professional training and employability

The program provides for partnerships with institutions such as SENAI and SENAC to offer professional courses in the areas of civil construction, logistics, mechanics, carpentry and administrative services. Municipal work fronts and qualification scholarships are also planned.

According to IBGE data, low education and labor informality are recurrent factors among homeless people, which reinforces the importance of professional qualification policies.

d. Comprehensive health and treatment of chemical dependency

The program provides for integration with the Unified Health System, including medical care, psychological follow-up and referral to Psychosocial Care Centers (CAPS).

Strategies for harm reduction and treatment of chemical dependency are also foreseen, respecting legal principles and individual rights.

e. Financial support

The program has an estimated annual cost of approximately R\$ 8.6 million, with funding coming from federal and state resources, parliamentary amendments and partnerships with the private sector.

This strategy seeks to ensure financial sustainability and reduce exclusive dependence on the municipal budget.

2.4 PUBLIC POLICIES AND MUNICIPAL GOVERNANCE

The effectiveness of public policies depends on the institutional capacity for planning and management. In this sense, Lenio Streck points out that the realization of fundamental rights requires constitutional interpretation committed to social transformation (Streck, 2017, p. 94).

The proposal of the Recomeçar Program seeks precisely to materialize this constitutional commitment by articulating different public policies in an integrated model of social inclusion.

3 FINAL CONSIDERATIONS

The homeless population represents one of the most complex social challenges faced by Brazilian municipalities. It is a multifactorial phenomenon that requires structured public policies, capable of integrating social assistance, housing, health and productive inclusion.

The analysis carried out demonstrates that the Recomeçar Lages Program has legal consistency, alignment with constitutional principles and compatibility with the Objectives of Sustainable Development of the 2030 Agenda.

The 2030 Agenda for Sustainable Development is a global action plan aimed at promoting shared prosperity, environmental protection, and social inclusion. The signatory States commit to adopting concrete measures to eradicate poverty in all its forms, reduce inequalities and ensure that all people have access to decent living conditions. In this context, public policies aimed at social inclusion, the protection of vulnerable groups, and the promotion of human dignity represent fundamental instruments for the fulfillment of the Sustainable Development Goals, especially those related to the eradication of poverty, the reduction of inequalities, and the construction of more inclusive and sustainable cities. (UN, 2015, p. 5).

By adopting an integrated approach based on assisted housing, professional training and access to public services, the program contributes to overcoming welfare models and promoting effective social reintegration.

Structured municipal initiatives, when articulated with national policies and with inter-institutional participation, have a high potential to reduce the homeless population and strengthen human dignity as the foundation of the democratic rule of law.

REFERENCES

- Brasil. (1988). Constituição da República Federativa do Brasil de 1988.
- Brasil. (1993). Lei nº 8.742, de 7 de dezembro de 1993: Lei Orgânica da Assistência Social.
- Brasil. (2009). Decreto nº 7.053, de 23 de dezembro de 2009: Política Nacional para a População em Situação de Rua.
- Freire, P. (1996). Pedagogia da autonomia: Saberes necessários à prática educativa. Paz e Terra.
- Instituto Brasileiro de Geografia e Estatística (IBGE). (2023). Indicadores sociais brasileiros. IBGE.
- Instituto de Pesquisa Econômica Aplicada (IPEA). (2023). Estimativa da população em situação de rua no Brasil. IPEA.
- Organização das Nações Unidas (ONU). (2015). Transformando nosso mundo: A Agenda 2030 para o desenvolvimento sustentável. ONU.
- Pimenta, S. G. (2012). Formação de professores: Identidade e saberes da docência. Cortez.

- Rodrigues, R., & Gonçalves, J. C. (2023). Procedimentos de metodologia científica (11ª ed.). Papervest.
- Sen, A. (2000). Desenvolvimento como liberdade. Companhia das Letras.
- Serrano, P. E. A. P. (2016). Autoritarismo e golpes na América Latina. Alameda.
- Streck, L. L. (2017). Jurisdição constitucional e hermenêutica. Forense.
- Žižek, S. (2014). Violência. Boitempo.
- United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development. UN.

HUMAN RIGHTS AND THE RIGHT TO EDUCATION: A SOCIO-ANTHROPOLOGICAL PERSPECTIVE ON DEAF LEARNERS

DIREITOS HUMANOS E O DIREITO À EDUCAÇÃO: POR UM OLHAR SOCIOANTROPOLÓGICO DOS EDUCANDOS SURDOS

DERECHOS HUMANOS Y EL DERECHO A LA EDUCACIÓN: PARA UNA MIRADA SOCIOANTROPOLÓGICA DE EL ESTUDIANTES SORDOS



<https://doi.org/10.56238/sevened2026.008-231>

Simone Aparecida dos Santos Silva¹, Jose Santos Xavier²

ABSTRACT

This study was developed to understand whether clinic-therapeutic conceptions still overlap the socio-anthropological perspective of deaf learners within established legal rights that ensure access to the right to education, which are achievements resulting from struggles for human rights. It briefly addresses the history of Human Rights related to the right to education, as well as analyzes legislation concerning the current conception of deafness and hearing impairment. The methodology used was a qualitative descriptive study based on a socio-historical framework. The instrument consisted of a bibliographic review of laws and authors who have contributed to the discussion of human rights in the current struggle for the recognition of deaf education that meets the needs of this group. The results highlight the need to discuss a more appropriate inclusive school model to foster the autonomy and learning of deaf students. As a contribution, this study finds that established legal rights still largely present a clinic-therapeutic character. However, it also shows advances in legislation toward a socio-anthropological view of the deaf individual, emphasizing the value of Brazilian Sign Language (Libras), thus opening space for a truly inclusive and bilingual school capable of contributing to the construction of autonomy, identity, development, and social participation, enabling individuals to be constituted as subjects of rights and active citizens.

Keywords: Human Rights. Deaf Education. Hearing Impairment. Right to Education.

RESUMO

Este trabalho foi elaborado para compreender se as concepções clinicoterápicas ainda sobrepõem a visão socioantropológica dos educandos surdos dentro dos direitos positivados, que criam acesso ao direito à educação, os quais são conquistas de lutas por direitos humanos. Fazendo uma breve abordagem sobre a história dos Direitos Humanos para o direito à educação, bem como, analisar a legislação sobre a concepção atual sobre surdo e deficiência auditiva. Utilizei como metodologia o estudo descritivo qualitativo com aporte no referencial socio-histórico. Como instrumento a revisão bibliográfica de leis e de

¹ Dr. in Human Development and School Psychology. Universidade de Brasília (UnB).

E-mail: simone.silva061@gmail.com Orcid: <https://orcid.org/0000-0001-9525-9610>

Lattes: <https://lattes.cnpq.br/4528141663131430>

² Dr. in Education Sciences. Facultad Interamericana de Ciencias Sociales.

Orcid: <https://orcid.org/0009-0006-1418-587X> Lattes: <http://lattes.cnpq.br/4901892994841305>

autores que vêm colaborando para discussão dos direitos humanos na atual luta pelo reconhecimento de uma educação de surdo que atenda a necessidade deste grupo. Os resultados evidenciam a necessidade de dialogar sobre a escola inclusiva mais adequada para o fomento da autonomia e aprendizagem deste educando surdo. Como contribuição deste estudo, verifica que, ainda, os direitos positivados, em sua maioria, apresentam um caráter clinicoterapêutico. No entanto, mostra avanços na legislação para uma visão socioantropológica do sujeito surdo, que perpassa pela valorização da língua brasileira de sinais- Libras, abrindo espaço para uma escola inclusiva, que seja realmente bilíngue capaz de contribuir para a construção da autonomia, de sua identidade, permitindo o seu desenvolvimento e participação social para sua constituição como sujeito de direito e político.

Palavras-chave: Direitos Humanos. Educação de Surdo. Deficiência Auditiva. Direito à Educação.

RESUMEN

Este trabajo fue elaborado para comprender si las concepciones clinicoterapéuticas aún se superponen a la perspectiva socioantropológica de los estudiantes sordos dentro de los derechos positivados, que garantizan el acceso al derecho a la educación, los cuales son conquistas derivadas de las luchas por los derechos humanos. Se realiza una breve aproximación a la historia de los Derechos Humanos en relación con el derecho a la educación, así como un análisis de la legislación sobre la concepción actual de la sordera y la deficiencia auditiva. La metodología utilizada fue un estudio descriptivo cualitativo con base en el enfoque sociohistórico. Como instrumento, se empleó la revisión bibliográfica de leyes y de autores que han contribuido al debate sobre los derechos humanos en la lucha actual por el reconocimiento de una educación para sordos que atienda las necesidades de este grupo. Los resultados evidencian la necesidad de dialogar sobre un modelo de escuela inclusiva más adecuado para fomentar la autonomía y el aprendizaje de los estudiantes sordos. Como contribución, el estudio señala que los derechos positivados aún presentan, en su mayoría, un carácter clinicoterapêutico. No obstante, también se observan avances en la legislación hacia una visión socioantropológica del sujeto sordo, destacando la valorización de la Lengua Brasileña de Señas (Libras), lo que abre espacio para una escuela inclusiva verdaderamente bilingüe, capaz de contribuir a la construcción de la autonomía, la identidad, el desarrollo y la participación social, permitiendo su constitución como sujeto de derechos y ciudadano activo.

Palabras clave: Derechos Humanos. Educación de Sordos. Deficiencia Auditiva. Derecho a la Educación.

1 INTRODUCTION

Currently we can talk about human rights thanks to the struggles of people, groups and movements that were and still are protagonists of this process. In this scope, this work aims to articulate human rights with the right to education of deaf subjects with a qualitative methodology from a socio-historical perspective using the critical analysis of the literature review studied. With this said, analyzing the conceptions of human rights, deafness and the right to education, as well as understanding the legislation on the combination of these themes requiring spaces for new dialogues, makes this study relevant to the context of education and diversity. I believe that the type of inclusive school we currently have denies an autonomous interactional relationship of these subjects with the social, so the objective of this study is to understand if the clinicotherapeutic conceptions still overlap the socio-anthropological view of deaf students within the positive rights.

To think about the history of human rights, there is not a single way, and it is made up of a complex and diffuse character. In one of these ways, we have many philosophers who claim that rights are intrinsically linked to the way we determine what it is to be human and the implications that this carries when we question the way we see the other in this relationship. In this aspect, it is configured that human beings are possessors of rights by virtue of their human dignity, that is, by the fact that we are human and it is impossible to measure the value of each one. It is necessary to have the conviction that human beings have values, while non-humans have a price. This great distinction has also placed man a slave to man himself. The human being is unique and irreplaceable, and it is unacceptable to set a price for his life. To understand this fact, it is enough to identify those who can have access to a quality school, those who are marginalized because they are not considered fit for the needs of the capitalist market, or have their potential subjugated. In this scope, the deaf student has been harmed and suffering violations of rights that come from their quality academic training. The right to education is one of the first steps to reduce social inequality. This should be a fact, however, we still see today a specialized and cruel slavery.

2 DEVELOPMENT

Human dignity is not a closed concept, and can vary according to time, location of society, peoples, beliefs and values. From this come great criticisms about the concept of human dignity and, consequently, the universality of human rights because they are proper to human nature (Santos, 2006). Here we are using a Kantian concept of human dignity, which states that nothing in the world is superior or similar to it. Human dignity can take on other contexts and configurations according to the attributes that are proposed to it.

For the author Lynn Hunt (2009), in her book *"The Invention of Human Rights; a history"* - human rights have a diffuse and omnipresent history today, which requires a broader and debatable history, but self-evidence is very important for understanding it. One of the great contributions of Hunt (2009) is to make a theoretical-bibliographic approach to the documents that underpinned human rights, highlighting their relevance without ignoring that it is a risk to take them as the history of human rights for the whole world. In addition, it transits in the field of literature, through epistolary novels that influenced individual feelings, to argue the creation of new social and political concepts for the flourishing of human rights. It analyzes the Declaration of Independence of the United States (1776), the Declaration of Man and of the Citizen that gained momentum with the French Revolution of 1789 until reaching the Universal Declaration of Human Rights (UDHR) (1948). Showing that there was a certain consensus between the last two statements, despite their particularities, "although the changes in language were significant, the echo between the two documents is unequivocal" (Hunt, 2009, p.15). Although almost two centuries have passed between the contradictory actions of the French Revolution and UDHR (1948), there is in common, among other aspects, the historical contexts to which they were forged, and which placed human rights as natural, because we were born free, equal in dignity and rights.

The author shows that it was a process of construction that demanded an inner awareness on the part of the individual and that this required the transformation of thought, social structure, politics and culture. According to Hunt:

Human rights are not just a doctrine formulated in documents: they are based on a disposition towards other people, a set of convictions about what people are like and how they distinguish right and wrong in the secular world (Hunt, 2009, p. 25).

Hunt (2009) argues that even though the Declaration of Human Rights (1948) was an advance, due to the way society was structured at the time, there were exclusions for some people. This was true for women, slaves, children, and people considered "abnormal." For these people, "natural, equal, and universal human rights" were not possible because of the way they were perceived by the others who proposed the declaration. They were considered incapable of having a "moral autonomy".

Human rights remain subject to discussion because our perception of who has rights and what those rights are constantly changes according to the very historicity of human life. The struggle for human rights is "ongoing" (Hunt, 2009). The Declaration of Human Rights should be seen as the beginning of the journey. Each generation embodies the law of the other generation, not in a linear way, but in a way that writes the history of human rights itself

in a dialectical way.

The Universal Declaration did not simply reaffirm eighteenth-century notions of individual rights, such as equality before the law, freedom of speech, freedom of religion, the right to participate in government, the protection of private property, and the rejection of torture and cruel punishment. It also expressly forbade slavery and provided for universal and equal suffrage by secret ballot. In addition, it required freedom of movement, the right to a nationality, the right to marry and, most controversially, the right to social security; the right to work, with equal pay for equal work, on the basis of a living wage; the right to rest and leisure; and the **right to education**, which should be free at the elementary levels (Hunt, 2009, p. 206 – *emphasis mine*).

It was from it that education as a right emerged. The Universal Declaration of Human Rights configured and still is a reference for different generations and dimensions of Human Rights. Such as the generation of civil and political rights, the generation of economic, social and cultural rights in the nineteenth century until the middle of the twentieth century (which had its rise against exclusionary capitalism) and the generation of the collective rights of humanity. Undoubtedly, it is a human "invention" that deserves to have its relevance recognized. Therefore, we need to *(re)invent human rights*, based on what we perceive and define what it is *to be human* today and also, as a continuous process, built by political struggles. According to Herrera Flores (2008), it is a cultural convention in a tense field, they are processes of openness that are built from the claims and demands of the subjective and objective human needs for human dignity. A critical stance is needed in relation to human rights, so that it is not a legacy only for a specific people, group or class. May their ideals of liberty, equality and fraternity be influenced not only by empathy, but beyond. May it be seen with solidarity and otherness, that the consequences of this Declaration truly reach everyone, respecting the principles of equality and difference (Santos, 2006). Where the continuity of the history of human rights does not allow exclusion and human suffering, for lack of recognizing oneself in the other.

Based on these assumptions, nowadays, there are several dialogues about being deaf and hearing impaired. We have movements that emphasize the importance of a socio-anthropological view of deafness, which defends the bilingual school ^[1], as well as the defenders of the clinical-therapeutic view, who can defend oralism ^[2]. In this context, Bourdieu (2010) uses *cultural capital* to explain how culture, in a society divided into classes, is transformed into a kind of currency that the dominant classes use to accentuate "inequalities". Culture becomes an instrument of domination. In addition, the ruling class imposes on the dominated classes its own culture, giving it an unquestionable value, making them a unique and correct model of culture. For example, we have the education of the deaf totally

influenced by a dominant culture of oralism, which is based on the reproduction of the audist culture, denying any deaf culture. According to Lopes,

The struggles for the recognition of sign language in schools, for the recognition of the deaf community and for the end of oralist practices in working with deaf subjects occupied the educational scenario with more academic, social and political expression only from the end of the eighties and the beginning of the nineties of the twentieth century. p. 25).

Without the participation of the deaf, there was the Milan Congress in 1880, in which the method of oralism was considered the only form of teaching methodology for the deaf. A setback in the education of these subjects. An imposition of the dominant Audist culture, which bases its culture on the act of listening, on the culture of the dominated, the deaf. Bourdieu (2010), perceiving this dynamic of symbolic power, defined it as *arbitrary dominant cultural*, which is nothing more than one culture imposing itself on another. These relationships are constantly changing, both due to technological advances and how society perceives and relates to people who have these attributes. It all depends on which reference is given to the question. In line with Lopes' idea, we have that:

As previously developed, while the first (*being deaf*) implies the presence of sets of cultural practices that start from deaf referents of ways of being, the second (*hearing impaired*) implies the presence of sets of practices, also cultural, but that start from hearing referents of ways of being. There is a significant distance between these two sets of practices (Lopes, 2012, p. 243).

However, according to the principle of equality and the principle of difference of Santos (2006), it is the subject of the discourse who must empower and recognize himself. It is a debate with a productive tension, which makes us resignify the other and ourselves. Starting from the fact that the struggle for human rights aims at the dignity of human life, thus, guided by the socio-historical and cultural framework, to briefly analyze the positive rights that evidence this constant struggle for recognition and rights.

The 1975 Declaration of the Rights of the Disabled Person, promoted by the United Nations - UN - despite being a great advance, was shown in its arguments as a kind of concession. In 1981, the same institution promotes the International Year of Persons with Disabilities, which culminated in 1982 the World Program of Action on Persons with Disabilities, it is considered by many authors as a textual milestone that puts the issue of the human rights of people with disabilities on the agenda in an inclusive perspective because it wants to promote paths and not just grant them. This program talks about equal opportunity to have access and participate in society more effectively. Thus taking the focus off the

dominant view that was had: the medical approach to disability, where rehabilitation was seen as salvationist. The problem with the medical view was to absolutize rehabilitation as the only possible path. In this aspect of rehabilitation, of being framed by the norm, that is, "curing" the abnormality, the analysis of the clinical-therapeutic definition of deafness, makes us think that if it were only the issue of hearing, the human rights of the hearing person would be fully respected and enforced. Next, the UN organizes a text on December 14, 1990, Resolution No. 45/1991, which demanded a change in perception about disability, all of this forged by struggles of various social groups that experienced exclusion due to lack of objective and subjective material conditions, which society was organized, it was a change of paradigms: from perception to action.

The Vienna Declaration (1993), according to Lindgren Alves (1995), had as one of its milestones the reaffirmation that all human rights and fundamental freedoms are universal. It can be inferred from this statement that the inclusion, without restrictions, of the person with disabilities, in its item 63:

6. Rights of Persons with Disabilities 63. The World Conference on Human Rights reaffirms that all human rights and fundamental freedoms are universal in them, and therefore include without reservation persons with disabilities. All people are born equal with the same rights to life and well-being, to education and work, to live independently and to actively participate in all aspects of life in society. Thus, any direct discrimination or other negative discriminatory treatment of a person with a disability constitutes a violation of his or her rights. The World Conference on Human Rights calls on Governments, where necessary, to adopt or adapt existing legislation to ensure access to these and other rights for persons with disabilities (UN, 1993).

This declaration, according to Alves (1995), had relevant characteristics about the universality and indivisibility of human rights. He put on the agenda the right to solidarity and peace, the right to development and environmental rights, as well as Human Rights in Brazilian policies. Item 64 states that the place of the person with disabilities is everywhere. Item 65 makes evident the promotion of equal opportunities for all. Knowing that for this, a change in thinking about humanistic education would be necessary, in its item 78, it states the importance of education in human rights for a culture of peace and development.

64. Persons with disabilities must have a place everywhere. Equal opportunities for people with disabilities should be guaranteed through the elimination of all socially imposed barriers, whether physical, financial, social or psychological, which exclude or limit their full participation in life in society (UN, 1993).

This declaration became a milestone that put Human Rights on the world stage again, the Vienna Declaration gave rise to the Salamanca Declaration of 1994, which highlights the

concept of education for all and respect for differences. It also contributes to the appreciation of what the Brazilian Federal Constitution of 1988 already stated in its Chapter III, Articles 205, 206 and 208. Who say that education is a right of all and a duty of the State, specifying and detailing this right.

The 1999 Guatemala Convention, the so-called Inter-American Convention for the Elimination of All Forms of Discrimination Against Persons with Disabilities, with Brazil as a signatory, which creates Decree 3.956/2001 agreeing with deliberate actions in this convention, opened space for other proposals that contributed to the base text in favor of persons with disabilities. It fosters in inclusive public policies Decree No. 3,298/99 CONADE - National Council for the Rights of Persons with Disabilities, and registers in Decree No. 5,926/04, article 3, the first item that defines *disability* as: "any loss or abnormality of a psychological, physiological or anatomical structure or function that generates incapacity to perform an activity, within the standard considered normal for human beings". In its second item, it defines *permanent disability* as "that which has occurred or stabilized for a period of time sufficient to not allow recovery or to have a probability of changing, despite new treatments". In its third item, it defines *disability* as "an effective and marked reduction in the capacity for social integration, with the need for equipment, adaptations, means or special resources so that the person with disabilities can receive or transmit information necessary for their well-being and the performance of the function or activity to be performed". (BRAZIL, 2004). This same decree, in article 4, item II, was amended in 2005, now providing:

According to Decree 5.626, of December 22, 2005, Art. 2:

[...] a deaf person is considered to be one who, due to hearing loss, understands and interacts with the world through visual experiences, manifesting their culture mainly through the use of the Brazilian Sign Language - Libras. Sole Paragraph. Hearing impairment is considered to be bilateral, partial or total, loss of forty-one decibels (dB) or more, measured by audiogram at the frequencies of 500Hz, 1,000Hz, 2,000Hz and 3,000Hz (Brazil, 2005).

We can analyze that in these positive rights, the definition of disability is perceived by loss, abnormality, incapacity, placing the definition of hearing impairment on the same level as clinicotherapy, with a medicalized view that seeks a standard of normality.

In the Libras Law, we can understand a significant advance in its 22 years of existence. This Decree No. 5,626/05, which regulates Law No. 10,436/02 - Libras Law and in its article 2, presents a more socio-anthropological conception of deafness, by emphasizing the cultural identities of these subjects from the communicative and linguistic action through Libras and by the way it relates to the world through visual experiences. The approval of Libras (Brazilian

Sign Language) in 2002, as the official Brazilian language, thus having two legally recognized languages, the Portuguese language and the Brazilian sign language - Libras, was and is a historical reference in positive law for the deaf person and the community in which he or she is inserted.

According to Lopes (2012), from this instrument it is possible to resignify the deaf subject in other social spheres, in addition to the corrective views for such normality. In 2006, the UN General Assembly, based on the International Convention on the Rights of Persons with Disabilities, which had as its motto "*Nothing about us, Without us*", in its article 2, builds legal advances for the disabled person. The rights to health, inclusive education, transportation, leisure, culture, habilitation, rehabilitation, work and professional training are established. He is seen, legally, as a subject of law, encompassing both conceptions, both clinicotherapeutic and socio-anthropological (Santos, 2017, Silva & Pedroza, 2023). An advance for dialogues and the various ways of recognizing people with disabilities.

Article 1 - The purpose of this Convention is to promote, protect and ensure the full and equitable enjoyment of all human rights and fundamental freedoms by all persons with disabilities and to promote respect for their inherent dignity. People with disabilities are those who have physical, intellectual or sensory impairments, which, in interaction with various barriers, can obstruct their full and effective participation in society with other people (CORDE, 2008).

According to the IBGE (2010 Census), 23.90% of the total Brazilian population, that is, 45,606,048 Brazilians are people with disabilities. In the 2022 Census, it increased to 18.6 million people with disabilities, which corresponds to 8.9% of the Brazilian population aged 2 years and over. According to the IBGE (2022 Census), the number of deaf people in Brazil exceeds 10 million. It points out that despite the law that determines the use of Libras, these subjects still face great difficulties in accessing basic day-to-day services, provided by public and private agencies.

In the Federal District, according to CODEPLAN (2018), hearing impairment has an incidence rate of 0.9% of the total population, and the percentage of people with some disability has the highest rate in low-income (5.5%) and middle-income (5.3%) Administrative Regions (RAs), compared to high-income (3.2%) and upper-middle-income (4.7%) ARs. Thus, it can be inferred that people with disabilities are in greater numbers in low-income areas.

With this, we have a significant number of people who live in D, who self-declared themselves as one of the options in relation to "listening". Therefore, severe hearing impairment and/or deafness, according to how we analyzed the possible definitions above,

need an affirmative public policy for these people. Based on this analysis, the right to education for this population, it is essential to have human rights as a reference as a foundation for new advances.

If we consider ourselves deaf, it does not mean that we have paranoia. It means that we are being the other with our otherness. We are the deaf, the unanimous people gathered in the self-presence of sign language, of language that evokes a difference from other peoples, of visual culture, of the way of being. We are alterities proven by experience, other alterities. We are deaf! (Perlin ^[3], 2003, p. 92).

In view of this, these subjects can self-declare themselves deaf users of Libras, as well as hearing impaired. In line with the book "The Convention on the Rights of Persons with Disabilities Commented" (CORDE; SEDH, 2008), which adds to the motto of the 2006 convention, "Nothing About Persons with Disabilities without Persons with Disabilities!", we have that the definition of being deaf and/or hearing impaired is beyond dichotomies. According to Skliar (1999):

Deafness is currently configured as a territory of representations that cannot be easily delimited or distributed in opposing conceptual models, such as clinical or socio-anthropological. It is, in other words, an irregular territory through which asymmetrical discourses and practices transit in terms of the power/knowledge relations that determine them. Moving from the naturalization of medicine to the curiosity of ethnography [...] And the central issue seems to me to be, instead, to move from ethnographic curiosity to the political recognition of deafness as a difference (Skliar, 1999, p. 10).

Starting from this author and the extremely relevant contributions of Perlin (2003), the articulation between human rights and the education of the deaf is in a dialectical tension (Santos, 2006), which aims at the relations between the subject and the object, realizing that culture is for human nature, and vice versa, thus breaking with old paradigms, which studied man separated from his culture, and try to respond to the challenges of inequalities and exclusions that the crisis of Modernity presents. Informing that the inclusive school ^[4] for these subjects of rights should value the deaf culture ^[5] and its implications for social participation. Currently, the socio-anthropological and biopsychosocial vision has been showing advances towards the right to education of these subjects of rights, also with the approval of the Statute of Persons with Disabilities, Law No. 13,146/2015, known as the Brazilian Law of Inclusion - (LBI). From effective actions and positive rights, we can have a new vision of these subjects of rights for political subjects (Freire, 2023). The problem or obstacle is not found in the person or in his disability, but evokes that the disability assumes a social construct that leads to marginalization and, consequently, exclusion. Evidencing that the social structure and its

networks must create spaces for dialogue and actions to contemplate the different human diversities.

3 CONCLUSIONS

The history of human rights should be perceived as an advance for the good of humanity and a social and human construct. We cannot attribute its creation only to the West or the East, because we know that the history of humanity itself has had neither as the center of all human production. In fact, the Declaration of Human Rights (1948) must have its importance recognized, for being a human production made from struggles aimed at human dignity, for being courageous in the face of the demand of the time and its contributions to the present day. We know the cruelty that men are capable of, and their creation serves to show that it is possible to build a better future for all humanity

As a contribution of this study, we found that legislation according to its distancing or approximation of conceptions about human rights can have a clinical-therapeutic and socio-anthropological character on deafness. This actively influences the social conditions and access to the right for these deaf students. For this, it is essential to recognize the autonomy and capacity for emancipation of the subjects involved through alterity to overcome the hegemonic domination of cultures considered as dominant cultural capitals (Bourdieu, 2010). Having the right to education goes through the process of resignifying this education itself. Including discussing what kind of inclusive school should be built for the demands and expectations of these subjects. The definition of deaf and hearing impaired depends on the contour of the gaze we give. However, it is up to the subject himself to define himself. The different definitions for these terms are found in a discourse that demands an epistemic rupture in order not to be just an exchange of terms, it must go through the recognition of the difference that constitutes multifaceted subjects and possessors of rights. Seeking a school that meets the objective and subjective needs, that promotes independence for the social transformation of these deaf students is to promote human rights and their ramifications in various social, cultural and economic spaces, it is to move towards the construction of a more just society.

REFERENCES

- Bourdieu, P. (2010). *O poder simbólico* (14^a ed., F. Tomaz, Trad.). Bertrand Brasil.
- Brasil. (1988). *Constituição da República Federativa do Brasil*. Recuperado em 9 janeiro, 2024, de http://www.planalto.gov.br/ccivil_03/constituicao/ConstituicaoCompilado.htm
- Brasil. (2002). Lei nº 10.436, de 24 de abril de 2002: Dispõe sobre a Língua Brasileira de

Sinais – Libras – e dá outras providências. Diário Oficial da União.

Brasil. (2015). Lei nº 13.146, de 6 de julho de 2015: Lei Brasileira de Inclusão da Pessoa com Deficiência (Estatuto da Pessoa com Deficiência). http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Lei/L13146.htm

Brasil. (2005). Decreto nº 5.626, de 2005: Regulamenta a Lei nº 10.436 sobre a Língua Brasileira de Sinais (Libras). Recuperado em 9 janeiro, 2024, de http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2005/Decreto/D5626.htm

Brasil. (1999). Decreto nº 3.298, de 1999: Política Nacional para a Integração da Pessoa Portadora de Deficiência. Recuperado em 9 janeiro, 2024, de http://www.planalto.gov.br/ccivil_03/decreto/d3298.htm

Brasil. (2001). Decreto nº 3.956, de 8 de outubro de 2001: Promulga a Convenção Interamericana para a Eliminação de Todas as Formas de Discriminação contra as Pessoas Portadoras de Deficiência. Recuperado em 9 janeiro, 2024, de http://www.planalto.gov.br/ccivil_03/decreto/2001/d3956.htm

Companhia de Desenvolvimento do Planalto Central (CODEPLAN). (2018). Pesquisa distrital por amostra de domicílios – Distrito Federal (PDAD/DF 2018).

Instituto Brasileiro de Geografia e Estatística (IBGE). (2010). Censo demográfico 2010. Recuperado em 28 dezembro, 2023, de <http://censo2010.ibge.gov.br/>

Instituto Brasileiro de Geografia e Estatística (IBGE). (2022). Censo demográfico 2022. Recuperado em 16 janeiro, 2024, de <https://censo2022.ibge.gov.br/>

Herrera Flores, J. (2009). A (re)invenção dos direitos humanos (C. R. D. Garcia et al., Trad.). Fundação Boiteux; IDHID.

Hunt, L. (2009). A invenção dos direitos humanos: Uma história (R. Eichenberg, Trad.). Companhia das Letras.

Freire, P. (2023). Pedagogia do oprimido. Paz e Terra.

Lindgren Alves, J. A. (1995). Os direitos humanos como tema global. Fundação Alexandre Gusmão; Perspectiva.

Lopes, M. C. (2007). Surdez & educação. Autêntica.

Lopes, M. C. (2012). Escola bilíngue para surdos. Em M. C. Lopes (Org.), Cultura surda & Libras. Editora Unisinos. Recuperado em 15 novembro, 2023, de <http://cdn.veduca.com.br/uploads/lecture/material/335%20-%20Livro%20da%20disciplina%20-%20Cultura%20Surda%20e%20Libras.pdf>

Organização das Nações Unidas (ONU). (1975). Declaração dos direitos das pessoas deficientes. Recuperado em 6 janeiro, 2024, de http://portal.mec.gov.br/seesp/arquivos/pdf/dec_def.pdf

Organização das Nações Unidas (ONU). (1993). Declaração e programa de ação de Viena: Conferência Mundial sobre Direitos Humanos. Recuperado em 16 janeiro, 2024, de <http://www.cedin.com.br/wp-content/uploads/2014/05/Declara%C3%A7%C3%A3o-e->

- Perlin, G. T. T. (2003). O ser e o estar sendo surdos: Alteridade, diferença e identidade (Tese de doutorado). Universidade Federal do Rio Grande do Sul.
- Santos, S. A. dos. (2017). O direito ao acesso à educação superior como direito humano de pessoas surdas (Dissertação de mestrado). Universidade de Brasília. Recuperado em 18 janeiro, 2024, de <https://repositorio.unb.br/handle/10482/31552>
- Santos, B. de S. (1996). Para uma pedagogia do conflito. Em L. H. Silva, J. C. Azevedo, & E. S. Santos (Orgs.), *Novos mapas culturais: Perspectivas educacionais*. Sulina.
- Santos, B. de S. (2006). Para uma concepção intercultural dos direitos humanos. Em B. de S. Santos, *A gramática do tempo: Para uma nova cultura política*. Cortez.
- Secretaria de Direitos Humanos da Presidência da República (SDH/PR) & Secretaria Nacional de Promoção dos Direitos da Pessoa com Deficiência (SNPD). (2012). *Cartilha do Censo 2010 – Pessoas com deficiência*.
- Secretaria Especial dos Direitos Humanos (SEDH/CORDE). (2008). *A Convenção sobre os direitos das pessoas com deficiência comentada*. Recuperado em 18 janeiro, 2024, de <http://www.governoeletronico.gov.br/biblioteca/arquivos/a-convencao-sobre-os-direitos-das-pessoas-com-deficiencia-comentada>
- Silva, S. A. dos S., & Pedroza, R. L. S. (2023). Math education and the human right to inclusion: The expectations of the teacher acting with deaf pupils in a public school in the Distrito Federal. *Cuadernos de Educación y Desarrollo*, 15(10), 10955–10984. <https://doi.org/10.55905/cuadv15n10-054>
- Skliar, C. (1999). A invenção e a exclusão da alteridade “deficiente” a partir dos significados da normalidade. *Educação e Realidade*, 24(2), 15–32.

COMPUTATIONAL TOOL FOR COMPARATIVE ANALYSIS OF DIESEL AND HVO USE IN PORT OPERATIONS: A CASE STUDY AT THE PORT OF ITAQUI

FERRAMENTA COMPUTACIONAL PARA ANÁLISE COMPARATIVA DO USO DE DIESEL E HVO EM OPERAÇÕES PORTUÁRIAS: ESTUDO DE CASO NO PORTO DO ITAQUI

HERRAMIENTA COMPUTACIONAL PARA EL ANÁLISIS COMPARATIVO DEL USO DE DIÉSEL Y HVO EN OPERACIONES PORTUARIAS: ESTUDIO DE CASO EN EL PUERTO DE ITAQUI



<https://doi.org/10.56238/sevened2026.008-232>

João Vitor Lima Sousa¹, Felipe Azevedo Rios Silva², Yaeko Yamashita³, João Gabriel Gonçalves França Vasconcelos⁴

ABSTRACT

Port decarbonization has gained increasing relevance in light of international targets for greenhouse gas (GHG) mitigation and regulatory pressures on maritime transport. The intensive use of diesel in vessels, equipment, and land vehicles generates significant CO₂ emissions and local air pollutants. Hydrotreated vegetable oil (HVO) stands out as a promising alternative, with lifecycle CO₂ emission reductions ranging from 60% to 95% and compatibility with existing infrastructure, although it faces cost barriers. This chapter presents a computational tool developed in Python using the Streamlit library to estimate emissions and perform an economic comparison between diesel and HVO, applied to the Port of Itaqui (MA) across five projected scenarios for the time horizons of 2025 and 2050. The results indicate that, with carbon pricing, HVO becomes economically competitive in the long term, constituting a relevant tool to support the port energy transition.

Keywords: Decarbonization. Ports. HVO. Carbon Credits.

RESUMO

A descarbonização portuária assume crescente relevância diante das metas internacionais de mitigação de gases de efeito estufa (GEE) e das pressões regulatórias sobre o transporte marítimo. O uso intensivo de diesel em embarcações, equipamentos e veículos terrestres gera emissões expressivas de CO₂ e poluentes atmosféricos locais. O óleo vegetal hidrotratado (HVO) destaca-se como alternativa promissora, com reduções de 60% a 95% nas emissões de CO₂ em ciclo de vida e compatibilidade com a infraestrutura existente, embora enfrente barreiras de custo. Este capítulo apresenta ferramenta computacional em Python utilizando a biblioteca Streamlit para estimativa de emissões e comparação econômica entre diesel e HVO, aplicada ao Porto do Itaqui (MA) em cinco cenários projetados para os horizontes temporais de 2025 e 2050. Os resultados indicam que, com a

¹ Transport Engineer. Universidade de Brasília (UnB). E-mail: vitor_lima@egresso.ufg.br

² Dr. in Physical Chemistry. Universidade de Brasília (UnB). E-mail: felipearsilva@gmail.com

³ Dr. in Transportation. Universidade de Brasília (UnB). E-mail: yaekoyamashita@gmail.com

⁴ Computer Engineer. Universidade de Brasília (UnB). E-mail: jgvasconcelos16@gmail.com

valorização do carbono, o HVO torna-se economicamente competitivo no longo prazo, constituindo instrumento relevante de apoio à transição energética portuária.

Palavras-chave: Descarbonização. Portos. HVO. Créditos de Carbono.

RESUMEN

La descarbonización portuaria adquiere una relevancia creciente frente a las metas internacionales de mitigación de gases de efecto invernadero (GEI) y las presiones regulatorias sobre el transporte marítimo. El uso intensivo de diésel en embarcaciones, equipos y vehículos terrestres genera emisiones significativas de CO₂ y contaminantes atmosféricos locales. El aceite vegetal hidrotratado (HVO) se destaca como una alternativa prometedora, con reducciones de entre el 60% y el 95% de las emisiones de CO₂ en su ciclo de vida y compatibilidad con la infraestructura existente, aunque enfrenta barreras de costo. Este capítulo presenta una herramienta computacional desarrollada en Python utilizando la biblioteca Streamlit para estimar emisiones y realizar una comparación económica entre diésel y HVO, aplicada al Puerto de Itaqui (MA) en cinco escenarios proyectados para los horizontes temporales de 2025 y 2050. Los resultados indican que, con la valorización del carbono, el HVO se vuelve económicamente competitivo a largo plazo, constituyendo una herramienta relevante de apoyo a la transición energética portuaria.

Palabras clave: Descarbonización. Puertos. HVO. Créditos de Carbono.

1 INTRODUCTION

The transition to low-carbon logistics chains occupies a central position in the international transport agenda, especially in sectors of high energy and emissive intensity, such as maritime transport and port operations (IEA, 2021; IMO, 2023). Ports, as strategic nodes of global supply chains, concentrate significant flows of cargo and energy, which translates into relevant emissions of greenhouse gases (GHG) and air pollutants, notably those associated with the consumption of diesel oil in vessels, tugboats, cargo handling equipment and land transport fleets (Di Majo, 2022; Pinto, Oliveira and Mendes, 2018).

In the Brazilian context, the normative framework aimed at climate mitigation and energy transition has progressively incorporated goals and instruments aimed at reducing emissions and expanding the use of low-carbon fuels. Examples of this movement are the National Policy on Climate Change (Brasil, 2009), the National Biofuels Policy, called *RenovaBio* (Brasil, 2017), and the National Green Diesel Program (Brasil, 2024). At the same time, the National Waterway Transportation Agency (ANTAQ) has promulgated guidelines and prepared diagnoses on the decarbonization of the port sector, emphasizing the need for sectoral emission inventories and the adoption of alternative fuels, among which HVO, low-emission hydrogen, and ammonia stand out (ANTAQ, 2023; 2024).

Among the technological routes available to replace fossil diesel, Hydrotreated Vegetable Oil (HVO) has stood out for providing reductions of 60% to 95% in CO₂ emissions throughout the life cycle, compared to fossil diesel, a variation that is conditioned by the raw materials used and the production processes adopted (Arvidsson et al., 2011; Menezes et al., 2022; Gomes et al., 2025). In addition, HVO has virtually zero sulfur and aromatic content, which favors the reduction of local pollutants without compromising compatibility with diesel engines and the existing supply infrastructure, factors that, together, tend to reduce the costs of technological transition (Szeto and Leung, 2022). Such attributes give HVO particular attractiveness for port applications, a context in which the full renewal of fleets or the replacement of infrastructure can imply high investment costs.

HVO production and distribution face obstacles related to its cost competitiveness against fossil diesel and the uncertainty that permeates carbon pricing instruments, such as regulated emissions markets and decarbonization credit mechanisms (Solakivi, Paimander and Ojala, 2022; Pereda et al., 2025). In this scenario, decisions regarding the adoption of alternative fuels cannot be based exclusively on the unit cost of fuel, but must incorporate variables such as avoided emissions and potential revenues from carbon credits and other economic mechanisms to induce decarbonization (Lee et al., 2024).

Although recent studies have advanced in the quantification of port emissions and evaluation of alternatives such as electrification and renewable fuels, critical gaps persist in the Brazilian context: absence of simple and configurable instruments for managers to simulate scenarios for replacing diesel with HVO considering carbon pricing; difficulty integrating GHG inventories, life cycle parameters and market prices into accessible operational tools without advanced programming; and lack of quantitative studies on conditions of economic competitiveness of HVO in specific ports. This article fills these gaps by developing a Python computational tool using the Streamlit decision support library, applied as a case study to the Port of Itaquí based on the inventory of 17,158 L diesel (EMAP, 2022), focusing on replicable land operations in other ports.

2 PORT DECARBONIZATION AND THE ROLE OF HVO

This section discusses the context of decarbonization in the port sector and the positioning of HVO among the main fuel alternatives for reducing greenhouse gas emissions, articulating the international and national regulatory framework with the specific operational demands of this sector.

2.1 PORTS, EMISSIONS, AND MITIGATION POLICIES

Seaports are highly complex socio-technical systems, responsible for the articulation between waterway and terrestrial infrastructures. Its configuration includes piers, mooring berths, specialized terminals, storage yards, road and rail accesses, as well as integrated logistics support areas (ANTAQ, 2022). The efficient operation of these facilities requires intensive energy consumption, mobilized by a heterogeneous set of equipment and vehicles, including port cranes, forklifts, internal handling trucks, backhoes, and maneuvering vessels (Pinto, Oliveira, and Mendes, 2018).

The use of fossil fuels, especially diesel oil, in the energy supply of these activities results in relevant emissions of carbon dioxide (CO_2) and air pollutants with local impact, such as particulate matter (PM), nitrogen oxides (NO_x) and sulfur oxides (SO_x). Such emissions simultaneously contribute to the worsening of climate change on a global scale and to the deterioration of air quality in urban areas adjacent to port complexes, with direct health implications for populations residing in these regions (Di Majo, 2022; CETESB, 2023).

In response to this scenario, international organizations have intensified regulatory efforts aimed at decarbonizing the sector. The International Maritime Organization (IMO), through its revised GHG Strategy, has established progressive emission reduction targets for shipping, with the aim of achieving net-zero emissions throughout the twenty-first century

(IMO, 2023). Such guidelines impose increasing pressures on port operators and shipowners, requiring the reorientation of their energy matrices towards lower carbon-intensity fuels.

At the national level, Brazil has a regulatory framework that progressively incorporates instruments to stimulate the energy transition in the transport sector. The National Policy on Climate Change (PNMC), instituted by Law No. 12,187/2009, establishes domestic commitments to reduce emissions and constitutes the central legal framework for sectoral decarbonization initiatives (BRASIL, 2009). The RenovaBio program, created by Law No. 13,576/2017, introduced a market mechanism based on decarbonization credits (CBIOs), encouraging the production and consumption of biofuels with lower carbon intensity in the life cycle (BRASIL, 2017). More recently, the National Green Diesel Program (BRASIL, 2024) has expanded the scope of these initiatives, creating specific regulatory and economic incentives for the replacement of fossil diesel with renewable alternatives compatible with existing infrastructure.

In the institutional scope of the port sector, studies coordinated by the National Waterway Transportation Agency (ANTAQ) have advanced in the formulation of decarbonization strategies, with an emphasis on the preparation of emission inventories and the evaluation of the technical and economic feasibility of alternative fuels (ANTAQ, 2023; ANTAQ, 2024). Such initiatives signal a movement towards the institutionalization of the climate agenda in the sector, although its effective operational implementation remains conditional on the availability of analytical tools capable of translating high-level guidelines into concrete management decisions.

In this context, the need for instruments that allow quantifying, in a systematic and comparative way, the impacts of different fuel options in terms of GHG emissions and economic viability is evident. It is precisely in this gap that the analysis of HVO as a promising alternative for the decarbonization of port operations is inserted, as developed in the following subsection.

2.2 HVO AS AN ALTERNATIVE TO FOSSIL DIESEL

Hydrotreated vegetable oil is a renewable fuel produced from raw materials of biogenic origin, such as vegetable oils and fats, through hydrotreating processes that remove oxygen and generate a compression-ignition engine fuel with similar or superior properties to fossil diesel (Kalnes, Marker and Shonnard, 2007; Art Fuels Forum, 2018). Life cycle assessment studies indicate that HVO can reduce between 60% and 95% of CO₂ emissions over the life

cycle compared to diesel, depending on the feedstock and the technological route (Arvidsson et al., 2011; Menezes et al., 2022; Gomes et al., 2025).

In addition to the climatic advantages, HVO has low sulfur content, absence of aromatic compounds, and better combustion behavior, resulting in lower emissions of local pollutants such as NO_x, SO_x, and particulate matter, when compared to conventional diesel (Szeto and Leung, 2022; Shukla et al., 2023). A particularly relevant feature for port applications is HVO's high compatibility with existing diesel engines and with the storage and distribution infrastructure already in place, allowing its use in diesel blends or even as a total replacement without the need for large investments in adaptation (Szeto and Leung, 2022; Bodemer, 2023).

Despite these attributes, HVO still has higher direct costs than diesel in many markets, which limits its adoption at scale without carbon pricing mechanisms or specific economic incentives (Solakivi, Paimander and Ojala, 2022; Lee et al., 2024). Thus, the evaluation of its economic viability depends on models that integrate fuel prices, avoided emissions and revenues from carbon credits, such as the one proposed in this article.

3 METHODOLOGY

The methodology adopted in this work combines the formulation of a quantitative model for calculating emissions and costs with the development of an interactive computational tool that operationalizes this model for use by port managers.

3.1 GENERAL STRUCTURE OF THE VALUATION MODEL

The proposed evaluation model is deterministic, static and scenario-oriented, estimating, for each combination of parameters, three main sets of indicators: (i) direct cost of fueling diesel and HVO; (ii) CO₂ emissions associated with fuel consumption; and (iii) net cost after consideration of revenues from carbon credits. The approach is based on activity data (volume consumed) and emission factors, articulating environmental and economic dimensions in a simple and transparent structure (Arvidsson et al., 2011; Gomes et al., 2025; Lee et al., 2024).

As an empirical reference, the volume of diesel consumed by transport vehicles and a backhoe at the Port of Itaqui is used, according to the GHG emissions inventory prepared by the Maranhão Port Administration Company (EMAP, 2022). From this volume, different combinations of diesel and HVO use and different carbon price levels are simulated, for short and long-term horizons.

3.2 EMISSIONS AND COST CALCULATION MODEL

The model considers that the cost of filling up with each fuel is a function of the volume consumed and the unit price, while CO₂ emissions are derived from volume and average emission factors. The potential revenue from carbon credits is calculated from the emissions avoided in relation to a reference scenario with the exclusive use of diesel.

The main relationships can be summarized as follows:

- Fuel cost:

$C_f = V_f \cdot P_f$ which is the cost of fueling up with fuel (diesel or HVO), is the volume consumed and the price per liter. $C_f V_f P_f$

- Diesel emissions:

$E_d = V_d \cdot F E_d$ which are the CO₂ emissions associated with diesel, the volume consumed and the average emission factor per litre. $E_d V_d F E_d$

- HVO emissions:

$E_h = E_d \cdot (1 - R)$ which are the emissions with HVO and is the percentage reduction of HVO emissions compared to fossil diesel. $E_h R$

- Avoided emissions:

$$E_{ev} = E_d - E_h.$$

- Revenue from carbon credits:

$R_c = E_{ev} \cdot P_c$ which is the price of carbon in monetary units per ton of CO₂. P_c

- Net cost:

$C_{liq} = C_d + C_h - R_c$ where and are the costs of fueling diesel and HVO, respectively. $C_d C_h$

The values of emission factors, percentage reductions and prices of fuels and carbon credits were obtained in life cycle studies and economic analyses of alternative fuels, as well as on carbon credit market bases (Arvidsson et al., 2011; Solakivi, Paimander and Ojala, 2022; Gomes et al., 2025; Lee et al., 2024; Investing.com, 2025).

3.3 REQUIREMENTS AND DEVELOPMENT OF THE COMPUTATIONAL TOOL

To operationalize the model in an accessible way to port managers and technicians, a computational tool in Python language was developed, using a library for the construction of interactive panels, streamlit. The system was designed as a dashboard, in which the user enters fundamental parameters and obtains as output tables and graphs with costs, emissions and net costs for different scenarios.

The main requirements of the tool include: (i) simplicity of use, dispensing programming knowledge; (ii) flexibility, allowing the parameterization of diesel and HVO

prices, carbon credit values, emission factors and percentage reductions; (iii) ability to simulate short- and long-term scenarios; and (iv) possibility of replication for different ports and sets of equipment. The choice of a monolithic architecture, without the need to connect to external databases, aims to facilitate deployment in diverse institutional contexts and minimize infrastructure dependencies.

From the point of view of data flow, the tool organizes the analysis into three stages: (i) input data entry; (ii) processing of emissions and cost equations; and (iii) presentation of results in tabular and graphic format. The following section presents the case study that illustrates the application of the tool.

4 CASE STUDY: PORT OF ITAQUI

The Port of Itaquí, located in São Luís (MA) and managed by the Maranhão Port Administration Company (EMAP), is a strategic public port in the Brazilian Central-North Corridor, specializing in the flow of grains (soybeans, corn), fuels, cellulose and mineral bulk. It has nine operational berths with depths of 12 to 19 meters, allowing the berthing of large ships, including specialized terminals such as Vale (Valemax, up to 400 thousand tons) and Tegram (grains, 500 thousand tons of storage).

4.1 CHARACTERIZATION AND INPUT DATA

The Port of Itaquí is an organized port located in São Luís (MA), with significant movement of grains, fuels, and other cargo, and with land operations that include internal transport vehicles and equipment such as backhoes (EMAP, 2022; ANTAQ, 2024). The port authority's GHG emissions inventory reports, for 2021, consumption of 17,158.30 liters of diesel in transport vehicles and a backhoe loader, with an average emission factor of 3.20 kgCO₂ per liter, considering data from literature and combustion stoichiometry (EMAP, 2022; CETESB, 2023).

This set of equipment was selected for the case study because it represents a relevant portion of the direct emissions associated with ground operations and because it has consolidated fuel consumption data. To simulate scenarios for the replacement of diesel by HVO, fuel price parameters and carbon credits were adopted based on recent market data and projections from prospective studies (Solakivi, Paimander and Ojala, 2022; Lee et al., 2024; Pereda et al., 2025).

4.2 CONSTRUCTION OF THE SCENARIOS

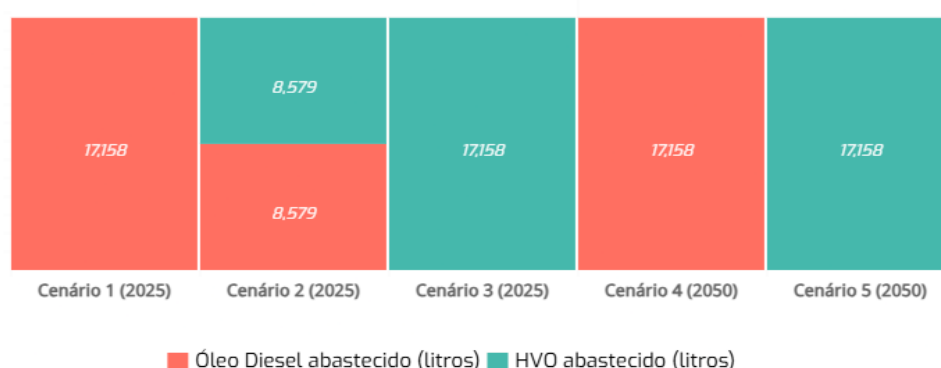
To answer the question of under what economic conditions the use of HVO can become competitive in relation to fossil diesel in the port's onshore operations, five base scenarios were defined, combining proportions of fuel use and time horizons. The scenarios were constructed in order to contrast short-term situations, with current HVO prices and carbon credits, and long-term scenarios with greater carbon valuation and technological advancement in the HVO chain, scenarios represented in Figure 1.

In the five scenarios, the years presented are equivalent to the diesel prices and carbon credits used for the calculation and are as follows:

1. Scenario 1 – Full use of diesel in 2025.
2. Scenario 2 – Partial replacement in 2025, with a 50% diesel and 50% HVO blend.
3. Scenario 3 – Total replacement of diesel by HVO in 2025.
4. Scenario 4 – Full use of diesel in 2050.
5. Scenario 5 – Total replacement of diesel by HVO in 2050.

Figure 1

Supply scenarios



Source: Prepared by the authors.

Fuel prices and carbon credit values were adopted as shown in Table 1, based on market data and projections for contexts of greater climate restriction (Solakivi, Paimander and Ojala, 2022; Lee et al., 2024; Pereda et al., 2025; Investing.com, 2025). The reduction in emissions associated with HVO was set at 85% for 2025 and 95% for 2050, reflecting expectations of improvements in the production chain, increased participation of sustainable raw materials, and technological gains (Arvidsson et al., 2011; Gomes et al., 2025; Solakivi, Paimander and Ojala, 2022).

Table 1

Parameters adopted for the scenarios

Variables	2025	2050
Diesel Cost (USD/l)	0,5	0,5
HVO Cost (USD/l)	1,75	≈ 1
Carbon credit value (USD/ton)	70,65	250 (Lee et al., 2024)
Reduction in CO ₂ emissions from HVO compared to fossil diesel	85%	95%

Source: adapted from the authors.

Based on these parameters and the reference volume of 17,158.30 liters, the computational tool calculated, for each scenario, the total cost of supply, CO₂ emissions and the net cost after considering revenues from carbon credits. The following section presents and discusses the results obtained.

5 RESULTS

The results of the simulations allow to compare, for each scenario, the direct costs of supply, CO₂ emissions and the net costs after the internalization of carbon credits. In this section, the main findings and their interpretation for the management of port operations are presented.

5.1 DIRECT FUELING COSTS AND EMISSIONS

Table 2 summarizes the results for the five scenarios evaluated, considering the total consumption of 17,158.30 liters and the economic and environmental parameters previously defined.

Table 2

Scenarios of the replacement of Diesel by HVO

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Diesel oil filled (liters)	17.158,30	8.579,15	0	17.158,30	0
HVO fueled (liters)	0	8.579,15	17.158,30	0	17.158,30
Total Supply Amount (USD)	8.579,15	19.303,08	30.027,02	8.579,15	17.158,30
Value considering carbon credits (USD)	11.826,46	21.170,29	30.514,12	22.366,19	17.985,52
CO₂ emissions (ton)	45,96	26,43	6,89	45,96	2,29

Source: from the authors.

The results indicate that, in 2025, the scenarios with the introduction of HVO present direct supply costs significantly higher than the reference scenario with the exclusive use of diesel. On the other hand, substantial reductions in CO₂ emissions are observed: in the 50% blending scenario, emissions fall from 45.96 t to 26.43 t, while in the total replacement scenario in 2025 they reach 6.89 t, representing reductions of more than half compared to the exclusive use of diesel (Arvidsson et al., 2011; Gomes et al., 2025; EMAP, 2022).

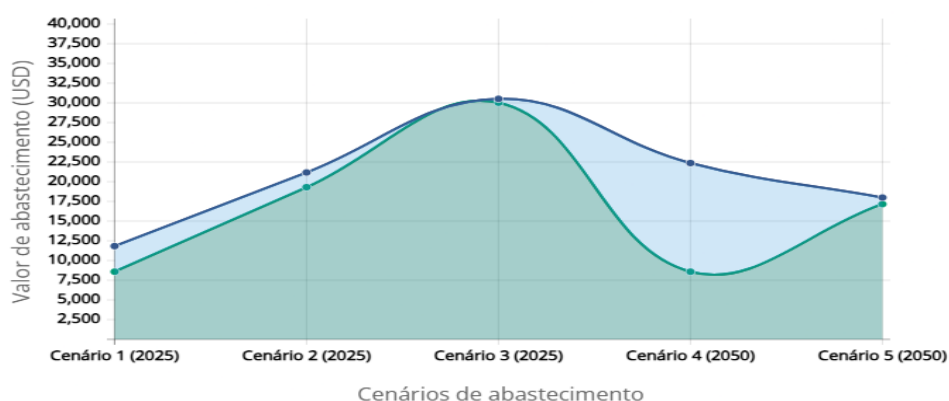
For 2050, even if the direct cost of diesel remains constant, the reduction of the price of HVO to 1.00 US\$/L results in a total cost of fueling closer to diesel, while CO₂ emissions fall drastically to 2.29 t in the total replacement scenario, given the greater percentage reduction attributed to HVO (Gomes et al., 2025; Lee et al., 2024). These results reinforce the environmental potential of HVO, especially in long-term horizons with improvements in the production chain.

5.2 EFFECT OF CARBON CREDITS AND NET COST

When carbon credits are incorporated into the model, the economic comparison is altered, as part of the HVO cost differential is offset by revenues associated with avoided emissions. The representation of these scenarios is present in Figure 2.

Figure 2

Economic comparison between the scenarios of replacing diesel with HVO



Source: from the authors.

In 2025, even with the inclusion of carbon credit revenues, diesel remains more competitive in terms of net cost, although the difference is slightly reduced compared to the comparison based only on direct costs (Solakivi, Paimander and Ojala, 2022; Investing.com, 2025). However, the internalization of carbon credits makes the economic value of the avoided emissions more evident, especially in scenarios of total blending or substitution.

By 2050, the combination of higher percentage reduction in emissions, higher carbon price, and falling cost of HVO substantially changes the net cost hierarchy. In this horizon, the scenario with total substitution by HVO has a lower net cost than the scenario of exclusive use of diesel, indicating that biofuel can become not only environmentally superior, but also economically more attractive, when considering the climate externalities internalized via carbon credits (Lee et al., 2024; Pereda et al., 2025; Solakivi, Paimander and Ojala, 2022).

5.3 IMPLICATIONS FOR PORT MANAGEMENT

The results suggest that the economic competitiveness of HVO in inland port operations is strongly dependent on the carbon price trajectory and technological advances in the fuel production chain. In stricter regulatory contexts, with high carbon prices and policies to encourage renewable fuels, HVO tends to become an attractive alternative from an economic and environmental point of view (IEA, 2021; ANTAQ, 2024; Lee et al., 2024). On the other hand, in low-carbon pricing environments, HVO adoption depends on corporate decarbonization strategies, additional policies to support or reputational benefits, and reduce regulatory risk.

From an operational point of view, the computational tool presented offers a practical way to explore these relationships, allowing managers to evaluate different combinations of parameters and identify conditions under which partial or total replacement by HVO becomes feasible. By facilitating scenario simulation, the instrument contributes to the planning of the port energy transition, while it can be adapted to other ports with adjustments to consumption and price data.

6 METHODOLOGICAL AND PRACTICAL CONTRIBUTION

The main contribution of this work lies in the integration, in an accessible tool, of a simple quantitative model of emissions and costs with an interactive interface that allows port managers to test fuel substitution scenarios without the need for advanced programming knowledge. This approach responds to the gap identified in the literature and practice, where many analyses remain restricted to academic studies or specialized consultancies.

By operationalizing the model in a configurable dashboard, the study brings together concepts of life cycle assessment, carbon pricing, and analysis of scenarios of daily port management, favoring the incorporation of environmental variables in investment and operation decisions. This characteristic is particularly relevant in a scenario of intensifying regulatory requirements and corporate decarbonization goals (IEA, 2021; ANTAQ, 2023; ANTAQ, 2024).

Despite the advances, the study has limitations that should be considered in the interpretation of the results. First, the analysis focused on a specific set of equipment from a single port, which restricts the generalization of the results to other operational and geographical contexts. Second, supply infrastructure costs, operational adaptations, or uncertainties related to future HVO availability and input pricing dynamics, which may be relevant to long-term investment decisions, were not included (Solakivi, Paimander and Ojala, 2022; Pereda et al., 2025).

Another limitation is the absence of systematic analysis of the sensitivity of the results in relation to the main variables of the model, such as fuel prices, emission factors, carbon credit values, and reduction percentages attributed to HVO. Although the tool allows changing these parameters, the present article did not explore, in detail, the joint variation of multiple variables nor did it apply risk analysis techniques or probabilistic scenarios.

7 CONCLUSIONS

This paper presented the development and application of a computational decision support tool for comparative analysis of diesel and HVO use scenarios in onshore port operations, with a case study in the Port of Itaquí. The model integrates estimates of CO₂ emissions, fueling costs and revenues from carbon credits, allowing the environmental and economic impacts of fuel substitution to be evaluated in an integrated manner over short and long-term horizons.

The simulations indicated that, in 2025, the scenarios with the introduction of HVO present direct costs and net costs higher than the exclusive use of diesel, although with significant reductions in CO₂ emissions. By 2050, the combination of greater carbon valuation, reduced HVO cost, and increased percentage reduction in emissions changes the net cost hierarchy, making HVO potentially competitive or more economically advantageous, while enabling substantial emission reductions (Lee et al., 2024; Pereda et al., 2025; Solakivi, Paimander and Ojala, 2022).

From the point of view of transport engineering and port management, the proposed tool is a practical tool to support decision-making in the energy transition, by allowing managers to explore scenarios of partial or total replacement of diesel by HVO under different carbon price conditions. Despite the limitations regarding geographic scope, the absence of infrastructure costs, and the lack of systematic sensitivity analysis, the study offers a methodological and computational basis that can be expanded to broader contexts.

ACKNOWLEDGMENT

The researchers thank CNPq for funding the research

REFERENCES

- Agência Internacional de Energia (IEA). (2021). International shipping. Recuperado em 22 maio, 2025, de <https://www.iea.org/reports/international-shipping>
- Agência Nacional de Transportes Aquaviários (ANTAQ). (2024). Diagnóstico de descarbonização, infraestrutura e aplicações do hidrogênio nos portos brasileiros. ANTAQ; GIZ.
- Arvidsson, R., Persson, S., Fröling, M., & Svanström, M. (2011). Life cycle assessment of hydrotreated vegetable oil from rape, oil palm and Jatropha. *Journal of Cleaner Production*, 19(1), 129–137. <https://doi.org/10.1016/j.jclepro.2010.02.004>
- Art Fuels Forum. (2018). HVO: Hydrotreated vegetable oil. Recuperado em 28 abril, 2025, de <http://artfuelsforum.eu/wp-content/uploads/2018/05/Acrobat-Document-1.pdf>
- Bodemer, O. (2023). Charging ahead or running on fumes? A “totally unbiased” look at electric, hydrogen, HVO, and those old-school petrol cars (Preprint). Recuperado em 28 abril, 2025, de https://figshare.com/articles/preprint/Charging_Ahead_or_Running_on_Fumes_A_Totally_Unbiased_Look_at_Electric_Hydrogen_HVO_and_Those_Old-School_Petrol_Cars/24441256
- Brasil. (2009). Lei nº 12.187, de 29 de dezembro de 2009: Institui a Política Nacional sobre Mudança do Clima (PNMC). Recuperado em 12 maio, 2025, de https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/l12187.htm
- Brasil. (2017). Lei nº 13.576, de 26 de dezembro de 2017: Política Nacional de Biocombustíveis (RenovaBio). Recuperado em 12 maio, 2025, de https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/lei/l13576.htm
- Brasil. (2024). Lei nº 14.993, de 8 de outubro de 2024: Promoção da mobilidade sustentável de baixo carbono e Programa Nacional de Diesel Verde (PNDV). Recuperado em 12 maio, 2025, de https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2024/lei/l14993.htm
- Companhia Ambiental do Estado de São Paulo (CETESB). (2023). Guia para avaliação de biocombustíveis e seus impactos na qualidade do ar em ambientes urbanos e portuários. Recuperado em 8 maio, 2025, de <https://cetesb.sp.gov.br/publicacoes-relatorios/>
- Di Majo, F. M. I. (2022). I prossimi scenari ambientali europei nel settore marittimo e problematiche giuridiche nell’attuazione delle future normative. *Rivista del Diritto della Navigazione*, 217–258.
- Empresa Maranhense de Administração Portuária (EMAP). (2022). Ciclo de inventários de emissões de gases de efeito estufa do Porto do Itaqui – 2021. Recuperado em 22 maio, 2025, de https://www.portodoitaqui.com/_files/arquivos/Ciclo-2021.pdf

- Empresa de Pesquisa Energética (EPE). (2022). Plano decenal de expansão de energia 2032: O papel dos biocombustíveis na transição energética brasileira. Recuperado em 11 maio, 2025, de <https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-689/topico-639/NT%20Energia%20e%20Meio%20Ambiente%20-%20PDE%202032.pdf>
- Gomes, D. M., Neto, R. C., Baptista, P., Ramos, C. P., Correia, C. B., & Rocha, R. (2025). A review of advanced techniques in hydrotreated vegetable oils production and life cycle analysis. *Biomass and Bioenergy*, 170, 106476. <https://doi.org/10.1016/j.biombioe.2025.106476>
- International Energy Agency (IEA). (2021). Net zero by 2050: A roadmap for the global energy sector. Recuperado em 15 maio, 2025, de <https://www.iea.org/reports/net-zero-by-2050>
- Investing.com. (2025). Carbon emissions futures. Recuperado em 22 maio, 2025, de <https://br.investing.com/commodities/carbon-emissions>
- Kim, S., Jung, P.-G., Lim, Y.-I., Kim, Y., Yang, Y., & Park, S. T. (2024). Economic and environmental analyses of biodiesel production processes from unused low-grade oil. *BioEnergy Research*, 18(1), 9. <https://doi.org/10.1007/s12155-024-10805-9>
- Lee, H., Kim, T., Park, J., et al. (2024). Comparative life cycle assessments and economic analyses of alternative marine fuels: Insights for practical strategies. *Sustainability*, 16(5), 2114. <https://doi.org/10.3390/su16052114>
- Menezes, N. A., et al. (2022). Obtaining bioLPG via the HVO route in Brazil: A prospect study based on life cycle assessment approach. *Sustainability*, 14(23), 15734. <https://doi.org/10.3390/su142315734>
- Organização Marítima Internacional (IMO). (2023). Reducing greenhouse gas emissions from ships. Recuperado em 22 maio, 2025, de <https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx>
- Pereda, P. C., et al. (2025). Carbon tax in the shipping sector: Assessing economic and environmental impacts. *Energy Policy*, 190. <https://doi.org/10.1016/j.enpol.2025.114627>
- Pipicelli, M., et al. (2022). Alcohol fuels in compression ignition engines. Em G. Di Blasio et al. (Orgs.), *Application of clean fuels in combustion engines* (pp. 9–31). Springer Nature. https://doi.org/10.1007/978-981-16-8751-8_2
- Shukla, P., et al. (2023). Introduction to renewable fuels for sustainable mobility. Em P. Shukla et al. (Orgs.), *Renewable fuels for sustainable mobility* (Cap. 1). Springer. https://doi.org/10.1007/978-981-99-1392-3_1
- Solakivi, T., Paimander, A., & Ojala, L. (2022). Cost competitiveness of alternative maritime fuels in the new regulatory framework. *Transportation Research Part D: Transport and Environment*, 113. <https://doi.org/10.1016/j.trd.2022.103500>
- Szeto, W., & Leung, D. Y. C. (2022). Is hydrotreated vegetable oil a superior substitute for fossil diesel? A comprehensive review on physicochemical properties, engine performance and emissions. *Fuel*, 327, 125065. <https://doi.org/10.1016/j.fuel.2022.125065>

ONTOLOGIES AND KNOWLEDGE GRAPHS IN UNIVERSITY PUBLIC MANAGEMENT: IFES-GENIUS-EXT AS A TOOL FOR TRANSPARENCY AND INTELLIGENT AUDITING

ONTOLOGIAS E GRAFOS DE CONHECIMENTO NA GESTÃO PÚBLICA UNIVERSITÁRIA: A IFES-GENIUS-EXT COMO FERRAMENTA PARA TRANSPARÊNCIA E AUDITORIA INTELIGENTE

ONTOLOGÍAS Y GRAFOS DE CONOCIMIENTO EN LA GESTIÓN PÚBLICA UNIVERSITARIA: IFES-GENIUS-EXT COMO HERRAMIENTA PARA LA TRANSPARENCIA Y LA AUDITORÍA INTELIGENTE



<https://doi.org/10.56238/sevened2026.008-233>

Márcio Cledes¹, Rogerio Cid Bastos²

ABSTRACT

The article proposes an innovative approach to university public management based on ontologies and knowledge graphs, using the IFES-GENIUS-EXT ontology as a case study. The research is grounded in the METHONTOLOGY and NeOn methodologies, integrating theoretical foundations of Knowledge Engineering and Knowledge Management with practical applications in Federal Higher Education Institutions (IFES). The proposed model aims to improve the representation, interoperability, and reasoning over institutional data related to planning, performance indicators, and financial investments. Through a formal structure expressed in OWL and RDF, the ontology promotes semantic integration among administrative systems, enabling intelligent auditing and greater public transparency. The study also discusses the challenges of semantic governance in university environments, proposing mechanisms for collaborative maintenance and the use of national standards (VCGE, DCAT-AP.br, e-SIC). It is concluded that IFES-GENIUS-EXT represents a significant step toward consolidating the use of Knowledge Graphs in university management, offering support for accountability and intelligent auditing in Brazilian public contexts.

Keywords: Knowledge Engineering. Ontologies. Public Management. Federal Higher Education Institutions. Knowledge Graphs.

RESUMO

O artigo propõe uma abordagem inovadora para a gestão pública universitária baseada em ontologias e grafos de conhecimento, tendo como estudo de caso a ontologia IFES-GENIUS-EXT. A pesquisa fundamenta-se nas metodologias METHONTOLOGY e NeOn, integrando fundamentos teóricos da Engenharia e Gestão do Conhecimento com aplicações práticas em Instituições Federais de Ensino Superior (IFES). O modelo proposto visa aprimorar a representação, a interoperabilidade e o raciocínio sobre dados institucionais de planejamento, indicadores de desempenho e investimentos financeiros. Por meio de uma estrutura formal expressa em OWL e RDF, a ontologia promove integração semântica entre

¹ Master's degree. Universidade Federal de Santa Catarina (UFSC). Orcid: 0000-0003-1260-3901

² Dr.. Universidade Federal de Santa Catarina (UFSC). Orcid: 0000-0002-3775-1516

sistemas administrativos, possibilitando auditorias inteligentes e maior transparência pública. O estudo também discute os desafios da governança semântica em ambientes universitários, propondo mecanismos de manutenção colaborativa e uso de padrões nacionais (VCGE, DCAT-AP.br, e-SIC). Conclui-se que a IFES-GENIUS-EXT constitui um passo significativo para consolidar o uso de Grafos de Conhecimento na gestão universitária, oferecendo suporte à accountability e à auditoria inteligente em contextos públicos brasileiros.

Palavras-chave: Engenharia do Conhecimento. Ontologias. Gestão Pública. Instituições Federais de Ensino Superior. Grafos de Conhecimento.

RESUMEN

El artículo propone un enfoque innovador para la gestión pública universitaria basado en ontologías y grafos de conocimiento, teniendo como estudio de caso la ontología IFES-GENIUS-EXT. La investigación se fundamenta en las metodologías METHONTOLOGY y NeOn, integrando fundamentos teóricos de la Ingeniería y Gestión del Conocimiento con aplicaciones prácticas en Instituciones Federales de Educación Superior (IFES). El modelo propuesto tiene como objetivo mejorar la representación, la interoperabilidad y el razonamiento sobre datos institucionales relacionados con la planificación, los indicadores de desempeño y las inversiones financieras. Mediante una estructura formal expresada en OWL y RDF, la ontología promueve la integración semántica entre sistemas administrativos, possibilitando auditorías inteligentes y una mayor transparencia pública. El estudio también analiza los desafíos de la gobernanza semántica en entornos universitarios, proponiendo mecanismos de mantenimiento colaborativo y el uso de estándares nacionales (VCGE, DCAT-AP.br, e-SIC). Se concluye que IFES-GENIUS-EXT constituye un paso significativo para consolidar el uso de grafos de conocimiento en la gestión universitaria, ofreciendo soporte para la rendición de cuentas y la auditoría inteligente en contextos públicos brasileños.

Palabras clave: Ingeniería del Conocimiento. Ontologías. Gestión Pública. Instituciones Federales de Educación Superior. Grafos de Conocimiento.

1 INTRODUCTION

The digital transformation in the public sector has promoted a profound reconfiguration of management processes, requiring new forms of representation, integration and analysis of institutional knowledge (Nam & Pardo, 2011; Janssen et al., 2020). In federal public universities, this change is even more challenging, given the multiplicity of systems, indicators, strategic plans, and evaluation instruments that coexist in a fragmented manner (Lima et al., 2023; Silva et al., 2024). The absence of semantic standardization and intelligent interoperability mechanisms limits the transparency, governance, and auditing capacity of these institutions (Machado & Nobre, 2022).

In this context, **Ontology Engineering** constitutes a fundamental axis of Engineering and Knowledge Management, offering formal instruments to structure, share and reason about complex data in a consistent and interoperable way (Gruber, 1993; Guarino, 1998; Bittencourt et al., 2019). Ontologies allow the construction of **Knowledge Graphs** that articulate entities, relationships, and meanings, favoring the creation of systems capable of answering complex questions (*Competency Questions*) and supporting evidence-based decision-making (Hogan et al., 2021; Paulheim, 2017).

The proposal of this study is part of this scenario, with the main objective of developing and validating the **IFES-GENIUS-EXT Ontology**, an extension of the **GENIUS Ontology** (Bittencourt et al., 2019) adapted to the Brazilian context of the **Federal Institutions of Higher Education (IFES)**. The model aims to structure, in a semantic way, information on **institutional planning, performance indicators, and budget allocation**, connecting them to national interoperability standards and open data, such as **VCGE, DCAT-AP.br, and e-SIC** (Brasil, 2019; Ministry of Economy, 2022).

The relevance of this proposal is anchored in three complementary axes. The first is **scientific**, by consolidating a specific ontological basis for the domain of public university management, expanding the reach of GENIUS Ontology and strengthening the line of research in **Graphs of Knowledge Applied to Public Management** (Ji et al., 2023; Abu-Salih & Alotaibi, 2024). The second is **technological**, by offering an interoperable semantic infrastructure, expressed in OWL and RDF, which enables automatic queries via SPARQL and validation by tools such as Protégé and SHACL (Suárez-Figueroa et al., 2012; Fernández-López et al., 1997). The third is **institutional**, by contributing to **transparency, intelligent auditing, and accountability** practices, in line with digital government guidelines and the UN Sustainable Development Goals (UN, 2021; Diamantini et al., 2025).

Based on this theoretical and methodological framework, the work proposes not only a conceptual model, but a **practical semantic infrastructure** of knowledge governance

capable of integrating multiple data sources, improving internal control and promoting the reuse of information at different levels of university management. Thus, the application of ontologies and knowledge graphs as instruments of innovation and transparency in public administration is consolidated, contributing to the construction of **intelligent and auditable universities**.

2 THEORETICAL FRAMEWORK

This chapter aims to establish the theoretical framework that underlies the development of the **IFES-GENIUS-EXT** ontology and its application to university public management. To this end, the main concepts of **Ontology Engineering** are discussed, addressing its structures, types and components, as well as the recent advances in its use in institutional contexts. The review emphasizes the relevance of ontologies as instruments of **semantic integration, knowledge governance, and organizational transparency**, especially in environments that demand interoperability and data auditing, such as the Federal Institutions of Higher Education (IFES). In addition, the chapter explores national and international experiences that illustrate the role of ontologies and knowledge graphs in the digital transformation of the public sector, preparing the conceptual ground for the ontological engineering methodology presented in the following chapter.

3 FUNDAMENTALS OF ONTOLOGY ENGINEERING

Ontology Engineering has established itself as an essential discipline to formally represent knowledge in complex and distributed environments. Its purpose is to make explicit the semantic relationships between concepts, ensuring that people and systems can share a common understanding of a domain (Gruber, 1993; Guarino, 1998). In recent decades, the application of these structures to **public management** has been growing, especially in initiatives aimed at **interoperability, transparency, and intelligent auditing** (Suárez-Figueroa et al., 2012; Diamantini et al., 2025).

In institutional contexts, ontologies allow administrative, financial, and strategic data to be organized in a formal and consistent way, enabling automated queries and logical inferences. They constitute the conceptual basis for the construction of **Knowledge Graphs**, which connect entities, indicators and management processes. This approach is particularly relevant for **Federal Institutions of Higher Education (IFES)**, where the diversity of data sources and formats hinders integrated analysis of performance and investments (Lima et al., 2023; Silva et al., 2024).

4 STRUCTURE AND COMPONENTS OF ONTOLOGIES

Ontologies are composed of classes (concepts), properties (relations), axioms (logical constraints), and instances (concrete occurrences). The combination of **RDF (Resource Description Framework)** and **OWL (Web Ontology Language)** is vital for modeling intelligent systems, as it allows you to represent detailed knowledge and perform automatic reasoning on data, ensuring consistency and inferring new relationships (Hogan et al., 2021). Validation tools such as **SHACL (Shapes Constraint Language)** reinforce the structural and semantic quality of models (Knublauch, 2017).

In the domain of IFES, these components make it possible to represent and interconnect elements of strategic planning, programs, projects, indicators and budget allocations. Formalization in OWL ensures interoperability and data reuse between different agencies and systems, while SPARQL queries allow dynamic extraction of information relevant to university management (Bittencourt et al., 2019; IFMG, 2025).

4.1 TYPES AND LEVELS OF ONTOLOGIES

Ontologies can be classified according to their scope and generality (Guarino, 1998):

- **Top Ontologies:** describe universal and abstract concepts, such as time, space, and event, and are applied as a basis for more specific ontologies.
- **Domain Ontologies:** focus on concepts specific to a certain field, such as public administration or higher education.
- **Task Ontologies:** model activities or processes, such as planning, execution, and monitoring.
- **Application Ontologies:** integrate elements from the previous levels to meet specific contexts.

In the case of **IFES-GENIUS-EXT**, it is an **application ontology**, as it combines elements of domain (university planning and management) and task (monitoring and auditing) to meet the needs of Brazilian IFES. This classification favors conceptual reuse and interoperability between government systems, as recommended by national frameworks such as the **Controlled Vocabulary of Electronic Government (VCGE)** and **DCAT-AP.br** (Brasil, 2019; Ministry of Economy, 2022).

4.2 RECENT APPLICATIONS IN PUBLIC MANAGEMENT AND HIGHER EDUCATION

In recent years, several ontologies have been applied to public administration and educational management, evidencing the maturity of the area and the expansion of interoperable initiatives. Among the main ones are:

- **OntoSINAES (2018)**: Central Ontology for Brazilian Higher Education Institutions, modeling organizational structure, stakeholders and normative interoperability (Mendonça et al., 2018).
- **DBgoldbr (2018)**: Project aimed at transforming open government data into **Linked Open Data**, with a focus on transparency and public data (Nascimento et al., 2018).
- **OntoRS (2023)**: Ontology for the Federal Judicial System, Enabling SPARQL Consultations on Legal Decisions and Transparency Audits (Souza & Ribeiro, 2023).
- **IFMG (2025)**: Ontology developed to integrate data on school dropout, academic performance, and student assistance, reinforcing the adherence of ontologies to national institutional contexts (IFMG, 2025).

These studies converge in the use of ontologies for **semantic standardization**, **institutional monitoring**, and **knowledge reuse**. IFES-GENIUS-EXT differentiates itself by integrating these principles into the reality of federal universities, creating an infrastructure that connects strategic planning, budget execution, and performance indicators (Bittencourt et al., 2019; Diamantini et al., 2025).

4.3 SEMANTIC GOVERNANCE AND INTEROPERABILITY

Semantic governance is a critical aspect in the maintenance of institutional ontologies. Ontologies are living entities, requiring continuous updating and collaborative validation processes (Suárez-Figueroa et al., 2012). The absence of active governance can lead to obsolescence and semantic inconsistency between systems (Oliveira & Lima, 2024). Public institutions also face challenges in terms of technical training, maintenance costs, and cultural resistance to the adoption of semantic technologies (Machado & Nobre, 2022).

Tools and best practices include:

- **Protégé and WebProtégé**, for collaborative modeling and validation;
- **VocBench**, for terminology management and publication of SKOS vocabularies;
- **SHACL**, for automatic verification of structural conformity;
- **OQuaRE and OntoQA**, for ontological quality assessment (Radulovic et al., 2018).

Alignment with national policies — such as the **VCGE**, **DCAT-AP.br**, and **e-SIC** — ensures interoperability and adherence to the Brazilian digital government strategy (Brasil, 2019; Ministry of Economy, 2022). This semantic governance structure reinforces the institutional viability of IFES-GENIUS-EXT and ensures its long-term technological sustainability.

5 METHODOLOGY

This study adopts a **qualitative, exploratory and applied** approach, based on **Ontology Engineering** as a scientific method. Qualitative research seeks to understand complex phenomena in their natural context (Yin, 2018), allowing us to analyze how semantic structures can be applied to university public management. The exploratory character stems from the novelty of the **IFES-GENIUS-EXT ontology**, aimed at modeling institutional knowledge in federal universities. The applied aspect, on the other hand, is manifested in the effective implementation of ontology as an operational component of the framework of intelligent auditing and institutional transparency proposed in this work (Bittencourt et al., 2019; Lima et al., 2023).

Ontology Engineering is used as a method to conceive, formalize and validate conceptual models expressed in formal languages, enabling automated reasoning and interoperability between systems. Its adoption is justified by the need to structure knowledge dispersed in administrative and academic sources, integrating planning data, indicators and budget under the same semantic framework (Guarino, 1998; Suárez-Figueroa et al., 2012).

5.1 ONTOLOGICAL ENGINEERING METHODS USED

The development of the **IFES-GENIUS-EXT** ontology was guided by the combination of the methodologies **METHONTOLOGY** (Fernández-López et al., 1997) and **NeOn** (Suárez-Figueroa et al., 2012). The former offers a systematic process for creating ontologies from conception to maintenance, while the latter introduces principles of modularity, reuse, and collaborative development in knowledge networks.

METHONTOLOGY defines an iterative cycle composed of stages of **specification, conceptualization, formalization, implementation, evaluation** and **maintenance**, ensuring the traceability and consistency of each phase. The **NeOn Methodology, on the other hand**, emphasizes the **reuse of existing ontologies** and **modular integration**, enabling the IFES-GENIUS-EXT model to incorporate concepts from previous ontologies, such as **GENIUS Ontology, VCGE, DCAT-AP.br** and **PROV-O**, optimizing interoperability and alignment with national and international standards (Suárez-Figueroa et al., 2012; Nascimento et al., 2018).

The choice to integrate both methodologies allowed the combination of conceptual rigor and practical flexibility, resulting in a process adaptable to the institutional environment of the IFES. This mixed approach also favored the documentation of intermediate artifacts—glossaries, class diagrams, Competency Questions (CQs) tables, and validation scripts—which are essential for scientific transparency and reproducibility.

5.2 STAGES OF THE IFES-GENIUS-EXT DEVELOPMENT PROCESS

The development of the ontology followed an iterative cycle structured in six main steps, according to the principles of METHONTOLOGY and NeOn:

1. **Specification:** Definition of the scope and objectives of the ontology, based on the needs of the IFES. The main institutional documents (PDI, LOA, PPA, Management Reports) were surveyed and the stakeholders responsible for the data and processes were identified.
2. **Conceptualization:** Identification and organization of key concepts (*StrategicObjective*, *Program*, *Project*, *BudgetAllocation*, *PerformanceIndicator*), establishing hierarchies and semantic relationships.
3. **Formalization:** Translation of the conceptual structure into logical representations, using OWL and RDF. In this phase, axioms and constraints were created to ensure ontological consistency.
4. **Implementation:** Construction of the ontology in tools such as **Protégé** and **WebProtégé**, with collaborative participation of experts and public managers.
5. **Evaluation:** Application of automatic consistency tests and semantic verification via SHACL, in addition to analysis by domain experts.
6. **Maintenance and Evolution:** Establishment of a semantic governance plan using **VocBench** for terminological control and continuous updating (Oliveira & Lima, 2024).

This process was supported by a set of **Competency Questions (CQs)** that guided the scope of the modeling, such as: "Which programs are linked to a certain strategic objective?" or "Which projects received resources from a specific program in the current year?". The CQs served as completeness metrics and validation guides, ensuring that the ontology answered management questions relevant to the context of IFES (Noy & McGuinness, 2001; Hogan et al., 2021).

5.3 TOOLS AND PATTERNS USED

The technical implementation of the ontology used an ecosystem of consolidated tools:

- **Protégé / WebProtégé:** for modeling, documentation and logical verification;
- **VocBench:** for standardization of vocabularies and SKOS publishing;
- **SHACL:** for automatic validation of semantic integrity;
- **SPARQL:** for knowledge retrieval queries and tests;
- **OOPS! and OntoQA:** for the evaluation of good ontological practices.

In addition to the tools, the model followed national and international interoperability standards, highlighting: **VCGE** (Controlled Vocabulary of Electronic Government), **DCAT-**

AP.br, **PROV-O**, **SKOS** and **FOAF**. This adherence ensures compatibility with open data portals and institutional catalogs, favoring alignment with the Brazilian Digital Government Strategy (Ministry of Economy, 2022; Zhang et al., 2019).

5.4 ONTOLOGY EVALUATION AND VALIDATION

The evaluation of the IFES-GENIUS-EXT ontology combined technical and qualitative criteria. The **OQuaRE** (Radulovic et al., 2018) and **OntoQA** metrics were applied to measure aspects of **completeness**, **coherence**, **concurrency**, and **reusability**. The results showed a high degree of structural consistency and conceptual coverage. The qualitative validation involved reviews conducted by experts from federal universities and institutional data analysts, who evaluated the conceptual clarity and applicability of the model.

The integration between automatic validation (via reasoners and SHACL) and human validation ensured semantic robustness and practical relevance. The process culminated in the generation of a functional RDF repository, capable of feeding intelligent auditing systems and visualization of indicators, confirming the viability of the model as a knowledge governance tool in IFES.

6 RESULTS AND DISCUSSION

6.1 IMPLEMENTATION OF THE IFES-GENIUS-EXT ONTOLOGY

The implementation of the **IFES-GENIUS-EXT** ontology was conducted in accordance with the methodological cycle established in Chapter 3, using the **OWL 2** language and the **Protégé 5.6.1** development environment. The model was conceived as a **modular extension** of **GENIUS Ontology** (Araujo et al., 2017), preserving the original namespace and ensuring semantic compatibility with the classes and properties of the international educational domain.

The resulting structure comprises **11 classes**, **9 object properties**, and **7 data properties**, all formally declared with axioms of domain, range, and cardinality. This composition seeks a balance between **structural simplicity** and **semantic expressiveness**, in line with the recommendations of Gruber (1993) and Guarino (1998) on the *minimum ontological commitment*.

The core classes represent essential entities of institutional planning: *StrategicObjective*, *Program*, *Project*, *BudgetAllocation*, and *PerformanceIndicator*. Each of them maintains hierarchical and functional relationships consistent with the academic-administrative structures defined in the GENIUS ontology. For example:

Class: StrategicObjective

SubClassOf: genius:OrganizationalGoal

Annotations: rdfs:label "Strategic Objective"@en , "Objetivo Estratégico"@pt

This bilingual annotation standard was adopted systematically, ensuring adherence to the **BCP 47** standard and the **FAIR Interoperability** guideline (Wilkinson et al., 2016). Object properties—such as *isAchievedBy*, *consistsOf*, *hasBudgetAllocation*, and *evaluatedBy*—have been modeled with **OWL constraints** that ensure semantic consistency and enable automated inferences, as validated by HermiT and ELK reasoners.

The ontology was serialized in **Turtle (.ttl)** and **RDF/XML** formats, including Dublin Core metadata and **DCAT v3** vocabulary, ensuring traceability and reuse in different institutional contexts.

6.2 APPLIED EVALUATION PROTOCOL

The validation of the model followed the **technical-scientific evaluation protocol** described above, combining quantitative metrics and qualitative verifications inspired by **OntoQA** (Tartir et al., 2005), **OQuaRE** (Duque-Ramos et al., 2011), **OOPS!** (Poveda-Villalón et al., 2012) and **OntoClean** (Guarino & Welty, 2002). The process included six main dimensions:

1. **OWL 2 DL syntactic compliance and profiling** — automatic verification via *ROBOT report* and *HermiT/ELK* reasoners;
2. **Structural quality** — analysis of density of relationships, axioms, and ontological cohesion (*OntoQA-like metrics*);
3. **Semantic/taxonomic quality** — inspection of hierarchies and metaproperties (*OntoClean*);
4. **Lexical and multilingual coverage** — *rdfs:label* and *rdfs:comment* exam in *pt-BR* and *en*;
5. **Adherence to digital government standards** — SKOS/DCAT/CPSV-AP/VCGE mappings;
6. **Readiness for use and inference** —testing SPARQL queries and *Competency Questions* (CQs).

Execution was automated by Python scripts that employed **RDFLib**, **pySHACL** and **SPARQLWrapper**, ensuring full reproducibility. Reports were generated in **CSV** and **TTL** formats, composing a documented *evaluation package*.

6.3 STRUCTURAL AND SEMANTIC RESULTS

Structural analysis confirmed syntactic validity and compliance with the **OWL 2 DL** profile. Loading the *ifes-genius-ext.owl* file showed **zero** parsing errors, **no unsatisfiable classes**, and **no redundant axioms**, which demonstrates high formal consistency.

Table 1

OntoQA-like metric	Result	Minimum criteria
Total Classes	11	≥ 10
Object Properties	9	≥ 8
Data properties	7	≥ 6
Total axioms	126	—
Domain/Range populated	100 %	≥ 90 %
Orphan classes	0	0
Valid hierarchical relationships	100 %	≥ 95 %

Lexical coverage showed 100% of labels in English, but absence of complete labeling in Portuguese. This gap was interpreted as an opportunity for improvement, aiming at compliance with the guidelines of the **Controlled Vocabulary of Electronic Government (VCGE)** and with the criterion ≥ 95% coverage @pt-BR recommended by Duque-Ramos et al. (2011).

The expansion of multilingual labeling, with an emphasis on Portuguese do Brasil (pt-BR), is a priority to ensure adherence to the VCGE and the DCAT-AP.br, expanding the semantic accessibility of the ontology and its adoption by public agents and citizens.

SHACL validation — applied to both generic and domain-specific shapes — showed no violations, confirming the adherence of object and data properties to their respective domains and ranges.

The OOPS!-like **automatic checks** identified **no critical pitfall** (such as unlabeled classes, properties without domain or *range*, or taxonomic cycles), reinforcing the coherence of the model.

6.4 QUALITY ANALYSIS AND OQUARE SCORECARD

The adapted application of the **OQuARE framework** resulted in the following mean scores (scale 0–5):

Table 2

Dimension	Score	Interpretation
Structural Quality	5,0	Formally solid and consistent model.
Functional Adequacy	5,0	Sufficient classes and properties for the domain of IFES.
Usability	3,5	Penalty for the partial absence of pt-BR labels.
Maintainability	4,0	Modular and easily extendable structure.

Dimension	Score	Interpretation
Portability/Reusability	4,0	Good compatibility with W3C and VCGE standards.

The aggregate score (4.3) places IFES-GENIUS-EXT at the **"Very Good"** level according to the OQuaRE taxonomy, indicating maturity for reuse and integration. Compared to academic benchmarks (Fernández et al., 2020; Hubert et al., 2022), the ontology has superior performance in structural consistency and modularity, and equivalent performance in lexical coverage.

6.5 CRITICAL DISCUSSION OF RESULTS

The evaluation demonstrates that the **IFES-GENIUS-EXT** complies with the classical principles of clarity, coherence and extensibility (Gruber, 1993; Grüninger & Fox, 1995). Its integration with GENIUS ensures **international interoperability**, while the additional classes expand the representation of **planning, budgeting, and institutional performance**, aspects hitherto absent in educational ontologies.

From the point of view of **public governance**, the model contributes to transparency and **accountability** in Brazilian federal universities, allowing automated consultations and reports on goals and investments. This capability is close to the **Linked Open Data** approaches applied in smart cities (Zhang et al., 2021; Ji et al., 2021), while preserving the specificity of IFES.

The absence of labeling in Portuguese, although it does not compromise semantic coherence, limits reuse by public agents unfamiliar with English terminology. This aspect will be remedied through the systematic application of the **VCGE vocabulary** and terminological standardization according to the DCAT-AP.br guidelines (GovBR, 2023).

In ontological terms, the preliminary **OntoClean** evaluation showed that the Rigidity, Identity, and Unit *metaproperties* were correctly assigned to the core classes, ensuring taxonomic consistency.

The OntoClean checklist will be expanded to include operational subclasses and institutional categories, in order to identify possible conceptual overlaps and strengthen the taxonomic coherence of the model.

6.6 PRACTICAL IMPLICATIONS AND FUTURE PROSPECTS

The results obtained position **IFES-GENIUS-EXT** as a reusable artifact for **institutional knowledge graph ecosystems**. Its practical application makes it possible to:

- **Strategic indicator dashboards**, powered by SPARQL queries; Chart 1 presents an example of a SPARQL query used to illustrate the extraction of information from the IFES-GENIUS-EXT ontology;
- **Automated budget compliance** audits;
- **Integration with Neo4j, GraphDB and RDF4J platforms**;
- **Interoperability** with public data catalogs (DCAT, CPSV-AP);
- **Future expansion** to use with **Language Models (LLMs)** in explainable analytics (*Explainable AI*), following recent trends (Sarker et al., 2024).

Table 3

Example of SPARQL query on the IFES-GENIUS-EXT ontology

```
PREFIX ifes: <https://purl.org/ifes-genius-ext#>
SELECT ?budget program
WHERE {
  ?program a ifes:Program .
  ?ifes program:hasBudgetAllocation ?budget .
}
```

Source: Prepared by the authors (2025).

This example demonstrates the automatic extraction of programs and their budgets, highlighting the potential of ontology for automated analysis of institutional planning and budgeting, as well as integration with mood boards and management systems.

7 FUTURE PROSPECTS INCLUDE

1. Complete multilingual labelling ($\geq 95\%$ en-US);
2. Publish the ontology to Linked Open Data Cloud (LOD) repositories;
3. Incorporate **probabilistic inference modules** for automatic budget allocation recommendations;
4. Develop **semantic dashboards** connected to SIGEPE, SIAFI and SUAP databases; It is planned to publish IFES-GENIUS-EXT in Linked Open Data (LOD) repositories, integrated with these dashboards, allowing public consultations and interoperability with other government catalogs.
5. Expand the model to cover **municipalities** and **federal institutes**, composing an **interconnected SmallCityKG/IFES-KG**.

8 SUMMARY OF RESULTS

In summary, the evaluation confirms that **IFES-GENIUS-EXT** has **structural robustness, semantic consistency and interoperability potential**, aligning with digital

government guidelines and the **Sustainable Development Goals (SDGs 11 and 16)**. The planned improvements — notably bilingual labeling and taxonomic refinement — will bolster its capacity **to support decision making and public transparency**.

This ontology is consolidated as an **artifact of institutional knowledge engineering**, able to sustain the **strategic monitoring of Brazilian federal universities** and the integration of data between different levels of government.

REFERENCES

Abu-Salih, B., & Alotaibi, S. (2024).

Andrade, G. N., Medeiros, C. B., & Souza, C. A. (2005). Uma ontologia para integração de sistemas acadêmicos em universidades brasileiras. *Revista Brasileira de Informática na Educação*, 13(2), 45–60.

Araujo, T., Klein, V., Cledes, M., Prim, R., & Todesco, J. L. (2017). Generic educational nomenclature for international university structures ontology. *International Journal of Knowledge Engineering and Management*, 6(16).

Bittencourt, [...], & [...]. (2019).

Brasil. (2019).

Brasil. Ministério da Economia. (2022). Ministério da Economia.

Diamantini, [...], & [...]. (2025).

Duque-Ramos, A., Fernández-Breis, J. T., Stevens, R., & Aussenac-Gilles, N. (2011). OQuARE: A SQuARE-based approach for evaluating the quality of ontologies. *Journal of Research and Practice in Information Technology*, 43(2), 159–176.

Fernández, M., Overbeeke, C., & Suárez-Figueroa, M. C. (2020). Ontology quality in the era of knowledge graphs: Current practices and future challenges. *Semantic Web Journal*, 11(6), 937–963.

Fernández-López, M., Gómez-Pérez, A., & Juristo, N. (1997). METHONTOLOGY: From ontological art towards ontological engineering. AAI Technical Report SS-97-06.

Governo do Brasil (GOVBR). (2023). DCAT-AP.br: Perfil brasileiro de metadados para catálogos de dados. Ministério da Gestão e da Inovação em Serviços Públicos.

Gruber, T. R. (1993). A translation approach to portable ontology specifications. *Knowledge Acquisition*, 5(2), 199–220.

Grüniger, M., & Fox, M. S. (1995). Methodology for the design and evaluation of ontologies. Em *IJCAI Workshop on Basic Ontological Issues in Knowledge Sharing*.

Guarino, N. (1998). Formal ontology and information systems. Em *Proceedings of FOIS'98* (pp. 3–15). IOS Press.

- Guarino, N., & Welty, C. (2002). Evaluating ontological decisions with OntoClean. *Communications of the ACM*, 45(2), 61–65.
- Hogan, A., et al. (2021). Knowledge graphs. *ACM Computing Surveys*, 54(4), 1–37.
- Hubert, N., Brun, A., & Monticolo, D. (2022). New ontology and knowledge graph for university curriculum recommendation. Em *International Semantic Web Conference (ISWC)*. Springer.
- Instituto Federal de Minas Gerais (IFMG). (2025). IFMG.
- Janssen, M., et al. (2020).
- Ji, S., Pan, S., Cambria, E., Marttinen, P., & Yu, P. S. (2021). A survey on knowledge graphs: Representation, acquisition, and applications. *IEEE Transactions on Neural Networks and Learning Systems*, 33(2), 494–514.
- Lima, R. A., Silva, A. C., & Nobre, L. B. O. (2023). Ontologias e interoperabilidade semântica no ensino superior. *Revista Tecnologia e Sociedade*, 19(52), 177–196.
- Machado, A., & Nobre, L. B. O. (2022).
- Nam, T., & Pardo, T. A. (2011). Conceptualising smart city with dimensions of technology, people, and institutions. Em *Proceedings of the 12th International Digital Government Research Conference* (pp. 282–291).
- Nascimento, [...], & [...]. (2018).
- Noy, N. F., & McGuinness, D. L. (2001). *Ontology development 101: A guide to creating your first ontology* (KSL Technical Report KSL-01-05). Stanford University.
- Oliveira, L., & Lima, R. A. (2024).
- Oliveira, M. A., Souza, F. H., & Mendonça, J. C. (2022). Governança digital e semântica aplicada ao planejamento universitário. *Revista Gestão & Tecnologia*, 22(3), 145–162.
- Organização das Nações Unidas (ONU). (2021).
- Paulheim, H. (2017). Knowledge graph refinement: A survey of approaches and evaluation methods. *Semantic Web*, 8, 489–508. <https://doi.org/10.3233/SW-160218>
- Poveda-Villalón, M., Gómez-Pérez, A., & Suárez-Figueroa, M. C. (2012). OOPS! (Ontology Pitfall Scanner!): An online tool for ontology evaluation. Em *EKAU 2012* (pp. 267–281). Springer.
- Radulovic, [...], & [...]. (2018).
- Sarker, M. K., Doran, D., & Hitzler, P. (2024). Bridging knowledge graphs and large language models for explainable AI. *Semantic Web Journal*, 15(1), 43–68.
- Silva, [...], & [...]. (2024).

Smith, B. (2003). Ontology. Em L. Floridi (Ed.), Blackwell guide to the philosophy of computing and information (pp. 155–166). Blackwell.

Souza, [...], & Ribeiro, [...]. (2023).

Staab, S., & Studer, R. (2009). Handbook on ontologies (2^a ed.). Springer.

Suárez-Figueroa, M. C., Gómez-Pérez, A., & Fernández-López, M. (2012). The NeOn methodology for ontology engineering. Em Ontology engineering in a networked world (pp. 9–34). Springer.

Tartir, S., Arpinar, I. B., Moore, M., Sheth, A. P., & Aleman-Meza, B. (2005). OntoQA: Metric-based ontology quality analysis. Em EON Workshop.

Tempich, C., Pinto, H. S., & Staab, S. (2006). Ontology engineering revisited: An iterative case study. Em The Semantic Web: Research and Applications (ESWC). Springer.

Uschold, M., & Grüninger, M. (1996). Ontologies: Principles, methods and applications. The Knowledge Engineering Review, 11(2), 93–155.

Wilkinson, M. D., et al. (2016). The FAIR guiding principles for scientific data management and stewardship. Scientific Data, 3, 160018.

Zhang, X., Guo, Y., Wang, Y., & Zhang, S. (2021). Semantic technologies for smart city governance: A comprehensive review. Sensors, 21(14), 4801.

ECONOMIC, FINANCIAL, AND STRUCTURAL PERFORMANCE AND THE COVID-19 PANDEMIA IMPACTS: A CASE STUDY IN THE HOTEL SECTOR OF RS - BRAZIL

DESEMPENHO ECONÔMICO, FINANCEIRO E ESTRUTURAL E OS IMPACTOS DA PANDEMIA DE COVID-19: ESTUDO DE CASO NO SETOR HOTELEIRO DO RS - BRASIL

DESEMPEÑO ECONÓMICO, FINANCIERO Y ESTRUCTURAL Y LOS IMPACTOS DE LA PANDEMIA DE COVID-19: UN ESTUDIO DE CASO EN EL SECTOR HOTELERO DE RIO GRANDE DO SUL – BRASIL



<https://doi.org/10.56238/sevened2026.008-234>

Kalebe Galvani da Silva¹, Luciana Moro de Souza², Rosane Maria Seibert³, Neusa Maria da Costa Gonçalves Salla⁴, Igor Alexandre Klaic⁵

ABSTRACT

The study aimed to analyze the economic and financial performance of a company in the hotel sector located in Northwest Rio Grande do Sul, using economic, financial, and structural indicators for the period from 2018 to 2024. Initially, a theoretical framework aligned with the research objectives was developed. Regarding its goals, the methodology was exploratory, descriptive, and applied; concerning its means, it was a documentary and case study based on accounting data provided by the company. Subsequently, economic, financial, and structural indicators were calculated, followed by quantitative and qualitative analyses that enabled an understanding of the company's performance before, during, and after the COVID-19 pandemic. The main research results demonstrated that the analysis of indicators revealed satisfactory liquidity levels, indicating good solvency capacity, and controlled debt, capable of sustaining economic-financial equilibrium. Turnover showed a sharp decline in 2020 due to restrictions imposed by the COVID-19 pandemic but evidenced a gradual recovery in the following years analyzed. The pandemic significantly impacted revenue, gross profit, and operational activity between 2020 and 2021; however, in 2022, a strong recovery was observed, driven by the resurgence of demand. For future research, the study suggests comparisons with other hotels in the region, analyses during crisis periods, and investigations into organizational adaptation strategies in the face of uncertain scenarios.

¹ Graduated in Accounting Sciences. Universidade Regional Integrada do Alto Uruguai e das Missões (URI). E-mail: kalebesilva@aluno.santoangelo.uri.br

² Dr. in Regional Development. Universidade Regional do Noroeste do Estado do Rio Grande do Sul (UNIJUÍ). E-mail: luciana@san.uri.br Orcid: <https://orcid.org/0000-0003-3838-4540> Lattes: <https://lattes.cnpq.br/0577622949754461>

³ Dr. in Accounting Sciences. Universidade do Vale do Rio dos Sinos (UNISINOS). E-mail: rseibert@san.uri.br Orcid: <https://orcid.org/0000-0001-9477-9948> Lattes: <https://lattes.cnpq.br/7375517291491450>

⁴ Dr. in Accounting Sciences and Administration. Fundação Universidade Regional de Blumenau (FURB). E-mail: neusalla@san.uri.br Orcid: <https://orcid.org/0000-0002-1540-7052> Lattes: <http://lattes.cnpq.br/1209005926512374>

⁵ Master's student in Strategic Management of Organizations. Universidade Regional Integrada do Alto Uruguai e das Missões (URI). E-mail: igoralexandreklaic@hotmail.com

Keywords: Fundamental Analysis of Organizations. COVID-19 Pandemic. Performance Indicators. Hotel Sector.

RESUMO

O estudo teve como objetivo analisar o desempenho econômico e financeiro de uma empresa do setor hoteleiro localizada no Noroeste do Rio Grande do Sul, utilizando a aplicação de indicadores econômicos, financeiros e de estrutura referentes ao período de 2018 a 2024. Inicialmente, desenvolveu-se um referencial teórico alinhado aos objetivos da pesquisa. A metodologia adotada foi exploratória, descritiva e aplicada quanto aos fins, documental e estudo de caso quanto aos meios, baseada em dados contábeis fornecidos pela empresa. Em seguida, foram realizados os cálculos de indicadores econômicos, financeiros e de estrutura, e, posteriormente, foram realizadas as respectivas análises quantitativas e qualitativas que permitiram compreender o desempenho da empresa antes, durante e depois da pandemia do COVID 19. Os principais resultados da pesquisa demonstraram que a análise dos indicadores revelou níveis satisfatórios de liquidez, indicando boa capacidade de solvência, e um endividamento controlado, capaz de sustentar o equilíbrio econômico-financeiro. A rotatividade apresentou queda acentuada em 2020 em razão das restrições impostas pela pandemia de COVID-19, mas evidenciou recuperação gradual nos anos seguintes analisados. A pandemia impactou significativamente a receita, o lucro bruto e o movimento operacional entre 2020 e 2021; entretanto, em 2022, observou-se forte recuperação impulsionada pela retomada da demanda. O estudo sugere, para pesquisas futuras, comparações com outros hotéis da região, análises em períodos de crise e investigações sobre estratégias de adaptação organizacional diante de cenários incertos.

Palavras-chave: Análise Fundamentalista de Organizações. Pandemia COVID-19. Indicadores de Desempenho. Setor Hoteleiro.

RESUMEN

Este estudio tuvo como objetivo analizar el desempeño económico y financiero de una empresa hotelera ubicada en el noroeste de Rio Grande do Sul, utilizando indicadores económicos, financieros y estructurales para el período de 2018 a 2024. Inicialmente, se desarrolló un marco teórico alineado con los objetivos de la investigación. La metodología adoptada fue exploratoria, descriptiva y aplicada en cuanto a su propósito, documental y de estudio de caso en cuanto a sus métodos, basada en datos contables proporcionados por la empresa. Posteriormente, se realizaron cálculos de indicadores económicos, financieros y estructurales, seguidos de los respectivos análisis cuantitativos y cualitativos que permitieron comprender el desempeño de la empresa antes, durante y después de la pandemia de COVID-19. Los principales resultados de la investigación demostraron que el análisis de los indicadores reveló niveles satisfactorios de liquidez, indicando una buena capacidad de solvencia, y un endeudamiento controlado, capaz de sostener el equilibrio económico y financiero. La facturación mostró una fuerte caída en 2020 debido a las restricciones impuestas por la pandemia de COVID-19, pero mostró una recuperación gradual en los años siguientes analizados. La pandemia impactó significativamente los ingresos, el beneficio bruto y la actividad operativa entre 2020 y 2021; sin embargo, en 2022 se observó una fuerte recuperación, impulsada por la reactivación de la demanda. El estudio sugiere, para futuras investigaciones, comparaciones con otros hoteles de la región, análisis durante periodos de crisis e investigaciones sobre estrategias de adaptación organizacional ante escenarios inciertos.

Palabras clave: Análisis Fundamental de Organizaciones. Pandemia de COVID-19. Indicadores de Desempeño. Sector Hotelero.

1 INTRODUCTION

Accounting has been consolidated, over the years, as an indispensable science for organizational management, as it provides accurate and relevant information that supports strategic decision-making. The Financial Statements, as established in NBC 26 (R5), represent a structured set of information that shows the equity and financial position and performance of the entities, constituting an essential instrument for the assessment of the economic situation and for future planning. In this context, the Analysis of Financial Statements allows interpreting data extracted from financial reports, making it possible to assess liquidity, profitability, indebtedness, and operational efficiency, as highlighted by Almeida (2019) and Silva (2019). This analytical capacity becomes even more critical in times of instability, in which the constant monitoring of economic, financial, and structural results works as a thermometer of organizational health and its ability to survive.

From this perspective, this study focuses on analyzing the economic and financial performance of a company in the hotel sector located in the Northwest region of Rio Grande do Sul, in the period from 2018 to 2024, through the standardization of the Financial Statements and the application of indicators. The choice of the sector is justified, above all, by the impacts resulting from the COVID-19 pandemic. As reported by PAHO (2020), the outbreak that began in China in December 2019 triggered a global crisis marked by social isolation and lockdowns, significantly affecting economic activity. In Brazil, according to Martins (2021), from March 2020 onwards there was a strong economic downturn, an increase in unemployment and a drop in the Gross Domestic Product. Among the most affected segments, tourism is one of the most affected, with the hotel sector facing an abrupt drop in the occupancy rate and consequent reduction in revenues, as observed by Conto (2021). Such a scenario highlighted the vulnerability of organizations in the face of systemic events and reinforced the need for strategic and robust financial management to face extreme uncertainties and maintain operational continuity.

Given this scenario, this study answered the following research problem: what were the effects of the COVID-19 pandemic on the economic, financial, and structural performance of a hotel organization in the Northwest region of the state of Rio Grande do Sul - Brazil? To this end, the general objective was to analyze such effects based on the analysis of financial, economic, and structural indicators in the period from 2018 to 2024.

The relevance of the research lies in the possibility of evidencing the impacts produced by the health crisis, providing subsidies for decision-making and strategic planning in scenarios of uncertainty. More than a historical record, the study seeks to understand how the organization's governance reacted to the crisis, offering economic, financial, and

structural information about resilience and the importance of being prepared for abrupt disruptions in cash flow.

The structure of the article initially includes the introduction, then there is the theoretical framework that supported the research, the methodological procedures used to carry out the research, then there is the presentation and analysis of the results. Finally, there are the final considerations and the references used.

2 ACCOUNTING AND ITS REPORTING

Accounting, as Martins (2020) points out, can be understood as a model that seeks to present in detail the reality of the economic, financial, and structural situation of the organization. It is important that each organization adopts specific characteristics of its economic, financial and patrimonial reality for strategic planning and definition of actions to be adopted in the future of the organization. In this sense, accounting is no longer a mere historical record to become a prospecting tool, essential for survival in volatile markets.

According to CPC 00(R2), the financial statements must provide useful information about the organization's assets, liabilities, shareholders' equity, expenses, and revenues, as well as the result of each accounting year, in order to enable a more accurate evaluation and analysis of the management of its resources (CPC, 2019). This usefulness of information is what allows managers to monitor the entity's solvency in real time, anticipating possible financial collapses.

AASB 26 (R5) mentions that:

Financial statements are a structured representation of the entity's equity and financial position and performance. The purpose of financial statements is to provide information about the equity and financial position, performance and cash flows of the entity that will be useful to a large number of users in their valuations and economic decision-making. The financial statements also aim to present the results of the management's performance, in view of its duties and responsibilities in the diligent management of the resources entrusted to it. To meet this objective, the financial statements provide information to the entity about the following: (Text amended by CFC Resolution No. 1,376/11)

- (a) assets;
- (b) liabilities;
- (c) shareholders' equity;
- (d) income and expenses, including gains and losses;
- (e) changes in equity through payments by the owners and distributions to them; e
- (f) cash flows (CFC, 2019, p. 6).

The financial statements must be prepared and demonstrated in accordance with the legislation and standards, from these disclosures it is possible to carry out economic, financial

and equity analyses through specific performance indicators. These indicators translate raw data into business intelligence, allowing management to understand not only how much the company has, but how it is reacting to external pressures.

Ignácio and Goularte (2021) and Almeida (2019) reinforce that the analysis provides relevant information to several users interested in understanding operational activities. According to Lins and Francisco Filho (2012), the analyses should be used as an instrument to control the economic, financial and patrimonial situation, allowing a clear assessment for the decision making of managers.

3 ECONOMIC, FINANCIAL AND STRUCTURAL INDICATORS

3.1 LIQUIDITY INDICATORS

Padoveze and Benedicto (2010) describe in their bibliography that the elaboration of liquidity indicators aims to analyze the payment capacity of companies, understanding liquidity as availability in currency to honor their agreements. It is related to the idea of liquidation and liquidation, and liquidation represents the settlement of the obligation, therefore, the indicators intend to measure whether the company's assets and rights are sufficient for the settlement of its debts. In periods of crisis, liquidity becomes the main indicator of survival, as the lack of immediate cash can lead to insolvency, even if the company has solid equity.

Liquidity ratios make it possible to analyze the financial health of the entity in the face of its obligations, demonstrating the company's ability to meet its commitments and consequently have continuity in the market (Martins, 2020).

The fact of the existence of assets and liabilities with different forms and deadlines of realization led to the development of several types of Liquidity Indicators to measure the ability to pay, thus, financial analysts work with indicators and among them the most used are Current Liquidity, Dry Liquidity, Immediate Liquidity and General Liquidity (Padoveze; Benedicto, 2010)

3.2 INDEBTEDNESS INDICATORS

According to Padoveze and Benedicto (2010), the indebtedness indicators show how much the organization's assets are financed by its own resources or those of third parties, allowing the analysis of the degree of external dependence. A capital structure that is excessively dependent on third parties increases the organization's vulnerability in scenarios of declining revenue, such as what occurred during the pandemic.

Debt ratios indicate that the higher the degree of indebtedness, the greater the tendency for organizations to use accounting methods to increase profit. As this index increases, the risk of non-compliance with obligations increases, increasing the probability of insolvency (Iudícibus; Lopes, 2004).

3.3 STRUCTURE INDICATORS

The Asset structure looks at the share of each account group in the organization's total Assets, assuming a 100% basis for the total Assets, calculating the share of the account subgroups. This information is found in the Vertical Balance Sheet Analysis. These indicators are presented as Participation of Current Assets in Total Assets (PAC), Participation of Long-Term Realizable in Total Assets (PRLP) and Participation of Fixed Assets in Total Assets (PAF), (Padoveze; Benedicto, 2010).

The efficient management of fundraising and structure is one of the main organizational activities, as it promotes a fundamental role for the growth, development and sustainability of organizations, understanding the form and sources of financing among the entity's sets of resources (Reis; Ritta; Fabris, 2015). Among these, EBITDA (EBITDA) stands out, an indicator to highlight the potential for operating cash generation, disregarding financial and tax effects that could mask the real performance of the hotel activity in years of crisis (Almeida, 2019). Operational analysis, in turn, allows the identification of variations in sales cycles and volumes, contributing to the construction of scenarios and risk mitigation (Silva, 2019). Understanding these cycles is what allows the organization to adjust its cost structure quickly in the face of a downturn in demand.

EBITDA, also known as EBITDA, is a performance indicator in companies used in the economic and financial part, calculated in the financial statements based on the income statement for the year (P&L), which reflects the operations in a given period, without accounting for some effects such as interest, taxes, depreciation, and amortization (Almeida, 2019). As Martins (2020, p.184) points out: "With the globalization of markets, measures of economic and financial performance that can make the results measured in different countries comparable become extremely desirable."

Operational analysis, as Padoveze and Benedicto (2010) point out, is an essential tool to understand the efficiency of the entity's activities, understand the cycles and resources to obtain an adequate analysis. This topic aims to highlight them, demonstrating the cycles, indicators, and their importance for understanding a result in the analysis statements.

According to Alves and Laffin (2018), Operational Analysis comprises the use of instruments or sources for the proper functioning of the organization, allowing the analysis in

a certain period of time of the purchases or products that will be resold and the receipt of sales values. Adopting measures to mitigate risks and implement procedures to strengthen the financial health of the business.

Operational Analysis aims to assess the economic viability of the entity, identify variations in business results and behavior, becoming an essential tool to analyze and verify the impacts and procedures based on any variation in sales volume, contributing to the construction of scenarios (Silva, 2019).

3.4 PROFITABILITY INDICATORS

The use of Economic Indicators offers information that helps in obtaining correct decisions. Profitability indicators indicate the return on invested resources, evaluating the efficiency of management over time (Alves; Laffin, 2018). The use of Economic Indicators is extremely important for the contribution of business management, as they offer accurate information that helps managers in the decision-making process, contributing to the economic and financial growth of the organization.

As described by Alves and Laffin (2018, p.30): "The use of indicators affirms the relationship between accounts or a group of accounts in the financial statements that present relevant elements of the company's economic or financial position". Alves and Laffin (2018) highlight the following economic indicators:

Indicators are essential for business management, and are also useful to measure the company's activities in the competing market. It is known that companies have a great variation in their performance, which ends up hiding the complexity of the changes that have occurred in different economic sectors, including the various business segments. Through the oscillation of business performance, it is possible to evaluate and understand why some companies in the same field have better commitment than others (Alves; Laffin, 2018, p.24).

The combination of Asset items is what generates revenue for the company, as Assets means investments made by the company to obtain profitability, that is, to increase its profitability. In this way, economic indicators were created to calculate the company's earning power, the profit that was achieved in real invested (Marion, 2012).

Economic indicators are related to results and their operating activity. Thus, in the following topic, Profitability Indicators will be addressed, one of the essential indicators to analyze the company's efficiency.

The Profitability Indicators consist of a number or percentage that indicates how much return it has from the resources invested in it. This return evaluates the efficiency of management in using the assets in its activities, in relation to the organization's assets, as

well as in relation to the sales made by the organization, evaluating profitability over time (Alves; Laffin, 2018).

Understanding and efficiently managing the company's activities are essential for operational growth, increasing profitability, minimizing liquidity difficulties, and mitigating risks, allowing for evolutionary development and adequate financial health (Almeida, 2019).

4 EXTERNAL EVENTS AND UNCERTAINTY MANAGEMENT

Companies must maintain constant attention to events and transformations in the external environment to adopt measures that neutralize or prevent threats, with the objective of anticipating actions to ensure the continuity of the organization (Paiva; Neves, 2008). The external environment exerts a significant influence on the development of organizations, and can directly affect their functioning, triggering methods of adaptation to the market, especially in periods of crisis. It is evident that the organization has adapted to the development in order to generate profit, whether for sales or service activities (Addono, 2018).

The capacity for organizational resilience is directly linked to the agility in interpreting these external variables and adjusting the financial strategy. The fundamental point of external analysis is to understand, whenever possible, in order to anticipate the changes caused by the most diverse variables that may be inside or outside the company's control, allowing a strategic activity in the face of different scenarios and threats (Paiva; Neves, 2008).

In the face of unexpected scenarios, such as economic crises and changes, whether national or global, all organizations are subject to impacts and risks, whether controllable or not. Internal control must seek methods capable of mitigating the effects of these events for the greatest possible stability within the organization (Lima, 2023). What differentiates organizations that survive global crises from those that close their activities is the robustness of their planning and the speed of response to impacts.

It is evident that external events exert a significant influence on the performance of organizations and their economic stability. Among these events, the COVID-19 pandemic stands out. In view of the contagion of the Covid-19 pandemic, there was the closure of activities and temporary suspension of face-to-face services by determination of the public authorities, causing a huge paralysis in the market. This scenario has had a direct impact on the economy of organizations, hindering their growth and causing a drop in revenue, in addition to bringing difficulties in meeting their finances (Coimbra; Caldeira; Serrão, 2020).

The pandemic was not only a health crisis, but an unprecedented financial stress test. With the advance of the Covid-19 pandemic, the financial system was drastically affected, the increase in economic risks caused a drop in stocks, in addition to shaking the functioning

of the market. The conditions of companies worsened rapidly, generating uncertainties regarding the stability of their assets, crises to maintain their cash flow, financial obligations, and difficulty in accessing financing (Bernanke, 2024). In other words, the financial system was affected by uncertainties about equity stability and cash flow difficulties (Bernanke, 2024).

As highlighted by Mendes *et al* (2020), sectors such as hotels, restaurants, events, among others, suffered significant drops in sales and service revenues while maintaining fixed obligations such as rents and salaries, which generated severe liquidity problems. In this context, the monitoring of the indicators previously described has become the compass for the resumption of the economic and financial balance of organizations.

5 METHODOLOGICAL PROCEDURES

The research is characterized as exploratory, descriptive and applied, as to the ends, and documentary, bibliographic and case study, as to the means. The exploratory and descriptive nature is justified by the need to observe and detail the behavior of financial variables in a crisis scenario, while the applied character lies in the generation of knowledge that can help in the management of organizations in the same segment. The methodological design was adopted with the objective of analyzing the structural, economic and financial impacts resulting from the COVID-19 pandemic in an organization of the hotel segment located in the northwest region of Rio Grande do Sul - Brazil.

The investigation used primary data extracted from the financial statements, Balance Sheet and Income Statement, provided by the organization under study, referring to the periods from 2018 to 2024. This time frame was strategically selected to allow a comparative analysis in three distinct moments: the pre-pandemic period (2018-2019), the peak of the health crisis (2020-2021) and the recovery and stabilization process (2022-2024). From these financial statements, fundamental structural, economic and financial indicators were calculated, such as liquidity, indebtedness, equity structure, financial leverage and profitability ratios according to the formulas established in the accounting literature.

The theoretical basis was built through bibliographic research in books, scientific articles, accounting standards and technical pronouncements (CPCs and NBCs), providing the necessary conceptual support for the interpretation of the results. In addition, non-standardized interviews were conducted with professionals from the company's accounting area, with the purpose of clarifying operational information, confirming specific events of the period and qualitatively contextualizing the raw data extracted from the reports.

The quantitative approach was carried out through measurement, organization in electronic spreadsheets and comparison of the indicators calculated over the seven years. The qualitative approach was manifested from the reflective interpretation of the results in the light of the organizational context, the regional economic environment and the particularities of the hotel sector in the face of the mobility restrictions imposed by the pandemic. This integration of methods allowed the numbers to be translated into explanations about the resilience and adaptive capacity of the organization studied.

6 PRESENTATION AND ANALYSIS OF RESULTS

The presentation and analysis of the results begins with the indicators. As described by Padoveze and Benedicto (2010), the relationship between economic, financial and structural indicators is based on the integration between the accounts of the Balance Sheet and the Statement of Income for the Year, which allows the manager to base strategic decisions with a greater probability of success and organizational growth. The results on the effects of the Covid-19 Pandemic on the performance of the studied organization are presented below.

6.1 LIQUIDITY INDICATORS

Liquidity Indicators, in Martins' (2020) view, allow the organization's financial situation to be assessed, determining the ability to pay its debts and ensure continuity in its operations. These ratios work as a security measure, indicating the entity's financial leeway in the face of its short- and long-term commitments. The following is the Current Liquidity, Dry Liquidity, Immediate Liquidity and General Liquidity ratios of the organization that is the object of the research.

The results obtained by applying the formulas to the data extracted from the company's Financial Statements are shown in Table 1.

Table 1

Liquidity Indicators

	Current Ratio	Dry Ratio	Quick Ratio	General Liquidity Ratio
2018	R\$ 4,71	R\$ 4,16	R\$ 3,74	R\$ 2,25
2019	R\$ 3,37	R\$ 2,93	R\$ 2,47	R\$ 1,72
2020	R\$ 2,92	R\$ 2,34	R\$ 1,97	R\$ 1,33
2021	R\$ 2,91	R\$ 2,38	R\$ 1,95	R\$ 1,52
2022	R\$ 5,69	R\$ 5,02	R\$ 4,36	R\$ 2,39
2023	R\$ 6,88	R\$ 6,38	R\$ 5,82	R\$ 3,08
2024	R\$ 9,24	R\$ 8,69	R\$ 7,76	R\$ 3,65

Source: Survey data (2025).

Padoveze and Benedicto (2010) describe that the interpretation of these indices reveals how much the organization makes available for each R\$ 1.00 of debt. Table 1 shows these values for the period from 2018 to 2024, showing that results above R\$1.00 indicate solvency capacity, while values below this level signal difficulties in honoring obligations. In this sense, the higher the index, the greater the financial robustness and the ability to survive in the market. According to the information presented in Table 1, it is noted that although the indices were reduced in 2020 and 2021, the company managed to maintain its solvency in all indicators. This resistance is remarkable, as it demonstrates that, even with the abrupt drop in hotel activities, the organization had enough reserves or a flexible cost structure not to go into immediate insolvency. The drop observed in the 2020-2021 biennium is related to the systemic impacts of the COVID-19 pandemic, which compressed working capital and cash availability. However, there is a sharp recovery from 2022 onwards, culminating in 2024 as the year with the greatest historical evolution of the Liquidity Indices. Current Ratio, for example, reached the expressive level of R\$9.24 for every R\$1.00 of short-term debt, which reflects not only the recovery of the sector, but possibly a strategy of profit retention or financial deleveraging after the critical period.

6.2 INDEBTEDNESS INDICATORS

In this topic, the Indebtedness Indicators are presented, which allow the evaluation of the degree of financial dependence of the organization. According to Padoveze and Benedicto (2010), these indicators show how much the organization depends on third-party capital to maintain its activities. In times of instability, such as the one observed between 2020 and 2021, monitoring these ratios is vital to avoid overcommitting cash flow to financial charges.

The results achieved from the Financial Statements, through the analysis of the General Indebtedness Ratio and Financial Indebtedness are shown in Table 2.

Table 2*Indebtedness Ratios*

	General Indebtedness Ratio	Financial Indebtedness Ratio
2018	20,47%	11,08%
2019	24,37%	12,46%
2020	24,63%	13,65%
2021	31,15%	16,44%
2022	28,75%	15,59%
2023	26,18%	17,18%
2024	21,58%	14,34%

Source: Survey Data (2025).

Iudícibus and Lopes (2004) report that the higher the level of indebtedness, the greater the risk of defaulting on their financial obligations. According to table 2, it can be seen that in the General Indebtedness Index there was a growth between 2018 and 2021, from 20.47% to 31.15%. This increase, although it suggests greater pressure on liabilities, reflects the company's need to raise external funds to address the shortage of operating revenues during the critical period of the pandemic. As of 2022, this ratio decreases, reaching 21.58% in 2024, which shows an improvement in the capital structure and a return to financial autonomy.

The Financial Indebtedness Ratio determines the organization's dependence on third-party capital, demonstrating the effective financial costs. This indicator identifies an increase from 11.08% (2018) to 16.44% (2021). In 2023, the index reached its peak (17.18%), suggesting that the company may have taken advantage of the recovery moment to make investments or consolidate previous debts. In 2024, the reduction to 14.34% confirms a stabilization trajectory. In general, the company has balanced ratios, evidencing prudent management that avoided over-indebtedness even in the face of a severe crisis in the sector.

6.3 STRUCTURE INDICATORS

The Structure Indicators, as highlighted by Martins (2020), are instruments that show how the organization finances its assets and maintains the balance between its resources. Analysis of asset ownership and composition reveals how agile a company can be in responding to sudden changes in the market.

Table 3 is presented below, showing the results obtained through the survey of the Equity Immobilization Index.

Table 3*Equity Immobilization Ratio*

	Equity Asset Ratio
2018	73,94%
2019	81,85%
2020	91,14%
2021	83,21%
2022	59,57%
2023	45,24%
2024	42,45%

Source: Survey Data (2025).

In the hotel industry, it is common for a large part of the Shareholders' Equity to be linked to Fixed Assets (facilities and equipment). The index reached 91.14% in 2020, showing that, at the height of the crisis, practically all equity was "locked" in permanent assets, drastically reducing financial flexibility. However, the systematic reduction to 42.45% in 2024 is a telling fact: it indicates that the organization has strengthened its Shareholders' Equity and liquidity, becoming much less dependent on its fixed assets to sustain its value. This indicates an improvement in the capital structure, with more balance between its resources invested in fixed assets. Much of this evolution tends to adapt after the impacts of the pandemic, allowing for long-term sustainability.

Next, the results obtained on the Asset Structure Ratios are presented, divided into Participation of Current Assets in Total Assets and Participation of Fixed Assets in Total Assets.

Table 4*Asset Structure Index*

	Share of Current Assets in Total Assets %	Share of Fixed Assets in Total Assets %
2018	38,20%	61,38%
2019	33,74%	65,81%
2020	26,32%	73,13%
2021	36,07%	63,45%
2022	53,37%	46,27%
2023	63,88%	35,85%
2024	64,74%	34,92%

Source: Survey Data (2025).

The Asset Structure Ratio shows the proportion of Current Assets and Non-Current or Fixed Assets in the company's assets, allowing an understanding of its investments, reporting whether its resources are linked to short-term or long-term assets. Padoveze and Benedicto (2010) warn that one should always be aware of the oscillations that may occur in these

indicators, as it is a signal for possible changes and analyses of the organization and the market.

When analyzing the Asset Structure, as shown in Table 4, a strategic inversion can be noted: in 2020, Fixed Assets represented 73% of the total, falling to 35% in 2024. At the same time, Current Assets jumped from 26% to 65%. This change in profile indicates a "financialization" of the company's structure, which began to favor highly liquid assets (cash and equivalents) to the detriment of new large fixed assets. This strategy significantly increases the organization's resilience to face future crises.

According to Padoveze and Benedicto (2010), the Liability Structure Index aims to present a broad view of the composition of its company financing, evidencing the participation of each group of accounts of its Liabilities in relation to Total Assets. Table 5 shows the results for the Liability Structure Ratio in Total Assets.

Table 5

Liability Structure Ratio in Total Assets

Share of Current Liabilities in Total Assets %	Share of Noncurrent Liabilities in Total Assets %	Share of Total Liabilities in Total Assets %	Share of Shareholders' Equity in Total Assets %
8,12%	8,88%	16,99%	83,01%
10,00%	9,59%	19,59%	80,41%
9,01%	10,75%	19,76%	80,24%
12,38%	11,37%	23,75%	76,25%
9,39%	12,94%	22,33%	77,67%
9,28%	11,47%	20,75%	79,25%
7,00%	10,74%	17,75%	82,25%

Source: Survey Data (2025).

According to the concepts of Padoveze and Benedicto (2010), the indices of liability structure and participation of liabilities in total assets allow the evaluation of the degree of dependence on third-party capital and the financial autonomy of the organization.

Table 5 reinforces the financial autonomy of the company. The Participation of Shareholders' Equity in Total Assets remained high (above 76% in the entire period), reaching 82.25% in 2024. According to Padoveze and Benedicto (2010), this predominance of own resources provides the company with exceptional security, allowing it to operate with a low risk of insolvency and less exposure to variations in market interest rates.

6.4 PROFITABILITY INDICATORS

According to Alves and Laffin (2018), Profitability Indicators demonstrate the efficiency of management in transforming assets and capital into profit. For the hotel sector, which has high fixed costs, profitability is the indicator that suffers the most in periods of low occupancy.

This subtitle presents the results obtained from the calculations and analysis of the Indicators of Return on Assets, Return on Equity, Degree of Financial Leverage and Interest Coverage Indicator.

Table 6 shows the results obtained on Earnings Before Financial Expenses (EBIT).

Table 6

Earnings Before Financial Expenses (EBIT)

	Gross Profit	EBIT
2018	R\$ 2,432,445.57	R\$ 301,933.43
2019	R\$ 2,494,976.71	R\$ 131,347.22
2020	R\$ 1,431,967.98	-R\$ 387,135.32
2021	R\$ 3,233,328.38	R\$ 598,886.27
2022	R\$ 4,852,661.46	R\$ 1,944,290.14
2023	R\$ 5,896,553.02	R\$ 2,337,421.78
2024	R\$ 6,022,964.77	R\$ 1,405,401.33

Source: Survey Data (2025).

Table 6 shows the Profit before Financial Expenses between the periods of 2018 and 2024 of the hotel company under study. Through this information, it becomes possible to visualize the oscillations over the periods, demonstrating the periods of low and high, allowing to observe the company's ability to return to profitability after periods of economic stability. It was also used as a calculation for the statements of the Return on Assets, Coverage Indicator and EBITDA (EBITDA) indicators.

EBIT reflects the health of the operation. The negative result of -R\$ 387,135.32 in 2020 illustrates the devastating impact of the lockdown. However, the recovery in 2022 and 2023 is robust, with operating profit jumping into the millions. This turnaround demonstrates that the company's business model is solid and capable of generating large surpluses as soon as external demand normalizes.

Table 7 shows the results obtained from the Profitability Indicators, from the application of the formulas in the data extracted from the Financial Statements.

Table 7

Profitability Indicators

	Return on Asset (RSA)	Return on Equity (ROE)	Degree of Financial Leverage	Interest Coverage Indicator
2018	8,27%	2,96%	0,36	5,89
2019	3,19%	1,11%	0,35	2,15
2020	-9,63%	-12,02%	1,25	-11,81
2021	14,37%	6,33%	0,44	9,10
2022	45,33%	25,80%	0,57	10,94
2023	52,53%	26,64%	0,51	9,84
2024	28,12%	14,95%	0,53	5,17

Source: Survey Data (2025).

According to Alves and Laffin (2018), profitability indicators allow the evaluation of the company's efficiency in the use of its resources and the ability to generate returns over time. From this perspective, the results of ROA and ROE confirm the shock of 2020 (with negative returns of -9.63% and -12.02%, respectively). However, the profitability achieved in 2022 (ROA of 45.33% and ROE of 25.80%) is extraordinary for the sector, indicating a repressed recovery. The Financial Leverage Degree (GAF) remained, most of the time, below 1.00 (except in 2020 due to losses), which, according to the literature, indicates that the company was not using debt in order to "leverage" its profit, but rather maintaining a conservative and safe stance. The significant improvement in the Interest Coverage Indicator after 2021 ratifies that the company has recovered its full capacity to honor financial charges, consolidating its stability in the post-pandemic period.

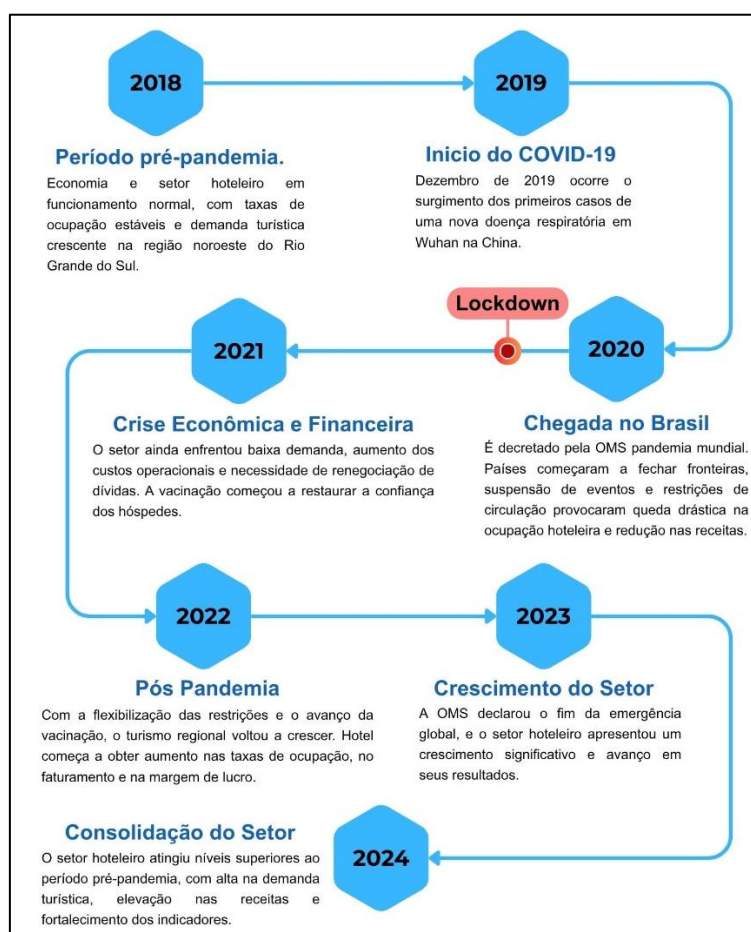
6.6 EFFECTS OF THE COVID 19 PANDEMIC ON ECONOMIC AND FINANCIAL PERFORMANCE

According to Bernarke (2024), the COVID-19 pandemic triggered financial and economic impacts on a global scale, reflecting an increase in risks that led to the devaluation of services and marked instability in the market. Companies had to adapt to the scenario quickly, facing uncertainties, difficulties to maintain their activities and honor their commitments, requiring unprecedented crisis management to maintain solvency.

Next, figure 1, COVID-19 Pandemic in the Hotel sector between 2018 and 2024, is presented, and then demonstrates the economic and financial effects directly interconnected to the company object of the study. This visual representation allows us to understand the chronology of external events that guided the company's internal decisions.

Figure 1

COVID-19 pandemic in the Hotel sector between 2018 and 2024



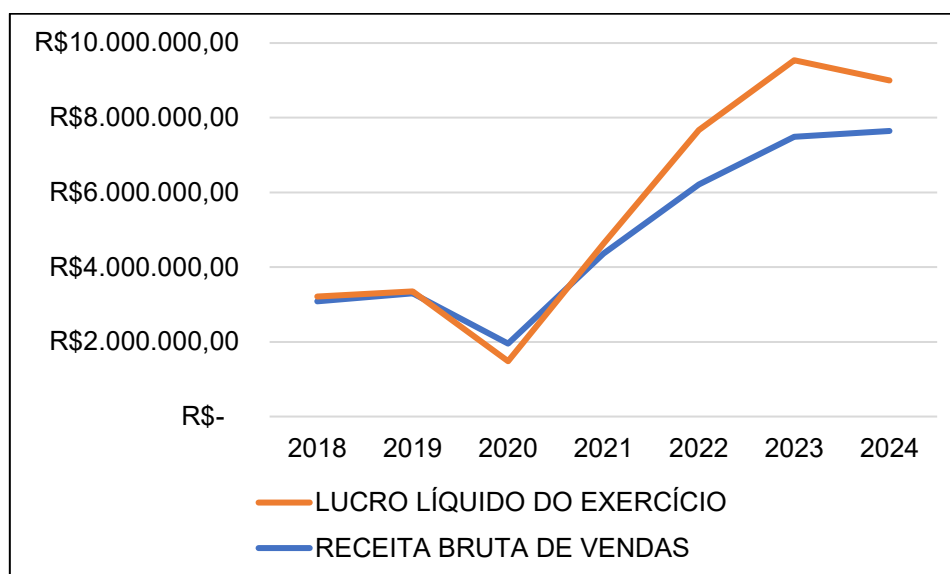
Source: Prepared by the authors based on WHO and Research Data (2025).

From the analysis of economic and financial indicators, it was identified that in the periods of the pandemic shown in figure 1, the emergence of the COVID-19 pandemic is evident, and with it companies begin to face a drop in their revenues. This phenomenon was the result of the reduction in employment rates and the temporary suspension of activities, causing financial and economic imbalance in organizations. In the hotel sector, specifically, the rigidity of fixed costs coupled with demand volatility has aggravated the pressure on working capital.

To highlight the effects of the COVID-19 pandemic on the financial performance of the company under study, Figure 2 was prepared, which demonstrates the Effects of the COVID-19 Pandemic on Gross Revenue and Net Income in the period from 2018 to 2024.

Figure 2

Effects of the COVID-19 Pandemic on Gross Revenue and Net Income



Source: Survey Data (2025).

Graph 1 shows significant fluctuations in both revenue and profit of the hotel company. Between 2018 and 2019, it is observed that the company had been experiencing a slight growth in its operations, but with a reduction in its profit, due to higher expenses with operating costs and expenses. The period of 2020 stands out with the greatest impact, with a drastic drop in its revenues and leaving its Net Income negative, reflecting the effects of the pandemic in relation to tourism, causing companies to close due to *the lockdown* and reducing the demand for accommodation. This negative result highlights the fragility of the sector in the face of the total interruption of the flow of customers.

From 2021, a vaccination process begins in Brazil, determining a gradual recovery in revenue and high growth in profitability. Driven by the resumption of activities in 2021 and the significant increase in demand after the confinement period, a phenomenon often classified as pent-up demand, the company presented its best indexes in 2022 and 2023. During this period, it achieved high levels of revenue and profit, with a significant expansion of its financial and economic indicators, consolidating the efficiency of the recovery strategies adopted in the post-crisis.

In the 2024 period, the company manages to maintain its positive results, although it demonstrates a reduction in Net Income for the Year. This retraction suggests a phase of stabilization of the hotel market in Rio Grande do Sul, where the increase in operating costs or the normalization of demand may be impacting profit margins, maintaining instability in its operations.

After presenting the effects of the COVID 19 pandemic on the economic and financial performance of the company object of the research, the research continued by presenting the final considerations with the main results of the research.

7 FINAL CONSIDERATIONS

The objective of this study was to analyze the Financial Statements of a hotel company located in the Northwest of Rio Grande do Sul, seeking to evaluate its economic and financial performance between 2018 and 2024. To this end, it was based on the precepts of the classical analysis of balance sheets and on the theories of capital structure, using a methodology of applied nature with a quantitative approach and case study procedures. Through this study, it was possible to broadly understand the equity structure of the company object of the study and observe the evolution of the main indicators, contributing to the identification of strengths, the need for attention in resource management and adaptation in uncertain scenarios.

Liquidity analyses were fundamental to assess the company's ability to honor its commitments in both the short and long term. The results showed that, over the years, even in the face of the impacts generated by the pandemic, the organization managed to maintain its liquidity indicators above average. This performance reveals a satisfactory level of solvency and indicates that the company has adopted effective strategic management, even in a scenario marked by crises and uncertainties, such as that caused by COVID-19, validating the importance of maintaining liquidity reserves for operational continuity.

The main results of the survey regarding the debt structure showed that the company presented variations over the period analyzed. However, it consistently maintained a level of indebtedness considered controllable, without compromising the economic and financial balance of the organization. Although there was an increase in overall indebtedness in 2021, reflecting the need for working capital financing during the height of the crisis, subsequent periods demonstrated the company's ability to stabilize this indicator, reflecting prudent management between equity and third-party capital. This posture contributed to the reduction of risks and less dependence on external resources, ensuring greater security and financial sustainability to operations.

The turnover analysis, as one of the main results of the survey, brought relevant information about the operational efficiency of the hotel company, evidencing the relationship between payment, receipt and storage terms. It was found that, in 2020, a period marked by *the lockdown* and the restrictions resulting from the pandemic, there was a significant reduction in inventory turnover. However, it was found that, with the resumption of activities

in the following periods, the company showed a gradual recovery of this indicator, demonstrating the reestablishment of operational balance and greater efficiency in the management of inventories and other resources, following the recovery movement of the hotel sector at the regional and national levels.

The study showed that the effects of the COVID-19 pandemic directly impacted the performance of the company under study in the 2020 fiscal year, resulting in a significant reduction in its economic and financial operations, with a drop in all indicators developed in the survey in this period, especially in Gross Profit and Net Revenue for the year. This scenario reflected the restrictions imposed by the isolation and decrease in tourist activities, which directly affected the hotel industry. However, in the period of 2022, it was found that the recovery was gradual and driven, due to the increase in demand from the sector and visitors in the region, which evidenced a capacity for economic and financial growth. This demonstrates that the company was able to adapt to adverse scenarios and efficiency in management to reestablish its performance and strengthen its situation in the market.

Despite the results achieved, the present study has limitations, such as the focus restricted to a single organization, which prevents the generalization of the results to the entire hotel sector in Rio Grande do Sul. In addition, the analysis was based on quantitative data from the financial statements, without considering qualitative variables of the managers' perception. Therefore, it is recommended that future research expand the analysis from different perspectives. One possibility is to deepen the study by comparing the performance of the company analyzed with other organizations in the hotel sector in the region or in different states, allowing the identification of good management practices. It is also suggested to investigate the impact of recent climatic events in the region on the 2024 and 2025 indicators, in order to understand the resilience of the sector in the face of new crises of different nature.

Finally, this research work contributes to the understanding of the importance of the analysis of financial statements as a tool to support decision making within the company, not only in the hotel sector, but also in other market niches, demonstrating the relevance of accounting as an instrument of evaluation and planning. Academically, the research fills a gap on the impacts of the health crisis on small and medium-sized companies in the interior of Rio Grande do Sul.

REFERENCES

Addonno, R. E. (2018). O financiamento das empresas no Brasil: Impactos tributários (E-book). Almedina. Recuperado em maio, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9788584934652>

- Almeida, M. C. (2019). Análise das demonstrações contábeis em IFRS e CPC: Facilitada e sistematizada. Atlas. Recuperado em março, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9788597020779>
- Alves, A., & Laffin, N. H. F. (2018). Análises das demonstrações financeiras (E-book). Sagah. Recuperado em abril, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9788595027428>
- Bernanke, B. S. (2024). A política monetária do século XXI: Da grande inflação à COVID-19 (E-book). Alta Books. Recuperado em maio, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9788550823430>
- Comitê de Pronunciamentos Contábeis (CPC). (2019). Estrutura conceitual para relatório financeiro CPC 00 (R2): Demonstrações contábeis. Recuperado em abril, 2025, de [http://static.cpc.aatb.com.br/Documentos/573_CPC00\(R2\).pdf](http://static.cpc.aatb.com.br/Documentos/573_CPC00(R2).pdf)
- Conselho Federal de Contabilidade (CFC). (2017). Normas brasileiras de contabilidade NBC TG 26 (R5): Apresentação das demonstrações contábeis. Recuperado em março, 2025, de [https://www1.cfc.org.br/sisweb/SRE/docs/NBCTG26\(R5\).pdf](https://www1.cfc.org.br/sisweb/SRE/docs/NBCTG26(R5).pdf)
- Conselho Federal de Contabilidade (CFC). (2009). Normas brasileiras de contabilidade NBC T 19.27: Apresentação das demonstrações contábeis. Recuperado em abril, 2025, de <https://www.contadores.cnt.br/legislacoes/resolucao-cfc-n-1-185-de-28-de-agosto-de-2009.html>
- Coimbra, J. D., Caldeira, M., & Serrão, T. (2020). Direito administrativo da emergência: Organização administrativa, procedimento administrativo, contratação pública e processo administrativo na resposta à COVID-19 (E-book). Almedina. Recuperado em maio, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9789724085067>
- Conto, S. M. de, Finfler, R., Steiner, V. L., & Bonin, S. M. (2021). A pandemia COVID-19 e o turismo: Reflexões para o estabelecimento de uma agenda para a área. Recuperado em abril, 2025, de <https://sou.ucs.br/etc/revistas/index.php/rosadosventos/article/view/9973>
- Ignácio, P. F., & Gularte, J. L. L. (2021). Análise econômico-financeira das demonstrações contábeis no município de Sant'Ana do Livramento no período de 2015 a 2019. Recuperado em abril, 2025.
- Iudícibus, S. de. (2023). Teoria da contabilidade (12ª ed.) (E-book). Atlas. Recuperado em março, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9788597028041>
- Iudícibus, S. de, & Lopes, A. B. (2004). Teoria avançada da contabilidade. Atlas.
- Lima, F. G. (2023). Análise de riscos (3ª ed.) (E-book). Atlas. Recuperado em maio, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9786559775088>
- Lins, L. dos S., & Francisco Filho, J. (2012). Fundamentos e análise das demonstrações contábeis: Uma abordagem interativa. Atlas.
- Marion, J. C. (2012). Análise das demonstrações contábeis: Contabilidade empresarial (7ª ed.). Atlas.

- Martins, E. (2020). Análise didática das demonstrações contábeis (3ª ed.) (E-book). Atlas. Recuperado em março, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9788597025439>
- Martins, E. (2021). Do indivíduo à nação: A economia em tudo o que se vive (E-book). Atena. Recuperado em março, 2025, de <https://www.academia.edu>
- Mendes, G. F., Santana, H. L. de S., & Afonso, J. R. (2020). Governance 4.0 para COVID-19 no Brasil: Propostas para gestão pública e para políticas sociais e econômicas (E-book). Almedina. Recuperado em maio, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9786556270869>
- Organização Pan-Americana da Saúde (OPAS). (2020). Histórico da emergência internacional de COVID-19. Recuperado em março, 2025, de <https://www.paho.org/pt/historico-da-emergencia-internacional-covid-19>
- Padoveze, C. L., & Benedicto, G. C. de. (2010). Análise das demonstrações financeiras (3ª ed.). Cengage Learning.
- Paiva, H. A. B. de, & Neves, M. F. (2008). Planejamento estratégico de eventos: Como organizar um plano estratégico para eventos turísticos e empresas de eventos (E-book). Atlas. Recuperado em maio, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9788522464531>
- Reis, L. G. dos, Ritta, C. de O., & Fabris, T. R. (2015). Relação entre os indicadores de estrutura de capital e o EBITDA das empresas brasileiras listadas na BM&FBOVESPA. Recuperado em maio, 2025, de <https://congressousp.fipecafi.org/anais/artigos152015/65.pdf>
- Silva, A. A. da. (2019). Estrutura, análise e interpretação das demonstrações contábeis (5ª ed.) (E-book). Atlas. Recuperado em março, 2025, de <https://integrada.minhabiblioteca.com.br/reader/books/9788597012897>

ANALYSIS OF THE PERCEPTION OF GRADUATES ABOUT THE CONTRIBUTIONS OF UEFS PET ECONOMY TO THEIR ACADEMIC TRAJECTORY

ANÁLISE DA PERCEPÇÃO DE EGRESSOS SOBRE AS CONTRIBUIÇÕES DO PET ECONOMIA DA UEFS EM SUA TRAJETÓRIA ACADÊMICA

ANÁLISIS DE LA PERCEPCIÓN DE LOS GRADUADOS SOBRE LAS CONTRIBUCIONES DEL PROGRAMA DE ECONOMÍA DEL PET EN LA UEFS A SU TRAYECTORIA ACADÉMICA



<https://doi.org/10.56238/sevened2026.008-235>

Geovane dos Reis Dantas¹, Leandro Batista Duarte², Jamile da Silva Teixeira Goes de Jesus³, Paloma Fernandes Freitas⁴, Amanda dos Santos Gonçalves⁵, João Vitor dos Santos Sobrinho⁶, Edrei Santos de Lima⁷, Eviny Torres De Jesus⁸, Lucas Mateus Ferreira Oliveira⁹, Valéria Caroline Batista Santana¹⁰, Milena Andrade Déo¹¹, Carlos Adrian Gomes de Oliveira¹²

¹ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: reisdantas.geovane@gmail.com Orcid: <https://orcid.org/0009-0008-1594-5329> Lattes: <http://lattes.cnpq.br/9199820627402478>

² Dr. in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: lbduarte@uefs.br Orcid: <https://orcid.org/0000-0002-4968-5368> Lattes: <https://lattes.cnpq.br/4806705572357487>

³ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: milegoes.jg@gmail.com Orcid: <https://orcid.org/0009-0002-6344-8868> Lattes: <http://lattes.cnpq.br/1995947746118476>

⁴ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: palomaf40@gmail.com Orcid: <https://orcid.org/0009-0001-6457-6856> Lattes: <http://lattes.cnpq.br/2697109693486260>

⁵ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: amandagclv@gmail.com Orcid: <https://orcid.org/0009-0002-6164-7927> Lattes: <http://lattes.cnpq.br/5083443432939728>

⁶ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: vito.toro.jv1@gmail.com Orcid: <https://orcid.org/0009-0003-6221-2682> Lattes: <http://lattes.cnpq.br/7233516391520140>

⁷ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: edreisantoscontact@gmail.com Orcid: <https://orcid.org/0009-0009-9678-9563> Lattes: <http://lattes.cnpq.br/6319106436755020>

⁸ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: evinytorresdejesus@gmail.com Orcid: <https://orcid.org/0009-0000-1443-7308> Lattes: <http://lattes.cnpq.br/8892934451813102>

⁹ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: lucasmateusof@gmail.com Orcid: <https://orcid.org/0009-0001-5645-7208> Lattes: <http://lattes.cnpq.br/1349054034737619>

¹⁰ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: valeriacarolin3@hotmail.com Orcid: <https://orcid.org/0009-0006-7779-260X> Lattes: <http://lattes.cnpq.br/9886967351164179>

¹¹ Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS). E-mail: Milenandradeo@outlook.com Orcid: <https://orcid.org/0009-0006-0777-9231> Lattes: <http://lattes.cnpq.br/4485474360021985>

¹² Undergraduated student in Economics. Universidade Estadual de Feira de Santana (UEFS).

ABSTRACT

This present work aims to identify the perception of graduates about the contributions of the Tutorial Education Program of the undergraduate course in Economics at the State University of Feira de Santana in their academic trajectory, verify the skills acquired in the Program and evaluate the importance of this as a strategy teaching, research and extension. Data were collected using an online, self-administered questionnaire and were described in absolute and relative frequency. 22 graduates participated in the study. The main reasons for participating in the Program were to complete the university degree, gain experience, scholarship opportunities and obtain a promising CV.

Keywords: Teaching. Search. Extension. Economy.

RESUMO

Este presente trabalho tem como objetivo identificar a percepção de egressos sobre as contribuições do Programa de Educação Tutorial do curso de graduação em Economia da Universidade Estadual de Feira de Santana na sua trajetória acadêmica, verificar as habilidades adquiridas no Programa e avaliar a importância desse enquanto estratégia de ensino, pesquisa e extensão. Os dados foram coletados utilizando-se um questionário on-line e autoaplicável e foram descritos em frequência absoluta e relativa. Participaram do estudo 22 egressos. Os principais motivos para participar do Programa foram realizar a tríade universitária, adquirir experiências, oportunidade de bolsa e obter currículo promissor.

Palavras-chave: Ensino. Pesquisa. Extensão. Economia.

RESUMEN

Este estudio tiene como objetivo identificar la percepción de los egresados sobre las contribuciones del Programa de Tutorías de la carrera de Economía en la Universidad Estatal de Feira de Santana a su trayectoria académica, verificar las competencias adquiridas en el Programa y evaluar su importancia como estrategia de docencia, investigación y extensión. Los datos se recopilaron mediante un cuestionario en línea autoadministrado y se describieron en frecuencia absoluta y relativa. Veintidós egresados participaron en el estudio. Las principales razones para participar en el Programa fueron completar la tríada universitaria, adquirir experiencia, obtener oportunidades de becas y lograr un currículo prometedor.

Palabras clave: Docencia. Investigación. Extensión. Economía.

1 INTRODUCTION

The Tutorial Education Program is carried out by higher education institutions (HEIs) across the country. Under the tutorship of a professor with experience and academic production, the PETs are developed by undergraduate students who, gathered in learning groups, carry out academic activities (teaching, research and extension) with the objective of applying the knowledge acquired and strengthening academic training (SESU/MEC, 2006).

Teaching, research and extension form a mandatory tripod in universities and are inseparable through article 207 of the 1998 Constitution (Brasil, 1998). The triad, in addition to contributing to university production, contemplates the solidary, social and cultural role towards society (Moita and Andrade, 2005).

In this way, PET provides students, under the guidance of a tutor, with extracurricular activities that complement the students' academic training and, at the same time, meet the needs of the undergraduate course itself. In this way, it is intended as a tutor to motivate students of the Economics course to become competent professionals and academic producers of knowledge. In this sense, it is expected to provide an improvement in the academic quality of undergraduate courses supported by PET.

According to the Basic Guidelines Manual – PET (2006), it is expected to foster the training of higher education professionals, in the various areas of knowledge, endowed with high scientific, technical, ethical and social responsibility standards, in the various areas of knowledge, who are capable of acting towards the transformation of the national reality, especially as teachers and post-graduate researchers in professional areas.

Thus, conducting research with graduates of the PET groups allows an investigation into the fulfillment of the program's objectives and the appropriation of the information, skills and tools supposedly offered by the educational program by the participants. Also, knowing the impact and benefits of the Program for its scholarship holders is of paramount importance so that there is due appreciation and adjustments in its guidelines and mode of action, when necessary (Fernandes *et al.*, 2020).

Although the PET Economics group at the State University of Feira de Santana (UEFS) has been in existence for many years, few studies have aimed to profile PET scholarship holders from the undergraduate course in Economics. The idea here is to specify the contributions of the Program in the academic trajectory of the scholarship holders, reinforcing the need for more studies on this topic with graduates of the Program of this course.

Therefore, the objective is to identify the perception of the PET Economics graduate from UEFS about the contributions of the Program in their academic trajectory. Also, to verify

the skills acquired in the Program and evaluate the importance of PET as a teaching, research and extension strategy for the training of higher education professionals.

2 RESEARCH AS A PET ACTIVITY

Thus, in relation to "Research", the activities thus proposed tend to develop academic works in quality standards of excellence, since this practice presents an active learning methodology, with emphasis on the solution of the technological problems that the communities have, through a group that, due to its composition, already acts in an interdisciplinary and collective way. The academic training of the participating undergraduates is enriched both by the challenges posed and by the subsequent effort, to report the solutions forwarded, including in scientific dissemination events.

Scientific activity is determined by the ideas and expectations of the scientist who, with inferences, researches to guide theories or discard hypotheses. When a new phenomenon is not yet explained and theorized, it indicates a problem; Therefore, pointing out ways out of this problem is the primary object of any research. As stated by Alves *et al.* (1998) Science begins "[...] when we do not know how to explain a phenomenon, or when traditional explanations do not work - that is, when we are faced with a problem".

In Brazil, according to Schwartzman (2022), the first research institutions were organized by the empire in the nineteenth century, initially focused on the development of the economy, from pest control solutions in crops, as well as the discovery of treatments for diseases. However, the research branch is still waiting for investments and funding to intensify initiatives so that innovations and facts take the place of hypotheses.

In the universities, research began to emerge with the arrival of research professors from Italy, France and Germany, around 1934, they were allocated to research at the University of São Paulo (USP). Thus, in the 40s, with the advancement of research in Brazil, the Brazilian Society for the Advancement of Science was created, then the government instituted the National Research Council in 1951, but with minimal resources.

Tosta (2016) understands that, at PET, the member students stand out in the research dimension and are efficient like the scientific initiation (CI) students. In this sense, "it allows us to affirm that the PET model offers a more comprehensive and richer academic environment than that experienced by other scientific initiation students", with this, it is perceived that PET is an important tool that acts for the development of students.

The Tutorial Education Program (PET) contributes to the insertion of student members in the environment of research scientists. The protagonism to detect problems and the participation in scientific construction are evident characteristics in the petians. Thus, the

experiences lived by academics with extracurricular research activities are essential in professional and personal development, and on the other hand, fundamental for the continuous development of science and established formulations. In this way, the mastery of PET in scientific production and in the training of students is evident.

3 METHODOLOGY

This is a descriptive, cross-sectional research, in which a quantitative approach was used for data collection and analysis. The selection of the site for the study was intentional, and the UEFS headquarters campus was chosen, in the city of Feira de Santana. The study population consisted of graduates of the PET Economics of UEFS, covering the period from the creation of the Program in the institution (2007) to the academic year of 2025. The target population was identified from a survey carried out on data available in the Tutorial Education Program Management System (SIGPET), database and own documentation. In addition, as the graduates were contacted, it was also asked if they knew other graduates who could be added to the research.

All identified participants were contacted individually through electronic mail or in the form of a hidden list, being informed about the objectives, stages and other pertinent information. The participation of the volunteers took place through the consent of the Informed Consent Form (ICF) through agreement at the time of data collection.

Data were collected using an *online*, structured, and self-administered questionnaire through Google *Forms*, developed based on Rychescki et al., (2023); in literature searches and in the objectives of the study. The questions captured data on the perception of this population about the Program, the activities and skills developed in it, and its importance for the academic and professional trajectory. A total of 26 objective questions were asked, divided into three blocks: "Personal information", "Professional information" and "Experience and view on PET". The answer options were dichotomous (yes or no), multiple choice, single-answer questions, or five-point *Likert scale* (Likert, 1932). The collected data were transferred to a Microsoft Office Excel® spreadsheet and described in absolute and relative frequency.

A *Likert* scale is a rating scale used to measure attitudes, perceptions, and opinions. Often used in market research and social sciences, researchers use scale to understand views and sentiment towards a product, service, brand, or market. The *Likert* scale was developed in the United States in the 30s, and unlike a question in which one chooses between yes and no, the questions constructed from the *Likert* scale present a self-descriptive statement.

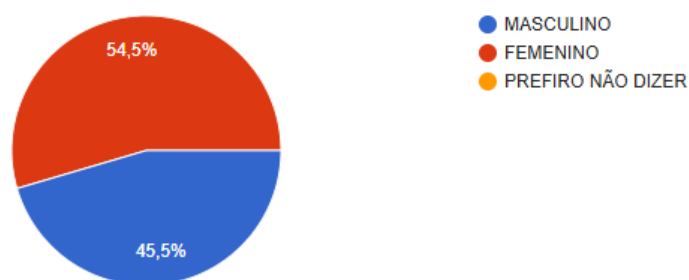
With this, it allows brands to discover different levels of intensity of people's opinions about the same subject or theme. Conceptually, and for experts in the field, the Likert scale combines applied mathematics (statistics) with psychology to promote a logical immersion in the mind of those who consume. An approach capable of extracting qualitative insights from a quantitatively structured question.

4 RESULTS AND DISCUSSIONS

A total of 69 PET graduates of the UEFS Economics course were identified, of which 22 (27.5%) answered the questionnaire and were included in the analysis. I emphasize that the study is still in progress and these are the first results of the analysis. Among the participants in this study, the majority were female (54.5%) and aged between 19 and 21 years (Figures 1 and 2).

Figure 1

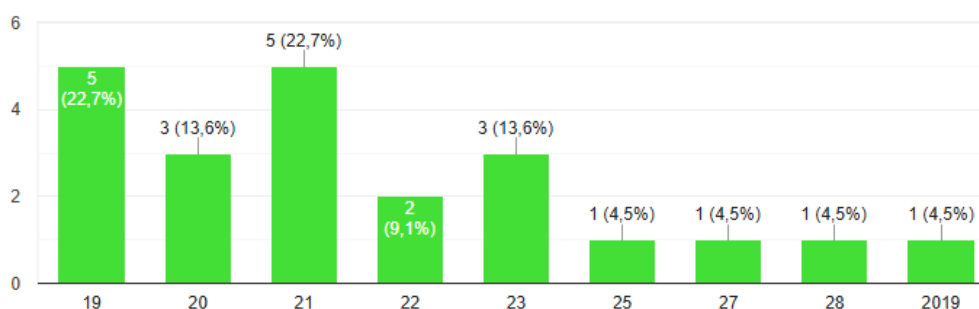
Gender of the graduates of the PET Economics of UEFS



Source: Survey Results.

Figure 2

Age at PET Economics



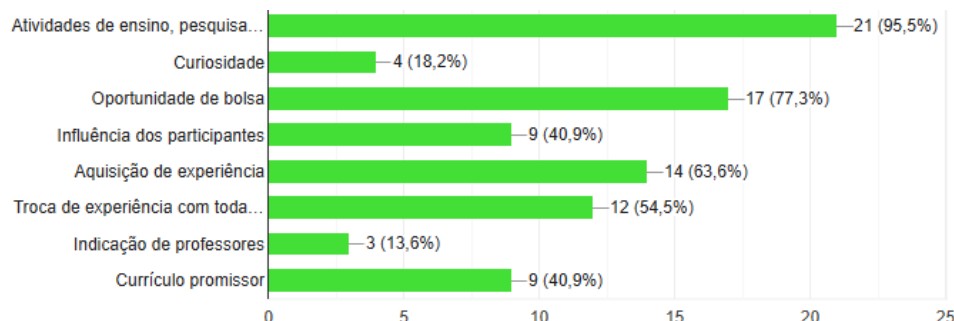
Source: Survey Results.

Among the reasons that led the graduates to participate in the Program, the main ones were to carry out activities of the university triad (95.5%), scholarship opportunities (77.3%), to acquire experiences (63.3%) and to exchange experiences (54.5%). Studies such as the one by Morel *et al.* (2020) and Rychescki *et al.* (2023) found similar results, and the main

reason for entering the Program of the Economics course at UEFS, specifically, was the development of teaching, research, and extension activities (Figure 3).

Figure 3

Motivation to participate in the PET Economy program

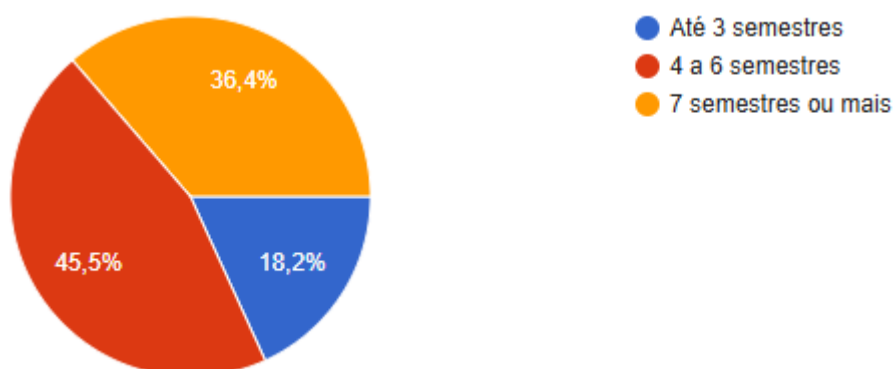


Source: Survey Results.

Most of the graduates remained in PET Economics between 4 and 6 semesters (45.5%) and similar data were also found in studies with other PET groups (Júnior *et al.*, 2021; Lopes *et al.*, 2020; Fernandes *et al.*, 2020). This result can be considered positive, since the graduates had a large period of their education impacted by the multidisciplinary activities in teaching, research and extension promoted by the Program (Figure 4).

Figure 4

Length of stay in the PET Economy program



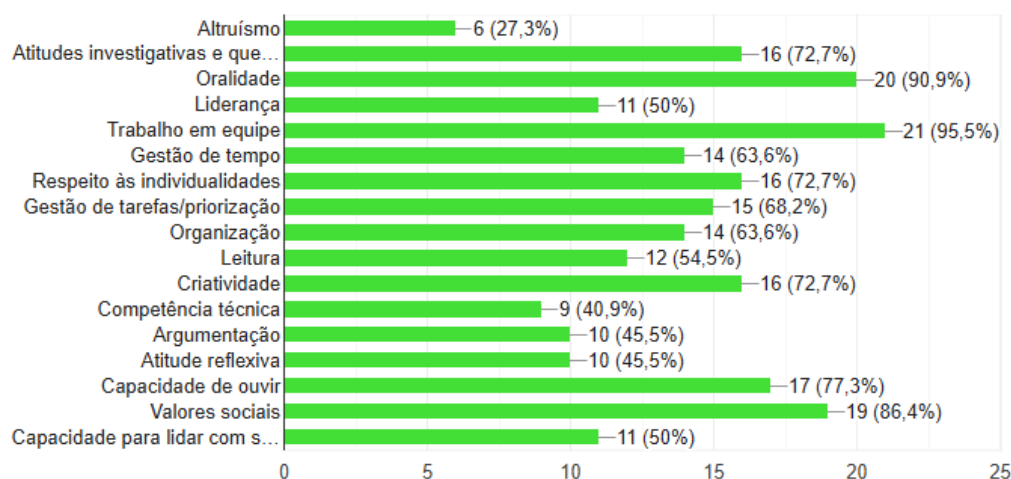
Source: Survey Results.

In addition, 100% (n=78) of the participants stated that the PET provided the development of important skills for education, among them, the following stood out: teamwork (95.5%), orality (90.9%), social values (86.4%), and listening ability (77.3%) (Figure 5). The development of these and other personal and interpersonal skills were also mentioned in

previous studies on PET graduates from various courses (Júnior *et al.*, 2021; Lopes *et al.*, 2020; Fernandes *et al.*, 2020; Morel *et al.*, 2020).

Figure 5

Skills developed while participating in the program.



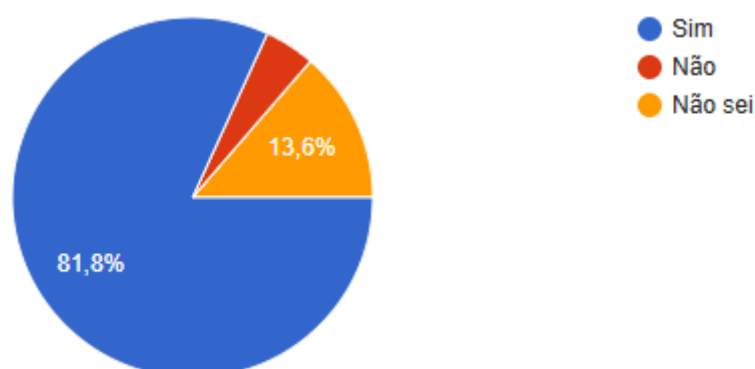
Source: Survey Results.

In this scenario, it is worth noting that the National Curriculum Guidelines for the Undergraduate Course in Economics have some general competencies and skills to be developed during the training of the economist. Thus, according to the data found, it is possible to note that PET Economics has the potential to provide personal, academic and professional improvement through spaces and experiences of teaching, research and extension, with contact with the community, academia and other professionals.

Specifically regarding the competence of permanent education, the Program itself, as it is characterized as a tutorial method, gives scholarship holders the opportunity to become increasingly independent in relation to the management of their learning needs (Dearo, 2017). In fact, 81.8% of the graduates stated that the PET contributed to the increase in their undergraduate performance coefficient (Figure 6).

Figure 6

Program contributes to raising the coefficient of performance in undergraduate courses.

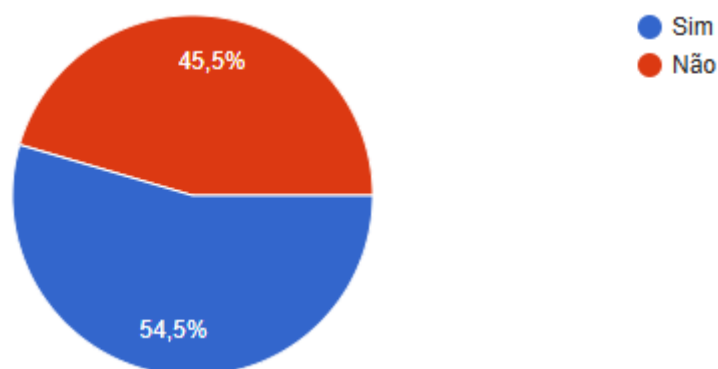


Source: Survey Results.

In addition, the majority stated that the Program encouraged/improved learning in a foreign language, a skill also specified in the Curricular Guidelines (Brasil, 2001), since it is directly related to communication (Figure 7).

Figure 7

Program encouraged learning in a foreign language



Source: Survey Results.

Regarding the activities developed during their participation in the Program, the participants reported that most of the activities were extension activities (90.9%), but also with a frequency close to teaching and research (86.4% and 77.3), respectively) (Figure 8). One of the main pillars of the Program is the university tripod of teaching, research and extension, inseparably united, which allows the student a global, critical, citizen, multiplying and excellent education (Brasil, 2010; Barbosa, 2017; Galdino *et al.*, 2021; Braga, *et al.*, 2021).

Figure 8

Activities developed in the PET Economics program

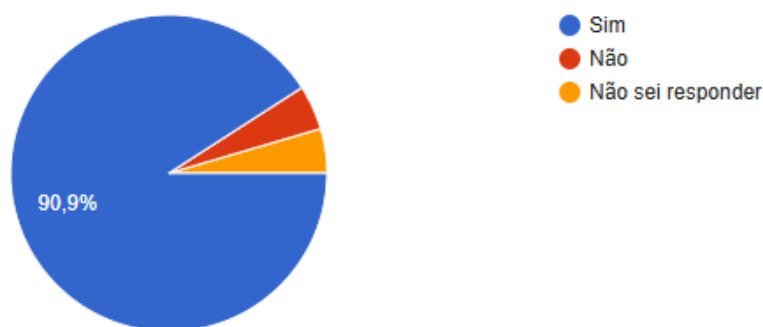


Source: Survey Results.

When asked if they participated in any project involving the triad (teaching, research and extension), the majority said yes (90.9%), and the majority also answered that the PET has no difficulty in articulating these three axes (54.5%), similar to the study by Lopes *et al.* (2020), in which 68% of graduates stated that the PET reached the university tripod (Figures 9 and 10).

Figure 9

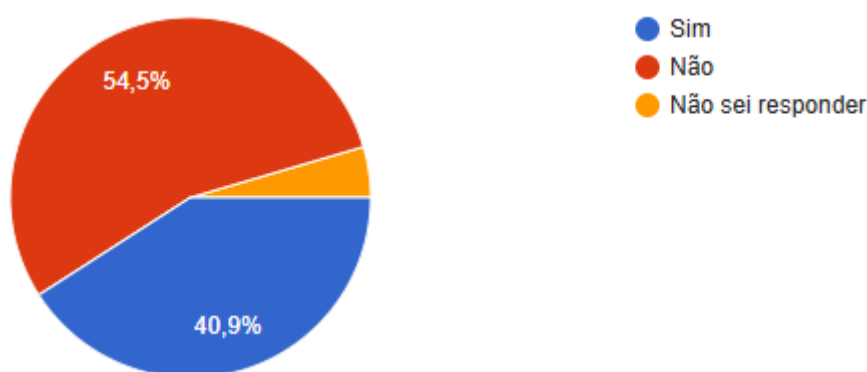
Performance in a project or action involving the triad of teaching, research and extension



Source: Survey Results.

Figure 10

If the program has difficulty articulating the triad (teaching, research and extension)

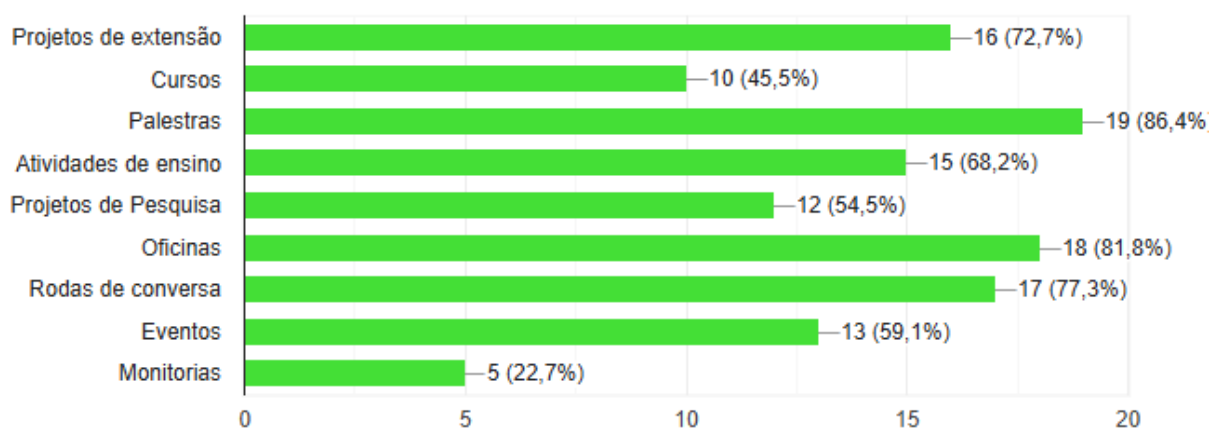


Source: Survey Results.

The activities most worked on within the program, according to the study participants, were lectures (86.4%), workshops (81.8%), conversation circles (77.3%) and extension projects (72.7%) (Figure 11).

Figure 11

Actions most worked on within the PET Economy program

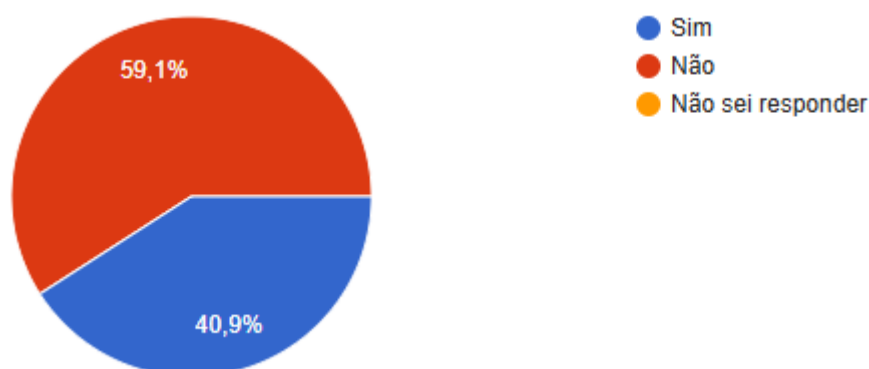


Source: Survey Results.

In addition, a part (40.9%) stated that they had some publication (abstracts or articles) linked to the activities developed in the program, and also presented oral works at events (72.7%), taught a course or lecture during their participation (72.7%) or participated in training exclusively for scholarship holders (courses, lectures, training) (72.7%) (Figures 12, 13, 14 and 15).

Figure 12

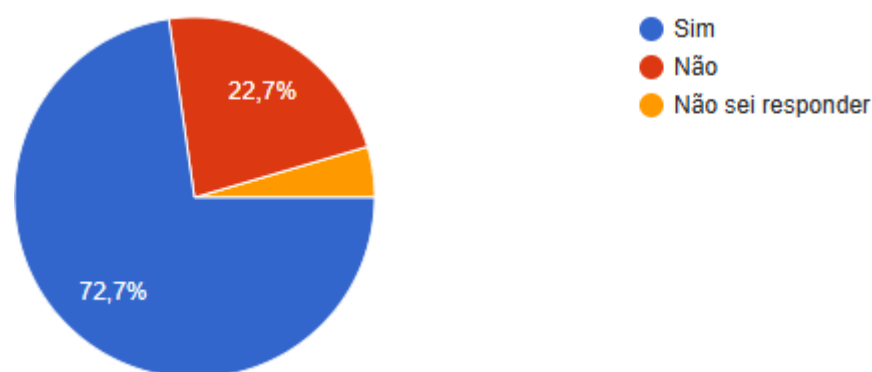
Published abstracts or articles of activities linked to the program



Source: Survey Results.

Figure 13

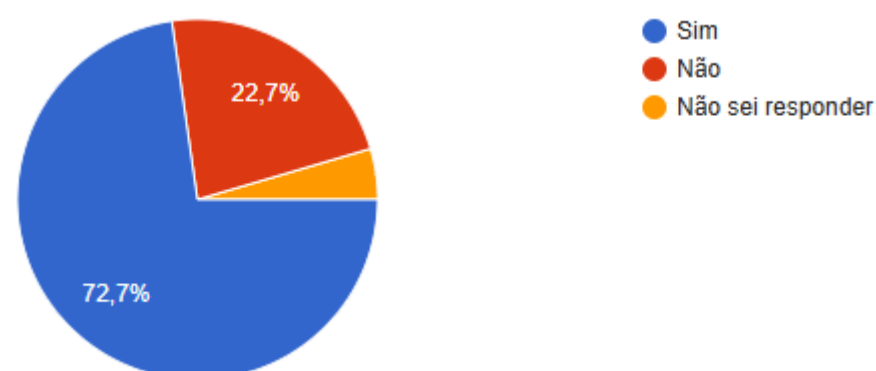
Presented oral papers at events linked to the program



Source: Survey Results.

Figure 14

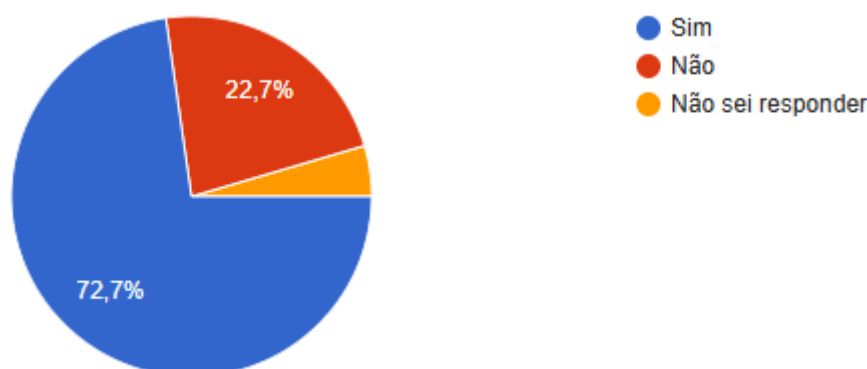
Taught a course or lecture during the participation in PET Economics



Source: Survey Results.

Figure 15

Received internal training exclusively for scholarship holders



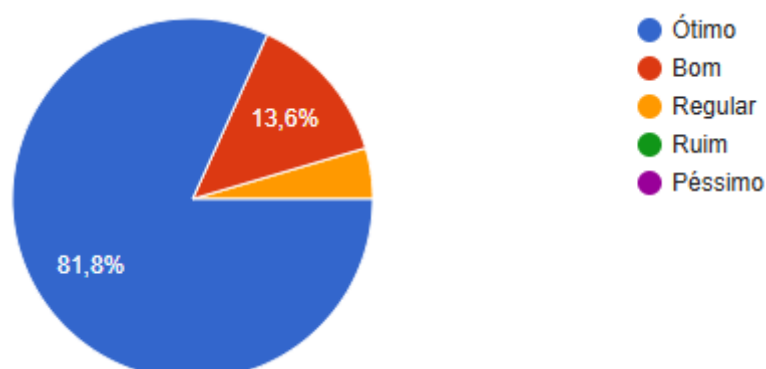
Source: Survey Results.

Added to this is the fact that these publications provide a visualization of the continuity in the academic career after graduation, as reported by 40% of the participants in the study by Lopes *et al.* (2018). In addition, the study Marcelino *et al.* (2017) evaluated the scientific production of PET participants during and after their stay in the Program, and found that 83% of the scientific productions analyzed in the graduates' curricula took place during their stay in the Program, reinforcing the importance of PET in academic production.

Most of the graduates evaluated the PET as excellent (81.8%) or good (13.6%) (Figure 16). Similar to this, in the study by Morel *et al.* (2020) most graduates also evaluated the Program well (66% as excellent and 32% as very good). The study by Rychescki *et al.* (2023) evaluated it as excellent (71%) and good (26%).

Figure 16

Evaluation of the PET Economics program by graduates



Source: Survey Results.

The research participants believe that PET contributed to the development of interdisciplinary activities within PET and undergraduate (100%).

Figure 17

Program contributes to interdisciplinary activities

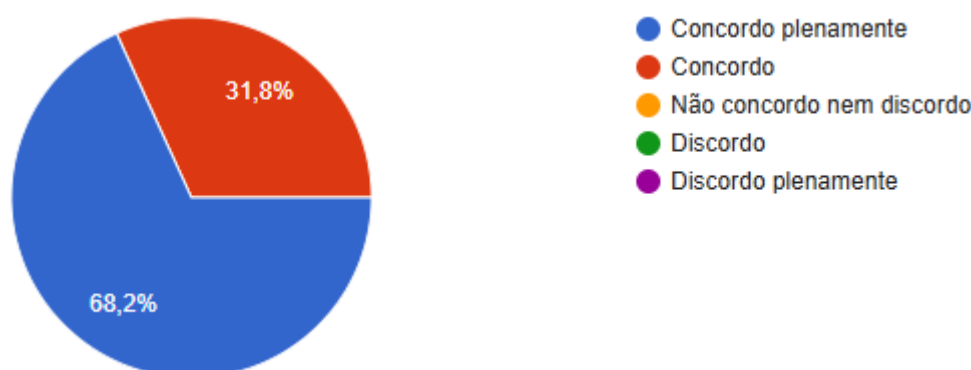


Source: Survey Results.

In addition, the majority agree or fully agree that the PET manages to achieve its objectives of disseminating new ideas and practices to the other students of the course (62.8%), raising the quality of the academic training of the members (77.3%; n=76) and stimulating the training of professionals and teachers with high technical, scientific, technological and academic qualifications (63.6%) (Figures 18, 19 and 20). The aforementioned objectives and others were established by Law No. 11,180, of September 23, 2005 and updated by Ordinance No. 343, of April 24, 2013 (Brasil, 2005; Brazil, 2013).

Figure 18

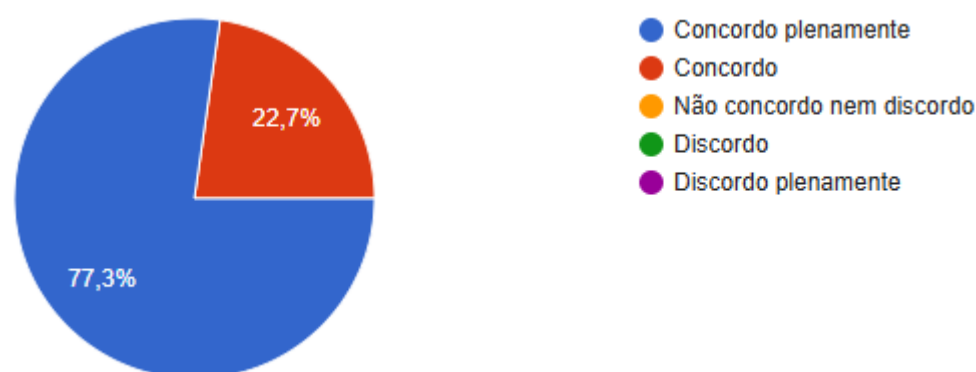
Can disseminate new ideas and practices



Source: Survey Results.

Figure 19

Contributes to raising the quality of academic training.

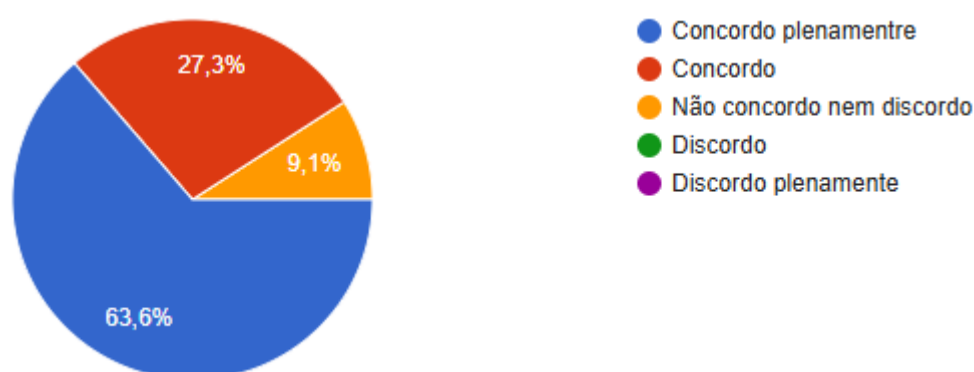


Source: Survey Results.

Thus, according to the PET graduates, the program achieves its main objectives and similar results were found in the study by Lopes (2020), demonstrating the efficiency of the program as a whole. The achievement of such objectives is important for the improvement of higher education and academic training both of scholarship holders, non-scholarship holders and volunteers of the program and of the other students of the course, who benefit from the actions carried out by the Program.

Figure 20

Stimulates the training of professionals and teachers with high technical, scientific, technological and academic qualifications



Source: Survey Results.

In the specific case of UEFS's PET Economics, the aforementioned objectives, added to the objective of stimulating critical thinking and professional performance guided by citizenship and the social function of higher education, complement the pedagogical proposal of the course to train professionals capable of providing comprehensive, humanized and critical care, working as a team and understanding the reality in which the population lives.

5 CONCLUSIONS

The accomplishment of this study allowed us to understand the contribution of the Program in the academic and professional trajectory of the graduates, as well as to evaluate whether it has been carried out in accordance with its proposal and objectives. Most participants evaluated the Program positively, corroborating the results expected by the research, and it was possible to infer that it has been effective in fulfilling its objectives, according to the perception of the graduates.

Also, the present study contributes to the other research carried out in the scope of the PET evaluation, bringing results about the PET of the undergraduate course in Economics at UEFS. It should be noted that more research is needed that includes a greater number of graduates and more Programs for even more reliable results. It is worth highlighting, in conclusion, the potential of the PET of the undergraduate course in Economics at UEFS to raise the quality of the course, as well as the academic training of the members of the Program and the other students of the course, making them better prepared for the professional and/or academic trajectory.

REFERENCES

- Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Recuperado em 6 julho, 2019, de https://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm
- Dearo, P., et al. (2021). Potencialidades e fragilidades do programa de educação tutorial: Percepções de acadêmicos. *Caminho Aberto: Revista de Extensão do IFSC*, 37–45. <https://doi.org/10.35700/ca20170037-452071>
- Fernandes, B., et al. (2020). Contribuições do programa de educação tutorial: Um estudo com egressos do grupo Conexão de Saberes em Física e Popularização da Ciência da Unifei-Itabira. *Research, Society and Development*, 9(11). <https://doi.org/10.33448/rsdv9i11.9642>
- Galdino, J. H., et al. (2021). Programa de educação tutorial na formação de enfermeiros: Reflexões de egressos. *Revista Eletrônica de Enfermagem*, 23, 1–8. <https://doi.org/10.5216/ree.v23.62257>
- Júnior, H., et al. (2021). Programa de educação tutorial na formação de enfermeiros: Reflexões de egressos. *Revista Eletrônica de Enfermagem*, 23, 1–8. <https://doi.org/10.5216/ree.v23.62257>
- Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, 22(140), 55.
- Lopes, T. F., et al. (2020). Atuação profissional dos egressos do programa de educação tutorial de um curso de enfermagem. *Revista Enfermagem Contemporânea*, 9(2), 211–217. <https://doi.org/10.17267/2317-3378rec.v9i2.2913>

- Lopes, T. F., et al. (2018). Perfil dos egressos do programa de educação tutorial (PET/Enfermagem). Em Anais do XXII Enfermaio. Recuperado em 21 março, 2023, de <https://www.uece.br/eventos/xxiienfermaio/anais>
- Marcelino, E. M., et al. (2017). O perfil dos egressos de um grupo do programa de educação tutorial (PET - Fitoterapia): A importância de uma PIC na formação superior. Em Congresso Nacional de Práticas Integrativas e Complementares em Saúde. Recuperado em 21 março, 2023, de <https://www.editorarealize.com.br/artigo/visualizar/31894>
- Moita, F. M. G. S. C., & Andrade, F. C. (2005). A indissociabilidade entre ensino, pesquisa e extensão: O caso do estágio de docência na pós-graduação. Olhar de Professor, 8(2), 77–92.
- Morel, L., et al. (2020). Avaliação dos egressos do programa de educação tutorial (PET) do curso de Odontologia da Universidade Federal de Pelotas. Revista da ABENO, 20(2), 119–130. <https://doi.org/10.30979/rev.abeno.v20i2.1108>
- Rychescki, G. G., et al. (2023). Percepção de egressos sobre as contribuições do programa de educação tutorial em nutrição da Universidade Federal de Santa Catarina na trajetória acadêmica. Revista Eletrônica do Programa de Educação Tutorial, 5(5), 145–160.
- Secretaria de Educação Superior (SESU/MEC). (2006). PET – Programa de Orientação Tutorial: Manual de orientações básicas.
- Tosta, R. M., et al. (2006). Programa de educação tutorial (PET): Uma alternativa para a melhoria da graduação. Psicologia para América Latina, (8).
- Alves-Mazzotti, A. J., & Gewandsznajder, F. (1998). O método nas ciências naturais e sociais: Pesquisa quantitativa e qualitativa. Pioneira.
- Silveira, D. T., & Córdova, F. P. (2009). A pesquisa científica. Em Métodos de pesquisa (pp. 33–44). Editora da UFRGS.
- Schwartzman, S. (2022). Pesquisa e pós-graduação no Brasil: Duas faces da mesma moeda? Estudos Avançados, 36, 227–254.

ANNEX - QUESTIONNAIRE

PROFILE OF UEFS ECONOMICS PET GRADUATES REGARDING AGE, GENDER, LENGTH OF STAY AND REASON FOR PARTICIPATION IN THE PROGRAM (N=22)

CURRENT AGE:

AGE AT WHICH HE ENTERED THE PET:

GENDER: () Male () Female

Length of stay in the Program:

() Up to 3 semesters () 4 to 6 semesters () 7 semesters or more

Motivation to participate in the Program:

- () Teaching, research and extension activities
- () Curiosity
- () Scholarship opportunity
- () Influence of participants
- () Acquisition of experience
- () Exchange of experience with all phases of the course
- () Indication of teachers
- () Promising curriculum

PERCEPTION OF UEFS PET ECONOMICS GRADUATES REGARDING THE CONTRIBUTION OF THE PROGRAM IN THE DEVELOPMENT OF SKILLS, IN THE COEFFICIENT OF PERFORMANCE IN GRADUATION AND LEARNING IN A FOREIGN LANGUAGE (N=22).

Developed important skills while participating in the Program: () Yes () No

Skills developed by participating in the Program:

- () Altruism
- () Investigative and questioning attitudes
- () Orality
- () Leadership
- () Teamwork
- () Time management
- () Respect for individualities
- () Task management/prioritization
- () Organization
- () Reading

- ☐ Creativity
- ☐ Technical competence
- ☐ Argumentation
- ☐ Reflective attitude
- ☐ Ability to listen
- ☐ Social values
- ☐ Ability to deal with complex situations

The program contributed to raising the coefficient of performance in undergraduate courses:

☐ Yes ☐ No ☐ I don't know

Program encouraged foreign language learning:

☐ Yes ☐ No

ACTIVITIES DEVELOPED BY THE GRADUATES OF THE UEFS PET ECONOMICS (N=22).

Activities developed in the Program: ☐ Extension ☐ Teaching ☐ Research

He worked in a project or action involving the triad of teaching, research and extension in an inseparable way:

☐ Yes ☐ No ☐ Didn't know how to answer

Program has difficulty articulating the triad (teaching, research and extension):

☐ Yes ☐ No ☐ Didn't know how to answer

Actions most worked on within the program:

- ☐ Extension Projects
- ☐ Courses
- ☐ Lectures
- ☐ Teaching Activities
- ☐ Research Projects
- ☐ Workshops
- ☐ Conversation circles
- ☐ Events
- ☐ Monitoring

Published abstracts or articles of activities linked to the Program:

☐ Yes ☐ No ☐ Didn't know how to answer

He presented oral papers at events linked to the Program:

☐ Yes ☐ No ☐ Didn't know how to answer

Taught a course or lecture during the participation in the PET:

☐ Yes ☐ No ☐ Didn't know how to answer

Received internal training exclusively for scholarship holders:

☐ Yes ☐ No ☐ Didn't know how to answer

How do you evaluate the PET program:

☐ Great ☐ Good ☐ Fair ☐ Poor ☐ Very Bad

PERCEPTION OF UEFS ECONOMICS PET GRADUATES ABOUT THE PROGRAM

(N=22).

Program contributed to interdisciplinary activities:

☐ Yes ☐ No ☐ Didn't know how to answer

PET manages to achieve its goal in the sense of:

Disseminate new ideas and practices to other students in the course, through the role of scholarship holders as multiplier agents:

☐ I completely agree

☐ I agree

☐ I neither agree nor disagree

☐ Disagree

☐ I strongly disagree

Contribute to raising the quality of the academic training of the students who are members of the PET group:

☐ I completely agree

☐ I agree

☐ I neither agree nor disagree

☐ Disagree

☐ I strongly disagree

To stimulate the training of professionals and teachers with high technical, scientific, technological and academic qualifications:

☐ I completely agree

☐ I agree

☐ I neither agree nor disagree

() Disagree

() I strongly disagree

WOMEN'S WORK IN RURAL AREAS: INVISIBILITY, GENDER INEQUALITIES, AND SOCIAL SECURITY ISSUES

TRABALHO FEMININO NO ESPAÇO RURAL: INVISIBILIDADE, DESIGUALDADES DE GÊNERO E PREVIDENCIÁRIAS

EL TRABAJO DE LAS MUJERES EN LAS ZONAS RURALES: INVISIBILIDAD, DESIGUALDADES DE GÉNERO Y PROBLEMAS DE SEGURIDAD SOCIAL



<https://doi.org/10.56238/sevened2026.008-236>

Larissa Gonçalves Fratari Moreira¹, Elicardo Heber de Almeida Batista²

ABSTRACT

This study aimed to analyze how scientific production has addressed the invisibility of women's work in rural areas, with an emphasis on the relationships between work, gender, and access to social security. The completed research was based on a systematic literature review, including authors such as Santos, Lefebvre, Massey, Wanderley, Tuan, and Martins. Twenty-two academic studies were selected, including articles, theses, dissertations, and undergraduate theses, prioritizing productions that addressed the institutional recognition of rural women and their right to retirement. The materials were analyzed using analytical note-taking, which allowed for the identification of recurring theoretical approaches, methodologies, and results. The results showed that exclusion from social security and the invisibility of women's work constituted structural phenomena, reinforced by patriarchal practices and the absence of policies sensitive to the reality of women in rural areas. It was concluded that theoretical advances and the strengthening of a critical and feminist approach were fundamental for the understanding and effective recognition of the rights of rural women.

Keywords: Rural Area. Women's Work. Invisibility.

RESUMO

Este trabalho teve como objetivo analisar como a produção científica abordou a invisibilidade do trabalho feminino no espaço rural, com ênfase nas relações entre trabalho, gênero e acesso à previdência social. A pesquisa, concluída, fundamentou-se em revisão bibliográfica sistemática, contemplando autores como Santos, Lefebvre, Massey, Wanderley, Tuan e Martins. Foram selecionados 22 estudos acadêmicos, entre artigos, teses, dissertações e TCCs, priorizando produções que trataram do reconhecimento institucional das mulheres rurais e de seu direito à aposentadoria. Os materiais foram analisados por meio de fichamento analítico, o que permitiu identificar abordagens teóricas, metodologias e resultados recorrentes. Os resultados evidenciaram que a exclusão previdenciária e a invisibilidade do trabalho das mulheres constituíram fenômenos estruturais, reforçados por práticas patriarcais e pela ausência de políticas sensíveis à realidade feminina no campo.

¹ Master's student in Geography. Universidade Federal de Uberlândia (UFU). E-mail: larissa.fratari@ufu.br
Orcid: <https://orcid.org/0009-0003-1150-612x> Lattes: <https://lattes.cnpq.br/7667526212702894>

² Dr. in Geography. Universidade Estadual Paulista (UNESP). E-mail: elicardo.batista@uemg.br
Orcid: <https://orcid.org/0000-0002-3961-3088> Lattes: <http://lattes.cnpq.br/8783870712473018>

Concluiu-se que os avanços teóricos e o fortalecimento de uma abordagem crítica e feminista foram fundamentais para a compreensão e o reconhecimento efetivo dos direitos das mulheres rurais.

Palavras-chave: Espaço Rural. Trabalho Feminino. Invisibilidade.

RESUMEN

Este estudio tuvo como objetivo analizar cómo la producción científica ha abordado la invisibilidad del trabajo de las mujeres en las zonas rurales, con énfasis en las relaciones entre trabajo, género y acceso a la seguridad social. La investigación se basó en una revisión sistemática de la literatura, que incluyó a autores como Santos, Lefebvre, Massey, Wanderley, Tuan y Martins. Se seleccionaron veintidós estudios académicos, entre artículos, tesis, disertaciones y trabajos de fin de grado, priorizando aquellos que abordaban el reconocimiento institucional de las mujeres rurales y su derecho a la jubilación. Los materiales se analizaron mediante la toma de notas analíticas, lo que permitió identificar enfoques teóricos, metodologías y resultados recurrentes. Los resultados mostraron que la exclusión de la seguridad social y la invisibilidad del trabajo de las mujeres constituían fenómenos estructurales, reforzados por prácticas patriarcales y la ausencia de políticas sensibles a la realidad de las mujeres en las zonas rurales. Se concluyó que los avances teóricos y el fortalecimiento de un enfoque crítico y feminista eran fundamentales para la comprensión y el reconocimiento efectivo de los derechos de las mujeres rurales.

Palabras clave: Zona Rural. Trabajo de Mujeres. Invisibilidade.

1 INTRODUCTION

Geography, as a field of knowledge, has historically been dedicated to unveiling the multiple dimensions of space, overcoming the traditional view that conceived it only as a static scenario or a mere support for human actions. Under the influence of Critical Geography, especially from the 1970s onwards, authors such as Lefebvre (1974) and Santos (1996) consolidated the understanding of space as a historical, relational construction permeated by power relations. From this perspective, space is neither neutral nor given, but the result of disputes, interests and social processes that are expressed both in the urban and in the rural.

In the context of the Brazilian rural space, such an approach allows us to highlight how patriarchal, capitalist and institutional practices have historically produced inequalities, exclusions and silencing, especially with regard to the role of women. The countryside, more than a space for agricultural production, is a living space, crossed by land conflicts, labor relations, and forms of social organization that make women's work invisible and make it difficult for women to access basic rights, such as rural retirement, as demonstrated by Castilho (2018) and Moreira (2022).

From this perspective, the understanding of labor relations in capitalism dispenses with the interpretation of the ways in which subjects are inserted in the world of work, and it should be noted that this inclusion does not occur in a homogeneous way, since "factors of gender, race/ethnicity and generation mark the world of work in a deep and constant way" (CHERON, 2010, p. 241), in rural areas, this inequality takes on its own contours, because, although women participate in planting, harvesting, cultivating gardens and backyards, raising small animals, processing production and, often, small-scale commercialization, such activities are not always recognized as productive work, leaving women at a significant disadvantage, especially black women and those with a low level of formal education.

As Paulilo (1987) demonstrates, a significant part of these tasks is socially treated as "help", and not as work per se. This classification contributes to shifting to the field of naturalization and gratuitousness activities that are indispensable to the maintenance of the family productive unit, reinforcing the separation between what is socially recognized as productive and what is attributed to women as an extension of domestic obligations. In this sense, Brumer (2002, 2004, 2012) shows that the devaluation of women's work compromises the social and economic recognition of women's work in rural areas, while Paula (2019) highlights that this invisibility has a direct impact on access to social protection rights and policies.

In the social security plan, this dynamic is especially relevant, although Brazilian legislation recognizes the figure of the special insured as a rural worker, women still face

systematic difficulties in accessing social security rights, especially retirement due to rural age, due to the lack of recognition of women's efforts as work. The requirement to prove rural activity, associated with low female land ownership, the informality of family production and the concentration of documents in the name of men, means that many workers arrive at the moment of applying for social security without sufficient material proof of work effectively performed throughout their lives.

Although we have noticed, over the last few years, the expansion of opportunities in different occupations in the labor market for women, such expansion does not eliminate gender stereotypes, nor does it revert to equality, to the point that women who exercise or have exercised rural activities during their life trajectory are denied the right to retire, because their effort is not recognized as work.

In this context, this work carried out an analysis of the scientific production focused on geographic space, rural space and Feminist Geography, systematizing the main studies on the invisibility of women's work and its implications for women's rights and social security in the countryside. The objective of this work was to analyze how scientific production has addressed the invisibility of women's work in rural areas, with emphasis on the relations between work, gender and access to social security for rural women.

2 METHODOLOGICAL PROCEDURES

The present research is characterized as a qualitative study based on a systematic bibliographic review, aimed at the critical analysis of scientific production on geographic space, rural space, Feminist Geography and the invisibility of women's work in the field. To understand the epistemological transformations of the concept of space and its interfaces with gender issues in rural areas, the review was based on classical and contemporary authors such as Milton Santos, Henri Lefebvre, Yi-Fu Tuan, Doreen Massey, Maria Nazareth Wanderley and José de Souza Martins.

The selection of the 22 academic papers — including scientific articles, theses, dissertations, and TCCs published in journals, repositories, and events in the areas of Geography and Human Sciences — followed criteria of thematic relevance and topicality, prioritizing studies that deal with the invisibility of rural women's work, institutional recognition, and access to retirement. The documents were submitted to the analytical file technique, identifying theoretical approaches, methods used, recurrent categories and evidenced results. The analysis focused on how the concept of space is mobilized in different productions, articulating gender, space, and social security inequalities, and made it possible to map gaps, advances, and perspectives for the consolidation of a critical and feminist

geographic approach to women's work in the field. In this way, the methodological path allowed not only to gather theoretical references and empirical studies on the subject, but also to systematize interpretations that highlight the historical and institutional obstacles to the social security recognition of rural women.

3 THEORETICAL CONTRIBUTION

The understanding of geographic space has undergone significant transformations throughout the history of Geography, evolving from a naturalistic conception to a critical and relational approach. In Classical Geography, influenced by authors such as Friedrich Ratzel and Vidal de la Blache, space was conceived as a physical stage where natural and human phenomena unfolded, with a strong emphasis on environmental determinism Abrão (2010).

With the advancement of Positivist Geography, especially in the twentieth century, geographic space began to be analyzed as a quantifiable and mappable surface, favoring the measurement of phenomena and the elaboration of spatial models Abrão (2010). This approach, although technically sophisticated, neglected the social, political and subjective dimensions of the production of space, treating it as a neutral datum.

From the 1970s onwards, with the emergence of Critical Geography and the influence of Marxist thought, authors such as Henri Lefebvre and Milton Santos began to consider space as a product of social relations. For Santos (1996), space is the inseparable set of systems of objects and systems of actions, being produced by and for society. This change in perspective allowed the space to be understood as a historical and ideological construction, reflecting relations of power, domination, and resistance.

In the rural context, this critical conception reveals how the agrarian space is structured based on patriarchal logics that make women's work invisible. As discussed by Castilho (2018), the exclusion of women from institutional recognition as formal workers is a concrete manifestation of the way space is selectively produced, denying them access to retirement and other social rights.

The rural space, historically associated with agricultural production and dispersed housing, is, in contemporary times, understood as a complex geographical category, marked by the plurality of functions and subjects. According to Wanderley (2001), the rural is not reduced to agricultural activity, but encompasses social relations, ways of life, knowledge and resistance that configure a living and dynamic territory. Martins (2009) also points out that the Brazilian rural space is crossed by conflicts, land inequalities and processes of exclusion that reproduce historically constructed social hierarchies. From this perspective, rural space

should be understood as a historical-social product, structured by power relations, where patriarchal and capitalist practices shape land use, division of labor and access to rights.

Parallel to these transformations, the advance of humanistic and phenomenological approaches in the following decades, with authors such as Yi-Fu Tuan and Edward Relph, brought to light the importance of lived experience and perceived space. For Tuan (1977), space acquires meaning through the sensory, affective and practical experiences of individuals, who transform it into a place. Relph (1976), in turn, highlights that the attachment to the place, built by symbolic and everyday bonds, is essential to understand how the subjects relate to the world. From these perspectives, it is recognized that geographic space is neither neutral nor abstract, but loaded with meanings that emerge from concrete practices and experiences. This theoretical inflection opened the way for readings that value women's daily lives and symbolic relations with space, elements that would later be central in the analysis of Feminist Geography.

In this sense, Feminist Geography, as highlighted in the article published in the journal *Moreira* (2022), introduces an intersectional reading of rural space, considering gender, class, and space as inseparable dimensions of spatial production. The author argues that "the organization of the Brazilian agrarian space is marked by structural inequalities that silence the productive and reproductive contribution of women" *Moreira* (2022, p. 4). In this sense, space is no longer just a physical medium and is now understood as a condensation of social gender relations, which materialize in forms such as social security exclusion and the absence of female land ownership.

This perspective is reinforced by authors such as Massey (1994), who understand space as relational, multiple and constituted by social practices marked by hierarchies and inequalities. By analyzing the rural space from this perspective, it is possible to understand that the invisibility of women's work is not a circumstantial flaw, but a structural condition of the way space is produced and managed in the Brazilian countryside.

In this way, adopting a critical approach to the concept of space allows us to unveil the mechanisms by which rural women are excluded from public policies, especially social security, revealing that access to or denial of rights is also a matter of the production of geographic space.

4 RESULTS AND DISCUSSION

The bibliographic analysis identified and systematized 22 academic works, including theses, monographs, scientific articles, TCCs and reviews, dedicated to understanding the invisibility of women's work in rural areas and its implications for retirement and social rights.

These studies present diversified methodological approaches, ranging from qualitative analyses to theoretical reviews, covering a variety of Brazilian territories and theoretical-methodological perspectives.

Empirical studies — mostly theses and monographs — carried out interviews, spatial mappings and participant observations, revealing qualitative and quantitative data on the reality experienced by peasant women. For example, Castilho (2018) investigated the trajectory of women farmers in the Ribeira Valley/SP, showing that many of these women are unable to formally prove their productive activity, despite decades of dedication, because they are excluded from official records and registers. According to the study, "the social security recognition of the farmer is strained by a patriarchal logic that disregards her daily work as a legitimate work activity" (Castilho, 2018, p. 101).

Similarly, in the work developed by Costa (2016), carried out in a rural community in Maranhão, women were interviewed who, even though they were responsible for a significant part of subsistence production and commercialization, did not have access to land in their names or records that would allow them to claim rural retirement. Many reported that their husbands were the only ones officially recognized as workers, although they fully shared the productive and domestic responsibilities.

The study by Guedes (2014) showed that rural space is still organized under patriarchal and capitalist logics, in which the sexual division of labor assigns women tasks that are less economically valued and invisible in public statistics. This model has direct consequences in old age, when, after decades of invisible contributions, many face bureaucratic and legal difficulties to access the right to retirement.

On a more theoretical level, the studies of Francisco (2020) and Moreira (2022), based on a literature review, contributed to the critical rereading of rural space and Feminist Geography. Francisco (2020), when analyzing several publications in Agrarian Geography, identified that the concept of space is still, to a large extent, treated in a neutral or masculine way, which hides gender specificities. Moreira (2022), in turn, argues that agrarian space is the product of "social relations marked by the intersection between gender, class, and territory," and that this structure shapes both work and the non-recognition of women as political and economic subjects.

Other studies, such as those by Costa (2016) and Francisco (2020), highlight that public policies for rural social security do not keep up with the reality of women, as they require forms of proof — such as invoices, union registrations, or documents in their own name — that many do not have, due to the family, informal, and collective nature of their work.

A joint reading of these studies allows us to perceive that the invisibility of women's work in the countryside is not only due to the absence of direct income or individualized remuneration, but also to the way in which the activity performed by women is socially and institutionally classified. In many cases, what sustains the family productive unit and guarantees the daily reproduction of life in the countryside continues to be understood as mere help, domestic collaboration or extension of women's obligations, and not as rural work *per se*.

Another recurring aspect in the studies analyzed is the mismatch between the concrete experience of rural women and the formal criteria of state recognition. Although they participate in planting, harvesting, caring for small animals, processing production and, often, marketing, these activities do not always appear in official documents. The requirement for individualized evidence, in contexts marked by informality, family production and low female tenure, contributes to reproducing rejections and administrative obstacles, even when the work trajectory of rural women is socially known in the community.

It is also observed, in the studies analyzed, that academic production has been shifting the debate from the mere observation of inequality to the identification of concrete mechanisms of invisibility. It is not only a matter of affirming that rural women work a lot and receive little recognition, but of demonstrating how certain family, institutional and legal arrangements contribute to erasing their condition as workers. This change is important because it allows us to understand that the problem does not lie in the absence of female participation in rural work, but in the way this participation is registered, interpreted and socially validated.

Research converges to show that rural space is made up of deep-rooted inequalities, which operate both on the material and symbolic levels. The absence of land ownership, the double or triple working day, the institutional silencing of women's work and the difficulty of access to social security are not isolated facts, but expressions of an exclusionary spatial, social and legal structure.

On the other hand, studies also reveal strategies of resistance and organization. Several studies report that the women interviewed participate in collectives, rural associations and social movements that promote political education, legal guidance and visibility actions. These initiatives have made possible, even if with limits, advances in the achievement of rights and in the recognition of women's work in the countryside.

Such experiences of resistance demonstrate that, despite historical and institutional obstacles, rural women do not occupy a merely passive position in the face of inequalities. On the contrary, they build collective forms of confrontation, share knowledge, strengthen

support networks and claim social and legal recognition. The presence of these strategies in the analyzed works also indicates that the expansion of access to rights depends not only on normative changes, but on the strengthening of spaces for participation, information and political organization in rural areas.

In order to systematize the theoretical and empirical contributions on the invisibility of women's work in rural areas, as well as its implications for access to retirement, a table was prepared that summarizes the main works analyzed in this research. Contemplating aspects such as the type of study, methods used, samples researched and the most relevant results identified in each investigation.

Table 1

Main results of the analyses

Author (Year)	Study Type	Method	Sample	Main results
Abram (2010)	Theoretical Article	Literature review	Not applicable	Review of the evolution of the concept of geographic space; emphasis on critical and phenomenological approaches.
Antunes (1999)	Theoretical book	Theoretical foundation	Not applicable	It broadens the notion of the working class and contributes to understanding the organization of work under capitalism, including in rural areas.
Brumer (2002)	Theoretical Article	Literature review	Not applicable	It discusses rural social security and gender, highlighting inequalities in the recognition of women's work and access to rights.
Brumer (2004)	Theoretical Article	Literature review	Not applicable	It analyzes the situation of women in agriculture, highlighting gender inequalities and devaluation of female participation in rural work.
Brumer; Angels (2012)	Theoretical Article	Literature review	Not applicable	It examines gender and social reproduction in family farming, showing the centrality of women's work and its undervaluation.
Castilho (2018)	Thesis	Semi-structured interviews	Unspecified; cases in SP	Invisibility of women's work; difficulties in proving retirement; patriarchal logic.
Cheron (2010)	Theoretical Article	Literature review	Not applicable	It shows that gender, race/ethnicity and generation unequally mark the insertion of subjects in the world of work.
Costa, Raíssa (2016)	TCC	Interviews	5 women in Maranhão	Absence of ownership; informality prevents retirement; invisible productive role.
Guedes (2014)	Thesis	Qualitative study, social analysis	Unspecified; Settlements	Sexual division of labor; economic invisibility; difficulties in retirement.
Francis (2020)	Review Article	Literature review	Not applicable	Neutral or male rural space; it hides gender inequalities.
Junqueira; Lima (2008)	Theoretical Article	Literature review	Not applicable	It discusses public policies for family farming and points out historical inequalities among rural workers, including gender.

Author (Year)	Study Type	Method	Sample	Main results
Kreter; Bacha (2006)	Theoretical Article	Literature review	Not applicable	It evaluates the equity of social security in the Brazilian rural environment, contributing to understanding inequalities in access to social security rights.
Moreira (2022)	Critical Review Article	Literature review	Not applicable	Agrarian space as an intersectional construction; structural inequalities of gender, class and territory.
Lefebvre (1974)	Theoretical Book	Theoretical foundation	Not applicable	Space as social, ideological and material production.
Massey (1994)	Theoretical Book	Theoretical foundation	Not applicable	Relational space, multiple and marked by social hierarchies.
Martins (2009)	Theoretical Book	Theoretical foundation	Not applicable	Rural space marked by conflicts, exclusions and historical inequalities.
Paula (2019)	Theoretical Article	Literature review	Not applicable	It discusses the trajectory of rural women's struggle for recognition and rights, highlighting political mobilization and social visibility.
Paulilo (1987)	Theoretical Article	Literature review	Not applicable	It problematizes the notion of "light work", showing how rural female work is devalued and treated as help.
Relph (1976)	Theoretical Book	Theoretical foundation	Not applicable	Importance of attachment to the place and experience of the space.
Santos (1996)	Theoretical Book	Theoretical foundation	Not applicable	Space as a set of objects and actions, social production of reality.
Wanderley (2001)	Book Chapter	Historical and theoretical review	Not applicable	Rural space as a living territory, marked by ways of life, knowledge and resistance.

Source: Org. MOREIRA, L. G. F. 2025

The integrated analysis of the information presented in chart 1 allows us to perceive the methodological diversity and thematic breadth of research on the subject. It is observed that qualitative studies, especially those that used interviews and documentary analysis, provide fundamental data on the real conditions experienced by women in rural areas, highlighting social security exclusion and the invisibility of work.

5 FINAL CONSIDERATIONS

The research carried out evidenced the complexity of the social and spatial dynamics that structure the Brazilian rural space, demonstrating how scientific production has been expanding the understanding of the invisibility of women's work in the countryside. The methodological path, of a bibliographic nature, allowed us to analyze, from different theoretical and empirical perspectives, the multiple dimensions of gender inequalities in the rural context, especially with regard to institutional recognition, the struggle for rights and the barriers historically imposed on rural women.

By gathering and confronting contributions from Critical Geography, Feminist Geography and the social sciences, the research contributes to the strengthening of an

approach sensitive to the specificities of rural women's work, highlighting both the barriers faced and the strategies of resistance and organization carried out by them. The results presented highlight the need for public policies and new institutional practices that recognize and value the role of women in the agrarian space, collaborating for the construction of a fairer and more inclusive scientific and social field.

It was possible to perceive that the formal requirements for the recognition of women's rural activity, although institutionally presented as technical criteria, do not always correspond to the concrete forms of organization of life and work in rural areas. In many contexts, family production, self-consumption, collective work and informality in productive relations make it difficult to create documents in the name of women, contributing to the permanence of bureaucratic obstacles and the denial of rights. Thus, the non-recognition of women's work in the countryside cannot be understood as a simple individual failure to prove it, but as an expression of a historical logic that has little valued the centrality of women's action in the reproduction of rural life.

Another relevant aspect concerns the contribution of Geography to the interpretation of this problem. By understanding the rural space as a historical and social product, crossed by power relations, the geographical analysis allows us to reveal that unequal access to rights is also manifested territorially. The fact that many women do not have land in their names, the unequal distribution of productive and reproductive tasks, and the difficulty of insertion in formal spaces of representation demonstrate that the invisibility of women's work is directly related to the way the Brazilian agrarian space has been structured and managed over time.

The research analyzed also showed that, despite the numerous obstacles, rural women build practices of resistance, mobilization and collective demands. Participation in associations, unions, social movements and community networks shows that the recognition of rights does not occur only through legal norms, but also through political action and the social visibility achieved on a daily basis. This data is particularly important because it breaks with passive views of rural women and reaffirms their condition as historical subjects and agents of transformation.

Finally, it is noteworthy that this study does not exhaust the theme, but reinforces the need for deepening research that articulates gender, space, feminization of work and public policies, especially from regional perspectives, empirical analyses and direct listening to rural women. Future investigations may contribute to broaden the understanding of the contemporary effects of inequalities that cross the rural environment, as well as to subsidize institutional practices that are more sensitive to the reality of rural workers. It is hoped, therefore, that this research will contribute not only to the academic debate, but also to the

strengthening of critical perspectives committed to social justice, recognition and dignity for women who live and work in the field.

REFERENCES

- Abrão, J. A. A. (2010). A construção do conceito de espaço geográfico e suas implicações para a Geografia. *Sociedade e Território*, 22(1), 46–64.
- Antunes, R. (1999). *Os sentidos do trabalho: Ensaio sobre a afirmação e a negação do trabalho*. Boitempo.
- Brumer, A., & Anjos, G. dos. (2012). Gênero e reprodução social na agricultura familiar. *Revista NERA*, (12), 6–17. <https://doi.org/10.47946/rnera.v0i12.1396>
- Brumer, A. (2004). Gênero e agricultura: A situação da mulher na agricultura do Rio Grande do Sul. *Revista de Estudos Feministas*, 12(1). <https://doi.org/10.1590/S0104-026X2004000100011>
- Brumer, A. (2002). Previdência social rural e gênero. *Sociologias*, 4(7), 50–81.
- Castilho, A. G. de. (2018). “Aposentada sim, mas ainda trabalhadora”: Envelhecimento, trabalho e cuidado entre agricultoras familiares no Vale do Ribeira/SP (Tese de doutorado). Universidade Estadual de Campinas.
- Cheron, C. (2010). A trabalhadora da região metropolitana de Porto Alegre: Das desigualdades às alternativas pela via do empoderamento. *CSONline – Revista Eletrônica de Ciências Sociais*, 4(9).
- Costa, A. R. da. (2016). A invisibilidade do trabalho das mulheres agricultoras na prática cotidiana e os desafios do reconhecimento (Trabalho de conclusão de curso). Universidade Federal do Maranhão.
- Francisco, D. de S. (2020). Geografia, gênero e trabalho familiar: Uma análise da contribuição das mulheres para a agricultura familiar na região Sul do Brasil. *Caminhos de Geografia*, 21(74), 14–27.
- Guedes, A. G. de. (2014). Trabalho, cuidado e aposentadoria entre mulheres agricultoras: Envelhecimento em áreas de reforma agrária (Tese de doutorado). Fundação Oswaldo Cruz.
- Junqueira, C. P., & Lima, J. F. de. (2008). Políticas públicas para a agricultura familiar no Brasil. *Semina: Ciências Sociais e Humanas*, 29(2), 159–176. <https://doi.org/10.5433/1679-0383.2008v29n2p159>
- Kreter, A. C., & Bacha, C. J. C. (2006). Avaliação da equidade da previdência no meio rural do Brasil. *Revista de Economia e Sociologia Rural*, 44(3), 467–502. <https://doi.org/10.1590/S0103-20032006000300006>
- Lefebvre, H. (1974). *La production de l’espace*. Anthropos.
- Massey, D. (1994). *Space, place and gender*. Polity Press.

- Martins, J. S. (2009). *O poder do atraso: Ensaio de sociologia da história lenta* (5ª ed.). Hucitec.
- Moreira, A. P. (2022). O gênero para a Geografia: Por uma ciência feita com mulheres. *Revista da ANPEGE*, 18(36), 1–28. <https://doi.org/10.5418/ra2022.v18i36.13293>
- Paula, L. A. C. de. (2019). As Margaridas seguem o caminho: A mulher rural e sua trajetória de luta por reconhecimento e direitos. *Caderno Prudentino de Geografia*, 3(41), 100–121.
- Paulilo, M. I. (1987). O peso do trabalho leve. *Ciência Hoje*, 5(28), 64–70.
- Relph, E. (1976). *Place and placelessness*. Pion.
- Santos, M. (1996). *A natureza do espaço: Técnica e tempo, razão e emoção*. Hucitec.
- Tuan, Y.-F. (1977). *Space and place: The perspective of experience*. University of Minnesota Press.
- Wanderley, M. N. B. (2001). Raízes históricas do campesinato no Brasil. Em M. N. B. Wanderley (Org.), *O mundo rural como espaço de vida* (pp. 27–60). Editora da UFRGS.

CANNABIDIOL IN THE MANAGEMENT OF PAIN ASSOCIATED WITH TEMPOROMANDIBULAR DISORDERS

CANABIDIOL NO MANEJO DA DOR ASSOCIADA À DISFUNÇÃO TEMPOROMANDIBULAR

CANNABIDIOL EN EL TRATAMIENTO DEL DOLOR ASOCIADO CON LA DISFUNCIÓN TEMPOROMANDIBULAR



<https://doi.org/10.56238/sevened2026.008-237>

Andréia de Carvalho Knipp¹, Vivian Rabelo Cunha², Maria Luiza Gomes Reis³, Raphaella Aparecida Silva⁴, Rafaela Timóteo de Souza Ribeiro⁵, Marcela Oliveira Santos⁶, Maria Eduarda Ricardo de Barros⁷, Patrícia de Hollanda Cavalcanti Aragão Costa⁸, Monica Marletti Almeida⁹, João Carlos da Silva¹⁰, Kayole Alves Landim Borges¹¹, Tânia Aparecida Oliveira Ramos¹², Vitória Fonseca Eugênio Duarte¹³, Cristiano Veloso¹⁴, João Victor de Vasconcellos Ferreira¹⁵, Fabiano de Paiva Sales¹⁶, Samara Mesquita Monteiro¹⁷, Ana Caroline Justo Bellafronte Rique¹⁸, Lizandra Cristina Oriel de Sousa¹⁹, Bruna Maria Silva Frauches²⁰, Simone Justi²¹, Cristina

¹ Nurse. Dental Surgeon. Universidade Salgado de Oliveira. E-mail: dra.andreiaKnipp@gmail.com

² Physiotherapist. Faculdade Pitágoras. E-mail: vivianrcunha@yahoo.com.br

³ Postgraduate certificate in Pediatric Dentistry, Postgraduate in Orthodontics. Instituto Federal de Educação, Ciência e Tecnologia de Goiás. Centro Universitário Euro-Americano (UNIEURO). Fundação de Ensino e Pesquisa em Ciências da Saúde (FEPECS). Instituto de Pós-Graduação em Odontologia (IPESP). E-mail: marialuizagreis@gmail.com

⁴ Specialist in Prosthodontics. São Leopoldo Mandic. E-mail: rapha-aps@hotmail.com

⁵ Dental Student. Faculdade Integrada da Amazônia (FINAMA Prime). E-mail: rafaelatimoteo88@gmail.com

⁶ Dental Surgeon. Universidade Federal de Sergipe (UFS). E-mail: dra.marcela.oliveira1@gmail.com

⁷ Dental Student. Afya Universidade Unigranrio. E-mail: mariaeduardarb007@gmail.com

⁸ Dr. in Dentistry (Restorative Dentistry). Universidade Federal Fluminense (UFF). E-mail: patriciahollandah@gmail.com

⁹ Postdoctoral researcher in Dentistry. Universidade Federal do Maranhão (UFMA). E-mail: monicamarletti@gmail.com

¹⁰ Master's Student. Pontifícia Universidade Católica de São Paulo (PUC-SP). E-mail: joaocarlosbmd@gmail.com

¹¹ Specialist in Implant Dentistry, Specialist in Orthodontics. Universidade Paulista (UNIP). E-mail: espsorrir@hotmail.com

¹² Dental Surgeon. Universidade de Santo Amaro (UNISA). E-mail: taniaramosdentista@gmail.com

¹³ Dental Surgeon. Afya Universidade Unigranrio. E-mail: fonsecavitoria105@gmail.com

¹⁴ Master's degree in Dental Medicine. Universidade Federal Fluminense (UFF), Faculdade Paulo Picanço, Instituto Universitário Egas Moniz. E-mail: veloso.cristiano@icloud.com

¹⁵ Graduated in Dentistry. UNIESP. E-mail: jv.vasconcellos260@gmail.com

¹⁶ Postgraduate certificate. Faculdade de Odontologia de Barretos (UNIFEBE). E-mail: fabianotucurui@gmail.com

¹⁷ Dental Surgeon. INTA/UNINTA. E-mail: mesquitasamara0@gmail.com

¹⁸ Dentistry. Periodontics. Universidade Unigranrio. E-mail: carolbellafronterique@gmail.com

¹⁹ Master's degree in Dentistry (Implant Dentistry). Universidade de Santo Amaro (UNISA). Associação Nacional de Estudos Odontológicos (ANEOD). Faculdade Inovare. E-mail: lizandraoriel@gmail.com

²⁰ Dental Surgeon. Universidade Iguazu (UNIG). E-mail: brunamariafrauches@hotmail.com

²¹ Master's degree. Universidade do Oeste Paulista (UNOESTE). E-mail: simonejusti77@gmail.com

ABSTRACT

Temporomandibular disorder (TMD) comprises a group of conditions affecting the temporomandibular joint and associated structures, representing one of the main causes of non-odontogenic orofacial pain. Given the limitations of conventional therapeutic approaches, cannabidiol (CBD) has emerged as a potential alternative for pain management due to its analgesic, anti-inflammatory, and endocannabinoid system-modulating properties. This study aimed to critically analyze the scientific evidence regarding the use of cannabidiol in the management of pain associated with TMD. This is a narrative literature review with a qualitative approach, conducted in the PubMed, SciELO, and ScienceDirect databases, including publications from 2015 to 2025. Clinical studies, reviews, and experimental research addressing the use of CBD in orofacial pain, myofascial pain, or TMD were included. The findings revealed a predominance of indirect evidence, including reviews and experimental models, with a limited number of randomized clinical trials. Two recent clinical studies demonstrated significant reductions in pain and muscle activity in TMD patients treated with cannabidiol. Additionally, preclinical evidence supports the analgesic and anti-inflammatory effects of CBD, reinforcing its biological plausibility. However, methodological heterogeneity and the scarcity of robust clinical evidence limit the generalization of the findings. It is concluded that cannabidiol presents therapeutic potential in managing pain associated with TMD, particularly of muscular origin, although further clinical studies are required to establish its efficacy, safety, and clinical applicability.

Keywords: Cannabidiol. Temporomandibular Disorder. Orofacial Pain. Myofascial Pain. Endocannabinoid System.

RESUMO

A disfunção temporomandibular (DTM) constitui um conjunto de condições que afetam a articulação temporomandibular e estruturas associadas, sendo uma das principais causas de dor orofacial não odontogênica. Diante das limitações das abordagens terapêuticas convencionais, o canabidiol (CBD) tem emergido como uma alternativa potencial no manejo da dor, devido às suas propriedades analgésicas, anti-inflamatórias e moduladoras do sistema endocanabinoide. O presente estudo teve como objetivo analisar criticamente as evidências científicas acerca do uso do canabidiol no manejo da dor associada à DTM. Trata-se de uma revisão narrativa de literatura, com abordagem qualitativa, realizada nas bases de dados PubMed, SciELO e ScienceDirect, contemplando publicações no período de 2015 a 2025. Foram incluídos estudos clínicos, revisões e pesquisas experimentais que abordassem direta ou indiretamente a utilização do CBD em dor orofacial, dor miofascial ou DTM. Os resultados evidenciaram uma predominância de estudos indiretos, incluindo revisões e modelos experimentais, com número limitado de ensaios clínicos randomizados. Destacam-se dois estudos clínicos recentes que demonstraram redução significativa da dor e da atividade muscular em pacientes com DTM tratados com canabidiol. Adicionalmente, evidências pré-clínicas indicam efeitos analgésicos e anti-inflamatórios do CBD, reforçando sua plausibilidade biológica. No entanto, a heterogeneidade metodológica dos estudos e a escassez de evidências clínicas robustas limitam a generalização dos achados. Conclui-se que o canabidiol apresenta potencial terapêutico no manejo da dor associada à DTM,

²² Specialist in Implant Dentistry, Prosthodontics and Orthodontics. Universidade Tuiuti do Paraná. Pontifícia Universidade Católica do Paraná (PUC-PR). E-mail: cris.xavier@msn.com

²³ Dental Surgeon. UNIME. E-mail: dra.gisellepestana@outlook.com.br

²⁴ Dr. in Clinical Dentistry. Anhanguera. E-mail: aranha9@hotmail.com

²⁵ Dental Student. Faculdade Ieducare. E-mail: rosamirtesouza26@gmail.com

especialmente de origem muscular, sendo necessários estudos clínicos adicionais para estabelecer sua eficácia, segurança e aplicabilidade clínica.

Palavras-chave: Canabidiol. Disfunção Temporomandibular. Dor Orofacial. Dor Miofascial. Sistema Endocanabinoide.

RESUMEN

La disfunción temporomandibular (DTM) constituye un conjunto de afecciones que afectan la articulación temporomandibular y las estructuras asociadas, siendo una de las principales causas de dolor orofacial no odontogénico. Ante las limitaciones de los enfoques terapéuticos convencionales, el cannabidiol (CBD) ha surgido como una alternativa potencial en el manejo del dolor, debido a sus propiedades analgésicas, antiinflamatorias y moduladoras del sistema endocannabinoide. Este estudio tuvo como objetivo analizar críticamente la evidencia científica sobre el uso de cannabidiol en el manejo del dolor asociado a la DTM. Se trata de una revisión narrativa de la literatura, con un enfoque cualitativo, realizada en las bases de datos PubMed, SciELO y ScienceDirect, que abarca publicaciones desde 2015 hasta 2025. Se incluyeron estudios clínicos, revisiones e investigaciones experimentales que abordaron directa o indirectamente el uso de CBD en el dolor orofacial, el dolor miofascial o la DTM. Los resultados mostraron un predominio de estudios indirectos, incluyendo revisiones y diseños experimentales, con un número limitado de ensayos clínicos aleatorizados. Dos estudios clínicos recientes destacan por demostrar una reducción significativa del dolor y la actividad muscular en pacientes con disfunción temporomandibular (DTM) tratados con cannabidiol. Además, la evidencia preclínica indica efectos analgésicos y antiinflamatorios del CBD, lo que refuerza su plausibilidad biológica. Sin embargo, la heterogeneidad metodológica de los estudios y la escasez de evidencia clínica sólida limitan la generalización de los hallazgos. Se concluye que el cannabidiol presenta potencial terapéutico en el manejo del dolor asociado a la DTM, especialmente el de origen muscular, pero se necesitan más estudios clínicos para establecer su eficacia, seguridad y aplicabilidad clínica.

Palabras clave: Cannabidiol. Disfunción Temporomandibular. Dolor Orofacial. Dolor Miofascial. Sistema Endocannabinoide.

1 INTRODUCTION

Temporomandibular disorder (TMD) is a set of conditions that affect the temporomandibular joint, masticatory muscles, and associated structures, and is considered one of the main causes of non-odontogenic orofacial pain. Its etiology is multifactorial, involving biomechanical, neuromuscular, and psychosocial factors, which contribute to the complexity of diagnosis and clinical management (GOLANSKA et al., 2021). In addition, TMD has a significant impact on patients' quality of life, and can compromise functions such as chewing, speaking, and sleeping, in addition to being frequently associated with chronic pain (WU et al., 2021).

From a pathophysiological point of view, TMD-associated pain is often related to local inflammation and peripheral and central sensitization, mediated by pro-inflammatory substances, such as cytokines and chemokines, especially in cases of myofascial pain. Studies have shown that changes in the expression of inflammatory mediators play a relevant role in pain maintenance and dysfunction progression (QIAO et al., 2023; ZWIRI et al., 2020). In this context, understanding the biological mechanisms involved in myofascial and joint pain is essential for the development of new, more effective therapeutic approaches.

In recent years, cannabidiol (CBD), one of the main non-psychoactive components of *Cannabis sativa*, has been widely investigated due to its analgesic, anti-inflammatory, and endocannabinoid system modulating properties, without showing relevant psychoactive effects. Evidence suggests that CBD acts on the modulation of CB1 and CB2 receptors, in addition to influencing pathways related to the release of inflammatory cytokines and nociceptive transmission (MLOST et al., 2020; PISANTI et al., 2017; SERMET et al., 2021). These effects make CBD a potential therapeutic agent in the management of chronic painful conditions, including those of musculoskeletal origin.

In the field of orofacial pain, recent reviews indicate that cannabinoids, including cannabidiol, may contribute to the reduction of pain and muscle activity in different clinical conditions, although the evidence is still heterogeneous (GROSSMAN et al., 2021; DAVID et al., 2022). Experimental studies also demonstrate that CBD has an analgesic effect in myofascial pain models, reinforcing its biological plausibility in the context of TMD (WONG; CAIRNS, 2019). However, the transposition of these findings into clinical practice still depends on more robust evidence.

Despite the therapeutic potential observed, the scientific literature shows a significant limitation regarding the availability of clinical studies directed at the use of cannabidiol (CBD) in patients with temporomandibular disorder. To date, only two randomized controlled trials have been identified that have directly investigated this application (NITECKA-BUCHTA et

al., 2019; WALCZYŃSKA-DRAGON et al., 2024), which demonstrated a significant reduction in pain and muscle activity in patients with TMD of muscular origin. However, the scarcity of studies and the associated methodological limitations prevent the consolidation of robust clinical evidence. In this context, considering the limitations of conventional treatments and the need for new therapeutic approaches, the present study aims to critically analyze the use of cannabidiol in the management of pain associated with temporomandibular disorder, based on the available scientific evidence.

2 METHODOLOGY

The present study is characterized as a narrative literature review, with a qualitative approach, whose objective was to critically analyze the available scientific evidence on the use of cannabidiol in the management of pain associated with temporomandibular disorder.

The bibliographic search was carried out between January and March 2026, in the PubMed, SciELO, and ScienceDirect databases, including publications in the period from 2015 to 2025. Controlled descriptors and free terms in English and Portuguese were used, based on the MeSH (Medical Subject Headings) and DeCS (Health Sciences Descriptors) vocabularies, including: "cannabidiol", "CBD", "temporomandibular disorders", "TMD", "pain", "orofacial pain" and "myofascial pain". The terms were combined using Boolean operators, using the following search strategy: ("cannabidiol" OR "CBD") AND ("temporomandibular disorders" OR "TMD") AND ("pain" OR "orofacial pain" OR "myofascial pain").

The selection of studies was carried out in stages. Initially, the screening was carried out by reading the titles and abstracts. Subsequently, the potentially eligible studies were submitted to reading in full, being evaluated according to the previously established inclusion and exclusion criteria. At the end of the selection process, 21 articles were included to compose the final sample of the review.

The following inclusion criteria were adopted: complete scientific articles, published between 2015 and 2025, available in indexed databases, written in English or Portuguese, and that directly or indirectly addressed the use of cannabidiol in the context of orofacial pain, myofascial pain or temporomandibular disorder, without restriction on the methodological design, as long as they are relevant to the objective of the study. Duplicate studies, articles outside the established period, studies with themes unrelated to the research objective, as well as studies with an exclusively analytical, methodological or non-clinically relevant focus were excluded.

The included studies included different methodological designs, such as randomized clinical trials, systematic and narrative reviews, as well as experimental studies, allowing

critical and comparative analysis of the available evidence. Data analysis was performed in a descriptive and interpretative manner, considering the methodological design, robustness, and level of evidence of each study. Information such as author, year of publication, type of study, objective, main findings and contributions to the theme were extracted. The findings were organized into previously defined thematic categories, including: pathophysiology of temporomandibular disorder, mechanisms of action of cannabidiol, and clinical and preclinical evidence in pain management.

A narrative review was chosen due to the heterogeneity of the available studies, which present different methodological designs, populations, and interventions, making it difficult to apply systematic methods of synthesis.

As this is a literature review based on secondary data in the public domain, there was no need to submit it to the Research Ethics Committee, in accordance with the current ethical guidelines. It should be noted that all the information used was properly referenced, ensuring the scientific integrity and traceability of the sources.

As a limitation, it is noteworthy that, as it is a narrative review, the study is subject to bias in the selection and interpretation of data, not presenting the rigorous methodological systematization characteristic of systematic reviews. In addition, the heterogeneity of the designs of the included studies may limit the direct comparison between the findings. Even so, we sought to ensure the quality of the analysis through the careful selection of relevant, current, and methodologically consistent studies.

3 RESULTS

The synthesis of the studies included in this review is presented in Table 1, which brings together the main methodological characteristics and relevant findings of the selected studies. A total of 21 studies were analyzed, covering different designs, including randomized clinical trials, systematic and narrative reviews, as well as in vivo and in vitro experimental studies.

There is a predominance of indirect evidence in the literature, mainly from reviews and experimental studies, with a limited number of direct clinical evidence specifically focused on temporomandibular disorder. The analyzed data allow a comparative evaluation of the methodological designs, the populations investigated and the main findings related to the use of cannabidiol in pain management, evidencing both its therapeutic potential and the current limitations of the scientific literature.

Table 1

Summary of included studies on the use of cannabidiol in the management of pain associated with temporomandibular disorder

Article Title	Author/Year	Method (Study Design)	Sample/Model	Main results
Myorelaxant Effect of Transdermal Cannabidiol Application in Patients with TMD	Nitecka-Buchta et al., 2019	Randomized, double-blind, placebo-controlled clinical trial	TMD Patients	Significant reduction in pain and muscle activity
Cannabidiol Intervention for Muscular Tension, Pain, and Sleep Bruxism Intensity	Walczyńska-Dragoń et al., 2024	Randomized, double-blind, placebo-controlled clinical trial	Patients with TMD and bruxism	Significant reduction in pain, electromyographic activity, and bruxism
Cannabidiol, Cannabinol and Their Combinations Act as Peripheral Analgesics	Wong & Cairns, 2019	In vivo experimental study	Animal model of myofascial pain	Peripheral analgesic effect
Cannabidiol has therapeutic potential for myofascial pain	Vivanco-Estela et al., 2021	In vivo experimental study	Animal model of myofascial pain	Reduced pain and inflammation
Cannabis and orofacial pain: A systematic review	Grossman et al., 2021	Systematic review	Clinical Studies in Orofacial Pain	Pain reduction with high heterogeneity
Cannabidiol in Dentistry: A Scoping Review	David et al., 2022	Scoping Review	Dental studies	Indicates therapeutic potential with limitations
Cannabidiol for Pain Treatment: Focus on Pharmacology	Mlost et al., 2020	Narrative review	Preclinical studies	Analgesic and anti-inflammatory action
Cannabidiol: State of the art and new challenges	Pisanti et al., 2017	Narrative review	Experimental and clinical studies	Modulation of the endocannabinoid system
Cannabidiol selectively modulates IL-1 β and IL-6	Sermet et al., 2021	In vitro experimental study	Human cells	Reduction of pro-inflammatory cytokines
Temporomandibular Myofascial Pain Syndrome	Golanska et al., 2021	Narrative review	DTM	Influence of biopsychosocial factors
Therapeutic Agents for Temporomandibular Disorders	Wu et al., 2021	Narrative review	DTM	Diversity of therapeutic approaches
Biomarkers for Temporomandibular Disorders	Zwiri et al., 2020	Narrative review	Biomarkers in TMD	Role of inflammatory cytokines
Chemokine Regulation in Temporomandibular Joint Disease	Qiao et al., 2023	Narrative review	DTM	Role of chemokines in inflammation
Cannabinoid delivery systems for pain and inflammation	Bruni et al., 2018	Narrative review	Pharmacological delivery systems	Influence of route of administration

Molecular and Cellular Mechanisms of Action of Cannabidiol	Martinez Naya et al., 2023	Narrative review	Molecular studies	Cellular modulation of cannabidiol
Effects of endocannabinoids and opioids on orofacial pain	Zubrzycki et al., 2017	In vivo experimental study	Orofacial pain animal model	Orofacial pain modulation
Effectiveness of cannabinoids in neuropathic pain	Boychuk et al., 2015	Systematic review	Clinical studies	Reduction of chronic pain
Patterns of medicinal cannabis use in chronic pain	Baron et al., 2018	Observational study	Patients with chronic pain	Reduction of pain self-reported by patients
Efficacy of topical interventions for TMD	Mena et al., 2020	Systematic review with meta-analysis	Topical interventions in TMD	Limited evidence for CBD
Cannabinoids and Orofacial Pain Management	Weerathataphan et al., 2021	Narrative review	Orofacial pain	Indicates therapeutic potential of cannabinoids
Cannabidiol (CBD) and its analogs: effects on inflammation	Burstein, 2015	Narrative review	Inflammatory processes	Anti-inflammatory effect

Source: Authors.

4 DISCUSSION

The results of this review show that the use of cannabidiol (CBD) in the management of pain associated with temporomandibular disorder (TMD) has relevant therapeutic potential, but supported predominantly by indirect evidence. The analysis of the included studies demonstrates that most of the available research consists of reviews and experimental studies, with a limited number of randomized controlled trials specifically targeting TMD, which imposes restrictions on the consolidation of clinical recommendations based on robust evidence.

From a clinical standpoint, only two identified studies have directly evaluated the use of CBD in TMD patients. The clinical trial conducted by Nitecka-Buchta et al. (2019) demonstrated a significant reduction in pain and muscle activity after transdermal application of cannabidiol, while Walczyńska-Dragoń et al. (2024) observed a significant reduction in pain, electromyographic activity of masticatory muscles, and the sleep bruxism index with the use of CBD-containing formulations. These findings suggest initial clinical efficacy, especially in cases of TMD of muscular origin, but still insufficient to establish consolidated therapeutic recommendations, considering the scarcity of studies and sample limitations.

The predominance of indirect evidence in the literature reinforces the need for cautious interpretation of the findings. Systematic and narrative reviews, including meta-analysis, indicate that cannabinoids, including cannabidiol, have potential to reduce orofacial and

chronic pain, although with high methodological heterogeneity (GROSSMAN et al., 2021; DAVID et al., 2022; BOYCHUK et al., 2015; MENA et al., 2020; WEERATHATAPHAN et al., 2021). In addition, observational studies suggest pain improvement in patients who use medical cannabis, although without strict control of variables and at risk of bias (BARON et al., 2018). Thus, although the findings are promising, they do not replace controlled and standardized clinical evidence.

Regarding biological plausibility, experimental studies present consistent results and contribute significantly to the understanding of CBD's mechanisms of action. Evidence indicates that cannabidiol exerts a peripheral analgesic effect in myofascial pain models (WONG; CAIRNS, 2019), in addition to reducing pain and inflammation under experimental conditions (VIVANCO-ESTELA et al., 2021; ZUBRZYCKI et al., 2017). Additionally, in vitro studies demonstrate that CBD modulates the production of inflammatory cytokines, such as IL-1 β and IL-6 (SERMET et al., 2021), corroborating its anti-inflammatory action. However, it is observed that, although preclinical studies present consistent results, these findings have not yet been fully confirmed in human clinical studies.

These mechanisms are supported by reviews describing CBD's role in the endocannabinoid system and in pathways related to nociception and inflammation (MLOST et al., 2020; PISANTI et al., 2017; MARTINEZ NAYA et al., 2023; BURSTEIN, 2015). The modulation of inflammatory receptors and mediators suggests that cannabidiol can act on both the peripheral and central phases of pain, which is particularly relevant in conditions such as TMD, characterized by peripheral and central sensitization.

The pathophysiology of TMD also contributes to the interpretation of the observed effects. Studies indicate that pain in this condition is associated with inflammatory processes, with the participation of cytokines and chemokines (ZWIRI et al., 2020; QIAO et al., 2023), as well as biopsychosocial factors that influence pain perception (GOLANSKA et al., 2021). The diversity of therapeutic approaches described in the literature (WU et al., 2021) reinforces the complexity of TMD and the need for multimodal therapeutic strategies.

Another relevant aspect concerns the forms of administration of cannabidiol, since different delivery systems can influence its therapeutic efficacy (BRUNI et al., 2018). In this context, topical and transdermal routes have potential clinical applicability in dentistry, especially in the management of orofacial pain, although they still lack standardization regarding dosage and form of use.

In this sense, there is a mismatch between the robustness of the preclinical findings and the limited clinical evidence available, which reinforces the need for caution in the interpretation of the results and in the clinical application of cannabidiol in the context of TMD.

Despite the advances observed, this review highlights important limitations in the current literature. The heterogeneity of the designs, the predominance of experimental studies, and the scarcity of randomized clinical trials specific to TMD limit the robustness of the conclusions. In addition, the lack of standardization regarding doses, routes of administration, and duration of treatment makes it difficult to compare studies and define clinical protocols.

Thus, although cannabidiol presents itself as a promising alternative in the management of pain associated with temporomandibular disorder, especially in cases of muscular origin, additional clinical studies are needed, with greater methodological rigor, representative samples, and standardization of protocols, to establish its efficacy, safety, and clinical applicability consistently. In this context, the available data support biological plausibility and indicate initial clinical benefits; However, the current evidence base is still insufficient to support robust clinical recommendations.

5 CONCLUSION

The present study showed that cannabidiol (CBD) has relevant therapeutic potential in the management of pain associated with temporomandibular disorder, especially in conditions of muscular origin. The findings indicate that CBD has analgesic and anti-inflammatory properties, supported by consistent experimental evidence and biological mechanisms related to the modulation of the endocannabinoid system and the regulation of inflammatory mediators.

However, the critical analysis of the literature demonstrates that direct clinical evidence is still limited, being based on a small number of randomized controlled trials. Thus, despite the promising results, it is not possible, at the moment, to establish definitive clinical recommendations regarding the use of cannabidiol in the treatment of temporomandibular disorder.

In addition, significant heterogeneity was observed among the studies, especially in relation to doses, routes of administration, and methodological designs, which makes it difficult to standardize therapeutic protocols and compare findings.

In view of this, it is concluded that cannabidiol represents a promising therapeutic alternative, but still in the phase of scientific consolidation. The need for additional clinical studies with greater methodological rigor, representative samples, and standardization of interventions is emphasized, in order to establish their efficacy, safety, and clinical applicability in the context of temporomandibular disorders.

REFERENCES

- Baron, E. P., et al. (2018). Patterns of medicinal cannabis use, strain analysis, and substitution effect among patients with migraine, headache, arthritis, and chronic pain in a medicinal cannabis cohort. *The Journal of Headache and Pain*, 19(1), 37. <https://doi.org/10.1186/s10194-018-0862-2>
- Boychuk, D. G., et al. (2015). The effectiveness of cannabinoids in the management of chronic nonmalignant neuropathic pain: A systematic review. *Journal of Oral & Facial Pain and Headache*, 29(1), 7–14. <https://doi.org/10.11607/ofph.1274>
- Bruni, N., et al. (2018). Cannabinoid delivery systems for pain and inflammation treatment. *Molecules*, 23(10), 2478. <https://doi.org/10.3390/molecules23102478>
- Burstein, S. (2015). Cannabidiol (CBD) and its analogs: A review of their effects on inflammation. *Bioorganic & Medicinal Chemistry*, 23(7), 1377–1385. <https://doi.org/10.1016/j.bmc.2015.01.059>
- David, C., et al. (2022). Cannabidiol in dentistry: A scoping review. *Dentistry Journal*, 10(10), 193. <https://doi.org/10.3390/dj10100193>
- Golanska, P., et al. (2021). Temporomandibular myofascial pain syndrome—Aetiology and biopsychosocial modulation: A narrative review. *International Journal of Environmental Research and Public Health*, 18(15), 7807. <https://doi.org/10.3390/ijerph18157807>
- Grossman, S., Tan, H., & Gadiwalla, Y. (2021). Cannabis and orofacial pain: A systematic review. *British Journal of Oral and Maxillofacial Surgery*, 60(6), e677–e690. <https://doi.org/10.1016/j.bjoms.2021.03.004>
- Martinez Naya, N., et al. (2023). Molecular and cellular mechanisms of action of cannabidiol. *Molecules*, 28(16), 5980. <https://doi.org/10.3390/molecules28165980>
- Mena, M., et al. (2020). Efficacy of topical interventions for temporomandibular disorders compared to placebo or control therapy: A systematic review with meta-analysis. *Journal of Dental Anesthesia and Pain Medicine*, 20(6), 337–356. <https://doi.org/10.17245/jdapm.2020.20.6.337>
- Mlost, J., et al. (2020). Cannabidiol for pain treatment: Focus on pharmacology and mechanism of action. *International Journal of Molecular Sciences*, 21(22), 8870. <https://doi.org/10.3390/ijms21228870>
- Nitecka-Buchta, A., et al. (2019). Myorelaxant effect of transdermal cannabidiol application in patients with temporomandibular disorders: A randomized, double-blind trial. *Journal of Clinical Medicine*, 8(11), 1886. <https://doi.org/10.3390/jcm8111886>
- Pisanti, S., et al. (2017). Cannabidiol: State of the art and new challenges for therapeutic applications. *Pharmacology & Therapeutics*, 175, 133–150. <https://doi.org/10.1016/j.pharmthera.2017.02.041>
- Qiao, Y., et al. (2023). Chemokine regulation in temporomandibular joint disease: A comprehensive review. *Genes*, 14(2), 408. <https://doi.org/10.3390/genes14020408>

- Sermet, S., et al. (2021). Cannabidiol selectively modulates interleukin (IL)-1 β and IL-6 production in human peripheral blood monocytes. *Toxicology*, 464, 153016. <https://doi.org/10.1016/j.tox.2021.153016>
- Vivanco-Estela, A. N., et al. (2021). Cannabidiol has therapeutic potential for myofascial pain in parkinsonian rats. *Neuropharmacology*, 196, 108700. <https://doi.org/10.1016/j.neuropharm.2021.108700>
- Walczyńska-Dragoń, K., et al. (2024). Cannabidiol intervention for muscular tension, pain, and sleep bruxism intensity: A randomized, double-blind clinical trial. *Journal of Clinical Medicine*, 13(5), 1417. <https://doi.org/10.3390/jcm13051417>
- Weerathataphan, S., et al. (2021). Cannabinoids and orofacial pain management: A review. *International Journal of Dentistry and Oral Science*, 8, 5123–5132.
- Wong, H., & Cairns, B. E. (2019). Cannabidiol, cannabinal and their combinations act as peripheral analgesics in a rat model of myofascial pain. *Archives of Oral Biology*, 104, 33–39. <https://doi.org/10.1016/j.archoralbio.2019.05.012>
- Wu, M., et al. (2021). Therapeutic agents for the treatment of temporomandibular joint disorders: Progress and perspective. *Frontiers in Pharmacology*, 11, 596099. <https://doi.org/10.3389/fphar.2020.596099>
- Zwiri, A., et al. (2020). Biomarkers for temporomandibular disorders: Current status and future directions. *Diagnostics*, 10(5), 303. <https://doi.org/10.3390/diagnostics10050303>
- Zubrzycki, M., et al. (2017). Effects of centrally administered endocannabinoids and opioids on orofacial pain perception in rats. *British Journal of Pharmacology*, 174(21), 3780–3789. <https://doi.org/10.1111/bph.13906>

COMPARISON BETWEEN VAGAL MANEUVERS AND ADENOSINE IN PAROXYSMAL SUPRAVENTRICULAR TACHYCARDIA

COMPARAÇÃO ENTRE MANOBRAS VAGAIS E ADENOSINA NA TAQUICARDIA SUPRAVENTRICULAR PAROXÍSTICA

COMPARACIÓN ENTRE MANIOBRAS VAGALES Y ADENOSINA EN TAQUICARDIA SUPRAVENTRICULAR PAROXÍSTICA



<https://doi.org/10.56238/sevened2026.008-238>

Isis Souza Rabelo¹, Fernanda Scharf², Alessandra Aniszewski Kucner³, Matheus Teixeira Schumacher⁴, Maryane de Oliveira Pessôa⁵, Marco Antônio Barbieri⁶, Vitor Roble de Oliveira⁷, Giovanna de Souza Frasson⁸, Maria Clara Barreira⁹, Júlia Wagner Pedrazzi¹⁰, Vania Targanski Benitez¹¹, Ana Paula Schonarth¹², João Pedro Almeida Antunes dos Santos¹³, Samuel Owusu-Baah¹⁴, Nicole Barbosa Amaral¹⁵, Luís Otávio Garcia de Oliveira¹⁶, Rafael Pereira Barcelos Severino Borges¹⁷, Renan Pereira Barcelos Severino Borges¹⁸, Victor Pacheco de Campos Neto¹⁹, Jéssica Carneiro de

¹ Medical Doctor. Univassouras. E-mail: isissouzarabelo@gmail.com

² Medical Student. Universidade Santo Amaro. E-mail: scharf.fernada@gmail.com

³ Medical Student. Universidade Federal de Santa Maria (UFSM). E-mail: alekucner@gmail.com

⁴ Medical Doctor. Universidade Federal de Santa Maria (UFSM). E-mail: matheusschu@gmail.com

⁵ Medicine. Centro Universitário de Votuporanga (UNIFEV). E-mail: maryane.pessoa@gmail.com

⁶ Medical Student. Universidade do Contestado (UNC). E-mail: marcoantonio280220@gmail.com

⁷ General Practitioner. Universidade Federal da Grande Dourados (UFGD). E-mail: vitor_roble@hotmail.com

⁸ Medical Doctor. Universidade do Sul de Santa Catarina (UNISUL). E-mail: giovanna.frasson@hotmail.com

⁹ Medical Doctor. Universidade Anhembi Morumbi. E-mail: mariiaclara45@hotmail.com

¹⁰ Medicine. Universidade do Vale do Rio dos Sinos (UNISINOS). E-mail: juliapedrazzi@gmail.com

¹¹ Family and Community Physician. Universidade Cristiana da Bolívia. Universidade Federal de Mato Grosso (UFMT). E-mail: dratarganski@gmail.com

¹² Medical Doctor. Universidade para o Desenvolvimento do Alto Vale do Itajaí (UNIDAVI).

E-mail: paulaschonarth@hotmail.com

¹³ Medicine. Universidade Municipal de São Caetano do Sul (USCS). E-mail: medjoaoalmeida@gmail.com

¹⁴ Postgraduate in Intensive Care. Faculdade de Medicina da Universidade Federal do Rio de Janeiro (FM-UFRJ), IDOR-SP. E-mail: sammybaahnm10@gmail.com

¹⁵ Medicine. Centro Universitário Serra dos Órgãos (UNIFESO). E-mail: nicole.b.amaral123@gmail.com

¹⁶ Medicine. Universidade de Marília. E-mail: luisotavio_garcia@icloud.com

¹⁷ Medical Doctor. Faculdade Atenas de Sete Lagoas. E-mail: rafaelpbsb_@hotmail.com

¹⁸ Medical Doctor. Centro Universitário do Planalto Central Aparecido dos Santos (UNICEPLAC). E-mail: renan.barcelos.73@hotmail.com

¹⁹ Specialist in Family and Community Medicine. Associação Médica Brasileira (AMB). E-mail: dr.victorcampos@hotmail.com

ABSTRACT

Paroxysmal supraventricular tachycardia (PSVT) is one of the most common arrhythmias in clinical practice, characterized by sudden episodes of supraventricular tachycardia. The management of this condition in hemodynamically stable patients is initially based on the use of vagal maneuvers, followed by adenosine administration in cases of failure. This study aimed to compare the effectiveness, safety, and clinical applicability of vagal maneuvers and adenosine in the treatment of PSVT through an integrative literature review. The search was conducted in the PubMed/MEDLINE, SciELO, and ScienceDirect databases, considering studies published between 2015 and 2025, using controlled descriptors and free terms in combination. Randomized clinical trials, systematic reviews, meta-analyses, and clinical guidelines addressing the management of PSVT were included. The results demonstrated that vagal maneuvers present variable efficacy, generally with success rates below 50%, whereas adenosine showed reversal rates above 80–90%. The modified Valsalva maneuver showed higher effectiveness compared to the standard technique, although still inferior to adenosine. It is concluded that, although vagal maneuvers are recommended as first-line therapy due to their safety and ease of application, adenosine stands out as the most effective strategy for restoring sinus rhythm and should be used after the failure of non-pharmacological interventions.

Keywords: Paroxysmal Supraventricular Tachycardia. Vagal Maneuvers. Valsalva Maneuver. Adenosine. Cardiac Arrhythmias.

RESUMO

A taquicardia supraventricular paroxística (TSVP) é uma das arritmias mais frequentes na prática clínica, caracterizada por episódios súbitos de taquicardia de origem supraventricular. O manejo dessa condição em pacientes hemodinamicamente estáveis baseia-se, inicialmente, na realização de manobras vagais, seguidas do uso de adenosina nos casos de insucesso. Este estudo teve como objetivo comparar a eficácia, segurança e aplicabilidade clínica das manobras vagais e da adenosina no tratamento da TSVP, por meio de uma revisão integrativa da literatura. A busca foi realizada nas bases de dados PubMed/MEDLINE, SciELO e ScienceDirect, considerando estudos publicados entre 2015 e 2025, com utilização de descritores controlados e termos livres combinados. Foram incluídos ensaios clínicos randomizados, revisões sistemáticas, metanálises e diretrizes clínicas que abordassem diretamente o manejo da TSVP. Os resultados evidenciaram que as manobras vagais apresentam eficácia variável, com taxas de sucesso geralmente inferiores a 50%, enquanto a adenosina demonstrou taxas de reversão superiores a 80–90%. A manobra de Valsalva modificada apresentou maior eficácia em relação à técnica padrão, embora ainda inferior à adenosina. Conclui-se que, apesar das manobras vagais serem recomendadas como primeira linha devido à sua segurança e facilidade de aplicação, a adenosina se destaca como a estratégia mais eficaz na reversão do ritmo sinusal, sendo fundamental sua utilização após falha das intervenções não farmacológicas.

²⁰ Specialist in Family and Community Medicine. Associação Médica Brasileira (AMB).

E-mail: dr.victorcampos@hotmail.com

²¹ Medical Doctor. UCEBOL. Universidade Federal de Alfenas (UNIFAL-MG). E-mail: crm15572@icloud.com

²² Medical Student. Universidade Federal do Paraná (UFPR). E-mail: nephtaliemoise3@gmail.com

²³ Medical Student. Universidade Camilo Castelo Branco. Universidade Cruzeiro do Sul. Universidade das Américas. E-mail: giuliana.valderano@gmail.com

²⁴ Medical Doctor. Universidade Federal do Pampa (UNIPAMPA). E-mail: clícia.ferreira.g@gmail.com

²⁵ Medical Doctor. Universidad Privada del Este (UPE). Universidade Federal de Goiás (UFG). E-mail: aguidamarques_med2016@outlook.com

Palavras-chave: Taquicardia Supraventricular Paroxística. Manobras Vagais. Manobra de Valsalva. Adenosina. Arritmias Cardíacas.

RESUMEN

La taquicardia supraventricular paroxística (TSVP) es una de las arritmias más frecuentes en la práctica clínica, caracterizada por episodios súbitos de taquicardia de origen supraventricular. El tratamiento de esta afección en pacientes hemodinámicamente estables se basa inicialmente en maniobras vagales, seguidas del uso de adenosina en caso de fracaso. Este estudio tuvo como objetivo comparar la eficacia, seguridad y aplicabilidad clínica de las maniobras vagales y la adenosina en el tratamiento de la TSVP mediante una revisión integradora de la literatura. La búsqueda se realizó en las bases de datos PubMed/MEDLINE, SciELO y ScienceDirect, considerando estudios publicados entre 2015 y 2025, utilizando descriptores controlados y términos libres combinados. Se incluyeron ensayos clínicos aleatorizados, revisiones sistemáticas, metaanálisis y guías clínicas que abordaran directamente el tratamiento de la TSVP. Los resultados mostraron que las maniobras vagales tienen una eficacia variable, con tasas de éxito generalmente inferiores al 50%, mientras que la adenosina demostró tasas de reversión superiores al 80-90%. La maniobra de Valsalva modificada mostró mayor eficacia que la técnica estándar, aunque inferior a la adenosina. Se concluye que, si bien las maniobras vagales se recomiendan como tratamiento de primera línea por su seguridad y facilidad de aplicación, la adenosina se destaca como la estrategia más eficaz para revertir el ritmo sinusal, y su uso es fundamental tras el fracaso de las intervenciones no farmacológicas.

Palabras clave: Taquicardia Supraventricular Paroxística. Maniobras Vagales. Maniobra de Valsalva. Adenosina. Arritmias Cardíacas.

1 INTRODUCTION

Paroxysmal supraventricular tachycardia (PVST) is one of the most frequent arrhythmias in clinical practice, and is characterized by sudden episodes of tachycardia of supraventricular origin, usually with narrow QRS complexes and abrupt onset and termination. This condition can affect individuals of different age groups, presenting clinical manifestations such as palpitations, dyspnea, dizziness, and, in more severe cases, hemodynamic instability (BRUGADA et al., 2019; PAGE et al., 2016). Due to its high incidence in emergency services, PVRT represents an important diagnostic and therapeutic challenge, requiring rapid and effective interventions.

The management of PVRT depends mainly on the hemodynamic stability of the patient, and in stable individuals, international guidelines initially recommend the use of vagal maneuvers as a first-line therapeutic strategy (BRUGADA et al., 2019; LATIŞ et al., 2023). These maneuvers act by increasing parasympathetic tone, promoting the reduction of atrioventricular nodal conduction and enabling the reversal of sinus rhythm. Among the most used techniques are the Valsalva maneuver and carotid sinus massage, which have advantages such as low cost, easy execution, and reduced risk of adverse events.

However, despite their safety and broad recommendation, the efficacy of vagal maneuvers is variable, with success rates ranging from 19% to 54%, often lower in real clinical scenarios (APPELBOAM et al., 2015; LATIŞ et al., 2023). In this context, modifications to the traditional technique, such as the modified Valsalva maneuver, have been proposed with the aim of increasing the rate of rhythm reversal, presenting significantly superior results compared to the standard technique (HUANG et al., 2022; ABDULHAMID et al., 2021).

When vagal maneuvers are not effective, intravenous adenosine is recommended as the pharmacological therapy of choice, due to its high success rate and rapid action in blocking atrioventricular conduction. Clinical studies show that adenosine has reversal rates greater than 80–90%, and is considered safe, despite being associated with transient adverse effects, such as flushing, dyspnea, and feelings of chest discomfort (ALABED et al., 2017; BICILIOĞLU et al., 2020). Thus, adenosine is consolidated as the main pharmacological therapeutic resource in the management of PVRT.

In view of this scenario, it is essential to analyze the comparative effectiveness between vagal maneuvers and adenosine in the treatment of PVT, considering aspects such as efficacy, safety, and clinical applicability. Recent studies indicate that, although vagal maneuvers are recommended as an initial approach, adenosine has a higher success rate in reversing sinus rhythm, and is often necessary after failure of non-pharmacological interventions (XIAO et al., 2024; HUANG et al., 2022). Thus, this integrative review aims to

critically analyze the evidence available in the literature about these two therapeutic strategies, contributing to the improvement of evidence-based clinical decision-making.

2 METHODOLOGY

The present study is characterized as an integrative literature review, with a qualitative and descriptive approach, with the objective of gathering, analyzing and synthesizing scientific evidence regarding the comparison between vagal maneuvers and the use of adenosine in the treatment of paroxysmal supraventricular tachycardia (PSRT).

The identification of studies was carried out in recognized databases in the health area, including PubMed/MEDLINE, SciELO and ScienceDirect, including studies published in the last ten years (2015–2025). Descriptors in English and Portuguese related to the theme were used, such as: "supraventricular tachycardia", "vagal maneuvers", "Valsalva maneuver", "adenosine" and "paroxysmal supraventricular tachycardia", as well as their counterparts in Portuguese, used in combination to identify relevant studies.

The following inclusion criteria were adopted: original articles, randomized clinical trials, systematic reviews, meta-analyses, and clinical guidelines that directly addressed the management of PVRT with vagal and/or adenosine maneuvers; studies published in the delimited period; and articles available in full. Exclusion criteria included duplicate studies, isolated case reports, and articles with non-representative samples, or articles that were not directly related to the research objective.

The selection of studies was carried out intentionally and non-probabilistically, prioritizing evidence with a higher methodological level and scientific relevance to the proposed theme. Studies considered classic and international guidelines were included, due to their importance in consolidating current clinical recommendations.

After selection, the studies were read in full and the relevant data were extracted and organized for comparative analysis. The data analysis was conducted critically, allowing the identification of the main evidence related to the efficacy, safety, and applicability of vagal maneuvers in comparison with adenosine in the context of PVRT.

Finally, the selected studies were organized, analyzed, and synthesized in a descriptive manner, enabling the construction of a comprehensive and grounded view on the subject, contributing to evidence-based clinical practice.

3 RESULTS

The selected studies were analyzed for the efficacy, safety, and applicability of vagal maneuvers and adenosine in the management of paroxysmal supraventricular tachycardia (PVRT). Randomized clinical trials, systematic reviews, meta-analyses, and clinical guidelines were included, which showed relevant differences between therapeutic strategies.

Vagal maneuvers have been consistently described as the first therapeutic approach in hemodynamically stable patients, as recommended by international guidelines (BRUGADA et al., 2019; PAGE et al., 2016). However, its efficacy was variable among the studies analyzed, with sinus rhythm reversal rates generally lower than 50% (APPELBOAM et al., 2015; IMMANUEL et al., 2025). In addition, evidence shows that the effectiveness of vagal maneuvers may be even lower in everyday clinical practice, reinforcing their limitations as an isolated strategy (LATIŞ et al., 2023).

The REVERT study demonstrated a success rate of 17% with the standard Valsalva maneuver, compared to 43% with the modified Valsalva (APPELBOAM et al., 2015). Similarly, recent meta-analyses have indicated that modified Valsalva is more effective compared to the traditional technique, and can significantly increase the rate of cardioversion and reduce the need for pharmacological interventions (HUANG et al., 2022; ABDULHAMID et al., 2021). Additional studies reinforce that this technique has better performance among the available vagal maneuvers, maintaining a similar safety profile (IMMANUEL et al., 2025).

With regard to adenosine, the studies analyzed demonstrated high efficacy in reversing PVRT, with success rates ranging from 80% to 95% (ALABED et al., 2017; BICILIOĞLU et al., 2020). In a clinical study, a positive response was observed in approximately 95.8% of patients treated with adenosine, while about 38% responded to vagal maneuvers (BICILIOĞLU et al., 2020). Additional clinical trials have demonstrated success rates of over 90%, reinforcing the high effectiveness of this pharmacological intervention (KOTRUCHIN et al., 2022).

Direct comparative studies reinforce the superiority of adenosine over vagal maneuvers. In a recent study, the success rate was 42.11% for the modified Valsalva maneuver, 75% for adenosine, and 86.11% for combination therapy (XIAO et al., 2024). Although the combination of strategies showed a higher reversal rate, there was no statistically significant difference in relation to the use of adenosine alone, indicating that it remains the most effective intervention in clinical practice.

In addition, studies comparing different vagal techniques have shown that the modified Valsalva maneuver is superior to standard Valsalva and carotid sinus massage, with a higher success rate and less need for medication (HUANG et al., 2022; IMMANUEL et al., 2025).

Other techniques, such as deep breathing in a declined position, showed similar efficacy, but without superiority over modified Valsalva (LIM et al., 2021).

In general, the results show that, although vagal maneuvers are recommended as the first line due to their safety and ease of application, their efficacy is limited. Adenosine, in turn, has a higher success rate in reversing sinus rhythm, consolidating itself as the most effective pharmacological treatment after failure of vagal maneuvers (ALABED et al., 2017; PAGE et al., 2016).

Table 1

Synthesis of the studies included in the integrative review on vagal maneuvers and adenosine in paroxysmal supraventricular tachycardia (PVRT)

Author/Year	Type of study	Sample	Intervention	Main results	Conclusion
BRUGADA et al. (2019)	Clinical guideline (ESC)	—	Management of PVT	Recommends vagal maneuvers such as first line and adenosine after failure	International standard of management
PAGE et al. (2016)	Clinical Guideline (AHA)	—	Management of PVT	Vagal maneuvers as an initial approach; adenosine as primary pharmacologic therapy	Basis of clinical management
APPELBOAM et al. (2015)	Randomized controlled trial	n = 433	Standard versus modified Valsalva	17% versus 43% (p < 0.001)	Most effective modified Valsalva
HUANG et al. (2022)	Meta-analysis	19 studies	Vagal maneuvers	Upper modified Valsalva (RR up to 5.47)	Best vagal technique
ABDULHAMID et al. (2021)	Systematic review	4 RCTs	Modified versus standard Valsalva	2.5 times more effective	Reduces adenosine use
IMMANUEL et al. (2025)	Network Analysis	n = 2545	Vagal techniques	Higher success rate	Best non-pharmacological strategy
LATIŞ et al. (2023)	Narrative review	—	Vagal maneuvers	Efficacy 19%–54%	Clinical limitations
LIM et al. (2021)	Randomized controlled trial	n = 41	Deep Breathing vs Modified Valsalva	31.6% vs 36.8%	No superiority
SMITH et al. (2015)	Cochrane review	n = 316	Vagal maneuvers	~19% Successful	Limited evidence
ALABED et al. (2017)	Cochrane review	n = 622	Adenosine vs BCC	~90% Successful	Standard therapy
BICILIOĞLU et al. (2020)	Clinical study	n = 30	Adenosine vs vagal	95.8% vs 38%	Adenosine Superior
KOTRUCHIN et al. (2022)	Clinical trial	—	Administration of adenosine	93–100%	High efficacy
DAENGBUBPHA et al. (2022)	Clinical trial	—	Adenosine Techniques	80–86,7%	Effective

ZOU et al. (2025)	Observational	—	Use of adenosine	80–90%	Underutilization
XIAO et al. (2024)	Comparison	—	Valsalva versus adenosine versus combination	42% vs 75% vs 86%	Adenosine Superior
BRADY et al. (1996)	Clinical study	—	Vagal maneuvers versus adenosine	7–11% vs 69%	Adenosine Superior
PAN et al. (2024)	Clinical study	n = 15	Management of PVRT in pregnant women	Low response to vagal maneuvers	Need for pharmacologic therapy
LU et al. (2024)	Meta-analysis	n = 2527	Modified Valsalva	RR 1.8–2.0	High efficacy
LODEWYCKX; BERGS (2021)	Meta-analysis	—	Modified Valsalva	Higher success rate over standard technique	Confirms superiority

Source: Prepared by the authors (2026).

4 DISCUSSION

The findings of this integrative review show that, although vagal maneuvers are widely recommended as the first line in the management of paroxysmal supraventricular tachycardia (PVRT), their clinical effectiveness has important limitations when compared to adenosine. International guidelines consistently establish the initial use of these maneuvers in hemodynamically stable patients, mainly due to their safety profile, low cost, and easy applicability (BRUGADA et al., 2019; PAGE et al., 2016). However, the literature shows that this recommendation is more related to the safety of the method than to its therapeutic effectiveness, especially in real clinical scenarios (LATIŞ et al., 2023; SMITH et al., 2015).

The variability in the response to vagal maneuvers is one of the main points of discussion. Clinical studies and systematic reviews have shown relatively low success rates, often below 50%, and can reach even lower values in daily clinical practice (APPELBOAM et al., 2015; LATIŞ et al., 2023; SMITH et al., 2015). In this context, the introduction of the modified Valsalva maneuver represents a relevant advance, since studies such as REVERT have shown a significant increase in sinus rhythm reversal rates when compared to the traditional technique (APPELBOAM et al., 2015). Recent meta-analyses corroborate these findings, indicating that modified Valsalva is significantly more effective than other vagal maneuvers, in addition to reducing the need for pharmacological interventions (HUANG et al., 2022; ABDULHAMID et al., 2021; LU et al., 2024; IMMANUEL et al., 2025).

Despite these advances, the performance of vagal maneuvers remains inferior to that of adenosine. Comparative studies show that even with the use of modified Valsalva, success rates do not reach the levels observed with pharmacological therapies (XIAO et al., 2024). In

addition, other vagal techniques, such as deep breathing in a declined position, did not show significant superiority, reinforcing the global limitation of these strategies (LIM et al., 2021). Thus, although vagal maneuvers are useful as an initial approach, their effectiveness alone is restricted.

On the other hand, adenosine demonstrated consistently high efficacy among the different types of studies analyzed. Clinical trials, systematic reviews, and meta-analyses indicate reversal rates above 80–90%, and can reach values close to 100% in certain clinical contexts (ALABED et al., 2017; BICILIOĞLU et al., 2020; KOTRUCHIN et al., 2022; DAENGBUBPHA et al., 2022; ZOU et al., 2025). These findings are reinforced by clinical studies that demonstrate clear superiority of adenosine over vagal maneuvers, with significant differences in therapeutic success rates (BICILIOĞLU et al., 2020; BRADY et al., 1996).

Direct comparison between therapeutic strategies confirms this superiority. Recent studies have shown that adenosine has significantly higher rates of sinus rhythm reversal when compared to vagal maneuvers, even when the latter are performed in an optimized way (XIAO et al., 2024). Although the combination of vagal maneuvers and adenosine has demonstrated even higher success rates, there is no consistent evidence of statistically significant superiority over the use of adenosine alone, which reinforces its role as the main therapeutic intervention after failure of non-pharmacological strategies.

Another relevant aspect refers to the clinical applicability of the interventions. Vagal maneuvers have clear advantages, such as lack of costs, easy execution, and low risk of complications, being particularly useful in environments with limited resources (BRUGADA et al., 2019; PAGE et al., 2016). However, their reduced clinical performance may result in delayed sinus rhythm reversal, prolonging symptoms and potentially impacting the patient's prognosis. On the other hand, adenosine, despite its high efficacy, can cause transient adverse effects, such as feelings of imminent death, dyspnea, and chest discomfort, in addition to requiring monitoring during its administration (ALABED et al., 2017; ZOU et al., 2025). Still, such effects are generally self-limiting, not compromising its overall security profile.

Thus, the findings of this review indicate that vagal maneuvers should be maintained as the initial approach in the management of PVT, as recommended by international guidelines, especially due to their safety and ease of application. However, its limited effectiveness reinforces the need for rapid progression to pharmacological therapy in cases of failure. Adenosine, in turn, has consistent superiority in terms of efficacy, consolidating itself as the treatment of choice in clinical practice. The modified Valsalva maneuver

represents a relevant advance in the context of non-pharmacological interventions; however, it has not yet been shown to be effective enough to replace adenosine in reversing sinus rhythm.

5 CONCLUSION

The present integrative review showed that vagal maneuvers, although recommended as the first line in the management of paroxysmal supraventricular tachycardia (PSRT) due to their safety, low cost, and easy applicability, have limited efficacy in reversing sinus rhythm. The introduction of the modified Valsalva maneuver represents a relevant advance, with a significant increase in success rates, but still lower than that observed with pharmacological interventions.

Adenosine has demonstrated high efficacy and rapid action, consolidating itself as the main therapeutic strategy after failure of vagal maneuvers, with consistently higher reversal rates and an adequate safety profile. The comparison between the approaches confirms the superiority of adenosine, although vagal maneuvers maintain an important role as an initial intervention.

Thus, it is concluded that the management of PVRT should follow a staggered approach, starting with vagal maneuvers, preferably modified Valsalva, and progressing to the use of adenosine in cases of failure. The integration of these strategies contributes to treatment optimization and evidence-based clinical practice.

REFERENCES

- Alabed, S., et al. (2017). Adenosine versus intravenous calcium channel antagonists for supraventricular tachycardia. *Cochrane Database of Systematic Reviews*. <https://doi.org/10.1002/14651858.CD005154.pub3>
- Appelboam, A., et al. (2015). Postural modification to the standard Valsalva manoeuvre for emergency treatment of supraventricular tachycardias (REVERT): A randomised controlled trial. *The Lancet*, 386(10005), 1747–1753. [https://doi.org/10.1016/S0140-6736\(15\)61485-4](https://doi.org/10.1016/S0140-6736(15)61485-4)
- Abdulhamid, M., et al. (2021). Modified Valsalva maneuver versus standard Valsalva maneuver for supraventricular tachycardia: Systematic review and meta-analysis. *The American Journal of Emergency Medicine*. <https://doi.org/10.1016/j.ajem.2021.03.017>
- Bicilioğlu, Y., et al. (2020). Supraventricular tachycardia treatment in the pediatric emergency department: Adenosine versus vagal maneuvers. *Journal of Pediatric Emergency Care*. <https://doi.org/10.1097/PEC.0000000000001841>
- Brady, W. J., et al. (1996). Treatment of out-of-hospital supraventricular tachycardia: Adenosine versus vagal maneuvers. *Prehospital Emergency Care*.

- Brugada, J., et al. (2020). 2019 ESC guidelines for the management of patients with supraventricular tachycardia. *European Heart Journal*, 41(5), 655–720. <https://doi.org/10.1093/eurheartj/ehz467>
- Daengbubpha, S., et al. (2022). Comparing methods of adenosine administration in supraventricular tachycardia: A randomized controlled trial. *The American Journal of Emergency Medicine*. <https://doi.org/10.1016/j.ajem.2022.02.010>
- Huang, Y., et al. (2022). Comparison of various vagal maneuvers for supraventricular tachycardia: A network meta-analysis. *The American Journal of Emergency Medicine*. <https://doi.org/10.1016/j.ajem.2021.12.024>
- Immanuel, A., et al. (2025). Pursuit of optimal vagal maneuvers in stable supraventricular tachycardia: A network meta-analysis. *The Journal of Emergency Medicine*. <https://doi.org/10.1016/j.jemermed.2024.10.012>
- Kotruchin, P., et al. (2022). Comparison between the double-syringe and standard technique of adenosine administration in supraventricular tachycardia. *The American Journal of Emergency Medicine*. <https://doi.org/10.1016/j.ajem.2021.12.067>
- Latiş, O., et al. (2023). Vagal maneuvers in treating acute supraventricular tachycardia: A review. *Medicina*, 59(2). <https://doi.org/10.3390/medicina59020346>
- Lim, S. H., et al. (2021). Randomised controlled trial assessing head-down deep breathing versus modified Valsalva maneuver for supraventricular tachycardia. *European Journal of Emergency Medicine*. <https://doi.org/10.1097/MEJ.0000000000000797>
- Lodewyckx, S., & Bergs, J. (2021). Effectiveness of the modified Valsalva manoeuvre in adults with supraventricular tachycardia: A systematic review. *European Journal of Emergency Medicine*. <https://doi.org/10.1097/MEJ.0000000000000792>
- Lu, X., et al. (2024). Efficacy and safety of modified Valsalva maneuver for supraventricular tachycardia: A meta-analysis. *The American Journal of Emergency Medicine*. <https://doi.org/10.1016/j.ajem.2023.10.012>
- Page, R. L., et al. (2016). 2015 ACC/AHA/HRS guideline for the management of adult patients with supraventricular tachycardia. *Circulation*, 133(14), e506–e574. <https://doi.org/10.1161/CIR.0000000000000311>
- Pan, X., et al. (2024). Managing supraventricular tachyarrhythmia in pregnant patients: Clinical outcomes. *BMC Cardiovascular Disorders*. <https://doi.org/10.1186/s12872-024-03789-1>
- Smith, G., et al. (2015). Effectiveness of the Valsalva manoeuvre for reversion of supraventricular tachycardia. *Cochrane Database of Systematic Reviews*. <https://doi.org/10.1002/14651858.CD009502.pub2>
- Xiao, Y., et al. (2024). Combined modified Valsalva maneuver with adenosine versus adenosine alone in supraventricular tachycardia. *The American Journal of Emergency Medicine*. <https://doi.org/10.1016/j.ajem.2024.01.045>

Zou, Y., et al. (2025). Current practices and knowledge of adenosine use in supraventricular tachycardia. BMC Emergency Medicine. <https://doi.org/10.1186/s12873-025-01025-4>

INTRANASAL ESKETAMINE AND MAOI COMBINATION IN THE MANAGEMENT OF TREATMENT-RESISTANT DEPRESSION: A CASE REPORT

ASSOCIAÇÃO DE ESKETAMINA INTRANASAL E INIBIDOR DA MONOAMINOXIDASE (IMAO) NO MANEJO DA DEPRESSÃO RESISTENTE: RELATO DE CASO

ASOCIACIÓN DE ESKETAMINA INTRANASAL E INHIBIDOR DE LA MONOAMINOXIDASA (IMAO) EN EL TRATAMIENTO DE LA DEPRESIÓN RESISTENTE AL TRATAMIENTO: INFORME DE UN CASO



<https://doi.org/10.56238/sevened2026.008-239>

Paulo Artur da Silva Rodrigues¹, Giovana dos Santos Couto², Bárbara Corrêa Garcia Simões³, Pablo Gnutzmann Pereira⁴

ABSTRACT

Introduction: Treatment-resistant depression (TRD) represents a significant clinical challenge, particularly when associated with suicidal ideation. Intranasal esketamine has emerged as an effective therapeutic option in refractory cases, while monoamine oxidase inhibitors (MAOIs) remain relevant in the management of severe and resistant conditions.

Objective: To describe the clinical course of a patient with TRD treated with the combination of intranasal esketamine and tranylcypromine.

Method: Case report of a 27-year-old female patient diagnosed with recurrent depressive disorder and a history of therapeutic failure to multiple classes of antidepressants, mood stabilizers, and antipsychotics, followed through clinical evaluation and standardized rating scales (HAM-A and MADRS).

Results: After initiation of the combined treatment, a rapid and sustained clinical improvement was observed, with significant reduction of depressive and anxiety symptoms, as well as remission of suicidal ideation. The treatment was well tolerated, with no relevant adverse events.

Conclusion: The association of intranasal esketamine and a MAOI proved to be effective and safe in this case of TRD, suggesting that it may represent a viable therapeutic alternative in selected situations, provided that strict clinical monitoring is ensured.

¹ Medical Doctor. Hospital Nilton Lins (HNL). E-mail: paulo.asr.med@gmail.com

Orcid: <https://orcid.org/0000-0003-3784-3426> Lattes: <https://lattes.cnpq.br/3348620542406979>

² Medical Student. Universidade Federal do Amazonas (UFAM). E-mail: gio.couto4@gmail.com

Orcid: <https://orcid.org/0009-0008-0565-3103> Lattes: <http://lattes.cnpq.br/7233206743407198>

³ Medical Student. Universidade Federal do Amazonas (UFAM). E-mail: barbaracgs14@gmail.com

Orcid: <https://orcid.org/0000-0002-0285-3133> Lattes: <http://lattes.cnpq.br/9400208753813017>

⁴ Medical Doctor. Universidade Federal do Amazonas (UFAM). E-mail: pablogpereira@hotmail.com

Orcid: <https://orcid.org/0009-0000-9721-6710> Lattes: <https://lattes.cnpq.br/7817604764904645>

Keywords: Depressive Disorder. Treatment-Resistant Esketamine. Monoamine Oxidase Inhibitors.

RESUMO

Introdução: O transtorno depressivo resistente ao tratamento (TDR) representa um desafio clínico significativo, especialmente quando associado à ideação suicida. A escetamina intranasal tem emergido como uma opção terapêutica eficaz em casos refratários, enquanto os inibidores da monoaminooxidase (IMAO) permanecem relevantes no manejo de quadros graves e resistentes.

Objetivo: Descrever a evolução clínica de uma paciente com TDR submetida à associação de escetamina intranasal e tranilcipromina.

Método: Relato de caso de paciente do sexo feminino, 27 anos, com diagnóstico de transtorno depressivo recorrente e histórico de falha terapêutica a múltiplas classes de antidepressivos, estabilizadores de humor e antipsicóticos, acompanhada por avaliação clínica e escalas padronizadas (HAM-A e MADRS).

Resultados: Após a introdução do tratamento combinado, observou-se melhora clínica rápida e sustentada, com redução significativa dos sintomas depressivos e ansiosos, além de remissão da ideação suicida. O tratamento foi bem tolerado, sem ocorrência de eventos adversos relevantes.

Conclusão: A associação de escetamina intranasal e IMAO mostrou-se eficaz e segura neste caso de TDR, sugerindo ser uma alternativa terapêutica viável em situações selecionadas, desde que realizada sob monitoramento clínico rigoroso.

Palavras-chave: Depressão Resistente ao Tratamento. Escetamina. Inibidores da Monoaminooxidase.

RESUMEN

Introducción: La depresión resistente al tratamiento (TDR) representa un desafío clínico significativo, especialmente cuando se asocia con ideación suicida. La escetamina intranasal ha surgido como una opción terapéutica eficaz en casos refractarios, mientras que los inhibidores de la monoaminooxidasa (IMAO) siguen siendo relevantes en el manejo de cuadros graves y resistentes.

Objetivo: Describir la evolución clínica de una paciente con TDR sometida a la asociación de escetamina intranasal y tranilcipromina.

Método: Reporte de caso de una paciente de sexo femenino, de 27 años, con diagnóstico de trastorno depresivo recorrente y antecedentes de fracaso terapéutico a múltiples clases de antidepressivos, estabilizadores del estado de ánimo y antipsicóticos, acompañada mediante evaluación clínica y escalas estandarizadas (HAM-A y MADRS).

Resultados: Tras la introducción del tratamiento combinado, se observó una mejoría clínica rápida y sostenida, con reducción significativa de los síntomas depresivos y ansiosos, además de remisión de la ideación suicida. El tratamiento fue bien tolerado, sin eventos adversos relevantes.

Conclusión: La asociación de escetamina intranasal e IMAO resultó eficaz y segura en este caso de TDR, lo que sugiere que puede constituir una alternativa terapéutica viable en situaciones seleccionadas, siempre que se realice bajo un monitoreo clínico riguroso.

Palabras clave: Depresión Resistente al Tratamiento. Escetamina. Inhibidores de la Monoaminooxidasa.

1 INTRODUCTION

Major depressive disorder (MDD) is a psychiatric condition defined by the presence of at least five symptoms over a period of at least two weeks, and the presence of depressed mood and/or loss of interest or pleasure (anhedonia) is mandatory, according to the diagnostic criteria established by the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5). These additional symptoms may include changes in appetite or weight, sleep disturbances, fatigue, feelings of worthlessness or excessive guilt, difficulty concentrating, and recurring thoughts of death or suicide. A precise understanding of these criteria is essential, especially when considering emerging therapeutic interventions, such as intranasal esketamine, which has an approved indication for cases of MDD with acute suicidal ideation, reinforcing the need for careful and individualized clinical evaluation in these contexts ¹.

This disorder significantly impacts the quality of life and daily functioning of individuals, in addition to being associated with a high mortality rate. It is estimated that between 10% and 20% of patients with MDD attempt suicide in their lifetime, and life expectancy can be reduced by up to 10 years. Despite the widespread availability of antidepressant treatments, therapeutic response is still a challenge: only one-third of patients achieve remission with first-line treatment, while another third develop treatment-resistant depression (RDT) ².

Treatment-resistant depression (RDT) represents a major challenge in clinical practice, especially when accompanied by suicidal ideation. In this context, intranasal esketamine, ketamine's S-enantiomer, an N-methyl-D-aspartate (NMDA) receptor antagonist, has stood out as a promising therapeutic option, especially when used in association with conventional antidepressants ^{3,4}. Its mechanism of action involves modulating glutamate neurotransmission, promoting increased neurotrophic factor release and stimulating synaptogenesis. Unlike antidepressants that act on the monoaminergic system, esketamine exerts its antidepressant effect through a distinct primary pathway, which contributes to its relevance in the management of RDT ^{5,6}.

Monoamine oxidase inhibitors (MAOIs), irreversible and non-selective drugs, were the first to be used in the treatment of depression, preceding the discovery of tricyclic antidepressants in the 1950s and the emergence of other therapeutic classes in the following decades. Initially, MAOIs were the main option for patients with atypical depression, characterized by symptoms such as phobic anxiety, hyperphagia, hypersomnia, and mood reactivity. However, despite studies suggesting similar efficacy among different classes of antidepressants in the treatment of major depressive disorder, the use of MAOIs has become less frequent due to dietary restrictions and drug interactions associated with their use,

impacting their acceptability and tolerability. Currently, these drugs are generally indicated for cases of treatment-resistant depression ^{7,8}.

We report the case of a patient with severe RDT who showed significant improvement after the introduction of intranasal esketamine combined with tranylcypromine, a monoamine oxidase inhibitor (MAOI), highlighting the synergy of this approach in the management of a complex clinical picture.

2 CLINICAL CASE

A 27-year-old female patient has been under psychiatric follow-up since 2015, with a diagnosis of recurrent depressive disorder. Throughout the evolution, she was submitted to multiple psychopharmacological strategies, including antidepressants of different classes (selective serotonin reuptake inhibitors, serotonin and norepinephrine reuptake inhibitors, and atypical antidepressants), mood stabilizers, atypical antipsychotics, as well as hypnotics, anxiolytics, and psychostimulants. All medications were administered in therapeutic doses and for periods considered adequate, according to current clinical guidelines. Despite the interventions performed, there was no satisfactory clinical response, characterizing treatment-resistant depression.

In January 2023, she started a new psychiatric follow-up in a severe depressive episode, presenting persistent depressed mood (hypothymia), intense anxiety, a feeling of helplessness, and recurrent suicidal ideation. In the initial evaluation, high scores were observed on the Hamilton Anxiety Rating Scale (HAM-A: 24 points) and Montgomery–Åsberg Depression Rating Scale (MADRS: 33 points). Pharmacological treatment with paroxetine (25 mg/night) was instituted, associated with the recommendation of psychotherapy.

Despite the initial improvement observed in February 2023, the patient presented a progressive worsening of the clinical condition in subsequent consultations, evidenced by the increase in the scores on the evaluation scales (Figure 1), even after therapeutic adjustments, including increasing the dose of paroxetine to 50 mg/night and potentiation with brexpiprazole (2 mg/night), in addition to strengthening adherence to psychotherapy.

In September 2023, in view of the worsening of symptoms and intensification of suicidal ideation, with HAM-A scores of 28 and MADRS of 43, it was decided to change the drug regimen to tranylcypromine (60 mg/day), associated with quetiapine (25 mg/night), and authorization was requested to start treatment with intranasal esketamine, considering the diagnosis of recurrent depressive disorder in a severe episode, resistant to pharmacological treatment, associated with recurrent suicidal ideation.

The authorization for the use of intranasal esketamine was granted in December 2023. The patient underwent the standard therapeutic protocol, consisting of two weekly applications for four weeks (84 mg per application), followed by a weekly application for four weeks, and then fortnightly applications for four months, with the end of the maintenance phase in May 2024. Throughout the protocol, the patient maintained regular use of tranylcypromine (60 mg/day) and showed good adherence to psychotherapy. The association was well tolerated, with no occurrence of significant adverse events.

After the start of combined treatment, rapid and sustained clinical improvement was observed, with a significant reduction in depressive and anxious symptoms, in addition to complete remission of suicidal ideation. The scores on the HAM-A and MADRS scales progressively decreased, reaching 9 points in both at the end of the treatment. In January 2024, after the second month of esketamine use, the patient already had a substantial clinical response, with stability of the condition and important functional improvement.

The patient fully complied with the intranasal esketamine protocol and, at the end of treatment, was clinically stable, with no need to restart the medication. Currently, he remains under regular psychiatric follow-up, using tranylcypromine (60 mg/day), with periodic clinical monitoring to assess the maintenance of the therapeutic response.

3 DISCUSSION

This case report highlights the efficacy of intranasal esketamine as part of a combination therapeutic strategy in the management of treatment-resistant depressive disorder (RDT), particularly in a context of high suicide risk. The association with tranylcypromine proved to be a promising alternative, possibly due to the synergistic effect between the modulation of the glutamatergic system promoted by esketamine and the increase in the levels of monoaminergic neurotransmitters resulting from the inhibition of monoamine oxidase.⁹

The efficacy and safety of intranasal esketamine have already been demonstrated in randomized controlled trials, such as the ASPIRE I and II studies, which evaluated patients with resistant depression associated with acute suicidal ideation. These studies showed a significant reduction in depression scores in the first 24 hours after administration, in addition to a favorable tolerability profile ^{6,10}. Recent systematic reviews reinforce these findings, highlighting the rapid antidepressant action of esketamine when compared to conventional antidepressants, especially as an adjuvant therapy in cases of RDT ¹¹.

On the other hand, monoamine oxidase inhibitors, although currently less used due to dietary restrictions and the potential for drug interactions, remain a relevant therapeutic option

in severe and refractory depressive conditions. The combination of intranasal esketamine with MAOIs, such as tranylcypromine, is still little explored in the literature, especially in controlled studies, which makes the present report clinically relevant. In this case, the association was well tolerated and was not associated with serious adverse events, possibly due to the rigorous clinical monitoring and multidisciplinary approach adopted.

The observed clinical response reinforces the importance of therapeutic individualization in patients with RDT, especially in those who do not have a satisfactory response to conventional strategies. In complex clinical scenarios, such as the one described, combined approaches can be fundamental to achieve symptomatic remission and suicide risk reduction, expanding the therapeutic possibilities available for the management of RDT.

4 CONCLUSION

The association of intranasal esketamine with tranylcypromine proved to be effective in the management of a case of severe treatment-resistant depressive disorder (RDT) in a patient with a history of refractoriness to multiple therapeutic approaches. Significant clinical improvement in depressive and anxious symptoms was observed, as well as a substantial reduction in suicidal risk. Although still little explored in the literature, the pharmacological combination was well tolerated in this case, with no occurrence of relevant adverse events, reinforcing its clinical viability when conducted under close monitoring.

This report highlights the importance of combined and individualized therapeutic strategies in the management of RDT, especially in complex clinical contexts, in which conventional approaches alone are insufficient. Continuous follow-up and periodic reassessment of the need to maintain treatment remain essential to sustain the clinical benefits achieved.

REFERENCES

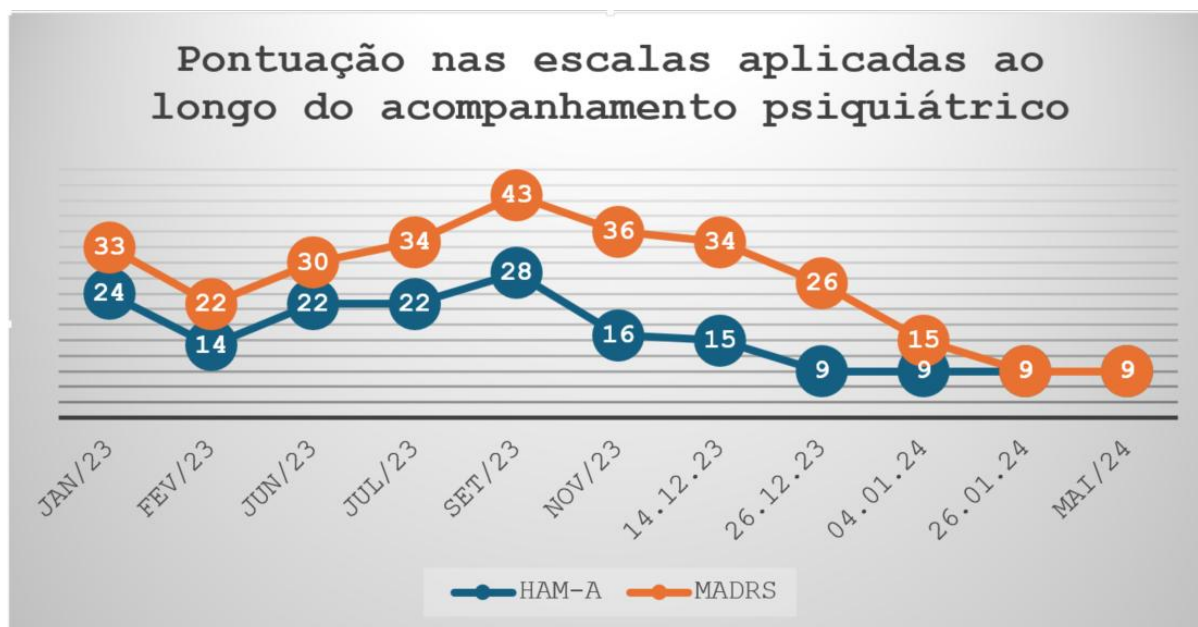
- Gonçalves, W. S., Lassen, R. D. H., Appolinario, J. C., & Nardi, A. E. (2022). Diagnóstico e estratégias terapêuticas na depressão resistente ao tratamento. *Med Cienc Arte*, 1(3), 94–104.
- Soares, B., Kanevsky, G., Teng, C. T., et al. (2021). Prevalence and impact of treatment-resistant depression in Latin America: A prospective observational study. *Psychiatric Quarterly*, 92(4), 1797–1815. <https://doi.org/10.1007/s11126-021-09930-x>
- Zaki, N., Chen, C., Lane, R., et al. (2023). Long-term safety and maintenance of response with esketamine nasal spray in participants with treatment-resistant depression: Interim results of the SUSTAIN-3 study. *Neuropsychopharmacology*, 48, 1–9. <https://doi.org/10.1038/s41386-023-01577-4>

- Patarroyo-Rodriguez, L., Pazdernik, V. K., Vande Voort, J. L., Kung, S., Frye, M. A., & Singh, B. (2025). Ketamine reduces suicidality-associated emergency department utilization in patients with treatment-resistant depression: A 6-month mirror-image study. *Journal of Clinical Psychiatry*, 86(4), 25m15941. <https://doi.org/10.4088/JCP.25m15941>
- Martinotti, G., Chiappini, S., Pettorruso, M., et al. (2022). Real-world experience of esketamine use to manage treatment-resistant depression: A multicenter study on safety and effectiveness (REAL-ESK). *Journal of Affective Disorders*, 319, 646–654. <https://doi.org/10.1016/j.jad.2022.09.061>
- Fu, D. J., Ionescu, D. F., Li, X., et al. (2020). Esketamine nasal spray for rapid reduction of major depressive disorder symptoms in patients with active suicidal ideation with intent: A randomized, double-blind study (ASPIRE I). *Journal of Clinical Psychiatry*, 81(3), 19m13191. <https://doi.org/10.4088/JCP.19m13191>
- Thase, M. E. (2012). The role of monoamine oxidase inhibitors in depression treatment guidelines. *Journal of Clinical Psychiatry*, 73(Suppl 1), 10–16. <https://doi.org/10.4088/JCP.11096su1c.02>
- Ricken, R., Ulrich, S., Schlattmann, P., & Adli, M. (2017). Tranylcypromine revisited (Part II): A systematic review and meta-analysis of controlled studies in depression. *European Neuropsychopharmacology*, 27(8), 714–731. <https://doi.org/10.1016/j.euroneuro.2017.04.003>
- Santos, J. M. L., Couto, H. L. O., & Monteiro, D. C. (2022). Monoamine oxidase inhibitors and ketamine: A safe association? *Debates em Psiquiatria*, 12, 1–20. <https://doi.org/10.25118/2763-9037.2022.v>
- Canuso, C. M., Singh, J. B., Fedgchin, M., et al. (2018). Efficacy and safety of intranasal esketamine for the rapid reduction of depressive symptoms and suicidality in patients at imminent risk for suicide: A randomized, double-blind, placebo-controlled study. *American Journal of Psychiatry*, 175(7), 620–630. <https://doi.org/10.1176/appi.ajp.2018.17060720>
- Floriano, I., Silvinato, A., & Bernardo, W. M. (2023). Esketamine in the treatment of patients with antidepressant-resistant depression: A systematic review and meta-analysis. *Revista da Associação Médica Brasileira*, 69(6), e2023D696. <https://doi.org/10.1590/1806-9282.2023D696>

ANNEX

Figure 1

Longitudinal evolution of Hamilton Anxiety Rating Scale (HAM-A) and Montgomery–Åsberg Depression Rating Scale (MADRS) scores during combination treatment with tranylcypromine and intranasal esketamine



Source: Authors.

THE CONVERGENCE OF BEAUTY: AN ANALYTICAL AND FRACTAL APPROACH TO THE SANGAKU CHAIN OF CIRCLES

A CONVERGÊNCIA DA BELEZA: UMA ABORDAGEM ANALÍTICA E FRACTAL DA CADEIA DE CÍRCULOS DE SANGAKU

LA CONVERGENCIA DE LA BELLEZA: UN ENFOQUE ANALÍTICO Y FRACTAL DE LA CADENA DE CÍRCULOS DE SANGAKU



<https://doi.org/10.56238/sevened2026.008-240>

Fábio Henrique Marinho Cabral¹

ABSTRACT

Considering the aesthetic and technical problem of the "Chain of Circles in an Acute Angle," recurring in the Japanese Sangaku tradition, and the need for didactic resources that connect synthetic geometry to the rigor of infinite series to overcome curricular fragmentation, it aims to analytically demonstrate the convergence of the total area occupied by this infinite succession of tangent circles, reducing the visual complexity of the problem to an elegant trigonometric solution. To this end, we proceed to an exploratory theoretical research, grounded in the deductive method and geometric modeling. In this way, it is observed that, through the identification of similarity properties and the application of geometric series summation, the total area results in a finite function strictly dependent on the initial radius and the opening angle. Which allows us to conclude that the beauty of the solution lies in the economy of the mathematical argument, reaffirming the effectiveness of synthetic geometry in simplifying iterative phenomena and providing a solid foundation for pedagogical practices aimed at integrating limits and plane geometry.

Keywords: Synthetic Geometry. Geometric Series. Mathematical Elegance. Mathematics Education. Convergence.

RESUMO

Considerando o problema estético e técnico da "Cadeia de Círculos em Ângulo Agudo", recorrente na tradição dos Sangakus japoneses, e a necessidade de recursos didáticos que conectem a geometria sintética ao rigor das séries infinitas para superar a fragmentação curricular, objetiva-se demonstrar analiticamente a convergência da área total ocupada por essa sucessão infinita de círculos tangentes, reduzindo a complexidade visual do problema a uma solução trigonométrica elegante. Para tanto, procede-se a uma pesquisa teórica de natureza exploratória, fundamentada no método dedutivo e na modelagem geométrica. Desse modo, observa-se que, através da identificação de propriedades de semelhança e da aplicação do somatório de séries, a área total resulta em uma função finita dependente estritamente do raio inicial e do ângulo de abertura. O que permite concluir que a beleza da solução reside na economia do argumento matemático, reafirmando a eficácia da geometria

¹ Master's degree in Mathematics. Instituto Federal do Pará (IFPA). E-mail: fabio.cabral@ifpa.edu.br

sintética na simplificação de fenômenos iterativos e oferecendo uma base sólida para práticas pedagógicas que visam a integração de limites e geometria plana.

Palavras-chave: Geometria Sintética. Séries Geométricas. Elegância Matemática. Educação Matemática. Convergência.

RESUMEN

Considerando el problema estético y técnico de la "Cadena de Círculos en Ángulo Agudo", recurrente en la tradición de los Sangakus japoneses, y la necesidad de recursos didácticos que conecten la geometría sintética con el rigor de las series infinitas para superar la fragmentación curricular, tiene como finalidad demostrar analíticamente la convergencia del área total ocupada por esta sucesión infinita de círculos tangentes, reduciendo la complejidad visual del problema a una solución trigonométrica elegante. Para ello se procede a una investigación teórica de naturaleza exploratoria, fundamentada en el método deductivo y en el modelado geométrico. De esta manera se observa que, a través de la identificación de propiedades de semejanza y la aplicación de la suma de series geométricas, el área total resulta en una función finita que depende estrictamente del radio inicial y del ángulo de apertura. Lo que permite concluir que la belleza de la solución reside en la economía del argumento matemático, reafirmando la eficacia de la geometría sintética en la simplificación de fenómenos iterativos y ofreciendo una base sólida para prácticas pedagógicas que busquen la integración de límites y geometría plana.

Palabras clave: Geometría Sintética. Series Geométricas. Elegancia Matemática. Educación Matemática. Convergencia.

1 INTRODUCTION

Mathematics is often described by G. H. Hardy (1940) as a creative art, where beauty lies in inevitability and the economy of arguments. For the author, mathematical patterns, as well as those of a painter or poet, must have an intrinsic harmony where there is no place for the superfluous. In the context of Olympic competitions and higher education, problems involving infinite iterative processes such as fractals and pavements tend to be enchanting precisely because of this dichotomy between the apparent complexity of the figure and the elegant simplicity of the final answer.

Historically, classical geometry found in Japanese sangakus (wooden votive tablets with geometric challenges) fertile ground for the exploration of tangency and inscription properties. Among these problems, the configuration of circles successively inscribed at an acute angle stands out as a classic example of "trapped infinity" in a finite, bounded region. While visualizing an infinite sequence of tangent circles may suggest unattainable complexity, the application of synthetic geometry and series analysis tools reveals a surprisingly regular recurrence structure.

The fascination with infinite sequences inserted in finite geometric contexts is not a modern concern, finding roots in Greek antiquity with Archimedes' method of exhaustion, as Sá (2011) tells us. However, the specific aesthetics of the "Chain of Circles" refer to the visual rigor of the Japanese mathematicians of the Edo period, who saw geometry as a form of intellectual devotion. As Fukagawa and Rothman (2008) point out, Sangaku's problems often challenged the observer to find complex tangency relations that, under careful analysis, revealed golden ratio properties or harmonic progressions. This tradition emphasizes that problem solving is primarily an exercise in perceiving patterns that transcend the mere application of formulas.

Additionally, the iterative nature of this problem allows a direct connection with the concept of self-similarity, a fundamental characteristic of fractal objects. In the contemporary scenario, the use of dynamic geometry software, such as GeoGebra, allows properties previously restricted to the abstract field to be empirically explored, allowing the invariance of the ratio between the radii to be verified in real time. This modern approach does not invalidate synthetic rigor, but complements it by offering a new layer of visual interpretation that reinforces the perception of the mathematical order in structures that grow or shrink indefinitely.

In addition to the historical and technological aspect, the analysis of the total area occupied by this succession of circles offers a unique pedagogical opportunity to discuss the transversality between Plane Geometry and Differential and Integral Calculus. In higher

education, the transition from discrete to continuous is one of the most significant conceptual hurdles for students. According to Simmons (2016), the visualization of infinite series through tangible geometric models helps in the understanding of convergence, transforming the abstract concept of limit into a visible spatial reality. By observing that the sum of the areas of infinite circles does not result in an infinite value, but rather in an exact fraction of the total area of the angular sector, the student consolidates the notion of the sum of a geometric series in an intuitive way.

In this context, the central question of this research arises: How can the transition between geometric visual perception and algebraic modeling of infinite series simplify the determination of the total area occupied by a chain of tangent circles at an acute angle? The justification for this study lies in the need for didactic materials that bridge the gap between the Plane Geometry of advanced High School and the formal rigor of Real Analysis. By exploring what we call the "Trumpet of Circles", the work offers undergraduate students and Olympiad enthusiasts an integrated view of mathematics, where algebra is not just a calculation tool, but the means by which the intrinsic harmony of a geometric form is revealed.

Finally, the relevance of this study is anchored in the concept of "elegant proof", defined by Aigner and Ziegler (2018) as one that achieves the result with the minimum of structural effort and the maximum of logical clarity. In the case of the "Trumpet of Circles", the solution that uses the similarity of triangles to deduce the ratio of the progression avoids the unnecessary use of complex Cartesian coordinates, favoring synthetic geometry. This economy of thought not only facilitates the solution, but educates the researcher's eye to seek simplicity in apparently fractal problems, reinforcing that analytical efficiency is one of the pillars of excellence in Olympic and academic mathematics.

The general objective of this work is to investigate the properties of analytic convergence and the aesthetics of the "Chain of Circles at Acute Angle", establishing a mathematical model that integrates classical Japanese geometry and the analysis of infinite series. To achieve this, the following specific objectives are outlined:

- a) Analytically demonstrate the ratio of similarity between the radii of consecutive circles inscribed at an acute angle 2θ , establishing the law of sequence formation;
- b) Model the sum of the areas of the infinite chain as a convergent geometric series, proving that the total area is a function dependent exclusively on the initial radius r_1 and angle θ ;
- c) Evaluate the mathematical "argument economy" by comparing the visual complexity of the figure with the simplicity of the final trigonometric solution, discussing its potential as a resource for teaching limits and progressions.

2 THEORETICAL FRAMEWORK

Classical Japanese geometry, manifested in the Sangakus, offers a vast repertoire of problems involving tangent circles and polygons inscribed in complex shapes. Unlike the Western Euclidean tradition, which prioritized axiomatic logical deduction, the mathematics of the Edo period emphasized visual harmony and intellectual challenge. Fukagawa and Rothman (2008) point out that these problems were not mere exercises, but forms of devotion that revealed profound properties of proportion and symmetry. In the case of the chain of circles at an acute angle, beauty lies in the infinite repetition of the same shape that decreases in scale, but maintains the same tangency relationship with the lines that define the angle.

From the perspective of contemporary Mathematics Education, the use of these historical problems is aligned with the Methodology of Teaching-Learning of Mathematics through Problem Solving (MEAMRP). Onuchic and Allevato (2011) argue that the problem should be the starting point for the construction of new concepts, and not just an application of formulas. When facing the "Trumpet of Circles", the student is challenged to investigate properties before formalizing the content of grades, which, according to the authors, generates learning with greater meaning and depth.

The analysis of the total area occupied by an infinite sequence of objects requires the transition from discrete geometric thinking to the rigor of real analysis. According to Simmons (2016), the use of tangible geometric models is essential for the student to understand that a sum of infinite plots can result in a finite and exact value. The convergence of a geometric series is guaranteed when the ratio between consecutive terms obeys the interval $q - 1 < q < 1$. In the proposed problem, the ratio is derived from the trigonometric properties of the opening angle, allowing the fractal complexity of the figure to be reduced to an elegant algebraic formula.

In this context, the proposed mathematical research assumes an exploratory character. Ponte (2014) argues that research work in the classroom allows the student to act as a mathematician, formulating conjectures and testing validities. For the author, this practice is essential in higher education and teacher training, as it shifts the focus from "know-how" to "understanding why", allowing the elegance of the solution to be perceived as part of investigative rigor.

The concept of "elegant proof" is central to the evaluation of the quality of a mathematical argument. For Aigner and Ziegler (2018), a demonstration is considered elegant when it achieves the result with logical clarity and minimal structural effort. This perspective is in line with Hardy's (1940) view, for whom mathematics should have an intrinsic

harmony where there is no room for the superfluous. Santos and Heidemann (2017) reinforce that aesthetics in mathematics is not an adornment, but a component of cognition itself; The simplicity of a trigonometric solution to a visually dense problem reduces cognitive load and broadens conceptual understanding.

The analysis of problems that integrate different areas of mathematics, such as plane geometry and infinitesimal calculus, is a fundamental strategy for the development of critical thinking. According to Simmons (2016), the fragmentation of knowledge prevents the student from perceiving mathematics as a single and cohesive body. Bairral (2019) observes that the integration of concepts, mediated by visual representations, is what allows the transition from empirical to formal reasoning. By introducing the "Chain of Circles", the teacher allows basic trigonometry concepts to become the key to understanding sequence limits.

Infinite tangency problems function as simplified models of fractal structures, where self-similarity is the dominant feature. As Pires (2010) points out, clarity in the exposition of the methodology is what guarantees the reliability of a study. In the context of this paper, modeling extends to understanding how a local geometric formation rule determines the global behavior of an infinite series. Although visual intuition is the starting point, formal rigor is indispensable. Aigner and Ziegler (2018) argue that the elegance of a demonstration lies in its ability to be understood without the aid of excessively dense algebraic artifices. In the case of the "Trumpet of Circles", the preference for synthetic geometry reinforces economy of thought and logical clarity.

The transition from the discrete concept of the sum of areas to the continuous concept of limit is one of the most challenging points of Higher Education. Simmons (2016) argues that the spatial visualization of series helps to consolidate this notion. By demonstrating that the total area occupied by the circles is an exact and finite fraction of the area of the angular sector, the work offers empirical proof of convergence. Returning to Hardy's philosophy (1940), mathematical inquiry should be seen as a creative activity similar to art, where "beauty" is the final criterion of truth. Understanding this harmony is what differentiates the act of calculating from the act of doing mathematics, elevating the resolution of a problem to the status of production of scientific knowledge.

The use of visual resources and semiotic representations in the teaching of geometry is defended by authors such as Arcavi (2003), who defines visualization as the ability to interpret and articulate images and diagrams to facilitate the understanding of abstract concepts. In the case of the chain of circles, the transition from visual perception of tangency to algebraic representation of ratio is q not just a technical step, but a process of "seeing" the geometric invariance behind the change in scale. This mathematical visualization skill is

essential for the student to be able to anticipate the convergence of the grade even before performing the formal calculations, strengthening geometric intuition.

In addition, the insertion of the historical dimension, through the Sangakus, acts as a humanizing element of mathematics. According to Miguel and Miorim (2011), the history of mathematics should not be seen as an isolated curiosity, but as a "laboratory" of problems that reveals different forms of rationality. By confronting the student with the problems of feudal Japan, mathematics is removed from the field of immediate pragmatism and placed in the field of culture and aesthetics. This displacement favors cognitive engagement, as the problem ceases to be a textbook exercise to become a historical enigma to be deciphered from the perspective of modernity.

Finally, the problem of the sum of the areas of the "Trumpet of Circles" touches on one of the most fertile paradoxes of the discipline: the coexistence between the discrete (individual circles) and the continuum (the total area of the sector). Healy (2015) points out that the challenge of converting iterative processes into general laws is the basis of advanced algebraic thinking. By demonstrating that a sum of infinite terms can be encapsulated in a finite trigonometric function, the paper provides an intuitive counterexample to the fallacy that infinity is always "unreachable." This discussion is vital to demystify the concept of limit and prepare the ground for Differential Calculus, where the understanding of infinitesimal sums is the structuring pillar.

3 METHODOLOGY

The methodology applied in this work outlines the procedures used to conduct the mathematical investigation, ensuring the necessary transparency for the replicability and reliability of the results. The study is characterized as a theoretical and exploratory research, based on the deductive method, with the objective of converting a geometric configuration into an analytical model of convergence.

The research adopts a qualitative and analytical approach, focused on problem-solving and mathematical modeling. According to Pires (2010), relational coherence should start with the justification of the problem and then detail the methods used. In this way, the study starts from the geometric configuration of an infinite chain of circles to build a proof based on properties of similarity and series.

The data analysis procedures were divided into three main stages:

- a) Synthetic Geometric Analysis: identification of the properties of tangency and construction of auxiliary right triangles to relate the consecutive (r_n e r_{n+1}) radii to the 2θ opening angle;

- b) Algebraic Modeling: application of the rigor of Euclidean geometry to the establishment of a law of recurrent formation, defining the ratio q of geometric progression;
- c) Analytical Synthesis: use of the sum of infinite series to determine the total area, evaluating the convergence of the model with the area of the angular sector.

The analysis of the results is based on the criterion of mathematical "argument economy", as defined by Aigner and Ziegler (2018). The limitations of the study are restricted to cases of acute angles ($2\theta < 90^\circ$), ensuring that the sequence of internal tangent circles is perfectly defined and that the resulting series is convergent.

4 RESULTS AND DISCUSSIONS

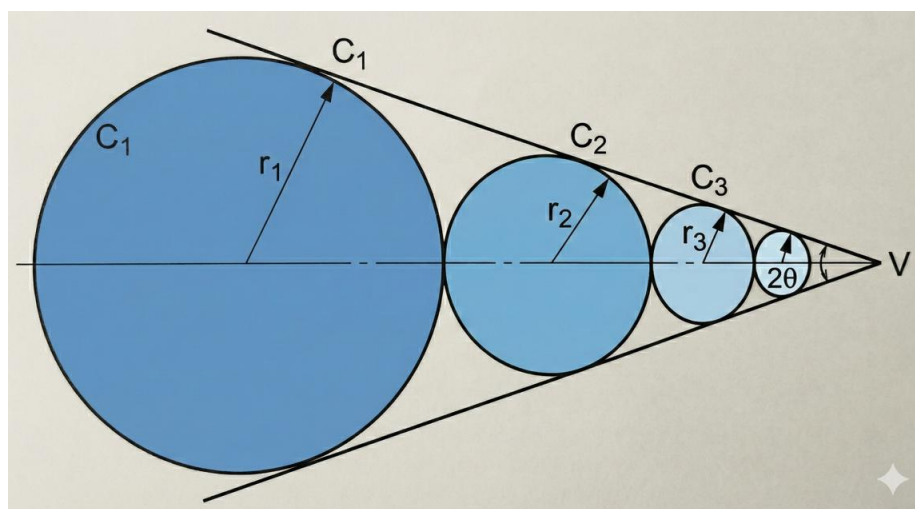
The results obtained reveal that the visual complexity of the "Trumpet of Circles" can be reduced to a geometric progression whose ratio depends strictly on the opening of the angle. Next, the analytical deduction and the discussion of its implications are presented.

4.1 DEDUCTION OF THE SIMILARITY RATIO

Consider an acute opening angle 2θ with vertex at the origin V . Let C_1 the first circle of radius r_1 and center O_1 , and C_2 the second circle of radius r_2 and center O_2 , both tangent to the semi-lines that form the angle and tangent to each other. The process repeats infinitely, generating a sequence $\{C_n\}$ of circles tangent to the sides and to the previous circle, decreasing towards the vertex of the angle as shown in Figure 1.

Figure 1

Geometric visualization of the problem



Source: Prepared by the author.

4.1.1 Initial approach

A student accustomed only to Cartesian analytic geometry would try to position the vertex at the origin $(0,0)$ and the bisector on the axis x . He would search for centers and $(x_n, 0)$ solve systems of quadratic equations based on the distance between centers.

$$(x_n - x_{n+1})^2 = (r_n + r_{n+1})^2 \quad (1)$$

Along with the trigonometric relation $r_n = x_n \sin(\theta)$. Although correct, this path generates dense algebraic manipulations that obscure the geometric "soul" of the problem, making the solution visually "ugly" and prone to miscalculations.

4.1.2 The elegant solution

Beauty emerges when we observe the self-similarity of the figure. We can solve the problem by focusing on the homothetic relationship.

4.1.2.1 The Homothetia Ratio (q)

Consider three points aligned in the bisector: the vertex V , the center O_n of and C_n the center O_{n+1} of C_{n+1} . By the geometry of the right triangle formed by the center, the point of tangency and the vertex, we have:

$$\sin(\theta) = \frac{r_n}{d_n} \quad (2)$$

Where d_n is the distance from the vertex to the center O_n .

The distance between the centers is the sum of the rays:

$$d_n - d_{n+1} = r_n + r_{n+1} \quad (3)$$

Substituting $d_n = \frac{r_n}{\sin(\theta)}$ and $d_{n+1} = \frac{r_{n+1}}{\sin(\theta)}$ in (3), we have

$$\frac{r_n}{\sin(\theta)} - \frac{r_{n+1}}{\sin(\theta)} = r_n + r_{n+1} \quad (4)$$

$$r_n - r_{n+1} = (r_n + r_{n+1}) \sin(\theta) \quad (5)$$

Reordering to isolate reason $q = \frac{r_{n+1}}{r_n}$, we get:

$$r_{n+1}(1 + \sin(\theta)) = r_n(1 - \sin(\theta)) \quad (6)$$

$$q = \frac{1 - \sin(\theta)}{1 + \sin(\theta)} \quad (7)$$

We thus conclude that the ratio q is purely trigonometric and constant. This proves that the rays form a Geometric Progression (P.G.).

4.2 THE CALCULATION OF THE TOTAL AREA

As the rays form a P.G. of q ratio, the areas $A_n = \pi R_n^2$ form a P.G. q^2 of ratio. Given that $0 < \theta < \frac{\pi}{2}$, we have $0 < \sin(\theta) < 1$, therefore, guaranteeing the convergence of the series. $0 < q < 1$ The total area S of the infinite chain is the sum:

$$S = \sum_{n=1}^{\infty} \pi r_n^2 = \pi r_1^2 + \pi(r_1 q)^2 + \pi(r_1 q^2)^2 + \dots \quad (8)$$

$$S = \pi r_1^2(1 + q^2 + q^4 + \dots) = \pi r_1^2 \left(\frac{1}{1 - q^2} \right) \quad (9)$$

Substituting $q = \frac{1 - \sin(\theta)}{1 + \sin(\theta)}$ (where $k := \sin(\theta)$), we have

$$1 - q^2 = \left(\frac{1 - k}{1 + k} \right)^2 = \frac{(1 + k)^2 - (1 - k)^2}{(1 + k)^2} = \frac{4k}{(1 + k)^2} \quad (10)$$

Thus, the final simplified solution expresses the total area only in terms of the initial radius and angle:

$$S = \frac{\pi r_1^2 (1 + \sin(\theta))^2}{4 \sin(\theta)} \quad (11)$$

4.3 BEHAVIOR ANALYSIS AND THE PARADOX OF INFINITY

From the result of the S Area of equation (11), we can analyze its behavior at its extreme limits. This analysis reveals how our geometric intuition can fail to deal with infinity.

If we imagine the opening angle approaching π (In other words, $\theta \rightarrow \frac{\pi}{2}$), the "walls" of our angle become almost parallel horizontal straight. Mathematically, $\sin \theta = 1$.

Substituting in the formula, the total S area tends exactly to $2r_1$. This makes perfect geometric sense: with flat walls tangential to the first circle, there is no oblique space for a second circle to exist, the q ratio tends to zero, and the chain of circles "dies" in the first element.

On the other hand, what happens if the angle becomes extremely acute, like the tip of an infinitesimal needle ($\theta \rightarrow 0^\circ$)? In this case, $\sin \theta = 0$. As we have θ in the denominator of our formula, the value S of explodes to infinity ($2r_1$). If we keep the radius fixed, the vertex of the angle will be pushed infinitely away. The ratio of the q radii will approach , meaning that the circles will decrease in size incredibly slowly, and the sum of their areas will diverge.

And what happens with any fixed acute angle (for example, $\theta = \frac{\pi}{6}$)? We have literally an infinite amount of circles being drawn one after the other. For a layman, the sum of infinite positive areas should necessarily result in an infinite area. However, our solution proves that the sum is perfectly finite and exact. This cognitive shock, that is, infinity fitting within the finite, is one of the most beautiful concepts in mathematics.

The interpretation of the result (7) in the light of Hardy's literature (1940) confirms the hypothesis of "economy of arguments". The transition from an infinite sum to a finite trigonometric expression illustrates the power of mathematical modeling in simplifying seemingly fractal phenomena.

The self-similar nature of the chain of circles allows for an in-depth discussion of the concept of fractals in higher education. As noted by Bairral (2019), the recognition of patterns that repeat at different scales is an essential skill for the development of advanced geometric reasoning. In the problem in question, the invariance of the q ratio (equation 7) works as a fractal generator that maintains the proportion between the terms of the series, transforming the figure into an object of study that unites the rigidity of Euclidean geometry with the fluidity of contemporary fractal objects. This perspective reinforces Santos and Heidemann's (2017) argument about mathematical aesthetics, where beauty is perceived in the intrinsic order that governs the infinite growth of forms

In addition, the transition between visual intuition and formal proof is strengthened when mediated by dynamic geometry environments. According to Healy (2015), the manipulation of parameters in real time allows the student to carry out "mathematical investigations", as proposed by Ponte (2014), validating the convergence of the series empirically before its algebraic deduction. By observing that, regardless of the scale, the tangency relationship remains unchanged, the researcher consolidates the understanding of continuity and limit, overcoming the fragmentation of knowledge criticized by Simmons (2016). Thus, the "elegant proof" is no longer just a theoretical construct of Aigner and Ziegler (2018) to become a tangible and replicable cognitive reality.

Comparing with the findings of Fukagawa and Rothman (2008), it is observed that, while Sangaku's problems focused on the relationship between rays, this study expands the discussion to the convergence of areas, offering a solid basis for teaching practice. The divergence observed in similar problems that use Cartesian coordinates lies in the algebraic load; here, synthetic geometry allowed for an "elegant proof" (Aigner; Ziegler, 2018), reducing cognitive error and highlighting the harmony of form.

5 CONCLUSION

This work proposed to investigate the "Chain of Circles at Acute Angle", using it as an object of study to demonstrate the convergence between synthetic geometry and the analysis of infinite series. Throughout the development, it was possible to unveil the intrinsic harmony of the problem, transforming a visual configuration of fractal complexity into a mathematical model of remarkable simplicity.

The specific objectives were fully achieved. First, the analytic demonstration established that the ratio of similarity between the circles is an exclusive function of the sine of half the opening angle, consolidating a strict law of formation. Second, modeling the total area as a geometric series proved that, despite the infinite nature of succession, spatial occupation is finite and predictable, dependent only on the r_1 initial radius and θ angle. Finally, the evaluation of the "argument economy" confirmed that the synthetic approach offers a pedagogical clarity superior to the exhaustive algebraic manipulations of Cartesian analytic geometry.

Furthermore, the integration of historical perspectives, such as the Sangakus, with contemporary technological tools of dynamic geometry, reaffirms the perenniality of geometric challenges as engines of educational innovation. By overcoming the barrier between empirical-visual reasoning and algorithmic formalization, this study demonstrated that mathematical investigation, when mediated by the search for elegance, is capable of mitigating the fragmentation of knowledge between basic and higher education. Therefore, the "Trumpet of Circles" does not end in itself as a theoretical curiosity, but is projected as a replicable model of investigation that values mathematical visualization and analytical rigor as inseparable skills in the formation of critical and up-to-date scientific thinking.

The contributions of this study extend beyond the resolution of a classical geometry problem. The article offers teachers and students a didactic resource that exemplifies the "elegant proof", encouraging the search for aesthetics and precision in mathematical investigation. As a fundamental conclusion, it is reiterated that beauty in mathematics, as

advocated by Hardy, is not a subjective attribute, but the manifestation of the logical inevitability and structural efficiency of an argument.

ACKNOWLEDGMENTS

I would like to thank the Federal Institute of Pará – Abaetetuba Campus for the institutional support and for financing the costs of publishing this article in a qualis journal. The institution's incentive was fundamental for the realization of this research and for the dissemination of the results to the academic community. I also recognize the contribution of colleagues and students who, directly or indirectly, collaborated in the development of the ideas presented here, strengthening the collective commitment to excellence in Mathematics Education.

REFERENCES

- Aigner, M., & Ziegler, G. M. (2018). *Proofs from THE BOOK* (6ª ed.). Springer.
- Arcavi, A. (2003). The role of visualization in the learning and teaching of mathematics. *Educational Studies in Mathematics*, 52(3), 215–241.
- Bairral, M. A. (2019). *Práticas de geometria com tecnologias digitais*. Edur.
- Fukagawa, H., & Rothman, T. (2008). *Sacred mathematics: Japanese temple geometry*. Princeton University Press.
- Hardy, G. H. (1940). *A mathematician's apology*. Cambridge University Press.
- Healy, L. (2015). Geometria e tecnologias digitais: Reflexões sobre o aprendizado e o ensino. *Revista Eletrônica de Educação Matemática*, 10(1).
- Miguel, A., & Miorim, M. A. (2011). *História na educação matemática: Propostas e desafios* (2ª ed.). Autêntica.
- Onuchic, L. R., & Allevato, N. S. G. (2011). Pesquisa em resolução de problemas: Caminhos, avanços e novas perspectivas. *Bolema*, 25(41), 73–98.
- Pires, A. C. (2010). *Diretrizes para redação científica*. Editora Acadêmica.
- Ponte, J. P. (2014). *Investigação matemática na sala de aula* (3ª ed.). Autêntica.
- Sá, I. P. de. (2011). Arquimedes de Siracusa e o seu método da exaustão: Uma atividade didática para o cálculo de π . Universidade de Vassouras. Recuperado em 19 março, 2026, de <https://www.periodicos.capes.gov.br/index.php/acervo/buscaador.html?task=detalhes&source=all&id=W4240316652>
- Santos, J. P., & Heidemann, L. A. (2017). A estética e a elegância no ensino de ciências e matemática. *Revista Brasileira de Ensino de Ciência e Tecnologia*, 10(2).

Simmons, G. F. (2016). Cálculo com geometria analítica (Vol. 2). McGraw-Hill.

IMPACT OF TRANSFORMATIONAL LEADERSHIP ON SUSTAINABLE DEVELOPMENT OF NEPALESE HYDROPOWER INDUSTRY

IMPACTO DA LIDERANÇA TRANSFORMACIONAL NO DESENVOLVIMENTO SUSTENTÁVEL DA INDÚSTRIA HIDRELÉTRICA NEPALESA

IMPACTO DEL LIDERAZGO TRANSFORMACIONAL EN EL DESARROLLO SOSTENIBLE DE LA INDUSTRIA HIDROELÉCTRICA NEPALESA



<https://doi.org/10.56238/sevened2026.008-241>

Tulsi Ram Pandey¹, Khamphe Phoungthong², Kuaanan Techato³, Flávio de São Pedro Filho⁴, Paulo Roberto Meloni Monteiro Bressan⁵, Aírton Ribeiro dos Santos⁶, João Pedro de Souza Coelho⁷, Adjalma Campos de França Neto⁸, Rafael Ayres Romanholo⁹, Delson Fernando Barcellos Xavier¹⁰, Fabio Robson Casara Cavalcante¹¹, Fabrício Moraes de Almeida¹²

ABSTRACT

This investigation explores the connection between transformational leadership and sustainable growth in Nepalese hydropower companies. Utilizing a quantitative approach, data were collected from 200 employees across various Nepali hydropower businesses. The findings indicate a positive correlation between sustainable development practices and transformational leadership in these enterprises. Moreover, the research identifies corporate culture as a crucial mediating factor in this association. The study highlights that the impact of transformational leadership on sustainable development practices is more pronounced in the presence of a robust organizational culture. Conclusively, the research underscores that Nepalese hydropower companies can enhance their sustainable development methods by fostering an environment conducive to transformational leadership. This study represents a significant contribution to the field, emphasizing the pivotal role of organizational culture in amplifying the influence of transformational leadership on sustainable development practices within Nepalese hydropower enterprises.

¹ Faculty of Environmental Management. Prince of Songkla University. Thailand. Orcid: 0009-0003-5553-7390

² Faculty of Environmental Management. Prince of Songkla University. Thailand. Orcid: 0000-0003-4218-1439

³ Faculty of Environmental Management. Prince of Songkla University. Thailand. Orcid: 0000-0002-9178-8416

⁴ Master's degree in Administration. Universidade Federal de Rondônia (UFRO). Brazil.

Orcid: 0000-0002-0481-4189

⁵ Doctoral student. Universidad de La Frontera (PGDRA/UFRO).

⁶ Master student. Universidad de La Frontera (PGDRA/UFRO).

⁷ Doctoral student. Universidad de La Frontera (PGDRA/UFRO).

⁸ Dr. in Agronomy. Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP). Universidade Federal de Rondônia (UFRO).

⁹ Dr. in Regional Development and Environment. Instituto Federal de Rondônia (IFRO).

¹⁰ Dr. in City Law. Universidade Federal de Rondônia (UFRO).

¹¹ Dr. in Sciences: Socio-environmental Development. Universidade Federal de Rondônia (UFRO).

¹² Dr. in Physics. Universidade Federal do Ceará (UFC). Universidad de La Frontera (PGDRA/UFRO).

E-mail: dr.fabriciomoraes001@gmail.com Orcid: 0000-0003-4173-4636

Keywords: Organizational Culture. Transformational Leadership. Sustainable Development. Nepalese Hydropower Companies.

RESUMO

Esta investigação explora a relação entre a liderança transformacional e o crescimento sustentável em empresas hidrelétricas nepalesas. Utilizando uma abordagem quantitativa, foram coletados dados de 200 funcionários de diversas empresas hidrelétricas do Nepal. Os resultados indicam uma correlação positiva entre práticas de desenvolvimento sustentável e liderança transformacional nessas organizações. Além disso, a pesquisa identifica a cultura organizacional como um fator mediador crucial nessa relação. O estudo destaca que o impacto da liderança transformacional sobre as práticas de desenvolvimento sustentável é mais pronunciado na presença de uma cultura organizacional robusta. Em conclusão, a pesquisa ressalta que as empresas hidrelétricas nepalesas podem aprimorar seus métodos de desenvolvimento sustentável ao promover um ambiente favorável à liderança transformacional. Este estudo representa uma contribuição significativa para a área, enfatizando o papel fundamental da cultura organizacional na amplificação da influência da liderança transformacional sobre as práticas de desenvolvimento sustentável nas empresas hidrelétricas do Nepal.

Palavras-chave: Cultura Organizacional. Liderança Transformacional. Desenvolvimento Sustentável. Empresas Hidrelétricas Nepalesas.

RESUMEN

Esta investigación explora la relación entre el liderazgo transformacional y el crecimiento sostenible en las empresas hidroeléctricas nepalesas. Utilizando un enfoque cuantitativo, se recopilieron datos de 200 empleados de diversas empresas hidroeléctricas de Nepal. Los resultados indican una correlación positiva entre las prácticas de desarrollo sostenible y el liderazgo transformacional en estas organizaciones. Además, la investigación identifica la cultura organizacional como un factor mediador crucial en esta relación. El estudio destaca que el impacto del liderazgo transformacional en las prácticas de desarrollo sostenible es más pronunciado en presencia de una cultura organizacional sólida. En conclusión, la investigación subraya que las empresas hidroeléctricas nepalesas pueden mejorar sus métodos de desarrollo sostenible fomentando un entorno propicio para el liderazgo transformacional. Este estudio representa una contribución significativa al campo, destacando el papel fundamental de la cultura organizacional en la amplificación de la influencia del liderazgo transformacional sobre las prácticas de desarrollo sostenible en las empresas hidroeléctricas de Nepal.

Palabras clave: Cultura Organizacional. Liderazgo Transformacional. Desarrollo Sostenible. Empresas Hidroeléctricas Nepalesas.

1 INTRODUCTION

Since 1990, Nepal has established several mini hydropower projects (micro schemes), the majority of which have capacities under 100 kW. Moreover, it built a few medium-sized hydroelectric plants, several of which are now being planned or built. Only one large-scale project, the 144 MW Kaligandaki, has been completed so far, and several others, including the Upper Tamakoshi, are still under construction (456 MW). Large-scale plans are not yet in place, but serious conversations are underway. Academic institutions, training facilities, and growing numbers of international universities all contribute to the pool of trained human resources. The NEA already has a substantial pool of 10,000 employees working in the industry.

Multi-criteria analysis is particularly intriguing because there are varied viewpoints on the use of hydropower and existing programs in Nepal. As said to a limited extent 1.0, we are depicting different hydropower sizes according to nine alternate points of view: specialized, social, ecological, monetary, monetary, venture, engineer's, political, and risk. Talking, medium hydropower is the most reasonable scale; however, the latest thing focuses on an inclination for enormous scope projects soon. On an inclination request premise, pretty much nothing and miniature size plans precede medium and enormous scope methodologies, however the other way around.

Little plans are effectively acknowledged according to a social viewpoint, while enormous frameworks are not. This minuscule generator miniature plans just proposition a humble level of power inclusion. Due to the current social limit and the sizeable amount of force commitment expected to cover bigger than that from miniature plans, little hydro projects have all the earmarks of being a promising speculation. Medium-scale projects appear to be the most suited given increased power generation and improved coverage capabilities, and similar trends are currently being seen for large projects as well. The major purpose of these projects is to export electricity to neighboring nations; as a result, they do not contribute to the country's overall electrification coverage.

Large activities check out from a monetary viewpoint while considering the prompt energy expected to help the public economy as well as the fundamental as well as optional financial prizes and assets available. Big projects might be desired in the long run, although they are now least preferred due to energy export and their minimal economic impact on the country. Small- and medium-sized hydropower is appealing and preferred in turn. Because of their relatively high costs and modest power output, microsystems have a limited impact.

Sedimentation, floods, environmental change, avalanches, and waterway progression are a portion of the ecological issues in the Nepalese setting from a natural point of view.

From an environmental standpoint, Nepal seems to be the greatest place for modest hydro projects. Micro schemes rank second best. Medium plans are recommended, but only when further environmental precautions are taken. Large plants are the least preferred in the current situation, even though larger plans are less preferred.

Politics, including government interest in plans, programs, strategies, and goals, currently appears to be quite ambitious, and the government is searching for a speedy solution to the energy problems. The development of decentralized energy for access is still encouraged by the government, although major projects like Upper Tamakoshi (656 MW), Budhigandaki (600 MW), and Nausyalgad have lately drawn attention. So, given the current need for energy and following government guidelines, large-scale plans are preferable to medium-scale power plants. Even if the government wants to implement big plans, they won't take precedence until later. Micro and small-scale energy solutions are undoubtedly not the best way to address urgent energy needs, but legislative support for micro-energy access plans for remote areas is preferred over tiny plans.

Because of political disturbances before, financial backers were hesitant to face critical gambling challenges from an effective money management viewpoint. However, due to declining costs for electro-mechanical hardware, earlier certainty, and the new improvement in the political environment, engineers' inclinations are slowly moving towards medium and huge-scope projects. In any case, most engineers are worried about time or cost overwhelms, which keeps their advantage in small and medium-sized projects. Gigantic forthright expenses, an extended incubation time, and vulnerabilities deflect designers from undertaking aggressive and far-reaching plans. Because of various impediments joined with an absence of information, Nepalese engineers are most intrigued by unobtrusive and medium-sized plans. While massive systems are beyond their consideration, developers are not interested in micro schemes. If the right financial engineering is developed, the country's financial resources might cover a sizable funding requirement. Big-scale plans seem least likely to succeed given the resources at hand and the willingness of finance partners. Big initiatives are now ranked lowest because they cannot be implemented with in-country financing and a half. Even though there is support for awards and appropriations, miniature plans are not interesting to private financial backers.

A crucial viewpoint is country preparedness. A key component of water assets, which also include agriculture, ranger services, the tourist sector, and other assets, is the hydropower industry. To guarantee legitimate advantages from water assets and hydropower, broad arrangement and examination are required. Support foundation is additionally significant for the development of the hydropower business. However, large

projects would likely demand electricity send-out agreements with India as requirements, and the country isn't prepared to check. Yet, major plans via careful organizing may be taken into consideration. The nation is in an ideal situation to acquire little and medium-sized projects, trailed by micro-projects. By its actual nature, hydropower is loaded with risk and vulnerability. Timetable and cost invades are incredibly normal, and they commonly deteriorate as tasks get greater. The most uninclined plan will be hugely trailed by enormous size, one can find while considering all dangers that are pertinent to the Nepalese hydropower business. The most reasonable arrangement seems, by all accounts, to be for the development of little hydropower, and medium hydropower will be tantamount. Miniature plans are similarly less perilous, even though they fall behind medium and small as far as hazard power and issues gathering cash from oppressed regions.

Hydropower companies play a significant role in Nepal in promoting sustainable development and supplying the country with clean energy. To be socially, environmentally, and commercially sustainable, these enterprises must, nevertheless, overcome several challenges. In response to these challenges, transformational leadership has gained increased significance in promoting sustainable growth and improving organizational performance. Transformational leaders are those who inspire and motivate others, foster innovation and creativity, and support a culture of ongoing learning and development. By implementing transformational leadership techniques, hydropower companies in Nepal may improve employee satisfaction and retention, encourage a more sustainable work environment, and bolster their reputation. A few studies have found that value-based leadership does not improve performance as much as transformational leadership [1]. Another research [2] found that, in addition to having a significant influence on individual performance, transformational leadership style also has a significant impact on organizational performance. The current review's goal is to more thoroughly assess the actual impact of transformational leadership training on the organizational performance of the Nepali hydropower sector.

Ensuring the success of the company's personnel is the primary goal of human resources. People collaborate across the organization to accomplish both individual and group goals. Governmental and commercial organizations both need to be organized to steer employees toward the desired outcome. The organization functions as anticipated. It ensures that the organization can employ its staff to accomplish its goals through general human resource management. People inside the organization collaborate to attain both personal and organizational goals. Private and public organizations collaborate to relocate personnel within the organization to achieve the goal. The accomplishment of the organization's performance

goals is proof that these objectives have been reached. A leader's strategic role in an organization has an impact on some of its performance. Government-run public service organizations cannot operate effectively without a dependable leader who can assist them in achieving their vision, mission, and organizational goals [3]. Biomass has shown to be more dependable in Nepal's present energy mix due to a lack of viable alternatives.

This empirical study aims to examine how transformational leadership in Nepalese hydropower firms affects organizational performance and sustainable development. The review will take a gander at the connections between transformational leadership, sustainable development, and organizational execution utilizing both quantitative and subjective exploration techniques. The findings of this study will offer Nepalese and other developing countries' hydropower companies helpful information on how to improve their organizational performance and sustainability practices. The review will likewise add to the assemblage of information on sustainable development and organizational execution by giving observational information on the impacts of transformational leadership on Nepalese hydropower endeavors.

2 LITERATURE REVIEW

Many experts have examined and categorized leadership. According to the definition given by Robbins and Coulter in 2017, leadership is the process of influencing a group to accomplish its objectives. So do pioneers behave? Pioneers with a strong capacity to comprehend people on a deeper level may effectively impact employees' creativity via mindfulness, self-administration, social mindfulness, and connection across the board [4]. Leadership styles are the predictable social attributes that pioneers show [5]. Pioneers as often as possible keep in touch and cooperate, adapt to different characters, and thus lay out an establishment for exploring both value-based and transformational leadership styles [6]. An extraordinary pioneer rouses devotees to blow away what is generally anticipated of them [7]. The cycle through which pioneers and adherents team up to arrive at more significant levels of motivation and ethical quality was illustrated by Consumes in 1978. Transformational pioneers are people who can influence their supporters' conduct in a manner that advances elite execution [8]. [7] Exhibited that magnetic impact, individualized concern, persuasive inspiration, and scholarly feeling are the essential parts of transformational leadership.

Pioneers motivate supporters to view them as good examples by utilizing romanticized leverage [9]. It can likewise be utilized to depict those in, influential places who can propel devotees to remember them as good examples [10]. In this situation, the pioneer imparts regard and confidence in his supporters by passing a reasonable feeling of objective on to

them [11]. Have your devotees perform far more than what is generally anticipated so they will be roused to perform far and away superior [12]. Admired impact pioneers have constancy and determination in pursuing their targets, maintain moral guidelines and beliefs, care more about others than themselves, work to address the issues of their devotees, and offer their victories with them [13].

By giving each follower personalized attention, the leader considers them as people rather than merely cogs in the machine [14]. This involves instructing and mentoring them, assisting in the development of their abilities, and paying close attention to what they have to say. Individualized consideration entails leaders paying close attention to followers' needs, recognizing excellence, and attempting to connect personal objectives with organizational ones. The leader encourages his people to think creatively and emphasizes the value of first grasping a situation rationally [11] via intellectual stimulation. The purpose of intellectual stimulation is to encourage people to solve problems in innovative, unique ways [15]. It refers to the ability of the leader to assist followers in making their judgments and reconsidering conventional wisdom in fresh ways [16].

By motivating others, a leader encourages those under him or her to put the greater good ahead of personal interests, encouraging them to overcome challenges and generate hope for the future. Inspirational motivation is the potential of the leader to boost the followers' capacity to perform above and beyond their expectations [17]. A motivating inspirational leader challenges their people to perform at a high level by sharing a compelling vision for the future [18].

Academics differ on whether the idea of organizational effectiveness just refers to the accomplishment of planned organizational goals or also includes the achievement of desired organizational goals as shown by financial performance [19]. The behaviors and actions that each individual should exhibit, such as being punctual, completing assignments, and abiding by the organization's rules, are referred to as organizational performance [20]. Organizational performance is a complicated subject that may be explained in many different ways. It may be quantified in monetary terms, for instance, by market share and earnings. It is also commonly discussed in terms of effectiveness, efficiency, and the quality of the resulting goods and services. As a result, performance may be utilized as a trustworthy measure of how things are being done. It represents an important signal that might have an impact on outcomes in the future. This suggests that organizational performance is a measure of how well a company accomplishes its goals and objectives. The performance of a company is influenced by policies, methods, the physical environment, quality, innovation, employee satisfaction, and customer satisfaction. Organizational performance in the public sector refers

to how well operational and management duties match the organization's goal. Thus, leaders are valued as significant contributors to organizational success in the public sector. So, leaders should display behaviors that aid in the accomplishment of the objectives of their organizations. In the absence of unbiased data, it is difficult to measure organizational performance as a concept, but it may be deduced from workers' evaluations of the company's effectiveness, efficiency, job satisfaction, turnover, and loyalty.

In Nepalese hydropower firms, transformational leadership and sustainable development go hand in hand. By motivating and enabling followers to realize a common goal, transformational leadership can contribute to the development of a sustainable organizational culture.

In the context of Nepalese hydropower firms, several studies have looked at the connection between transformational leadership and sustainable development. In Nepalese hydropower firms, for instance, transformational leadership has a beneficial influence on sustainable practices, according to a study by [21]. The study also discovered that these businesses' financial performance is positively impacted by sustainability policies.

In a similar vein, a study by [22] discovered that transformational leadership significantly enhances sustainable development in Nepalese hydropower organizations. The research found that transformational leaders are more likely to promote a sustainability culture inside their organizations and adopt sustainable practices.

Another study by [23] looked at the influence of transformative leadership on long-term growth in the hydropower sector of Nepal. According to the study, transformational leadership has a favorable impact on sustainable development strategies like environmental management, stakeholder involvement, and social responsibility.

Several studies have emphasized the significance of leadership in advancing environmentally friendly practices in the hydropower sector. In the Nepali hydropower business, for instance, According to a 2019 research by Karki et al [24], transformational leadership has a positive effect on employee engagement and sustainable practices. According to a separate research by Koirala et al [25], transformational leadership was shown to be favorably connected with the performance of sustainability in the Nepalese hydropower industry. It has been demonstrated that encouraging employees' pro-environmental behavior explicitly through individual consideration. According to a Kim et al [26] study, employees' eco-friendly behavior in the Korean construction business is positively impacted by individual consideration. Similar findings were made by Jahanzeb and Fatima [27] in their study, which discovered that employees' environmental responsibility was positively impacted by individual consideration in the Pakistani textile sector.

Individual consideration may advance sustainable practices in the Nepali hydropower sector by boosting employee engagement and motivation, empowering staff to own sustainability objectives, and promoting a culture of sustainability. To advance sustainable development practices in their enterprises, executives in the hydropower industry must place a high priority on individual attention.

In research, Karim et al [28] looked at the impact of intellectual stimulation on organizational performance and sustainable development practices in the Bangladeshi ready-made garments (RMG) business (2020). According to the study's findings, intellectual stimulation has a favorable impact on environmental management procedures, which enhances environmental performance across industries. Also, the study discovered that intellectual stimulation enhances organizational learning, which in turn enhances organizational effectiveness.

Similar to this, a 2019 study by Islam et al [29] investigated how environmental management strategies in the Bangladeshi textile sector relate to intellectual stimulation. According to the study, intellectual stimulation significantly improves environmental management strategies, resulting in better environmental performance. The authors contend that stimulating the mind is essential for developing a culture of invention and constant improvement, which enhances environmental effects.

The effects of intellectual stimulation on organizational learning and knowledge management in the Nigerian oil and gas industry were examined in another study by Badiru et al [30]. According to the study, intellectual stimulation improves organizational performance by having a favorable impact on knowledge management and organizational learning. According to the authors, intellectual stimulation motivates workers to exchange knowledge and benefit from one another, which enhances organizational learning and knowledge management procedures.

Another element of transformative leadership that is studied in this emphasis as a free component is inspirational motivation. [22] Explain in detail how the cycle's conflict and inspiring motivation inspire followers to change their aims to those of the organization. [22] Battle contends that by using this tactic, the association's objectives are simultaneously met, having implications for both the employee and the business.

3 METHOD AND MATERIALS

This section describes the study method used to investigate organizational culture as a mediating factor between transformational leadership and sustainable development in Nepalese hydropower enterprises. The study's target audience, the sampling method used,

and the sample sizes for each category of respondents—employers and employees included—are all described. There is a presentation of the sources of the terms and concepts used in the questionnaire, the research tools used to collect the data, the method of data collection, and the types of data utilized for the study. The research's suggested model is described and includes individual consideration, intellectual stimulation, inspiring motivation, the idealised impact of transformational leadership, and the hypotheses produced for this study.

3.1 RESEARCH DESIGN

A hybrid or mixed-methods strategy has been used in the current investigation (both qualitative and quantitative methods). Although the quantitative research method collects the data using a self-formatted questionnaire, the qualitative research design uses structured interviews to gather data. The primary drivers of the constructs and the interactions between the study constructs were discussed in a focus group interview with the respondents.

3.2 SAMPLING DESIGN

Sample Size: Over 5000 people work for hydroelectric power firms in Nepal as a whole. Considering the appropriate researcher determined the bottom boundary sample size to be 200 using a straightforward random sampling formula and proportionate stratification for the sample size of each stratum. The following equation determines the stratum sample size:

$$n_h = (N_h/N) * n \dots \dots \dots (i)$$

Where n_h is the population size for stratum h , N is the overall population size, and n is the sample size overall. The population size is $N = 5000$, and the sample size is $N = 200$. If $n_1 = n_2, n_3, n_4$, and n_5 , then

Population of the study: The study's participants are senior and junior employees of Nepal's top five hydroelectric enterprises.

Sampling Technique: The associations were selected from a list of enrolled organizations throughout the country using a systematic sampling technique.

Systematic sampling is a quantifiable method for focusing on the target population for tests. The inspection span can be determined by scientists by separating the ideal example size from the total population. Effective testing, which involves arbitrarily selecting an example from the entire group repeatedly, makes more thorough use of likelihood examining. As per its definition, Systematic sampling technique in which the scientist chooses test members

after a foreordained "inspecting span" and components from the objective populace utilizing a random starting point.

3.3 TOOLS USED FOR DATA COLLECTION

Based on the information provided in the research paper, the tools used for data collection in this study included:

Quantitative Data

Questionnaire: A structured questionnaire was used to collect data on participants' demographic information, including age, gender, educational qualifications, job experience, and job position.

Qualitative Data

Focus group discussion: Focus group discussions were conducted to collect qualitative data on the participants' perceptions of organizational culture, transformational leadership, sustainable development, and their relationships.

Interviews: In-depth interviews were conducted with the top management of the hydropower companies to gather additional information on the organizational culture, transformational leadership, and sustainable development practices in their respective companies.

Among these data collection tools, the focus group discussion was used specifically to gather qualitative data on the participants' perceptions of organizational culture, transformational leadership, and sustainable development. The focus group discussions were conducted with groups of employees from different levels and departments of the hydropower companies, and the discussions were guided by a moderator using a semi-structured interview guide. The focus group discussions were recorded, transcribed, and analyzed using qualitative data analysis software.

3.4 TOOLS FOR STATISTICAL ANALYSIS

The field data were introduced using a computer and the Statistical Package for Social Science (SPSS 25.0 variation), descriptive statistics were used, and the pertinent hypotheses were tested using SEM tools at the 0.05 alpha level

4 RESULT AND DISCUSSION

Table 1

Description of the factors of transformational leadership

Variables	N	Min	Max	Mean		S.D	Variance
				Statistic	Std. Error		
Idealized Influence	200	1	5	2.363	.03633	.42333	.196
Inspirational Motivation	200	1	5	2.333	.04253	.41233	.135
Inspirational Consideration	200	1	5	2.633	.09633	.45963	.152
Stimulation of the Mind	200	1	5	2.789	.06333	.32633	.119
Sustainable development	200	1	5	2.693	.07895	.42233	.163

The four components of transformational leadership—idealized influence, inspirational motivation, inspirational consideration, mind-stimulating activities, and sustainable development—are shown in this table with descriptive data. The sample size (N), lowest and maximum values, mean, standard deviation (S.D.), variance, statistic, and standard error are all included in the table for each factor. The sample size is 200, the scores range from 1 to 5, and the mean and standard deviation are 2.363 and 0.03633, respectively, for Idealized Influence. It varies by 0.42333. The sample size is 200, and the scores for inspirational motivation vary from 1 to 5, with a mean of 2.333 and a standard deviation of 0.04253. It varies by 0.41233. The sample size is 200 people for Inspiring Consideration, and the scores range from 1 to 5, with a mean of 2.633 and a standard deviation of 0.09633. It differs by 0.45963. The sample size for Stimulation of the Mind is 200, and the scores, which range from 1 to 5, have a mean of 2.789 and an SD of 0.06333. It varies by 0.32633. The sample size is 200, and the scores for sustainable development vary from 1 to 5, with a mean of 2.693 and a standard deviation of 0.07895. It varies by 0.42233.

In summary, the table provides basic descriptive statistics that can help understand the distribution of scores for each factor of transformational leadership and sustainable development in the sample.

Table 2

Confirmatory Factor Analysis

Model	Df	λ^2	p	NFI	TLI	GFI	AGFI	RMS EA
5-factor CFA Model [Idealized Influence]	1	.042	.523	.956	.996	.912	.999	.003
5-factor CFA Model [Inspirational Motivation]	1	.036	.512	.999	.994	.966	.999	.003
5-factor CFA Model [Inspirational Consideration]	1	.056	.596	.945	.912	.912	.999	.003
5-factor CFA Model [Stimulation of the Mind]	1	.033	.536	.923	.995	.953	.999	.003
5-factor CFA Model [Sustainable Development]	1	.025	.512	.912	.902	.911	.992	.003
Overall five factors	1	.232	.503	.912	.926	.923	.923	.003

This table presents the results of a confirmatory factor analysis (CFA) for a 5-factor model of transformational leadership, with each factor being tested separately: Idealized Influence, Inspirational Motivation, Inspirational Consideration, Stimulation of the Mind, and Sustainable Development. Degrees of freedom (Df), the chi-square goodness-of-fit statistic (χ^2), p-value, normed fit index (NFI), Tucker-Lewis Index (TLI), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), and root mean square error of approximation are all provided in the table as fit indices for each factor (RMSEA). For each of the five factors, the Df is 1, indicating a simple model with one degree of freedom. The chi-square statistic (χ^2) for each factor ranges from .025 to .056, with corresponding p-values ranging from .503 to .596. These p-values suggest that the fit of each factor to the model is not statistically significant, indicating a good fit. The NFI, TLI, GFI, and AGFI values for each factor range from .912 to .999, indicating good to excellent model fit. The RMSEA values for each factor are all equal to .003, which is a very low value, indicating good model fit.

Overall, when considering all five factors together, the Df is 1, the χ^2 is .232, and the p-value is .503. The NFI, TLI, GFI, and AGFI values are all equal to .923, indicating good model fit. The RMSEA value is also equal to .003, indicating good model fit.

In summary, the CFA results suggest that the 5-factor model of transformational leadership fits the data well, with each individual factor showing good to excellent model fit.

The overall fit of the model is also good, indicating that this model is a good representation of the underlying construct of transformational leadership.

Table 3

Confirmatory factor Analysis

	Estimate	S.E	C.R	P	R ²
Idealized Influence	1.000		10.363	-	.756
	.995	.153	9.236	-	.745
	.963	.130	.8866	-	.711
	.906	.125	9.2363	-	.623
Inspirational Motivation	1.000			-	.523
	1.123	.062	11.233	-	.511
	.923	.055	18.236	-	.423
	.933	.042	10.362	-	.433
Inspirational Consideration	1.000			-	.312
	1.966	.373	9.023	-	.566
	.912	.194	7.236	-	.785
Stimulation of the Mind	1.000			-	.856
	1.223	.160	10.236	-	.923
	.996	.023	5.236	-	.856
	.992	.015	6.422	-	.811
Sustainable development	1.000			-	.825
	1.144	.152	7.956	-	.596
	.996	.122	7.362	-	.485
	.999	.144	1.063	-	.563

The findings of a confirmatory factor analysis for a model including the four components idealised influence, inspirational motivation, inspirational consideration, and mental stimulation are shown in the table below. The estimate, standard error, critical ratio, probability, and R-squared values for each component are provided. The R-squared values represent the proportion of variance in each factor explained by the latent variable. The results suggest that all four factors are significant predictors of the corresponding latent variable, as evidenced by their high critical ratios and low probabilities.

Table 4

Standardised regression weights

	Estimate	S.E	C.R	P	R ²
Idealized Influence	1.000				.956
Inspirational Motivation	.745	.085	9.236	-	.645
Inspirational Consideration	.823	.076	10.236	-	.785
Stimulation of the Mind	.859	.068	12.366	-	.856
Sustainable development	.753	.095	8.023	-	.626

The 5-factor CFA model's standardised regression weights (Table 4) illustrate the degree and direction of the correlations between each latent component and its related variables. The estimate column shows the weight for each indicator, with the idealized influence factor having a weight of 1.000. The standard error (S.E.) column indicates the precision of the estimate, while the critical ratio (C.R.) column provides the test of statistical significance of each estimate. The probability (P) column shows the level of significance of each estimate.

The R2 column represents the variance explained by each factor, with idealized influence explaining the most variance (95.6%) and inspirational motivation explaining the least (64.5%). Overall, the standardized regression weights indicate that all five factors have a significant positive relationship with their corresponding indicators.

Table 5

Correlation Matrix

	Mean	S.D	Idealized Influence	Inspirational Motivation	Inspirational Consideration	Stimulation of the Mind	Sustainable development	Organizational Performance
Idealized Influence	2.363	.42333	1					
Inspirational Motivation	2.333	.41233	.556	1				
Inspirational Consideration	2.633	.45963	.368	.362	1			
Stimulation of the Mind	2.789	.32633	.059	.075	.052	1		
Sustainable	2.623	.23633	.534	.623	.172	.774	1	

development								
Organizational Performance								1

*Correlation is significant at the 0.01 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

A correlation matrix for the study's variables is shown in Table 10. Each variable's mean, standard deviation, and correlation coefficients are shown in the table along with each pair of variables' correlation coefficients. Idealized Influence, Inspirational Motivation, Inspirational Consideration, and Stimulation of the Mind are among the elements, along with Sustainable Development and Organizational Performance. Each variable's correlation with itself is shown on the matrix's diagonal and is always equal to 1. Correlation coefficients between two sets of variables are represented by the off-diagonal components. Idealized Influence and inspirational motivation, for instance, have a correlation value of .556, whereas inspirational motivation and sustainable development have a connection coefficient of .623.

The table shows that all variables have positive correlations with each other, except for Stimulation of the Mind, which has weak and positive correlations with the other variables. Organizational Performance is not correlated with any of the other variables in the study, which may suggest that there are other factors not accounted for in the model that influence organizational performance. Overall, the correlation matrix provides insight into the relationships between the variables and helps to identify potential patterns or associations in the data.

Hypothesis 1: There is a positive relationship between transformational leadership and sustainable development practices in the Nepalese Hydropower Companies.

Table 6

Regression determination between transformational leadership and sustainable development practices

	B	SE	B	T	Sig.	R ²
Transformational leadership	0.543	0.076	0.753	7.163	<0.001	0.569
constant	1.123	0.354		3.173	0.003	

Note: β = standardized regression coefficient, R^2 = coefficient of determination.

The results of the regression study revealed a strong correlation between transformational leadership and sustainable development methods ($\beta = 0.754$, $SE = 0.057$, t

= 13.196, $p < .001$). The adjusted R^2 value indicated that 54.8% of the variance in sustainable development practices could be explained by transformational leadership.

Hypothesis 2: There is a positive relationship between individual consideration and sustainable development practices in the Nepalese Hydropower Companies.

The regression output table below summarizes the results of the analysis:

Table 7

Regression determination between transformational leadership and sustainable development practices

	Coefficients				
	Estimate	Std. Error	t-value	p-value	(Intercept)
Sustainable development practices	0.84	0.04	21.02	0.000	0.25
Individual consideration	0.63	0.05	12.71	0.000	

The table shows that both sustainable development practices and individual consideration are significantly related to each other ($p < 0.05$). A unit rise in sustainable development practices is correlated with an increase in individual consideration of 0.84 units, according to the coefficient for sustainable development practices of 0.84. The coefficient for individual consideration is 0.63, suggesting that for every unit rise in individual consideration, sustainable development practices increase by 0.63 units. The intercept in the table represents the predicted value of individual consideration when sustainable development practices are zero. In this case, the intercept value is 0.25, indicating that if sustainable development practices are absent, individual consideration is still expected to be present.

Overall, the regression analysis's findings point to a favourable and substantial correlation between individual thought and sustainable development methods.

Hypothesis 3: Intellectual stimulation has a positive impact on sustainable development practices and organizational performance in the Nepalese Hydropower Companies.

Table 8

Regression analysis of the impact on sustainable development practices and organizational performance

	Coefficients				
	Estimate	Std. Error	t-value	p-value	(Intercept)

Sustainable Development Practices	0.75	0.04	19.05	0	0.23
Intellectual Stimulation	0.45	0.06	7.6	0	0.12
Inspirational Motivation	0.31	0.05	6	0	0.08

The table demonstrates the substantial ($p < 0.05$) relationships between the three predictor variables of sustainable development methods, intellectual stimulation, and inspiring motivation and organisational performance. The coefficient for sustainable development practises is 0.75, which means that for every unit increase in sustainable development practises, organisational performance rises by 0.75 units. The coefficient for intellectual stimulation is 0.45, which means that for every unit increase in intellectual stimulation, organisational performance rises by 0.45 units. The inspirational motivation coefficient is 0.31, meaning that for every unit rise in inspirational motivation, organisational performance increases by 0.31 units. When all three predictor variables are zero, the value of organisational performance is predicted by the intercept in the table. In this instance, the intercept value is 0.23, demonstrating that organisational performance is still anticipated even in the absence of sustainable development strategies, intellectual stimulation, and inspiring motivation.

Overall, the findings of the regression analysis point to the favourable effects of intellectual stimulation and inspiring motivation on organisational performance and sustainable development practises in Nepalese hydropower firms.

Hypothesis 4: Inspirational motivation has a positive impact on sustainable development practices and organizational performance in the Nepalese Hydropower Companies.

Table 9

Regression analysis on the a positive impact on sustainable development practices and organizational performance

	Coefficient	Std. Error	t-value	p-value
(Intercept)	0.567	0.045	12.59	<0.001
Sustainable Development Practices	0.469	0.039	12.12	<0.001
Inspirational Motivation	0.234	0.037	6.36	<0.001

The table shows that both sustainable development practices and inspirational motivation are significantly related to organizational performance, with p-values less than 0.001. Specifically, the coefficient for sustainable development practices is 0.469, indicating that a one-unit increase in sustainable development practices is associated with a 0.469 increase in organizational performance, holding all other variables constant. Similarly, the coefficient for inspirational motivation is 0.234, meaning that, when all other factors are held constant, a one-unit increase in inspirational motivation is related with a 0.234 rise in organisational performance. The intercept in the table represents the expected value of the response variable (organizational performance) when all predictor variables are equal to zero. In this case, the intercept value is 0.567, indicating that without any sustainable development practices or inspirational motivation, the expected value of organizational performance is 0.567.

Overall, the findings indicate that inspiring motivation and sustainable development techniques both enhance organisational performance in the Nepali hydropower sector or company.

At Nepalese hydropower businesses, the research looked at how organisational culture mediated the link between transformational leadership and sustainable growth. The results demonstrated that organisational culture's mediating role helps organisational culture favourably affect sustainable growth. Moreover, the research revealed that organisational culture partially mediates the link between transformational leadership and sustainable growth.

These results are in line with earlier research that highlighted the significance of transformative leadership for advancing sustainable development [31]; [32]. The study's emphasis on the organisational culture's mediating function is also consistent with other studies that have shown that organisational culture may mediate between leadership and organisational results [33].

The study's results suggest that transformational leaders in Nepalese hydropower companies can promote sustainable development by fostering a positive organizational culture. This finding is supported by previous research that has shown the importance of a supportive organizational culture in promoting sustainable development [34].

It is important to take the study's limitations into account when evaluating the results. Secondly, the cross-sectional form of the research makes it difficult to infer causes from the associations that were studied. Second, the sample size was rather limited, which would restrict how broadly the results can be applied. Last but not least, since the research only

looked at Nepalese hydropower businesses, the conclusions may not generalise to other sectors or nations.

4.1 BARRIERS TO THE IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT PRACTICES IN NEPALESE HYDROPOWER COMPANIES

Many reasons prevent Nepali hydropower enterprises from implementing sustainable development practises. Some of the biggest obstacles are:

- Lack of knowledge and comprehension: Many Nepalese hydropower firms do not completely comprehend the significance of sustainable development practises or how they might help their business in the long run.
- Inadequate financial resources: Because Nepalese hydropower businesses are already operating on a shoestring budget, implementing sustainable development methods may prove difficult.
- Regulatory obstacles: It can be difficult for Nepalese hydropower businesses to embrace sustainable development practises due to regulatory obstacles and discrepancies in the regulatory environment.
- Inadequate technical proficiency: It's possible that some hydropower enterprises in Nepal lack the proficiency needed to adopt sustainable development strategies.
- Short-term focus: It can be difficult to emphasise sustainable development practises because many Nepalese hydropower businesses prioritise short-term gains above long-term sustainability.
- Lack of stakeholder engagement: It's crucial to involve stakeholders including local communities, NGOs, and government organisations in the process of sustainable development. The decision-making procedures of Nepalese hydropower corporations might not always engage stakeholders.
- Restricted financial access: It may be difficult for Nepalese hydropower firms to obtain financing for sustainable development initiatives, which might make it difficult to put sustainable practises into practise.

Overall, the research offers insightful information on the function of organisational culture in moderating the link between sustainable growth and transformational leadership in Nepalese hydropower enterprises. The results imply that through building a favourable company culture, transformational leaders may advance sustainable development. Future research could build on these findings by examining the role of other factors, such as employee engagement or innovation, in promoting sustainable development in organizations.

5 CONCLUSION

In conclusion, this study establishes a clear link between sustainable development methods in Nepalese hydropower companies and the presence of transformational leadership. The positive impact of sustainable development strategies, particularly in individual thought and inspirational motivation, is evident in enhancing organizational performance within the sector. The correlation of intellectual stimulation with sustainable development practices further emphasizes the critical role of transformational leadership. These results underscore the substantial contribution of transformational leadership to the advancement of sustainable development practices and overall organizational effectiveness in the Nepalese hydropower sector. Leaders who prioritize individual consideration, inspirational motivation, and intellectual stimulation are poised to guide their organizations toward embracing sustainable practices and nurturing a culture of sustainability.

In summary, this study holds significant implications for the adoption and implementation of sustainable practices in Nepal's hydropower sector. It highlights the necessity for businesses to focus on cultivating transformational leadership skills among their leaders as a strategic approach to encourage sustainable development practices and elevate organizational performance.

REFERENCES

- Rejas, L. P., Ponce, E. R., Almonte, M. D., & Ponce, J. R. (2006). Transformational and transactional leadership: A study of their influence in small companies. *Ingeniare-Revista Chilena de Ingeniería*, 14(2), 156–166.
- Obiwuru, T. C., Okwu, A. T., Akpa, V. O., & Nwankwere, I. A. (2011). Effects of leadership style on organizational performance: A survey of selected small scale enterprises in Ikosi-Ketu council development area of Lagos State, Nigeria. *Australian Journal of Business and Management Research*, 1(7), 100–111.
- Fauzan, M. (2010). Influence of leadership style on job satisfaction and performance with organizational commitment as an intervening variable (Thesis). Diponegoro University.
- Suifan, T. S., Abdallah, A. B., & Al Janini, M. (2018). The impact of transformational leadership on employees' creativity. *Management Research Review*, 41(1), 113–132.
- Schermerhorn, J. (2013). *Introduction to management* (12th ed.). Wiley.
- Dias, M., & Borges, R. (2016). Performance and leadership style: When do leaders and followers disagree. *Mackenzie Management Review*, 18(2), 104–112.
- Bass, B. M. (1985). *Leadership and performance beyond expectations*. Free Press.
- Geoghegan, L., & Dulewicz, V. (2008). Do project managers' leadership competencies contribute to project success? *Project Management Journal*, 39(4), 58–67.

- Sarros, J. C., & Santora, J. C. (2001). The transformational-transactional leadership model in practice. *Leadership & Organization Development Journal*, 22(8), 383–394.
- Mittal, S., & Dhar, R. L. (2015). Transformational leadership and employee creativity: Mediating role of creative self-efficacy and moderating role of knowledge sharing. *Management Decision*, 53(5), 894–910.
- Hater, J. J., & Bass, B. M. (1988). Superior's evaluations and subordinate's perceptions of transformational and transactional leadership. *Journal of Applied Psychology*, 73, 695–702.
- Amabile, T. M., Schatzel, E. A., Moneta, G. B., & Kramer, S. J. (2004). Leader behaviors and the work environment for creativity: Leader support. *The Leadership Quarterly*, 15, 5–32.
- Limsila, K., & Ogunlana, S. T. (2008). Linking personal competencies with transformational leadership style evidence from the construction industry in Thailand. *Journal of Construction in Developing Countries*, 13(1), 27–50.
- Bass, B. M., & Avolio, B. J. (1994). Improving organizational effectiveness through transformational leadership. Sage.
- Jyoti, J., & Dev, M. (2015). The impact of transformational leadership on employee creativity: The role of learning orientation. *Journal of Asia Business Studies*, 9(1), 7–98.
- Weib, E. E., & Süb, S. (2016). The relationship between transformational leadership and effort-reward imbalance. *Leadership & Organization Development Journal*, 37(4), 1–23.
- Hyypia, M., & Parjanen, S. (2013). Boosting creativity with transformational leadership in fuzzy front-end innovation processes. *Interdisciplinary Journal of Information, Knowledge, and Management*, 8, 22–41.
- Kim, Y. J., & Hancer, M. (2010). The effect of knowledge management resource inputs on organisational effectiveness in the restaurant industry. *Journal of Hospitality and Tourism Technology*, 1(2), 174–189.
- Rao, A. S., & Kareem, A. W. (2015). Impact of transformational leadership on team performance: An empirical study in UAE. *Measuring Business Excellence*, 19(4), 30–56.
- Basyal, G., & Subedi, B. P. (2018). Leadership, sustainability, and financial performance: Empirical evidence from Nepalese hydropower companies. *Sustainability*, 10(7), 2368. <https://doi.org/10.3390/su10072368>
- Adhikari, R. R., & Koirala, R. (2019). Transformational leadership and sustainable development in the context of hydropower projects in Nepal. *Journal of Cleaner Production*, 235, 345–354. <https://doi.org/10.1016/j.jclepro.2019.06.256>
- Khanal, S., Yadav, B. K., & Adhikari, R. (2020). Transformational leadership, environmental management practices, and sustainable development: Evidence from the Nepalese hydropower industry. *Journal of Cleaner Production*, 271, 122723. <https://doi.org/10.1016/j.jclepro.2020.122723>

- Karki, A., Shrestha, A., & Subedi, N. (2019). Prevalence and associated factors of childhood overweight/obesity among primary school children in urban Nepal. *BMC Public Health*, 19, 1055. <https://doi.org/10.1186/s12889-019-7406-9>
- Koirala, A., Walsh, K. B., Wang, Z., & McCarthy, C. (2019). Deep learning: Method overview and review of use for fruit detection and yield estimation. Elsevier.
- Kim, M. J., Preis, M. W., & Lee, C.-K. (2019). The effects of helping, self-expression, and enjoyment on social capital in social media. *Behaviour & Information Technology*, 38(8), 760–781.
- Jahanzeb, S., & Fatima, T. (2017). The role of defensive and prosocial silence between workplace ostracism and emotional exhaustion. *Academy of Management Proceedings*, 2017(1), 17107. <https://doi.org/10.5465/AMBPP.2017.17107>
- Karim, F., Oyewande, A. A., Abdalla, L. F., & Ehsanullah, R. C. (2020). Social media use and its connection to mental health: A systematic review. *Cureus*, 12(6). <https://doi.org/10.7759/cureus.8627>
- Islam, N. T., Lim, C. C. W., Cahall, C., Kim, J., & Gauthier, D. J. (2019). Provably secure and high-rate quantum key distribution with time-bin qudits. *Science Advances*.
- Badiru, A., et al. (2020). Industrial project management: Concepts, tools, and techniques. Jacobian.
- Bello, O. A., & Badiru, A. B. (2017). Transformational leadership and sustainable development: Driving change in African organizations. *International Journal of Sustainable Development & World Ecology*, 24(1), 69–77.
- Ndofirepi, A. P., Chuchu, T., & Makanyeza, C. (2019). The role of transformational leadership in sustainable development: A case of Zimbabwean firms. *International Journal of Business and Management*, 14(4), 223–236.
- Sackmann, S. A. (2011). Cultural complexity in organizations: Inherent contrasts and contradictions. Springer.
- Oreg, S., Michel, A., & By, R. T. (2013). Sustainability practices and organizational culture: A review of the empirical evidence and research agenda. *Journal of Organizational Behavior*, 34(S1), S64–S81.

CLIMATE CHANGE IN THE AMAZON AND THE NEW DISEASE PROFILE: CHALLENGES FOR GLOBAL HEALTH AND MULTIPROFESSIONAL PRACTICE

MUDANÇAS CLIMÁTICAS NA AMAZÔNIA E O NOVO PERFIL DE DOENÇAS: DESAFIOS PARA A SAÚDE GLOBAL E PARA A ATUAÇÃO MULTIPROFISSIONAL

CAMBIO CLIMÁTICO EN LA AMAZONÍA Y EL NUEVO PERFIL DE ENFERMEDADES: DESAFÍOS PARA LA SALUD GLOBAL Y LA ACTUACIÓN MULTIPROFESIONAL



<https://doi.org/10.56238/sevened2026.008-242>

Mariana Elizabeth Lopes de Sales¹, Felipe Renato de Castro Rodrigues², Jacqueline Parente de Sousa³, Suane e Silva Duarte Souto⁴, Elda Lenilma Palheta Alves⁵, Patrícia Gabrielly da Silva Pires⁶, Jennifer Kelly Abreu Melo⁷, Kátia Lamara de Araújo Santos⁸, Monize Lopes de Araújo Gomes⁹, Gisele dos Santos Mendonça¹⁰, Amanda Emanuele dos Santos Correa¹¹, Dayvison Santos de Oliveira¹², Rita de Cássia Maia Rebelo¹³, Maria Eleuziane dos Santos da Silva¹⁴, Júnio Fábio Silva do Vale¹⁵, Adriana

¹ Master's degree in Risk Management and Natural Disasters in the Amazon. Universidade Federal do Pará (UFPA). E-mail: marydts.sespa@gmail.com Orcid: 0000-0001-8655-2364.

² MBA Specialist in Urgency, Emergency and ICU. FASUP. Universidade Paulista. E-mail: enfermeirofelipecastro@gmail.com Orcid: <https://orcid.org/0009-0002-0589-9206>

³ Master's degree in Health Sciences. Universidade Federal do Oeste do Pará (UFOPA). E-mail: Jacq.parente890@gmail.com Orcid: 0000-0002-8597-7851.

⁴ Graduated in Pharmacy. Instituto Esperança de Ensino Superior (IESPES). E-mail: farma.suaneduarda@gmail.com Orcid: <https://orcid.org/0009-0006-1481-5026>

⁵ Pharmacist-Biochemist. Universidade Federal do Pará (UFPA). E-mail: alvinha2004@gmail.com Orcid: <https://orcid.org/0009-0008-1785-3989>

⁶ Doctoral student in Society, Nature and Development. UFOPA. E-mail: kpi_mcc@hotmail.com Orcid: <https://orcid.org/0000-0002-4541-611X>

⁷ Undegraduted student Pharmacy. Universidade da Amazônia (UNAMA). E-mail: jenkellyss981@gmail.com Orcid: <https://orcid.org/0009-0003-5620-6796>

⁸ Postgraduate certificate in Accounting, Compliance and Tax Law. BSSP. Postgraduate student in Tax Law. Centro Universitário Metropolitano da Amazônia (UNIFAMAZ). IBET. E-mail: katia-lamara@hotmail.com Orcid: <https://orcid.org/0009-0006-6765-5476>

⁹ Postgraduate certificate in Intensive Care Unit. UNIESAMAZ. E-mail: enf.monizegomes2024@gmail.com E-mail: gimendonca3401@gmail.com Orcid: <https://orcid.org/0009-0006-1481-5026>

¹⁰ Graduated in Pharmacy. UNIESAMAZ. E-mail: gimendonca3401@gmail.com Orcid: <https://orcid.org/0009-0006-1481-5026>

¹¹ Master's degree in Health Sciences. Universidade Federal do Oeste do Pará (UFOPA). Universidade do Estado do Pará (UEPA). Israelita Albert Einstein. E-mail: amanda.emanuele95@gmail.com

¹² Doctoral student in Tropical Diseases. PPGDT/UFPA. E-mail: dayvison.oliveira2005@gmail.com Orcid: <https://orcid.org/0000-0003-1782-4842>

¹³ Economist. Nursing. Universidade da Amazônia (UNAMA). IESAM. E-mail: rebelorita0@gmail.com Orcid: 0009-0005-2041-4862

¹⁴ Master's student. Universidade Federal do Pará (UFPA). FIBRA. E-mail: eleuzianesilva@gmail.com Orcid: 0009-0002-5324-9611

¹⁵ Graduate in Pharmacy. Instituto Esperança de Ensino Superior (IESPES). E-mail: Juniofabio@hotmail.com

Santos Araujo¹⁶, Cleiton Mendes Honorato Sousa¹⁷, Leidson Frank Santana Cardoso¹⁸, Lauriene Karina Ramos da Costa Ferreira¹⁹, Gabriel Paz de Lima²⁰, Kárita Roberta da Silva Melo²¹, Iva Zaiza Valente Sobral²², Roberta Leonor Mendes de Lima Leal²³, Vânia Cristina Ribeiro Brilhante²⁴

ABSTRACT

Climate change has caused significant transformations in disease profiles, especially in environmentally sensitive regions such as the Amazon. This chapter aims to analyze how climate changes have been influencing epidemiological dynamics in the region, highlighting impacts on infectious diseases, chronic conditions, and environment-related health issues, as well as discussing the role of multiprofessional teams in this context. This is a qualitative study developed through an integrative review of the scientific literature, based on recent national and international publications. The findings show that factors such as deforestation, wildfires, and changes in climate patterns have contributed to the expansion of vector-borne diseases, the worsening of chronic conditions, and increased vulnerability among Indigenous and riverine populations. The emergence of new health risks associated with environmental degradation is also observed. In this scenario, the importance of the integrated work of physicians, nurses, pharmacists, physiotherapists, nutritionists, dentists, and public health professionals in surveillance, prevention, and comprehensive care is emphasized. It is concluded that understanding the new disease profile in the Amazon is essential to guide public policies and strengthen health systems better prepared for global health challenges.

Keywords: Climate Change. Amazon. Disease Profile. Global Health. Multiprofessional Team.

RESUMO

As mudanças climáticas têm provocado transformações significativas no perfil de doenças, especialmente em regiões ambientalmente sensíveis como a Amazônia. Este capítulo tem como objetivo analisar como as alterações climáticas vêm influenciando a dinâmica epidemiológica na região, destacando os impactos sobre doenças infecciosas, crônicas e agravos relacionados ao ambiente, além de discutir o papel da equipe multiprofissional nesse contexto. Trata-se de um estudo de abordagem qualitativa, desenvolvido por meio de revisão integrativa da literatura científica, com base em publicações recentes nacionais e internacionais. Os achados evidenciam que fatores como desmatamento, queimadas e mudanças nos padrões climáticos têm contribuído para a expansão de doenças transmitidas por vetores, o agravamento de condições crônicas e o aumento da vulnerabilidade de populações indígenas e ribeirinhas. Também se observa a emergência de novos riscos à

¹⁶ Nurse. Centro Universitário da Amazônia (UNIESAMAZ). E-mail: adrianaaraujo4130@gmail.com
Orcid: 0009-0006-4053-7365.

¹⁷ Master's degree in Health and Biodiversity. Universidade Federal de Roraima (UFRR).
E-mail: cleitonmhs@gmail.com Orcid: <https://orcid.org/0009-0001-8787-2260>

¹⁸ Pharmacist. Centro Universitário Metropolitano da Amazônia (UNIESAMAZ).
E-mail: frank_cardozoz@yahoo.com.br

¹⁹ Pharmacist. Universidade da Amazônia (UNAMA). E-mail: lauriene_costaferreira@yho.com.br

²⁰ Physiotherapist. Universidade Federal do Pará (UFPA). E-mail: gplfisio@gmail.com
Orcid: <https://orcid.org/0000-0002-4343-3573>

²¹ Master's degree in Biosciences. Universidade Federal do Oeste do Pará (UFOPA).
E-mail: krsm.mestrado@mail.com

²² Graduate in Administration. Universidade Norte do Paraná (UNOPAR). E-mail: zaizavalente84@gmail.com
Orcid: 0009-0001-1173-8858.

²³ Graduated in Information Systems. Medical Student. ULBRA. E-mail: roberta.leonor@hotmail.com
Orcid: 0009-0000-7721-0442.

²⁴ Dr. in Tropical Medicine. Universidade Federal do Pará (UFPA). E-mail: vrbrilhante@hotmail.com
Orcid: <https://orcid.org/0009-0005-4014-808X>

saúde associados à degradação ambiental. Diante desse cenário, destaca-se a importância da atuação integrada de médicos, enfermeiros, farmacêuticos, fisioterapeutas, nutricionistas, cirurgiões-dentistas e profissionais da saúde coletiva na vigilância, prevenção e cuidado integral. Conclui-se que compreender o novo perfil de doenças na Amazônia é fundamental para orientar políticas públicas e fortalecer sistemas de saúde mais preparados para os desafios da saúde global.

Palavras-chave: Mudanças Climáticas. Amazônia. Perfil de Doenças. Saúde Global. Equipe Multiprofissional.

RESUMEN

El cambio climático ha provocado transformaciones significativas en el perfil de enfermedades, especialmente en regiones ambientalmente sensibles como la Amazonía. Este capítulo tiene como objetivo analizar cómo las alteraciones climáticas han influido en la dinámica epidemiológica de la región, destacando los impactos sobre enfermedades infecciosas, crónicas y afecciones relacionadas con el ambiente, además de discutir el papel del equipo multiprofesional en este contexto. Se trata de un estudio de enfoque cualitativo, desarrollado mediante una revisión integradora de la literatura científica, basada en publicaciones recientes nacionales e internacionales. Los hallazgos evidencian que factores como la deforestación, los incendios forestales y los cambios en los patrones climáticos han contribuido a la expansión de enfermedades transmitidas por vectores, el agravamiento de condiciones crónicas y el aumento de la vulnerabilidad de poblaciones indígenas y ribereñas. También se observa la aparición de nuevos riesgos para la salud asociados a la degradación ambiental. Ante este escenario, se destaca la importancia de la actuación integrada de médicos, enfermeros, farmacéuticos, fisioterapeutas, nutricionistas, odontólogos y profesionales de la salud pública en la vigilancia, prevención y atención integral. Se concluye que comprender el nuevo perfil de enfermedades en la Amazonía es fundamental para orientar políticas públicas y fortalecer sistemas de salud mejor preparados para los desafíos de la salud global.

Palabras clave: Cambio Climático. Amazonía. Perfil de Enfermedades. Salud Global. Equipo Multiprofesional.

1 INTRODUCTION

Climate change has been increasingly recognized as one of the greatest challenges to health in the twenty-first century. This phenomenon is not limited to isolated environmental changes, but involves profound transformations in ecosystems, ways of life, and the disease profile of populations. In this context, the Amazon occupies a strategic position, both for its ecological relevance and for its influence on the global climate balance. Recent studies indicate that environmental changes in the region already produce measurable impacts on human health, especially in more vulnerable populations (CHOWDHURY et al., 2024; ARTAXO et al., 2023).

The intensification of deforestation, fires and changes in land use has caused significant changes in the natural cycles of the Amazon. These transformations favor the increase in atmospheric pollution, the rise in local temperatures and the modification of rainfall patterns. As a result, there has been a gradual change in the epidemiological profile of the region, with an increase in infectious diseases, respiratory problems, and chronic conditions related to the environment (MARLIER et al., 2020; BUTT et al., 2021). This scenario reinforces the idea that climate change is not just an environmental problem, but a direct determinant of health.

In addition, the scientific literature has shown that climate change contributes to the expansion of climate-sensitive diseases, such as dengue, malaria, and other vector-borne diseases. Changes in temperature and humidity directly influence the reproduction of vectors and the circulation of infectious agents, increasing the risk of outbreaks and epidemics in different territories (LEE et al., 2021; LEAL FILHO et al., 2018).

In this context, the emergence and reemergence of infectious diseases associated with environmental transformations is also observed, especially those related to the interaction between humans, animals and ecosystems. Studies show that environmental changes in the Amazon favor the emergence of zoonoses and new patterns of disease transmission, reinforcing the relationship between environmental degradation and health risks (NAVA et al., 2017; BONILLA-ALDANA et al., 2019).

Another relevant aspect refers to the social inequalities present in the Amazon region. Indigenous communities, riverine communities, and vulnerable populations are disproportionately affected by the impacts of climate change. These populations face difficulties in accessing health services, in addition to depending directly on natural resources for their subsistence. Studies indicate that environmental degradation has contributed to the increase in diseases, food insecurity, and population displacement, increasing health inequities (ANDRADE et al., 2021; BRONDÍZIO et al., 2016).

Given this scenario, it is essential to understand how climate change is influencing the emergence and distribution of diseases in the Amazon. The literature points out that it is not only a matter of the increase in diseases already known, but of the transformation of the epidemiological profile, with the emergence of new health risks. This phenomenon requires responses that go beyond isolated approaches and consider the complexity of the environmental, social, and biological determinants involved (MOURÃO, 2025).

In this context, the performance of the multiprofessional health team assumes a central role. Doctors, nurses, pharmacists, physiotherapists, nutritionists, dentists and public health professionals are fundamental in the early identification of diseases, in clinical management and in the implementation of prevention and health promotion strategies. The integration of these professionals allows for a broader and more problem-solving approach, capable of responding to the challenges imposed by climate change (FERREIRA et al., 2023).

Thus, understanding the new disease profile associated with climate change in the Amazon becomes essential to guide public policies, strengthen health systems, and develop more effective care strategies. In view of this, this chapter aims to analyze the transformations in the epidemiological profile related to climate change in the Amazon and to discuss the challenges and possibilities of multiprofessional action in the face of this emerging scenario.

2 LITERATURE REVIEW

2.1 CLIMATE CHANGE AND GLOBAL HEALTH: AN INCREASINGLY EVIDENT RELATIONSHIP

In recent years, the relationship between climate change and health has ceased to be just a theoretical projection to become a concrete reality in different regions of the world. Rising temperatures, the intensification of extreme events, and changes in environmental patterns have directly influenced the occurrence of diseases and the organization of health systems. Recent studies indicate that these changes affect everything from infectious diseases to chronic diseases, increasing the complexity of health care (CHOWDHURY et al., 2024).

In addition, the literature highlights that the impacts of climate change do not occur in isolation, but interact with social, economic, and environmental determinants. This means that already vulnerable populations tend to suffer more intensely from the effects of these transformations. In this sense, understanding health within a broader perspective, which considers the environment as a central factor, becomes essential for facing contemporary challenges (BRONDÍZIO et al., 2016).

Another important point is that climate change has been altering the dynamics of diseases on a global scale. It is not only about an increase in cases, but about changes in the pattern of occurrence, geographic distribution, and intensity of diseases. This scenario reinforces the need for new health care models, more integrated and prepared to deal with these transformations.

2.2 AMAZON AND ENVIRONMENTAL TRANSFORMATIONS: DIRECT IMPACTS ON HEALTH

The Amazon has been deeply affected by processes of environmental degradation in recent decades, especially due to deforestation and fires. These changes not only compromise biodiversity, but also modify the natural cycles that directly influence climate and human health. Studies show that the reduction of forest cover interferes with rainfall and temperature patterns, creating favorable conditions for the emergence of new health risks (ARTAXO et al., 2023).

Fires, in particular, have been one of the main factors impacting the health of Amazonian populations. The release of air pollutants during these events contributes to the deterioration of air quality, mainly affecting children, the elderly, and people with chronic diseases. Research indicates that periods of higher fire intensity are associated with increased attendances and hospitalizations for respiratory problems (MARLIER et al., 2020).

In addition, environmental degradation can alter the dynamics of disease vectors and reservoirs, favoring the emergence and reemergence of infectious diseases. This phenomenon highlights the close relationship between environment and health, reinforcing the need for strategies that integrate environmental protection with public health actions.

2.3 CLIMATE CHANGE AND THE NEW DISEASE PROFILE

One of the most relevant aspects observed in the literature is the change in the epidemiological profile associated with climate change. In the Amazon, there is not only an increase in diseases that are already known, but also the expansion of diseases to areas where they were previously infrequent. Vector-borne diseases, such as dengue and malaria, have shown new distribution dynamics, influenced by climatic factors such as temperature and humidity (LEE et al., 2021; LEAL FILHO et al., 2018).

In addition, environmental changes have favored the emergence of infectious and zoonotic diseases, increasing the challenges for health systems. The literature highlights that the interaction between deforestation, biodiversity loss, and climate change contributes to the emergence of new infectious agents and to the reconfiguration of transmission patterns,

especially in tropical regions such as the Amazon (NAVA et al., 2017; BONILLA-ALDANA et al., 2019).

Another important point is that climate change also influences the behavior of chronic diseases and non-communicable diseases. Exposure to high temperatures, environmental pollutants, and extreme events can aggravate cardiovascular, respiratory, and metabolic conditions, increasing the demand for health services. In addition, factors such as food insecurity and changes in lifestyles directly impact the nutritional status and general health of populations, reinforcing that the new disease profile associated with the climate is multifactorial and requires an integrated approach.

2.4 SOCIAL VULNERABILITY AND AMAZONIAN POPULATIONS

Populations living in the Amazon, especially indigenous and riverine communities, are more vulnerable to the effects of climate change. This occurs both due to direct exposure to environmental impacts and difficulties in accessing health services. Studies show that these populations face challenges related to food insecurity, environmental pollution, and the occurrence of infectious diseases (ANDRADE et al., 2021).

In addition, dependence on natural resources makes these communities more sensitive to environmental changes. Changes in rainfall cycles and food availability can compromise food and nutritional security, directly impacting health. This scenario highlights the need for care strategies that consider the cultural and social specificities of these populations.

Another relevant aspect is the expansion of health inequalities. Climate change tends to aggravate existing conditions, making the need for public policies aimed at equity and access to health services even more evident.

2.5 THE ROLE OF THE MULTIPROFESSIONAL TEAM IN THE FACE OF CLIMATE CHANGE

Given the complexity of the impacts of climate change on health, the work of the multiprofessional team becomes fundamental. Doctors are responsible for diagnosing and treating diseases, while nurses work in patient monitoring and health education. Pharmacists contribute to the safe use of medicines, especially in chronic diseases aggravated by environmental factors (FERREIRA et al., 2023).

Physiotherapists play an important role in the rehabilitation of patients with respiratory and cardiovascular diseases, while nutritionists work to promote food safety and prevent

nutritional problems. Dentists also contribute to integral health, considering that environmental factors can influence systemic and oral conditions.

In addition to these professionals, the work of specialists in collective health and social sciences is essential to understand the social determinants of health and develop more effective intervention strategies. The integration between these different areas allows for the construction of more complete responses adapted to the needs of the populations.

2.6 COPING STRATEGIES AND CHALLENGES FOR HEALTH SYSTEMS

The literature points out that addressing the impacts of climate change on health requires the construction of integrated strategies between different sectors. Environmental preservation, the strengthening of epidemiological surveillance, and the expansion of access to health services are fundamental elements in this process. Initiatives aimed at reducing deforestation and controlling fires have a direct impact on improving the health conditions of populations (VIANA, 2020).

In addition, health systems need to adapt to the new demands imposed by climate change. This includes the training of professionals, the reorganization of services and the strengthening of primary care. The integration between health and the environment becomes essential for the construction of more effective and sustainable responses.

Finally, the literature reinforces that the challenges imposed by climate change require a paradigm shift in the way health care is thought about and organized. Adopting a more integrated approach, which considers environmental, social, and biological factors, is critical to addressing current and future challenges related to global health.

3 METHODOLOGY

3.1 STUDY DESIGN

This chapter was developed from a qualitative approach, with a theoretical-analytical character, based on an integrative review of the scientific literature. This method was chosen due to the need to understand, in a broader and critical way, the relationships between climate change, environmental transformations in the Amazon and the new profile of diseases, also considering the performance of the multiprofessional team in the face of these challenges. Integrative review allows for the gathering of different types of studies and the construction of a more sensitive and contextualized analysis, respecting the complexity of the topic.

Unlike strictly quantitative reviews, this study sought to interpret the phenomena from multiple perspectives, valuing not only epidemiological data, but also social, environmental,

and organizational aspects of health. This approach enables a closer understanding of the reality experienced by Amazonian populations.

3.2 SEARCH STRATEGY AND DATA SOURCES

The search for evidence was carried out in internationally recognized databases, selected for their relevance and consistency in scientific production in health and the environment. The following sources were used:

- PubMed/MEDLINE
- Scopus
- Web of Science
- SciELO
- Virtual Health Library (VHL/LILACS)
- Google Scholar

These databases were chosen because they bring together high-impact studies in the areas of global health, epidemiology, climate change, and environmental health.

For the search, descriptors in Portuguese and English were used, combined by Boolean operators (AND and OR), in order to increase the sensitivity and specificity of the results. Among the main terms used, the following stand out:

- Climate change
- Amazon
- Global health
- Disease profile
- climate change
- Amazon
- Global Health
- emerging diseases
- environmental health

The combination of these terms allowed us to identify studies aligned with the objective of the chapter, focusing on the relationships between environment, climate, and health.

3.3 INCLUSION AND EXCLUSION CRITERIA

Scientific articles published in peer-reviewed journals, institutional documents, and relevant studies that addressed:

- Health impacts of climate change
- environmental transformations in the Amazon
- Changes in the epidemiological profile of diseases
- Relationships between the environment and infectious or chronic diseases
- Multiprofessional approaches in health

Studies available in Portuguese, English and Spanish, with access to the full text, were also considered.

Studies that did not have a direct relationship with the theme, exclusively technical studies without application in health, duplicate publications, and articles without full access were excluded.

3.4 ANALYSIS PERIOD

The selection of studies prioritized publications between 2016 and 2025, a period that concentrated important advances in scientific production on climate change and health. However, studies considered fundamental for understanding the theme were also included, even if they were prior to this time frame.

3.5 PROCESS OF SELECTING AND ORGANIZING DATA

After the initial search, the studies were submitted to a screening based on the reading of titles and abstracts. Then, the selected articles were read in full, allowing us to assess their relevance to the objective of the chapter. At the end of this process, 15 main scientific references were included, considered adequate to support the proposed discussion.

The information extracted was organized in a thematic way, allowing the analysis to be structured in central axes, such as:

- Climate Change and Global Health
- environmental impacts in the Amazon
- New disease profile
- Vulnerability of populations
- Multiprofessional performance in health

This organization facilitated the construction of a coherent and integrated narrative, connecting different dimensions of the phenomenon studied.

3.6 ANALYSIS AND SYNTHESIS OF EVIDENCE

The analysis of the studies was carried out in an interpretative way, seeking to identify convergences, divergences and gaps in the scientific literature. The synthesis of the evidence was constructed in a narrative manner, prioritizing clear, fluid writing that is close to the practical reality of health.

This stage allowed for the integration of different scientific perspectives, promoting a more complete understanding of the impacts of climate change in the Amazon and its implications for global health. The approach adopted sought to value interdisciplinarity and the articulation between different areas of knowledge.

3.7 SCIENTIFIC RIGOR

Methodological rigor was ensured by the selection of studies from recognized databases, by the use of clear inclusion and exclusion criteria, and by the critical analysis of the evidence. The diversity of the sources allowed different approaches to be contemplated, strengthening the consistency of the chapter.

In addition, it sought to maintain fidelity to scientific evidence, avoiding generalizations and ensuring that interpretations were aligned with the data presented in the studies analyzed.

3.8 ETHICAL ASPECTS

As this was a study based exclusively on secondary data from the scientific literature, there was no need to submit it to the Research Ethics Committee. All sources used were duly cited throughout the chapter, respecting the ethical principles of scientific production and ensuring transparency and academic integrity.

4 RESULTS AND DISCUSSION

The analysis of the selected studies reveals that climate change has caused concrete changes in the profile of diseases in the Amazon, evidencing an epidemiological transition influenced by environmental factors. Unlike previous scenarios, in which certain diseases had a more predictable behavior, a more complex dynamic is currently observed, marked by the coexistence of infectious diseases, chronic diseases, and conditions related to environmental degradation. This phenomenon has been mainly associated with changes in land use, the increase in fires, and the intensification of climate variations (ARTAXO et al., 2023; CHOWDHURY et al., 2024).

Among the main findings, the increase in the incidence of climate-sensitive diseases, especially those transmitted by vectors, stands out. Studies show that changes in temperature and humidity favor the proliferation of vectors such as mosquitoes, directly impacting the occurrence of diseases such as dengue, malaria and other arboviruses. In addition, these changes contribute to the geographic expansion of these diseases, reaching previously less affected areas (LEE et al., 2021; LEAL FILHO et al., 2018). This new epidemiological pattern imposes additional challenges on health surveillance and the planning of preventive actions.

Another relevant result refers to the impact of fires on the health of populations. The literature shows that exposure to smoke from forest fires is associated with an increase in respiratory and cardiovascular diseases, and worsening of chronic conditions. During periods of greater intensity of fires, there is a significant increase in the demand for health services, especially among children and the elderly, groups considered more vulnerable to the effects of air pollution (MARLIER et al., 2020; YE et al., 2021). This scenario highlights the direct relationship between environmental events and overload of health systems.

In addition to infectious and respiratory diseases, studies also indicate an increase in health problems related to environmental stress, including cardiovascular problems and impacts on mental health. Situations such as food insecurity, loss of territory, and extreme weather events have been associated with increased anxiety, psychological distress, and other mental health-related conditions, especially in more vulnerable populations (MOURÃO, 2025). This aspect further broadens the understanding of the impact of climate change, showing that its effects go beyond the physical dimension of health.

The vulnerability of Amazonian populations appears as one of the central elements in the discussion of the results. Indigenous and riverine communities are particularly affected, both by direct exposure to environmental impacts and by limitations in access to health services. Studies indicate that these populations face greater difficulties in coping with diseases, due to factors such as geographic isolation, social inequalities, and the fragility of health care networks (ANDRADE et al., 2021; BRONDÍZIO et al., 2016). This context reinforces the need for public policies that consider the territorial and cultural specificities of the region.

In this scenario, the performance of the multiprofessional health team is essential. The results indicate that effective responses to changes in the profile of diseases depend on the integration between different areas of knowledge. Doctors and nurses work directly in the diagnosis and clinical management, while pharmacists contribute to safe therapeutic follow-up. Physiotherapists play an important role in the rehabilitation of patients with respiratory

and cardiovascular diseases, and nutritionists work to prevent problems related to food insecurity and malnutrition (FERREIRA et al., 2023).

In addition, the work of professionals in the public health and social sciences is essential to understand the social determinants of health and develop more effective intervention strategies. The integration of these different areas allows us to build more complete responses, capable of dealing with the complexity of the impacts of climate change on health.

The discussion of the results also highlights the need to strengthen health systems in the face of the new demands imposed by climate change. The expansion of epidemiological surveillance, the qualification of professionals and the reorganization of health services are essential measures to ensure faster and more effective responses. In addition, public policies aimed at environmental protection, such as the control of deforestation and fires, play a fundamental role in reducing negative impacts on health (VIANA, 2020).

Overall, the findings indicate that climate change in the Amazon not only increases the occurrence of diseases, but also profoundly transforms the epidemiological profile of the region. This process requires a change in the way of thinking and organizing health care, valuing integrated and multiprofessional approaches. The construction of strategies that articulate health, environment and public policies becomes essential to face current and future challenges, ensuring better living conditions for Amazonian populations and contributing to global health.

5 CONCLUSION

The analysis developed in this chapter shows that climate change in the Amazon has caused profound transformations in the profile of diseases, configuring an increasingly complex scenario for public health. It is not only a matter of the increase in already known diseases, but of a reconfiguration of the epidemiological pattern, marked by the coexistence of infectious diseases, chronic conditions, and environment-related conditions. This new context reinforces that the climate crisis must also be understood as a health crisis, with direct impacts on the lives of populations.

The results indicate that factors such as deforestation, fires, and changes in natural cycles have contributed significantly to the emergence and intensification of climate-sensitive diseases. At the same time, these processes amplify existing social vulnerabilities, especially among indigenous populations, riverside dwellers, and communities in situations of greater socioeconomic fragility. In this way, climate change not only influences health, but also deepens inequalities, requiring fairer and more contextualized responses.

In this scenario, the performance of the multiprofessional health team becomes indispensable. The complexity of the diseases requires an integrated approach, in which physicians, nurses, pharmacists, physiotherapists, nutritionists, dental surgeons and public health professionals act in an articulated manner. This integration allows not only the clinical management of diseases, but also the development of strategies for prevention, health promotion, and epidemiological surveillance that are more effective and sensitive to local realities.

In addition, the findings reinforce the need to strengthen health systems, especially in primary care, which plays a central role in the early identification of diseases and in the follow-up of populations. Investing in professional qualification, expanding access to services, and integrating health and the environment is essential to respond to the new demands imposed by climate change.

Another essential point concerns the importance of intersectoral public policies. The protection of the Amazon, the control of fires and the preservation of ecosystems are not only environmental measures, but fundamental strategies for health promotion. The articulation between environmental, social and health policies is indispensable to face current challenges and reduce future impacts.

In this context, it is concluded that understanding and facing the new profile of diseases in the Amazon requires a change of perspective, which recognizes the interdependence between environment, society and health. The construction of effective responses necessarily involves the integration between science, professional practice and public policies, valuing multiprofessional care and sustainability as fundamental pillars for global health.

REFERENCES

- Andrade, L. M. B., et al. (2021). Health-related vulnerability to climate extremes in the Brazilian Amazon. *PLOS ONE*, 16(11), e0259988.
- Artaxo, P., et al. (2023). Amazon deforestation and climate change: Impacts on biodiversity and global climate. *Proceedings of the National Academy of Sciences*, 120(50), e2303630120.
- Bonilla-Aldana, D. K., et al. (2019). Amazonian zoonoses and emerging infectious diseases: Challenges for global health. *Travel Medicine and Infectious Disease*, 31.
- Brondízio, E. S., et al. (2016). The Amazonian challenge: Development and social impacts of climate change. *Global Public Health*, 11(5–6), 566–582.
- Butt, E. W., et al. (2021). Large air quality and human health impacts due to Amazonian fires. *GeoHealth*, 5(8), e2021GH000429.

- Chowdhury, R., et al. (2024). Saving the Amazon and implications for global health. *The Lancet Global Health*, 12(3), e450–e458.
- Ferreira, M. A. M., et al. (2023). Impact of climate change on public health in Brazil. *Revista de Saúde Pública*, 57.
- Leal Filho, W., et al. (2018). Climate change and vector-borne diseases in Brazil: A review. *Journal of Cleaner Production*, 196, 135–145.
- Lee, S. A., et al. (2021). Climate change and the expansion of dengue in Brazil. *PLoS Neglected Tropical Diseases*, 15(3), e0009210.
- Marlier, M. E., et al. (2020). How do Brazilian fires affect air pollution and public health? *GeoHealth*, 4(2), e2019GH000218.
- Mourão, R. M. S. (2025). Environmental degradation and climate extremes as determinants of health in the Amazon. *Revista Pan-Amazônica de Saúde*, 16, e202501825.
- Nava, A., et al. (2017). Environmental changes and emerging infectious diseases in Brazil. *ILAR Journal*, 58(3), 393–404.
- Viana, V. (2020). Climate justice, deforestation and global health. In *Sustainable development in the Amazon* (pp. 215–230). Springer.
- Ye, T., et al. (2021). Risk and burden of hospital admissions associated with wildfire-related PM2.5 in Brazil. *The Lancet Planetary Health*, 5(7), e386–e395.

AESTHETIC REHABILITATION USING THE DOUBLE CEMENTATION TECHNIQUE TO MASK DENTAL SUBSTRATES OF DIFFERENT COLORS – CASE REPORT

REABILITAÇÃO ESTÉTICA UTILIZANDO A TÉCNICA DA DUPLA CIMENTAÇÃO PARA MASCARAR SUBSTRATOS DENTÁRIOS DE CORES DIFERENTES – RELATO DE CASO

REHABILITACIÓN ESTÉTICA UTILIZANDO LA TÉCNICA DE DOBLE CEMENTACIÓN PARA ENMASCARAR SUSTRATOS DENTALES DE DIFERENTES COLORES – REPORTE DE CASO



<https://doi.org/10.56238/sevened2026.008-243>

Adria Stephanie Xavier Barroso¹, Hévilly Yorrana Alcântara Aguiar², Hêmilly Suélen Sousa Guilherme³, Maria Nikaele Campos do Carmo Alcantara⁴, Pedro Henrique Soares Silva⁵, Ana Kellen Parente do Nascimento⁶, Rayssa de Fátima Lopes Arruda Carneiro⁷, Conceição Mikaelly de Vasconcelos Linhares⁸

ABSTRACT

Discomfort related to the color and shape of teeth has become one of the main reasons patients seek rehabilitative treatment. Therefore, it is particularly challenging when the teeth involved in this disharmony are anterior. The diagnosis of the type of stain will determine the technique that the dentist should use. The choice of material, planning, and execution criteria are extremely important for the success of the procedure. The present study aims to report a clinical case of a patient who attended a dental office in the city of Sobral, Ceará, with an aesthetic complaint. This research adopts a qualitative approach, without a control group, of a narrative nature, with a descriptive and observational purpose, based on a single clinical case sample to be studied. The bibliographic search was carried out in the PubMed, SciELO, and Google Scholar databases, related to the restorative technique for darkened teeth using ceramic veneers. The descriptors used were: “tooth whitening,” “dental trauma,” “dental porcelain,” and “endodontics.” The clinical case concerns a 35-year-old female patient, systemically healthy, who attended the dental office complaining about the color and size of her anterior teeth. After a detailed anamnesis, clinical and radiographic examinations, and the patient’s medical history, endodontic treatment was observed in tooth 11, along with coronal discoloration and disharmony in the height/width proportion of teeth 13, 12, 11, 21, 22, and 23. Subsequently, ceramic rehabilitation using lithium disilicate veneers was

¹ Dental Surgeon. Centro Universitário INTA-UNINTA. E-mail: adriastephanie6@gmail.com

² Dental Student. Faculdade Luciano Feijão (FLF). E-mail: hevillyyorranaflf@gmail.com

³ Dental Student. Faculdade Luciano Feijão (FLF). E-mail: hemillyssousa@gmail.com

⁴ Dental Student. Faculdade Luciano Feijão (FLF). E-mail: nikaele120529.at@gmail.com

⁵ Dental Student. Faculdade Luciano Feijão (FLF). E-mail: Phsodalca@outlook.com

⁶ Dental Student. Faculdade Luciano Feijão (FLF). E-mail: kellenparente@gmail.com

⁷ Master’s degree in Health Sciences. Universidade Federal do Ceará (UFC).

E-mail: rayssa_carneiro@hotmail.com

⁸ Master’s degree in Dentistry. Universidade de Fortaleza (UNIFOR).

E-mail: mikaelly.linhares@flucianofejao.com.br

performed on these dental elements, along with a full metal-free crown and veneer on tooth 11.

Keywords: Tooth Whitening. Dental Trauma. Dental Porcelain. Endodontics.

RESUMO

O desconforto atrelado à coloração e formato dos dentes tornou-se uma das grandes procuras por tratamento reabilitador. Portanto, é desafiador, especialmente quando os dentes envolvidos nessa desarmonia são anteriores. O diagnóstico do tipo de mancha irá indicar a técnica que o cirurgião dentista deverá utilizar. A escolha do material, o planejamento e os critérios na execução são de extrema valia para o sucesso do procedimento. O presente estudo tem como objetivo relatar um caso clínico de uma paciente que compareceu ao consultório odontológico, na cidade de Sobral-Ceará, com queixa estética. Essa pesquisa apresenta uma abordagem do tipo qualitativa, sem grupo de controle de caráter narrativo, que tem finalidade descritiva e observacional, de amostra única de um caso clínico a ser estudado. As buscas bibliográficas foram realizadas nas bases de dados PubMed, SciELO, Google Acadêmico, relacionados à técnica restauradora de dentes escurecidos com facetas cerâmicas. Os descritores utilizados foram: “clareamento dentário”, “traumatismo dentário”, “porcelana dentária” e “endodontia”. O caso clínico trata-se de uma paciente do sexo feminino, 35 anos de idade, normossistêmica, que compareceu ao consultório odontológico, queixando-se da cor e do tamanho dos dentes anteriores. Após anamnese detalhada, exames clínicos, radiográficos e história pregressa da paciente, foi observado tratamento endodôntico no elemento 11, escurecimento coronário, além de desarmonia entre a proporção altura/largura dos elementos 13, 12, 11, 21, 22 e 23, e posteriormente foi realizada reabilitação cerâmica de dissilicato de lítio do tipo faceta nesses elementos dentários e coroa metal free total mais faceta no elemento 11.

Palavras-chave: Clareamento Dentário. Traumatismo Dentário. Porcelana Dentária. Endodontia.

RESUMEN

La incomodidad relacionada con el color y la forma de los dientes se ha convertido en una de las principales razones por las que los pacientes buscan tratamiento reabilitador. Por lo tanto, resulta especialmente desafiante cuando los dientes involucrados en esta desarmonía son anteriores. El diagnóstico del tipo de mancha indicará la técnica que el odontólogo deberá utilizar. La elección del material, la planificación y los criterios de ejecución son de suma importancia para el éxito del procedimiento. El presente estudio tiene como objetivo reportar un caso clínico de una paciente que acudió a una consulta odontológica en la ciudad de Sobral, Ceará, con una queja estética. Esta investigación presenta un enfoque cualitativo, sin grupo de control, de carácter narrativo, con finalidad descriptiva y observacional, basada en una muestra única de un caso clínico a ser estudiado. La búsqueda bibliográfica se realizó en las bases de datos PubMed, SciELO y Google Académico, relacionadas con la técnica restauradora de dientes oscurecidos mediante carillas cerámicas. Los descriptores utilizados fueron: “blanqueamiento dental”, “traumatismo dental”, “porcelana dental” y “endodoncia”. El caso clínico corresponde a una paciente de sexo femenino, de 35 años, sistémicamente sana, que acudió a la consulta odontológica quejándose del color y tamaño de los dientes anteriores. Tras una anamnesis detallada, exámenes clínicos, radiográficos y la historia previa de la paciente, se observó tratamiento endodóntico en el diente 11, oscurecimiento coronario y desarmonía en la proporción altura/ancho de los dientes 13, 12, 11, 21, 22 y 23. Posteriormente, se realizó rehabilitación cerámica con carillas de disilicato de litio en estos elementos dentarios, además de una corona total libre de metal junto con carilla en el diente 11.

Palabras clave: Blanqueamiento Dental. Traumatismo Dental. Porcelana Dental. Endodoncia.

1 INTRODUCTION

Overestimating the aesthetic standards imposed by the media resulted in the search for a standard of beauty representative of professional, economic, and social success (BISPO, 2018). In this sense, it is known that dental aesthetics is directly linked to the patient's well-being and there are several ways to correct problems related to alignment, symmetry, position, texture. Among the elements that make up the aesthetics of the smile, the color of the teeth is the one that most bothers the individual (GRESNIGT; KALK; OZCAN, 2012).

Alves Rezende and Fajardo (2016) explain that progress, the circulation of new operative techniques and new dental materials have opened an important direction for aesthetics and health in the field of dentistry by both professionals and patients.

Therefore, according to today's aesthetic premises, discomfort with tooth color is, without a doubt, one of the main reasons that leads patients to seek a more harmonious smile (BARBOSA; NERES; AMARAL, 2021).

It is known that color is a complex and subjective phenomenon, which can be captured in different ways, depending on the object, source of lighting and the observer. In addition, tooth color is affected by several factors, such as enamel morphology and thickness, light, presence of pigmentation characterized by intrinsic and extrinsic factors, and the amount of dentin eventually exposed (SHEN; RAWLS; ESQUIVEL-UPSHAW, 2023).

As the tooth ages, there is a decrease in the size of the pulp chamber, a characteristic of this course, leading to the deposition of secondary dentin, modifying the color of the dental substrate to a darker tone. In addition, the association of abrasion and erosion processes causes a reduction in the amount of enamel, gradually transmuting the evident color of the underlying dentin (BEGUM et al., 2014).

Tooth pigmentations of intrinsic causes can be defined and localized, confined to the region of a single tooth element. Its causes are: trauma to developing teeth, periapical infection, trauma to the deciduous tooth, pigmentation by amalgam or inadequate endodontic treatment. In addition, they can also be generalized, dispersed throughout the crown of one or several teeth, among them are: amelogenesis imperfecta, dentinogenesis imperfecta; 12 accompanied by systemic disorders. There are also postnatal causes, such as infections, drug therapy, nutritional deficiencies, and hematopoietic diseases (BISPO, 2018).

Thinking about the correction of these types of dental stains, new materials, techniques and protocols are made available to the dental surgeon, bringing new techniques to mask unwanted substrates, resulting in restorations that appear close to the natural tooth (BASEGIO, 2018).

Tooth whitening is a technique that can be exemplified as conservative, developed to

improve the appearance of the smile through changes in dental nuances, being considered a non-invasive and low-cost method (VASCONCELOS; NILLIO, 2021).

In addition, currently, there is a diversity of ceramic systems available for both aesthetic and functional rehabilitation. However, there is no single all-ceramic system that can be used in all clinical situations (ZÜGE, 2018).

An integral adhesion between ceramic materials and the tooth structure can be obtained through adhesive cementation, which promotes mechanical integration of the system, contributing to its resistance to fracture. In addition, there was a need for improvements in adhesive dentistry and computer-aided technologies, which made it possible to describe various treatment options for the rehabilitation of anterior teeth, such as crowns, veneers, laminates, among others (GUNDOGDU; ALADAG, 2018).

However, the elevation of patients' aesthetic expectations to achieve good results in anterior teeth requires materials with optical properties similar to natural teeth, making rehabilitation more imperceptible (DANESHPOOY, 2019).

Given the above, it is presented how the analyzed clinical case will enable an aesthetic rehabilitation of darkened and heterogeneous dental substrates, using the technique of double cementation of personalized ceramic copings associated with ceramic veneers.

2 OBJECTIVES

2.1 GENERAL OBJECTIVE

OBJECTIVE: To report a clinical case of rehabilitation using the double cementation technique in anterior teeth, with the association of personalized ceramic coping and ceramic veneer, as an aesthetic solution for masking dental substrates of different colors.

2.2 SPECIFIC OBJECTIVES

- a) To highlight the etiology of tooth darkening;
- b) To address the main techniques for aesthetic restoration in darkened teeth;
- c) Report the clinical and operative steps of the double cementation technique of ceramic custom copings

3 THEORETICAL FRAMEWORK

3.1 DENTAL AESTHETICS

Cosmetic dentistry is expressed as a very representative division in modern dentistry, through which the importance given by patients to achieving an aesthetically promising smile is increasingly verified. In addition, the search for a standard of beauty pre-established by

society in which the appearance of the smile must be a real reproduction of natural teeth is notorious (FRADEANI, 2007 apud OLIVEIRA et al., 2019).

However, it is known that dental aesthetics is a crucial reason to achieve a smile considered beautiful and harmonious, and it is essential to determine some parameters, such as the size and shape of the teeth, to establish the formation of a dentofacial pattern. Another important criterion is the golden ratio, which can be applied as a system of aesthetic predictions, whose objective is to work on the harmony between the size and width of the teeth. Therefore, many studies suggest it as an aesthetic criterion that serves to restore and reproduce the previous and superior elements (PONTANEGRA et al., 2022).

Another important factor to be considered in the analysis of the smile is gingival aesthetics, which often requires surgical interventions, such as gingivoplasty and/or gingivectomy, in order to provide an enlargement of the dental clinical crown and correct the proportion displayed in the smile (BARROS et al., 2018). The balance between white aesthetics and red aesthetics is the secret to success in rehabilitation treatments. Thus, it is essential to use interdisciplinary protocols in the various areas of dentistry, especially in periodontics and dentistry, which are connected to treatments for aesthetic purposes (VIEIRA et al., 2018).

Therefore, there are several factors that alter dental aesthetics, including its change in shape, such as trauma; color change due to the state of pulp vitality; use of drugs; diet; pigmentation by filling materials; aging; pulp hemorrhages and surface alterations, such as dental malformation, fluorosis, amelogenesis imperfecta, among others (BARBOSA; NERES; AMARAL, 2021).

3.2 ETIOLOGY OF TOOTH DARKENING

Tooth darkening occurs due to natural aging of the teeth or by factors called intrinsic or extrinsic (TREVISAN et al., 2018). In addition, it has a negative effect on an individual's well-being, especially when it comes to a previous element. In this case, it is common for patients to seek professional help, aiming for a harmonious and satisfactory result (FAGOGENI et al., 2019).

Variation in tooth pigmentation is a common objection of people and has a multifactorial etiology. Of the intrinsic type, it results from odontogenesis, fluorosis, dental weakening as a result of the generation of repairing dentin, trauma, pulp necrosis, among other factors; the extrinsic type is caused by environmental or behavioral factors: smoking, consumption of products with dyes such as coffee, wine, tea, and even the use of medications (BANDÉCA et al., 2010; COSTA et al., 2020; DONATO, 2017).

It is important to note that congenital intrinsic spots are due to dentinogenesis imperfecta, amelogenesis imperfecta, and fluorosis. Acquired lesions, on the other hand, are subdivided into pre-eruption, such as those caused by the use of tetracycline, and posteruptive, such as those resulting from trauma; as well as those of iatrogenic causes, due to the inappropriate use of some root canal filling materials or the performance of metal restorations (CAMARGO et al., 2019).

Another situation is when the endodontic access to the crown is insufficient, generating a grayish stain, caused by necrotic residues of pulp in this region (CAMPAGNOLI; JUNIOR; 2008).

Thus, the change in tooth color is considered an aesthetic difficulty that results mainly from the incomplete removal of pulp tissue during endodontic treatment or even from the prolonged use of some intracanal materials, such as medications used between sessions and also by trauma injuries. Likewise, the color variation occurs due to the rupture of blood vessels, leading to hemorrhage in the pulp chamber, where there is a change in the color of the crown caused by the entry of blood components into the dentin tubules (OLIVEIRA et al., 2019).

The prognosis for rehabilitation of darkened anterior teeth depends on the time in which the trauma occurred, the intervention, the restorative technique chosen, and therefore the extent of the preparation (SILVA et al., 2019).

It is known that pigmented teeth can cause discomfort when smiling and introversion for the patient. However, the treatment for these cases is still complex and involves a precise analysis and understanding of their etiology (BARBOSA; NERES; AMARAL, 2021; DONATO et al., 2017; SILVA NETO et al., 2020).

3.2.1 Dental Trauma

Dental trauma follows a major impact on the teeth, which can lead to injuries to intraoral and extraoral structures, hard and soft tissues, causing from tooth displacement, deformation of the supporting tissues, to fracture of the affected tooth. In this context, dental injury usually happens either occasionally, unexpectedly, or accidentally, and may require emergency care (DANG et al., 2015).

However, those that involve the anterior dental elements influence the function and aesthetics of the individual, affecting their behavior. It becomes an occurrence that goes beyond dentistry and endodontics, being able to include other dental specialties, such as surgery, periodontics, prosthetics and orthodontics (VASCONCELLOS; MARZOLA; GENU 2006).

Therefore, dental trauma is an objection in global public health, caused mainly in children, adolescents, and young adults (LEVIN et al., 2020). Pulp tissue can go through a process called dystrophic calcification, when there is not enough blood and there is the presence of ischemic and necrotic tissues, and can reach the entire length of the tissue, obliterating the entire pulp cavity, leaving the tooth with a dark color of varying nuances (MILESKI et al., 2018).

Therefore, there are diversified options to camouflage teeth with darkened substrates, for example, the use of teeth whitening, composite resins and the use of ceramics. Thus, it is up to the dental surgeon to choose the most appropriate material, following its indications, contraindications, and mastery of the technique (CORDEIRO, 2021).

3.2.2 Endodontic Treatment

According to Mandras et al. (2013), endodontic treatment aims to clean and shape the root canal, favoring the removal of infected or necrotic live pulp, reducing the amount of microorganisms and their by-products present.

Regarding endodontic therapy, according to Tour Savadkouhi and Fazlyab (2016), the main causes of the change in tooth color and structure are the filling materials. This is due to its incorporation into the dentin tubules (RABELO et al., 2022).

However, the variation in tooth color generated after endodontic treatment is a challenge to clinical practice and an inconvenience to the patient, due to the undesirable appearance, especially in anterior teeth (BOSENBECKER, 2020).

When the cause of the darkening is due to dental trauma, Marin, Bartold, and Heithersay (1997) report that enamel pigmentation by blood components possibly becomes more expressed with long-term display. Even if enamel does not have tubular morphology, its organic structural characteristics at the dentin-enamel junction may play a role in the staining process.

3.3 TEETH WHITENING

According to Bispo (2018), tooth whitening is a procedure based on scientific evidence that seeks to combat undesirable agents related to color changes of extrinsic or intrinsic cause. Its objective is based on the use of substances that have a high potential for oxygen release through an oxidation reaction of collagen fibers, which occurs due to the oxidation process of organic pigments present in teeth. Whitening agents release oxygen molecules that break down these pigments responsible for tooth stains, thus leading to discoloration of these compounds and resulting in teeth whitening (FIORILLO et al., 2019).

The most commonly used bleaching agents are hydrogen peroxide, carbamide peroxide, and sodium perborate (BANDÉCA et al., 2010; CARDOSO et al., 2011; MARTINS et al., 2009). They are mainly indicated for pigmentation of extrinsic origin, as previously mentioned, arising from pigments present in food and beverages, chromogenic or chromogenic bacteria, tobacco tar and chemical products (BISPO 2018).

The whitening process can be carried out both in the office, by the dental surgeon, applying higher concentrations of hydrogen peroxide or 18 carbamide, and at home, using individual trays with the same bleaching agents at lower concentrations (ALMEIDA et al., 2021; RODRIGUES et al., 2018); or even the combination of the two types of procedures (CAMARGO et al., 2021).

According to Vasconcelos and Nillio (2021), regarding the advantages, it is stated that regardless of the method chosen, tooth whitening is the most careful, economical and regularly used option to solve patients' concerns regarding tooth pigmentation and is very effective in modifying the value of the tooth.

However, it is a technique that requires correct indication and a thorough clinical evaluation, as it has as contraindications the presence of caries, supragingival stones, gingivitis, periodontitis, root exposures, among others. The procedure is also not recommended for children under 18 years of age or for pregnant and breastfeeding women, according to the Council of European Dentists (CED) (VASCONCELOS; NILLIO, 2021).

3.3.1 Internal Whitening

For Maran et al. (2018), endogenous whitening is a choice for teeth that have undergone endodontic treatment, inserting the whitening substances inside the pulp chamber, which can be used in three ways: mediate, immediate, or mixed.

According to De Geus (2018), in the mediate technique, the patient remains with the product inside the pulp chamber for a period of three to seven days, changing it until the desired color is obtained. In the second method, the bleaching agent is applied both inside the pulp chamber and on the buccal surface of the element, obtaining the result soon after the completion of the procedure in a single session. In the mixed process, the two techniques mentioned above are united.

Mediate internal whitening was a widely applied technique due to its minimally invasive characteristic, however, it had some possible side effects, such as external cervical resorption and color recurrence (CARDOSO et al., 2011).

According to Bispo (2008), the effects of pulp tissue decomposition, caused by dental trauma or necrosis, would be the main indication of this technique, as it obtained satisfactory

results in 95% of cases. This happens because the 19 stain comes from the premature destruction of red blood cells, promoting yellowish-brown coloration, originating from the concomitant production of ferrous sulfate in the dentin tubules.

Therefore, another option for the mediate technique would be: sodium perborate with 35% carbamide peroxide (approximate values of 10-12% hydrogen peroxide), in which the release of peroxide radicals is less severe and slower, when compared to the mixture with hydrogen peroxide. In this way, sodium perborate decomposes into sodium metaborate, hydrogen peroxide, and oxygen, thus creating the expected whitening effect (BISPO 2018).

3.3.2 External Whitening

External whitening is more indicated for vital teeth, through office techniques that apply hydrogen peroxide or carbamide peroxide on tooth surfaces, or through the home technique, in which an individual tray is made using the same agents in lower concentrations (BANDÉCA et al., 2010; CARDOSO et al., 2011; MARTINS et al., 2009; RODRIGUES et al., 2018).

Idealized by Ames (1937), according to Marson, Sensi and Arruda (2008) and Azevedo (2009), the bleaching agents used are hydrogen peroxide with its concentrations varying between 6%, 7.5%, 10%, 30%, 38% and 40%, and carbamide peroxide, changing its concentrations between 10%, 16%, 22%, 35% and 37%.

In office whitening, the technique is performed in one or three clinical sessions, with hydrogen peroxide or carbamide solutions, applied to the teeth, most commonly used at a concentration of 35% for the time recommended by the manufacturer. As disadvantages, care must be taken, as hydrogen peroxide is highly oxidizing and harmful to soft tissues when used in large concentrations. Therefore, the gums, tongue and cheeks must be protected by means of retractors and physical barriers (VAZ et al., 2016).

There are 3 forms of presentation on the market, manual mixing with heat blocker, for the use of light sources during the procedure; another of mechanized mixing, which is done by means of 2 syringes attached; and, finally, the double syringe, with its self-mixing tip that only activates the amount sufficient for application (REIS, 2021). 20 For home whitening, a whitening gel based on carbamide peroxide is used with percentages of 10%, 16%, 22% and 35%, or hydrogen peroxide of 6%, 7.5% and 10% (BISPO, 2018).

Its technique consists of the use of individual trays, with which the patient applies the gel himself. Therefore, it is essential that the patient collaborates for an ideal result during treatment (BARBOSA et.al., 2017). The instructions for use of the product should follow the manufacturer's recommendations, which sometimes advises two applications a day lasting between 30 minutes and 2 hours, or one application, depending on the product's interval.

Treatment can last from 2 to 6 weeks. The patient should be instructed on how to place the whitening gel on the trays and how to remove excess (RODRIGUEZ; MARTINEZ, et.al., 2018).

It is worth noting that even considered a safe procedure, whitening may have side effects, such as tooth sensitivity, in addition to little predictability of the final result (BEGUM et al., 2014).

3.4 COMPOSITE RESIN VENEERS

Veneers are defined by the covering of the buccal surface of the dental element by a restorative material, connected to the tooth, which can be made in two ways, by the direct or indirect technique (MAGNE; BELSER, 2003). They are indicated for deficient corrections after orthodontic treatment, such as in cases of congenital disabilities and acquired aesthetic deficiencies, as well as for discolorations, diastemas, abfraction injuries, abrasion and erosion, dental fractures, caries and functional defects (DIETSCHI, 2008).

Despite the many advantages of resins, there are still difficulties when selecting their color. This step is considered essential in restorative success, however, if the anatomical shape is not correct, the result will not seem natural and harmonious either (PONTONS-MELO; FURUSE; MONDELLI, 2011).

Nahsan et al. (2012) ensure the practice of preserving the dental structure, especially in young patients such as children and adolescents, since with each restoration change, which is inevitable throughout the patient's life, there is a healthy tooth loss, inexorable to its practice. Therefore, the first composite resin restoration should be as conservative as possible, avoiding complex costs and treatments in the future.

Aesthetic flaws are one of the main reasons for changing resin restorations. Not only is it necessary to mimic tooth coloring with resin color at the time of restoration, but also that this set maintains its aesthetic properties over time (SCHULZE et al., 2003).

3.5 CERAMIC LAMINATES

Ceramic Laminates are considered an aesthetic method, with appropriate optical properties and correlated with good mechanical resistance, as well as having a high biocompatibility. In this sense, the use of this material is considered one of the preferable treatment alternatives, aiming at modifying the hue and shape of the anterior teeth with aesthetic compromise, such as fractured, darkened or poorly positioned teeth in the arch (KANDIL et al., 2019).

Thus, with the technological development in the area of ceramics and cementing

agents, it is plausible to achieve restorations very similar to natural teeth (TURGUT; BAGIS, 2013).

In this context, the search for aesthetic materials that resemble the natural characteristics of the teeth has made dental ceramic systems improve more and more, and are currently highly demanded in offices, due to their characteristics and clinical performance. Therefore, the daily use of ceramic restorations to reestablish aesthetics in dental clinics is evident (SANTOS; COSTA, 2019).

Currently, ceramics are the crucial alternative restorative material for previously destroyed tooth structure, due to their properties, such as: compressive strength, thermal conductivity, radiopacity, marginal integrity, hue stability and biomimicry (CORDEIRO; MONTEIRO, 2021).

According to Almeida and Silva (2011), lithium disilicate-based ceramics are a great possibility to mask the darkened substrate, since it has good properties in relation to chroma in small thicknesses, excellent mechanical properties.

Santos and Costa (2019) emphasize another important point to be considered, the correct indication of the different types of pure ceramic systems available on the market. To do this, the dentist must understand the main differences between crowns, veneers, lenses, and ceramic laminates, thus reaching the minimum thickness required for these indirect restorations for aesthetic and functional results.

Depending on the variations of substrate in the tooth, a correct selection of the thickness of the ceramic, as well as the color of the cement, is essential for better aesthetic results (VASCONCELOS; NILLIO, 2021).

An important piece of information highlighted by Alothaman and Bamasoud (2018) is that porcelain veneers enable excellent aesthetic results, longevity and patient satisfaction.

Vargas, Bergeron and DiazArnold (2011) explain the classification of ceramic systems, according to the composition of their matrix, into: Glassy Ceramics, Feldspar Ceramics, Glassy Ceramics Infiltrated by Crystalline Particles, Leucite Reinforced Ceramics, Lithium Disilicate Reinforced Ceramics, Crystalline/Polycrystalline Ceramics, Alumina Reinforced Polycrystalline Ceramics and Zirconia Reinforced Polycrystalline Ceramics.

3.5.1 Classification of Ceramics

· Lithium Disilicate Reinforced Ceramics

Classified as a vitreous ceramic with a high crystalline content, its difference is that it can be manufactured with a reduced thickness, up to 0.2 millimeters, without compromising its resistance, and presents excellent aesthetic results (TUNCDEMIR; GULBAHCE;

AYKENT, 2020).

"Lithium disilicate crystals are dispersed in a blocking structure that prevents the propagation of cracks through energy-absorbing processes, such as deflection cracking and branching" (SCHWEIGER et al., 1999).

Its composition is formed by lithium dioxide, alumina, quartz, potassium oxide, phosphoric oxide, in addition to other elements. In addition, it has an appearance similar to natural dentition and high resistance to thermal shock due to its low thermal expansion resulting from its processing (RITTER, 2010).

According to Gundogdu and Aladag (2018), the type of cement and the specific cementation technique applied also play significant roles in the clinical success and longevity of ceramic restorations. Soft-23 cements are recommended for the cementation of all-ceramic restorations, especially for those using silica-based ceramics.

3.6 CEMENTS

Cements are divided into conventional and adhesive. Conventional cements undergo acid/base reaction in their setting process, such as Zinc Phosphate Cement, considered the oldest among cementing agents, which has high intrinsic properties, however, it does not adhere to the tooth structure or the material, requiring retentive preparation (LEE; MCLAUREN, 2012).

In addition, another type of conventional cement is Glass Ionomer Cement (CIV), which binds to calcium by a process called chelation, however, it does not adhere to restorative materials, and retentive preparation is also necessary (ANUSAVICE, 2013).

Resin cements are the most recommended for the adhesive cementation of ceramic tiles. They provide better adhesion, as well as superior mechanical and optical properties (greater selection possibilities and color stability), high hydrolysis resistance, and great tensile strength (CAMARGO et al., 2019; GUILARDI et al., 2020; KIRSTEN et al., 2018).

According to Anusavice (2013), these are classified according to the form of activation, which can be physical, chemical or dual. Physical activation happens through photoactivation, with light as activator and the initiator of the pre, camphorquinone. Chemically activated compounds have tertiary amine (base paste) as an accelerator and benzoyl peroxide (catalyst paste) as a pre initiator. Finally, the dual system has both physical and chemical form of activation.

These cements can also be classified according to the mode of adhesion, which can be conventional, through the hybridization of the dental substrate with conventional, self-etching or self-adhesive dentin adhesives, dispensing with the treatment of the tooth surface

(ANUSAVICE, 2013).

Conventional cements, in addition to favorable aesthetics, have better flexural strength, compression and higher shear strength, greater retention and fracture resistance of restorations, in addition to minimal infiltration and low solubility in aqueous medium (OLIVEIRA, 2013). However, they have the disadvantage of a judicious step, which is the drying of the dental substrate, because while the enamel needs to be completely dry, the dentin needs to be slightly moist for the formation of the hybrid layer to occur, making it a step often neglected by the operator (CHIRCA; BICLESANU; FLORESCU et al., 2021).

Self-adhesive cements have the advantage of simplifying adhesion procedures, saving time and, more importantly, thus reducing the "contamination window" (CAMARGO et al., 2019). They are believed to be moisture tolerant, release fluoride, and have no postoperative sensitivity (MAZIOLI et al., 2017). As disadvantages, adhesion to enamel produces lower bond strength than conventional cements (DE MUNCK et al., 2004; ABOHAMAR et al., 2005; HIKITA et al., 2007; DUARTE JUNIOR et al., 2008). Another example is its high viscosity, limited number of colors, yellowing of the surface due to the presence of tertiary amine and the short shelf life of some commercial brands (SOUZA et al., 2011).

According to Kirsten et al. (2018), most resin cements are dual-cured, composed of both self-curing and light-curing components. In some clinical conditions, the polymerization of light-curing cements becomes deficient due to the distance from the light source, the thickness and opacity of the restoration, which impairs adhesion (AZAD et al., 2018).

It is also worth mentioning the importance of treating the internal surface of the prosthetic piece in strengthening the union between the resin cements and the ceramic restoration, as well as the proper preparation of the enamel and dentin surfaces, which promotes the union between the tooth and the cement, as mentioned above (GUNDOGDU; ALADAG, 2018).

Therefore, the type of cement, the technique employed and the thickness of the restoration play an important role in the clinical success and longevity of ceramic restorations (GUPTA; GUPTA; GILL, 2021).

4 METHODOLOGY

The present study is a case report with a qualitative approach, with descriptive purposes, whose purpose is to show its clinical relevance, facilitate research and new reports on the same theme, based on evidence. To this end, all ethical and legal principles were respected in the conduct of patient treatments, consistent with the precepts of the Declaration of Helsinki of Resolution 466/12 of the National Health Council (CNS).

4.1 RISKS AND BENEFITS

The work presents minimal risks, since the researchers ensured the confidentiality of the information by signing documents such as the Informed Consent Form (ICF) signed by the patient and the Data Use Commitment Agreement (TCUD), avoiding the disclosure of confidential data, invasion of privacy, access to identification data, and risk to the security of the medical record. In case of damages resulting from the case report, full and free assistance will be offered for the necessary time, as well as the right to compensation.

On the other hand, as benefits, the research portrays a treatment option that has the potential to help not only the patient, but similar cases that may eventually arise, providing more scientific basis in the future.

4.2 ETHICAL ASPECTS

The clinical case report was approved by the Research Ethics Committee (CEP) of the INTA University Center – UNINTA, with an opinion number of 6,429,111. After 1 month of the patient's care and the identification of the possibility of reporting the procedure performed, she was informed about the publication of her case and invited to sign the Informed Consent Form (ICF) (Appendix A) and the Image Use Authorization Form (TAUI) (APPENDIX B), allowing the use and disclosure of data from her medical records and radiographic exams. It was evident that, in case of withdrawal, the patient could withdraw from participating in the research and withdraw her consent at any time.

The technical person responsible for the dental clinic was also invited to sign a Term of Trustee (TFD) (APPENDIX C), authorizing the researchers' access to the data contained in the medical records of the patient involved in this research. The letter of consent (APPENDIX D) of the establishment in which the research was carried out was also obtained and then presented to the CEP. The researchers will assume the commitment to maintain ethical conduct when handling and accessing the data in question with the CEP of the Centro Universitário INTA - UNINTA, ensuring the confidentiality of the data collected and the privacy of its contents, as recommended by Resolutions 466/12, of the CNS, through a Term of Commitment for the Use of Data (TCUD) (APPENDIX E).

5 CASE REPORT

The clinical case refers to a 35-year-old female patient who sought dental care in a private practice in the city of SobralCeará, reporting dissatisfaction when smiling, due to the size and color of the anterior dental substrates. After detailed anamnesis, clinical examination and radiographic examinations, tooth darkening of element 11 was identified due to

endodontic treatment and the restoration of composite resin with unsatisfactory color and shape (Figures 1 and 2), in addition to disharmony between the height/width ratio of the other teeth.

Initially, initial impressions were made to obtain a study model and assembly on an articulator for diagnostic wax-up (Figure 3).

Figure 1

Initial clinical appearance



Source: The authors, 2022.

Figure 2

Initial clinical aspect showing tooth darkening in tooth 11



Source: The authors, 2022.

Figure 3*Waxed model*

Source: The authors, 2022.

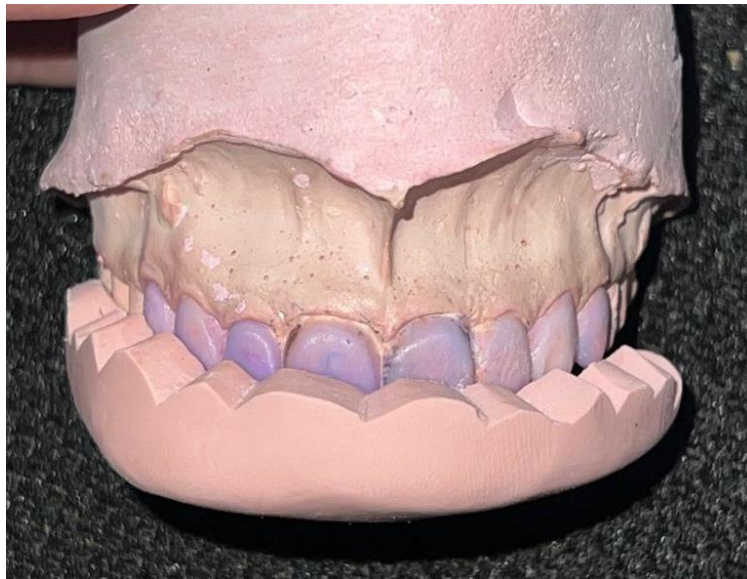
After the planning phase, external tooth whitening was performed in the office technique, in 3 sessions (Figure 4). Then, a silicone guide was made by molding the wax-up (Figure 5) of teeth 13, 12, 11, 21, 22 and 23 with heavy condensation silicon (Zetaplus®); and, subsequently, the mockup (Figure 6) was performed in bisacrylic resin (PROTEMP 3M®) before the dental preparation stage, thus respecting its initial format. Before the approval of the shape of the teeth, the patient requested rounding of the incisal battlements and reduction of 1 mm of the incisal border (Figure 7).

Figure 4*After external tooth whitening. Silicone guide made under diagnostic waxing*

Source: The authors, 2022.

Figure 5

Silicone guide made under diagnostic wax-up



Source: The authors, 2022.

Figure 6

1st Mockup in bisacrillic resin



Source: The authors, 2022.

Figure 7

2nd Mockup in bisacrolean resin



Source: The authors, 2022.

Next, the preparation of a ceramic crown was performed on tooth 11, in which a more invasive wear on the cervical third was recommended due to the degree of darkening of the tooth substrate; in the other elements, from 13 to 23, ceramic veneer preparation was performed (Figures 8 and 9). Both preparations were made with a diamond tip with a conical trunk shape with a rounded end – Tip 4138 (KG).®

Figure 8

Preparation for ceramic crown and ceramic veneer



Source: The authors, 2022.

Figure 9

Preparation for ceramic crown and ceramic veneers seen in profile



Source: The authors, 2022.

Then, the molding stage began. First, a retractor wire numbered 000 (Ultrapack-ULTRADENT®) was inserted, followed by the numbering 00 (Ultrapack-ULTRADENT)® (Figure 10). Then, the molding was carried out by the rebasing technique, using a total perforated plastic tray (MORELLI)® and addition silicone of light and heavy consistency (FUTURA DFL®). The preparations were initially captured with heavy silicon and then the internal part of the mold was worn with a spherical diamond drill bit numbered 1018 (KG).® Subsequently, a light consistency silicone was inserted inside the mold and on the surface of the preparations. Next, the tray was repositioned over the upper dental arch. The mold was sent to the prosthetic laboratory for pouring and making of the ceramic pieces.

Figure 10

Image after insertion of the retractor wires



Source: The authors, 2022.

The color selection of the darkened dental substrate was performed through photographs with external lighting sent to the laboratory (Figure 11).

Figure 11

Approximate image with an external light source for color selection in the laboratory



Source: The authors, 2022.

After molding, a third mockup was performed as a temporary character to wait for the veneers to be made, this time with the anatomy previously approved by the patient (Figure 12).

Figure 12

Mockup used as a provisional with anatomy approved by the patient.



Source: The authors, 2022.

The prosthetic specimen was made of ceramic with the addition of lithium disilicate by the injection method (IPS e-max Press, Ivoclar Vivadent, Schaan, Lietchenstein) (Figures 13, 14, 15, 16 and 17).

Figure 13

Veneers of teeth 12, 13, 22 and 23 adapted to the plaster model.



Source: The authors, 2022.

Figure 14

Personalized coping made over tooth 11



Source: The authors, 2022.

Figure 15

Personalized ceramic coping with overlaid ceramic facet



Source: The authors, 2022.

Figure 16

Adaptation of the ceramic veneer on the personalized ceramic coping of tooth 11



Source: The authors, 2022.

Figure 17

Ceramic pieces of elements 13, 12, 11, 21, 22 and 23.



Source: The authors, 2022.

After receiving the ceramic pieces from the laboratory, a dry test was performed to evaluate the adaptation, color, shape, proximal contacts, occlusal contact, and the need for rounding and reducing the incisal edge by 1.0 mm was identified, in addition to deepening the third inclination of the central incisors (Figures 18 and 19).

Figure 18

Dry proof of the ceramic in front view



Source: The authors, 2022.

Figure 19

Dry proof of the ceramic seen in profile



Source: The authors, 2022.

In the second session of the porcelain test, the requested corrections were checked (Figure 20) and, after the patient's approval, the resin cement was chosen through test cements (TRYING-ALLCEM®) (Figures 21 and 22).

Figure 20

Image showing the correction of the 3rd inclination of the central incisors.



Source: The authors, 2022.

Figure 21

Image of the color selection showing tooth 11 with a slightly grayer color



Source: The authors, 2022.

Figure 22

Image showing the correction of the color of tooth 11 after color selection using the test cements



Source: The authors, 2022.

Then, the cementing stage of the pieces began. It was prepared with 10% hydrofluoric acid (Condac porcelain, FGM®) for 20 seconds on its internal surface, cervical edges and on the external surface of the personalized ceramic coping; then, plenty of washing (Figures 23 and 24) and drying with an air jet were performed, followed by the application of silane (Prosil, FGM®) and natural drying for 1 minute (Figure 25).

Absolute isolation of the prepared teeth was performed using Young's archwire (Golgran®), rubber sheet (MADEITEX®) and ties with dental floss (Oral B®) (Figure 26).

Next, the tooth surface was prepared. Initially, prophylaxis was performed with a Robinson brush (Preven®) and pumice stone (Biodynamics®). Thus, tooth 11 was conditioned with 37% phosphoric acid (Condac - FGM®) for 15 seconds and then a conventional dentin adhesive (Single bond2 – 3M ESPE®) was applied; with the aid of an air jet, the solvent was volatilized for 30 seconds and then photocured for 20 seconds (Radii-cal SDI).® Selective acid was conditioned only on the enamel for 30 seconds on the other teeth; on the dentin, a universal dentin adhesive (Amber Universal APS - FGM®) was applied; the solvent was volatilized with the aid of an air jet and light-cured for 20 seconds. For cementation, a conventional light-curing resin cement (FGM® – Allcem Veneer APS) was used, which was applied inside the pieces that were then positioned on the preparations. Thus, it began with the cementation of the personalized coping and the use of transparent cement; bleach color was used for the cementation of the veneer of tooth 11 over the coping, while for the cementation of the other veneers, the color A1 was used.

The removal of excess cement was done with the aid of a microbrush (KG)® and dental floss (Oral B®). Then, light-curing was performed with a high-power LED photoactivator (Radii Cal-SDI®) for 60 seconds on each tooth face.

After cementing the ceramic pieces, the cementing line was polished with rubbers impregnated with silicon carbide, with medium and fine granulometry (Ultra-Gloss CA – American Burrs ®) (Figures 27 and 28).

Figure 23

Conditioning of the parts with 10% hydrofluoric acid for 20 seconds



Source: The authors, 2022.

Figure 24

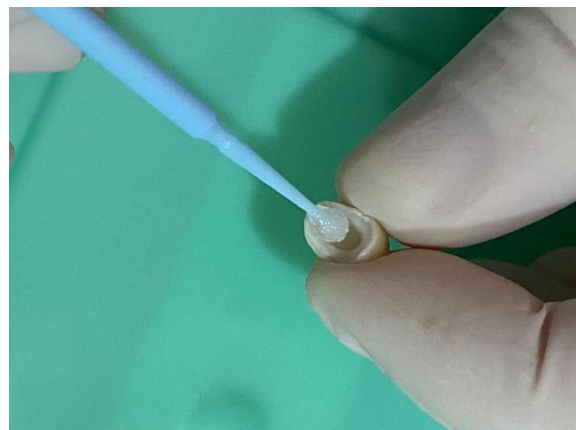
Plenty of washing



Source: The authors, 2022.

Figure 25

Application of silane (Prosil, FGM)



Source: The authors, 2022.

Figure 26

Absolute isolation



Source: The authors, 2022.

Figure 27

Final aspect with frontal view



Source: The authors, 2022.

Figure 28

Final appearance with profile view



Source: The authors, 2022.

After 5 months, maintenance of the ceramic veneers was performed, in which a new polishing of the cementation line was performed with fine polishing rubbers (America burrs®) (Figures 29 and 30).

Figure 29

Maintenance of veneers



Source: The authors, 2022.

Figure 30

Maintenance of veneers



Source: The authors, 2022.

6 DISCUSSION

According to Magner and Belser (2003), indirect veneers are indicated when dental problems arise in terms of shape, position, symmetry, texture and color, as can be seen in the case reported, in which the patient's main complaint was dissatisfaction with the color and shape of the anterior maxillary dental elements.

However, ceramic laminate veneers have been shown to be a successful treatment option for aesthetic rehabilitation in clinical practice in recent years. Ceramics have become the material of first choice as their excellent properties have been highlighted, such as biocompatibility, color stability, longevity, tooth-like appearances, different degrees of translucency and predictability of results (BENETTI et al., 2003).

Edelhoff et al. (2018), in addition to the aesthetic advantages, also reported the importance of ceramic restorations in terms of their biomechanical characteristics, such as high mechanical strength, durability, reestablishment of the biomechanics of the dentition and adequate function.

Therefore, as can be observed in the case in question, the heterogeneity of the substrate colors due to the presence of tooth darkening and pigmented restorations motivated the choice of lithium disilicate for the manufacture of veneers, due to its optical, biomechanical and adhesive properties, which reinforce the factors previously mentioned in the literature.

For Catão et al. (2007), the main danger associated with the internal whitening of a pulped tooth is the possible occurrence, within seven years after the procedure, of external dentin resorption. This resorption manifests itself in the neck of the tooth, in the area adjacent to the gingiva and is located near the point where the guttapercha was sealed, extending towards the apical end to the crest of the alveolar bone.

The origin of this phenomenon is not completely clear. However, there is speculation that hydrogen peroxide, when activated by heat, may diffuse through the dentin tubules until it reaches the region of the cervical periodontal ligament, potentially causing alterations in these structures and resulting in cell necrosis, thus triggering a process of inflammatory resorption (CATÃO et al., 2007).

Endorsing this information, Wendler et al. (2017) reported that lithium disilicate (IPS E.max - IvoclarVivadent), in its ability to reproduce the natural enamel of teeth, has excellent mechanical and aesthetic properties, as it has different opacity scales, ranging from translucent to opaque, thus having an impressive potential to mask different types of darkened substrates, resulting in color stability.

In addition, it is important to highlight the great advantage of using this ceramic system, which allows the manufacture of different restorations, as well as veneer and total crown. This is because the use of the same ceramic material for both restorations avoids aesthetic compromise between teeth and adjacent restorations, considering that there will be no influence of different optical properties resulting from different ceramic systems (PERRONI et al., 2015).

It is known that, in addition to the selection of the material of choice, a series of factors such as the thickness of this material, cement to be used, and the underlying structure of the tooth are essential for the success of the aesthetic rehabilitation treatment, as it has its particularities in the influence of the final color of the restorations (GEL, 2018).

In the present case, two distinct types of dental preparations can be observed, which were motivated by the type of rehabilitation to be performed and the degree of pigmentation of the dental substrate. Dental preparations for veneers are commonly limited to enamel, making ceramic pieces very thin and translucent. Therefore, laminates allow light to be transmitted through them and light scattering and reflection from the substrate, making it challenging to mask the underlying structures of the prepared tooth (EDELHOFF et al., 2018).

According to Sari et al., (2018), the thickness of the piece directly interferes with the final aesthetic result, since a thicker laminate will be less translucent and more opaque, thus reducing the effects of diffuse reflection of the underlying tooth, improving the propensity for masking.

In the case reported, tooth darkening of the acquired intrinsic type caused by endodontic filling materials in element 11 was observed, and of the extrinsic type caused by unsatisfactory restorative material. The literature reports the importance of the etiology of tooth darkening, as it is known that, in endodontically treated teeth, progressive pigmentation can occur that is difficult to remove caused by the presence of some endodontic filling cements positioned in the pulp chamber (ALSUBAIT; AL-HAIDAR; AL-SHARYAN, 2017).

In addition to the change in the color of the substrate, the intensity of darkening is also an important factor in the planning for this type of rehabilitation, influencing the amount of wear and the optical characteristics of the prosthetic specimen (ALSUBAIT; AL-HAIDAR; AL-SHARYAN, 2017).

Another important step for the success of rehabilitation is cementation, a fundamental factor for the longevity of the treatment. For the case in question, resinous cements of the conventional type were used, in order to obtain color stability and a lasting bond of the ceramic pieces with the dental tissue.

Reaffirming this information, Basso et al., (2017), report that the use of lithium disilicate crystals allowed the emergence of extremely thin ceramic veneers (3mm), associated with minimally invasive preparations. However, for this type of restoration, the use of appropriate resin cements is essential for the maintenance of aesthetics and color stability, since the small thickness of these restorations does not allow to mask the color changes of chemically activated cements, since these, together with dual resin cements, have tertiary amine as a chemical activator in their composition, which can compromise and cause changes in color over time, thus causing disharmony between restorations.

In line with what was reported, Perroni et al., (2016) state that these cements have different shades, and when the color of the ceramic is not completely satisfactory, it is possible to manipulate the tone of the cement so that a good color combination is reached between the laminates to be cemented and the adjacent teeth, which has become a high point in the choice of this type of cement for the case in question.

In this case, the lithium disilicate ceramic crown, as well as the veneers, aimed to mimic the substrate of element 11 compared to the other previous elements (13, 12, 21, 22 and 23), in order to harmonize the same nuance for everyone. To this end, the use of conventional resin cement was favored due to the wear obtained by the preparation of the ceramic crown on tooth 11, which allowed the application of an opaque layer at the base of the restoration. Conventional resin cements also allow for adhesive bond quality. Confirming the present case report, a good mimicry was observed, even in the case of substrates of different thicknesses and colors in more than one dental element.

7 CONCLUSION

During the planning of aesthetic rehabilitation of darkened teeth, the dental surgeon must understand the etiology of tooth staining, as well as the best masking alternative. In addition, it is essential to know the materials for choosing indirect restorations, their correct indications and limitations so that the objectives outlined in the treatment plan are achieved.

Therefore, it was possible to conclude that lithium disilicate ceramic system restorations are excellent restorative materials due to their variability and ability to mimic dental substrates of different colors, in addition to their color stability and long-term strength.

Finally, together with the choice of the restorative material, it was possible to see that the final color of the restorations is influenced by the type and thickness of the ceramic material chosen, the amount of wear on the substrate and the shade of the selected resin cement, emphasizing that all these factors must be planned in advance to obtain the desired harmony between color and shape at the end of the treatment.

REFERENCES

- Cavigli, L., et al. (2022). The acute effects of an ultramarathon on atrial function and supraventricular arrhythmias in master athletes. *Journal of Clinical Medicine*, 11(3), 528.
- Contreras-Briceño, F., et al. (2021). Circulating vascular cell adhesion molecule-1 (sVCAM-1) is associated with left atrial remodeling in long-distance runners. *Frontiers in Cardiovascular Medicine*, 8, 737285.
- D'Andrea, A., et al. (2010). Left atrial volume index in highly trained athletes. *American Heart Journal*, 159(6), 1155–1161.
- D'Andrea, A., et al. (2016). Exercise-induced atrial remodeling: The forgotten chamber. *Cardiology Clinics*, 34(4), 557–565.
- D'Ascenzi, F., et al. (2013). Characterization of right atrial function and dimension in top-level athletes: A speckle tracking study. *The International Journal of Cardiovascular Imaging*, 29(1), 87–94.
- D'Ascenzi, F., et al. (2014). Morphological and functional adaptation of left and right atria induced by training in highly trained female athletes. *Circulation: Cardiovascular Imaging*, 7(2), 222–229.
- D'Ascenzi, F., et al. (2015). Increased left atrial size is associated with reduced atrial stiffness and preserved reservoir function in athlete's heart. *The International Journal of Cardiovascular Imaging*, 31(4), 699–705.
- D'Ascenzi, F., et al. (2015). Training-induced dynamic changes in left atrial reservoir, conduit, and active volumes in professional soccer players. *European Journal of Applied Physiology*, 115(8), 1715–1723.
- D'Ascenzi, F., et al. (2016). Atrial chamber remodelling in healthy pre-adolescent athletes engaged in endurance sports: A study with a longitudinal design. *International Journal of Cardiology*, 223, 325–330.
- D'Ascenzi, F., et al. (2016). P-wave morphology is unaffected by training-induced biatrial dilatation: A prospective, longitudinal study in healthy athletes. *The International Journal of Cardiovascular Imaging*, 32, 407–415.
- Di Gioia, G., et al. (2025). Right and left atrial strain by speckle-tracking echocardiography: Sex differences and correlation with cardiorespiratory fitness in Olympic athletes. *Journal of the American Society of Echocardiography*, 39(2).
- Diaz Babio, G., et al. (2021). Atrial size and sports: A great training for a greater left atrium—how much is too much? *The International Journal of Cardiovascular Imaging*, 37, 981–988.
- Elliott, A. D., et al. (2016). Atrial fibrillation in endurance athletes: From mechanism to management. *Cardiology Clinics*, 34(4), 567–578.
- Lakatos, B. K., et al. (2020). Relationship between cardiac remodeling and exercise capacity in elite athletes: Incremental value of left atrial morphology and function assessed by

three-dimensional echocardiography. *Journal of the American Society of Echocardiography*, 33(1), 101–109.

Pagourelas, E. D., et al. (2013). Right atrial and ventricular adaptations to training in male Caucasian athletes: An echocardiographic study. *Journal of the American Society of Echocardiography*, 26(11), 1344–1352.

Pelliccia, A., et al. (2005). Prevalence and clinical significance of left atrial remodeling in competitive athletes. *Journal of the American College of Cardiology*, 46(4), 690–696.

Sanz-de la Garza, M., et al. (2016). Acute, exercise dose-dependent impairment in atrial performance during an endurance race. *JACC: Cardiovascular Imaging*, 9(12), 1380–1388.

Simard, F., et al. (2022). Sex as a main determinant of bi-atrial acute and chronic adaptation to exercise. *European Journal of Applied Physiology*, 122, 2585–2596.

Spencer, L. W., et al. (2024). Atrial cardiomyopathy in endurance athletes. *NPJ Cardiovascular Health*, 1, 1–9.

Szałek-Goralewska, A., et al. (2025). Assessment of atrial strain variations in amateur runners. *International Journal of Cardiology*, 421, 132880.

Wilhelm, M., et al. (2012). Long-term cardiac remodeling and arrhythmias in nonelite marathon runners. *The American Journal of Cardiology*, 110(1), 129–135.

Zimmermann, P., et al. (2022). Athlete's heart in elite biathlon, Nordic cross-country and ski-mountaineering athletes. *Journal of Cardiovascular Development and Disease*, 9(8), 8.

APPENDIX

INFORMED CONSENT FORM (ICF)

Research entitled: Aesthetic rehabilitation using the technique of double cement to mask dental substrates of different colors – case report, proposed by the researcher in charge Prof. Me. Conceição Mikaelly de Vasconcelos Linhares and assistant researcher Adria Stephanie Xavier Barroso.

Dear participant,

This document you are reading is called the Informed Consent Form (ICF). It contains an explanation of the study that you are being invited to participate in. Before deciding whether to authorize (of your own free will) the use of your clinical data, you should read the term and understand the research proposal. At the end, if you decide to participate, you will be asked to sign accepting the conditions presented. Before signing, ask questions about everything you have not understood well, through the contacts provided. The study team will answer your questions at any time (before, during, and after the study). This consent form is printed in two copies, one copy of which will be filed by the responsible researcher, and the other will be provided to the participant. For any other information, you can contact the researcher by e-mail mikaelly.linhares@flucianofeijao.com.br or by phone (85) 99617-0990 and motivate my decision, if you wish.

Nature and objectives of the study

The objective of the study will be to report its clinical case which consists of the use of the technique of double cement to mask dental substrates of different colors, in a scientific environment, due to the particularities of their clinical condition, diagnostic methodology and the proposed treatment.

Study procedures

Its participation consists of authorizing the use of its dental record that is in the archives of the DENTAL CLINIC clinic, located at Rua Eurípedes Ferreira Gomes, 380, Pedrinhas. Zip Code: 62040-750, for the collection of your clinical data, laboratory, photographic images for the purpose of reporting the clinical case.

Risks and benefits

The risks are minimal, since the researcher ensures the confidentiality of the information by means of documents, which refer to the possibility of disclosure of information, regarding access to identification data, invasion of privacy, disclosure of confidential data and risk to safety of the ready. In case of damages resulting from the case report, full and free assistance will be offered for the necessary time, as well as the right to compensation.

Benefits: As benefits, this study will contribute to improving the diagnosis and therapeutic management of cases similar to this one, enabling further studies in the future.

Participation, refusal and right to withdraw from the study

Their authorization is voluntary. Refusal to authorize will not result in any penalty or modification in the form of care provided by dentists, assistants and researchers.

As provided by the Brazilian standards for research with the participation of human beings, you will not receive any type of financial compensation for your participation in this study.

Confidentiality

Your data will be handled only by the researchers and will not be allowed access to other people.

The results of this work may be presented at conferences, conferences or scientific journals, however, it will only show the results obtained as a whole, without revealing its name, or any information that is related to its privacy.

Considering that I have been informed of the objectives and relevance of the proposed study, how my participation will be, the procedures and risks arising from this study, I declare my consent to participate in the research, as well as I agree that the data obtained in the research be used for scientific purposes (dissemination at events and publications).

In case of doubts regarding the ethical aspects of this study, you may consult the Research Ethics Committee – CEP of the INTA-UNINTA University Center, which is located at Rua Coronel Antônio Rodrigues Magalhães, 700, 2nd floor (in front of the Selection Processes Board)) – Administrative pr – Bairro Dom

Exedito – Sobral – Ceará – C.E.P. 62.011-230. Phone (88) 3112-3500, (88) 9.99420072 ext. 3552 – e-mail: cep@uninta.edu.br/sec.cep@uninta.edu.br.

The researcher in charge declares that the research follows CNS Resolution 466/12.

Taiana Soares Sousa Rocha

Participant's Signature

Conceição Mikaelly de Vasconcelos Leites

Signature of the Principal Investigator

TERM OF AUTHORIZATION FOR THE USE OF IMAGE (TAUI) IN ACCORDANCE WITH THE GENERAL LAW FOR THE PROTECTION OF PERSONAL DATA (LAW NO. 13,709/2018)

By this TERM OF AUTHORIZATION FOR THE USE OF IMAGE, I, Taiana

Soares Souza Rocha, Brazilian nationality, marital status Married, bearer of RG n.º 2003023035477, registered with the CPF under no.º 035.783.273.60, residing at Rua Miriam Mont Alverne n.º 919, city Sobral – state of Ceará; in this act, and for all purposes admitted in law, I expressly authorize the DENTAL CLINIC Clinic, located at Rua Eurípedes Ferreira Gomes, 380, Pedrinhas. Zip Code: 62040-750. Telephone: (88) 99381-4948, hereinafter referred to as AUTHORIZED, the capture, use, custody and exhibition/execution of the image in a definitive and free car, resulting from their participation in the photography session, carried out for the planning and execution of dental treatment of cer facets produced by the Dental Clinic of the University Center INTA – UNINTA, for exclusively educational purposes, and may be used at any time by the AUTHORIZED PARTIES, in accordance with the General Law for the Protection of Personal Data (Law No. 13,709/2018).

This authorization covers all forms of use and modalities of use permitted, known or hereafter known, including, but not limited to, the following situations:

- A. The images may be used through any and all means of communication to the public, being hereby authorized to be made available (including for download and in digital repositories) and/or broadcast/executed in a place open to the public on the internet (including use in distance learning courses) and internet, with all its existing and future tools and technologies, throughout the national and international territory, in whole or in part;
- B. It is also authorized, for example, the use of images in public presentations, publications and academic disclosures, exhibitions/executions at festivals and national and international awards;
- C. This authorization also includes the possibility of distributing the images to the public, for example, on DVDs, CDs, Blu-rays, Pen Drives, Virtual Discs or any other similar media that may exist, throughout the national and international territory, in whole or in part;
- D. Partial or full reproduction and printing in any type of material, including leaflets, advertisements, promotional material, banners, brochures, intranet, written or electronic media, panels or other similar forms that involve merchandising and dissemination actions throughout the national and international territory, is authorized;

The AUTHORIZED PARTIES, from now on, can edit and assemble all the materials in which the minor participates (filming, photos, audio recordings, etc.), conducting the reproductions they deem necessary (without limitation), as well as being able to archive them in any means available for this purpose.

This particular instrument of authorization is entered into in a DEFINITIVE, GRATUITOUS, IRREVERSIBLE and IRREVOCABLE manner, obliging the parties, by themselves and their successors in any capacity, to fully respect the terms and conditions stipulated in this instrument.

As this is the expression of my will, I declare that I authorize the use described above without there being anything to be claimed in terms of rights related to the image or any other, and I sign this authorization in 02 copies of the same content and form.

Sobral, May 08, 2023.

Tatiana Soares Sousa Podua

AUTHORIZING OFFICER

I, Josis Aristeu de Vasconcelos Neto, head of the private clinic DENTALCLINIC, faithful deposit of the dental records of the patient in question, I authorize the researcher Adria Stephanie Xavier Barroso to collect data from the records for the purposes of his course completion work study entitled "Aesthetic rehabilitation using the technique of double cementation to mask dental substrates of different colors – case report".

Sobral, May 08, 2023.



Josis Aristeu de Vasconcelos Neto

I, Josis Aristeu de Vasconcelos Neto legally responsible for the OdontoClinic Clinic in order to enable the execution of the research project entitled: Aesthetic rehabilitation using the technique of double cement to mask dental substrates of different colors – case report, under the responsibility of the researcher Conceição Mikaelly de Vasconcelos Linhares, Adria Stephanie Xavier Barroso, I declare that the OdontoClinic DENTALCLINIC allows the use of its facilities, as well as the use of the data contained in the medical record of the patient involved in this research.

Agreed and aware.

Sobral, May 08, 2023.



Dr. Josis Aristeu de Vasconcelos Neto

CRO-CE

Rua Eurípedes Ferreira Gomes, 380, Pedrinhas

Sobral/CE

(88) 993814948

jaristeu@gmail.com

The responsible researcher Conceição Mikaelly de Vasconcelos Linhares and assistant researcher Adria Stephanie Xavier Barroso, of the research project entitled "Aesthetic rehabilitation using the technique of double cement to mask dental substrates of different colors – case report", we declare, for due purposes, to know and comply with the Brazilian Ethical Resolutions, in particular Resolution No. 466/12 of the National Health Council.

We are committed to maintaining ethical conduct when handling and accessing the data contained in the medical record, in the files of radiographic images, tomography and photographs that are the responsibility of custody and protection of the Dental Clinic DENTALCLINIC, located at Rua Eurípedes Ferreira Gomes, 380, Pedrinhas, Sobral-CE, Cep: 62040-750, which will be used only after receiving the approval of the ethics and research committee (CEP) of the Centro Universitário UNINTA, within the established by Resolution numbers 196/96 and 466/12, of the National Council of Health de/MS, for human experiments.

We are committed to ensuring the confidentiality and secrecy of the data contained in the record, in the files of radiographic, tomographic and photographic images, as well as the privacy of its contents, maintaining the moral integrity and privacy of the individual who will have their information accessed. We will not pass on the data and images collected in its entirety, or part of it, to people not involved in the research team.

We are also committed to the safekeeping, care and use of information only for the fulfillment of the objectives set forth in this research referred to here. Any other research in

which we need to collect information will be submitted for consideration by the ethics and research committee (CEP) of the Centro Universitário. The data obtained from the documentary research will be kept confidential, secure, confidential and private, for five years, and then destroyed.

By publishing the results of the research, we will maintain the anonymity of the person whose data was searched, as well as the anonymity of the OdontoClinic Clinic.

Sobral, May 08, 2023.

Conceição Mikaelly de Vasconcelos Linhares

Conception Mikaelly de Vasconcelos Linhares
Principal Investigator

Adria Stephanie Xavier Barroso

Adria Stephanie Xavier Barroso
Research Assistant

MARKETING CONSULTING IN INFORMATION UNITS

CONSULTORIA DE MARKETING EM UNIDADES DE INFORMAÇÃO

CONSULTORÍA DE MARKETING EN UNIDADES DE INFORMACIÓN



<https://doi.org/10.56238/sevened2026.008-244>

Georgete Lopes Freitas¹, Rayanne Ferreira Coelho²

ABSTRACT

Study on the creation of a marketing consulting service in libraries. It discusses the importance of applying marketing consulting related to the 4Ps (Product, Price, Place, Promotion) as a way to propose solutions to the demands identified in libraries, and to provide librarians with an alternative for developing a business related to their field of activity. It relates the concept of entrepreneurship in Library Science; maps the theoretical references in the consulting process; correlates the 4Ps of marketing within the context of libraries; and presents the main aspects related to the creation of consulting services aimed at libraries, including phases, services, and legal and bureaucratic aspects. Na metodologia, utiliza a pesquisa bibliográfica e documental e discute o empreendedorismo na área biblioteconômica, elencando exemplos de empresas oriundas de bibliotecário, no Brasil, e alguns especificamente no estado do Maranhão. It highlights consulting in its historical, conceptual, and categorical aspects (craft-based, specialized, total, and globalized). It emphasizes marketing in libraries, contrasting it with the challenge of making it a strategic tool focused on meeting users' informational needs through the resolution of problems that affect the organizational environment of libraries and distinguishes between a product-oriented and a marketing-oriented approach in libraries. It concludes by emphasizing the relevance of marketing consulting in libraries as a means to contribute solutions to organizational demands of these institutions and to advance the fields of Library Science and Information Science through research focused on entrepreneurship, consulting, and marketing, which still lacks broader academic production.

Keywords: Marketing. Libraries. Entrepreneurship. Consulting.

RESUMO

Estudo sobre a criação de uma consultoria de marketing em bibliotecas. Discorre sobre a importância da aplicação da consultoria de marketing concernentes ao 4P (Produto, Preço, Praça, Promoção) como forma de propor soluções para as demandas identificadas nas bibliotecas, e oportunizar aos bibliotecários uma alternativa de desenvolver um negócio que esteja relacionada a sua área de atuação. Relaciona a concepção de empreendedorismo na Biblioteconomia; mapeia os referencias teóricos no processo de consultoria; correlaciona os 4P do marketing no contexto das bibliotecas; e apresenta os principais aspectos referentes

¹ Dr. in Education Sciences. Universidade Federal do Maranhão (UFMA). E-mail: georgete.lf@ufma.br
Orcid: <https://orcid.org/0000-0003-3846-6677> Lattes: <http://lattes.cnpq.br/8111250991425851>

² Graduate in Library Science. Universidade Federal do Maranhão (UFMA). E-mail: rayannefc@outlook.com
Orcid: <https://orcid.org/0009-0004-5235-6997> Lattes: <http://lattes.cnpq.br/5178569792375741>

à criação da consultoria voltada para as bibliotecas concernentes às fases, serviços e os aspectos legais e burocráticos. Na metodologia, utiliza a pesquisa bibliográfica e documental e discute o empreendedorismo na área biblioteconômica, elencando exemplos de empresas oriundas de bibliotecário, no Brasil, e alguns especificamente no estado do Maranhão. Ressalta a consultoria em seus aspectos histórico, conceitual e categórico (artesanal, especializada, total e globalizada). Ressalta o marketing em bibliotecas, em contraste com o desafio de torná-lo ferramenta estratégica focalizada no suprimento das necessidades informacionais dos clientes a partir da resolução de problemas que afetam o ambiente organizacional das bibliotecas e distingue a orientação da biblioteca para o produto e para o marketing. Conclui realçando a relevância da consultoria de marketing em bibliotecas a fim de contribuir com soluções de demandas organizacionais dessas instituições e para o avanço da ciência, Biblioteconomia e Ciência da Informação com pesquisas voltadas para o empreendedorismo, consultoria e marketing que carece de mais produções.

Palavras-chave: Marketing. Bibliotecas. Empreendedorismo. Consultoria.

RESUMEN

Estudio sobre la creación de una consultoría de marketing en bibliotecas. Aborda la importancia de la aplicación de la consultoría de marketing en relación con las 4P (Producto, Precio, Plaza, Promoción) como una forma de proponer soluciones a las demandas identificadas en las bibliotecas, y de ofrecer a los bibliotecarios una alternativa para desarrollar un negocio relacionado con su área de actuación. Relaciona la concepción de emprendimiento en la Bibliotecología; mapea los referentes teóricos en el proceso de consultoría; correlaciona las 4P del marketing en el contexto de las bibliotecas; y presenta los principales aspectos relacionados con la creación de una consultoría dirigida a bibliotecas, incluyendo fases, servicios y aspectos legales y burocráticos. Na metodologia, utiliza a pesquisa bibliográfica e documental e discute o empreendedorismo na área biblioteconômica, elencando exemplos de empresas oriundas de bibliotecário, no Brasil, e alguns especificamente no estado do Maranhão. Destaca a consultoria em seus aspectos históricos, conceptuales y categóricos (artesanal, especializada, total y globalizada). Resalta el marketing en bibliotecas, en contraste con el desafío de convertirlo en una herramienta estratégica enfocada en satisfacer las necesidades informacionales de los usuarios mediante la resolución de problemas que afectan el entorno organizacional de las bibliotecas y distingue entre la orientación de la biblioteca hacia el producto y hacia el marketing. Concluye destacando la relevancia de la consultoría de marketing en bibliotecas como un medio para contribuir con soluciones a las demandas organizacionales de estas instituciones y para el avance de la Bibliotecología y la Ciencia de la Información mediante investigaciones orientadas al emprendimiento, la consultoría y el marketing, áreas que aún requieren mayor producción académica.

Palabras clave: Marketing. Bibliotecas. Emprendimiento. Consultoría.

1 INTRODUCTION

Society is marked by intense changes in social, political and economic aspects. In the twenty-first century, these transformations occur due to the origin of several factors such as globalization, the growth of capitalism and the insertion of information and communication technologies that contribute to the scenarios in the organizational world, which are in charge of new needs.

Thus, with the advent of the Capitalist Society, the market changed its labor relations, the forms of administrative management and the new professional profile. In addition, these new requirements caused the emergence of new models of administration, innovating in their administrative processes in order to resist a new type of society, the Knowledge Society (Maxiamiano, 2010).

The administrative process of an organization contemplates five functions: planning, organization, leadership, execution and control (Chiavenato, 2003). It is an uninterrupted and systematized process that infers decision-making. Therefore, management consists of carrying out activities developed efficiently and effectively, so as to ensure the achievement of its objectives. In addition, it is an interdisciplinary field that operates in the most diverse areas, enabling the use of some of its tools, such as: SWOT Analysis, Business Plan, Marketing Plan, etc., and one of the areas that uses these tools is entrepreneurship.

Entrepreneurship is "[...] the awakening of the individual to the full use of his rational and intuitive potentialities. [...]" (Baggio; Knebel, 2014, p. 26), that is, it is putting into action some innovative practices such as creating something unprecedented, pointing out a new way of doing things, developing solutions or simply identifying opportunities.

In the historical aspect, Chiavenato (2008) describes authors who gave rise to the conceptions of entrepreneurship, such as Richard Cantillon (approx. 1680-1734), Jean Baptiste Say (1767-1832) and Joseph Schumpeter (1833-1950). Such theorists studied entrepreneurship focused on Economist Theory, seeking to understand its relationship with the economy; where Joseph Schumpeter associated entrepreneurship with change and innovation. In addition to this theory, the Behaviorist Theory emerges, which aims to analyze the behavior of entrepreneurs as a way to draw a certain profile, with David C. McClelland (1917-1998) as a major contributor.

In Brazil, entrepreneurship can be characterized as: entrepreneurship by opportunity and entrepreneurship by necessity, the latter being the most recurrent motivation (Global Entrepreneurship Monitor, 2017). People idealize in the creation of a company the realization of a dream, an escape valve to stay in the market and an investment that seeks to obtain profits. However, the sum of these conjunctions makes them develop a business in the

impetus without obtaining the technical and conceptual knowledge that it requires. In this way, the importance of Knowledge Management (KM) arises for organizations that aim to identify, organize and make accessible useful knowledge for companies. KM can be considered as a business tool by motivating the creation of new services and products and the remodeling of organizational processes (Silva, 2016).

For Drucker (1992), the success of organizations is largely related to knowledge, which becomes the main element and a strategic mechanism for decision-making and competitiveness. In view of this, consultancies emerge, a new sector that offers specialized knowledge to organizations.

The areas of consulting and entrepreneurship are connected. While consulting offers knowledge, entrepreneurship seeks knowledge to be applied in the organizational sphere (Silva Júnior; Santos, 2014). Therefore, entrepreneurship is born from the desire to create and innovate new ideas, in a complementary way, consulting arises with the intention of solving the organizational demands that develop in these ventures. In this way, consultancies perform the function of advising on demands and problems observed, however, many consulting services are the result of entrepreneurs who seek to enter the market with something different and with value.

In view of this, Teixeira (2012, p. 22) defines consulting as "[...] as an advisory service, in a process in which the consultant helps the client to enhance its ability to achieve the organization's objectives", that is, its main objective is to investigate and identify the problems found in companies, in order to propose viable solutions that will solve the present needs. It has an analytical character, does not impose what must be done, it only points out the possible answers to demands, giving autonomy to the company with regard to decision-making power. Its work expanded in the 60s, however, it was only in the 80s that it became essential to face the effects of globalization, in the face of a new competitive scenario that requires speed and innovation inside and outside the country (Teixeira, 2012).

The consulting activity is determined from the interaction of two subjects: client and consultant, the latter most often coming from small or medium-sized companies, which develop a temporary relationship, without employment purposes. The process of joining the consultancy is carried out through proposals and projects that define the contractual aspect, as well as establishing direct contact between the consultant and client. Since the 1990s, the consulting market has grown in the economic sector, gaining prominence both in the business segments and in other entities that are not linked to business (Honório, 2009).

Consulting companies can work in different organizations, making it a promising field for librarians who can provide these types of services in libraries, since they have external

knowledge of the market and technical knowledge of the area. The consultancy contributes to the investigation of strengths and weaknesses, in the identification of problems and in the proposition of solutions, which often go unnoticed by professionals working in libraries due to the quick activities developed.

With regard to the librarian's performance, the Federal Council of Librarianship (2002, p. 10) prescribes through Resolution No. 042/2002 his role as a consultant, in which he is responsible for "[...] present methods and techniques compatible with the work offered, aiming at quality control and excellence in the provision of services during and after the execution of the work". In order for the consultant librarian to obtain improvement in the services provided, it is essential that he seeks interpersonal skills, technical skills and consulting skills, as highlighted by Case, Case and Franciatto (1997), with a view to performing his function and participating fruitfully in the entire consulting process, which involves from implementation to follow-up after the service is performed. In this sphere of work, the professional must increasingly seek continuing education so that he can have excellence in his activities.

In the context of libraries, there are several ways to work with consulting. Among them, a type that is little worked on is marketing consulting, which, according to Amaral (1990, p. 315) contributes

[...] for the social, economic, cultural and political development of the library because its activities respect the legal and ethical principles in force and aim, primarily, at the satisfaction of the user. For this reason, the adoption of its techniques implies changes in the library's performance policy [...]

The fundamental basis of marketing is to satisfy the needs of customers, corroborating the main objective of libraries: to satisfy the informational needs of their users. In this way, marketing is:

[...] a trading activity that was based on the concept of exchange. At the moment when the individuals and organizations of a society began to develop and need products and services, specializations were created [...] with specialization the process of exchange became easier [...] (Las Casas, 2008, p. 3).

Las Casas (2008) considers that marketing has all its activities focused on exchange relations, in addition to being seen as an act of commercialization that starts from a lack. However, it is important to emphasize and deconstruct the view that marketing is only sales, advertisements, that its performance focuses only on production, and that it aims only at profitable gains. On the contrary, marketing develops services and products focusing on

customers, through the analysis of their needs and undertaking the planning of activities to be developed in this process. It is basically answering the following questions "What is done", "For whom is it done" and "Why is it done" (Amaral, 2007). All its interests involve customers and in this orientation this is the triumph of the organization.

That said, there is a need to work on marketing based on the 4P's (Product, Price, Place and Promotion) and not only as a channel for the dissemination of a library's services and products. It is essential that marketing tools be used to identify strengths and weaknesses, as well as to develop a more in-depth study of the political, economic and social context of the institution that directly influences the Square, where the library is located; in the Product, which is the raw material through which the library works; in Price, which is related to the intangible value of information and user feedback; and in the Promotion, which consists of making the library's services and products known, in order to reach its target audience.

It is worth noting that the fields of entrepreneurship and marketing are extremely relevant for library environments, as they cross economic borders, since no one works alone. The participation of other members is essential, so that all activities carried out within the macro and micro environment of organizations are carried out efficiently and effectively. Therefore, in the development of the Marketing Mix in a holistic way in libraries, innovative practices can be carried out that approach and solve the information needs of the user. From this perspective, the consultancy works collaboratively to obtain these results.

Marketing consulting presents itself as a new work niche, an opportunity to manage your own business from the knowledge acquired in training. The creation of a consultancy is the result of a proposal that consists of market research, competition analysis, location analysis, product portfolio, financial analysis, among other issues.

The choice of the theme was made through the classes presented in the discipline of Marketing in Information Units, which develops a theoretical and practical work, which challenged the analysis of the variables: product, price, place and promotion related to libraries and the creation of a Marketing Plan. At first, the discipline worked with theory, which deconstructed the common sense of thinking of marketing as only the promotion and dissemination of a library and expanded knowledge by understanding marketing in the totality of the 4P's and verifying them empirically in the library environment.

It is worth noting that in the practice of the discipline, the student researchers were basically in the position of "consultants", identifying the problems related to the 4P, pointing out the strengths and weaknesses, and proposing solutions through the Marketing Plan; However, no changes were imposed, no criticism was directed to the institution or

professionals working in these spaces, some gave feedback on what should be improved in the institution through research, due to the sensitivity of understanding the workload of librarians that prevents them from perceiving or executing the need for transformation that the library requires, that were related to the Marketing Mix. In view of the perception of some weaknesses and demands found in libraries based on the knowledge and empirical data collected on marketing, this activity generated the restlessness of developing strategies that would contribute to meet the organizational needs of libraries.

Thus, thinking about the creation of a marketing consultancy for libraries, in order to generate ideas for new work fronts for the area, in addition to contributing to the development of a service that will bring qualitative benefits to libraries, the following research problem was defined: How to develop a marketing consultancy to contribute to the organizational demands of libraries?

Based on this questioning, the general objective aims to establish theoretical references in the proposition of establishing a marketing consulting service in the field of libraries, in order to meet their organizational demands in favor of serving users. The specific objectives are:

- a) map theoretical references in the process of creating a consultancy in interrelation with entrepreneurship and marketing in libraries;
- b) to correlate the 4P's of marketing in the context of libraries;
- c) to present the main aspects related to the creation of a marketing consulting company for libraries, concerning the phases, services and legal and bureaucratic aspects.

The research is characterized as bibliographic and documentary, with the purpose of knowing the different scientific contributions on entrepreneurship and the importance of a marketing consultancy for libraries.

The theme is relevant and this work seeks to contribute with the theoretical aspects for the production of the area of Library Science and Information Science. In addition, it aims to develop a study with professional contributions to provide librarians with opportunities to work with other work possibilities, combined with the skills acquired in training concerning libraries, through the identification and search for solutions to the problems found.

Regarding the organization of this study, it is structured in: "Introduction", consisting of contextualization, justification, problem and objectives; "Methodology", in which the path followed to carry out the research and present the results about the theoretical framework is exposed; "Literature Review" that addresses entrepreneurship in relation to its conception and history; "Consulting" that focuses on the concepts, typology, origin in Brazil and the main entities in this sector; "Marketing", describing its concepts and evolution; and Marketing in

libraries, understanding the importance of marketing and the relationship of the 4P's of marketing in libraries. In continuity, a company model was outlined that presents the process of building a marketing consultancy in libraries, with regard to the legal and specific requirements and the steps to be worked on and, finally, the "Final Considerations" of the research.

2 METHODOLOGY

As informed in the introductory comments, the research is characterized as bibliographic, which, for Prodanov and Freitas (2013), is carried out based on published materials and can be found in various documentary typologies: articles, theses, dissertations, monographs and books. Reinforcing this idea, Severino (2007, p. 122) points out that:

Bibliographic research is that which is carried out from the available record, resulting from previous research, in printed documents, such as books, articles, theses, etc. It uses data or theoretical categories already worked on by other researchers and duly recorded. The texts become sources of the themes to be researched. The researcher works from the contributions of the authors of the analytical studies contained in the texts.

Thus, the methodological path of this study is composed at first by working with central authors of Administration and Library Science about the terms "Entrepreneurship", "Consulting" and "Marketing" in journal articles, books, dissertations, theses and monographs, consulted in specific sources of information such as: Scientific Electronic Library Online (SciELO), Portal de Periódicos da Coordenação de Pessoal de Nível Superior (Capes), Brazilian Digital Library of Theses and Dissertations (*BDTD*), Database of Journals in Information Science (Brapci) and National Meeting of Research in Information Science (Enancib). In addition to these sources of information, others were used, such as blogs, newspapers and social networks (Instagram, Facebook and Youtube).

The choice of these communication channels was motivated by the fact that they work on the theme, allowing the search for publications from the last 20 years, with emphasis on the period from 1990 to 2019. This chronology refers to the fact that there has been a greater emphasis on discussions on entrepreneurship and consulting in Brazil since the 1990s (Oliveira, 2012), intensified in the 2000s, with the use of Information and Communication Technologies, which caused a change in the practices of professionals from different areas and, in particular, librarians in the "[...] search for new qualifications to meet market demands and a concern with innovation in the processes and services to be provided to have a competitive advantage [...]" (Spudeit; Magdalene; Florindo; Duarte, 2016, p. 677).

Table 1 presents the number of documents found about the terms listed.

Table 1

Retrieval of search terms in databases

Bases	Entrepreneurship	Consulting	Marketing	Library Marketing
BDTD	3185	392	6368	3207
Brapci	114	60		381
Capes	41	5812	More than 1,000,000	802
Enancib	4	9	-	25
Scielo	290	114	923	1

Source: Survey data (2020).

However, it is worth noting that this quantity of materials was not worked with, due to the fact that the terms are addressed in a generic way in the texts, not constituting the main subject of the research. This phenomenon, perceived in the search for specific literature, can be understood through the report of Lebrun (2007 *apud* Garcia, Gattaz; Gattaz, 2019) when classifying the keywords listed by the researchers in their texts, into three categories: general, intermediate, and specific. Regarding the general ones, he attributes that they are used by those who are interested in the theme, but belong to other areas.

It is reiterated that due to the vast majority of the works detected in the cited databases not matching the problem and objectives of this research, centered on presenting the procedures to create a consulting company for libraries, specialized in marketing, it was privileged, for the theoretical basis, the punctual literatures of authors of Administration and Library Science that discuss entrepreneurship, consulting and marketing in libraries, such as: Barreto (1998), Dolabela (1999), Filion (1999), Chiavenato (2008), Oliveira (2012), Spudeit (2016), among others; Gonçalves (1991), Lins (1999), Block (2001), Oliveira (2005), Donadone, Silveira and Ralio (2012), Pastore (2014), Spudeit, Madalena, Laurindo and Duarte (2016) and other scholars in the consulting area; and McCarthy (1982), Kotler (1999), Kotler and Armstrong (2007), Las Casas (2008), Cobra (2011), Kotler and Keller (2012) and other authors who discuss marketing.

In total, 113 (one hundred and thirteen) documents were worked with the specific subject of this research, duly cited in the text and identified in the References.

3 ENTREPRENEURSHIP

Entrepreneurship has become essential for the advancement of society, as it is about innovative actions that are born from ideas and transformed into services and products, generating something different and valuable. According to Chiavenato (2008, p. 1, emphasis added) "[...] The term entrepreneur – from the French *entrepreneur* means one who takes risks and starts something new", either in an original way or by introducing novelties that will bring a differential within an existing sector.

In the evolution of the study on entrepreneurship, some areas such as Sociology, Psychology, Anthropology and Economics contributed to its conception, summarizing in 2 (two) theories: Economist and Behaviorist, where "[...] economists associate the entrepreneur with innovation, while behaviorists focus on the creative and intuitive aspects [...]" (Filion, 1999, p. 6). In the Economist Theory, innovation had the purpose of profits, and the Behaviorist Theory studied the behavior of these entrepreneurs, seeking to identify the profile of successful entrepreneurs.

According to Chiavenato (2008), the pioneers of the Economist strand are Richard Cantillon (approx. 1680-1734), and Jean Baptiste Say (1767-1832), both converged on the idea of entrepreneurship, where the first considered the entrepreneur as someone who sought raw materials for one price and resold it for another, substantially a negotiator, who took risks, innovated and prioritized profitability; the second considered that economic growth was the result of new ventures. In other words, "Cantillon and Say regarded entrepreneurs as people who took risks, basically because they invested their own money [...]" (Filion, 1999, p. 7), that is, they invested their own financial resources without a guarantee of return, but because they believed in the potential of the business.

Oliveira (2012, p. 2) points out that Cantillon and Say respectively stated that "[...] The entrepreneur performs the functions of bringing together different factors of production, management and the ability to take risks. [...] someone who takes risks in the process of buying services or components for a certain price with the intention of reselling them later at an uncertain price [...]". For Oliveira (2012), Richard Cantillon and Jean Baptiste Say analyzed entrepreneurship focused on the economy, but not leaving aside that the act of entrepreneurship requires taking risks in decision-making, investments, negotiation and everything that this process involves. It is essential that the subject is aware of the market and its changing state. Still in the economic view, Filion (1999) states that it was Joseph Schumpeter (1833-1950) who effectively inserted the word innovation into the field of entrepreneurship, but that in addition to him there were characters such as Clark (1847-

1938), Baumol (1922-2017), Schloss (1889-1966) and among others who sought to understand the role of entrepreneurship for the economic system.

Regarding the behaviorist aspect, according to Fillion (1999), it is studied by professionals in the sciences who investigate human behavior. Among these scholars, one of the forerunners to care about the theme was Max Weber (1864-1920), who believed that the value system influenced entrepreneurial behavior, recognizing them as innovators. On the other hand, psychologist David C. McClelland (1917-1998) made contributions to the sciences that study this type of behavior by developing the value system based on some points, such as: "[...] needs of achievement, affiliation and power, as fundamental elements in explaining the behavior of the entrepreneur [...]" (Honesko, 2001, p. 12). However, he suffered harsh criticism about this theory, since it would not be only the need for achievement that drives someone to create or be a successful entrepreneur, just one of the reasons.

According to Fillion (1999, p. 9) "[...] Behaviorists dominated the field of entrepreneurship for 20 years, until the early 1980s. Their objective was to define what entrepreneurs are and their characteristics [...]", that is, they began to observe the personality traits of these people, in order to confer common characteristics for a group of entrepreneurs. To this end, Fillion (1999, p. 10) points out that:

It has not yet reached the point of being able to evaluate a person and then say, with certainty, whether he will be successful or not as an entrepreneur. However, it can be said whether it has the characteristics and aptitudes most commonly found in entrepreneurs. Although no scientific profile has been drawn, research has been the source of several guidelines for future entrepreneurs, helping them to better situate themselves [...]

For Fillion (1999) it is not possible to determine an entrepreneurial profile, but what can be established are skills that the entrepreneur can have or develop to stand out in the business, as well as improve them through a constant search for knowledge and become better every day at what he does.

In Bernardi's literature (2008) some characteristics that the entrepreneur requires are pointed out, such as: Sense of opportunity; Dominance; Aggressiveness and energy to perform; Self-confidence; Optimism; Dynamism; Independence; Persistence; Flexibility and resistance to frustration; Creativity; Risk propensity; Charismatic leadership; Ability to balance dream and fulfillment; and Relationship skills. Such characteristics can be developed and improved in people who intend to undertake, although they are not guarantees of success in the enterprise.

However, there is a myth that to be an entrepreneur, the subject must have such skills from birth and that these cannot be developed (Salim *et al.*, 2004). However, there is no basis

for such an argument, since in the history of many businesses, the motivations and circumstances for the creation of an enterprise, and consequently the appearance of an entrepreneur is not conditioned by personality traits. Thus, what characterizes an entrepreneurial impetus are three basic characteristics: the need for achievement, willingness to take risks and self-confidence (Bernardi, 2008; Chiavenato, 2007).

In this way, it is valid to say that entrepreneurial characteristics can be acquired and developed, and this means that it does not need to be linked to innate attributes. In addition, Dolabela (1999, p. 70) stresses that "[...] the individual with the conditions to undertake will know how to learn what is necessary to create, develop and realize his vision [...]", that is, far beyond the characteristics, there is the willpower to seek the knowledge necessary for the creation and maintenance of the business.

Regarding the definition of entrepreneurship, it has become plural and complex, as it is influenced by the Economist and Behaviorist Theories. To this end, it is an old concept that has undergone some adaptations over time. For example:

At the beginning of the twentieth century, the word entrepreneurship was used by economist Joseph Schumpeter in 1950 as being, in short, a person with creativity and capable of succeeding with innovations. In 1967 with K. Knight and in 1970 with Peter Drucker, the concept of risk was introduced, an entrepreneurial person needs to take risks in some business (Oliveira, 2012, p. 1).

Entrepreneurship is intrinsically related to the act of innovating, creating and taking risks, which are keywords in the concepts related to entrepreneurial characteristics. In general, entrepreneurship "[...] is a neologism derived from the free translation of the word *entrepreneurship* and used to designate studies related to the entrepreneur, his profile, his origins, his system of activities, his universe of action [...]" (Dolabela, 1999, p. 43) and such studies aim to explain to those interested the vast loci in which entrepreneurial initiatives can be implemented.

In addition, for Baggio and Knebel (2014, p. 2) entrepreneurship is:

[...] the art of making it happen with creativity and motivation. It consists of the pleasure of carrying out with synergism and innovation any personal or organizational project, in permanent challenge to opportunities and risks. It is assuming a proactive behavior in the face of issues that need to be resolved.

Baggio and Knebel (2014) relate entrepreneurship to creativity, motivation and innovation. It is not being apathetic to the needs of change and always being in search of the new, not necessarily to create original things, but to seek a new way of doing things.

Regarding the practical definition of entrepreneurship, Oliveira (2012, p. 2) defines it as "[...] the process by which people start and grow their businesses. It is a complex phenomenon, in which it involves the entrepreneur, the company and the customer, who are part of this process [...]". Oliveira (2012) describes entrepreneurship as the kick-off for the emergence of a business, composed of stages, which the entrepreneur must go through for the long-awaited success. It is not an individual process, but a collective one, which seeks to establish interpersonal relationships so that the enterprise takes stronger roots.

Converging with the other definitions described about entrepreneurship, Barreto (1998, p. 190) describes it as the "[...] ability to create and constitute something from very little or almost nothing". With regard to the professional who works in this field, the entrepreneur, "[...] is the person who starts and/or operates a business to carry out a personal idea or project, taking risks and responsibilities and continuously innovating [...]" (Chiavenato, 2007, p. 3), that is, he is a curious subject who seeks to realize his ideals. Continuously, Dolabela (1999) states that the entrepreneur in a broad way is the one who dedicates himself to managing wealth, whether in transforming knowledge into services and products, in the construction of his own knowledge or in innovating in an interdisciplinary way in areas such as marketing, production and organization.

From another perspective, Dolabela (2006, p. 26) defines the entrepreneur as:

[...] a dissatisfied person who transforms his nonconformity into discovery and positive proposals for himself and others. It is someone who prefers to follow untraveled paths, who defines from the undefined, believes that his actions can generate consequences. In short, someone who believes they can alter the world.

It is inferred that the entrepreneur is someone who does not conform to the natural and current state of things, lives in search of new directions and new ideas, putting them into practice and has a vision of the future (Dornellas, 2008). For Gerber (2004, p. 15) "[...] The entrepreneur is the visionary in us: the dreamer, the energy behind all human activity, the imagination that feeds the fire, the catalyst for change [...]", that is, someone who idealizes projects and who has the stimulus for change.

In view of all the definitions of entrepreneurship pointed out, it is clear that the entrepreneur is always looking for something new, which can represent various actions, such as adding innovations to an existing sector. That said, Spudeit, Madalena, Laurindo and Duarte (2016) reinforce that "[...] To create enterprises, it is not necessarily necessary to create a company. There are many ways to undertake using the basic concepts of the term and adding it to different sectors and areas of professional activity [...]". In other words, it is not just about creating unprecedented services and products for a new business, but

resignifying it through changes in the workplace and in the various social and cultural segments of a society, through innovative ideas.

Thus, in addition to the Business Entrepreneurship that concerns the creation of companies, the following stand out: Social Entrepreneurship, Cultural Entrepreneurship and Intrapreneurship (Spudeit; Magdalene; Laurindo; Duarte, 2016).

Social Entrepreneurship breaks the paradigm of traditional entrepreneurship that aims to obtain profits, and "[...] it comes to combine efforts in order to combine market practices and business vision with human development, proposing solutions to social problems" (David, 2004, p. 16). It is a subject taken over by a social conscience, which is unsatisfied with the injustices that happen through social causes at the local and global levels. In addition, social entrepreneurs are concerned and take risks for collective interests, for the benefit of the people the company serves. In relation to this practice in the organization, they are usually developed by non-profit institutions that act in a social way, or by private companies that have social responsibility (Brinckerhoff, 2000; Melo; Neto; Fróes, 2000; David, 2004).

As for **Cultural Entrepreneurship**, it can be focused on cultural and economic aspects. This type of entrepreneurship, at first, arises mainly with the objective of analyzing the role of the entrepreneur in the construction and maintenance of non-profit cultural organizations (libraries, theaters, art museums, orchestras, etc.) and, at the national level, these institutions are often subsidized by the government (Limeira, 2008).

On the other hand, Cultural Entrepreneurship also permeates economic issues, since it attributes value to cultural services and products, that is, "[...] it is based on the creation of economic and symbolic value in the area of culture and on new forms of work and learning, associated with entrepreneurial trajectories that constantly deal with risk and with relationships of trust" (Guerra; Paiva Júnior, 2011, p. 79).

As far as **Intrapreneurship** is concerned, it is a branch of entrepreneurship that consists of the development of entrepreneurial actions carried out by internal employees in organizations. Conceptually, Intrapreneurship refers to "[...] introduction and implementation of an innovation for the company by one or more employees working within an established organization" (Carrier, 1996, p. 7).

The term **Intrapreneurship**, which can be called **Corporate Entrepreneurship** or **Internal Entrepreneurship**, was created by Pinchot in 1985, who considered intrapreneurs as dreamers, who are in charge of developing any type of innovations within their workplace (David, 2004). Regarding this practice within organizations, Baldissera (2019, p. 16) believes that it contributes both to individuals as professionals, and to the company and "[...] provides

a differentiated view of the performance of the workforce, as it does not rely on people only for routine work activities, but also by returning employees to organizational interests in an entrepreneurial way".

In view of all the definitions of entrepreneurship, it is worth highlighting the entrepreneurial process branched out by Dornellas (2005) into 4 (four) stages: verifying and calculating opportunities; prepare the business plan; allocate necessary resources; and business administration. All these phases can be developed sequentially or at the same time.

Although all the phases exposed by Dornellas (2005) are of paramount importance, as they aim to support the entrepreneur in the decision-making of his business, it focuses on the business plan, as it is:

[...] A document used to describe a venture and the business model that underpins the company. Its elaboration involves a process of learning and self-knowledge and also allows the entrepreneur to situate himself in his business environment (Dornellas, 2016, p. 99).

It is through the preparation of this document (business plan) that the entrepreneur will be able to clearly analyze the feasibility of success of the business in his market, since the opportunities he can explore are exposed, as well as the possible threats that may occur in the business environment.

Sebrae (2020) corroborates Dornellas (2016) on the importance of the business plan as an essential management tool for the entrepreneur in business planning by pointing out that:

The **business plan** is the ideal instrument to draw a portrait of the market, the product and the entrepreneur's attitudes. It is through it that you will have detailed information about your industry, products and services, customers, competitors, suppliers and, above all, strengths and weaknesses of the business, contributing to the identification of the feasibility of your idea and the management of the company.

In this way, it is notorious how indispensable it is to create a business plan for any type of enterprise, since it allows a detailed view of the internal and external aspects of the business, thus allowing the entrepreneur to have a basis that allows him to establish an overview of the current situation of the company and what is the desired future situation, thus assisting in the elaboration of goals and strategies.

A relevant aspect that the entrepreneur must consider in the business plan so that the company can succeed in the market in which it operates, is that it is changeable, that is, the

needs of customers and their competitors change, therefore, the business plan as a planning tool that studies these aspects also changes, requiring constant updating (Dornellas, 2016).

Therefore, it is clear that to ensure success in the process of opening a business, it is not enough for the entrepreneur to have the skills to identify opportunities, take risks, innovative attitude, etc., but also to have the ability to develop what is outlined for the organization through the business plan.

In view of all that has been exposed, it can be seen that although the conception of the term entrepreneurship has been greatly influenced by other areas in its ideas, the authors cited: Dolabella (1999), Gerber (2004), Dornellas (2008), Chiavenato (2007), Oliveira (2012) among others, converge in defining the entrepreneur as: innovative, creative and able to take risks. And they present different types of entrepreneurial characteristics, not as a profile, but as aspects to be allocated to their behavior.

This section highlighted an overview of entrepreneurship and the entrepreneur in its conceptual and characteristic aspects, and in the next one entrepreneurship in Brazil will be briefly presented.

3.1 ENTREPRENEURSHIP IN BRAZIL

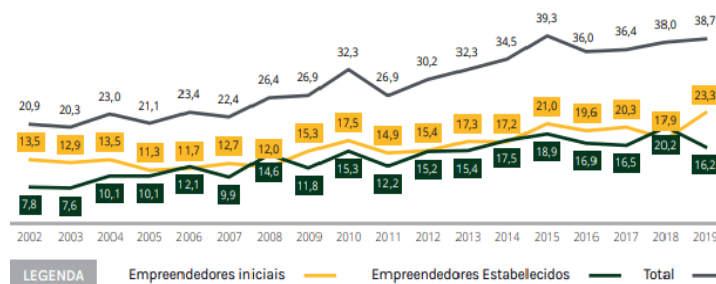
When analyzing entrepreneurship in Brazil, Oliveira (2012, p. 1) mentions that it is a new terminology, especially at the national level, in which "[...]It only emerged for us from the 90s onwards and has been growing along with the privatization process of large state-owned companies and the opening of the domestic market", that is, the term only gained prominence in the country with the insertion of private companies.

Studies by the Global Entrepreneurship Monitor (GEM) (2019), a program that evaluates the evolution of entrepreneurship in Brazil compared to other countries, point out how the development of entrepreneurship is taking place in Brazil.

Regarding the evolution of entrepreneurship in Brazil from 2002 to 2019, the Global Entrepreneurship Monitor (2019) portrays, in Figure 1, the rate of initial entrepreneurs (TEA), rate of established entrepreneurs (TEE) and the total rate of entrepreneurs (TTE) for the years 2002 to 2019, which demonstrates a balance of how entrepreneurship has maintained itself in recent years:

Figure 1

Entrepreneurship rates (in %) second stage of entrepreneurship TEA, TEE, TTE - Brazil - 2002:2019



Source: Global Entrepreneurship Monitor (2019, p. 11).

According to Figure 1, it is possible to see that the initial entrepreneurs have grown in recent years and remained stable. For the Global Entrepreneurship Monitor (2019) it stems from the country's new economic prospects. On the other hand, as for established entrepreneurs, there is an unstable balance of growth and declines, resulting from crises that lead companies to indebtedness, strong fall in demand, and defaults (Global Entrepreneurship Monitor, 2019).

Table 2 presents entrepreneurship according to the rate that corresponds to the population in the age group of 18 to 64 years in 2018 and 2019, where it describes the number of companies linked to the creation, improvement of a new business and the maintenance of some enterprise:

Table 2

Rates (in %) and estimates (in units) of entrepreneurship according to the internship and potential entrepreneurs - Brazil - 2018:2019

Taxas	Taxas		Estimativas	
	2018	2019	2018	2019
Empreendedorismo total	38,0	38,7	51.972.100	53.437.971
Empreendedorismo Inicial	17,9	23,3	24.456.016	32.177.117
Novos	16,4	15,8	22.473.982	21.880.835
Nascentes	1,7	8,1	2.264.472	11.120.000
Empreendedorismo estabelecido	20,2	16,2	27.697.118	22.323.036
Empreendedorismo potencial	26,0	30,2	22.092.889	25.545.666

Source: Global Entrepreneurship Monitor (2019, p. 10).

In the data presented in Table 2, it can be seen that among thousands of people between 18 and 64 years of age, 53.5% carry out an entrepreneurial action, either as a new business, improvement of a new business or striving to maintain the enterprise. It is also noted that the number of beginner entrepreneurs in 2019 compared to 2018 is higher than

established entrepreneurs, which means that entrepreneurship with regard to the creation of a new business has increased in the country (Global Entrepreneurship Monitor, 2019).

Debastiani (2003) brings the contribution that entrepreneurship is influenced by cooperativism characterized as a

[...] management model that seeks the union of ideas, efforts and resources of people who seek common goals. The creation of cooperatives aims, among other interests, to contribute to the reduction of unemployment or poverty, just as entrepreneurship by necessity happens through the individual action of people. (Debastiani, 2003, p. 26).

It is apprehended that cooperative entrepreneurship brings together people who share convergent ideas, democratically established, with the objective of obtaining advantages for the collective.

In the educational sphere, Dolabela (1999, p. 54) emphasizes that "[...] the first course on the area appeared in 1981, at the School of Business Administration of the Getúlio Vargas Foundation, São Paulo, on the initiative of Professor Ronald Degen [...]", however it was only a discipline of the specialization course in the area of Administration. Dolabela (1999) also points to a chronological trajectory in the growth of entrepreneurship as a teaching area, listed in Table 3.

Table 3

Chronological trajectory of entrepreneurship education in Brazil

Year	Trajectory of entrepreneurship education in Brazil
1984	Beginning of entrepreneurship teaching at the University of São Paulo - USP.
1985	The Faculty of Economics, Administration and Accounting at USP offered an entrepreneurship course focused on technological bases.
1992	The Federal University of Santa Catarina created ENE – School of Entrepreneurs.
1993	The CNPq Softex Program, through Fumsoft, has developed a method to offer the teaching of entrepreneurship in Computer Science.
1995	The Federal School of Engineering Itajubá created the Business Center for Entrepreneurial Training of Itajubá and also the University of Brasília created the School of entrepreneurs.
1996	It is considered the milestone of entrepreneurship in the country.
1997	The Softex program, already created by CNPq, started to be directed by the Softex Society, where it develops two projects: Genesis and Softstart, in the same year the Reune Program (University Teaching Network of Entrepreneurship) is created in the city of Minas Gerais.
1998	CNI-IEL together with Sebrae Nacional launched the Reune-Brasil Program, expanding the teaching of entrepreneurship in national university institutions.

Source: Adapted from Dolabela (1999).

Regarding the Brazilian Micro and Small Business Support Service (Sebrae) and the Brazilian Society for Software Export (Softex), they were companies that emerged

respectively in the 1990s and contributed to the growth of entrepreneurship in Brazil. Sebrae was created with the intention of bringing knowledge and possibilities to the opening of a business, while Softex was designed to develop software companies in the market through sales and stimulate local production, in addition, this company through its programs gave a Brazilian character to the term business plan, which was previously little used by entrepreneurs (Oliveira, 2012).

In the case of Sebrae, it is a company that welcomes people who have the desire to become entrepreneurs. It develops professional actions based on the construction and formation of the entrepreneur's knowledge, in partnership with other institutions, through workshops, courses and professionalization, consultancies to guide the opening and maintenance of a business, etc. It is worth mentioning Empretec, a methodology developed by the United Nations (UN) and incorporated in the country by Sebrae since 1993, which works on the behavior of the entrepreneur, as well as maps the opportunities arising from the market (SEBRAE, 2020).

Empretec is a training course that has a workload of 60 hours, where based on science it challenges the subject with practical activities to be performed, based on 10 characteristics necessary to be a successful entrepreneur: Search for opportunity and initiative; Persistence; Take calculated risks; Demand for quality and efficiency; Commitment; Search for information; Goal setting; Systematic planning and monitoring; Persuasion and networking; Independence and self-confidence (SEBRAE, 2020).

According to the Global Entrepreneurship Monitor (2017), there are 2 (two) initial motivations for Brazilian entrepreneurs to open their businesses: by necessity or opportunity. About this, the program discusses that:

[...] Entrepreneurs out of necessity decide to undertake because they do not have better employment alternatives, proposing to create a business that generates income, basically aiming at their subsistence and that of their families. With regard to entrepreneurs by opportunity, the GEM defines them as capable of identifying a business opportunity or a market niche, undertaking even if they have competing alternatives for employment and income [...] (Global Entrepreneurship Monitor, 2017, p. 29).

In this way, it is understood that the entrepreneur by opportunity is the one who is always attentive to the market, who guides his actions through planning and has a vision of the future, on the other hand, the entrepreneur by necessity is often driven by an emergency factor such as unemployment, and at first seeks only to meet his basic needs. With this, the motivations of entrepreneurs are distinguished and can influence the progress of the business, as it is necessary that they are stable motives that propel them to success and not

that nullify or slow down their growth in the market. Table 4 shows the updated percentage of what motivates entrepreneurs to create a company.

Table 4

Percentage of initial entrepreneurs according to motivations to start a new business - Brazil 2019

Motivação	Taxas
Para ganhar a vida porque os empregos são escassos	88,4
Para fazer diferença no mundo	51,4
Para construir uma grande riqueza ou uma renda muito alta	36,9
Para continuar uma tradição familiar	26,6

Source: Global Entrepreneurship Monitor (2019, p. 12).

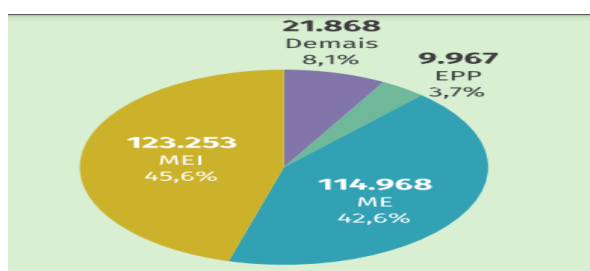
By analyzing Table 4, it is clear that the primary factor for opening a business is linked to the lack of formal jobs in the market. In this way, initial entrepreneurs set up their own businesses so as not to be on the sidelines of the job market. More than 50% are driven by making a difference in the world through the idea that becomes a company. In addition, a third of entrepreneurs ensure that the intention for development is based on the ambition to gather great wealth. And finally, a quarter of entrepreneurs are motivated by traditional aspects, that is, to continue Family Businesses (Global Entrepreneurship Monitor, 2019).

It is pertinent to point out entrepreneurship in Maranhão to understand how entrepreneurship is occurring in the state. In view of this, data were collected from the Board of Trade of Maranhão (Jucema), which shows a considerable growth in the number of active companies in 2020 with a percentage of 270,056 enterprises compared to 2014, which was 125,398 (Maranhão, 2020).

Figure 2 refers to the rate of companies by size: Individual Microentrepreneurs (MEI), Micro Companies (ME), and Small Businesses (EPP).

Figure 2

Total number of companies by size



Source: Maranhão (2020, p. 3).

It is apprehended that among the number of active companies, 123,253 (45.6%) corresponds to the number of individual microentrepreneurs and represents a higher percentage, followed by microentrepreneurs with 114,968 (42.6%), and small companies with 9,967 (3.7%) and the others that are the companies that do not fit into the other sizes with 21,868 (8.1%) (Maranhão, 2020).

The companies of São Luís - Maranhão established themselves with a business profile focused on services, adding up to about 88,466 in execution, of which 38,666 in the service sector, 37,528 in commerce, 6,105 in construction, 5,998 in industry and 169 in agriculture. Table 5 represents the number in some cities in Maranhão.

Table 5

Areas of operation of the companies in the cities of Maranhão

	Serviços	Comércio	Construção	Indústria	Agropecuária	Total
São Luís	38.666	37.528	6.105	5.998	169	88.466
Imperatriz	9.067	11.608	1.287	1.938	77	23.977
São José de Ribamar	3.502	5.372	829	885	37	10.625
Timon	2.355	3.654	528	757	18	7.312
Balsas	2.521	3.201	408	519	241	6.890
Paço do Lumiar	2.174	3.379	537	436	25	6.551
Caxias	1.890	3.298	325	413	27	5.953
Açailândia	1.974	2.820	352	501	92	5.739
Bacabal	1.335	3.016	247	295	13	4.906
Santa Inês	1.317	2.592	195	297	14	4.415

Source: Maranhão (2020, p. 4).

It is understood that in addition to São Luís, Imperatriz, São José de Ribamar and Timon stand out as other cities that have a dense growth mainly in the areas of services, commerce, construction and industry (Maranhão, 2019).

In view of all the data analyzed, it is worth pointing out that entrepreneurship concerning the opening of companies is analyzed according to the economic aspect that is linked to the social and political aspects of the country to maintain and be created in the market. However, it is an activity that is maintained due to financial contributions to the country, but it is necessary that more materials focused on the knowledge of the subject be produced so that real and potential entrepreneurs seek information in the literature that contributes to the business.

It is necessary to emphasize that there is the Association of Young Entrepreneurs of Maranhão (AJE), a non-profit institution that works with the objective of integrating young businessmen and entrepreneurs to propagate entrepreneurial knowledge that ensures the promotion of their growth from an intellectual and professional perspective (Association of Young Entrepreneurs of Maranhão, 2020).

The discussion about entrepreneurship is extensive and seeks multidisciplinary, because in all areas there are entrepreneurial individuals. Therefore, it is pertinent to highlight entrepreneurship in Librarianship, in order to encourage entrepreneurial attitudes in the area.

3.2 ENTREPRENEURSHIP IN LIBRARIANSHIP

The historical aspect of entrepreneurship in Librarianship, according to Spudeit (2016) occurs in the 1980s through the creation of formal companies originated by librarians, such as Redata - specialized in the document management of archives, libraries and documentation centers - and Bibliotec - Information Management of archives and libraries, previously focused on the traditional services of these organizations and, Currently, they meet the diverse informational demands represented in services and products, remaining in the document management market. It is emphasized that:

[...] from the 1990s onwards, there was an expansion in the range of services and new companies emerged such as Datacoop, eDoc Consultoria, Control, GedBrazil, Indexare, among others with a technological and managerial focus to meet specific demands in the market (Spudeit, 2016, p. 14).

It can be inferred that librarians have been organizing companies according to market standards, moving from the traditional professional practice of library organization, standardization and the like to the updating of technological innovations. In this perspective, Madalena and Spudeit (2017) ratify the importance of librarians knowing their field of activity in order to manage new work fronts and establish interdisciplinary partnerships.

Therefore, when dealing with entrepreneurship in Librarianship, Spudeit (2016, p. 14) refers to:

1. Skills developed and knowledge acquired throughout graduation and through complementary training applicable to new fields of activity that require a differentiated professional profile, attentive to opportunities;
2. Creation of a business in the area of information in which the librarian can act as a liberal professional to provide services aimed at specific demands of the market or society itself;
3. Projects aimed at the use of information for social transformation and empowerment of people, aiming to promote greater reflective and critical awareness for the full exercise of their citizenship;
4. Intrapreneurial actions that can be developed by librarians in different fields of activity, such as process management, e-commerce, information architecture, project management, among others, including in libraries.

Thus, the librarian can become an entrepreneur from the beginning of academic training. Regarding the librarian's role as an entrepreneur, Madalena and Spudeit (2017, p. 59) argue that "[...] he is able to transform opportunities, through resources available in a creative way, in order to create products and services in the area of information management", that is, this professional can transform all his knowledge into an opportunity to generate new ideas, within the infinite possibilities that the librarianship field offers, which goes beyond the walls of a library and also far from the public service.

There are many market niches through which librarians can develop their enterprises, this is because, by working with information, this professional has a broad knowledge about what is happening in the world, which favors the construction of new job and business opportunities (Madalena; Spudeit, 2017).

In addition, Girard, Fonseca and Gama (2017) expose the spaces of action of the creative economy in Librarianship, such as: blogs, publishing agencies, fashion products, professional brand designers, consulting services, among others. The creative economy in Librarianship is the inventive and innovative practice of the librarian in a physical or digital way.

Correlated to these spaces, Girard, Fonseca and Gama (2017) highlight as models: Santa Librarianship, a blog created in 2012 by a librarian, with the initial objective of passing on the knowledge acquired and helping her professional colleagues on topics involving the course, currently handouts for public exams are also posted; Class Cursos, which works to train professionals in the area of Library Science and Information Science, founded in 2015, also operates in the online course market; the Library Agency, created in 2011, is focused on communication and publication in the field of Librarianship, culture, education and literature.

In addition to these, there is also the company Documentar that operates in process management as well as Innova Gestão. The company Documentar stands out in the areas of Information Science, Automation via IT and Information Management; while Innova Gestão works with research, training and consulting services focused on areas such as Information Management, knowledge, innovation and others. Biblio ideias that works relating marketing with the library area exercising administration and finance activities. (Spudeit; Magdalene; Laurindo; Duarte, 2016).

Among the companies mentioned above, which exercise entrepreneurship in Librarianship, some are listed with the respective addresses of websites that work with activities aimed at consulting and continuing education of librarians, automation technologies, indexing and others (Table 6).

Table 6

Companies operating in the librarianship field

Companies	Email address
Access – Documentary Accessory	http://acessonett.com.br/
Agency Biblio	http://agenciabiblio.info/
Biblio Ideas	http://biblioideias.blogspot.com.br/
Biblio Consulting	http://www.inforbiblio.com.br/p/biblioconsultoria.html
BiblioCoop Cooperative	https://bibliocoop.webnode.com/
Biblioshop Software	http://www.biblioshop.com.br/#home
Bibliotec	http://www.bibliotec.com.br/
Class Courses	http://www.classscursos.com/
Content Mind	http://www.contentmind.com.br/
Control Information and Documentation	http://control.com.br/
Datacoop	http://blogdatacoop.blogspot.com.br/
eDoc Consulting	https://2020.edocconsultoria.com.br/
Egregore Intelligence	https://www.sympla.com.br/egregorainteligencia
Ged Brazil	http://www.gedbrazil.com.br/
Guarddoc - Document management and storage	https://guarddoc.com.br/servicos/guarda-e-gestao-de-documentos/
Guzzo Projects	http://guzzoprojetos.com/
iMID	http://imind.com.br/
Index Consult	http://www.indexconsult.com.br/
Indexare	http://www.indexare.com.br/empresa/
Innova Management	http://www.innovagestao.com.br/
Lepidus Technology -	https://lepidus.com.br/
Modal	https://modalnetworks.wordpress.com/
NS Consulting	http://www.nsconsultoria.com.br/
Periodical in Clouds	http://periodicos.emnuvens.com.br/
Praxis Solutions	www.praxis.com.br
Redata	https://redata.com.br/
Holy Librarianship	https://santabiblioteconomia.com.br/
Screening Consulting	http://www.triagemconsultoria.com.br/
T-Shirts Mural	http://www.t-shirtsmural.com.br/

Source: Adapted from Spudeit, Madalena, Laurindo and Duarte (2016).

These companies that work with the service of the library area outside the conventional field can be considered as entrepreneurial actions and serve as an affirmation that entrepreneurship is related to and can be developed in Librarianship. Spudeit, Madalena, Laurindo and Duarte (2016) mapped and found around 36 companies, which promote automation, consulting, knowledge management, continuing education, among others. However, when reviewing again if they are in operation, about 5 companies are in disuse. In Table 2, only the organizations that are in full exercise of their activities were scored. It can be seen, in accordance with Spudeit, Madalena, Laurindo and Duarte (2016), that with regard to the creation of companies, the action of librarians is still timid.

Junior enterprises (EJ) are also pointed out as entrepreneurial activities, as they contribute to the empirical performance of students and are ways for students to have the

experience of forming a company and exercising the professional practice of the area in their teaching-learning processes. They are defined as:

[...] a non-profit civil association, resulting from the union of students enrolled in an undergraduate course in higher education institutions in order to offer projects and services that contribute to training trained professionals committed to the purpose of transforming Brazil (Brasil Júnior, 2015, p. 6).

The mapping of Junior Enterprises (EJ) in the area of Librarianship was carried out from research carried out on the websites of the Faculties of Library Science, blogs, and also through the mapping table of EJ in Librarianship of the Course Completion Work of Reis (2017). Table 7 shows a mapping of the EJ in the federal universities.

Table 7

Mapping of EJ in the area of Librarianship

No.	EJ in Library Science	Institution	Year of Creation	Situation
1	InfoJr.	UFSCAR	2009	active
2	SETi Junior Consulting	UFPE	2013	active
3	Info Junior	UFSC	2013	active
4	BiblioMetrics	UFRN	2012	active
5	Junior Library	UFSC	2004	closed
6	AGIR Jr. Consulting	UFC- Cariri	2010	Inactive
7	EGID JR	UNESP-MARÍLIA	2007	Inactive
8	CGI-JR	UFMG	2009	Inactive
9	FESP Jr.	FESPSP	Information not found	closed

Source: Reis (2017, p. 31).

It can be seen that only 4 (four) EJ are active, such as: the InfoJr of the Library and Information Science Course at the Federal University of São Carlos, which offers services aimed at the normalization of academic works, textual review, updating of lattes curriculum, automation of collections, design and advertising; SETi Consultoria Jr of the Federal University of Pernambuco, which develops activities of organization of collections (classification, indexing and/or cataloging), standardization of academic works, and updating of Lattes Curriculums; Info Júnior of the Federal University of Santa Catarina, which provides services aimed at the areas of Archivology, Library Science and Information Science; and BiblioMetrics belonging to the Librarianship Course of the Federal University of Rio Grande do Norte, and work with the standardization of academic works, biblioFigureic survey, book publishing, organization of physical and digital collections, organization and systematization

of files on computers, tablets and smartphones, user research, policies, qualitative and quantitative, and information architecture (Reis, 2017).

In Maranhão, activities focused on corporate entrepreneurship, which deals with the creation of new companies, are still timid. However, actions such as Biblio Fora da Caixa³, created by librarians from Maranhão who use social media spaces (Facebook, Instagram and Youtube) to promote people and institutions that add differential content to the area of Library Science and Information Science, are found in the digital sphere; Normalize⁴, created by a student of the Library Science Course of Maranhão who posts content on Instagram related to ABNT rules and provides services for standardization and updating of the Lattes Curriculum; Elaborando,⁵ which works with documentary standardization (articles, abstracts, files, reviews, etc.), and the organization of lattes; and the Reading Pier⁶, a page created on Instagram by a student of the Librarianship Course, is a literary profile that socializes literary reviews, literary tips in order to awaken in followers the pleasure of reading. It is noted that most of the profiles found on social networks are focused on the normalization and organization services of the Lattes Curriculum.

In addition, librarians inserted in libraries can develop intrapreneurial actions, however, "[...] it is necessary to have autonomy of services, innovations and creations and also to count on the help of everyone in the institution in search of organizational success" (Brito, 2017, p. 26), so that the activities developed attract users and meet informational needs, not necessarily creating new things, but innovating in established services.

The job market is dynamic, and with each evolution of society, a demand arises. In the context of libraries, it is no different, information changes, new technologies emerge and in this way the world of work requires professionals who adapt to these changes. Thus, it is necessary for librarians to seek continuing education and new ways of working to walk side by side with these transformations. Therefore, Cardozo and Barbosa (2004, p. 23) point out that the entrepreneurial librarian must be "[...] creative, flexible, innovative and have a vision of the business in which it operates, in addition to always being aware of the need for permanent updating, with regard to knowledge and techniques and working methods". Therefore, when thinking about the entrepreneurial librarian, it is necessary, in addition to everything, to analyze the market and all the knowledge that the professional holds, so that

³ Biblio Fora da Caixa: [https://instagram.com/biblioforadacaixa?igshid=1hky8oxhb8kon](https://instagram.com/biblioforadacaixa?igshid=1hky8oxhb8kon;);
<https://www.facebook.com/biblioforadacaixa/>;
https://m.youtube.com/c/BiblioForadaCaixa?sub_confirmation=1.

⁴ Normalize: <https://instagram.com/normalizacao.lattes?igshid=1ki8v35dav8et>

⁵ Elaborating: <https://instagram.com/elaborando?igshid=1ajmvebpxgmjh>

⁶ Literary Wharf: <https://instagram.com/caisdaleitura?igshid=g7issno9ah6t>

he can create or recreate, in a differentiated way, new services or products that meet the needs of customers.

Regarding the various ways of developing a business, consulting arises as a result of entrepreneurial actions, contributing to the solution of problems in enterprises and to the creation of new companies. In addition to the possibility of being developed internally by the company's own employees who seek to identify and solve the problems of the organization inserted. However, the focus of the research will be directed to external consulting aimed at creating a marketing consulting company for libraries. Thus, in order to clarify more about this sector, the following section will address consulting.

4 CONSULTANCY

The expression consultancy, derived from the Latin *consultore*, can be apprehended as an exchange of offering and receiving advice. In a conservative perception, it was considered as a function developed by religious people, and in the last century as specific activities carried out, for example, by doctors, lawyers and accountants (Leite *et al.*, 2005). However, for Block (2013), anyone who influences the other without the direct power to generate changes is considered a consultant, because those who make them effective are the managers.

In the historical aspects of consulting, Grocco and Guttman (2005, p. 2) emphasize that,

[...] A brief and more attentive analysis of the history of humanity is enough to realize that it has existed since time immemorial. There are, for example, the Druids, magicians who, in addition to preparing potions, advised the chiefs of Celtic villages on various subjects and resolved various disputes between the villagers. The rabbis, similar to the Druids, advised the faithful, interpreted the scriptures, adding more knowledge to the people, and also resolved disputes.

In this context, Grocco and Guttman (2005) and Leite *et al.* (2005), converge with the idea that the activity of consulting, in its origin, was a practice carried out by the wise men of society. On the other hand, authors such as Bond (1999), Paes de Paula and Wood Júnior (2008) associate the history of consulting with the ideologies of *Management* (discourse focused on the reorganization of the areas of Strategy, Marketing and Human Resources) propagated in organizations. In addition to these, other theoretical sources emerged, such as Silva (1974) and Merron (2007), who based their historical studies on consulting on the system used by Frederick Taylor (he fragmented basic activities and analyzed the time in which work was carried out).

The origin of consulting in the form it is currently applied, according to Donadone, Silveira and Ralio (2012) emerged between the nineteenth and twentieth centuries, and can be considered as places of origin: England and the United States. With regard to the expansion of services to other fields, Lins (1999) demarcates the 1920s, especially in the United States, as the period in which consultants began to work in the areas of production, accounting, personal administration and human relations. Consulting activities were expanding in the various areas of work, and during the Post-War period, in the 1970s of the last century, consulting originated its work in marketing and other techniques aimed at operations research and systems modeling. With regard to consolidation, it is important to emphasize from 2 (two) processes:

The first of them being the legitimization of the activity as an alternative in conducting the analysis and even the management of public and private organizations [...] The second process is also linked to extensive changes, but with a focus on accounting, caused by the reformulation of laws regarding the relationship of companies with the financial sector and the calculation of taxes (Pastore, 2014, p. 38).

It is a remarkable period for this sector, since it legitimizes its function to establish links and professional partnerships with public and private organizations. In addition to performing specific work in other areas, such as accounting (Pastore, 2014).

In general, consulting is:

[...] a process of mutual learning between consultant and client, based on a constant cycle of action research, that is, trial-error-success. In this process, not only the consultant, but also the client must play an active role, since no two problems are ever the same, and because it is practically impossible for a consultant – and his team – to understand and apprehend all the complexity and interdependence of the political, social, technological and economic systems operated by the client, in the short contractual time normally available (Gonçalves, 1991, p. 91).

In relation to the concept presented by Gonçalves (1991), consultancies are activities developed in stages, through the interaction between the consultant and the client, which seek to reflect critically and analytically on various problems in organizations. Nothing comes ready, both are willing to take risks within the process. The client, in turn, is a fundamental piece for the unfolding of the consultant's activities, acting as an active agent, since he knows the company's organizational culture.

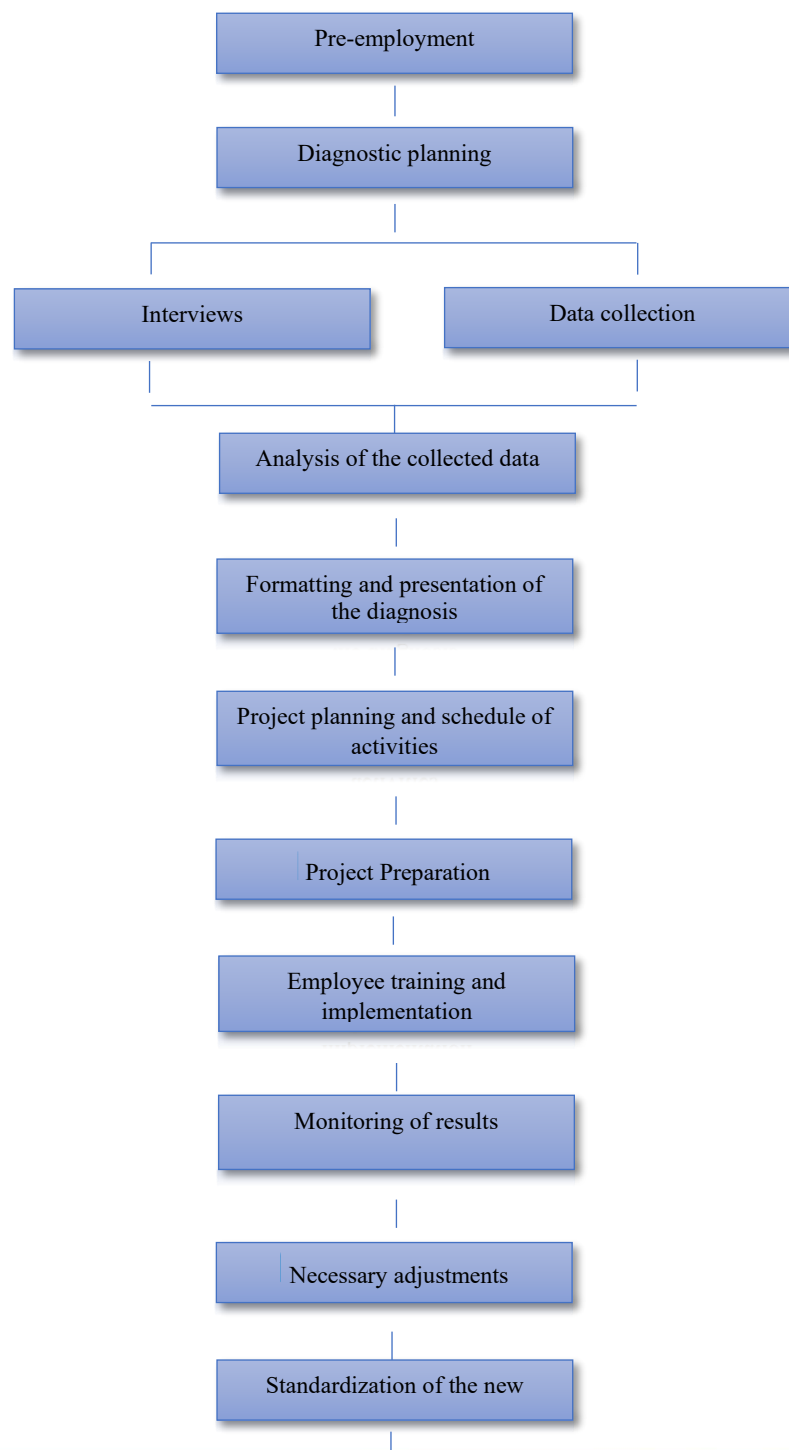
In the view of Grocco and Guttman (2005, p. 8), consulting is considered as an interactive process "[...] executed by one or more people, independent and external to the problem under analysis.", therefore, the consultant must diagnose, assist and propose

solutions to the problems identified. Similar to this, Reis Neto (2007) defines consulting as a partnership activity, where this interaction is decisive for obtaining results.

Block (2001), emphasizes the consulting process in 5 (five) ordered phases: Entry and Contract; Data Collection and Diagnosis; Feedback and Decision to Act; Engagement and Implementation; and Extension, Recycling, or Termination. In Figure 3, the activities developed in these stages are presented.

Figure 3

Activities of a Consultancy



Project completion

Source: Block (2001).

In each stage highlighted by Block (2001), the activities defined in the flowTable are established. In phase 1 Entry and Contract is the point where pre-contracting and diagnosis planning are worked; in Data Collection and Diagnosis it is the interview phase, data collection and analysis of collected data; Feedback and Decision to Act is related to the formatting and presentation of the diagnosis, project planning and schedule of activities and project preparation; Engagement and Implementation focuses on employee training and implementation; and Extension, Recycling or Completion which concerns the monitoring of results, necessary adjustments, standardization of the new process, and completion of the project. Therefore, it is the responsibility of the consultants to facilitate the phases of change of the client-company, together (consultant and client-company), so that interaction is developed in the stages of the process (Leite *et al.*, 2009). These phases are described in more detail in section 6.2.1.

For Lins (1999, p. 26) "Consulting has a primordial concept of helping third parties, exemplified in the situation of someone who has information and passes it on to the other who requested it and the other decides what to do with this information", whose services are provided to someone, not arbitrarily, but consensually, since the consultant does not have the autonomy to put into practice actions of change, if it is not granted by the customer. Reinforcing this idea, Block (2001, p. 2) describes the consultant as "[...] a person who is in a position to exert some influence over an individual, group, or organization, but who has no direct power to produce change or implementation programs [...]". Therefore, consultants must know the organizational demands, and propose solutions that will solve the identified needs, respecting the power of choices of the clients.

Regarding consultancies in Brazil, Donadone, Silveira and Ralio (2012) consider the country an important center that receives most of the national consulting firms, perhaps in Latin America. As a result, the authors carried out an analysis that aimed to identify the main centers of influence in the sector to develop a cartoFigurey of the Brazilian consulting space. Thus, they identified 3 (three) centers of action of the consultancies in the country represented by the Brazilian multinationals; and university students (Donadone; Silveira; Ralio, 2012).

Multinational consultancies are subdivided into accounting firms and artisanal consultancies. The first is associated with mass production, since it requires large-scale performance, a considerable number of professionals and the presence of a significant

number of recent graduates from Business Schools; In artisanal consultancies, their consultants are differentiated by the academic aspect, that is, the priority is in the qualification of their professionals. Brazilian consultancies, on the other hand, have fragmented characteristics because they cover small companies. The performance of these consultants is focused on specific knowledge and a network of relationships derived from the experiences lived in an existing sector. And university consulting is linked to an institution, and its differential from other consultancies is in the scientific methodology. It can be seen that the difference between the consultancies in Brazil is conditioned by the nuclei of action as well as on who will work (Donadone; Silveira; Ralio, 2012).

It is worth mentioning some associations created to bring together the various services offered to consultants, such as: Institute of Management Consultants (IMC) and Brazilian Institute of Organizational Consultants (IBCO). There is a need for consultants to engage in these Institutes to establish and increasingly strengthen consulting services in the market, and to be a way to add, through continuing education, more knowledge for better professional qualification and customer satisfaction.

In addition, the IMC is an organization focused on teaching and research regarding the improvement of management consulting practices through research, performance measurement and education of current and future management consultants. It aims to generate value, ethics and professionalism on the part of management consultants (IMC, [2019]).

Therefore, IBCO is a non-profit governmental organization that brings together consultants from consulting companies, independent consultants, internal consultants and institutional members who have voluntarily joined (IBCO, 2015), for its adhesion it must: "[...] participate in examsthat evaluate the training, experience and way of acting of candidates [...] IBCO's main activity is permanent research on techniques, technologies, ethics and quality of consulting" (IBCO, 2015), if approved, these professionals must be committed to the institute's mission, take careof the Code of Ethics and achieve its objectives.

According to data obtained by the Brazilian Institute of Organization Consultants (IBCO) in the most recent survey carried out in 2016, it is estimated that Brazil has about three thousand organization consultants carrying out activities in the area of Planning, Training and Human Capital, Strategic Management, Organizational Development and Restructuring, Process Management, Information Technology, Marketing and Commercialization, Finance, Research, Intelligence, Logistics, Creativity and Innovation, Sustainability, Legal and Tax, etc. (IBCO, 2016, p. 8).

According to IBCO (2019) Brazil corresponds to 75% of Latin American revenue, that is, "From 2008 – 2010, due to the impact on developed economies and the appreciation of the real, the Consulting business in Brazil expands at rates much higher than those presented in more developed countries" (IBCO, 2019, p. 16). In the country, almost 50% are independent consultants or consulting firms with only one consultant; and another 70% offer organizational consulting services maintained for five years and 18% have remained for 20 years (IBCO, 2019). These data were collected based on interviews with consultants by state. Table 6 shows the percentage of interviewees.

Table 6

Percentage of Respondents by region

Participação de Respondentes por Estado		
Estado	Quant.	%
Alagoas	6	3,08
Bahia	2	1,03
Ceará	11	5,64
Distrito Federal	7	3,59
Espírito Santo	5	2,56
Goiás	1	0,51
Minas Gerais	15	7,69
Mato Grosso	3	1,54
Maranhão	1	0,51
Pará	1	0,51
Paraíba	2	1,03
Pernambuco	2	1,03
Paraná	7	3,59
Rio de Janeiro	28	14,36
Rio Grande do Norte	1	0,51
Rio Grande do Sul	31	15,90
Santa Catarina	1	0,51
São Paulo	71	36,41
Total	195	100

Source: IBCO (2016, p. 23).

It can be inferred that the largest concentration of interviewees who work in the consulting industry belongs to the South and Southeast regions. In Maranhão there is a lower number and this may mean that the state lacks more due to the lack of consulting companies. However, it is possible that this sector has grown in Maranhão, however IBCO (2016) still does not have recent research, because when searching in the Google search engine, some companies were identified, such as: EJAD Business Innovation⁷, which operates in the field of consulting developing activities of Financial Plan, Spy Client, Business Plan, Marketing Plan, Strategic Planning, process mapping, job description, and market research; Gakkai Business Consulting⁸, which offers strategic planning services, Restructuring of Processes and Routines, Manualization of Processes, Strategic Financial Management, Trademark Registration, Business Plan, Coaching to Enhance Teams, Market Research, Satisfaction Survey, Selection of Professional Talents, Manual of Good Practices in Food, Franchise Network Start Up, and also provide a professionalization course to its customers. customers;

⁷ EJAD Business Innovation: <https://www.ejadconsultoria.com.br/>

⁸ Gakkai Business Consulting: <https://gakkaiconsultoria.com.br/>

Sapiens Consulting⁹, which operates in the areas of environment, training and strategic management; and Labore Consulting¹⁰ is a company that provides services to candidates with vacancies for internships, young apprentices, trainees, administrative positions, operational positions, specialists and managerial positions, and also provides services to companies by recruiting qualified professionals to enter companies.

It is worth noting that Sebrae operates in Maranhão as a consulting company providing information and training for entrepreneurs who are going to get their own business. An example of this is Sebratec, which is "[...] a Sebrae product that **provides technological services for your company**. Sebraetec connects small businesses to a wide network of technological service providers that serve throughout the Brazilian territory" (SEBRAE, 2020), and also enables the dissolution of demands in the areas of Design, Production and Quality, Technological Development, and Sustainability (SEBRAE, 2020).

Currently, in view of the pandemic crisis scenario, where it is affecting the economy, Sebrae is offering online consulting aimed at micro and small companies (MEI) granting 4-hour consultancies in the areas of Financial Management, Business Legal, Accounting/Tax, Process Management, Digital Marketing, Digital Media and Innovation (SEBRAE, 2020).

Regarding the consulting company focused on the field of Librarianship in Maranhão, it is possible to identify mostly more companies aimed at standardization, such as Silver Standardization¹¹, a member of the Brazilian Association of Technical Standards (ABNT) and affiliated to the Regional Council of Librarianship 13th Region, in Maranhão Standardization. 2020); and NC Academic Consulting¹², which works with standardization services, preparation of biblioFigureic references, slides, spreadsheets, tables and Figures.

In general, consulting can be developed internally and externally. In the perspective of Oliveira (2005, p. 61) the "[...] external consultant is represented by a self-employed consultant or by a professional from a consulting firm", while the "Internal consultant is represented by an employee of the client company; which performs services for different areas of the aforementioned company" (Oliveira, 2005, p. 61). These consultancies are distinguished through the relationship that the professional has with the company, as the external consultant is represented by the objectivity and impartiality of the service provider, while the internal consultant is part of the organization's staff.

Teixeira and Coelho (2012, p. 68) corroborate Oliveira (2005) when they cite that:

⁹ Sapiens Consulting: <https://consultoriasapiens.com/index.html>

¹⁰ Labore Consultoria: <http://www.labore-ma.com.br/index.php>

¹¹ Silver Standardization: <https://www.silvernormalizacao.com.br/>

¹² NC Consulting: <http://www.findglocal.com/BR/S%C3%A3o-Lu%C3%ADs/1587965388102832/NC-Consulting-Acad%C3%A2mica>

[...] external consulting is carried out by a professional without an employment relationship (CLT) with the client company, that is, an independent professional, with academic knowledge and business experience, who acts as a facilitator of the process, without, however, exercising any direct intervention in the management of the company and/or its processes. [...] Internal consulting is developed by a professional who is part of the company's staff. It uses experience, skills and knowledge to improve the forms of relationship and implement new forms of management.

Teixeira and Coelho (2012) refer to external and internal consultants sequentially, as the professional without the Consolidation of Labor Laws (CLT) regime with the contractor, but who uses his theoretical knowledge and professional experiences to collaborate with the company, not having the freedom to execute any decision made, unless authorized. On the other hand, internal consultants know the company because they are part of the organization's work environment, and gather the knowledge learned over the years to develop efficient ways for interpersonal relationships, as well as contribute to improving the management of their activities. Block (2004) claims that internal consultants usually act by imposition, while external consultants get involved with most situations, without being influenced by the organizational environment and have more opportunities in the market.

In addition, it is necessary to define the types of consultancies to think about the product, the way of acting, and the career as a consultant. Thus, the consultancies are divided, in terms of structure, into package consulting and artisanal consulting, and in terms of their breadth into specialized consulting, total consulting, and global consulting (Oliveira, 2005), described in Table 7.

Table 7

Types of Consultancies

Classification	Types
As for its structure	Package consulting – That which is carried out through the use of strong methodological structures and administrative techniques, seeking a standardization of the consulting service, without worrying about the adequacy to the context and reality in which the client company is inserted.
	Artisanal Consulting – That which seeks to provide personalized service to the customer's problems, elaborated with fundamental methods and techniques based on models applied in similar companies. Its final result has higher quality and provides the client's independence in relation to the consulting company.
	Specialized Consulting – Operates specifically in one or a few subjects in the organization, within an area of knowledge (marketing, HR, finance, etc.), being considered the fastest growing type of consulting in recent years. Some of its advantages are: higher quality in the services provided, greater agility with lower costs and a higher degree of training of the people involved.

As for its breadth	Total Consulting – Works in practically all operations of the client company. It is the target of criticism for the fact that it often deals with various issues in a non-integrated way, gives opinions in all sectors of the company and causes waste of efforts. It is important to analyze whether the methods applied are integrated and whether there is at least one specialist for each subject.
	Globalized Consulting – One that consolidates its services in globalized companies and operates in several countries. It has a strong technological evolution, especially in IT, and operates with the objective of forming free trade fields and economic blocs that interconnect markets, especially consumer and financial markets.

Source: Adapted from Oliveira (2010).

Oliveira's (2010) statements lead to a perception that the structural aspect of consulting revolves around its structure, how services are planned, such as package consulting, which works with pre-formed services, and artisanal consulting, which seeks to offer personalized products to solve contractors' problems. The breadth aspect refers to the dimension of the services, that is, to the area of activity, such as: specialized consulting that filters a segment and works specifically in a field of knowledge, total consulting that works in general in all activities developed by the contractor; and the globalized consultancy that works with global companies and provides consultancy in which place in the world the company operates.

Regarding consulting, according to Lins (1999, p.30) it is perceived that "[...] It presents some particular aspects, such as: it is an independent, advisory service, which provides knowledge and is not as easy as one imagines", that is, it is a guidance service that requires from the consultant discipline a distanced and deep analysis of the data, involvement, impartiality and the search for solutions to problems presented by the client company. Therefore, for Oliveira (2005) there is a difference between being a consultant and being a consultant, because to remain in this profession it is necessary that the professional has the vocation and competence to provide quality work. On the other hand, "[...] for consulting to become an efficient job, it is necessary for the company to create criteria for the consultant's needs, check their background, in addition to making appropriate use of their services" (Lins, 1999, p. 34) or, better said, offer working conditions for the consultant, know their professionals and know how to extract the contracted service from them.

Among the various segments that can be worked on in consulting, marketing stands out, which acts from the perspective of meeting the needs of customers, from the creation of the business to its maintenance in the market. In this way, consulting is inserted as a way to assist in the opening of a business and in the analysis of symptoms that reflect on organizational problems with solution proposals.

Marketing has become one of the specialized areas of consulting, due to its management process, especially in what corresponds to the 4P's, which includes all the company's functions – product, price, place and promotion. For a broad understanding of marketing, in the next topic a study on the subject was developed.

5 MARKETING

Marketing is an area of great prominence in the field of Administration, because it works with a focus on the customer, covering the entire business in order to meet their needs and desires. Its effective origin dates back after the First Industrial Revolution, in the seventeenth and nineteenth centuries. which at first had its focus on the product, and with the constant changes in the market, they started to focus on the customer. Since then, this area has expanded conceptually and has undergone major transformations in its technique and application (Cobra, 2011).

Regarding the term marketing, Amaral (2007, p. 19) points out that it is a "[...] Anglicism, adopted in the Portuguese language, since there is no single word that can express the conceptual totality included in the term in English". In addition, the author points out that the union of this word corresponds to "action" and "market", that is, market in action. In this way, marketing is linked to the marketing process that involves activities such as exchange and sale.

In the view of Kotler and Keller (2012, p. 3, emphasis added) "Marketing involves the identification and satisfaction of human and social needs. One of the most succinct and best definitions of marketing is that of 'meeting needs by generating profit'". It can be seen that the emphasis given by the authors is an area concerned with the client's needs without losing sight of their financial objectives. Similarly, Kotler and Armstrong (2007, p. 4) define marketing as "[...] an administrative and social process by which individuals and organizations obtain what they need and desire through the creation and exchange of value with others [...]", where all parties benefit.

Las Casas (2010) and Cobra (2011) relate marketing to the exchange process. For Las Casas (2010, p.14) marketing is "[...] a marketing activity that was based on the concept of exchange. [...] Exchange is characterized by the offer of a product with the receipt of another benefit [...]" and Cobra (2011, p. 23) defines marketing as "[...] the process in society through which the demand for goods and services can be anticipated or encompassed and satisfied through the design, exchange, promotion, and physical distribution of goods and services." In this concept, Cobra (2011) emphasizes one of the tools of the marketing mix and the relationship established between organizations and society.

Another concept is that of McCarthy (1982) who characterizes marketing as the act of identifying the needs of customers and satisfying them, revealing that there is a marketing action of goods and services. Reinforcing this idea, Amaral (1998, p. 55) says that marketing "[...] implies perceiving the expectations, needs and desires of the market we intend to meet [...]", is thinking like the customer to meet their demands, in addition to achieving organizational objectives.

In addition, marketing can be defined according to its scope in a macro or micro nature. Macromarketing is understood as a "[...] social process that directs the flow of goods and services from producers to consumers in order to effectively balance supply and demand, and to achieve the goals of society" (McCarthy, 1982, p. 30). While micromarketing "[...] it is the execution of activities that seek to achieve the objectives of the firm, anticipating the needs of the customer and moving a flow of goods and services, which can satisfy those needs from the producer to the consumer" (McCarthy, 1982, p. 29). Both are distinguished by their breadth, while macromarketing is concerned on a larger scale with the whole of society, micromarketing focuses on the individual interests of small groups.

In order to contribute to the conceptual understanding, in a chronological way, Table 8 describes some conceptions about marketing of basic theorists in the area.

Table 8

Evolution of marketing definitions

Author	Year	Marketing Definition
<i>American Marketing Association</i>	1960	The performance of goods and services activities from the producer to the consumer or user.
<i>Ohio State University</i>	1965	The process in society by which the structure of demand for economic goods and services is anticipated or encompassed and satisfied through the design, promotion, exchange, and physical distribution of goods and services.
Kotler and Sidney Levy	1969	The concept of marketing should also cover non-profit institutions.
William Lazer	1969	"Marketing should recognize the societal dimensions, that is, take into account the changes that have occurred in social relations."
David Luck	1969	Marketing should be limited to activities that result in market transactions.
Kotler and Gerald Zaltman	1969	The creation, implementation, and control of programs calculated to influence the acceptability of social ideas and involving considerations of product planning, pricing, communication, distribution, and marketing research.
Robert Bartis	1974	If marketing is to be looked at as encompassing economic activities, perhaps marketing as it was originally conceived will soon reappear under another name.
Robert Haas	1978	It is the process of discovering and interpreting consumer needs and wants for product and service specifications, creating demand for those products and services, and continuing to expand that demand.
Robert Haas	1978	Industrial Marketing - It is the process of discovering and interpreting the needs, desires and expectations of the industrial

		consumer and the requirements for the specifications of the product and service and continuing through effective promotion, distribution, after-sales assistance to convince more and more customers to use and continue using these products and services.
Phillip Kotler	1997	It is the process of planning and executing from the conception, pricing, promotion and distribution of ideas, goods and services to create exchanges that satisfy the objectives of people and organizations.

Source: Adapted from Cobra (2011).

In view of such definitions, it is possible to understand the conceptual evolution of marketing evidenced by theorists and organizations. The first concept enunciated is from the American Marketing Association (AMA) (1960), where the emphasis was concentrated on production processes, in search of increasing products, which as a result of World War II became small. In 1965, Ohio State University considered that marketing satisfied the needs of customers through the exchange of goods and services and the application of one of its compounds: promotion and distribution. Later, Kotler and Levy (1969) outline diverse ideas about marketing by emphasizing the possibility of thinking about it for non-profit organizations. Then Lazer (1969), Luck (1969) and Kotler and Zaltman (1969) characterize marketing as a social, managerial and marketing process.

Bartis (1974) becomes a visionary when he thinks about the possibilities of new marketing nomenclatures. Currently, marketing is configured according to the needs of each organization. Haas (1978) defines marketing based on 4 (four) central perspectives: needs, desires, demands, and after-sales assistance (currently known as relationship marketing). And finally, Kotler (1997) focuses marketing based on the exchange process.

The historical scenario of marketing is conditioned by the processes of transformation of society. Corresponding to the evolution of this sector, McCarthy (1982) and Las Casas (2008) consider that it went through three "Eras": the era of production, the era of sales, and the era of marketing.

Customers were not always considered the central focus of organizations, but rather they were concerned with the production and sale of products. According to McCarthy (1982), the Production Era was a period when there were few industrialized products, and the interest was centered on production. According to Las Casas (2008), the era of production was divided into 2 (two) phases: the product and the production. The first phase predominated the thought that the product sold by itself and the second phase was marked by mass production, as a result of the First Industrial Revolution and, in this period, demand was greater than supply.

Around 1930, the Age of Selling emerged, which focused on the marketing of products to customers and intermediaries (McCarthy, 1982). For Las Casas (2008), the Selling Era

was the one in which regardless of whether the customer needed the product or not, the seller should sell it at all costs, in which organizations adopted aggressive techniques for the sale of these products in order to move inventory.

And years later, in 1950, a new era begins, the era of marketing. At first, it was only as a department of the company that defined the short-term policy planning to compile the organization's activities, and was also in charge of advertising, research and other activities related to sales. Then, all their actions were fully centered on the client, seeking to meet their needs, desires and expectations (McCarthy, 1982; Las Casas, 2008).

In other words, Kotler, Kartajaya and Setiawan (2012) represent the eras of production, sales, marketing and relationship, respectively as: marketing 1.0, 2.0 and 3.0. In addition to introducing marketing 4.0, which revolves around the digital age. Table 9 shows a comparison between marketing 1.0, 2.0, 3.0, 4.0, 5.0 and 6.0.

Table 9

Comparison between marketing 1.0, 2.0, 3.0, 4.0, 5.0 and 6.0

Variables	Marketing 1.0 Product-Centric Marketing	Marketing 2.0 Consumer-facing marketing	Marketing 3.0 Value-driven marketing	Marketing 4.0, 5.0 and 6.0 Digital-Driven Marketing
Objective	Sell Products	Satisfying and retaining consumers	Making the world a better place	Making the world better by connecting people from the digital age; focus on artificial intelligence and personalized experience, with the emergence of interactive actions, concern with data privacy, and process automation to increase efficiency. Fusion between advanced technology and the human factor , with a focus on more immersive experiences capable of generating an emotional connection.
Driving forces	Industrial Revolution	Information Technology	New wave of technology	It was digital, social networks and Google.
How companies see the market	Mass Buyers with Physical Needs	Smart consumer, endowed with heart and mind	A full human being, with heart, mind and spirit	Digital human being who influences and is influenced
Marketing Concept	Product Development	Differentiation	Values	Joining the traditional and the digital
Company Marketing Guidelines	Product Specification	Product and company positioning	Company Mission, Vision & Values	Focus on the customer, on their behaviors, through technology.

Value Proposition	Functional	Functional and emotional	Functional, emotional and spiritual	Functional, emotional, spiritual, and digital
Interaction with consumers	One-to-one transaction	One-to-one relationship	One-to-one collaboration	They influence and are influenced

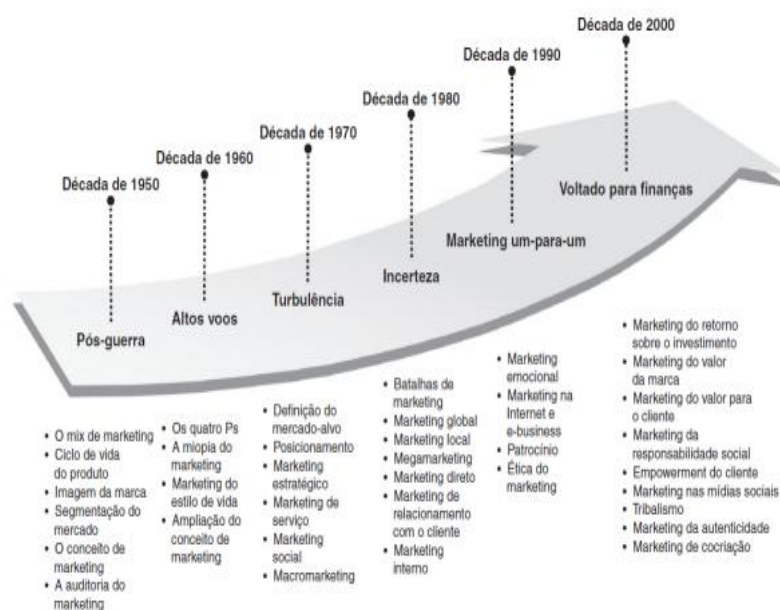
Source: Adapted from Kotler, Kartajaya and Setiawan (2025, p. 6).

With regard to marketing 1.0, it can be considered as the "Age of Products" originated in the First Industrial Revolution, which aimed at the massive production of products, as well as the reduction of costs and prices. In marketing 2.0, it is the moment when the customer realizes its value and importance to organizations, becoming more demanding and concerned with brands, price and product quality. Marketing 3.0 is worked with a focus on making the customer feel good in mind, heart and spirit, satisfying human needs linked to a sustainable and social perspective, that is, providing what the customer wants without harming the environment and contributing in a certain way to the resolution of social problems. One thinks, then, of social marketing, which according to Kotler (1978) is that carried out in favor of social causes, for example, demonstrations in defense of health, education, and even political campaigns.

When it comes to marketing 4.0, it is the phase in which consumers, in addition to using the product, want to post about it. The use of digital technologies is predominant, where behavior patterns are shaped through the digital environment. The process of social inclusion is developed, in the approximation and interaction of people from different cultures.

A new tool that marketing has used to reach customers occurs through social media. For Kotler, Kartajaya and Setiawan (2012, p. 9), "As social media becomes increasingly expressive, consumers will increasingly be able to influence other consumers with their opinions and experiences [...]"element. This statement has become a reality in recent years since 2015, with the new wave of digital influencers, people have inspired people and worked with the sharing and dissemination of the brands of large organizations.

Based on this evolution , Kotler, Kartajaya and Setiawan (2012, p. 29) argue that, "[...] Marketing concepts evolved from a product management focus of the 1950s and 1960s to a focus on customer management in the 1970s and 1980s. Then they evolved further and added the discipline of brand management in the 1990s to 2000s." And so, the authors ground marketing in three disciplines: product management, customer management, and brand management. Figure 4 shows the conceptual evolution of marketing between the years 1950 and 2000.

Figure 4*The evolution of marketing concepts*

Source: Kotler, Kartajaya and Setiawan (2012, p. 32).

It is understood that in the 1950s and 1960s the concept of Mix marketing was introduced. Mix Marketing is one of the most worked concepts in the area, since it revolves around activities that permeate the organization in the market. In terms of nomenclature, it can be known as: Marketing Compound, or titled by McCarthy (1982, p. 54) as 4P, which revolve around 4 (four) basic tools: product, price, place and promotion. As for the 1970s to 1980s, they mark a period where people began to interact through technologies, which brought customers even closer and made it possible to exchange information about the product. In this context, concepts of emotional, experiential marketing and brand value emerge. And, in turn, between the years 1990 and 2000, marketing concepts evolved to the point of reaching not only the minds of customers, but their hearts (Oliveira, 2013).

It is possible to say that marketing has been reinventing itself, improving and transforming itself according to the society in which it is inserted, in the evolution of social discourses and in a closer look at the needs of customers. The great leap that this area has taken, in shifting its focus from the product to the customer, has contributed to the emergence of new techniques, tools and marketing strategies that aim to reach the customer in different spaces.

In short, Oliveira (1985, p. 139) points out that:

There is a very important difference between that organization that approaches marketing starting with the product and then uses advertising to "sell" this product and

the one that starts the process by analyzing and identifying the behavior and needs of the various market segments, and from this data, develops a product/service specifically to solve problems and satisfy these needs that have been previously detected.

In this context, the author refers to organizations in terms of their type of orientation, citing sales and marketing orientation. In the sales orientation "[...] its objective is to sell what it manufactures, instead of manufacturing what the market wants" (Kotler, 2000, p. 40). Regarding the marketing orientation, it incorporates "[...] an outside-in perspective. It starts with a well-defined market, focuses on the needs of customers, coordinates all the activities that will affect them, and produces profits by satisfying them." This orientation focuses on the target market, customer needs, integrated marketing and profitability (Kotler, 2000).

For Amaral (1998, p.59) "The function of marketing is its generic task, that is, the set of techniques developed in the management process, including planning, organization, direction and control, which is called marketing management. [...]". According to Kotler (1998, p. 32) marketing management is "[...] the process of planning and executing the design, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational goals." These are theoretical and practical steps that revolve around the marketing mix to meet the demands of both customers and the company.

The marketing management process consists of 5 (five) steps: Market Research (PM); Segmentation, Target Audience Definition and Positioning (SDP); Mix Marketing or the 4P's (MM); Implementation (I); Control (C) (Kotler, 1999).

Regarding **Market Research**, Kotler (1999, p. 47) states that "[...] Research is the starting point for marketing. Without it, an organization enters a market blindly [...]". It is the primary stage of marketing, where the analysis of the market in which the company is inserted is carried out, in order to know not only the internal variables, but also the external variables that can influence the development of the organization, whether positively or negatively. In this sense, Gomes (2013) clarifies that the more information the company obtains from its customers, suppliers and competitors, the better its performance will be.

Based on this, Gomes (2013, p. 14) highlights 9 (nine) steps to be applied in the market research stage, as shown in Table 10.

Table 10

Stages of market research

Step	Objective
Definition of the target audience and objectives of the research	it delimits the public to whom the research and the establishment of what is intended to be achieved will be intended
Definition of data collection	carries out the survey of information that will serve for the research
Definition of the primary data search method	type of research that will be worked on
Sample Definition	Measure the size of the audience to be surveyed
Elaboration of research instruments	Use of forms for the collection of true information
Application of the research	Putting research into action
Data tabulation	Gather and group data
Preparation of the final report	Analysis of the survey based on the information collected
Decision making	Cognitive process that will be carried out at the end of the research so that fair decisions can be made

Source: Adapted from Gomes (2013).

Therefore, for Gomes (2013) research must be carried out, because even if it is in the long term it will bring results. And it is necessary to know and know how to manage the information obtained, so that it can ensure the permanence and expansion of organizations through decision-making.

The second step of marketing management refers to **Segmentation, Target Audience Definition and Positioning**. **Segmentation** consists of "[...] a subdivision of a company's global market into the most homogeneous portions possible, in order to formulate marketing strategies" (Cobra, 2011, p. 71), that is, the market is a macro environment that covers all segments, however, it is necessary for the organization to fragment its performance by choosing a specific niche of work so that it can invest in the right customer. Las Casas (2008) summarizes the process of implementing market segmentation in 3 (three) phases: identifying and defining profiles of certain groups of potential customers, who are interested in some specific type of segment; select the types of segments; and to determine and disseminate the quality of the product in the market.

Converging with this thought, Cobra and Franceschini (2012) argue that these 3 (three) phases seek to bring together people with similar needs, preferences and desires, establish interaction with the target segment and direct the product to the target market in order to show the customer that it meets their needs. For Cobra and Franceschini (2012),

market segmentation occurs in several ways, such as: by price, quality, location, age, among others. Therefore, the segmentation can be:

- A) GeoFigureic Segmentation - division by neighborhoods, cities, municipalities, states, regions, countries...;
- B) DemoFigureic Segmentation - age and life cycle, sex, income, occupation, education level, religion, race and nationality;
- C) PsychoFigureic Segmentation - social class, lifestyle, personality;
- D) Behavioral Segmentation - occasions (occasion in which one has the idea, in which one buys or uses the product), search for benefits (desired benefits of a class of products, people who want them and brands that contain them), usage rate (small, medium and large users), degree of loyalty (loyal to brands, stores, companies or no loyalty), aptitude stage (they are unaware of the product or want to buy it), attitude (enthusiastic, positive, indifferent, negative, hostile);
- E) Multi-attribute segmentation – use of two or more demoFigureic variables (geodemoFigureic) (Cobra; Franceschini, 2012, p. 26).

It can be seen that for each segment there are variables that differentiate customers and define the type of product to be offered, and that many of them are linked to social, cultural, political and economic elements that guide society and differentiate the groups inserted in it.

Regarding the **definition of the target audience**, Gomes (2013, p. 25) argues that "[...] It means identifying a particular segment or segments of the population you want to serve. [...]", while the organization characterizes the segment it will operate in, it manages to establish the right customer for whom its products will be destined. The definition of the target audience is conditioned to the delimitation of the segment. However, Marinho (2013) highlights that in the identification of the target audience it is essential that people have specific characteristics of the variables presented in the segments and not only be interested in the product.

Positioning is also **added**, which Kotler (1999, p. 48) defines as "[...] the effort to implant the key benefit(s) and differentiation in the minds of customers", that is, the image it seeks to convey to its customers. In another definition, positioning is considered as "[...] the company will organize itself, and position itself to operate in the market" (Rocha; Platt, 2015, p. 153), which is directly linked to the stages of segmentation and definition of the target audience. Las Casas (2008) considers that in order to achieve the objective of positioning, which is to keep the product in a prominent position in the customer's mind, it is necessary to sum up the actions carried out through marketing.

The Marketing Mix or 4P "[...] determine the strategies and marketing actions that seek to meet what consumers need and desire" (Lima, 2015, p. 24), that is, it is a whole process that involves everything from the creation, establishment, distribution and dissemination of the product in order to meet the needs of customers.

In this way, Kotler (1998, p. 90) conceptualizes Mix marketing as "[...] the set of controllable variables that the company can use to influence consumer responses". Through this Compound, companies have the power to persuade the customer to obtain the product. In another work, Kotler and Armstrong (2007, p. 42) define Mix Marketing as "[...] the set of tactical, controllable marketing tools that the company combines to produce the response it wants in the target market." It is understood that to reach the target audience, it is necessary for marketing tools to work in synergy, so that they achieve the objectives and goals set.

With regard to the 4P's, referring to Product, Price, Place and Promotion, it is clear that each P represents a different function and definitions, but that they must work in harmony for the company to succeed in the market.

In this Compound, the first variable to be worked on is the **Product**. In relation to this element, Chiavenato (2007) considers it as the process of creation and development according to the needs of customers. Madruga *et al.* (2004) consider the product as the main component of the marketing strategy, since it goes far beyond a physical good and also seeks to satisfy the needs of its customers, providing comfort, prestige and security. Services also fit into this regard.

For Kotler (1999, p. 126) "The basis of any business is a product or service [...]", so the organization must be concerned with offering the best so that it can be a differential in the market. In turn, Cobra (2011) presents some requirements that the product must have: Quality and standardization, in terms of its characteristics, operation and finishes; models and sizes, which satisfy the wishes of customers; and configuration, referring to physical sampling, packaging, branding and service.

The second variable is **the Price**. According to Madruga *et al.* (2004) price is directly related to the conception of quality, prestige and image. In addition, Chiavenato (2007) reveals that the price determination must be made based on the market and its competitors.

The third variable is the **Square**, which corresponds to the distribution. Madruga *et al.* (2004) characterizes it as an onerous activity for the organization, as well as one of the most important, and that distribution is related to marketing channels (which are the means by which the movement of products, resources and information between the company and its customers is made). The square is called by Cobra (2011) by "point", it is a relevant

component for the product because it positions it in the market, as Chiavenato (2007) defends it is the place where the product will be established in the market.

The last variable is **Promotion**, which can occur in two ways: mass or specific consumers, so the approach aimed at these groups must be different. In mass promotion, advertising, sales promotion and public relations occur, and in promotion aimed at specific consumers, personal sales are made (Madruga *et al.*, 2004). Cobra (2011) shares this same idea and even adds merchandising.

In turn, Chiavenato (2007) conceptualizes in a unique way terms such as advertising and merchandising that are linked to promotion. Chiavenato (2007, p. 203) defines promotion as "[...] planning and development of promotional events", advertising being the "[...] dissemination through advertising campaigns" and merchandising such as "[...] presentation and disposition of the merchandise at the point of sale". Promotion is a component of communication between the company and the customer, which goes far beyond publicity, and which has advertising and merchandising as other ways to promote the service or product.

Implementation inserted in the Marketing Management process is a stage that encompasses product creation, price determination, distribution and promotion. It is the set of the marketing mix in the execution phase, which requires a lot of attention so that it does not escape from its objectives and the promises offered to the customer (Kotler, 1999).

Control, in turn, is the final step in the process. According to Kotler (1999), for companies to be successful, they must not tire of learning and always be monitoring all the steps implemented, through audits, evaluation of results, always correct something that does not present the planned performance, and always be vigilant for the functioning of Mix Marketing.

It is understood that the marketing process is a chain formed by variables that are related to each other, and must be worked on collaboratively. In addition, this process centralizes its focus on the market and target audience, developing strategies that enable the satisfaction of its customers and the objective of selling the product.

In view of this, the application of marketing requires planning. For Kotler (2003, p. 174) "The company needs vision, vision requires strategy, strategy requires plans and plans need action". Hence the importance of the marketing plan "[...] represented by a document, which brings the main actions and activities to be developed to ensure the achievement of the objectives and goals of the marketing area [...] it is important to highlight that the marketing plan must be aligned with the company's strategic planning" (Stecca; Ávila, 2015, p. 79).

Conceptually, the marketing plan is "[...] the result of the process of organizing all the considerations and tasks required to market a product or service in an effective and orderly way in a logical flow", that is, it is a tool that contains all the information regarding the market, objectives and goals to be achieved by the company and methods of execution and control of its activities (Amaral, 2004, p. 25). The composition of the sections of the Marketing Plan will be explained in Table 11

Table 11

Sections of the Marketing Plan

Sections of a Marketing Plan	
Executive summary and summary	Provides a quick overview of the proposed plan
Situation analysis	It presents the relevant historical data regarding sales, costs, profits, market, competitors and the various forces that act in the macroenvironment.
Marketing Strategy	It defines the mission, marketing objectives, financial objectives, and needs that the product offered must satisfy, as well as its competitive positioning.
Financial Projections	They include sales and expense forecasting and a break-even analysis. On the revenue side, they show the sales volume forecast by month and by product category. On the expense side, they show the forecast of marketing costs broken down into categories. The break-even analysis estimates how many units should be sold on a monthly basis to offset the monthly fixed costs and average variable costs per unit.
Controls	The last section of the marketing plan outlines the controls to monitor and adjust your implementation. Goals and budget are specified in detail for each month or quarter, so that senior management can analyze the results each period and take appropriate corrective actions.

Source: Adapted from Kotler and Keller (2012).

The main function of the marketing plan is to "[...] provide solid information for strategic planning; identify strengths and weaknesses; analyze the competition; seek opportunities not yet explored; collaborate for the efficiency of processes; analyze alternative strategies; and provide a work plan" (Stecca; Ávila, 2015, p. 80). And so, the marketing plan contributes to the development of new products, resolution of problems related to the 4P's, establishment of guidelines for the application of activities in a coordinated manner, in order to achieve the stipulated objectives and goals and consequently customer satisfaction.

In view of all that has been discussed about marketing, it is also worth stating that "[...] Marketing is not, nor does it mean simply selling, nor is it limited only to dissemination or advertising. Their actions do not start with the product and services, they start with the customer [...]" (Amaral, 2007, p. 20). According to Amaral (2007), marketing is concerned with the interests and needs of its customers, and goes far beyond the practice of commercialization, its techniques can be applied in any organization, even non-profit

organizations. In this way, marketing in libraries is explained, aiming at its application and contribution to these institutions that do not aim at pecuniary profit.

6 MARKETING IN LIBRARIES

Marketing since its genesis has been linked to the commercialization process. The evolution resulting from the transformation of the market contributed to the emergence of new techniques and strategies that achieved customer satisfaction, and, above all, the sale of products to obtain profits. Therefore, the application of marketing has always been conditioned to for-profit organizations.

However, Table 4, cited above, describes the conceptual evolution of marketing and demonstrates the interest of Kotler and Levy (1969) in extending its concept to non-profit institutions. Thus, Amaral (1998, p. 68) points out that "[...] the transposition of a conceptual system from the sector that aims at profit to the non-profit sector represents a challenge for information units and other information units, as well as librarians [...]", that is, the challenge is to think about how marketing can be implemented in libraries, an institution that does not aim at the capitalist market.

However, to reflect on the application of marketing in these environments, it is necessary to understand that marketing does not mean only sales, but "[...] it is related to the development of products and services and to their communication to the potential market in the expectation of changing and/or influencing their behavior" (Oliveira, 1985, p. 137). Therefore, libraries can use marketing to their advantage, to keep real customers and attract potential customers. In view of this, Silveira (1987, p. 7) argues that:

Libraries that aim to awaken, provoke or guarantee exchanges of information where it does not exist and stimulate exchanges where they already exist, that is, to sensitize the potential user to make him a beneficiary of the system and encourage consumption by effective users — are developing a marketing function, whether they know it or not.

Even though they are used unconsciously, many libraries carry out marketing activities, when they carry out the study of the customer with the objective of bringing together both the real and the potential customer and take into account the social, demographic aspects and the needs of customers for the development of new services. However, "[...] when used consciously and skillfully, marketing can keep the library in a visible and relevant position" (Conroy, 1987, p. 23).

Some authors such as Edinger (1987), Conroy (1987), Wood (1987) and Baptista (1988) believe that there are several reasons for marketing to be applied in these institutions. In Edinger's conception (1987, p. 107) there are 2 (two) reasons, the first is to "[...] improve

the satisfaction of your potential users" and "[...] The second reason librarians begin to actively engage their library services with marketing is the emphasis placed on accountability in today's nonprofits [...]" (Edinger, 1987, p. 108), since libraries are administratively subordinated to sponsoring institutions.

In this regard, Baptista (1988, p. 99) lists some factors that justify the application of marketing in these institutions, such as:

- I. Provides a set of widely tested techniques and instruments to identify the needs, desires and preferences of the user;
- II. It forces a questioning of the library's relationship with its audience;
- III. It favors the exchange relationship (bilateral relationship), making the library offer products based on the needs of users and obtain, through use, recognition for its work;
- IV. It encourages communication, valid mainly for non-users, making the library staff leave their traditional immobility;
- V. It causes greater acceptance of the library, attracting new resources, to the extent that the library is seen as a fundamental piece for user satisfaction.

Therefore, marketing promotes the interaction between the library and the customer, as well as seeks to identify and meet their informational needs. And, in addition, "[...] helps librarians and information personnel to improve their reputation, both within institutions and as a profession within society [...]" (Wood, 1987, p. 173). That said, the application of these techniques brings benefits to all participatory agents in this process, that is, to the client in meeting his informational demands and to the librarian in building his image as a professional outside and inside the library.

However, for Oliveira (1985) some consider that marketing cannot be developed in non-profit organizations because it is based on the concept of exchange. But for Silveira (1987) this action brings benefits to both the library and the user. Therefore, the author points out that it brings advantages:

For the user, by the systematic obtaining of information at the desired level, which leads to a continuous development in their activities. For the library, in the sense of the professional valorization of its human resources, the allocation of greater financial resources to meet the demand of users, the achievement of an ideal standard of service compatible with the market and the achievement of the objectives of the maintaining organization (Silveira, 1987, p. 7).

It is understood that the exchange process that marketing promotes between the library and the customer is not directly related to the capture of financial profits, but to the

intangible value attributed to the supply of informational demands by customers, to the recognition of this service, to the image of the librarian, and to the fulfillment of the library's role in relation to the objectives stipulated hierarchically by the sponsoring organizations.

In general, in order for marketing to be applied in libraries, it is essential to identify its type of orientation. The administration of libraries can be oriented in 2 (two) ways: for the product or for marketing. Thus, Table 12 discusses the differences between both orientations.

Table 12

Differences between product-oriented and marketing-oriented library administration

Bottom line	Product orientation	Marketing Guidance
Library attitude towards patrons	Focuses on the generation of product/service information	Adjusts to users' informational needs
Focus on users	Waits for user requests	Anticipates by bringing information to users'
Relationship with users	Instrumental (as soon as possible)	Open relationship and availability in auxiliary
Deadline for obtaining the product/service	Depends on processing and procurement	Depends on users' activities
Product/Service Offering	Limited to what is found on the subject	Open to the outside world and according to the specific focus
Innovation	Aimed at reducing production costs	Allows for better service to users
Attitude towards products and services	The library offers only what it produces	The library strives to produce what it should offer
Information needs assessment	Mostly limited to printed documents	Broad and multivariate information
Product/service feedback	Mainly due to operational efficiency	Mainly due to the effectiveness in relation to users

Source: Sarvad (apud Amaral, 1998, p. 99).

In view of this, it can be seen that both orientations differ where their efforts are centered: on the product (product orientation) or on the user (marketing orientation). For Oliveira (1985, p. 139, emphasis added), product orientation is a process where "[...] the products are developed and then 'sold' [...]". Making the analogy for the library environment, they are those services and products created and then offered to customers without even analyzing their usefulness to them. Regarding marketing orientation:

[...] the organization first identifies the needs of the segments of its target market, creates products/services to satisfy these needs, and uses advertising and promotion to communicate to this segment the capacity that its product has to satisfy those desires and desires (Oliveira, 1985, p. 139).

Marketing orientation is the one where all the functions of marketing management are used in order to study customers, identify their demands and develop actions for service.

In addition to the orientation towards the product, Andreassen (1987) emphasizes the orientation focused on production, where it means "[...] design better information systems, better journal retrieval processes, provide more attractive environments, faster loans, better parking conditions, etc. [...]" (Andreassen, 1987, p. 40). This type of guidance seeks to develop better products at a lower cost.

Regarding the practice of applying marketing in libraries, methodologically, it occurs through:

[...] analysis of the problem, investigating everything that may be preventing a better relationship between the library and its audience. Then, the environment is evaluated, identifying the target market, competitors, the library's positioning in relation to other similar institutions and the organization's objectives. Finally, based on a careful analysis of the user's needs and desires, decisions are made about the product, how it will be promoted, valued and distributed (Baptista, 1988, p. 100).

All these elements pointed out by Baptista (1988) basically correspond to marketing management. In the context of libraries "[...] marketing management directs, therefore, the decisions of librarians regarding the quality and quantity of products and services, the guidelines of the price policy, the points and channels of distribution and the forms of promotion" (Silveira, 1987, p. 8), in addition to having contact with the external environment, in order to attract it to the use of information.

In this way, elements of marketing management are addressed, which can be developed in libraries in their application process.

6.1 MARKETING ADMINISTRATION IN LIBRARIES

Considerations about market analysis, market segmentation, positioning and Mix Marketing are presented.

6.1.1 Market Analysis

In libraries, market analysis can be carried out in order to identify in a concrete way who are the real and potential customers, as well as to assess

[...] the existence of different levels of interests and information needs among consumers, according to their own individual differences in age, sex, professional training, place of residence or other personal characteristics of psychological or sociological origin ... (Amaral, 1998, p. 101).

And, such information leads to market segmentation.

6.1.2 Market Segmentation

Market segmentation consists of filtering out different customers with similar tastes and needs. For Oliveira (1985, p. 141), "[...] the segmentation of the market into libraries offers a perspective to identify and serve the library's audience more effectively", that is, it is through the segmentation carried out based on some variables that these institutions get to know who their customers are and fragment their target audience to develop products and services that meet their needs.

In this way, libraries can perform market segmentation through variables such as the 4 (four) outlined below: **demoFigureic**, which refers to the study of some population factors of customers such as age, color, race, nationality, religion, etc.; **geoFigureic**, which seeks to identify the location of its users; **psychoFigureic**, which consists of evaluating the lifestyle, attitudes, personality and social class of customers; and **behaviorist**, focused on the behavioral analysis of the customer, where it can define who are the customers who frequent, have attended and can still attend (Mathews, 1987).

Oliveira (1985, p. 140) points out that "Libraries work under the principle of serving 100% of the population 100% of the time [...]", that is, they seek to serve all customers most of the time, which becomes a little unfeasible, because for Mathews (1987) libraries are not able to serve all their members. Hence the need for segmentation, which will form groups with similar needs for the use of the correct marketing techniques.

Still at this stage, there are 3 (three) types of marketing that can be practiced by libraries, which are: a) mass or undifferentiated marketing, according to Mathews (1987) is the one where only one offer is used to serve all audiences, considering that all its customers (real or potential) have the same tastes and needs. For Kotler (1978), undifferentiated marketing does not make use of market segmentation, seeking to serve all customers by generalizing their needs; b) concentrated marketing, for Mathews (1987, p. 90) means "[...] concentrate all its efforts on a specific segment, serving this group particularly well [...]"; and c) differentiated marketing, according to Kotler (1978) is the one where it operates in more than one or two segments, which uses different marketing strategies and develops the appropriate products and services for each audience.

6.1.3 Positioning

After the segmentation phase, the positioning stage begins, which is nothing more than "[...] the perception of the position that the library occupies among the range of competitors for community support. It is an understanding of how the target market sees the product and placing itself in the market promoting its advantages in relation to competitors"

(Oliveira, 1985, p. 144), or rather, it is the phase of communication and interaction with the public in order to understand the way the library is seen by customers

6.1.4 The 4P's of library marketing

With all the elements developed, a new tool emerges to be applied, the Mix marketing, popularly known as 4P, corresponding to the variables of product, price, place and promotion, listed below.

6.1.4.1 Product

One of the first variables to be worked on is that of the product, where "[...] it is through this that an organization defines 'how' the detected needs and desires of a user should be satisfied [...]" (Oliveira, 1985, p. 142, emphasis added), that is, there are several benefits brought together in a tangible or intangible way that are used to meet the informational needs of customers.

In general, Mathews (1987) objectively describes the products made available by libraries, subdividing them into three categories: a) materials, which include books, non-book material and audiovisual material; b) the sources, such as the reference service, the library's regulations, among others; and, c) animation programs, such as films and exhibitions.

The product must be updated according to the needs of its audience, so libraries must be aware if the product/service is achieving its objectives, which is to meet the informational needs of customers.

6.1.4.2 Price

When you define the product, you must assign a price to it. When it comes to libraries, this is one of the most difficult elements to be developed, since these institutions do not aim at profitable gains. Therefore, "[...] it is necessary to establish an adequate price, verifying the opinion of users to determine the different cost levels" (Oliveira, 1985, p. 143). From another perspective, the price can be attributed to the emotional value, both for the customer and for the library in terms of good service and sanitation of needs, which generates interaction between the parties.

Other types of values associated with the price of libraries come from Scientific Capital, which according to Bourdieu (2004, p. 26) "[...] consists of the recognition (or credit) attributed by the set of peer-competitors within the scientific field"; of the Cultural Capital that used to indicate[...]all the ways in which culture reflects or acts on the living conditions of individuals[...] (Silva, 1995, p. 25). And Symbolic Capital, which is nothing more than "[...] an

effect of the distribution of other forms of capital in terms of recognition or social value is "power attributed to those who have obtained sufficient recognition to be able to impose recognition" (Bourdieu, 1987, p. 164).

6.1.4.3 Square

The place or distribution point concerns the way the product will be moved, how this product will reach the customer. In relation to libraries, "[...] It is the point of contact between the product and the consumer. It can be the library building itself, an electronic medium, a personal contact, a manual information retrieval system, etc. [...]" (Oliveira, 1985, p. 143). It can be considered as the point of intersection between the customer and the product, whether in the physical or virtual environment.

6.1.4.4 Promotion

After the product and the price and location are defined, it is necessary to create strategies to make it known to the public, through promotion. Oliveira (1985) subdivides this stage into five areas: personal contact; advertising; advertising; incentives and the environment. At this stage, "[...] the library tries to convince the segment that its product has a greater capacity to satisfy its needs than the products of other organizations" (Oliveira, 1985, p. 143). It is the time for the institution to promote the product/service, demonstrating its importance and its differential.

In view of all the variables presented, it is apprehended that products and services must correspond to the needs and expectations of the market; their price is related to cost, demands and competition; promotion is a way of informing its product/service to the public; and the square is where the organization is set, making it accessible to the market and the target audience (Amaral, 1990).

In accordance with what was discussed about the 4P's of marketing in libraries, Table 13 makes a comparison between for-profit and non-profit organizations related to Mix Marketing.

Table 13

Marketing Mix in Purposeful and Non-Purpose Organizations Profitable

Marketing Compound (4P)	Comments
Product	Everything that is offered in a consumer market for the consumption and/or satisfaction of a need. It may or may not be material, but it must meet a demand. It exists in all types of organizations, for-profit or non-profit. Demand comes from consumers or users of the products and services that organizations provide.
Price	For-profit organizations - the formation of the price of the product or service considers the following factors: how much the consumer is willing to pay and how much the organization wants to receive in return for production. Managed conflicts consist of discovering and implementing the highest price that the consumer market accepts, maximizing its profitability, since its concern is the production of products and/or services to obtain profits. Non-profit organizations – the price also exists and should not be overlooked. However, in these organizations, the formation of the price of the product or service considers other factors. In addition to the cost to produce the product or service and the degree of essentiality of this product or service for the consumer, it is necessary to find the lowest possible price for the consumer, which can guarantee the sustainability of the organization, so that it reaches the largest number of consumers with the best possible quality.
Square (distribution)	The concern is similar in both types of organizations. The distribution and availability of the product can make a for-profit business unfeasible , or make it extremely advantageous. In non-profit organizations , efficient distribution is a factor that influences the productivity of the organization and the quality of the services provided by it.
Promotion	Promotion is an important activity in all types of organizations, but it has a greater presence in for-profit organizations due to resistance in non-profit organizations. But what's the point of offering a product and it doesn't reach your customers or users. Of course, the care with promotion is different in the types of organization. In for-profit companies, promotion is justified when the profits and sales increases generated by the promotion exceed the investment spent. In non-profit organizations, promotion must exist, but with the concern that promotion costs are not so high, generating an increase in the prices of products and services offered by the organization, to the point of reducing consumption by consumers, which would normally decrease the overall social profit by the organization.

Source: Adapted from Amaral (2007).

In this comparison, it can be seen that some elements converge between the organizations such as the product and the market, because the product is the input that meets the market's desires and the market is the means by which this product will be taken to customers. Price and promotion differ by the amount of value, while organizations seek to define the highest price accepted by the public, non-profit organizations seek the opposite, the lowest cost for their customers, allocating these resources to the organization itself.

Due to all these forms of application of marketing in libraries, it is important to highlight the insertion of marketing linked to a social perspective, in which "[...] it can be linked to the benefit achieved by the satisfaction of the user or consumer, obtained with his social well-being" (Amaral, 1998, p. 67). It is a marketing that goes far beyond the consumption of information, but is related to the change in attitude and behavior of these customers.

The evolution of marketing, which has its techniques and strategies shaped according to the context of society and the arrival of new information technologies, have contributed to the emergence of a new trend: digital marketing, which through the internet, promotes its products with a greater reach and enables interaction with its consumers. Libraries, in turn, must follow such changes and mold themselves to these spaces, not as a way to exhaust physical libraries, but to extend their products in order to promote them, gain visibility and conquer this new audience.

Conceptually, digital marketing is "[...] the set of marketing actions intermediated by electronic channels, such as the internet, in which the customer controls the amount and type of information received" (Limeira, 2010, p. 10). Electronic channels refer to the social media that organizations use as a tool to promote products, a channel for bringing institutions and customers closer together, and a way to be present in the daily lives of the target audience to identify their needs and bring the solution to them.

Finally, marketing is extremely important, because "[...] it is one of the ways that can provide strategies for libraries to promote their spaces of action and innovate their products and services, always seeking to satisfy and prioritize the needs and informational needs of the interagents" (Gulka; Lucas; Corrêa, 2018, p. 63).

It is necessary to emphasize that marketing is not the cure for all library problems, but "[...] can contribute significantly to its success, as the services traditionally offered by libraries in an archaic and outdated way, are seen through the lens of marketing with a different and new perspective" (Oliveira, 1985, p. 145), helping the librarian to get out of his comfort zone, in order to question problems and seek solutions so that some realities are transformed.

Therefore, the next section will present the design of a consulting firm to contribute to libraries in the application of marketing, with a view to promoting change and proactivity in these organizations.

7 THE CREATION OF A CONSULTANCY

To create a consultancy, it is necessary, like any other business, to follow legal procedures that aim at its legitimacy. Thus, in this section the main elements for opening a business will be addressed, as well as the legal and bureaucratic requirements. In addition, some aspects to be worked on by the library marketing consultancy and the details of the proposed services will be considered.

According to Bernardi (2008, p. 8) the idea of an enterprise is born in several ways:

[...] the observation, perception and analysis of activities, needs, trends and developments, in culture, society, social and consumption habits, or even as a natural development of an existing business. Opportunities detected or visualized, rationally or intuitively, of probable current and future needs and demands, and unmet needs [...]

It can be seen, then, that there are several ways in which ideas come and are interconnected to everyday life. Therefore, there is not necessarily a basic rule for this to happen, but it requires an attentive and insightful look at the context inserted by the entrepreneur so that he can capture the ideas of creating a new business.

Therefore, more and more entrepreneurs have emerged in the market, entering and adding innovative ideas, which in a way, contributes to the economic growth of the country and to "[...] the social development of communities and citizens, regardless of the area in which it is implemented, contributing to the quality of life, social and cultural responsibility and promoting citizenship" (Spudeit; Magdalene; Laurindo; Duarte, 2016, p. 679). However, the activity of opening and maintaining a company in the market is not an easy task, it is not enough just ideas, planned actions are needed.

Given this, an important step to be taken in the process of creating a company is the development of a business plan. In general, the business plan includes the description of some variables (objective, strategies, time and cost) as a way to identify the viability of the business, minimize risks and keep it in the market; where "[...] through it it is possible to make a pro-analysis of the data necessary for its implementation, it will clearly and objectively demonstrate all the need for planning the new company and even how it will behave" (Xavier, 2018, p. 12).

In this sense, after defining the idea of the business to be worked on, it is valid to point out as the first element for opening an enterprise, the preparation of a business plan that will guide the entrepreneur in the progress of the other steps that are part of this process.

Table 13 presents a business plan model proposed by Bernardi (2008), composed of 8 (eight) parts, which includes the analysis of the parts that involve the company.

Table 14

Business Plan Template

Business Plan Template	
Part I – Concept of the Idea and the Business (Executive Summary) 1. Nature of the business 1. Previous skills to have chosen the branch, the product and the service 1. Business vision 1. Legal and tax aspects for the operation of the company 1. Operation Form 1. Location and coverage or scope 1. Market and potential customer insight 1. Finance Part II – Organization and Structure 1. Legal structure of the business Corporate form and legal aspects of the structure 1. Proposed organizational Table and description Roles and Positions and Responsibilities 1. Description and experience of key executives Summarized curriculum and experiences relevant to the proposed business Personal profile with motivations, ambitions and other data relevant to the business Motivations for taking on the project 1. Organizational environment Type of culture and environment Personnel policies 1. Competency analysis and assessment Strengths and weaknesses Needs for improvement Part III – Strategic Marketing 1. Characteristics of the industry Operating model 1. Current affairs and trends in the field 1. Attractiveness and rules of the industry Profitability and growth 1. Segmentation 1. Target Market Features and size Research and trends Profile of target customers Needs Opportunities and threats	1. Positioning 1. Product or Service 1. Competition 1. Strategies 1. Commercialization Part IV – Products and services 1. Product or Service Description 1. Technological internship 1. Research and development Part V – Operations 1. Operational FlowTable 1. Production and service capacity 1. Vendors and Third Parties 1. Systems Part VI – Resources Needed 1. Fixed investments 1. Variable investments 1. Costs and expenses arising from the implementation Part VII – Economic and Financial Planning 1. Planning assumptions 1. Projection of economic results 1. Projection of the equity situation 1. Cash Flow Projection 1. Analysis of return and economic viability 1. Risk analysis and sensitivity 1. Analysis of capital structure and funding sources Part VIII – Implementation Proposal 1. Corporate form 1. Relevant legislation 1. Deployment and start-up schedule 1. Critical steps of the deployment timeline

Source: Bernardi (2008, p. 174).

The business plan model suggested by Bernardi (2008) is an instrument that can be used by the entrepreneur both in the implementation phase and for the maintenance of the enterprise. This plan contains eight (8) parts followed by summary descriptions required for each step. The first part corresponds to an introductory presentation of the nature of the business, that is, what it is about. The second part describes the legal and bureaucratic aspects foreseen for the company, as well as the professionals who will be working. In the third part, marketing tools are used in order to carry out an internal and external analysis of

the business to understand the field of activity and its competitor market. In the fourth part, the technical criteria of the products are defined.

Regarding the fifth part of the business plan, it is the phase of outlining the operation components that will be necessary for the generation of a certain good or service. When the other parts are analyzed, the sixth part is configured as the financial planning stage. In the seventh, the financial evaluations of the business plan that is intended to be introduced are evidenced and, finally, the eighth part is defined as the way in which the business will be directed, controlled and implemented (Bernardi, 2008).

Thus, after the construction of the company's business plan, the next step is to legalize it in the market, that is, to adapt to the bureaucratic requirements demanded by some government agencies (Board of Trade, Federal Revenue, State Revenue, City Hall, Fire Department, Caixa Econômica Federal, among others) in order to fully carry out all organizational activities. For this reason, it is essential to identify the legal and bureaucratic aspects that guide the opening of a company, which is the subject of the next subsections.

7.1 LEGAL AND BUREAUCRATIC ASPECTS FOR CREATING A BUSINESS

Prior to the full exercise of organizational activities, it is essential that the company is formalized and has basic knowledge of the laws that guarantee its legalization. At this point, one works with specific and technical knowledge of the sphere of Law, thus, the help of a lawyer is necessary to avoid any legal complications (Teixeira; Almeida, 2016).

Regarding the regulation of the opening of Micro and Small Enterprises (MSE), 3 (three) laws are specifically pointed out: Complementary Law No. 123/2006, which constitutes the "National Statute of Micro and Small Enterprises" also known as the "General Law of Micro and Small Enterprises"; Law No. 11,598/2007, which gave rise to the National Network for the Simplification of the Registration and Legalization of Companies and Businesses (REDESIM) and Complementary Law No. 128/2008 which establishes the figure of the Individual Microentrepreneur (MEI) (Brasil, 2020).

With regard to Complementary Law No. 123/2006, it is worth mentioning that:

Article 1 This Complementary Law establishes general rules regarding the differentiated and favored treatment to be given to micro and small businesses within the scope of the Powers of the Union, the States, the Federal District and the Municipalities, especially with regard to:

- I - the calculation and payment of taxes and contributions from the Union, the States, the Federal District and the Municipalities, through a single collection regime, including ancillary obligations;

- II - the fulfillment of labor and social security obligations, including ancillary obligations;
- III - access to credit and the market, including preference in the acquisition of goods and services by the Public Authorities, technology, associativism and inclusion rules.
- IV - to the single national registry of taxpayers referred to in item IV of the sole paragraph of article 146, in fine, of the Federal Constitution (Brasil, 2020).

The aforementioned Complementary Law No. 123/2006 encourages the reduction of tax burdens and the reduction of bureaucracy for opening, proceeding and possible closing of companies. In addition, it offers possibilities for the micro-entrepreneur to be better structured, so that it generates more profits and growth, in order to offer more jobs and contribute to the evolution of the local and national economy (SEBRAE, 2008).

Regarding **Law No. 11,598/2007**, it was created with the objective of simplifying the bureaucracies required by Brazilian legislation, which became an obstacle for the entrepreneur to open a business, due to the distance and lack of harmony between the federal, state and municipal institutions that were responsible for carrying out the entire legalization process (Silva, 2015).

Therefore, the National Network for the Simplification of the Registration and Legalization of Companies and Businesses (Redesim) was created, where it is explained in article 2 of the aforementioned Law No. 11,598/2007, with the purpose of:

[...] propose actions and rules to its members, whose participation in its composition will be mandatory for federal agencies and voluntary, by adhesion through a consortium, for non-federal agencies, authorities and entities with competencies and attributions linked to matters of interest to Redesim (Brasil, 2020).

In general terms, Silva (2015) highlights that Redesim can be considered as a plan that brings together federal, state and municipal agencies, aiming to "[...] the integration of procedures, avoiding duplication of requirements and ensuring greater linearity in the constitutive processes" (Silva, 2015, p. 14), that is, reducing bureaucracy in some procedures that interfered in the process of legitimacy of the business.

With regard to **Supplementary Law No. 128/2008, which creates the figure of the individual micro-entrepreneur**, Pilz (2017, p.11) emphasises that:

[...] through this law, the government created special conditions so that the worker known as informal can leave informality, legalize himself, register with the National Registry of Legal Entities (CNPJ), which facilitates the opening of a bank account and access to the issuance of invoices for his sales and still be entitled to various benefits, such as sickness benefit, maternity benefit, retirement, among others.

This means that the subject who performs his services on his own, with the exercise of Complementary Law No. 128/2008 , ensures legitimacy as a small entrepreneur, thus guaranteeing rights that working informally could not be enjoyed. In this way, the MEI legalization process takes place electronically through the Entrepreneur Portal and ends after the completion of all the steps that are part of this process.

With regard to the legalization and registration of the company, Sebrae (2020) highlights the importance of these aspects that promote the emergence of opportunities and numerous advantages, such as: partnerships, access to credit lines, security, and export and receipt of government subsidies, among others.

Under this focus, the other sections will specifically address the steps and requirements that need to be met during the formalization procedure.

7.1.1 Steps to opening a Business

At first, it is necessary to identify the legal form of the business, so that the appropriate regime for each company can be established. For Dias (2010, p. 46) "The option of the legal type of the company to be opened must take into account both the characteristics of the business and the objectives of the entrepreneur [...]", as it is the way in which the economic activities will be performed.

Therefore, companies are legally constituted in: Entrepreneur, self-employed, Simple Company, Business Company, Limited Liability Company, Autonomous Company, Collective Partnership, and Cooperative Society. Thus, Table 1 basically defines the legal types described.

Table 15

Legal Types that characterize a company

Legal Types	Definitions
Businessman	Form adopted by the entrepreneur who wants to be the sole owner and does not mind being unlimitedly liable for the obligations contracted in the company.
Self-employed	It is the liberal professional who does not characterize the activity of an entrepreneur. They sell services of an intellectual nature, even if they have the help of employees.
Simple Company	They are companies formed by people who exercise an intellectual profession (genre), of a scientific, literary or artistic nature (species), even if they have assistants or collaborators, unless the exercise of the profession constitutes an element of a company.
Business Company	It is one that professionally carries out an organized economic activity for the production or circulation of goods or services, constituting an element of a company.
Limited Liability Company	Form used when entrepreneurs wish to become partners and preserve limited liability over the obligations contracted in the company.
Joint stock company	It is the one that operates under the designative denomination of the corporate purpose, integrated by the expressions corporation or company, in full or abbreviated.
General Partnership	It is a corporate type that is characterized by the joint and unlimited participation of all partners who jointly respond to all the company's obligations.
Cooperative Society	It is the one whose participation among its partners happens freely and the responsibilities of the partners can be limited or unlimited

Source: Adapted from Sebrae (2020).

It can be seen that legal types can be evaluated and distinguished based on the number of members, nature and purpose of the business. In relation to the legal type **Entrepreneur**, its activities are focused on the flow of goods and services, while the **autonomous** type develops services of an intellectual nature. Therefore, in **the Simple Company type**, it has the same nature as the self-employed, however, it is formed by more people who share all obligations and gains in a mandatory and joint manner. Regarding the **Business Society**, it is made up of a larger number of entrepreneurs who work in an integrated manner in the development of economic activities of goods and services (SEBRAE, 2020).

In addition, the **Limited Liability Company** is a meeting of partners who can adhere to the Simple (Intellectual Services) or Business (Services of goods and services) type. In addition, the responsibilities are limited according to the parties assigned to each partner. With regard to the **Corporation**, it is the one where the division of its capital occurs through shares and the responsibility of each partner is proportional to the number of shares (SEBRAE, 2020).

Regarding the **General Partnership**, it is a corporate type that mainly covers individuals, where everyone has full responsibility for the company's debts and profits (SEBRAE, 2020). Finally, as for the **Cooperative Society**, it is made up of 20 (twenty) people who organize themselves democratically in relation to the economy (SEBRAE, 2020).

In a practical way, the opening of a company follows some formal requirements that make business activities legal in the market, which are: Feasibility Consultation; Registration with the Board of Trade; Formatting and Configuration of the Articles of Association; Social Registration, Name Consultation and Trademark Registration; Registration and Opening of the Company at the City Hall; Registration with the State Treasury Department; Registration in the National Register of Legal Entities; Operating License; and Firefighters' Authorization (SEBRAE, 2020), described below.

7.1.1.1 Feasibility Consultation

According to Teixeira and Almeida (2016, p. 64) the feasibility consultation "consists of verifying that the intended location for your company is in accordance with the rules of the region, imposed by municipal legislation, known as Master Plan, Location Code or Zoning Code [...]", that is, it is the stage where a permission is requested for the installation of the company in the desired location, as well as whether the type of business is suitable for the environment.

7.1.1.2 Registration with the Board of Trade

In order for the commercial registration of the company to be carried out, it is necessary to find out the competent body that performs this type of service in each state. In Maranhão, for example, the responsible institution is called "Junta Comercial do Maranhão (Jucema)", the registration is done electronically through the Easy Company System or in person.

According to Teixeira and Almeida (2016), it is the step where the request for feasibility is made with the qualified body, so that the obligations and procedures by which the business owners must adapt can be analyzed. After that, the entrepreneur waits for confirmation or denial of his request, if positive, he will be informed of the next steps regarding the process: requirements and necessary documents, if it is negative, guidelines are given for the adjustment of the request (SEBRAE, 2020).

It is worth noting that the registration procedures between Microenterprises and Individual Microentrepreneurs (MEI) differ. For Microenterprises, registration must be carried out at the city hall or regional administration of the state where the company is located, at the Federal Revenue Service and at Social Security. And MEI registration is carried out electronically on the Entrepreneur Portal (SEBRAE, 2020).

7.1.1.3 Formatting and Configuration of the Articles of Association

According to the authors Teixeira and Almeida (2016) and Dias (2010), the Articles of Association is a kind of "birth certificate" of the company, which serves to name it, stipulate the value of the capital, define the legal type and determine the place of operation. According to Sebrae (2020) the necessary requirements of the Articles of Association are:

- a) Corporate type;
- b) Complete qualification of the partners;
- c) Corporate name (company name or corporate name);
- d) Corporate purpose;
- e) Share capital;
- f) The share of each partner in the share capital;
- g) Liability of the partners (limited liability company);
- h) Whether or not the partners are liable, in the alternative, for the corporate obligations (simple partnerships);
- i) Appointment of the administrator and his powers (in contract or in a separate act);
- j) The participation of each partner in the profits and losses;
- k) Headquarters and jurisdiction;
- l) Duration.

In view of all the information defined, it is necessary to be validated by a lawyer, except for MSEs that are exempt from these obligations. In turn, the Social Registry is an extremely important document for ensuring the existence of the company in the market.

7.1.1.4 Registration of the Articles of Association, Consultation of the Name and Registration of the Trademark

When the Articles of Association are finalized, it is up to the entrepreneur to register it by forwarding it to the Board of Trade or the Registry Office of the Legal Entity of the State where the business will be implemented, with the following documentation: a) Articles of Association or Declaration of Individual Entrepreneur, signed in 3 (three) copies; b) Certified copy of the lawyer's Brazilian Bar Association (OAB) card (except for MSEs); c) Standard Application - Cover of the Board of Trade; d) Declaration of Microenterprise or small business, in 3 (three) copies; e) National Registry Form (Dias, 2010).

In the formalization of a business, it is necessary to define a business name in the way it wants to be legally recognized. This is a primary factor in the articles of association since it contributed to the identification of the business in the market. Regarding the choice of name, an unprecedented name is required, and for this to occur it is essential to investigate through

a consultation if there are other companies with the same desired name (Teixeira; Almeida, 2016).

Therefore, the consultation is carried out according to the legal type, such as the Simple Company, which performs this service at the Civil Registry Office of Legal Entities. For Dias (2010, p. 49), the corporate name, depending on the legal type, can occur in 3 (three) ways: individual firm, denomination and corporate name:

1. Individual Firm: the trade name will be the name of the owner to which the specification of the activity may or may not be added:
 - Henrique Silva Dias
 - Henrique Silva Dias Surfboard Repairs.
2. Name: It is a term created to which is added the objective of the company and its legal type, which can be abbreviated or in full:
 - Big Wave Surfboard Trade Limited.
 - Big Wave Comércio de Pranchas de Surfe Ltda.
3. Corporate Name: Consists of the use of the name of partners:
 - Silva e Dias Ltda.
 - Silva e Cia. Ltda.
 - Irmãos Silva e Cia. Ltda.

With the business nomenclature registered with the responsible agency, it guarantees the exclusivity of the trade name at the state level. After positive confirmation of the consultation, registration can be made at the National Institute of Industrial Property (INPI) (Teixeira; Almeida, 2016; Dias, 2010).

Certainly, trademark registration is one of the steps of fundamental importance in this process, since the trademark contributes to the establishment of the company's identity in the market, in differentiation from other competitors, and in the link between the company and the customer. In addition, the trademark is configured as an asset of the company, so its registration guarantees protection against possible theft or plagiarism (SEBRAE, 2020).

However, the process of applying for trademark registration requires pro-analysis and understanding of some criteria to verify the feasibility of trademark registration, such as: investigating the trademarks; define your brand's field of activity; the form of presentation (trade name, logo, physical brand); the nature of the mark (product, service, collective mark or certification); what are the fees imposed for registration. After carrying out this procedure, the entrepreneur is able to register the desired trademark with the INPI (SEBRAE, 2020).

7.1.1.5 Registration and Opening of the Company at the City Hall

The entrepreneur must issue the business license at the City Hall, such as its respective registration and registration as a municipal taxpayer from where the company is being generated. By following all legal procedures, the company acquires an opening registration.

In relation to the taxes required by the municipality, the service provision activities are responsible for paying the Service Tax (ISS) or Service Tax of Any Nature (ISSQN) (Teixeira; Almeida, 2016).

7.1.1.6 Registration with the State Treasury Department

The State registration of the State Treasury Department is required only for taxpayers of the Tax on the Circulation of Goods and Services (ICMS). Thus, enterprises that carry out service provision activities are exempt from this registration (SEBRAE, 2020; Teixeira; Almeida, 2016).

7.1.1.7 Registration in the National Registry of Legal Entities

This type of registration is required for all types of companies, the registration procedure is carried out together with the Federal Revenue agency, which grants the undertaking a National Registry of Legal Entities (CNPJ). In the final process of this stage, the Revenue guidelines for the issuance of the Basic Entry Document (DBE) are followed. With possession of the information received through the registration, the Federal Revenue Service is aware of the existence of the company and is able to collect the federal taxes imposed on the company. With this, when carrying all legal documents, it is necessary to request registration with the Board of Trade and all this information is forwarded to the municipal government for inspection and release of the operating license (Teixeira; Almeida, 2016).

7.1.1.8 Operating License

With the registration with the Federal Revenue Service completed, it is the phase of applying for the operating license with the City Hall. Corresponding to the permit, Dias (2010, p. 52) defines it as "[...] the document that allows the performance of commercial, industrial, agricultural, and service activities, as well as companies and associations of any kind, whether they are individuals or legal entities", that is, it is through it that companies are authorized to open the business.

7.1.1.9 Fire Brigade Authorization

Depending on the activity carried out by the companies, the City Hall requests a license from the Fire Department, in order to check the safety criteria and avoid any accident. The Fire Department carries out a technical inspection, through which it verifies the components that are in the company's physical space, the safety equipment and the type of activity performed on site (SEBRAE, 2020; Teixeira; Almeida, 2016).

After these procedures described for the creation of a company, in the next topic the phases of consulting determined by Block (2001) that can be applied in marketing consulting services for libraries will be addressed in detail.

7.2 MARKETING CONSULTING FOR LIBRARIES

There are several types of libraries by which they are differentiated, either by their role and the activities they offer, as well as by the users they serve and/or by their institutional connection. Therefore, some types of libraries can be listed: Public Library, Thematic Public Library, Community Library, Reading Point, National Library, School Library, University Library, Specialized Library and Reference Library (SNBP, 2020). Regarding the types of libraries, Table 16 describes them.

Table 16

Types of Libraries

Types	Features
Public Library	Its objective is to serve, through its collection and its services, the different reading and information interests of the community in which it is located, collaborating to expand access to information, reading and books, free of charge. It serves all audiences, babies, children, young people, adults, people of the best age and people with disabilities.
Thematic Public Library	They are public libraries that are characterized as libraries specialized in a certain area/subject. The environment is configured in such a way as to represent the area/subject in focus, as well as the collections that make up its collection, the services they offer and the cultural program
Community Library	It is a space to encourage reading and access to books. It is created and maintained by the local community, with no direct link to the State.
Reading Point	Spaces to encourage reading and access to books, created in communities, factories, hospitals, prisons and institutions in general.
National Library	Its function is to gather and preserve all the bibliographic production of the country. In each country there is a National Library. All bibliographic production in the country must be sent to the National Library, this is guaranteed by the Legal Deposit law.
School Library	Its objective is to meet the reading and information interests of its community and works in line with the pedagogical project of the school in which it is inserted. It serves, as a priority, students, teachers, employees of the teaching unit,

	and can also expand its action to serve the families of students and the surrounding community.
University Library	Its objective is to support teaching, research and extension activities through its collection and services. It serves students, professors, researchers and the academic community in general. It is linked to a higher education unit, which can be a public or private institution.
Specialized Library	Focused on a specific field of knowledge. Its collection and services meet the information and research needs of users interested in one or more specific areas of knowledge. It is linked to a public or private institution, and can also be characterized as a university library, when linked to a higher education unit
Reference Library	Specialized libraries that work with a focus on access, dissemination, production and use of information for a certain audience. Also called Information and Reference Center. Many of them do not have their own collection and work exclusively with the referencing of documents on a given subject (summaries and reviews).

Source: Adapted from **SNBP** (2020).

In view of Table 16 presented, it is clear that there are varieties of libraries present in society. Referring to the **Public Library**, it is aimed at the general public with different tastes and peculiarities, while the **Thematic Public Library** is restricted to users in the search for a certain specific area. The **Community Library** is formed by members of the community with the objective of reaching its surroundings. With regard to **Reading Points**, it can be considered as "mini-library", constituted within institutions in general (factories, hospitals, prisons) (SNBP, 2020).

On the other hand, the National Library is considered as the center point of the other libraries, since they hold the entire bibliographic collection in the country and still serve to preserve them. In relation to the School Library, it works based on the institutional pedagogical project, is aimed at everyone who is part of the school, as well as covers family members and everyone in the immediate vicinity of the institution. The University Library is subordinated to public or private institutions, integrating everyone in the academic community and in the surrounding area (SNBP, 2020).

With regard to the Specialized Library, it corresponds to a specific area of knowledge, having a well-defined public that is interested in the subject. It can be of a public or private nature or have a university bond. With regard to the Reference Library, it is also a specialized library that is concerned with supporting users in the use of the search for knowledge (SNBP, 2020).

Regarding the types of libraries, it is apprehended that they are equivalent in the mission of meeting the informational needs of customers, however they differ in their performance as well as in the services and products offered, in the places where they are

installed and in the projects they promote to attract them. With this, it is clear that they are basically unconsciously using the elements of marketing.

It is observed that there is a diversity of libraries in the market for the librarian's work. However, society is changeable and it is necessary to constantly adapt to these changes. Thus, **the role of the entrepreneurial librarian is resumed, which** seeks the proposal of creating a consulting company in order to continue the contents learned in the area of Librarianship, as well as to improve the management of these libraries through marketing.

In the previous sections, the legal aspects for the emergence of a company that serve to create a consultancy were portrayed. The following ones expose the step-by-step marketing consulting activity for libraries and its phases correspond to the stages established by the author Block (2001).

7.2.1 Phases of Consulting

The creation of a consultancy goes through stages. According to Block's (2001) proposal, these phases are sequentially mandatory, in order for the consultant to avoid setbacks in their application. It is a cycle of consulting services provided to customers, where in the present work are the libraries focused on marketing. Thus, in the following subsections, each phase of this enterprise is scrutinized.

7.2.1.1 Entry and Contract

It is the phase of the consultant's presentation with the client in relation to the development of the project. The activity of this stage is the moment to establish dialogue between the parties, the diagnosis of the root of the problem and the exposure of the expectations of both the client and the consultant in order to start the project. In this phase, some elements are worked on, such as: Negotiate needs; Facing conflicting motivations; Bring up concerns about exposure and loss of control; Triangular and rectangular contract (Block, 2001).

The first step of the contracting phase involves **negotiating the needs**, it is related to the dialogue between the client and consultant where both explain their desires and what they can offer each other. In the context of libraries, this dialogue occurs between the manager or the person in charge of the institution, who has the managerial knowledge of the library. The second step is **to face conflicting motivations**, it refers to the stage that arouses uncertainties and insecurities on the part of the client. In this way, it is necessary for the consultant to listen from the first step so that the consultancy works in a way that solves all these concerns (Block, 2001).

The third step involves **bringing up concerns about exposure and loss of control**, they are the fears that come from the client indirectly about the project that often show concern about losing control, however, this concern must be addressed from the first step, by which the consultancy indicates that the decision-making power will be in your hands. Regarding the fourth step of this phase, it corresponds to the **triangular and rectangular contract** in which it is necessary to be aware of how many clients the consultant will have from the contracting phase, since there are 2 (two) types of contracts (triangular and rectangular). The triangular contract is formed by the consultant, client, and client's boss. The rectangular contract is when both the consultant and the client are subordinate to a boss who must be aware of everything that happens in the process (Block, 2001). With regard to the library, it is essential to clarify the hierarchy and thus define who will be included in the contract.

7.2.1.2 Data Collection and Diagnosis

This phase is composed of the Analysis Levels; Political climate; Resistance to sharing information; and Interview as an intervention (Block, 2001).

Regarding the **levels of analysis**, they are related to the diagnosis of the main problem resulting from other implicit problems. Therefore, it is necessary for the consultant to structure the different levels of problems in a harmonious way. Regarding the **political climate**, it is directly associated with the company's policy, regardless of whether the customer is a family business or organization. It is essential to observe the behavior of those who work in the company, so that the consultant can understand whether this situation will affect the resolution of problems and the implementation of the project, such as resistance to change (Block, 2001).

About the **resistance to sharing information** worked on in this phase, it is attributed to the concealment of some data necessary to understand the problem. It is pertinent to emphasize the need for the consultant to work in such a way that the client feels comfortable exposing all the accurate information. Regarding the **interview as an intervention**, although there is no one who is totally neutral or only an observer, the consultant should act in a distanced manner at this stage so as not to contaminate the data collected (Block, 2001).

7.2.1.3 Feedback and Decision to Act

Regarding this phase, the issues addressed are: Funneling the data; Present personal and organizational data; Manage the feedback meeting; Focus on the here and now; and Not to see reactions as something personal (Block, 2001).

Referring to the first element, which is **to funnel the data**, this means that when collecting all the data, it is considerable to restrict the pertinent information that will actually solve the problem, however, with each decision, customers are informed. Regarding the second element that contemplates the importance of **presenting the personal and organizational data**, obtained in the collection of data, which are all the material, monetary, behavioral information of the team, in short, all the managerial data. This requirement of the feedback phase, which allows the consultant to give feedback to his clients, it is important to present recommendations on the personal data of employees not to demerit the professional image, but to propose suggestions that will be implemented in the report. It will be a professional view that the client cannot obtain from anyone else (Block, 2001).

Regarding the third element, that of **managing the feedback meeting**, it is the moment where everything that has been completed will be pointed out. It is a point of greater apprehension between consultant and client about what will be exposed, how the information will be received, since all the investigations will be exposed, but mainly reveal the proposed solutions. It is up to the consultant to have control of the situation and safeguard the entire subject addressed, because the more answers to the problems identified, the more feasible the implementation will be. The feedback phase is the moment to convince the client to buy the project (Block, 2001).

Considering the fourth element about **focusing on the here and now**, is the feedback phase in which the consultant must be aware of how the client is receiving the information. It is necessary to listen to what the client thinks of the proposal, since, "[...] the feedback process becomes a victim of the same managerial problems that gave rise to the need for its services [...]" (Block, 2001, p. 33). As it is the fifth element of the feedback phase, which is aimed **at not seeing reactions as something personal**, it is conditioned to the client's response, which can be positive or negative for the consultant, and the consultant must understand the client's decision in a professional way without taking it personally (Block, 2001).

7.2.1.4 Engagement and Implementation

This phase consists of components such as: Bet more on engagement than on imposition and persuasion; Plan more participation than presentation; Stimulate difficult public exchanges; Give the possibility of real choice; Change the conversation to change the culture; and Be aware of the place (Block, 2001).

As for the first step of implementation, which corresponds to **betting more on engagement than on imposition and persuasion**, no one works alone, it is necessary the

commitment of each member in what they give to each stage of the service, so that everything happens in the right way. The decision is important, but success is not guaranteed when it is forced. To the second step, which is **to plan more participation than presentation**, more participation, integration and interaction among members should be encouraged, as the influence of employees in the process can bring success to the resolution of the problems encountered (Block, 2001).

Regarding the third step by which the consultant **encourages difficult public exchanges**, carried out to emphasize the credibility of the consultancy, resolving all possible doubts in public and adopting a method of trust between the parties. The fourth step of this phase requires the consultant **to give the possibility of real choice**, it gives employees the power to decide on possible changes, as it guarantees more the probability of their commitment to the activities; giving the solution with speed is hasty and dangerous and there may be failures in solving problems. Not always a single answer is appropriate for each type of situation (Block, 2001).

Regarding the fifth step about **change the conversation to change the culture**, it means that it is important to remove from the minds of employees the feeling of guilt for the problems encountered, but the consultancy must structure "[...] the conversation around personal responsibility, questions of purpose and meaning, and what will be unique and new about the round of changes" (Block, 2001, p. 34). Finally, the last step of this phase requires the consultant **to be aware of the place**, so that he awakens the impact of the engagement and activities of the clients, a space that demonstrates seriousness and commitment, in addition to worrying about the way the consultant behaves, the way he conducts the meetings with clarity and attitude contribute to decision-making with clear and real intentions, and thus implement the project (Block, 2001).

7.2.1.5 Extension, Recycling, or Termination

This phase is related to the client's feedback to the consultant, as it is in this stage that it will be evaluated from engagement to the implementation of the consultancy. If the results obtained after implementation are satisfactory, in addition to providing valuable experience for both sides, it can keep the door open for the acquisition of new contracts with the client. However, after the implementation of the points listed in the consultancy, a new problem may arise in the organization that had not manifested itself until then, in which case the process must be recycled and the discussion of a new one started (Block, 2001).

In consulting, a part that must be considered by the consultant is the termination of the contract. This can occur both because of the negative result obtained after the

implementation of the project, but it can also occur even if the implementation is a total success, because "There are many options to end a relationship and the termination, in addition to being legitimate, should be considered an important part of the consultancy" (Block, 2001, p. 6). In view of this, all the phases presented by Block (2001) require the direct participation of the consultant and client, in order to obtain important results in the implementation and completion process.

Understanding the phases of consulting services, it will work with a new service in the market, focused on marketing in libraries. Marketing is a managerial process that is linked to all the services of the institution, that is, it involves from its location, services and products, distribution, as well as promotes actions to give visibility to libraries, through which all these elements, even if indirectly, interfere in the customer's contact with these institutions.

In this way, the consultancy aims to work on the diagnosis of management in its entirety, which means identifying the problem, proposing a solution to the problem and thus giving institutions the opportunity to create or resignify services and products according to the demand presented by the client/user and not only develop services and products without listening to what the interested party thinks. A more attentive professional look externally from other professionals/librarians who have knowledge in the area becomes relevant to perceive the strengths and especially the weaknesses that can be changed, and thus achieve the need and satisfaction of the customer/library and consequently your end customer.

8 CONCLUSION

Entrepreneurship is a multidisciplinary field that connects with the vast areas of knowledge, with the main objective of introducing the creation of new businesses that serve society through new offers, services, products and work in different niches. In addition, it can be incorporated into the work environment by a professional with innovative ideas who aims to contribute to the organization, keeping in mind that the act of entrepreneurship mainly requires taking risks.

With regard to the creation of a company, the entrepreneur seeks to own his own business, with this arises the need for marketing, which works for the enterprise to obtain profits, through planning so that it meets the needs of the customer. Corroborating the function of marketing, the consultancy proposes the investigation and solution of problems so that the organization satisfactorily serves customers.

Marketing is linked to for-profit institutions, however, it is an area with a history of many transformations and according to studies by Kotler (1998) they can be adapted to non-profit institutions, such as libraries. In this way, in order to create new ways of working, take on

challenges, and get out of the comfort zone; The present work was motivated to awaken librarians to create an external consultancy focused on library marketing based on the 4P (Product, Price, Place, Promotion).

The guiding question of the research was: How to develop a marketing consultancy to contribute to the organizational demands of libraries? To meet this problem, the general objective was to establish theoretical references in the proposition of establishing a marketing consulting service in the field of libraries, in order to meet their organizational demands in favor of serving users. And the specific ones dealt with:

- a) map theoretical references in the process of creating a consultancy in interrelation with entrepreneurship and marketing in libraries;
- b) to correlate the 4P's of marketing in the context of libraries;
- c) to present the main aspects related to the creation of a marketing consulting company for libraries, concerning the phases, services and legal and bureaucratic aspects.

The needs of libraries are related to the issue of marketing, which is not only linked to the dissemination of services and products, but since its creation refers to the business, products to be offered; price that for libraries is linked to symbolic, cultural and scientific capital; place or place, which refers to the service of the target audience. Any problem in these variables can affect libraries in their typological diversity and, consequently, affect the supply of customers' informational needs. It is necessary for the clientele to recognize libraries as an essential service for society, since it promotes the knowledge and development of opinion-forming individuals. For this to happen, it is important that the library has a mission and planning that is constantly updated.

Thus, through biblioFigureic research, although there are no studies that present the applicability of marketing consulting in libraries, it is possible to carry out consulting for the solution of organizational demands in these organizations. In this perspective, there is a need for research, for the analysis of the environment of the institution that is being studied, through some marketing tools : Market Research; Segmentation; Definition of target audience and positioning; SWOT Analysis and Marketing Plan. And thus identify which Marketing Mix is having difficulties in the institution so that problems can be found and, consequently, outline goals and objectives, and outline a means for them to be achieved.

Concerning the first specific objective stipulated, entrepreneurship is relatively new to the librarianship area. However, their actions begin within the classroom relating the theory and practice of knowledge, such as working on normalization techniques; participate in the construction and implementation of projects that serve the community, since from a social perspective entrepreneurship consists of the elaboration of social projects created for the

transformation of the environment in which it is inserted; and the creation of content related to the course on social media. In addition, the technical, theoretical and humanistic knowledge acquired in training contributes to intrapreneurial practices within the conventional field of work by effecting innovations in an existing sector; or traditional entrepreneurship that corresponds to the creation of a new business. However, for the development of innovative ideas and to make a difference in the market, it is necessary to constantly seek continuing education due to the changing state of the market.

Historically, the development of companies in the area of Librarianship performed only traditional activities in the field. With the changes coming from the market, companies began to reinvent themselves and enter technological means. A new aspect in entrepreneurship emerges, the Creative Economy, which are companies created that offer services and products in the physical or digital sphere, with the aim of selling. Companies such as Santa Librarianship, Class Curso, Index Consultoria, Documentar, Control Informação e Documentação, and Inform Document and Information Management, among others, stand out as Creative Economy in the field of librarianship. In addition to the fact that there are a few more companies related to Librarianship, the relationship between both areas is still timid: entrepreneurship and Librarianship with regard to the formation of enterprises.

Regarding the second specific objective, the research worked with authors such as Leite *et al.* (2005), Grocco Guttman (2005) and Block (2013) who relate the history of consulting traditionally as a practice developed by people who acted with influence within society because they were considered erudite. In another thought, the historical aspect was linked by Bond (1999) and Paes de Paula and Wood Júnior (2008) to management theories focused on the areas of Strategies, Marketing and Human Resources. In addition, Silva (1974) and Menon (20007) associated the history of consulting based on the studies of Frederick Taylor who analyzed the length of service.

Consultancies in Brazil are relevant because they are considered a central point that maintains most of the offices in this field nationally and internationally and operate in different niches, having as partner entities the associations: IMC, IBCO and Sebrae. Examples of consultancy that operate in Brazil were cited, it was noticed that most consultancies are of an organizational nature and provide activities focused on administration, few consultancies were found in the field of Librarianship, most of them are for the services of standardization, organization of informational units, automation and archiving. In Maranhão, the consultancies found propose more services for the standardization and organization of the Lattes Curriculum.

Two forms of consulting were identified, internal consulting (professional integrated into the organization) and external consulting (professional who does not have an employment relationship with the company). In addition, the consultancies are branched according to their classification: Structure (Package and Handmade) and Breadth (Specialized, Total and Global).

Consulting is an enterprise in which librarians can create from their skills and expertise, and thus generate a sense of autonomy and opportunities for others in a market that is currently increasingly scarce of formal and public jobs offered to professionals coming out of academies.

Regarding the third objective, it is relevant to demystify that the work of marketing in libraries does not apply only to promotion, but in an integral way using the 4P's (Product, Price, Place and Promotion). And for this to happen, it is important to have the perception that the library is an organization, is linked to a market and has its competitors. However, what changes are the services and products delivered without a monetary nature; it is also necessary to know clearly which audience the library is intended for and thus develop actions that solve their problems in order to attract and keep customers in libraries, but some strategies used to detect the problem of Mix marketing are different according to the type of library.

In general, the application of marketing does not correspond only to sales, but is based on creation, communication, and behavior change. Regarding the insertion of marketing in libraries, they should be oriented towards this aspect, that is, analyzing customers, pointing out their needs and based on this information, developing services and products that serve the public.

In marketing aimed at libraries, as in any other institution that makes use of this area, it is essential to segment the market, to know the social, cultural, political, religious and demographic context; define the target audience, in order to identify which type of community it serves and study how the library is positioned in the market, that is, how it is being observed by customers.

Regarding the correlation of the 4P's of Marketing in libraries, it was found that: the Product is what the library offers to its customers, which can also be in the form of services. Some stand out, such as: Collections in various media; Management Service; Reference Service; Treatment, organization and recovery of the bibliographic collection; Automation; Consultation of the collection; Bookbinding services; Training and Development of Collections; Reading Projects, among others. It is worth noting that not all of these services and products are offered in all types of libraries, such as school and community libraries.

Price is considered one of the problems related to marketing in libraries, however, to make marketing services monetary, what counts first is the customer's opinion. However, there are other values added to these institutions, such as symbolic capital, cultural capital and scientific capital, as well as the emotional value generated by the interaction of the customer with the library and the working professional. The Square is the meeting point between the customer and the library, physically or remotely, taking into account how the environment inside and outside the library is planned so that all real and potential customers have access to it; and digitally through the electronic channel: e-mail, manual retrieval system, alert system, among others, according to the specificity and audience of each library.

The Promotion seeks to inform the public about what services and products libraries offer, usually through library portals. A way to attract the target audience that does not have internet can be done through a partnership with the local radio, posters spread not only within the library, but with word of mouth marketing, that ant work between librarians and customers and these passing on to others.

And finally, the fourth specific objective refers to the legal and bureaucratic requirements for opening an enterprise, such as external consulting focused on library marketing and the services that this type of company intends to offer.

First, for the creation of a company, an idea is delineated, which starts from a lack in the market, from a dream, in search of being inserted in the market and not on the margins. In this way, it is essential to create a business plan that includes the appropriate information for the foundation and improvement of the enterprise in the market. After this requirement, it focused on the legal and bureaucratic requirements required of any company. Law No. 123/2006, Law No. 11598/2007 and Complementary Law No. 128/2008 stand out, which highlight the rights and duties of microentrepreneurs; therefore, the step-by-step process for the formation of a business was highlighted, such as: Feasibility Consultation; Registration with the Board of Trade; Formatting and Configuration of the Articles of Association; Social Registration, Name Consultation and Trademark Registration; Registration and Opening of the Company at the City Hall; Registration with the State Treasury Department; Registration in the National Register of Legal Entities; Operating License and Authorization of Firefighters.

Regarding the activities of the consultancies that can be improved, in the process of creating a marketing consultancy for libraries, a work composed of 5 phases (Entry and Contract; Data Collection and Diagnosis; Feedback and Decision to Act; Engagement and Implementation and Extension, Recycling or Termination), which are services to be provided to the contractor and emphasize the identification of the problem and solution of the institution that generates a project. However, it is worth noting that the consultancy does not have

decision-making power to implement proposals to solve problems, it only shows the means and the manager has the power to decide. Analogously, consultants are like psychologists who detect the root of the problem and the possible solution.

External marketing consulting focused on libraries is a way to contribute to the search for answers to problems presented in the library environment that sometimes go unnoticed or are ignored, leading to a series of other problems bringing harm to the clientele. The consultancy proposes to use marketing focused on Mix marketing in order to verify factors that are hindering the library from growing or exerting influence in the market where it is inserted, in addition to adding new techniques that the institution does not use to add ideas, propose solutions, contribute to cost reduction, gather data to investigate the market situation and how it can help the library to stay ahead of other competitors.

Finally, it is concluded that the study is promising and unveils spaces for others that aim to contribute to the sciences in general and, specifically, to Library Science and Information Science. Approaches are suggested about cooperatives that develop entrepreneurial actions in the area, carry out research to verify enterprises in the area of Library Science that operate outside the walls of libraries and enable the interrelationship of fields of knowledge such as entrepreneurship and marketing.

Since the primary objective of this study was to define the steps for building a marketing consulting company for libraries, the research allows librarians to rethink other ways of working without giving up their work techniques.

REFERENCES

- Amaral, S. A. do. (1998). Marketing: Abordagem em unidades de informação. Thesaurus.
- Amaral, S. A. do. (1990). Marketing e gerência de biblioteca. *Revista de Biblioteconomia de Brasília*, 18(2).
- Amaral, S. A. do. (2004). Marketing da informação na internet: Ações de promoção. Ed. Uniderp.
- Amaral, S. A. do. (2007). Marketing e inteligência competitiva. Em S. A. do Amaral, *Marketing na ciência da informação* (pp. 19–31). Ed. UnB.
- Andreasen, A. R. (1987). Avanço do marketing para biblioteca. Em A. Silveira (Org.), *Marketing em bibliotecas e serviços de informação* (pp. 37–64). Ibict.
- Associação dos Jovens Empresários do Maranhão. (2020). Sobre. Recuperado de <https://www.ajema.com.br>
- Baggio, A. F., & Knebel, D. B. (2014). Empreendedorismo: Conceitos e definições. *Revista de Empreendedorismo, Inovação e Tecnologia*, 1(1), 25–38.

- Baldissera, H. C. (2019). Inter-relações entre os influenciadores do intraempreendedorismo (Dissertação de mestrado).
- Baptista, S. G. (1988). Aplicação de marketing em bibliotecas. *Revista de Biblioteconomia de Brasília*, 16(1).
- Barreto, L. P. (1998). Educação para o empreendedorismo. Universidade Católica de Salvador.
- Bernardi, L. A. (2008). Manual de plano de negócios. Atlas.
- Bourdieu, P. (1987). Choses dites. Minuit.
- Bourdieu, P. (2004). Os usos sociais das ciências. Unesp.
- Bond, W. J. (1999). Vão solo. Nobel.
- Block, P. (2001). Consultoria: O desafio da liberdade (2ª ed.). Pearson.
- Block, P. (2013). Consultoria infalível (3ª ed.). M. Books.
- Brinckerhoff, P. C. (2000). Social entrepreneurship. Wiley.
- Brasil Júnior. (2015). Conceito nacional de empresa júnior.
- Brasil. (2007). Lei nº 11.598, de 3 de dezembro de 2007.
- Brasil. (2006). Lei complementar nº 123, de 14 de dezembro de 2006.
- Brito, B. S. de. (2017). Intraempreendedorismo em bibliotecas universitárias (Trabalho de conclusão de curso).
- Cardozo, T. R. B., & Barbosa, M. L. A. (2004). Políticas informacionais e práticas pedagógicas. Em Encontro Nacional de Ciência da Informação.
- Case, T. A., Case, S., & Franciatto, C. (1997). Empregabilidade. Makron Books.
- Chiavenato, I. (2007). Empreendedorismo (2ª ed.). Saraiva.
- Chiavenato, I. (2008). Empreendedorismo (3ª ed.). Saraiva.
- Cobra, M. (2011). Marketing básico (4ª ed.). Atlas.
- Cobra, M., & Franceschini, A. (2012). Se eu fosse você. Elsevier.
- Conroy, B. (1987). O marketing das megatendências. Em A. Silveira (Org.), *Marketing em bibliotecas e serviços de informação* (pp. 17–36). Ibict.
- Conselho Federal de Biblioteconomia. (2002). Resolução nº 42.
- David, D. E. H. (2004). Intraempreendedorismo social (Tese de doutorado).

- Debastiani, I. R. (2003). Empreendedorismo (Dissertação de mestrado).
- Dias, H. S. (2010). Guia para abertura de empresas (Trabalho de conclusão de curso).
- Dolabela, F. (1999). Oficina do empreendedor. Editora de Cultura.
- Dolabela, F. (2006). O segredo de Luísa (14^a ed.). Editora de Cultura.
- Donadone, J. C., Silveira, F. Z., & Ralio, V. R. Z. (2012). Consultoria para pequenas e médias empresas. *Gestão & Produção*, 19(1), 151–171.
- Dornellas, J. (2005). Empreendedorismo. Elsevier.
- Dornellas, J. C. A. (2008). Empreendedorismo corporativo (2^a ed.). Elsevier.
- Dornellas, J. (2016). Empreendedorismo (6^a ed.). Atlas.
- Drucker, P. F. (1992). Administração para o futuro (2^a ed.). Pioneira.
- Edinger, J. A. (1987). Marketing dos serviços da biblioteca. Em A. Silveira (Org.), *Marketing em bibliotecas e serviços de informação* (pp. 105–117). Ibict.
- Filion, L. J. (1999). Empreendedorismo. *Revista de Administração*, 34(2), 5–28.
- Garcia, D. C. F., Gattaz, C. C., & Gattaz, N. C. (2019). The relevance of title, abstract and keywords. *Revista de Administração Contemporânea*, 23(3).
- Gerber, M. E. (2004). Empreender. Editora Fundamento.
- Girard, C. D. T., Fonseca, D. L. S., & Gama, M. C. F. (2017). Economia criativa na biblioteconomia. *Revista Brasileira de Biblioteconomia e Documentação*, 13, 2589–2605.
- Gomes, I. M. (2013). Manual para plano de marketing. Em V. S. Costa et al. (Orgs.). Sebrae/MG.
- Gomes, I. M. (2013). Como elaborar pesquisa de mercado. Em V. S. Costa et al. (Orgs.). Sebrae/MG.
- Gonçalves, M. A. (1991). Consultoria. *Revista de Administração de Empresas*, 31(2), 91–98.
- Global Entrepreneurship Monitor. (2017). Empreendedorismo no Brasil.
- Global Entrepreneurship Monitor. (2019). Empreendedorismo no Brasil.
- Grocco, L., & Guttman, E. (2005). Consultoria empresarial. Saraiva.
- Guerra, J. R. F., & Paiva Júnior, F. G. (2011). Empreendedorismo cultural. *Revista de Administração e Inovação*, 8(3), 78–99.
- Gulka, J. A., Lucas, E. R. O., & Correa, C. D. (2018). Marketing digital em bibliotecas. *Ciência da Informação em Revista*, 5(1), 59–69.

- Honesko, A. (2001). Empreendedorismo em bibliotecas universitárias (Dissertação de mestrado).
- Honório, J. B. (2009). A dinâmica das relações consultor-cliente (Dissertação de mestrado).
- Instituto Brasileiro dos Consultores de Organizações. (2015). O instituto.
- Instituto Brasileiro dos Consultores de Organizações. (2016). Pesquisa IBCO de honorários.
- Institute of Management Consultants. (2019). About the foundation.
- Kotler, P. (1978). Marketing para organizações sem fins lucrativos. Atlas.
- Kotler, P. (1998). Administração de marketing (5ª ed.). Atlas.
- Kotler, P. (1999). Marketing para o século XXI (13ª ed.). Futura.
- Kotler, P. (2000). Administração de marketing (10ª ed.). Prentice Hall.
- Kotler, P. (2003). Marketing de A a Z. Campus.
- Kotler, P., & Armstrong, G. (2007). Princípios de marketing (12ª ed.). Pearson.
- Kotler, P., Kartajaya, H., & Setiawan, I. (2012). Marketing 3.0. Elsevier.
- Kotler, P., & Keller, K. L. (2012). Administração de marketing (14ª ed.). Pearson.
- Las Casas, A. L. (2008). Marketing. Atlas.
- Las Casas, A. L. (2010). Marketing (3ª ed.). Atlas.
- Leite, L. A. M. C., et al. (2005). Consultoria em gestão de pessoas. FGV.
- Leite, L. A. M. C., et al. (2009). Consultoria em gestão de pessoas (2ª ed.). FGV.
- Lins, N. V. M. (1999). Consultoria (Dissertação de mestrado).
- Lima, E. K. S. (2015). Ferramentas de marketing para pequenos negócios (Trabalho de conclusão de curso).
- Limeira, T. M. V. (2008). Empreendedor cultural. Em Encontro de Estudos Multidisciplinares em Cultura.
- Limeira, T. M. V. (2010). E-marketing (2ª ed.). Saraiva.
- Madalena, C. S., & Spudeit, D. (2017). Preceitos éticos do bibliotecário empreendedor. Ciência da Informação em Revista, 4(3), 58–67.
- Madrugá, R. P., et al. (2004). Administração de marketing. FGV.
- Maranhão. Secretaria de Indústria, Comércio e Energia. (2020). Boletim empresarial.
- Marinho, R. S. (2013). Público alvo (Trabalho de conclusão de curso).

- Mathews, A. J. (1987). Segmentação do mercado de bibliotecas. Em A. Silveira (Org.), *Marketing em bibliotecas* (pp. 83–103). Ibict.
- Maximiano, A. C. A. (2010). *Teoria geral da administração*. Atlas.
- Merron, K. (2007). *Dominando consultoria*. M. Books.
- McCarthy, E. J. (1982). *Marketing*. Campus.
- Melo Neto, F. P., & Froes, C. (2002). *Empreendedorismo social*. Qualitymark.
- Oliveira, D. P. R. (2005). *Manual de consultoria empresarial* (6ª ed.). Atlas.
- Oliveira, D. P. R. (2010). *Manual de consultoria empresarial* (9ª ed.). Atlas.
- Oliveira, E. S. (2005). *Critérios de decisão na contratação de consultoria* (Dissertação de mestrado).
- Oliveira, F. M. (2012). *Empreendedorismo: teoria e prática*. Revista Especialize Online.
- Oliveira, S. M. (1985). *Marketing em bibliotecas*. *Ciência da Informação*, 14(2), 137–147.
- Oliveira, T. W. B. (2013). *Marketing 3.0 em biblioteca escolar* (Trabalho de conclusão de curso).
- Paes de Paula, A. P., & Wood Júnior, T. (2008). Dilemas da indústria de consultoria. *RAC Eletrônica*, 2(2), 171–188.
- Pastore, O. R. A. (2014). *Internacionalização de empresas* (Dissertação de mestrado).
- Pilz, S. E. (2017). *Microempreendedor individual* (Trabalho de conclusão de curso).
- Prodanov, C. C., & Freitas, E. (2013). *Metodologia do trabalho*. Feevale.
- Reis, A. S. (2017). *Empresa júnior em biblioteconomia* (Trabalho de conclusão de curso).
- Rocha, R. A., & Platt, A. A. (2015). *Administração de marketing* (3ª ed.). UFSC.
- Salim, C. S., et al. (2004). *Administração empreendedora*. Elsevier.
- Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2020). *Plano de negócio*.
- Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2020). *6 passos para abrir negócio*.
- Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2020). *Consultoria online*.
- Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2020). *Forma jurídica para empresas*.
- Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2020). *Empretec*.

- Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2020). Sebraetec.
- Severino, A. J. (2016). Metodologia do trabalho científico (24^a ed.). Cortez.
- Silva, B. (1974). Taylor e Fayol (3^a ed.). FGV.
- Silva, G. O. V. (1995). Capital cultural em Bourdieu. *Informare*, 1(2), 24–36.
- Silva Júnior, G. B., & Santos, J. A. G. (2014). Consultoria organizacional e empreendedorismo. *Cadernos de Ciências Sociais Aplicadas*, 11(17), 103–126.
- Silva, T. D. (2015). Desburocratização de empresas (Trabalho de conclusão de curso).
- Silveira, A. (1987). Introdução. Em *Marketing em bibliotecas* (pp. 5–12). Ibict.
- Silver Normalização. (2020). Sobre.
- Sistema Nacional de Bibliotecas Públicas. (2020). Tipos de bibliotecas.
- Spudeit, D. (2016). Empreendedorismo na biblioteconomia. Em *Empreendedorismo na biblioteconomia*.
- Spudeit, D., Madalena, C. S., Laurindo, K. R., & Duarte, T. (2016). Empresas criadas por bibliotecários. *Revista ACB*, 21(3), 676–696.
- Stecca, F. L. P. A., & Ávila, L. V. (2015). Gestão de marketing. UFSM.
- Teixeira, G. C., & Coelho, R. (2012). Tipos e estratégias de consultoria. Em G. C. Teixeira (Org.), *Referenciais de consultoria do Sebrae*.
- Teixeira, P. R., & Almeida, W. S. S. (2016). Empreendedorismo na biblioteconomia. Em D. Spudeit (Org.), *Abertura de uma empresa*.
- Wood, E. J. (1987). Planejamento estratégico e marketing em bibliotecas. Em A. Silveira (Org.), *Marketing em bibliotecas* (pp. 65–82).
- Xavier, J. A. (2018). Plano de negócio: produção de ovos orgânicos (Trabalho de conclusão de curso).

SHEAR STRENGTH OF ONE-WAY RIBBED SLABS WITH STEEL FIBER CONCRETE

LAJES NERVURADAS UNIDIRECIONAIS DE CONCRETO ARMADO COM FIBRAS DE AÇO AO CISALHAMENTO

LOSAS NERVADAS UNIDIRECCIONALES DE CONCRETO ARMADO CON FIBRAS DE ACERO AL CORTANTE



<https://doi.org/10.56238/sevened2026.008-245>

Felipe da Silva Leite¹, Leomir Rafael Brito Silva², Dênio Ramam Carvalho de Oliveira³, Mateus Antônio Nogueira Oliveira⁴, Marcio Rodrigo Nunes de Souza⁵, Willander de Almeida Marques⁶, Francisco Xavier Gomes Pantoja Junior⁷, Edson Igreja Bentes⁸

ABSTRACT

The ribbed slabs are used both in small and large constructions, and its use is growing due to the advantages that this constructive system provides. However, considering the demeanor of these slabs without transverse reinforcements (stirrups), few studies were made in Brazil. This study brings an experimental analysis of 8 unidirectional ribbed slabs of reinforced concrete subjected to loads perpendicularly distributed to the ribs. 4 (four) reference slabs and 4 (four) reinforced slabs with steel fibers with a length of 1,700 mm and width ranging from 650 to 950 mm were tested, all with table thickness of 40 mm and ribs with cross section of (100 x 100) mm². The compressive strength of concrete was approximately of 30 MPa. The results were compared to those estimated by the design codes ACI 318 [1], EHE 08 [2], NBR 6118 [3] and MC10 [4]. It was verified that the increase in shear and bending strength of the reinforced slabs with fibers was substantial, what makes those slabs technically feasible.

Keywords: Ribbed Slab. One-Way Slab. Shear. Steel Fiber.

RESUMO

Lajes nervuradas são empregadas tanto em pequenas quanto em grandes obras e sua utilização cresce face as vantagens que este sistema construtivo proporciona. Entretanto, poucos estudos foram realizados no Brasil considerando o comportamento destas lajes sem

¹ Master's degree in Structures and Civil Construction. Universidade Federal do Pará.

E-mail: felipe.leite@ifap.edu.br

² Civil Engineer. Universidade Federal do Pará. E-mail: sgt.rafa@gmail.com

³ Dr. in Structures. Universidade Federal do Pará. E-mail: denio@ufpa.br

⁴ Dr. in Civil Engineering. Universidade Federal de Minas Gerais. E-mail: mateusantonio@ufmg.br

⁵ Dr. in Structures and Civil Construction. Instituto Federal do Amapá. E-mail: marcio.souza@ifap.edu.br

⁶ Civil Engineer. Universidade Federal do Amapá.

E-mail: willandermarques@gmail.com

⁷ Civil Engineer. Universidade Federal do Amapá.

E-mail: francisco.pantoja@ifap.edu.br

⁸ Civil Engineer and Occupational Safety Engineer. Universidade Federal do Amapá. E-mail: edson.bentes@ifap.edu.br

armaduras transversais (estribos), nas nervuras. Este trabalho apresenta uma análise experimental de 8 lajes nervuradas unidirecionais de concreto armado sujeitas a carregamentos distribuídos perpendicularmente às nervuras. Foram ensaiadas 4 (quatro) lajes de referência e 4 (quatro) lajes reforçadas com fibras de aço com comprimento de 1.700 mm e largura variando de 650 a 950 mm, todas com espessura de capa de 40 mm e nervuras com seção transversal de (100 x 100) mm². A resistência do concreto à compressão foi de aproximadamente 30 MPa. Os resultados foram comparados aos estimados pelas normas ACI 318 [1], EHE 08 [2], NBR 6118 [3] e MC10 [4]. Verificou-se aumento de resistência considerável ao cisalhamento e a flexão para as lajes reforçadas com fibra, tornando-as tecnicamente viáveis.

Palavras-chave: Laje Nervurada. Laje Unidirecional. Cisalhamento. Fibra de Aço.

RESUMEN

Las losas nervadas se emplean tanto en obras pequeñas como en grandes, y su uso crece debido a las ventajas que este sistema constructivo proporciona. Sin embargo, pocos estudios se han realizado en Brasil considerando el comportamiento de estas losas sin armaduras transversales (estribos) en las nervaduras. Este trabajo presenta un análisis experimental de 8 losas nervadas unidireccionales de concreto armado sometidas a cargas distribuidas perpendicularmente a las nervaduras. Se ensayaron 4 (cuatro) losas de referencia y 4 (cuatro) losas reforzadas con fibras de acero, con longitud de 1.700 mm y ancho variando entre 650 y 950 mm, todas con un espesor de capa de 40 mm y nervaduras con sección transversal de (100 × 100) mm². La resistencia a compresión del concreto fue de aproximadamente 30 MPa. Los resultados se compararon con los estimados por las normas ACI 318 [1], EHE 08 [2], NBR 6118 [3] y MC10 [4]. Se verificó un aumento considerable de la resistencia al corte y a la flexión en las losas reforzadas con fibra, haciéndolas técnicamente viables.

Palabras clave: Losa Nervada. Losa Unidireccional. Corte. Fibra de Acero.

1 INTRODUCTION

Currently, due to the demands of projects, the construction industry demands a growing need for larger spans and fewer beams. In this scenario, the use of ribbed slabs stands out, which, in turn, are lighter structures due to the use of expanded polystyrene (EPS), or even removable formwork in regions below the neutral line, where, in the case of solid slabs, this region would be filled with concrete, making the latter less economical, having to use part of its resistant capacity to combat self-weight and even increase the number of beams in order to reduce the arrows. According to Bochi Júnior (1995) [5], the use of ribbed slabs, due to the minimization of costs and deadlines, met the growing need for rationalization in civil construction.

Unidirectional ribbed slabs can be built in a precast way, totally or only ribbed, and this brings benefits, such as the reduction of material for the execution of form and shoring, reduction of labor for execution, shorter time for execution compared to conventional ones, lower concrete consumption due to the area filled by inert materials and reduction in the amount of debris on site, caused by wood discards. Despite the advantages mentioned, the elimination of beams, due to the gain in span increase provided by ribbed slabs, causes some disadvantages, such as the decrease in the overall stability of the structure, due to horizontal actions.

The importance of this study is to analyze the results of stresses, strains and displacements, intending to expand the knowledge about the shear resistant behavior of ribs and layers, considering the variation of the distance between rib axes (s) and the use of steel fiber reinforced concrete (CRFA), seeking to qualify and quantify the contribution of the system to the gain in shear strength. It seeks to evaluate the benefits of the use of steel fiber reinforced concrete (CRFA) in reinforced concrete ribbed slabs from experimental studies where the distance between the rib axes was the main variable, pointing out the influence of this variation on their behaviors and the advantages caused by the addition of steel fiber to concrete, as well as to evaluate the level of precision of the normative codes in relation to the shear strength of structures. It is noteworthy that Barros et al. (2003) [6] and Gava (2004) [7], have already verified the contribution of fibers as reinforcement and Claudio et al. (2014) [8] presents the technological advances in the development of fibers for concrete reinforcement.

2 LITERATURE REVIEW

2.1 STRUCTURAL BEHAVIOR

The improvement of the quality of design procedures related to shear is a concern of structural engineering. Shear failures in reinforced concrete structures usually occur in a fragile way, with little or no prior warning, in addition, they tend to be less predictable than flexural failures, due to the considerably more complex failure mechanisms. Unidirectional ribbed slabs characteristically present T-beam configurations with joined tables, requiring an understanding of the shear stresses and shear forces that will arise from external stresses. According to Rüsç (1960) [9], shear cracks can originate from flexural cracks. In these cases, these flexural cracks, as soon as they appear, trigger a considerable redistribution of internal stresses with consequences that are difficult to calculate and that influence the inclination of the shear cracks.

2.2 RESISTANT MECHANISMS

According to Rombach and Latte (2008) [10], the determination of the shear resistant capacity in reinforced concrete structures without transverse reinforcement is a classic structural problem studied for more than 100 years, and this difficulty consists in the quantification of the strength that compressed concrete can offer in the face of stresses. Despite this work, most of the research focuses on simply supported beams or on slabs covering strips with loads applied over the total width b less than $4 \cdot d$, with the useful height of the slab. Experimental studies show that the shear resistant capacity of a reinforced concrete beam can be divided into two parts: one resisted by the transverse reinforcement and the other by the concrete and its auxiliary mechanisms, which will be addressed in this item. That is, a beam, even without stirrups, has the ability to resist a certain shear force. Macgregor (1997) [11] shows the contribution of the various components of the shear strength mechanisms of unreinforced beams, except for the component relating to the arc effect, as shown in Figure 1. When the beam is stressed, the shear is transferred through the ABC line by the concrete strength mechanisms: uncracked concrete (V_{cy}), aggregate meshing (V_a) and longitudinal reinforcement pegging (V_d). Immediately after the bending cracks are inclined, between 40% and 60% of the total shear strength is resisted by the joint work of V_d and V_{cy} . Considering the DEF part of the fissured structure and assuming the moments with respect to point E, we have that V_d and V_a cause momentum with respect to point E, which must be balanced by the compressive force $C'1$. The equilibrium of the horizontal resultant in the ABDE section shows that $T1 = C1 + C'1$, and finally, $T1 = C1 + C'1$ should balance the external momentum of this section. As the diagonal crack progresses,

the plot decreases, V_a increasing the fraction resisted by V_{cy} and V_d . The dowel, V_d leads to the separation of the concrete along the reinforcement. When the crack occurs, it falls, approaching zero. When V_a and V_d disappear, then V_{cy} and C1 causes the result of all the shear and compression to be transmitted to the AB depth above the crack. At this point in the life of the structure, the AB section being too shallow, will not withstand the compressive forces required for balance. As a result this section crushes upwards, bringing no resistance to the stress. Collins et. al (2008) [12] present a review analysis of 60 years of research on the behavior of short reinforced concrete beams without stirrups, where it was concluded that the largest portion of shear strength is not found in the characteristic strength of concrete, but is affected by the dimensions of the structural element, the meshing of the aggregates and the pin effect of the longitudinal reinforcement. According to ACI-ASCE (1973) [13], for reinforced concrete structures subjected to shear stresses, the portion of strength due to concrete is the sum of several mechanisms capable of transmitting forces between sections, such as:

Aggregate interlock: this mechanism occurs between the two surfaces caused by a crack. The contribution of aggregate meshing to shear strength depends on crack opening and surface roughness;

Arching action: this mechanism occurs more expressively in beams with reduced spans due to the accommodation of compressive stresses in the arc and the intensity of these stresses depends mainly on the inclination of the arc, being directly linked to the a/d ratio, that is, the lower the value of the shear span a (short beams), the greater the arc effect;

Cantilever action: this mechanism occurs in uncracked sections of the beam (between two consecutive cracks) or in non-cracked parts of cracked elements (compression zone of a cracked section);

Dowel action-effect: Longitudinal reinforcement resists a portion of the displacement caused by shear force due to the pin effect on the bar. The pin force on the longitudinal reinforcement bar depends on the stiffness of the bar at the intersection with the crack.

2.3 PROPERTIES OF CRFA IN THE HARDENED STATE

Ductility, toughness and post-crack residual strength are some of the advantages of CRFA, compared to simple concrete. The distinct behavior between these materials can be attributed to the fiber-concrete interaction that develops at the time of crack formation. At this time, there is a transfer of forces between the concrete and the fibers. To explain this mechanism of stress transfer, Garcez (2005) [14] shows in Figure 2 that, after the occurrence of a crack (phase 5), the transfer of forces occurs by friction, and this frictional stress is

distributed at the fiber-concrete interface. For stress levels higher than the formation of a crack, the displacement of the fibers occurs (phase 4) and the process of tearing the fibers from the concrete mass begins (phase 2). At this moment, the effort for the fiber to be pulled out is high, which justifies the tenacity of CRFA. When the stress intensifies, the crack opening increases and the fibers begin to act as stress transfer bridges (phase 3) until their total pullout or rupture (phase 1 and 2, respectively).

2.4 FIBER-REINFORCED BEAMS AND SLABS

According to Hazrina et al (2017) [15], concrete reinforced with steel fibers with fiber consumption (C_f) of 1%, can fully replace conventional reinforcements, both bending and shear, with a load capacity practically equal to slabs with reinforcement. For Arslan (2014) [16], in concrete beams reinforced with steel fibers, the control of cracking resulting from normal stress is more effective compared to simple concrete, as the fibers provide greater rigidity after the onset of cracking. According to Macgregor and Whigt (2012) [17], steel fibers tend to increase the shear capacity by ensuring a tensile strength of the concrete along the inclined crack, resulting in an increase in the aggregate mesh component, similar to that observed in beams with transverse reinforcement. According to KWAK et al (2002) [18], the use of steel fiber-reinforced concrete in beams increases the shear strength, and the rupture, which is usually brittle, can be suppressed in favor of a ductile rupture. As previously mentioned, steel fibers help to form tension bridges that perform a greater distribution of forces, helping as a mechanism that slows down the propagation of cracks in concrete, providing greater bearing capacity (Dinh et al., 2010) [19].

To formulate the equilibrium condition for a steel fiber-reinforced, unstirruped, reinforced concrete beam, Lim and Oh (1999) [20] showed what is required to identify all the external and internal actions that may be present on the face of the inclined crack. The shear forces are transmitted through the following plots: effect of the uncracked concrete of the compressed region (V_c), effect of the meshing between the aggregates along the diagonal crack (V_a), pin effect of the longitudinal reinforcement that crosses this crack (V_d) and vertical components of the pullout force of the fibers along the inclined crack (V_f).

3 NORMATIVE RECOMMENDATIONS

3.1 NBR 6118 (2023)

According to the Brazilian standard, unidirectional ribbed slabs must be calculated according to the direction of the ribs, disregarding the transverse stiffness and torsional stiffness, this standard does not bring prescriptions for the calculation of slabs manufactured

with CRFA. NBR 6118 [3] prescribes that for ribbed slabs with spacing (l_0) between rib axes less than or equal to 650 mm, the verification of the bending of the table may be waived, and for the verification of the shear of the rib region, the consideration of the slab criteria (Equation 1) is allowed, in relation to the term (σ_{CP}), this was equated to zero since the tested slabs were not subjected to preloads or compressive stresses perpendicular to the cross-section. For slabs with rib axis spacing between 650 mm and 110 mm, the bending of the table is required, and the ribs must be checked for shear as beams, checking the tensile diagonal, (Equation 2). For the two equations, the weighting coefficient of concrete (γ_c) was not used, and the values of concrete, tensile and compressive strength were those found in the characterization tests, (f_c) and (f_t) presented in Table 1, aiming at the comparison between the equations and the experimental results.

$$V_{Rd} = [\tau_{Rd} \cdot k \cdot (1,2 + 40 \cdot \rho_l) + 0,15 \cdot \sigma_{CP}] \cdot b_w \cdot d \quad \text{Equation 1}$$

$$V_{Rd} = V_{c0} = 0,6 \cdot f_{ctd} \cdot b_w \cdot d \quad \text{Equation 2}$$

$$\rho_l = \frac{A_{sl}}{b_w \cdot d} \leq 0,02 \quad \text{Equation 3}$$

$$k = (1,6 - d) \geq 1 \quad \text{Equation 4}$$

$$f_{ctk,inf} = 0,7 \cdot f_{ct,m} \quad \text{Equation 5}$$

$$f_{ct,m} = 0,3 \cdot f_{ck}^{2/3} \quad \text{Equation 6}$$

$$f_{ct,d} = \frac{f_{ctk,inf}}{\gamma_c} \quad \text{Equation 7}$$

$$\tau_{Rd} = 0,25 \cdot f_{ct,d} \quad \text{Equation 8}$$

Where as:

f_c : Compressive strength of concrete;

f_t : Tensile strength of concrete;

f_{ck} : Characteristic compressive strength of concrete;

V_{Rd} : Calculation resistant shear force;

V_{c0} : Reference value for the portion of shear force resisted by the concrete;

ρ_l : Geometric longitudinal reinforcement rate of tensile;

τ_{Rd} : Shear stress resistant calculation;

f_{ctd} : Tensile strength of concrete;

σ_{CP} : initial stress in the concrete at the level of the barycenter of the prestressing reinforcement, due to the simultaneous prestressing of n cables;

γ_c : Weighting coefficient of the strength of concrete;

$f_{ctk,inf}$ Characteristic tensile strength of concrete with the lower value;

$f_{ct,m}$: Average tensile strength of concrete ($f_{ct,m} = f_t$);

A_{st} : Area of longitudinal tensile reinforcement;

k : Coefficient related to longitudinal tensile reinforcement;

b_w : Minimum width of the section along the usable height d .

3.2 ACI 318 (2014)

According to ACI 318 [1], the shear strength of unidirectional ribbed slabs of unshear reinforced concrete is based on the average shear stress of the effective cross-sectional surface $b_w \cdot d$ and the pin effect. For the calculation of beams without shear reinforcement, we have that $V_u = V_c$ according to Equation 8 and the shear strength can be expressed by Equation 9.

$$V_u = V_c \quad \text{Equation 8}$$

$$V_c = 0,16 \cdot \lambda \cdot \left(\sqrt{f'_c} + 17 \cdot \rho_w \right) \cdot b_w \cdot d \quad \text{Equation 9}$$

Where as:

V_c : Resistance to the shear force absorbed by the concrete in N.mm;

V_u : Shear effort requested last in N.mm;

f'_c : Compressive strength of concrete in Mpa;

ρ_w : Longitudinal reinforcement ratio ($\rho_w = \rho_l$);

λ : Stress modification factor in concrete (normal mass concrete $\lambda=1$)

3.3 EHE 08 (2010)

According to the Spanish standard EHE 08 [2], the shear strength of unreinforced concrete parts to shear (V_{u2}) is expressed by equation 10, where (V_{cu}) is estimated by equation 11 and the quantities (f_{cv}) and (ε) are estimated by equations 12 and 13, respectively. (V_{fu}) is the portion of strength absorbed by the steel fibers, calculated according to equation 9, the parameter (f_{R3}) is obtained with equation 29, in relation to equations 14, 15 and 16 the weighting coefficient (γ_c) was not used (γ_c) in the calculation of ($f_{R3,d}$) and in (f_{cv}) experimental values presented in table 3 were used, in order to compare the results of the equations to the results obtained in the experimental tests. f_{cv}

$$V_{u2} = V_{cu} + V_{fu} \quad \text{Equation 10}$$

$$V_{cu} = \frac{0,18}{\gamma_c} \cdot \varepsilon \cdot \left((100 \cdot \rho_l \cdot f_{cv})^{1/3} + 0,15 \cdot \sigma_{cp} \right) \cdot b_w \cdot d$$

$$\geq 0,75 \cdot \varepsilon^{2/3} \cdot f_{cv}^{1/2} \cdot b_w$$

Equation 11

$$f_{cv} = \min(f_{ck}; 60)$$

Equation 12

$$\varepsilon = \left(1 + \sqrt{\frac{200}{d}} \right) \leq 2$$

Equation 13

$$V_{fu} = 0,7 \cdot \varepsilon \cdot \tau_{fd} \cdot b_w \cdot d$$

Equation 14

$$\tau_{f,d} = 0,5 \cdot f_{ctR,d}$$

Equation 15

$$f_{ctR,d} = 0,33 \cdot f_{R3,d}$$

Equation 16

Where as:

V_{cu} : Contribution of concrete shear strength;

V_{fu} : Contribution of strength of steel fibers;

f_{cv} : Calculation resistance to shear stress ($f_{cv} = f_c$);

ε : Relative deformation along the height of the section (scale factor);

τ_{fd} : Calculation value of the increase in shear strength due to the reinforcement of steel fibers;

$f_{ctR,d}$: Calculation of the residual tensile strength of CRFA;

$f_{R3,d}$: Calculation value of the residual tensile strength of the CRFA at the flexion corresponding to the crack opening of 2.5 mm.

3.4 CEB-FIP MODEL CODE (2010)

The CEB-FIP Model Code (MC10) is a document produced in collaboration with 41 countries, with the main objective of serving as a basis for future codes and presenting new developments regarding concrete materials and structures, in order to achieve optimal behavior, based on performance requirements.

3.4.1 Shear Strength (V_R)

The shear strength ($V_{Rd,f}$) of concrete parts not reinforced to shear and reinforced with steel fibers is established as a function ($V_{Rd,f}$) as shown in equation 17, where (f_{Fts}) defined by equation 18, (f_{Fts}) according to equation 19 and (f_{ctk}) according to equation 20. The estimated strength of non-fiber-reinforced concrete was estimated by equation 21 and the

parameters (k_v) and (k_{dg}) were estimated by equations 22 and 23, respectively. For all equations, the test values referring to the resistant characteristics of the concrete and the weighting coefficient γ_c were discarded in order to compare these equations with the experimental results presented in Table 4.

$$V_{Rd,f} = \left\{ \frac{0,18}{\gamma_c} \cdot k \cdot \left[100 \cdot \rho \cdot \left(1 + 7,5 \cdot \frac{f_{Ftuk}}{f_{ctk}} \right) \cdot f_{ck} \right]^{1/3} + 0,15 \cdot \sigma_{CP} \right\} \cdot b_w \cdot d$$

$$\geq 0,035 \cdot k^{1,5} \cdot f_{CK}^{0,5} \cdot b_w \cdot d$$

Equation 17

$$f_{Ftuk} = f_{Fts} - \frac{1,5}{2,5} \cdot (f_{Fts} - 0,5 \cdot f_{R3} + 0,2 \cdot f_{R1}) \geq 0$$

Equation 18

$$f_{Fts} = 0,45 \cdot f_{R1}$$

Equation 19

$$f_{ctk} = 2 \cdot \ln \left(1 + \frac{f_{CK}}{10} \right)$$

Equation 20

$$V_R = K_V \cdot \frac{\sqrt{f_{ck}}}{\gamma_c} \cdot z \cdot b_w$$

Equation 21

$$k_v = \frac{0,4}{1 + 1500 \cdot \varepsilon_x} \cdot \frac{1300}{1000 + k_{dg} \cdot z}$$

Equation 22

$$k_{dg} = \frac{32}{16 + d_g} \geq 0,75$$

Equation 23

Where as:

$V_{Rd,f}$: Shear strength of fiber-reinforced concrete;

f_{Ftuk} : Characteristic value of ultimate residual tensile strength for CRFA;

f_{ctk} : Characteristic value of tensile strength for fiberless concrete;

f_{Fts} : Residual resistance in the service limit state;

f_{R1} : Calculation value of the residual tensile strength of the CRFA at the flexion corresponding to the crack opening of 0.5 mm;

ε_x : Deformation in the center of the vein;

z : Lever arm between the traction armature and the compression block;

d_g : Maximum aggregate diameter.

3.4.2 Flexural Strength

To determine the value of (M_R), the inflection model of (MC10) [4] was used. In this model, the contribution of steel fibers is given by (f_{Ftu}), which is calculated by equation 13. As shown in Figure 3, the quantities (F) and (y) are, respectively, the resulting forces and

their respective lever arms and, define the compression block, establish the values for the parameters $\lambda = 0,8$ and $\eta = 1$ for $f_c \leq 58 \text{ MPa}$.

Regarding the distribution of the strains, it is assumed that (ε_{cu}) is equal to $3.5\text{‰}\varepsilon_{cu}$, but it is observed that $(\varepsilon_{t,bot})$ should not be greater than (ε_{fu}) , estimated by equation 24. Admitting (S_{rm}) according to equation 27 leads to satisfactory answers. In this context, Table 5 presents a summary of the interactive process, as a function of the neutral line, after establishing the compatibility of the deformations and the equilibrium of the resulting forces ($\Sigma F \approx 0$).

$$\varepsilon_{fu} = \frac{w_u}{l_{cs}} \quad \text{Equation 24}$$

$$w_u = 2,5 \text{ mm} \quad \text{Equation 25}$$

$$l_{cs} = \min(y; S_{rm}) \quad \text{Equation 26}$$

$$S_{rm} = \frac{d}{2} \quad \text{Equation 27}$$

Where as:

Where as:

M_R : Moment resistant;

a : Shear span value;

ε_{fu} : Strain of non-metalic reinforcement at maximum force in tension;

l_{cs} Refers to the characteristic structural length;

w_u : Represents the maximum permissible crack opening;

S_{rm} : Value of the average distance between cracks;

y Represents the distance from the neutral line to the most tensile fiber of the section;

ε_{cu} : Maximum deformation in compressed concrete;

$\varepsilon_{t,bot}$: : Deformation in the most tensile fiber of the section.

4 EXPERIMENTAL PROGRAM

4.1 CHARACTERISTICS OF SLABS

Tests were carried out on 8 panels of unidirectional ribbed slabs of reinforced concrete until failure, without the presence of anti-shear reinforcement in the ribs. The slabs were divided into 2 groups of 4 slabs each, in which group C30 (Reinforced Concrete Slab) was composed of four panels of 1,700 mm in length, with variations in the distance between the rib axes (l_0) of 550 mm, 650 mm, 750 mm and 850 mm and the CRFA group (Fiber-Steel Reinforced Concrete Slab), composed of four slabs with the same variation as the previous group, but containing steel fiber in the concrete, as shown in Table 1. All slabs had a

thickness of 40 mm for the layer and ribs with a cross-section of (100 x 100) mm², leaving them with a total height of 140 mm (Figures 4 and 5).

The concrete cover adopted for all reinforcements was 20 mm. All panels have the same arrangements for the reinforcements, consisting of 2Ø12.5 mm in the ribs, at a useful height of 113.8 mm, resulting in a 2.06% reinforcement rate and with ratio $a/d = 3,08$, and with bars of 5 mm diameter to combat the bending of the tables. Shear reinforcement was not used in the ribs in order to quantify the contribution of the spacing between the ribs and steel fibers to the shear strength. To avoid localized crushing of the concrete due to the concentration of stresses in the regions of support and application of the load, it was decided to reinforce these locations using stirrups 2Ø6.3 mm in diameter and 100 mm apart from each other in the region of the supports and points of application of the load, figures 4 and 5 show the arrangements of the reinforcements. Figure 6 shows the steel fiber used in the reinforcement of the CRFA slabs, which was the Crimped type (Harvest W-LCS/50/75W) with a length (l_f) of 38 mm and equivalent diameter (d_f) of 1.28 mm, characteristics determined according to NBR 15530 [21], and tensile strength limit of 800 MPa.

With regard to the compressive strength of the concrete (f_c), MPa was adopted and the concreting of the slabs was carried out with concrete made in situ, together with the addition of steel fiber, requiring an approximate volume of 1 m³ to mold the slabs and the specimens. Figure 7 shows the stages of making the ribbed slabs.

4.2 INSTRUMENTATION

The instrumentation aimed to record the behavior of the slabs for later comparison, in order to identify the influence of the steel fibers on the shear performance and define the failure modes. For this purpose, the displacements and deformations in the reinforcements and concrete were monitored, in addition to the mapping of the cracks.

4.2.1 Displacements

The vertical displacements (deflects) were measured using 2 DIGIMESS dial indicators, with a maximum reading stroke of 50 mm and a precision of 0.01 mm, positioned in the middle of the span, spaced from one rib to the other and in contact with the upper surface of the slabs. In the lower part of the slab, near the center, an LVDT (Linear Variable Differential Transformer) of the DCTH3000A type, manufactured by the company RDP Electrosense, with a linear displacement of ±75 mm, positioned with the help of a magnetic support fixed to the reaction beam of the test frame, was used. Figure 8 shows the positioning of the indicator clocks.

4.2.2 Concrete surface

To measure the deformations in the concrete, 8 electric resistance extensometers (EER) were used, manufactured by the company EXCEL SENSORES, model PA-06-201BA-120L, one for each slab, fixed to the upper surface of the concrete, just above one of the ribs, in the middle of the span of these, and later connected to the data acquisition equipment (ALMEMO model). Such positioning is justified by the fact that it is the region of maximum bending moment, that is, the region of maximum compressive stress of the concrete. The positioning of the extensometers on the concrete surface is shown in Figure 8.

4.2.3 Bending Armor

The instrumentation of the flexural reinforcement was carried out by means of 8 electric resistance extensometers (EER), manufactured by the company EXCEL SENSORES, model PA-06-125AA-120L, which were fixed to one of the flexural reinforcement bars and in the middle of the span of a rib of each slab, as shown in Figure 8. Again, this position is justified by the fact that it is the region of maximum bending moment where the flow of the tensile reinforcements occurs.

4.3 TEST SYSTEM

The test system was mounted on a reaction slab and aimed at the response of the structure to the distributed loading, applied transversely to the ribs. Thus, the slabs were supported on rollers on metal beams, supporting the load applied perpendicular to the ribs (horizontal direction), on the upper face of the panel, through a bi-supported metal profile used for load distribution. The application of the loading took place through a manually operated hydraulic cylinder with a capacity of 1000 kN, connected to a hydraulic pump, and the recording of the loading intensity was carried out with the aid of a load cell with a capacity of 1000 kN and an accuracy of 1 kN connected to a digital display. The loads were established by 5 kN load steps.

The strain readings were obtained using a modular data acquisition system ALMEMO ®5690-2 m, from Ahlborn, compatible with the AMRWinControl software, which read the strain gauges positioned on the steel and concrete. Load increment intervals of 5 kN were used for each data collection, as well as for the proper reading of extensometers, indicator clocks and crack marking, in order to achieve a satisfactory number of readings aiming at the execution of the graphs that will represent the behavior of the slabs. Figure 9 shows details of the test system.

5 RESULTS

5.1 MATERIALS

The mechanical properties of the concrete were determined from compressive strength (f_c), tensile strength (f_t) by diametrical compression and modulus of elasticity (E_c) tests, according to the standards NBR 5739 [22], NBR 7222 [23] and NBR 8522 [24], respectively. The results presented in Table 2 are the average for 3 cylindrical specimens tested for each slab at their respective ages.

The characteristics of tensile steel were obtained through standardized tests and a normal distribution curve. Three 600 mm long specimens were extracted for the tensile tests, all from the same batch, with 12.5 mm diameter (CA-50), in order to determine the mechanical properties of the steel, such as yield stress (f_{ys}) equal to 570 MPa, rupture stress (f_u) equal to 687 MPa, yield strain (ε_{ys}) equal to 2.33 and modulus of elasticity (E_s) of 244.6 GPa.

Regarding steel fibers, the proposal by Moraes Neto et al. (2013) [25] to estimate the values of residual stresses ($f_{Ri}=1, 3$ and 4), used in the estimates of the load capacity of the slabs and this relates the fiber consumption (C_f) with the product between the fiber length (l_f) and the diameter (d_f) as follows:

$$f_{R1} = 7,5 \cdot \left(C_f \cdot \frac{l_f}{d_f}\right)^{0,8} \quad \text{Equation 28}$$

$$f_{R3} = 6,0 \cdot \left(C_f \cdot \frac{l_f}{d_f}\right)^{0,7} \quad \text{Equation 29}$$

5.2 DISPLACEMENTS

The indicator clocks were distributed in the middle of the rib span and the cover, in order to compare the behavior of the slabs due to the variation in the spacing between the ribs. Figure 10 shows the graph of the vertical displacements observed in the slabs. There was a greater displacement, until failure, in the CRFA-reinforced slabs compared to the C30 class slabs, on average 37% of increase, and this increase in ductility is explained by the crack control caused by the interaction of the fiber with the concrete. The displacement graphs also show an increase in stiffness provided by the increase in the modulus of elasticity of CRFA concrete.

5.3 CONCRETE DEFORMATIONS

It was decided to measure only the deformations in the rib region and the L1 and L6 slabs were the ones that presented the highest deformations, $1.1‰$ ($\varepsilon_{c,max}$), indicating that there was no concrete crushing in any of the slabs, as shown in Table 3.

5.4 BENDING REINFORCEMENT DEFORMATIONS

The highest deformations were recorded for the slabs with higher failure loads, all reinforced with CRFA (L6, L7 and L8), probably due to the increase in ductility of the concrete, generating greater displacements. The L8 slab showed a maximum deformation of $2.69‰$ ($\varepsilon_{s,max}$) in the flexural reinforcement, reaching the yield ($2.33‰$), being the only one to flow. Figure 11 shows the maximum deformations in the bending reinforcements for all slabs.

5.5 CRACKING PATTERN

The cracking pattern was similar for all slabs, where the beginning occurred with cracking in the center of the layers towards the ribs. In the ribs, inclined shear cracks occurred in the region of the supports, which configured the imminence of shear failure, and the rupture surface extended to the layer, leading to the collapse of the slab.

On the upper surface of the slab there was a longitudinal cracking pattern at the meeting between the layer and the rib, and in some slabs this crack reached the cross-section of the rib. This cracking on the upper surface is predicted by the standards for ribbed slabs with a wheelbase (l_0) above 650 mm, however, below this normative value there is no recommendation for analysis, and the layers of the L1 and L5 slabs presented this cracking parallel to the ribs excessively. The cracking patterns of the ribs of the slabs are shown in Figure 12. These veins showed a higher degree of cracking than the layers and were where the ruptures occurred.

5.6 ULTIMATE LOADS AND BURST MODES

The tested ribbed slabs reached failure with loads (P_u) of 116 kN, 95 kN, 91 kN, 107 kN, 118 kN, 140 kN, 178 kN and 186 kN for slabs L1 to L8 respectively, as shown in Figure 13. Based on previous studies carried out with ribbed slabs, the relevant influence of the screed stiffness on the shear strength of ribbed slabs was perceived, as already evidenced by Souza et al. (2014) [26].

There was a proportionality between the use of CRFA, with the distance between the ribs (l_0) and the increase in the ultimate breaking load, demonstrating that there was a

considerable gain in strength even without transverse reinforcement. All slabs failed by shear without showing yield of the rib flexural reinforcement, with the exception of L8. The value of the ultimate bending load (P_{FLEX}) was 176 kN, estimated by the CEB-FIP standard (MC10) [4], according to the interactive process presented in table 5, only the L7 and L8 slabs presented rupture loads (P_u) with values close to (P_{FLEX}), for the other slabs the values of the rupture loads (P_u), were lower than (P_{FLEX}), ratifying the observed failure mode. Table 3 presents the observed rupture modes and the relationship between P_{FLEX}/P_u .

5.7 COMPARISON BETWEEN EXPERIMENTAL AND ESTIMATED RESULTS

Table 4 presents the last experimental loads and estimated by the standards ACI 318 [1], EHE 08 [2], NBR 6118 [3] and MC10 [4] for shear strength (V_U), all standards, were used to estimate the strength of slabs made with concrete of class C30 and presented conservative results with regard to shear, on average, the results of NBR 6118 [3] were 40% lower than the experimental results and the results estimated by ACI 318 [1] were more conservative with results on average, 56% lower, compared to the experimental results. In the estimates of the slabs made with CRFA, the EHE 08 [2] and CEB-FIB MC [4] standards were used and the results were also conservative and reduced the shear strength on average, 41% when comparing the experimental results to the EHE 08 standard [2] and 39% when compared to the results estimated by the MC [4]. In the slabs reinforced with CRFA, the differences between the estimates and the experimental results were even more conservative when analyzing the slabs with greater distances between the ribs (l_0), that is, with a larger cover area, especially L8, whose experimental result was 99% higher than that estimated by EHE 08 [2].

6 CONCLUSIONS

The results of this study lead to the conclusion that the slabs executed with conventional concrete followed the pattern of higher strength for the smallest distances between ribs (l_0), and the explanation is that for the higher spacing between ribs there were greater vertical displacements of the layers, twisting the ribs and shortening the shear failure. For the slabs reinforced with CRFA, it was observed that all of them presented a gain in shear strength, and this phenomenon occurred due to the reinforcement with CRFA increasing the stiffness of the layer and the contribution of the residual stress of CRFA in the fight against cracking, minimizing the effects of torsion on the ribs. The layers with CRFA contributed to the shear strength more effectively than the layers made of C30 class concrete. None of the slabs reached the conventional deformation limit of the normative

flexural rupture concrete of 3.5%. On the upper surface of all slabs there was a cracking pattern at the layer-rib abutment, corroborating the normative prescriptions for verification of the flexural layer in ribbed slabs with excessive distance between the ribs. All the analyzed standards estimated shear strengths lower than the results found experimentally, underestimating these results by up to 60% by ACI 318 [1] and 50% by EHE 08 [2] for slabs without and with CFRA, respectively.

ACKNOWLEDGMENTS

The authors thank IPEAM for the financial support in all stages of the work.

REFERENCES

- Alves, M. M. D. S. (2017). Potencial biotecnológico de bactérias e leveduras isoladas da casca do coco-verde (*Cocos nucifera*) em fermentação (Tese de Doutorado). Instituto de Química e Biotecnologia, Universidade Federal de Alagoas, Maceió.
- Anagnostakis, S. L., & Hankin, L. (1975). Use of selective media to detect enzyme production by microorganisms in food products. *Journal of Milk and Food Technology*, 38(10), 570–572.
- Barbosa, P. M. G., et al. (2020). Leveduras selvagens isoladas do caldo de cana com perfil para a produção de enzimas. *Revista da Universidade Vale do Rio Verde*, 17(2).
- Bonfim, F. S. (2014). Diversidade de leveduras endofíticas em plantas medicinais (Dissertação de Mestrado). Universidade Federal de Pernambuco, Recife.
- Borzani, W., et al. (2001). *Biotecnologia industrial* (v. 2). São Paulo: Edgard Blücher.
- Buzzini, P., & Martini, A. (2002). Extracellular enzymatic activity profiles in yeast and yeast-like strains isolated from tropical environments. *Journal of Applied Microbiology*, 93(6), 1020–1025.
- Cattelan, A. J. (1999). Métodos quantitativos para a determinação de características bioquímicas e fisiológicas associadas com bactérias promotoras de crescimento vegetal (36 p.). Londrina: Embrapa Soja.
- Ceska, M. (1971). Enzyme catalysis of solidified media. *European Journal of Biochemistry*, 22(2), 186–192.
- Chaplin, M. F., & Bucke, C. (1992). *Enzyme technology*. Cambridge: Cambridge University Press.
- Cordeiro, C. A. M., Martins, M. L. L., & Luciano, A. B. (2002). Produção e propriedades da alfa-amilase do termofílico *Bacillus* sp. *Revista Brasileira de Microbiologia*, 33, 57–61.

- Couto, F. M. M. (2008). Leveduras produtoras de β -glicosidase e pectinase (Dissertação de Mestrado). Universidade Federal de Pernambuco, Recife.
- Farinas, C. S. (2011). A parede celular vegetal e as enzimas envolvidas na sua degradação (13 p.). São Carlos: Embrapa Instrumentação.
- Gupta, R., et al. (2003). Microbial α -amylases: A biotechnological perspective. *Process Biochemistry*, 38(11), 1599–1616.
- Hankin, L., & Anagnostakis, S. L. (1975). The use of solid media for detection of enzyme production by fungi. *Mycologia*, 67(3), 597–607.
- Jay, J. M. (1992). *Microbiologia moderna dos alimentos* (3ª ed.). Zaragoza: Acribia.
- Koelsch, G., et al. (2000). Enzymic characteristics of secreted aspartic proteases of *Candida albicans*. *Biochimica et Biophysica Acta*, 1480(1–2), 117–131.
- Kumar, A., et al. (2023). Industrial applications of fungal lipases: A review. *Frontiers in Microbiology*, 14, 1142536. <https://doi.org/10.3389/fmicb.2023.1142536>
- Kurtzman, C. P., & Fell, J. W. (Eds.). (1998). *The yeasts: A taxonomic study* (4ª ed., rev. and enl., v. 1). Amsterdam: Elsevier.
- Lin, J. E., Chang, D. C. N., & Shen, G. J. (1991). Correlations among several screening methods used for identifying wood-decay fungi that can degrade toxic chemicals. *Biotechnology Techniques*, 5(5), 275–280.
- Machado, M. A. A. (2015). Isolamento e seleção de leveduras para produção de enzimas de interesse industrial a partir de frutos do Cerrado (Dissertação de Mestrado em Biotecnologia). Universidade Católica Dom Bosco, Campo Grande.
- Maijala, P., Fagerstedt, K. V., & Raudaskoski, M. (1991). Detection of extracellular cellulolytic and proteolytic activity in ectomycorrhizal fungi and *Heterobasidion annosum*. *New Phytologist*, 117(4), 643–648.
- Melo, W. G. P., et al. (2019). Interações simbióticas entre microrganismos e insetos. *RG News*, 5(1), 48–56.
- Moreira, F. M. S., & Siqueira, J. O. (2006). *Microbiologia e bioquímica do solo* (2ª ed., v. 1). Lavras: UFLA.
- Motta, J. F. G., et al. (2023). Use of enzymes in the food industry: A review. *Food Science and Technology*, 43, e106222. <https://doi.org/10.1590/fst.106222>
- Oliveira, A. N. D., et al. (2006). Enzimas hidrolíticas extracelulares de isolados de rizóbia nativos da Amazônia Central. *Ciência e Tecnologia de Alimentos*, 26(4), 853–860.
- Peixoto, A. B. (2006). Estudo da produção de enzimas e gomas por leveduras selvagens coletadas em diversas regiões do Brasil (Dissertação de Mestrado). Universidade Estadual de Campinas, Campinas.

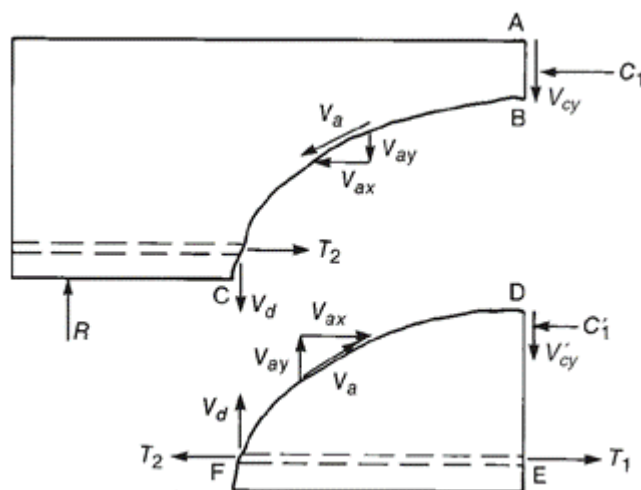
- Raju, E. V. N., & Divakar, G. (2013). Screening and isolation of pectinase producing bacteria from various regions of Bangalore. *International Journal of Pharmaceutical and Biomedical Research*, 4(1), 151–154.
- Ribeiro Júnior, J. C. (2015). Isolamento e identificação da microbiota esporulada e fúngica associada à deterioração do leite (Dissertação de Mestrado em Ciência Animal). Universidade Estadual de Londrina, Londrina.
- Rodarte, M. P. (2005). Atividade proteolítica de bactérias, leveduras e fungos isolados dos frutos e grãos de café (*Coffea arabica* L.) (Dissertação de Mestrado). Universidade Federal de Lavras, Lavras.
- Santos, T. T., et al. (2019). The digestive tract of *Phylloicus* (Trichoptera: Calamoceratidae) harbours different yeast taxa in Cerrado streams, Brazil. *Symbiosis*, 77(2), 147–160. <https://doi.org/10.1007/s13199-018-0577-9>
- Silva, B. N., et al. (2023). Fungi from the body surface of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) and bioassay of insecticidal activity. *Observatorio de la Economía Latinoamericana*, 21(9), 13647–13671. <https://doi.org/10.55905/oelv21n9-170>
- Silva, E. M., et al. (2024). Investigation of the presence and enzymatic activity of fungi in stored corn (*Zea mays* L.) and soybean (*Glycine max* (L.) Merrill) grains. *Caderno Pedagógico*, 21(4), 1–21. <https://doi.org/10.54033/cadpedv21n4-062>
- Sohail, M., et al. (2022). Cellulolytic and xylanolytic enzymes from yeasts: Properties and industrial applications. *Molecules*, 27(12), 3783. <https://doi.org/10.3390/molecules27123783>
- Spencer, J. F., & Spencer, D. M. (1996). Maintenance and culture of yeasts. *Methods in Molecular Biology*, 53, 5–15.
- Spier, M. R. (2005). Produção de enzimas amilolíticas fúngicas α -amilase e amiloglucosidase por fermentação (Dissertação de Mestrado). Universidade Federal do Paraná, Curitiba.
- Stamford, T. L. M., Araújo, J. M., & Stamford, N. P. (1998). Atividade enzimática de microrganismos isolados do jacatupé (*Pachyrhizus erosus* L. Urban). *Ciência e Tecnologia de Alimentos*, 18(4).
- Strauss, M. L. A., et al. (2001). Screening for the production of extracellular hydrolytic enzymes by non-Saccharomyces wine yeasts. *Journal of Applied Microbiology*, 91(1), 182–190.
- Sukmawati, D., et al. (2023). The potential of cellulolytic yeast *Pichia manshurica* UNJCC Y-123, *Saccharomyces cerevisiae* UNJCC Y-84, and *Saccharomyces cerevisiae* UNJCC Y-83 to produce cellulase enzyme. *Trends in Sciences*, 20(10), 1–15. <https://doi.org/10.48048/tis.2023.6950>
- Tavafi, H., et al. (2017). Screening of alginate lyase-producing bacteria and optimization of medium composition for extracellular production. *Iranian Biomedical Journal*, 21(1), 48–56.

- Teixeira, M. F. N. P., Souza, C. R., & Morais, P. B. (2022). Diversity and enzymatic capabilities of fungi associated with the digestive tract of larval stages of a shredder insect in Cerrado and Amazon Forest, Brazil. *Brazilian Journal of Biology*, 82, e260039.
- Wanderley, K. J., et al. (2004). Caracterização bioquímica da α -amilase da levedura *Cryptococcus flavus*. *FEMS Microbiology Letters*, 231(2), 165–169.
- Zaky, A. S., et al. (2014). Marine yeast isolation and industrial application. *FEMS Yeast Research*, 14(6), 813–825. <https://doi.org/10.1111/1567-1364.12158>

APPENDIX

Figure 1

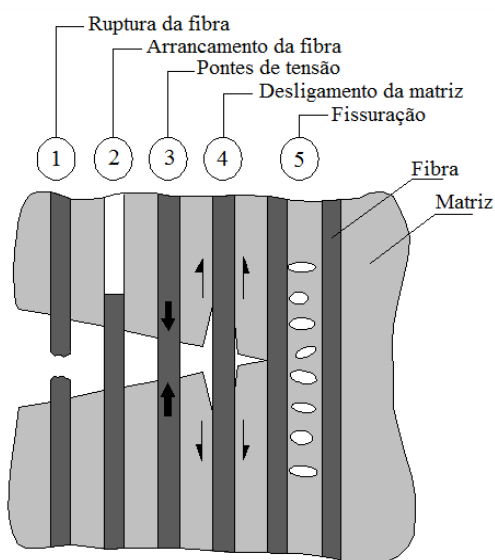
Forces acting on an inclined crack



Source: MACGREGOR, 1997.

Figure 2

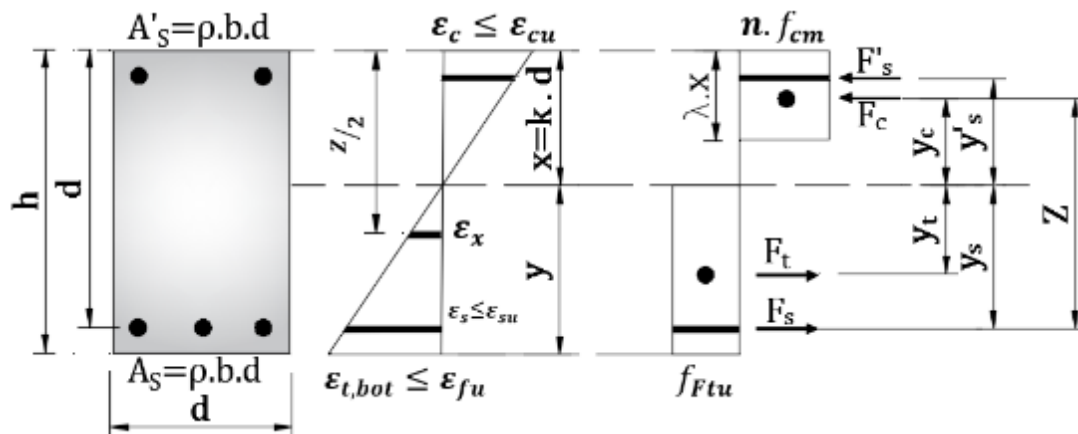
Effort transfer mechanism



Source: adapted from GARCEZ, 2005.

Figure 3

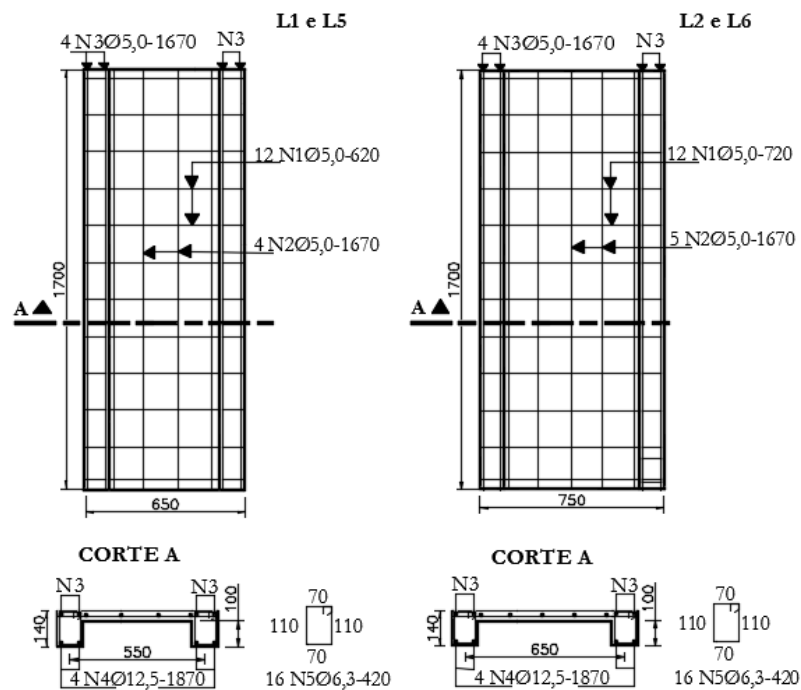
Flexion model of the CEB-FIP Model Code (2010)

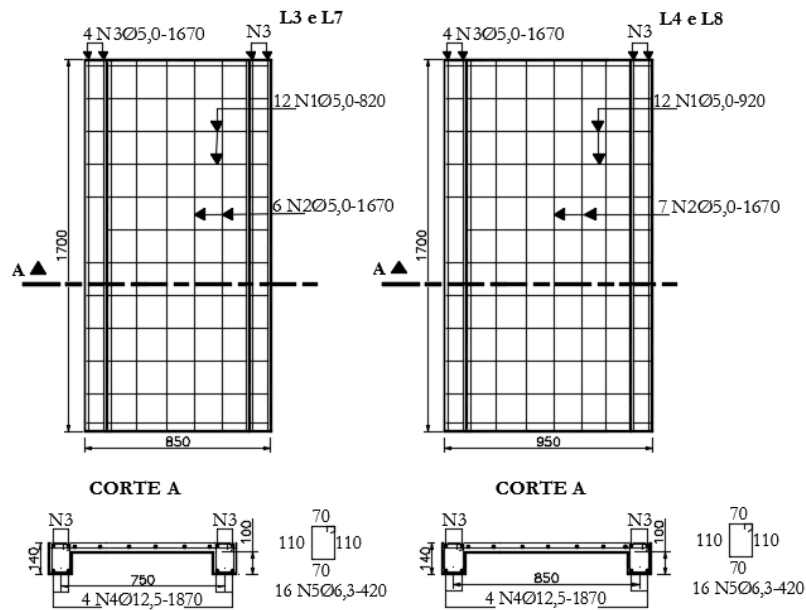


Source: CEB-FIP Model Code (2010).

Figure 4

Reinforcement of the slabs

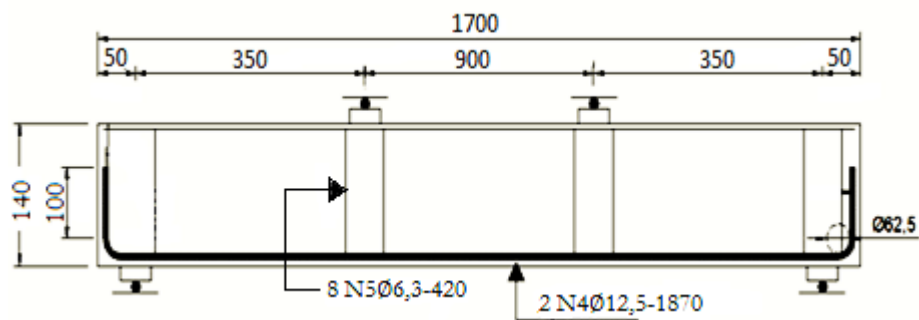




Source: The authors.

Figure 5

Rib reinforcements



Source: The authors.

Figure 6

Crimped fiber used in CRFA



Source: The authors.

Figure 7

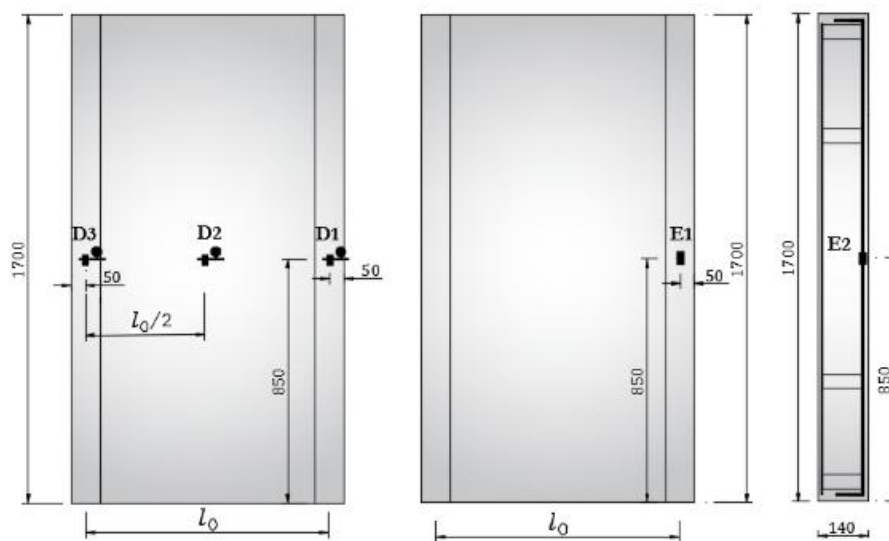
a) Arrangement for concreting b) Execution of the reinforcement, c) Regularization of the surface, d) Regularized surface



Source: The authors.

Figure 8

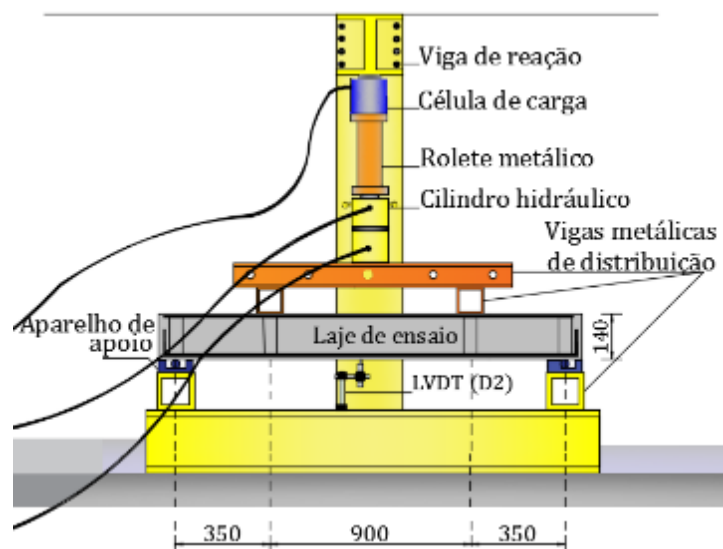
Position of the indicator clocks (D1 to D3) and extensometers on the covers (E1) and reinforcement of the ribs (E2) of the slabs



Source: The authors.

Figure 9

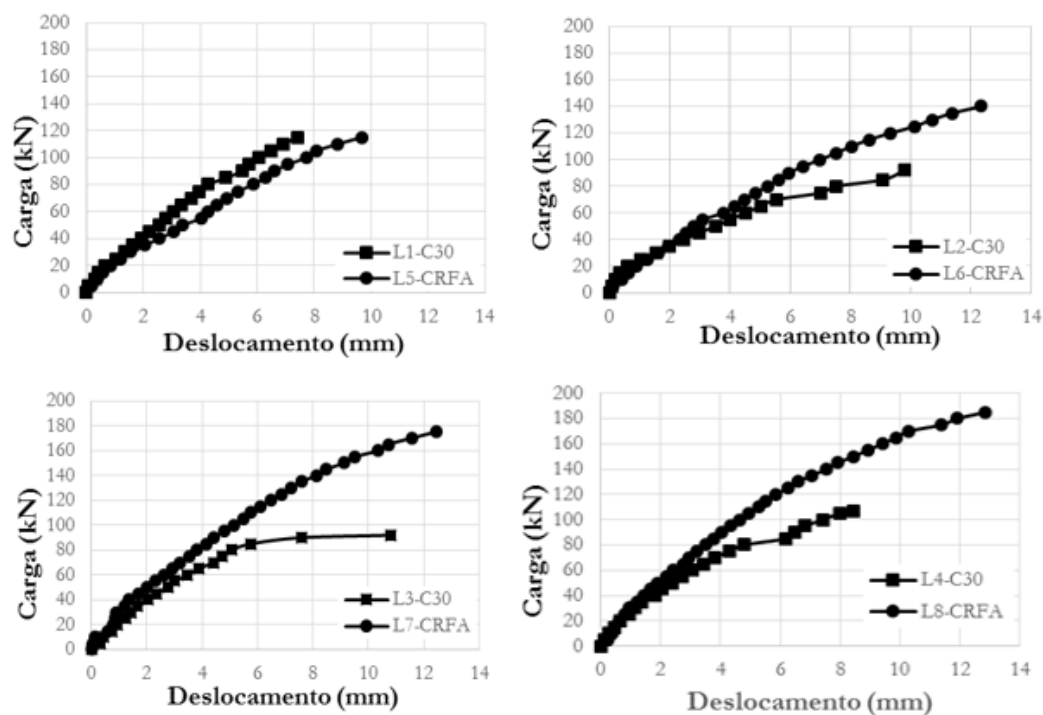
Details of the test system



Source: The authors.

Figure 10

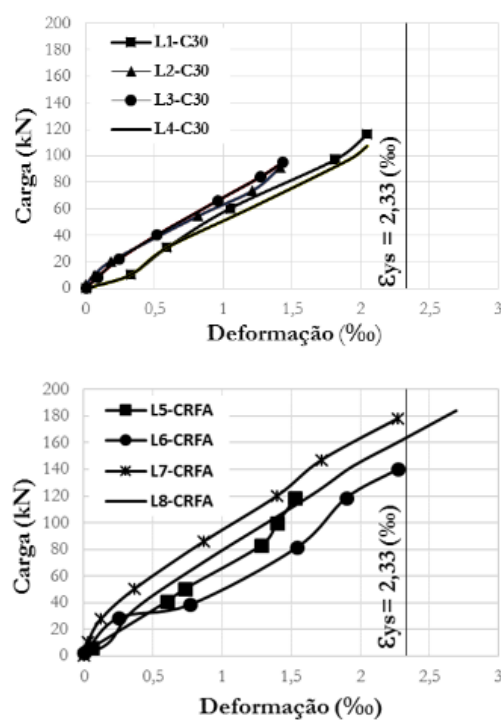
Maximum vertical displacements of the slabs



Source: Elaboration by the author (2020).

Figure 11

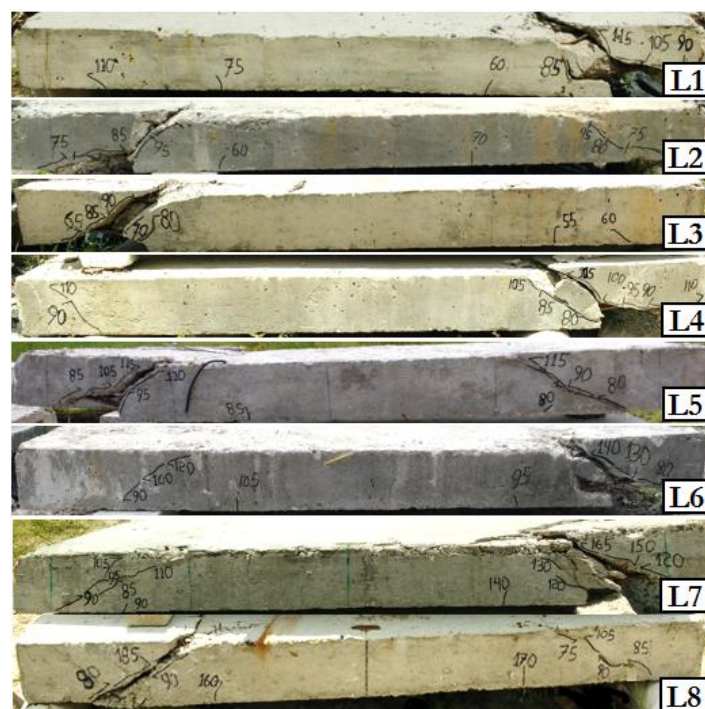
Deformations in the bending reinforcements of the ribs



Source: Elaboration by the author (2020).

Figure 12

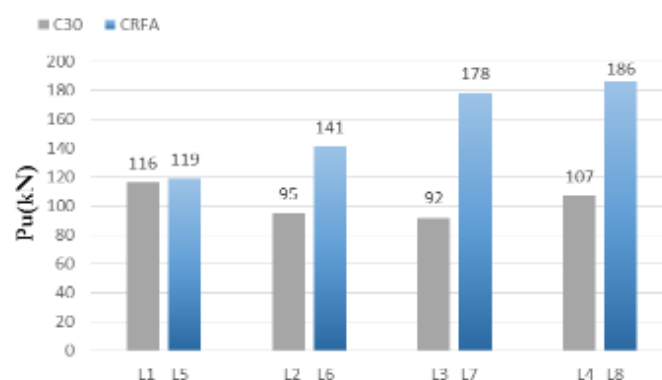
Appearance of the ribbed slabs after the tests



Source: The authors.

Figure 13

Breaking loads



Source: Elaboration by the author (2020).

Table 1

Characteristics of the slabs

Slab	l_0 (mm)	Group	f_c (MPa)
L1	550	C30	30
L2	650		28
L3	750		27
L4	850		31
L5	550	CRFA 1%	33
L6	650		33
L7	750		33
L8	850		32

Source: Elaboration by the author (2020).

Table 2

Mechanical properties of concrete.

Slab	Age (Days)	f_c (MPa)	f_t (MPa)	E_c (GPa)
L1	54	30,0	2,9	19,1
L2	49	28,0	2,8	18,4
L3	64	27,0	2,8	19,4
L4	60	31,0	3,0	19,4
L5	56	31,0	3,1	20,3
L6	70	32,0	3,2	21,8
L7	68	33,0	3,4	23,2
L8	74	33,0	3,7	24,9

Source: Elaboration by the author (2020).

Table 3
Loads and failure modes of the slabs

Slab	l_0 (mm)	Group	$\varepsilon_{s,max}$ (‰)	$\varepsilon_{c,max}$ (‰)	P_u (kN)	P_{FLEX}/P_u	Burst mode
L1	550	C30	2,02	1,10	116,1	1,52	Ribbed shear.
L2	650		1,41	0,33	95,0	1,85	
L3	750		1,43	0,26	91,8	1,92	
L4	850		2,04	0,55	107,5	1,64	
L5	550	CRFA 1%	1,84	0,32	118,8	1,48	
L6	650		2,27	1,10	140,4	1,25	
L7	750		2,28	0,48	178,7	0,98	
L8	850		2,69	0,59	186,3	0,94	

Source: Elaboration by the author (2020).

Table 4
Estimated and experimental last loads

Slab	l_0 (mm)	Group	P_u (kN)	P_{NBR} (kN)	P_{ACI} (kN)	P_{EHE} (kN)	P_{CEB} (kN)	$\frac{P_u}{P_{NBR}}$ (kN)	$\frac{P_u}{P_{ACI}}$ (kN)	$\frac{P_u}{P_{EHE}}$ (kN)	$\frac{P_u}{P_{CEB}}$ (kN)
L1	550	C30	116,1	70,8	46,2	64,1	69,5	1,64	2,51	1,81	1,67
L2	650		95	66,0	44,7	62,7	67,2	1,44	2,12	1,51	1,41
L3	750		91,8	53,5	44,1	61,9	66,0	1,71	2,08	1,48	1,39
L4	850		107,5	57,3	47,1	64,8	66,7	1,87	2,28	1,65	1,61
L5	550	CRFA 1%	118,8			92,2	96,0			1,28	1,23
L6	650		140,4			92,9	96,0			1,51	1,46
L7	750		178,7			92,9	96,0			1,92	1,86
L8	850		186,3			93,6	96,0			1,99	1,94

Source: Elaboration by the author (2020).

Table 5
Flexural strength

x (mm)	27,40
z	102,79
ε_c (‰)	3,50
ε_{fu} (‰)	43,96
ε_s (‰)	11,03
ε'_s (‰)	1,18
f_{ftu} (MPa)	0,71
f_s (MPa)	570,00

f'_s (MPa)	248,13
y_c (mm)	16,44
y_t (mm)	56,30
y_s (mm)	86,35
y'_s (mm)	9,25
F_c (kN)	328,80
F_t (kN)	16,08
F_s (kN)	280,4
F'_s (kN)	31,0
ΣF	0,00
m_R (kN. mm)	30,8
P_{FLEX} (kN)	175,8

Source: Elaboration by the author (2020).

NATIONAL PUBLIC POLICIES FOR MICRO AND SMALL ENTERPRISES: MARKET ACCESS AND THE PROMOTION OF INTEGRATIVE POLICIES BETWEEN THE STATE AND CITIZENS

AS POLÍTICAS PÚBLICAS NACIONAIS VOLTADAS ÀS MICRO E PEQUENAS EMPRESAS: ACESSO AOS MERCADOS E O FOMENTO ÀS POLÍTICAS AGREGADORAS ENTRE ESTADO E CIDADÃO

POLÍTICAS PÚBLICAS NACIONALES ORIENTADAS A LAS MICRO Y PEQUEÑAS EMPRESAS: ACCESO A LOS MERCADOS Y EL FOMENTO DE POLÍTICAS INTEGRADORAS ENTRE EL ESTADO Y EL CIUDADANO



<https://doi.org/10.56238/sevened2026.008-246>

Graziela Fernanda Bonato¹, Acácia Sayuri Wakasugi²

ABSTRACT

Micro and small enterprises (MSEs) represent 99% of formal businesses in Brazil and play a central role in economic and social development. However, access to markets, especially public markets, remains a structural challenge. This study investigates the association between the formalization of MSEs and their participation in public service procurement processes conducted within the Banrisul System during the first quarter of 2025, the first full cycle under Law No. 14,133/2021. The research adopts a mixed-methods approach, including documentary analysis of bidding notices and contracts, collection of secondary data (CNPJ and tax registries), and the application of questionnaires and interviews with entrepreneurs and managers. The methodological design is descriptive-correlational, with no intention of inferring causality. It is expected that the prospect of supplying to the State acts as an incentive for formalization, particularly in the service sector, which is characterized by high levels of informality. Preliminary results suggest a concentration of newly established firms close to the dates of bidding processes, indicating a relevant correlation between public procurement and entry into the formal market. It is concluded that the effectiveness of the policy depends not only on the legal framework but also on the institutional capacity of subnational entities and the mediating role of SEBRAE.

Keywords: Public Policies. Micro and Small Enterprises. Government Procurement. Formalization. Local Development.

RESUMO

As micro e pequenas empresas (MPes) representam 99% das empresas formais no Brasil e desempenham papel central no desenvolvimento econômico e social. Contudo, o acesso a mercados, especialmente ao mercado público, permanece como desafio estrutural. Este estudo investiga a associação entre a formalização de MPes e sua participação em licitações públicas de serviços realizadas no Sistema Banrisul, no primeiro trimestre de 2025, primeiro

¹ Master's degree. Universidade Federal do Rio Grande do Sul (UFRGS).

E-mail: grazielafernandabonato@gmail.com

² Master's degree. Universidad de Morón. E-mail: acacia@wakasugi.com.br

ciclo completo de vigência da Lei nº 14.133/2021. A pesquisa adota abordagem mista, com análise documental de editais e contratos, levantamento de dados secundários (CNPJ e cadastros fiscais) e aplicação de questionários e entrevistas a empreendedores e gestores. O desenho metodológico é descritivo-correlacional, sem pretensão de inferir causalidade. A expectativa é que a perspectiva de fornecimento ao Estado atue como incentivo à formalização, sobretudo no setor de serviços, marcado por alta informalidade. Os resultados preliminares sugerem concentração de empresas recém-constituídas próximas às datas de certames, apontando correlação relevante entre licitações e ingresso no mercado formal. Conclui-se que a efetividade da política depende não apenas do marco legal, mas da capacidade institucional dos entes subnacionais e do papel de mediação do SEBRAE.

Palavras-chave: Políticas Públicas. Micro e Pequenas Empresas. Compras Governamentais. Formalização. Desenvolvimento Local.

RESUMEN

Las micro y pequeñas empresas (MPEs) representan el 99% de las empresas formales en Brasil y desempeñan un papel central en el desarrollo económico y social. Sin embargo, el acceso a los mercados, especialmente al mercado público, sigue siendo un desafío estructural. Este estudio investiga la asociación entre la formalización de las MPEs y su participación en licitaciones públicas de servicios realizadas en el Sistema Banrisul durante el primer trimestre de 2025, primer ciclo completo de vigencia de la Ley nº 14.133/2021. La investigación adopta un enfoque mixto, que incluye análisis documental de pliegos y contratos, levantamiento de datos secundarios (CNPJ y registros fiscales) y la aplicación de cuestionarios y entrevistas a emprendedores y gestores. El diseño metodológico es descriptivo-correlacional, sin pretensión de inferir causalidad. Se espera que la perspectiva de proveer al Estado actúe como incentivo para la formalización, especialmente en el sector de servicios, caracterizado por altos niveles de informalidad. Los resultados preliminares sugieren una concentración de empresas de reciente creación próximas a las fechas de los procesos de licitación, lo que indica una correlación relevante entre las compras públicas y la entrada al mercado formal. Se concluye que la efectividad de la política depende no solo del marco legal, sino también de la capacidad institucional de las entidades subnacionales y del papel de mediación del SEBRAE.

Palabras clave: Políticas Públicas. Micro y Pequeñas Empresas. Compras Públicas. Formalización. Desarrollo Local.

1 INTRODUCTION

The Brazilian productive structure is marked by contrasts: large conglomerates and an immense base of micro and small enterprises (MSEs) coexist. According to SEBRAE (2023), MSEs account for about 99% of formal establishments, 52% of formal jobs, and 30% of GDP. It's not just numbers: they are businesses that irrigate neighborhoods and municipalities, give opportunity to those who undertake with few resources and move local networks of suppliers, services and work.

Access to markets, however, remains a bottleneck. The Sebrae ecosystem indicates that the services sector concentrated most of the new openings in 2024, which helps explain why informality weighs so heavily in this segment. In simple terms: where there are many small ones, there is more vulnerability. According to official data from the IBGE, the informality rate in Brazil reached 38.6% in the 4th quarter of 2024 — a clear sign of fragile productive insertion, which limits growth trajectories and the reach of public policies.

In this scenario, the State is not only a regulator: it buys, hires and can induce transformations. The 1988 Constitution (art. 170) ties economic development to social justice. In the same direction, Complementary Law No. 123/2006 consolidated the favored treatment of MSEs, and Law No. 14,133/2021 redesigned the bidding regime, making the application of pro-MPE provisions mandatory and opening space for contracting more aligned with local and sustainable development.

This is where this research is situated: to investigate whether there was an association between participation in public bids for services and the formalization of MSEs with up to one year of incorporation in Banrisul's Procurement System, in the first quarter of 2025. The time frame is opportune because it coincides with the first full cycle of mandatory validity of the new law, offering a more stable regulatory environment to observe the initial effects. The focus on services is justified both by the high presence of small businesses and by the greater exposure to informality.

The academic contribution is twofold. First, it delivers recent evidence, under a new legal framework, on a topic in which normative diagnoses predominate, but there is a lack of fine empirical readings. Second, it helps to illuminate informality as a structural problem of Brazilian development, connecting it to concrete instruments of economic induction. Finally, it intends to offer practical inputs to managers, control bodies and development institutions, bringing theory and public policy closer together.

It is important to clarify the evaluative scope: it is not an "impact assessment". In the light of Ramos and Schabbach (2012), the study configures an evaluation of results (ex post), of a descriptive-correlational nature, aimed at identifying associations, without the intention

of inferring causality. The evidence will be built by triangulation between documents (notices, minutes, contracts), administrative databases (CNPJ/Revenue) and primary data (questionnaires and interviews).

General objective: to analyze the existence of an association between participation in public procurement and the formalization of service SMEs at Banrisul. Specific objectives: to profile winners up to one year old; understand motivations for formalization; identify institutional and regulatory barriers to access; and to examine the support role of SEBRAE-RS.

2 SMES AND PUBLIC POLICIES ON MARKET ACCESS

Micro and small enterprises (MSEs) are protagonists of contemporary economies not only due to their quantitative expressiveness, but also due to their qualitative relevance with regard to the generation of employment, income and territorial dynamism. In Brazil, according to SEBRAE (2023), they represent more than 99% of formal enterprises, account for about 30% of the Gross Domestic Product (GDP), and are responsible for 52% of formal jobs. In terms of capillarity, they are present in practically all municipalities, which gives them a strategic role in territorial cohesion.

Despite their economic and social centrality, MSEs face a persistent set of obstacles to accessing formal markets — whether private or public. Among the main obstacles are low financial capacity, difficulty in accessing credit, insufficient human capital, bureaucratic complexity, and information asymmetries. This set of factors reinforces a circle of vulnerability that often pushes entrepreneurs into informality, perpetuating low levels of productivity.

In this context, public policies aimed at MSEs gain prominence. Cassiolato and Lastres (2003) point out that the State can act as a coordinating agent, using instruments to promote demand — such as government purchases — to induce desirable economic behaviors, including formalization, innovation and increased productivity. This perspective is part of the so-called "new institutional economics", which emphasizes the role of legal and institutional arrangements in shaping economic trajectories.

The Brazilian trajectory of policies aimed at MSEs has gone through different phases. Barreto (2011) argues that, initially, the emphasis was on tax regulation, as a way of simplifying and reducing the tax burden. Subsequently, there was an expansion to credit policies, training and debureaucratization. The creation of the National Statute of Micro and Small Enterprises (Complementary Law No. 123/2006) marked the consolidation of a transversal legal regime, which forced the Union, states and municipalities to grant differentiated treatment to MSEs.

In the specific field of market access, LC No. 123/2006 established innovative instruments: exclusivity in bids of up to R\$ 80 thousand, reserved quotas of up to 25% in divisible items, priority in case of a tie and the possibility of subcontracting by larger companies. According to Araújo Júnior (2018), such provisions represented a paradigmatic milestone, as they transformed public procurement into a policy of productive inclusion, linking differential treatment to the strengthening of the local business base.

However, the simple normative design does not ensure automatic results. Cabral, Reis and Sampaio (2015) highlight that the effective participation of MSEs depends on factors such as the simplicity of the public notices, the technical training of entrepreneurs, the clarity of the judgment criteria and the active performance of development agencies. Often, the distance between the norm and practical reality results in low effectiveness.

This gap is reinforced by cultural factors. A survey by the Getulio Vargas Foundation (FGV, 2020) revealed that many entrepreneurs perceive public procurement as a restricted space, marked by clientelism or favoring large suppliers. This perception discourages the participation of MSEs and increases the transaction cost for those who decide to compete.

In addition to the operational and cultural obstacles, the Brazilian federative complexity must be considered. As Abrucio (2005) and Pires and Gomide (2014) point out, the capacity to implement policies varies between states and municipalities. This means that the same legal provision can generate different results depending on the institutional context, administrative capacity and the level of articulation with support institutions, such as SEBRAE.

Another relevant point is the insertion of market access policies in the public policy cycle. According to the analysis model proposed by Souza (2006), policies go through phases of formulation, implementation and evaluation. In the case of policies for MSEs, the formulation advanced significantly with the enactment of LC No. 123/2006 and Law No. 14,133/2021. Implementation, however, encounters resistance and practical limitations, requiring greater attention to the evaluation phase to verify the effectiveness of the mechanisms.

The international literature also contributes to the analysis. In European Union countries, *procurement* policies have been used to promote sustainable development goals, innovation, and gender equity (ARROWSMITH; KUNZLIK, 2009). In the United States, the *Small Business Act* establishes mandatory percentages of participation of small companies in federal public contracts. These experiences demonstrate that public procurement can be powerful instruments, as long as it is accompanied by consistent institutional arrangements.

In Brazil, the implementation of similar instruments faces obstacles related to the

administrative culture and the conservatism of the control bodies, which often prioritize strict formal legality to the detriment of the social function of purchases (FARAH; MARQUES, 2017). This tension between legality and development is central to understanding the limits of market access policy.

In this sense, it is essential to observe that the success of public policy does not depend exclusively on the existence of a robust normative framework, but on the State's ability to promote complementary actions of support, training and interinstitutional articulation. As Ansell and Gash (2008) point out, the co-production of public policies requires mutual trust, institutional learning, and effective dialogue channels between government and civil society.

In the light of these reflections, it is hypothesized that access to public markets can act as a factor to stimulate formalization, especially when there is synergy between legal provisions and training and technical support policies. The present research seeks precisely to explore this hypothesis, examining the case of Rio Grande do Sul through the Banrisul System, which brings together in a centralized digital platform bids from various subnational public entities.

3 PUBLIC PROCUREMENT AS AN INSTRUMENT OF PRODUCTIVE INCLUSION

The State's role as an economic agent goes beyond its regulatory or collection function. When it mobilizes public resources to acquire goods and services, the State exercises power of induction over markets, production chains and business behavior. This purchasing power, called *public procurement* in the international literature, is increasingly recognized as a strategic instrument of public policy (McCRUDDEN, 2004).

In Brazil, government purchases move approximately 12% of the Gross Domestic Product (GDP), according to data from the Ministry of Economy (BRASIL, 2022). This means that the State, when acquiring products and services, not only meets its administrative needs, but can also direct demand in order to stimulate strategic sectors, reduce regional inequalities and foster the formalization of entrepreneurs.

3.1 THE ROLE OF PUBLIC PROCUREMENT IN ECONOMIC DEVELOPMENT

Historically, bidding was conceived as a mechanism to ensure efficiency and isonomy in the use of public resources, with an almost exclusive focus on the criterion of the lowest price. However, in recent decades, several countries have been attributing broader social and economic purposes to public procurement. According to Arrowsmith (2010), the evolution of *procurement standards* in the European Union demonstrates that the State can use its

purchasing power to induce technological innovation, promote environmental sustainability and expand the inclusion of vulnerable groups in the labor market.

In the United States, the *Small Business Act* establishes goals for the participation of small businesses in federal contracts, creating a protected market for this segment. A similar experience occurs in Chile, where the ChileCompra system reserves part of government purchases for local micro and small companies, stimulating territorial development. These examples show that *procurement* can be treated as a tool of industrial policy, and not just as an administrative process.

3.2 PUBLIC PROCUREMENT AND PRODUCTIVE INCLUSION OF MSEs

In the Brazilian context, the inclusion of micro and small companies in government procurement gained strength from Complementary Law No. 123/2006. The mechanisms provided for in Chapter V — exclusivity in contracts of up to R\$ 80 thousand, reserve quotas, tie-breaking criteria and subcontracting — were designed to reduce entry barriers and ensure greater competitiveness for MSEs.

Silva, Reis and Mello (2019) demonstrate that the probability of formalization among small service providers increases significantly when they identify concrete opportunities to supply the State. The requirement of tax and labor regularity for qualification in the competitions works as a direct incentive to formalization. At the same time, the potential for stable and larger contracts increases the attractiveness of leaving informality.

However, the effectiveness of this process is not automatic. As Oliveira (2021) points out, subnational entities do not always fully internalize the provisions of LC No. 123/2006 in their regulations, and many public notices continue to reproduce disproportionate requirements — such as minimum share capital or proof of high previous experience. This generates indirect exclusion of MSEs, even though the legislation provides for differentiated treatment.

3.3 THE BRAZILIAN CASE: ADVANCES AND LIMITATIONS

The new Law No. 14,133/2021 reaffirmed the favored treatment of MSEs and incorporated sustainable development and planning into hiring. Article 11, IV, determines that bids promote sustainable national development, making room for social, environmental and territorial criteria in the selection of suppliers. Despite this, obstacles remain. According to IPEA (2023), the participation of MSEs is hampered by disproportionate requirements (certificates and financial proofs), technicality and hermetic language of the notices, low training of auctioneers and managers — who, fearing accountability, adopt conservative

models — and fragile institutional articulation, with little dialogue between contracting bodies, SEBRAE and associations. Together, these barriers raise the cost of entry, reduce the competitiveness of small businesses, and weaken the inclusive function of public procurement, limiting results even with a robust framework.

3.4 THE BANRISUL SYSTEM AND THE EXPERIENCE OF RIO GRANDE DO SUL

In Rio Grande do Sul, Banrisul operates the Banrisul Online Auction platform, which centralizes bids for services and goods from city halls, municipalities and state agencies. In 2024, the system held more than 3 thousand bids in the service sector, moving significant amounts and increasing the transparency of processes (BANRISUL, 2025).

Electronic centralization brings advantages such as standardization, greater publicity, and reduced transaction costs. At the same time, it facilitates the empirical analysis of the participation of MSEs, since the data is concentrated in a single portal. For small entrepreneurs, however, there are still barriers related to the difficulty of interpreting the notices and gathering all the required documentation.

This context makes the case of Rio Grande do Sul especially interesting for analysis. On the one hand, there is a consolidated technological system, capable of democratizing access to information; on the other hand, institutional and cultural challenges remain that limit effective productive inclusion.

3.5 PUBLIC PROCUREMENT AND TERRITORIAL DEVELOPMENT

The literature on local development reinforces that public procurement can act as instruments for the territorialization of public policies. Marques and Faria (2015) argue that, by directing part of the acquisitions to local suppliers, the State contributes to creating virtuous cycles of income circulation, job creation and strengthening of the regional productive base.

In this sense, government purchases should not be seen only as supply mechanisms, but as public policies endowed with intentionality. This perspective brings the analysis closer to the field of democratic governance and the co-production of policies, highlighted by Osborne (2006), in which different actors — State, market and civil society — collaborate in the production of complex public goods.

In view of the above, it is understood that public procurement is a powerful instrument of productive inclusion, whose effectiveness, however, depends on the articulation of three inseparable dimensions. The first is the normative framework, ensured by LC No. 123/2006 and reaffirmed by Law No. 14,133/2021, which establishes legal bases for the differential treatment of MSEs and authorizes the strategic use of the State's purchasing power. The

second concerns the institutional capacity of the implementing entities, responsible for translating the legal provisions into accessible practices — from the planning and drafting of the public notices to the conduct of the bids and the contractual management. The third dimension involves the complementary performance of support institutions, with emphasis on SEBRAE, which trains, guides and reduces information asymmetries between potential suppliers and the public administration.

The proposed research observes precisely how these three layers are combined in the context of the Banrisul System, verifying to what extent the perspective of supplying the State has worked as an inducer of the formalization of newly constituted service companies. In other words, it seeks to identify whether the legal framework, local administrative capacity, and institutional support converge to transform normative opportunities into concrete results of economic inclusion.

4 LEGAL FRAMEWORK: LC NO. 123/2006 AND LAW NO. 14,133/2021

The institutionalization of differential treatment for micro and small enterprises (MSEs) in Brazil did not occur suddenly. It is the result of a historical process of political disputes, federative arrangements and changes in the understanding of the role of the State as an inducer of development. The most relevant milestone in this process is Complementary Law No. 123, of December 14, 2006, which established the National Statute of Micro and Small Enterprises. Subsequently, Law No. 14,133, of April 1, 2021, by replacing the former Law No. 8,666/1993, consolidated and expanded this regime, connecting it to a broader paradigm of sustainable development and contractual governance.

4.1 HISTORICAL BACKGROUND AND DISPUTES IN THE NATIONAL CONGRESS

The processing of LC No. 123/2006 reflected an environment of convergence between government sectors, parliamentarians and representative entities, such as SEBRAE and the Parliamentary Front for Micro and Small Enterprises. According to Nogueira (2010), there was strong pressure from business associations for the unification of the sparse legislation, which until then dealt with the issue in a fragmented way. The approved text sought not only to simplify the tax regime (with the Simples Nacional), but also to create instruments for access to credit and the market, including participation in public bids.

During the legislative debates, the perception that the State, as the largest buyer of the economy, had the duty to act as an agent of economic inclusion was highlighted. This understanding has gained strength due to the high rate of informality in the Brazilian labor market and the concentration of public contracts in large suppliers.

4.2 LAW NO. 14,133/2021 AND THE NEW PHASE OF THE CONTRACTING REGIME

The enactment of Law No. 14,133/2021 represented a structural change in the public procurement system. By repealing Law No. 8,666/1993, Law No. 10,520/2002 and part of the Differentiated Contracting Regime (RDC), it established a unified normative framework, closer to international best practices.

Chapter V of LC No. 123/2006 occupies a central position in this research because it concentrates the mechanisms of favoring micro and small enterprises (MSEs) in public procurement. Among these instruments, the exclusivity for contracts of up to R\$ 80 thousand (art. 48, I), which creates a protected competitive niche; reserved quotas of up to 25% of the object in divisible items (art. 48, III), which enable the participation of smaller companies in installments compatible with their scale; the tie-breaking criterion in favor of MSEs when their proposals are up to 10% above the best offer (art. 44), known as fictitious tie; and the compulsory subcontracting of MSEs in larger works and services (art. 48, § 3), a mechanism that integrates small suppliers into contracts of greater complexity.

Taken together, these provisions constitute affirmative actions of an economic nature (PEREIRA, 2015). Its logic is to reduce structural barriers to entry and correct competitive imbalances, while stimulating the formalization and insertion of SMEs in public supply chains. By reserving portions of the state market and making judgment criteria more flexible in situations of price equivalence, the law seeks to transform the State's purchasing power into a lever for local development and productive inclusion.

The effectiveness of these mechanisms, however, is not automatic and varies according to the adhesion and administrative capacity of the federative entities. A survey by the Federal Court of Auditors (Ruling No. 2,622/2013 – Plenary) pointed out that several public agencies failed to apply the benefits provided for in LC No. 123/2006 due to lack of knowledge, cultural resistance or fear of questioning by the control bodies. This diagnosis shows that the inclusive power of the legal framework depends on its internalization in regulations and public notices, as well as on the continuous training of auctioneers and procurement teams, in order to consolidate administrative routines aligned with the favored treatment and local development objectives.

4.3 TCU JURISPRUDENCE AND INTERPRETATION BY CONTROL BODIES

The Federal Court of Accounts has a fundamental role in the interpretative consolidation of the legislation. In decisions such as Ruling No. 1,214/2013 – Plenary, the TCU recognized the obligation to apply the rules of LC No. 123/2006, even when not explained in a public notice. More recently, in Ruling No. 2,731/2015 – Plenary, it reinforced

that the division of the object into smaller lots should not be seen as an illicit fractionation of the expense, but as a legitimate measure of inclusion of MSEs.

This interpretation is essential to provide legal certainty to public managers who are often reluctant to adopt differentiated measures for fear of liability. The case law of the TCU, by consolidating this understanding, contributes to disseminating more inclusive practices in subnational entities.

4.4 INTERNATIONAL COMPARISON: GOOD PRACTICES AND LIMITS

Comparing the Brazilian model to international experiences allows us to identify advances and gaps. In the United States, as mentioned, the *Small Business Act* establishes quantitative targets: at least 23% of federal contracts must be allocated to small businesses, with specific percentages for *women-owned* and *minority-owned businesses*. In the European Union, *Directive 2014/24/EU* explicitly encourages the division of contracts into lots, as a way to guarantee access to small and medium-sized enterprises.

Brazil has made progress in creating affirmative provisions in LC No. 123/2006, but it still lacks clear goals and robust monitoring mechanisms. The absence of national indicators makes it difficult to assess the real impact of public procurement on the formalization and survival of MSEs.

5 FORMALIZATION AND LOCAL ECONOMIC DEVELOPMENT

5.1 THE PHENOMENON OF INFORMALITY IN BRAZIL

Brazil has historically had high rates of informality in the labor market and in small enterprises. According to data from the Continuous PNAD/IBGE (2023), about 39% of the employed workforce works in informal conditions. In the business universe, studies by SEBRAE (2022) indicate that more than 25% of small businesses still operate without formal registration, especially in sectors such as street trading, personal services, and civil construction.

This informality stems from multiple factors: tax complexity, high compliance costs, absence of social and cultural guarantees and aversion to bureaucracy. As Hernando de Soto (2000) observes in his work *The Mystery of Capital*, informality is not the result of the irrationality of agents, but of institutional barriers that make formalization more costly than remaining on the sidelines.

5.2 INSTITUTIONS AND INCENTIVES FOR FORMALIZATION

The institutionalist approach of Douglass North (1990) helps to understand this

phenomenon. For the author, institutions – understood as "the rules of the game" that structure human interactions – determine transaction costs and influence the predictability of economic exchanges. In the Brazilian case, the institutions aimed at MSEs began to be redesigned from the 1988 Constitution and, above all, from LC No. 123/2006, which created tax incentives (Simples Nacional), credit and market.

Another fundamental point is that formalization is not restricted to legal registration. As Perry et al. (2007) point out, in *Informality: Exit and Exclusion*, informality can be both a voluntary exit of entrepreneurs who reject the costs of regulation ("exit"), and an involuntary exclusion due to lack of access to opportunities ("exclusion"). Public policies must, therefore, act on both levels: reduce entry costs and expand the concrete benefits of belonging to the formal regime.

5.3 PUBLIC PROCUREMENT AS A VECTOR OF FORMALIZATION

Government procurement plays a strategic role in this process. By requiring formal qualification (CNPJ, tax, labor and social security regularity), the State creates incentives for regularization.

The provision of exclusivity for bids of up to R\$ 80 thousand and quotas of up to 25% in larger objects enhances this effect, by opening doors to contracts compatible with the scale of MSEs.

In the case of Rio Grande do Sul, an exploratory analysis of the public base of Banrisul's Online Auction (own collection; April 2025) suggests that a significant portion of the participants had less than two years of incorporation. To ensure reproducibility and transparency, the consolidated values, the spreadsheet with the identification of the bids and the scraping script will be presented in a methodological appendix.

5.4 LOCAL ECONOMIC DEVELOPMENT AND PRODUCTIVE CHAINS

The effect of formalization goes beyond the individual entrepreneur. The presence of formalized MSEs in local supply chains strengthens regional economies, creates regular jobs and stimulates municipal tax collection.

The effect of formalization goes beyond the individual entrepreneur. The presence of formalized MSEs in local supply chains strengthens regional economies, creates regular jobs and stimulates municipal tax collection. Abramovay, Magalhães and Schröder (2008) emphasize that local development involves sustainable and inclusive productive chains.

In addition, public procurement policy can be designed to privilege suppliers from vulnerable territories, functioning as a mechanism to combat regional inequalities. This

strategy is particularly relevant in states with large internal disparities, such as Rio Grande do Sul, where the economic concentration in metropolitan regions contrasts with the fragility of small municipalities.

5.5 LIMITS AND CHALLENGES OF FORMALIZATION VIA PUBLIC PROCUREMENT

Despite the advances, there are limits to consider. First, formalization motivated exclusively by access to public contracts can result in short-term companies, created only to meet a specific demand and dissolved later. This turnover weakens the objective of consolidating sustainable business trajectories.

Second, the bureaucracy involved in participating in bids still represents a significant barrier, even with the advances of Law No. 14,133/2021. Small entrepreneurs often face difficulties in gathering clearance certificates, understanding public notices, and preparing competitive proposals.

Finally, there is the challenge of state capacity. Without trained technical teams and accessible digital systems, city halls – which concentrate a large part of small-value contracts – can turn the mechanisms of LC No. 123/2006 into a dead letter.

6 INSTITUTIONAL ANALYSIS: THE ROLE OF SEBRAE AND PUBLIC ADMINISTRATION

The effectiveness of public policies aimed at micro and small enterprises (MSEs) does not depend only on the existence of legal frameworks or normative provisions. Implementation requires institutional actors capable of translating such norms into concrete and accessible practices. Among these actors, the Brazilian Micro and Small Business Support Service (SEBRAE) and the public administration itself stand out, especially in its subnational dimension.

6.1 SEBRAE AS A SUPPORT AND DEVELOPMENT INSTITUTION

Since its creation in 1972, SEBRAE has consolidated itself as the main institution of technical, managerial and training support for micro and small entrepreneurs in Brazil. Its work goes beyond training and consulting: it involves political articulation, dissemination of good practices and support for the insertion of MSEs in production chains.

According to the institution's report (SEBRAE, 2023), more than 2 million entrepreneurs were served in qualification programs in the last three years. Many of these programs are directly linked to public procurement, such as the Brazil Purchase Program, which aims to train suppliers to participate in bids, reduce qualification failures and increase the competitiveness of local companies.

In addition, SEBRAE plays a strategic role in federative articulation, functioning as a bridge between the Union, states and municipalities. In many cases, the institution assists municipalities in the preparation of public notices that respect the prerogatives of LC No. 123/2006, which demonstrates its relevance in the decentralized implementation of the policy.

6.2 STATE CAPACITY AND SUBNATIONAL IMPLEMENTATION

The literature on public policies emphasizes the centrality of state capacity in implementation (Skocpol, 1985; Gomide and Pires, 2014). It is not enough for the State to legislate; It is necessary to have qualified bureaucracies, efficient digital systems, and an administrative culture focused on innovation.

In Brazil, the heterogeneity of municipal capacities represents one of the greatest challenges. While capitals and large cities have specialized technical teams, small municipalities face serious limitations in personnel and infrastructure. This asymmetry directly impacts the effectiveness of the mechanisms of LC No. 123/2006 and Law No. 14,133/2021.

A study by Pires and Gomide (2016) highlights that complex public policies, such as the access of MSEs to markets, require adaptive capacity, that is, the ability to adjust instruments to local realities without compromising the general objectives. In the case of public procurement, this means simplifying procedures, adopting accessible electronic auctions, and promoting training of civil servants.

Another relevant aspect is multilevel governance. The policy of support for MSEs is inscribed in a federative model in which the Union, states and municipalities share responsibilities. The Union, through national legislation and policies, establishes the general framework. States develop regional incentive programs and often offer digital bidding platforms. Municipalities, on the other hand, as the main contractors of small goods and services, are the privileged locus of implementation.

This arrangement creates coordination challenges. As Abrucio (2010) observes, federative fragmentation can compromise the effectiveness of national policies if there are no mechanisms for cooperation and institutional learning. In this sense, the role of SEBRAE and intermunicipal consortia becomes essential to reduce asymmetries and promote greater uniformity in the application of the rules.

6.3 CONTROL AND ACCOUNTABILITY BODIES

The institutional analysis must also consider the role of control bodies, such as Courts of Accounts and Public Prosecutors' Offices. These institutions influence the way public managers interpret and apply the provisions of LC No. 123/2006. Often, the fear of sanctions

leads to the adoption of conservative positions, which limit the use of mechanisms to favor MSEs.

Decisions by the Federal Court of Accounts (TCU) have reiterated the legality of reserved quotas and exclusivities for MSEs, reinforcing the importance of aligning control and promotion. However, there are cases in which divergent understandings in state courts of accounts generate legal uncertainty, especially in smaller municipalities.

6.4 CIVIL SOCIETY AND INTERMEDIARY ACTORS

The role of organized civil society, such as business associations, cooperatives and employers' unions, cannot be neglected. These actors act as intermediaries between entrepreneurs and public administration, organizing collective demands, pressing for greater simplification and, in many cases, enabling the fulfillment of contracts through cooperation networks.

An example of this are the cooperatives of family farmers, which, in several states, organize production and enable participation in school feeding programs. In these cases, shared governance expands the reach of public policies and strengthens the social fabric.

6.5 INSTITUTIONAL LIMITS AND CHALLENGES

Despite the existence of support institutions and a consistent legal framework, structural limitations persist that affect the effectiveness of the policy. The first is institutional fragmentation: the multiplicity of bodies with competences on the subject — at different federative levels — tends to produce overlapping efforts, coordination gaps, and dispersion of resources, weakening the strategic conduct of actions. Added to this is the unequal capacity between entities, as many municipalities, especially smaller ones, lack qualified technical teams and minimum infrastructure to plan contracts, prepare public notices accessible to MSEs and manage contracts efficiently.

In addition to these factors, there is dependence on external incentives, to the extent that a relevant part of the initiatives only advances when there is a contribution from federal programs, agreements or direct support from institutions such as SEBRAE – a sign of local institutional fragility and low sustainability of administrative routines. Finally, the legal uncertainty resulting from divergent interpretations of the control bodies discourages the adoption of pro-MPE mechanisms (such as division of the object into lots, quotas or subcontracting), reducing the willingness of managers to innovate and deepen the differentiated treatment provided for by law.

7 DIALOGUES WITH LITERATURE AND THEORETICAL CONTRIBUTIONS

The study of public policies aimed at micro and small enterprises (MSEs) gains analytical density when it dialogues with the literature that deals with both the formulation and implementation and the evaluation of policies. The access of SMEs to markets, via instruments such as government procurement, cannot be understood only as an economic phenomenon, but as the result of a complex political, institutional and social process.

7.1 IMPLEMENTATION OF PUBLIC POLICIES: FROM RATIONALITY LIMITED TO THE STREET

One of the landmarks of the literature is the work of Pressman and Wildavsky (1973), who introduce the perspective that implementation is not a mere stage subsequent to formulation, but a process subject to deviations, negotiations, and failures. This view is reinforced by Lipsky (1980), when analyzing street-level bureaucrats, whose discretion affects the concrete application of policy.

In the case of public procurement aimed at MSEs, local civil servants assume a similar role, as their interpretations of the legislation, qualification criteria and documentary requirements can facilitate or restrict the participation of small businesses. Thus, understanding politics requires analyzing the decision-making space of these actors, who are often invisible in the great normative plans.

7.2 PUBLIC POLICY CYCLE AND THE EVALUATION PHASE

The public policy cycle model, widely disseminated in the literature (Howlett, Ramesh and Perl, 2009), offers a useful analytical framework. Although criticized for its linear character, it allows us to highlight the evaluation phase, a moment in which the real effects of the policy are examined in comparison with its formal objectives.

In the case of LC No. 123/2006, almost two decades of validity allow us to question: was there in fact an expansion in the participation of MSEs in public bids? Has this inclusion resulted in local development and strengthening of formalized entrepreneurship? The Brazilian literature on policy evaluation (Ramos and Schabbach, 2012; Pires and Lotta, 2019) points out that it is precisely at this moment that the tensions between the institutional design and the results obtained are revealed.

7.3 FEDERALISM, COORDINATION AND TERRITORIAL INEQUALITIES

The insertion of MSEs in public markets cannot be dissociated from the Brazilian federative logic. As Abrucio (2010) and Souza (2005) discuss, federalism in Brazil is marked

by strong decentralization, but also by deep inequalities in institutional capacity between entities.

This federative asymmetry has a direct impact on the implementation of the policy: larger municipalities are able to structure electronic procurement departments, train civil servants and support local suppliers, while smaller cities are dependent on external arrangements, such as state platforms or the support of SEBRAE. Here, the literature on cooperative federalism is essential to understand the limits and possibilities of a national policy in an unequal context.

7.4 PRODUCTIVE DEVELOPMENT POLICIES AND THE INFORMAL ECONOMY

Another relevant field of dialogue is the literature on economic development and informal economics. Hernando de Soto (1987) argues that informality is not the result of entrepreneurial incapacity, but of institutional barriers that hinder formalization. Douglass North (1990), in turn, emphasizes the importance of institutions as rules of the game that shape economic incentives.

Applying these ideas to the case of Brazilian MSEs, it is observed that mechanisms such as simplified bids and reserved quotas function as institutional incentives for formalization, since only legally constituted companies can access these markets. In this sense, public policies for access to markets are not only for promotion, but also for institutional inclusion.

7.5 STATE CAPACITIES AND DEMOCRATIC GOVERNANCE

The literature on state capacities in Brazil (Gomide and Pires, 2014; Pires and Gomide, 2016) highlights the relevance of technical-administrative capacity and political capacity for the implementation of complex policies. Public procurement programs for MSEs require not only trained servers and functional digital systems, but also political support from managers who prioritize local development.

This discussion is connected to the debate on democratic governance in crisis contexts (Lavalle, 2011; Avritzer, 2019). Inclusive policies for small entrepreneurs have the potential to strengthen ties between the State and society, promoting democratic legitimacy. However, when poorly implemented, they can reinforce inequalities, benefiting only companies that already have a greater structure and capacity to compete.

7.6 THEORETICAL CONTRIBUTIONS OF THIS STUDY

The present work contributes to literature by proposing an integrated reading on three

analytical fronts. The first is the institutional dimension, which examines the legal framework and the role played by actors such as SEBRAE, control bodies and local governments, explaining how rules and organizational arrangements shape incentives and implementation routines. The second is the federative dimension, in which the asymmetries of capacity between subnational entities and the need for cooperation to reduce inequalities in execution and standardize inclusive practices in public procurement are considered. The third is the evaluation dimension, aimed at gauging the effectiveness of the policy based on the results observed in the access of MSEs to the competitions, bringing together normative design, administrative practice and empirical evidence.

By articulating these three dimensions, the study advances in relation to fragmented analyses and offers a more comprehensive look at the effectiveness of public policies aimed at MSEs, connecting legal foundations, implementation capacities and measurable results in the same explanatory framework.

8 METHODOLOGICAL PROCEDURES

The study adopts a descriptive-correlational design, with a mixed approach, to identify associations between participation in bids and formalization of MSEs, without causal pretension. The unit of analysis is bidding for services carried out/approved in Banrisul's Online Auction between 01/01/2025 and 03/31/2025. In the quantitative analysis, the following are used: (i) documents from the Banrisul Portal (notices, minutes, contracts, results, with URL and date of collection) for the object, modality, dates and list of participants/winners; (ii) CNPJ/Revenue (date of incorporation, legal nature, CNAE, municipality) with pairing routine; and (iii) certificates for binary indicators of tax/labor regularity. In the qualitative field, there is an intentional sampling of winning entrepreneurs with ≤ 1 year of CNPJ (stratification by size/region) and a convenience sample of managers/auctioneers, via semi-structured interviews and a Likert questionnaire on barriers, complexity and institutional support. Ethics and reproducibility: ICF, anonymization, codebook and repository with scripts/metadata. In the light of Ramos and Schabbach (2012), it is an evaluation of results (ex post), without a comparison group or pre-post measurement; We work with triangulation (documents, survey, interviews). The Logical Framework guides the execution (inputs, activities, products, results and non-causal analytical impacts), highlighting the indicator of "recent formalization" (CNPJ constituted in a window close to the bid), and risks/assumptions: integrity of records, identification of participants, response biases and municipal heterogeneity.

9 ANALYTICAL STRATEGY

The key variables are: (i) recent formalization, binary indicator (=1 when the CNPJ of the winning company/participant was constituted in the interval $[-90; +30]$ days in relation to the date of the bid; =0 otherwise), with sensitivity analyses in $[-60; +15]$ and $[-120; +60]$; (ii) participation and victory in (binary) bids; (iii) amount awarded (continuous, in R\$); (iv) CNAE segment (categorical, by the main code); and (v) municipality (categorical), to control territorial heterogeneity. In coherence with the evaluative framework, the findings will be treated as associative evidence, and not causal (RAMOS; SCHABBACH, 2012).

In the descriptions, the temporal density of constitution of the CNPJs aligned with the date of the contest (kernel) is estimated to detect agglomerations, and the Spearman correlation between the sectoral/municipal bidding intensity (number of service tenders in the period) and the rate of recent CNPJs (proportion with indicator=1 between participants/winners) is calculated, favoring non-parametric metrics.

To explore associations, logistic regressions (binary outcomes: recent formalization; victory) and Poisson counting models (or negative binomial, if there is overdispersion) are estimated for participation frequencies and victories by territorial/sectoral unit. Odds ratios and rate ratios are reported, with controls by CNAE and municipality dummies.

The qualitative analysis triangulates mechanisms (entry costs, design of public notices, support from SEBRAE). Limitations: measurement bias (underreporting, inconsistencies), municipal heterogeneity, and simultaneity between formalizing and participating, which prevents causal attributions.

10 FINAL CONSIDERATIONS

The analysis of public policies aimed at micro and small enterprises (MSEs), especially with regard to access to markets via government purchases, allows us to reflect on the advances and challenges of almost two decades of Complementary Law No. 123/2006 and the recent incorporation of Law No. 14,133/2021. Throughout the study, it was found that such normative frameworks are essential instruments for the promotion of inclusive economic development, but their effectiveness depends on a set of institutional, federative and administrative factors.

First, it should be recognized that the policy contributed to expanding the participation of MSEs in public procurement, creating opportunities for insertion in markets previously restricted to large companies. The reservation of quotas, the simplification of procedures and the prioritization of local suppliers were measures that encouraged formalization and stimulated competition. Such provisions also reinforced the role of the State as an inducing

agent of regional development, bringing the logic of bidding closer to the social function of the Public Administration.

However, the results still reveal significant inequalities. Municipalities with greater administrative and technological capacity are more apt to implement inclusive bidding processes, while smaller cities face difficulties in complying with legal requirements, limiting the scope of the policy. This disparity reflects the Brazilian federative asymmetry, already pointed out by authors such as Abrucio (2010), who identify the need for more consistent mechanisms of cooperation and coordination between federated entities.

In addition, it is observed that many MSEs still come up against bureaucratic and financial barriers, such as the requirement for clearance certificates, difficulties in accessing credit and lack of technical training to participate in competitions. Thus, full inclusion has not yet materialized for the most vulnerable segments, especially those located in peripheral territories or in sectors of less economic dynamism.

As an evaluation of results (*ex post*), the study is subject to selection bias and unobserved confounders; thus, the findings should be interpreted as correlations and not causality (RAMOS; SCHABBACH, 2012).

From an academic point of view, this work reinforces three central contributions articulated in a single argument. First, it promotes the integration between implementation theory and evaluation, showing that the effectiveness of public procurement for MSEs stems simultaneously from the daily interpretation of street-level bureaucrats — as proposed by Lipsky (1980) — and from *ex post* analyses that confront objectives and results, in the light of Ramos and Schabbach (2012). Secondly, it offers a federative reading of public policies, showing that decentralization, although it strengthens local autonomy, also increases asymmetries in implementation capacity, which requires cooperative solutions and coordination arrangements between subnational entities. Finally, it advances in the institutional-inclusive dimension, by relating the "rules of the game" (North, 1990) to the concrete incentives for formalization and economic participation of historically marginalized actors, situating public procurement as a mechanism that both organizes incentives and reduces barriers to entry into the state market.

In summary, the policy of access of SMEs to public markets represents an important advance in the Brazilian agenda of inclusive development. However, its full effectiveness requires more than legal norms: it requires state capacities, federative coordination, and political commitment to reducing inequalities.

Thus, the importance of understanding public procurement not only as instruments of administrative efficiency, but as policies of socioeconomic inclusion and strengthening of

democratic governance is reaffirmed. The challenge is to transform the legal provision into concrete results for thousands of entrepreneurs who depend on these opportunities to prosper, consolidating, finally, a virtuous cycle of local development and economic citizenship.

REFERENCES

- Abramovay, R., Magalhães, R., & Schröder, M. (2008). Social movements beyond the iron cage: Weak ties in territorial development. *World Development*, 36(12), 2906–2920.
- Abrucio, F. L. (2005). Coordenação federativa no Brasil: A experiência do período FHC e os desafios do governo Lula. *Revista de Sociologia e Política*, (24), 41–67.
- Abrucio, F. L. (2010). A dinâmica federativa da educação brasileira: Diagnóstico e propostas de aperfeiçoamento. In R. P. Oliveira & W. Santana (Orgs.), *Educação e federalismo no Brasil: Combater as desigualdades, garantir a diversidade*. UNESCO.
- Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory*, 18(4), 543–571.
- Araújo Júnior, I. T. de. (2018). Análise comparada sobre medidas de favorecimento de micro e pequenas empresas (MPEs) em compras públicas (Texto para Discussão nº 2422). Ipea.
- Arrowsmith, S. (2010). *The law of public and utilities procurement* (3rd ed.). Sweet & Maxwell.
- Arrowsmith, S., & Kunzlik, P. (Orgs.). (2009). *Social and environmental policies in EC procurement law*. Cambridge University Press.
- Avritzer, L. (2019). *O pêndulo da democracia. Ainda*.
- Banrisul. (2025). Pregão online Banrisul. Recuperado em 10 de março de 2026, de portal institucional.
- Barreto, F. (2011). Políticas públicas de apoio às MPEs: Uma análise da atuação do Estado brasileiro. *Revista do Serviço Público*, 62(3), 303–324.
- Brasil. (1988). *Constituição da República Federativa do Brasil*. Senado Federal.
- Brasil. (2015). Decreto nº 8.538, de 6 de outubro de 2015. *Diário Oficial da União*.
- Brasil. (2006). Lei complementar nº 123, de 14 de dezembro de 2006. *Diário Oficial da União*.
- Brasil. (2021). Lei nº 14.133, de 1º de abril de 2021. *Diário Oficial da União*.
- Cabral, S., Reis, P. R. da C., & Sampaio, A. da H. (2015). Determinantes da participação e sucesso das micro e pequenas empresas em compras públicas. *Revista de Administração*, 50(4), 477–491.
- Cassiolato, J. E., & Lastres, H. M. M. (2003). *Pequena empresa: Cooperação e desenvolvimento local*. Relume Dumará.

- De Soto, H. (2001). *O mistério do capital*. Record.
- Farah, M. F. S., & Marques, E. C. (2017). Políticas públicas no Brasil: Continuidade, mudanças e efeitos. *Revista Brasileira de Ciências Sociais*, 32(95), 1–25.
- Fundação Getúlio Vargas. (2020). *Compras públicas e percepção de empreendedores de pequeno porte*. FGV.
- Gomide, A., & Pires, R. R. C. (2014). *Capacidades estatais e burocracias no Brasil*. ENAP.
- Howlett, M., Ramesh, M., & Perl, A. (2009). *Studying public policy: Policy cycles and policy subsystems* (3rd ed.). Oxford University Press.
- Instituto Brasileiro de Geografia e Estatística. (2025). *PNAD contínua trimestral: Taxa de informalidade no Brasil*. Recuperado em 10 de março de 2026.
- Instituto de Pesquisa Econômica Aplicada. (2023). *Participação das MPEs nas compras públicas brasileiras: Avanços e desafios*. Ipea.
- Lavalle, A. G., & Isunza Vera, E. (2011). A trama da crítica democrática. *Lua Nova*, (84), 95–139.
- Lipsky, M. (1980). *Street-level bureaucracy*. Russell Sage Foundation.
- Marques, E. C., & Faria, C. A. P. (2015). A política pública como campo multidimensional. *Revista Brasileira de Ciências Sociais*, 30(89).
- McCrudden, C. (2004). Using public procurement to achieve social outcomes. *Natural Resources Forum*, 28, 257–267.
- Nogueira, M. (2010). *A construção do Estatuto da Micro e Pequena Empresa*. Câmara dos Deputados.
- North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge University Press.
- Oliveira, R. (2021). Compras públicas e MPEs: Limites e potencialidades após a Lei 14.133/2021. *Revista de Administração Pública*, 55(6).
- Osborne, S. P. (2006). The new public governance? *Public Management Review*, 8(3), 377–387.
- Pereira, A. (2015). Ações afirmativas econômicas e compras governamentais. *Revista de Direito Administrativo*, 270.
- Perry, G., et al. (2007). *Informality: Exit and exclusion*. World Bank.
- Pires, R., & Gomide, A. (2016). Capacidades estatais e democracia. *Revista de Sociologia e Política*, 24(58), 121–143.
- Pires, R. R. C., & Lotta, G. (Orgs.). (2019). *Burocracia e políticas públicas no Brasil*. ENAP.
- Pressman, J. L., & Wildavsky, A. (1973). *Implementation*. University of California Press.

Ramos, M. P., & Schabbach, L. M. (2012). Avaliação de políticas públicas no Brasil. *Revista de Administração Pública*, 46(5), 1271–1294.

Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2023). *Pequenos negócios: A base da economia*.

Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (2023). *Pequenos empreendimentos promovem a inclusão social*.

Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. (s.d.). *Anuário do trabalho na micro e pequena empresa*.

Silva, A., Reis, P. R. C., & Mello, B. (2019). Licitações e formalização de prestadores de serviços.

Souza, C. (2005). Federalismo: Conceitos, tipologias e abordagens. *Revista de Sociologia e Política*, (24), 65–83.

Souza, C. (2006). Políticas públicas: Uma revisão da literatura. *Sociologias*, 8(16), 20–45.

Tribunal de Contas da União. (2013). Acórdão nº 1.214/2013 – Plenário.

Tribunal de Contas da União. (2013). Acórdão nº 2.622/2013 – Plenário.

Tribunal de Contas da União. (2015). Acórdão nº 2.731/2015 – Plenário.

**SOCIAL REPRESENTATIONS OF INDIGENOUS LANDS AND THE
LEGITIMATION OF THE BRAZILIAN SUPREME FEDERAL COURT'S
DECISION ON THE "TEMPORAL FRAMEWORK" (MARCO TEMPORAL) IN
LIGHT OF MAX WEBER'S INTERPRETIVE SOCIOLOGY**

**REPRESENTAÇÕES SOCIAIS DAS TERRAS INDÍGENAS E LEGITIMAÇÃO DA
DECISÃO DO STF SOBRE O MARCO TEMPORAL À LUZ DA SOCIOLOGIA
COMPREENSIVA DE MAX WEBER**

**REPRESENTACIONES SOCIALES DE LAS TIERRAS INDÍGENAS Y
LEGITIMACIÓN DE LA DECISIÓN DEL SUPREMO TRIBUNAL FEDERAL (STF)
SOBRE EL "MARCO TEMPORAL", A LA LUZ DE LA SOCIOLOGÍA
COMPRENSIVA DE MAX WEBER**



<https://doi.org/10.56238/sevened2026.008-247>

Glenda Almeida Matos Moreira¹, Joaquim Ribeiro de Souza Junior²

ABSTRACT

For the present paper examines the decision of the Brazilian Supreme Federal Court (Supremo Tribunal Federal – STF) in RE 1.017.365/SC, which struck down the so-called “time frame” thesis for the demarcation of indigenous lands, in the light of Max Weber’s comprehensive sociology, with particular emphasis on the notion of social representation. Drawing on the concept of social action and on the centrality of the “subjectively represented meaning” in social relations, the paper seeks to identify the different value ideas that shape the representations of indigenous land in the Court’s reasoning: at times as an economic asset and an object of legal certainty for private property, at others as an original territory and a constitutive dimension of indigenous cultural identity. It is argued that culture, understood as an arena of disputes among competing representations, offers the key to understanding the Court’s decision not merely as a technical-legal application of constitutional rules, but as a moment of selection and consecration of particular value ideas in the Brazilian constitutional order. Finally, the article discusses to what extent the decision contributes to the legitimation of legal-rational domination and to the reshaping of social representations of indigenous peoples and their territories.

Keywords: Max Weber. Social Representation. Indigenous Lands. Time Frame Thesis. Brazilian Supreme Court.

RESUMO

Para o presente trabalho se analisa a decisão do Supremo Tribunal Federal no RE 1.017.365/SC, que rejeitou a tese do “marco temporal” para a demarcação de terras indígenas, a partir da sociologia compreensiva de Max Weber, com ênfase na noção de

¹ Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: glendaalmeidamoreira@gmail.com Orcid: <https://orcid.org/0000-0002-8940-3644>.

² Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: joaquimjunior33@gmail.com Orcid: <https://orcid.org/0000-0003-3488-5508>.

representação social. Partindo do conceito de ação social e da centralidade do “sentido subjetivamente representado” nas relações sociais, busca-se identificar as diferentes ideias de valor que estruturam as representações da terra indígena no julgamento: ora como bem econômico e objeto de segurança jurídica da propriedade privada, ora como território originário e dimensão constitutiva da identidade cultural dos povos indígenas. Argumenta-se que a cultura, entendida como arena de disputas entre representações em conflito, fornece a chave interpretativa para compreender a decisão do STF não apenas como aplicação técnico-jurídica de normas constitucionais, mas como momento de seleção e consagração de determinadas ideias de valor na ordem constitucional brasileira. Ao final, discute-se em que medida a decisão contribui para a legitimação da dominação legal-racional e para a reconfiguração das representações sociais acerca dos povos indígenas e de seus territórios.

Palavras-chave: Representação Social. Max Weber. Terras Indígenas. Marco Temporal. Supremo Tribunal Federal.

RESUMEN

En el presente trabajo se analiza la decisión del Supremo Tribunal Federal (STF) en el RE 1.017.365/SC, que rechazó la tesis del “marco temporal” para la demarcación de tierras indígenas, a partir de la sociología comprensiva de Max Weber, con énfasis en la noción de representación social. Partiendo del concepto de acción social y de la centralidad del “sentido subjetivamente representado” en las relaciones sociales, se busca identificar las diferentes ideas de valor que estructuran las representaciones de la tierra indígena en el juicio: ora como bien económico y objeto de seguridad jurídica de la propiedad privada, ora como territorio originario y dimensión constitutiva de la identidad cultural de los pueblos indígenas. Se sostiene que la cultura, entendida como arena de disputas entre representaciones en conflicto, proporciona la clave interpretativa para comprender la decisión del STF no solo como aplicación técnico-jurídica de normas constitucionales, sino como un momento de selección y consagración de determinadas ideas de valor en el orden constitucional brasileño. Por último, se discute en qué medida la decisión contribuye a la legitimación de la dominación legal-racional y a la reconfiguración de las representaciones sociales acerca de los pueblos indígenas y de sus territorios.

Palabras clave: Representación Social. Max Weber. Tierras Indígenas. Marco Temporal. Supremo Tribunal Federal.

1 INTRODUCTION

The controversy surrounding the demarcation of indigenous lands has occupied a central place in political, legal and symbolic disputes in Brazil for decades. The thesis of the so-called "time frame" – according to which indigenous peoples would only have the right to the lands they were occupying on October 5, 1988 – condensed, in a particularly acute way, long-term conflicts over property, territory, economic development and historical justice. When the Federal Supreme Court, in the judgment of Extraordinary Appeal No. 1.017.365/SC, in a regime of general repercussion, rejects this thesis and reaffirms the original character of indigenous territorial rights, it is not only solving a technical problem of constitutional interpretation: it is intervening in an arena dense with meanings, in which different groups dispute the very meaning of "land", "property", "State" and "indigenous people".

The strictly normativist reading tends to present this type of decision as a simple application of constitutional provisions and jurisprudential precedents. However, an approach inspired by Max Weber's comprehensive sociology allows us to take a different look at the phenomenon: instead of making the judicial decision only as the product of rules, it is a matter of reconstructing it as part of a process of social action, in which situated agents — ministers, lawyers, representatives of indigenous peoples, agribusiness entities, civil society organizations — guide their conduct based on socially constructed representations and ideas of value in dispute.

In Weber, social action is defined from the meaning that the agent attributes to his conduct, to the extent that it is guided by the existence of others. The social relation, in turn, is the intertwining of actions endowed with meaning, reciprocally referred to each other. In this context, to speak of "social representation" – even if the term does not appear in a systematic way in Weber as in Durkheim or in the more recent tradition inaugurated by Moscovici – means emphasizing precisely the significant dimension of practices: what individuals and groups think, imagine, project and dispute when they act in a field of relations. Culture, far from being a prior consensus of values, appears as an arena of struggle between different ideas of value that seek to impose themselves as legitimate guides of conduct.

The STF's decision on the time frame thus offers a particularly fruitful object to articulate Weberian theory and constitutional analysis. On the one hand, because it exposes in a very clear way contrasting representations of indigenous land: sometimes as an economic asset, the basis of productivity and legal security of private property; sometimes as an original territory, a condition for the physical and cultural existence of indigenous peoples and a structuring element of the 1988 Constituent Pact itself. On the other hand, because it

highlights the role of a constitutional court as an instance of selection and consecration of certain ideas of value, to the detriment of others, within a legal order that is intended to be legitimate.

In the light of comprehensive sociology, it is less interesting to ask whether the decision is "right" or "wrong" in abstract terms, and more to inquire what meanings are mobilized by the different actors, how these meanings are articulated in legal and political narratives, and how the court contributes to stabilizing certain social representations — of the land, of indigenous peoples, of the State itself — at a given historical moment. It is, therefore, a matter of shifting the focus from the isolated "normative content" to the intersection between culture, social action and legal-rational domination.

In this perspective, the present work has as a research problem the following question: how do the different social representations of indigenous land, reconstructed from the comprehensive sociology of Max Weber, manifest themselves and are selected in the STF's decision on the time frame, and how does this contribute to the legitimation of the Brazilian constitutional order? It is based on the hypothesis that the judgment in question can be understood as a moment of dispute and selection of social representations of the indigenous land, in which ideas of value prevail that recognize the cultural and original centrality of these territories, tensioning strictly patrimonial conceptions of property and reinforcing a certain configuration of legal-rational domination.

The general objective is to analyze how the STF's decision in RE 1.017.365/SC expresses, confronts and selects different social representations of indigenous land, in the light of Max Weber's comprehensive sociology. Specifically, it seeks to: (a) present Weber's concepts of social action, subjectively represented meaning, culture and social representation, as reconstructed by the specialized literature; (b) reconstruct the main lines of argument of the STF's judgment on the time frame, identifying the actors and narratives in conflict; (c) to identify the ideas of value and social representations of the indigenous land present in the votes and in the procedural manifestations; and (d) to evaluate the extent to which the decision contributes to the legitimation of a certain constitutional reading of indigenous territorial rights and to the reconfiguration of social representations about indigenous peoples and territory in Brazilian constitutionalism.

To achieve these objectives, a qualitative approach is adopted, based on documentary analysis of the decision, votes and selected procedural documents, interpreted in the light of the Weberian conceptual framework. The article is organized into four sections, in addition to this introduction. In the first, the central elements of the notion of social representation in Weber's comprehensive sociology are reconstructed, with emphasis on the relationship

between meaning, culture and ideas of value. In the second, the legal and political context of the judgment of the time frame is presented, with emphasis on the configuration of the conflict around the indigenous land. In the third, the social representations of the indigenous land within the STF decision are analyzed, identifying convergences and tensions between the narratives in dispute. Finally, the conclusion summarizes the main results and points out possible developments for the understanding of the relationship between constitutional courts, legal culture and social representations in societies marked by historical conflicts of a colonial nature.

2 SOCIAL REPRESENTATION IN COMPREHENSIVE SOCIOLOGY IN WEBER

By conceptualizing "social action", Weber already defines that this action is oriented towards the other (2015, p.3), that is, the individual's action is only relevant to sociology if the course of his acts is not directed towards himself. Following this idea, the "social relation" is the "reciprocally referred behavior" (WEBER, 2015, p. 16), in which the meaning is the content of the agents' social actions. It is precisely the content of this meaning of reciprocally referred (predictable, probable) actions that is of interest to the study of social representation.

Minayo (1995, p. 89), in an article on social representation in the classics, understands this theme as "categories of thought that express reality, explain it, justify it or question it". The author understands that in Weber the theme of social representations does not appear explicit as in Durkheim, however, she demonstrates that the author opposes the objectivist idea that social representation has a power of coercion, from society to the individual (Minayo, 1995). Let us see another peculiarity in the use of terms in Weber:

Max Weber elaborates his conceptions of the field of Social Representations through terms such as "ideas", "spirit", "conceptions", "mentality", often used as synonyms, and works in a particular way on the notion of "worldview".

Thus, it can be observed that two concepts are central to understanding representations in Weber, meaning (and its content) and culture. In the presentation of the work "The 'Objectivity' of Knowledge in the Social Sciences", written by Weber, Gabriel Cohn states that Weber opposes a dominant tendency to understand culture as a consensus on a set of values:

[...] for him, the world of culture is not that dimension of social reality that gives meaning to what men do, but, on the contrary, it is that **meaningful arena in which men themselves attribute value to what they do. Culture** operates as a kind of **filter**, which **selects** within the

set of possible experiences those that will be considered **significant** within **certain** human groups. The important thing is not the validity of values already given, but the **men themselves as actors** who, when acting, **are guided by guidelines** that they strive to enforce also for others. What is at stake are not "values" without more, but **"ideas of value"**, which refer to the way men perceive and think about values in the actions to which they give themselves. (WEBER, 2006, p.10-11, emphasis added).

Therefore, for Weber, culture is the result of the selections that occur in disputes for the most significant ideas of value, in a certain human group and in certain situations. On the other hand, meaning in Weber (here understood as the "subjectively aimed sense" or just "aimed") is precisely content that "sustains" social action. This point is fundamental in Weber's theory and the author makes it clear that he is not dealing here with an objective meaning, already disposed *a priori*, or "objectively 'correct' or a 'true' meaning obtained by metaphysical inquiry" (WEBER, 2015, p.4). Cohn, in an opening text to "Economy and Society" (WEBER, 2015, p. xiv) states that, despite being the best expression, "subjectively aimed sense" is not an absolutely satisfactory translation, thus dealing with what would be a "Weberian terminological nightmare."

The point is that, according to Cohn (WEBER, 2015, p. xiv), the term "subjective" can obviously be confused with a psychological term (an issue totally dismissed by Weber), but the biggest problem with the expression "subjectively aimed meaning" would reside precisely in the term "targeted", which could be understood as something already objectively posed before social action. In no way is this the intention of "meaning" in social action, so Cohn warns:

[...] the meaning of action is not something already given that is in some way "aimed" by the agent as the "goal" of his action, **but it is the representation** that he, as an agent, has **of the course of his action** and that commands its execution. [...] It would be appropriate to speak of a **"subjectively represented meaning"**, to make it clear that **what counts in the action and makes it effective** is not its meaning without more, but **the way in which the agent represents it to himself when conducting it**. (WEBER, 2015, p. xiv, author's italics, emphasis added)

It is noted that the concept of "subjectively aimed meaning", the content of the social action of individuals, is reciprocally and mutually referenced in social relations. Social representation is precisely the meaning observed by the other (or others) in social relations, so it is of essential importance to understand the concepts of culture and meaning in Weber.

In the Weberian analytical scheme, *everything* goes through the **conceptions or representations that the agents** (always individual, in the last instance) **have of the motives, means and ends of the social actions** in which they are involved. Hence the *subjective dimension* of action. And motives, means and ends have, for the agent, a significant character. Hence the dimension of *meaning* of the action. (WEBER, 2015, p. xiv, author's italics, emphasis added)

It is important to emphasize that this meaning of action or non-action in Weber (2006, p. 16) means "*taking* a position in favor of certain values" and going against other values. The author does not understand these values as determined by laws, mathematical or logical aspirations, but they are culturally constructed. Also in "The 'Objectivity' of Knowledge in the Social Sciences", Weber reiterates that reality can only be known, for the social scientist, from the cultural significance of social actions and their "regular repetition" (2006, p. 48).

Thus, social representation in Weber is the ideas of value that condition individual actions (WEBER, 2006, p.51). Thus, it can be understood that in Weber, "culture is a finite segment of the infinite course and devoid of its own meaning [...] to which thought has conferred [...] a meaning and a signification" (WEBER, 2006, p.58), while the "men of culture", in this process, can "assume a conscious *position* before the world and give it a meaning", and it is from this meaning that their evaluations are extracted. In other words, there is a reciprocal relationship, since "cultural knowledge is conditioned by certain ideas of value" (WEBER, 2006, p.58) and "cultural reality is always knowledge subordinated to *specifically* particular *points of view*" (WEBER, 2006, p.59). Gabriel Cohn, commenting on this aspect of Weber's theory, states:

[...] the precondition without which one cannot speak of scientific knowledge of the world of meanings and values (of culture) is the capacity of men ([...] motivated by interests based on values) to attribute meaning to what does not have it *per se*. (WEBER, 2006, p.58)

Similarly, Minayo (1995, p. 92-93) understands that for Weber, social representations (or ideas of value) are conditioned by reality, and vice versa:

[...] social **life** – which consists of the daily conduct of individuals – is loaded with **cultural significance**. This meaning is **given both by the material basis and by the ideas**, within an adequate relationship, in which both **mutually condition each other**. (Minayo, 1995, p. 92-93, emphasis added).

Thus, for Weber, the ideas of value, or the conceptions (modes of perception of the individual about the significant guidelines of culture), can guide the contents, or the

"subjectively aimed meanings" of social actions (always directed to the other), so social representation is precisely the meaning observed by the other (or others) in social relations, from the moment an agent assumes a point of view, instead of another. Therefore, one must observe both the cultural significance of these social actions and the regularity (repetition) of their meanings. Finally, even the concept of social representation in Weber is reciprocal, since both social life (culturally significant) and the subjectively aimed meanings of social actions (individual) are mutually conditioned, thus, we move on to the analysis of the Case of the Time Frame of Indigenous Lands in Brazil.

3 THE CASE OF THE TIME FRAME (RE 1.017.365/SC) AND THE CONFLICT OVER INDIGENOUS LAND

Extraordinary Appeal No. 1,017,365/SC, submitted to the system of general repercussion (Topic 1,031), has become the main paradigm for the definition of the legal-constitutional status of the ownership relations of areas of traditional indigenous occupation in the light of article 231 of the Federal Constitution. The lawsuit originates from a repossession action filed by the State of Santa Catarina against the Ibirama-Laklãnõ Indigenous Land, inhabited by the Xokleng people, with the presence of Guarani and Kaingang groups, in which the legality of the demarcation and the permanence of non-indigenous occupants in the area were discussed. According to the Indigenous Missionary Council (CIMI):

The time frame is a thesis that seeks to restrict the constitutional rights of indigenous peoples. In this interpretation, defended by ruralists and sectors interested in the exploitation of traditional lands, indigenous peoples would only have the right to the demarcation of lands that were in their possession on October 5, 1988, or that, on that date, were under proven physical or judicial dispute. (Mobilization, 2020).

In this understanding, the "time frame" thesis was constructed as a restrictive interpretation of article 231 of the Constitution. This formulation, initially articulated in decisions and opinions related to the Raposa Serra do Sol case and later systematized in an opinion of the Attorney General's Office, began to be claimed by agribusiness sectors and by the legislature as a criterion of legal certainty for rural property.

According to Ingo Wolfgang Sarlet (2004), legal certainty is part of the essential core of human dignity, thus functioning as a guarantee of the minimum existential conditions. This perspective illuminates the judgment of RE.1017.365/SC, in which the STF rejects the time frame thesis, reaffirming the original character of indigenous territorial rights, and such a

position can be seen as a means of preserving legal positions whose stability is indispensable for historically vulnerable groups.

This conception is particularly relevant when it comes to collective rights with strong cultural and existential density, whose effectiveness depends on continuity, predictability, and reinforced protection against state or private interference. Legal certainty, in this sense, is not limited to the protection of isolated individual acts, but encompasses the recognition and preservation of essential legal positions, especially those associated with the identity and permanence of historically vulnerable groups (SARLET, 2004).

The projection of reinforced protection on territories that constitute the material and cultural foundation of indigenous existence, recognizing that the rupture of these guarantees infringes the very structure of the Democratic State of Law, is finally established, and it is essential to point out the principle of prohibition of social regression, an element widely discussed by Sarlet (2009), which states that it participates in the Constitutional State, preventing legal achievements from being restricted by conjunctural pressures.

In this context, normative and institutional achievements are not mere circumstantial advances, but minimum levels of protection that cannot be reduced by the State without violating legitimate expectations and the integrity of the constitutional pact. This notion takes on special relevance when analyzing the protection of cultural, territorial and socio-environmental rights, since such rights, due to their collective nature, depend on legal stability to prevent conjunctural pressures from eroding fundamental guarantees that have already been consolidated (SARLET, 2009).

Thus, the protection of the environment and culture cannot be dissociated from human dignity, since both are indispensable elements for the full realization of the person and communities, given that the protection of collective identities and traditional ways of life is not ancillary or exceptional, but an integral part of the constitutional architecture aimed at preserving plurality and promoting an inclusive society (SARLET, 2013).

By setting aside the time frame, therefore, the Supreme Court prevents a restrictive interpretation from emptying the core of indigenous territorial rights, whose effectiveness derives directly from the CF/88, denying setbacks that would affect the cultural and territorial integrity of indigenous peoples and highlighting that the protection of these rights cannot be reduced based on readings that disregard their historicity and their centrality in the constituent pact.

Social, cultural and environmental rights are also part of the structuring axis of the Socio-Environmental State, in which human dignity presupposes social justice, cultural diversity and environmental preservation (SARLET, 2013). That said, by recognizing

indigenous lands as indispensable spaces for the physical, cultural and spiritual reproduction of these peoples, we are faced with the adoption of a constitutional model that goes beyond the patrimonialist logic of land and the non-result of state concessions in the face of the protection of indigenous territories.

It is also emphasized that legal certainty should not be interpreted in a merely formal or static way, but as an instrument that prevents the State from transforming historical vulnerabilities into valid legal criteria, where normative predictability and institutional trust are guarantees that should prevent structural inequalities from being naturalized or converted into limitations of rights. In contexts in which groups have been historically displaced, marginalized or prevented from fully exercising their constitutional prerogatives, legal certainty acts as a critical mechanism for containing injustices and rebuilding material equality (SARLET, 2004).

It is taken into account that the realization of fundamental rights requires a hermeneutical reading committed to the maximum protection of the legal positions that express essential values of the constitutional pact, especially when related to the dignity and identity of vulnerable groups.

The duty of progressivity, associated with the prohibition of retrogression, imposes on the interpreter a posture that favors the preservation of civilizational achievements and strengthens the community dimension of fundamental rights. Such a panorama reinforces the understanding that the legal protection of traditional territories, cultures and ways of life is not only a matter of normative technique, but a substantial element of the very idea of the material rule of law, guided by justice, inclusion and plurality (SARLET, 2009).

From the point of view of indigenous peoples and support entities, this interpretation is perceived as radically iniquitous, as it disregards the history of violent expulsions, forced removals and compulsory displacements to which several communities were subjected throughout the twentieth century, especially during the Military Dictatorship. By requiring physical presence on the date of 1988, the time frame thesis tends to "legalize" the consequences of dispossession and massacres, ignoring the fact that, until the 1988 Constitution, indigenous peoples were under state tutelage and with severe limitations to claim their rights in court.

In the judgment of RE 1.017.365/SC, the Federal Supreme Court, by a majority of 9 votes to 2, rejected the time frame thesis, stating that the recognition of the right to lands traditionally occupied by indigenous people is not subject to this rigid time criterion and must observe, instead, the so-called indigenato theory, which recognizes the original character of indigenous territorial rights prior to the State itself. In addition, the Court established a thesis

of general repercussion determining, among other points, the possibility of prior compensation to individuals in good faith for the improvements or, in certain cases, for the value of the bare land itself, under a regime of procedural separation in relation to the demarcation process.

The definition of this thesis had intense repercussions in the political, legal and economic scenario. On the one hand, it was celebrated by indigenous organizations, social movements, and a significant part of the academic community as an affirmation of the constitutional commitment to the protection of native peoples and to overcoming an interpretation that crystallized historical injustices. On the other hand, it generated a strong reaction from agribusiness sectors and parliamentary groups that defend the time frame, culminating in the approval of Law No. 14,701/2023, which sought to inscribe in ordinary law the thesis already rejected by the STF and which is currently the subject of concentrated control of constitutionality.

The case of the time frame, therefore, is not limited to the strictly legal dimension of the judgment. It condenses a broader dispute over how to narrate national history, the place of indigenous peoples in Brazilian society and the very definition of economic development. The street demonstrations, public hearings, oral arguments and parliamentary clashes that followed the trial indicate that what is at stake is not only the technical design of demarcation procedures, but the dispute of social representations about indigenous land: whether it will be seen primarily as a productive asset to be integrated into the land market or as an original territory, inseparable from the cultural identity of the peoples who inhabit it.

It is precisely in this key, in which constitutional decisions are understood as moments of condensation and selection of meanings, that RE 1.017.365/SC presents itself as a privileged object for the application of the Weberian theoretical framework outlined in the previous section. Judgment can be reconstructed as a complex social relation, in which multiple actors guide their actions based on conflicting ideas of value, producing competing representations of indigenous land and fighting to inscribe them in the constitutional order.

4 SOCIAL REPRESENTATIONS OF INDIGENOUS LAND IN THE STF JUDGMENT

The "time frame" thesis was constructed as a restrictive interpretation of article 231 of the Constitution, according to which indigenous peoples would only have the right to the demarcation of lands that were in their possession on October 5, 1988, the date of the promulgation of the constitutional text, or that, on that date, were under proven physical or judicial dispute. This formulation, initially articulated in decisions and opinions related to the Raposa Serra do Sol case and later systematized in an opinion of the Attorney General's

Office, began to be claimed by agribusiness sectors and by the legislature as a criterion of legal certainty for rural property.

4.1 SOCIAL REPRESENTATIONS OF INDIGENOUS LAND IN THE STF JUDGMENT

From the perspective of Weber's comprehensive sociology, the judgment of the time frame can be analyzed as a process in which different agents — ministers, lawyers, representatives of indigenous peoples, agribusiness entities, state agencies, civil society organizations — mobilize specific social representations of indigenous land, guiding their legal and political actions by certain ideas of value. The judgment and the individual votes function, in this perspective, as privileged records of these meanings in dispute.

4.2 INDIGENOUS LAND AS AN ECONOMIC ASSET AND OBJECT OF LEGAL CERTAINTY

A first constellation of representations can be identified in the emphasis given, by certain discourses, to land as an economic asset, the basis of agricultural productivity and an essential element of the legal security of private property. In this view, the stability of property titles, the predictability of rules of use and the protection of long-term investments appear as central values, often associated with the idea of national development, job creation and international competitiveness of Brazilian agribusiness.

Such representations are not limited to the interior of the Court, but permeate unsuccessful votes, manifestations of *amici curiae* linked to the productive sector, technical opinions and parliamentary pronouncements. The time frame thesis, in this context, operates as an ideal type that intends to organize the complex universe of indigenous territorial disputes based on an objective "cut-off date", capable of limiting the exposure of rural landowners to future litigation. Indigenous land is thus represented primarily as a potential space for land conflict, whose recognition must be made compatible with the preservation of already consolidated property expectations.

From the Weberian perspective, this social representation of indigenous land corresponds to a set of ideas of value that, culturally situated, guide the action of certain status groups and are of interest to a specific economic order. The defense of the time frame, in this sense, expresses an effort to rationalize legal-formal material interests, transfigured into a language of legal certainty, stability of the legal system and legitimate trust in institutions.

4.3 INDIGENOUS LAND AS AN ORIGINAL TERRITORY AND CULTURAL DIMENSION OF EXISTENCE

In contrast, a second constellation of representations emerges strongly in the majority position of the STF and in the manifestations of indigenous peoples, indigenous organizations, and part of the academic community. From this perspective, indigenous land is represented as an original territory, prior to the national state itself and a condition for the possibility of the physical and cultural existence of indigenous peoples. The reference to Article 231 of the Constitution, ILO Convention No. 169 and international human rights instruments reinforces a conception of territory as a space for social, spiritual and symbolic reproduction, inseparable from collective identity.

The votes that reject the time frame tend to emphasize the historicity of the indigenous occupation, the violence of the expulsion and removal processes, as well as the impossibility of taking the photograph of October 5, 1988 as a legitimate criterion for assessing original rights. Instead, they articulate the theory of *indigenato* as recognition of a special relationship between indigenous peoples and territory, which is not to be confused with the individualistic logic of civil property. The land, in this regime of representation, is not only an economic good, but a space of memory, ancestry and future.

In the light of comprehensive sociology, this second constellation corresponds to another configuration of ideas of value, equally rooted in historical experiences and specific worldviews. The representations of land as original territory guide the action of indigenous peoples and their allies, inform strategies for political mobilization, formulation of legal demands and evaluation of state decisions. In the STF's judgment, such representations are translated into legal-constitutional language, taking shape in categories such as "original rights", "traditionally occupied possession" and "cultural pluralism".

4.4 DISPUTE OF IDEAS OF VALUE AND SELECTION OF REPRESENTATIONS BY THE COURT

What RE 1.017.365/SC shows, therefore, is less the opposition between "legal technique" and "politics" and more the dispute between divergent social representations of the same reality – the indigenous land – within a specific legal field. Culture, in the Weberian sense, appears here as an arena in which these ideas of value confront each other, seeking to impose themselves as legitimate guides of state action.

By rejecting the time frame thesis and affirming the theory of *indigenato*, the STF not only applies a set of constitutional norms, but selects and enshrines one of the constellations of representations in dispute. The majority decision attributes centrality to the ideas of value

associated with historical justice, the protection of minorities and the recognition of original rights, relegating to the background conceptions that fully subordinate the indigenous territory to the logic of the security of private property. In Weberian terms, it can be said that the court actively participates in the process of cultural filtering, conferring greater legal and political significance to certain worldviews.

This selection does not imply the elimination of competing representations, which continue to guide actions and manifest themselves in other arenas, such as parliament (in the approval of Law No. 14,701/2023), the market (in the resistance of agribusiness sectors) and the justice system itself (in new litigation and legislative initiatives). It means, however, the provisional establishment of a predominant meaning within the constitutional order, with effects on the way future cases will be interpreted, how public policies will be formulated, and how society will symbolically represent indigenous peoples and their territories.

From the point of view of legal-rational domination, the decision also contributes to legitimizing the STF's role as an instance that guards the Constitution in matters of indigenous territorial rights. By basing its position on systematic, historical, and principled arguments, the Court seeks to construct a sense of legal rationality that presents itself as impersonal and universalizable, even if, as Weber's analysis shows, it is rooted in specific ideas of value. The legitimacy of the decision will depend, to a large extent, on the ability of these "defeated" or "winning" representations to be recognized, contested or incorporated by the various groups that make up Brazilian society.

5 FINAL CONSIDERATIONS

The analysis of the judgment of Extraordinary Appeal No. 1.017.365/SC in the light of Max Weber's comprehensive sociology allows us to shift the focus from a strictly normativist reading to an approach that privileges the significant dimension of social action and relations between groups. Instead of seeing the decision of the Federal Supreme Court only as an application of constitutional provisions related to indigenous lands, the study developed here sought to show how it is inserted in a field of symbolic disputes in which different social representations of indigenous land are mobilized, confronted and selected.

Starting from the concepts of social action, subjectively represented meaning, culture and ideas of value, reconstructed in Weber's work and in secondary literature, it was possible to interpret the case of the time frame as an arena in which, on the one hand, a representation of land is affirmed above all as an economic asset and object of legal security of property, and, on the other, a representation of the indigenous land as an original territory and an essential dimension of the physical and cultural existence of indigenous peoples. These

constellations of meaning guide the action of different status groups, inform the formulation of legal theses, and structure competing narratives about history, development, and justice.

The examination of the votes and the thesis of general repercussion established by the STF indicated that the Court, by rejecting the thesis of the time frame and adopting the theory of *indigenato*, contributes to the selection and consecration of certain ideas of value within the Brazilian constitutional order. The decision reaffirms the centrality of the recognition of original rights, the protection of minorities and cultural plurality, tensioning strictly patrimonial conceptions of property and reorienting the way the State should relate to indigenous peoples and their territories. In this sense, the court acts as an instance of cultural filtering, conferring greater legal significance to certain worldviews and producing effects on the future configuration of public policies and litigation.

At the same time, the persistence of political, legislative, and economic reactions contrary to the STF's understanding — as evidenced by the approval of Law No. 14,701/2023 and the actions for control of constitutionality related to it — shows that the process of dispute of representations is far from over. Culture, in a Weberian key, remains a field of open conflict, in which the ideas of value associated with indigenous land continue to be affirmed, contested, and reinterpreted as new events, decisions, and mobilizations unfold.

From a theoretical point of view, the case of the time frame reveals the fruitfulness of a reading that articulates comprehensive sociology and constitutional jurisdiction. Constitutional courts are not only organs for the technical application of norms, but privileged spaces for enunciating, stabilizing, and transforming fundamental social representations of who we are, what kind of society we want to be, and how we deal with legacies of violence and inequality. By bringing Weber closer to the study of constitutional jurisdiction in indigenous matters, a promising field of investigation on the relationship between legal culture, legal-rational domination and struggles for recognition in contexts marked by colonial histories is opened.

Finally, the analysis proposed here suggests that understanding the STF's decisions on indigenous lands requires not only mastery of dogmatic categories of constitutional law and indigenous law, but also sensitivity to the ways in which different groups represent land, property, the State, and the very idea of Brazil. In this sense, the dialogue between social theory and constitutional interpretation does not appear as an academic luxury, but as an indispensable tool to think, in a reflective way, about the foundations and effects of the legal choices that shape the future of indigenous peoples and the Brazilian democratic order itself.

REFERENCES

- Minayo, M. C. S. (1994). O conceito de representações sociais dentro da sociologia clássica. In S. Jovchelovitch & P. Guareschi (Orgs.), *Textos em representações sociais* (pp. 89–111). Vozes.
- Mobilização Nacional Indígena. (2020, outubro 18). Entenda o caso de repercussão geral no STF que pode definir o futuro das terras indígenas do Brasil. CIMI. <https://cimi.org.br/2020/10/entenda-repercussao-geral-stf-futuro-terras-indigenas>
- Portela, R. C., Menezes Júnior, E. E., & Silva, S. D. (2024). Marco temporal: O projeto político do agronegócio e a ameaça aos direitos dos povos indígenas. *Serviço Social & Sociedade*, 147(3). <https://doi.org/10.1590/0101-6628.418>
- Sarlet, I. W. (2004). Direitos fundamentais sociais e proibição de retrocesso: Algumas notas sobre o desafio da sobrevivência dos direitos sociais num contexto de crise. *Revista do Instituto de Hermenêutica Jurídica*, 1(2).
- Sarlet, I. W. (2023). Os direitos fundamentais (sociais) e a assim chamada proibição de retrocesso: Contributo para uma discussão. *Revista de Investigação e Desenvolvimento em Direito Brasileiro*, 2(1), 769–820. <https://repositorio.pucrs.br>
- Sarlet, I. W. (2009). Notas sobre a assim designada proibição de retrocesso social no constitucionalismo latino-americano. *Revista do Tribunal Superior do Trabalho*, 75(3). <https://www.abdpc.com.br>
- Supremo Tribunal Federal. (2023, setembro 27). STF define tese de repercussão geral em recurso que rejeitou marco temporal indígena. <https://noticias.stf.jus.br>
- Supremo Tribunal Federal. (2023, setembro 21). STF derruba tese do marco temporal para a demarcação de terras indígenas. <https://portal.stf.jus.br>
- Vandenberghe, F. (2005). As sociologias de Georg Simmel. EDUFPA.
- Vandenberghe, F. (1999). Simmel and Weber as ideal-typical founders of sociology. *Philosophy & Social Criticism*, 25(4), 57–80.
- Weber, M. (2006). A “objetividade” do conhecimento nas ciências sociais. *Ática*.
- Weber, M. (2015). Conceitos sociológicos fundamentais. In *Economia e sociedade: Fundamentos da sociologia compreensiva* (Vol. 1, pp. 3–35). Editora Universidade de Brasília.

HANNAH ARENDT: FREEDOM, POLITICS, AND LAW**HANNAH ARENDT: LIBERDADE, POLÍTICA E DIREITO****HANNAH ARENDT: LIBERTAD, POLÍTICA Y DERECHO**<https://doi.org/10.56238/sevened2026.008-248>**Maria Corga¹****ABSTRACT**

This study investigates the concept of freedom in Hannah Arendt, which transcends individual autonomy to manifest itself as a political commitment. The central question addresses how political freedom is only achieved in moderate regimes that respect plurality and citizen participation. The theoretical-analytical research is based on works such as *On Revolution*, *Truth and Politics*, and *Denktagebuch*, as well as analyses by Christian Volk and Jeremy Waldron. The results indicate that political freedom depends on the de-hierarchization between Law and Politics, the recognition of others, and an enlarged mentality that allows for the consideration of multiple perspectives. Active participation in public assemblies and the stabilizing role of Law are fundamental to ensuring political order. It is concluded that political freedom is a distinct way of guiding action among different communities, experienced through concerted action in a pluralistic environment.

Keywords: Freedom. Pluralist Politics. Law.

RESUMO

O presente trabalho investiga o conceito de liberdade em Hannah Arendt, que transcende a autonomia individual para se manifestar como um compromisso político. A questão central aborda como a liberdade política só é alcançada em regimes moderados que respeitam a pluralidade e a participação cidadã. A pesquisa teórico-analítica baseia-se em obras como *Sobre a Revolução*, *Verdade e Política* e *Denktagebuch*, além de análises de Christian Volk e Jeremy Waldron. Os resultados indicam que a liberdade política depende da desierarquização entre Direito e Política, do reconhecimento do outro e da mentalidade alargada, que permite considerar múltiplas perspetivas. A participação ativa nas assembleias públicas e o papel estabilizador do Direito são fundamentais para garantir a ordem política. Conclui-se que a liberdade política é um modo próprio de conduzir a ação entre diferentes comunidades, vivenciada por meio de uma ação em concerto num ambiente pluralista.

Palavras-chave: Liberdade. Política Pluralista. Direito.

RESUMEN

El presente trabajo investiga el concepto de libertad en Hannah Arendt, que trasciende la autonomía individual para manifestarse como un compromiso político. La cuestión central aborda cómo la libertad política solo se alcanza en regímenes moderados que respetan la

¹ Collaborating Member of the Institute of Philosophical Studies. Universidade de Coimbra.
E-mail: mariacorga@aeamatolusitano.edu.pt

pluralidad y la participación ciudadana. La investigación teórico-analítica se basa en obras como *Sobre la Revolución, Verdad y Política* y *Denktagebuch*, así como en los análisis de Christian Volk y Jeremy Waldron. Los resultados indican que la libertad política depende de la desjerarquización entre Derecho y Política, del reconocimiento del otro y de la mentalidad ampliada, que permite considerar múltiples perspectivas. La participación activa en las asambleas públicas y el papel estabilizador del Derecho son fundamentales para garantizar el orden político. Se concluye que la libertad política es un modo propio de conducir la acción entre diferentes comunidades, vivida a través de una acción concertada en un entorno pluralista.

Palabras clave: Libertad. Política Pluralista. Derecho.

1 INTRODUCTION

The perspective presented in this paper lies in the conviction that the growth of plural societies provides evidence that we are agents of progress, or in other words, we are active agents of recognition of the link of modern policies in the conceptual structures of contemporary policies.

Hannah Arendt's political theory was not literally followed as if it could accurately translate a certain classical model of integrative politics such as that found in Aristotle. It is stated that contemporaneity is an ongoing consequence, of an effect of (dis)figuring tendencies and ways. The understanding that has been acquired of society cannot be transcribed without understanding these metamorphoses, whether occurring in the horizon of ethics or in world (economic-social) policies. Thus, a perspective-proposal that would attenuate the tension between abuse of power and the common good would be welcomed, and it is in this sense that a rereading of Hannah Arendt can serve the purpose.

Considering what can be seen as political freedom, it is important to consider the presence of law as a relationship between ethical principles and their prescription in political life. It should be noted that the definition of law implies a normativity (rights and duties) of regulation of conduct. The various control mechanisms, now more visible, make it necessary to have the presence of the legal domain in these times of permanent change, despite the fact that there are no rules imposed without discussion, but a desire to seduce (rather than deduce) that touches the public domain indistinctly.

2 DEVELOPMENT

2.1 BASES OF POLITICAL FREEDOM: INFLUENCES OF MONTESQUIEU

A first question to be asked would be how to avoid the excesses that positions of power normally favor, or if you prefer, how to avoid the abuses of power so that political freedom could be an effective, disinterested, transparent reality. One cannot fail to think in this regard of some recommendations from the recent past. We allow ourselves to quote Montesquieu in this regard:

Political freedom is only found in moderate governments. But it does not always exist in moderate governments. It is only found there when power is not abused, it is necessary that by the disposition of things, power stops power. Thus, the Constitution should be such that no one is obliged to do things to which the law does not oblige him, or to stop doing things that the law permits him to. (Montesquieu, *On the Spirit of the Laws*, XI, 6)

Montesquieu's quote on political freedom reminds us that political problems are not solved by the possession (or abuse) of power, but by prioritizing moderate regimes. Montesquieu thus pointed to the need to institute a kind of alternative — a moderate policy based on laws that would guarantee political freedom.

Like Montesquieu, Hannah Arendt also inevitably criticizes the abuse of power. For Arendt, councils and popular societies are paradigmatic institutions of discursive and democratic spaces. In Volk's analysis, Hannah Arendt begins by defining political freedom as follows:

Being free is inherent in acting, and the power to do so is guaranteed by others as a security. Freedom does not consist in an I will, which, according to the case, can mean or contradict an I can without this questioning human freedom; To be free is manifested only in action, so that not having the power to act is the same as not being free, even if the (philosophical) freedom of the will remains intact. In other words, political freedom is not identical with inner freedom [...] it depends on whether a free nation guarantees the space within which action can have an impact and become visible. (Volk, 2017, p. 233)

Thus, following Hannah Arendt in this conception of political freedom, it can be said that this freedom consists of acting together in a concerted way. Such concerted action implies that individuals are aware of the meaning and scope of freedom in the global horizon of actions that impact the lives of all. Such a horizon can be translated into the participation that must take place in governance and in the emanation of laws. In this sense, let us take into account the words that Hannah Arendt reproduces in *On Revolution*, taken from one of the regiments of one of the Parisian sections:

Society will deal with everything that concerns the freedom, equality, unity, indivisibility of the republic; [its members] will instruct each other and especially inform each other about the respect due to the laws and decrees that are promulgated; The order in the debates: if a speaker digresses too much or gets tired, the listeners will stand up. (Arendt, 2011, p. 306)

A careful reading of this text allows us to understand that, in Hannah Arendt's thought, political freedom can only exist through joint action with others (naturally, one perceives here the echoes of Heidegger's thought, of being-with-others). And acting with the other(s) – which is an effective and real relationship – not only presupposes, but attests, ensures, certifies the plurality that exists in the political sphere. In this regard, Hannah Arendt, referring to a speech by Robespierre in 1791 in the National Assembly, points out:

Thus these associations were the true "pillars of the Constitution," not only because within them had come "a great number of men who will soon replace us," but also because they constituted the very "foundations of liberty"; anyone who interfered with their meetings would be "attacking liberty," and among the crimes against the revolution "the greatest was the persecution of societies." (Arendt, 2011, p. 303)

Thus, to be politically free means, in the first place, to recognize that the human being receives from the other members of the community the constitutional guarantee that he can act, if he so wishes. The opposite, that is, not being free in political terms, means that a person's power will be denied by the other members of the community. However, this does not mean an impediment to non-action, that is, it does not make it impossible for the person to act as a result of the impeding actions of others. In simpler language, if a person does not act, he will not have the experience of the true meaning of political freedom. In practice, this lack of political experience generates negative (i.e., sterile) long-term consequences. Thus, it is up to us to ask: what is the role of law in such a context? Can the Law express a contradiction in the conception of political freedom?

2.2 RELATIONSHIP AND DEHIERARCHIZATION BETWEEN LAW AND POLITICS: THE THEORETICAL-CONSTITUTIONAL PERSPECTIVE OF HANNAH ARENDT

For Hannah Arendt, Law and politics are closely related and refer to each other. Consequently, both the legal and political spheres take into account each other's requirements and include their needs. However, if one sphere is given primacy over the other, that is, if there is sovereignty of law or sovereignty of the people, and if the dichotomy between law and politics is maintained, the stability of the entire political order is put at risk. Therefore, what is intended to be exposed is that, according to Hannah Arendt, it is possible to argue in favor of a dehierarchization of the relationship between Law and Politics. This dehierarchization marks the political-normative core of Hannah Arendt's theoretical-constitutional thought. In this regard, it is important to mention two important examples to better understand his thinking: a successful policy that esteems the meetings in town *halls* in North America and the council system of the Hungarian Revolution.

Since it is not possible here to explain in detail the references presupposed by the philosopher, it remains, however, to ask: what is a successful policy? First of all, it would be a "structured policy" (Cf. Waldrom, 2000, p. 210). In this same sense, Arendt points out in *On Revolution*:

It was not any theory, theological, political, or philosophical, but the decision to leave the Old World and venture into an enterprise of one's own accord that led to a sequence of acts and occurrences, in which they would have perished if they had not thought about the matter with dedication and time enough to discover, almost

inadvertently, the elementary grammar of political action and its more complicated syntax. whose rules determine the rise and fall of human power. (Arendt, 2011, p. 226)

Following Hannah Arendt's line of thought, it is clear that it is through the concept of relationship that the dehierarchization between Law and Politics can be shown. In other words, just as an individual cannot claim to be superior to another, no one can claim to be sovereign over others. It can, however, refer to a distinction of functions, or, in other words, individuals operate in interrelated logical spheres.

In this sense, it is possible for Hannah Arendt to discern a mode of political action that follows the principles capable of safeguarding the recognition of the other and respect for their opinion. However, this requirement, and on this we agree with C. Volk, does not arise from an ethical formalism and therefore cannot claim universal validity. Volk is clear in this position when he states:

It is certainly possible to find a specific theorem running through all of Arendt's work and suggesting the recognition of the other and plurality – justifying is not exactly the word. He defends. However, as I must elaborate throughout the reflections on the Arendtian concept of politics, it is possible to discern a mode of political action that follows the principles capable of safeguarding the recognition of the other and respect for their opinion. This demand for recognition does not originate in ethical formalism and, therefore, cannot claim universal validity in the style of philosophical-moral foundation. I argue that, instead, the recognition of the other is the substrate of an "ethics of power developed from the force of judgment", as the author writes in her intellectual diary (*Denktagebuch*). (Volk, 2017, 233)

From these considerations, it is clear that, for Arendt, the durability and stability of the political order constitute its main point of orientation. And it is in this same sense that the philosopher says:

It was the modern preoccupation "with the perpetual state," so evident in Harrington's writings, that led Adams to call "divine" the new political science that dealt with "institutions that endure for many generations," and it was in Robespierre's maxim, "Death is the beginning of immortality," that the specifically modern emphasis on politics, evidenced in revolutions, found its most concise and grandiose definition. (Arendt, 2011, p. 292-293)

2.3 THE RECOGNITION OF THE OTHER AND THE "EXTENDED MENTALITY" AS CONDITIONS OF POLITICAL FREEDOM IN A CHANGING WORLD

"Tyrannies isolate men [from each other, physically]; isolated men are powerless, they cannot act in concert." (Freitas do Amaral, 2012, p. 559). This statement brings us back to totalitarianism and to Arendt. Totalitarianism was an entirely new form of government, applied

only in the first decades of the twentieth century, and which is, in his view, the only form of government with which it does not seem possible to coexist. Consequently, Hannah Arendt, in her political thought, focuses precisely on a politics of coexistence, on a political thought of recognition of the other, or more clearly, on a humanist politics. In this sense, Christian Volk says:

According to Arendt, although acting for another and acting against another arise repeatedly in the political sphere generating consensus and, thus, generating power, according to Arendt only acting with another is capable of producing a form of power in which plurality can be politically realized. In the author's view, being free means being able to participate in this action with another. (Volk, 2017, 185)

In *Civil Disobedience*, Arendt states:

No civilization – the human artifact to house successive generations – would ever have been possible without a cohesive and stable structure that provided the advent of scenarios that generate flows for change. Among the stabilizing factors come first of all the legal systems that regulate human life in the world and its daily affairs with each other, and which, of course, are more enduring than fashions, customs and traditions, it is constituted by the legal systems that regulate our life in the world and our daily relations with each other. (Arendt, 2017, p. 37)

In all political philosophy, legal systems impose themselves as organs for stabilizing and preserving political action. However, they do not seem to be satisfactory in themselves, because the problem of political freedom is not a problem of legislation, nor of law, but of a specific way of conducting political action, obeying rules that are based on the recognition of a plural society. In this sense, Arendt writes:

Moreover, the councils have always been organs not only of action but also of order, and in fact their aspiration was to establish the new order that generated conflict with the groups of professional revolutionaries, who wanted to reduce them to mere executive organs of revolutionary activity. (Arendt, 2011, p. 329)

Consequently, in a plural society, it is necessary to have representativeness and critical thinking as means of auditing and communication in political life. Without them, public life, in a world of rapid change, ceases to make sense. In this way, Hannah Arendt states that "the formation of opinions on which all political life is inevitably based can only gain from putting into practice a 'broad mentality'" (Volk, 2017, p. 290-291), a concept that Kant points out in his *Critique of the Faculty of Judging*, although without making explicit the political and moral implications of this concept. It is precisely to these implications that Arendt draws attention. In this regard, it states:

The more positions of people I have in my mind when reconsidering a certain problem, and the better I can imagine how I would feel and think, if I were in your place, the stronger my capacity for representative thinking will be and the stronger my conclusion, my opinion, therefore. (Arendt, 2005, p. 92-93)

In opposition to philosophical reflection that requires solitary dialogue with oneself, in the search for a new founding truth, the determining factor for the formation of opinion is, according to Arendt, that, even in the absence of those who are represented, their positions must be present in the spirit of those who represent them. For Arendt:

This process of representation or extended mentality does not blindly adopt the effective positions of those who are absent and contemplate the world from another perspective, it is not a matter of empathy, as if I seek to be or feel like someone else, nor of counting the votes of a majority to join them, but of being and thinking about my own identity somewhere, where I really am. (Arendt, 2005, p. 92-93)

Inevitably, the question arises: how is this representation possible? And how does this process of representation become legitimate? According to the philosopher, this situation is only possible when certain rules are followed during the formation of opinion. Hannah Arendt was a constitutionalist thinker and not just a thinker of the beginnings as she is generally known. Thus, political action, in order to be an action where political freedom occurs, must obey a set of rules, that is, there must be what Christian Volk calls political rationality. Hannah Arendt writes:

Opinions arise whenever men communicate freely and have the right to express their positions in public; but these positions, in their infinite variety, also seem to need purification and representation, and the original specific function of the Senate was to be the "medium" through which all public positions should pass. (Arendt, 2011, p. 288)

In this way, critical thinking is the way to combat isolation, because one is in the company of others and with others in a context of comprehensive representation. Let us recall what Hannah Arendt argues:

The more positions of people I have in my mind when reconsidering a certain problem, and the better I can imagine how I would feel and think, if I were in your place, the stronger my capacity for representative thinking will be and the stronger my conclusion, my opinion, therefore. (It is this aptitude for an enlarged mentality that enables men to judge.)" (Arendt, 2005, p. 92-93)

For Jeremy Waldrom, political action in Hannah Arendt can never function without (certain) rules, which effectively establishes the difference between structured politics and all

forms of "undifferentiated eruption of mass opinion in an extra-parliamentary context that so disturbed Arendt." (Apud, Volk, 2017, p. 200).

3 CONCLUSION

Political freedom can only occur in moderate regimes and obeys rules, functioning as a specific way of conducting political action, being, therefore, the opposite of the abuse of power. For Hannah Arendt, Law is seen as a relationship that is established between different entities. Law is desubstantialized, it means that it is something relative, as Arendt says "relations that exist and preserve different spheres of being" (Arendt, 2011, p. 244). Politics and Law have a relationship of dehierarchization, functioning according to different logics, which implies that neither is sovereign in relation to the other. The "extended mentality" represents a way of moving from pluralism to moral and political equality among human beings, and it is through this mentality that the recognition of the Other is achieved.

The multiplicity of interests and the diversity of opinions are essential characteristics of what can be considered a "free government". In addition, no one is able to form their own opinion without benefiting from a multiplicity of opinions from others, and it is important to highlight that the role of public opinion can put at risk even the opinion of those few who have the courage to disagree with it.

Critical thinking is, therefore, an essential condition to ensure the diversity of perspectives and ensure the acceptance of multiple interests in the face of a diverse reality. Critical thinking with a comprehensive view of perspectives is therefore necessary. In this way, participation in assemblies is a fundamental form of involvement in public governance. Based on the above, we conclude that Hannah Arendt can be considered a constitutionalist thinker, whose work reflects crucial issues for Politics and Law.

REFERENCES

- Arendt, H. (2005). *Verdade e política*. Lisboa Editora.
- Arendt, H. (2011). *Sobre a revolução*. Companhia das Letras.
- Arendt, H. (2017). *Desobediência civil*. Relógio D'Água.
- Arendt, H. (2020). *Denktagebuch: 1950–1973*. Piper Verlag.
- Campillo Iborra, N. (2014). *Hannah Arendt: Lo filosófico y lo político*. Publicacions de la Universitat de València.
- Hirura, K. (2019). *Arendt on freedom, liberation, and revolution*. Palgrave Macmillan.

Kant, I. (2017). *Crítica da faculdade do juízo*. Instituto Nacional Casa da Moeda.

Volk, C. (2017). *Arendtian constitutionalism: Law, politics and the order of freedom*. Bloomsbury.

Waldron, J. (2000). Arendt's constitutional politics. In D. Villa (Ed.), *The Cambridge companion to Hannah Arendt* (pp. 201–219). Cambridge University Press.

EXPENDITURES ON SCIENCE AND TECHNOLOGY (S&T) AND RESEARCH AND DEVELOPMENT (R&D) APPLIED TO THE MINISTRY OF HEALTH: CORRELATION WITH HUMAN RESOURCES TRAINING AND PUBLIC POLICIES FOR THE PERIOD 2014 – 2023

DISPÊNDIOS EM CIÊNCIA E TECNOLOGIA (C&T) E PESQUISA E DESENVOLVIMENTO (P&D) APLICADOS AO MINISTÉRIO DA SAÚDE (MS): CORRELAÇÕES COM A FORMAÇÃO DE RECURSOS HUMANOS E POLÍTICAS PÚBLICAS DO PERÍODO 2014-2023

GASTOS EN CIENCIA Y TECNOLOGÍA (C&T) E INVESTIGACIÓN Y DESARROLLO (I+D) APLICADOS AL MINISTERIO DE SALUD: CORRELACIONES CON LA FORMACIÓN DE RECURSOS HUMANOS Y LAS POLÍTICAS PÚBLICAS PARA EL PERÍODO 2014-2023



<https://doi.org/10.56238/sevened2026.008-249>

Roberto Augusto Caracas Neto¹, Marcelo Luiz Soares Pereira², Maira Uchôa Moura³, Thalita Duque Martins Paes⁴, Cristiana Maria do Valle Freitas⁵, Eduardo Winter⁶, Evanildo Vieira dos Santos⁷

ABSTRACT

This study analyzes public expenditures on Science and Technology (S&T) and Research and Development (R&D) within the Ministry of Health (MS), correlating them with human resources training provided by the Ministry of Education (MEC/CAPES) between 2014 and 2023. The timeframe covers the period from the 2015 fiscal crisis to the 2023 budgetary restoration, including the critical impact of the COVID-19 pandemic. The research investigates how structural investment in the scientific base and personnel qualification within

¹ Doctoral student. Programa de Pós-Graduação em Propriedade Intelectual e Inovação (PPGPI). E-mail: robertocaracas2000@gmail.com Orcid: <https://orcid.org/0000-0001-8484-411X> Lattes: <https://lattes.cnpq.br/4553279121829196>

² Doctoral student. Programa de Pós-Graduação em Propriedade Intelectual e Inovação (PPGPI). E-mail: marceloluiz2016@gmail.com Doctoral student: <https://orcid.org/0009-0009-1917-3554> Lattes: <https://lattes.cnpq.br/7433237430544504>

³ Master's student in Intellectual Property and Technology Transfer for Innovation. Universidade Federal de Pernambuco (UFPE). E-mail: maira.uchoa@ufpe.br Doctoral student: <https://orcid.org/0009-0007-1948-4147> Lattes: <https://lattes.cnpq.br/9179958502552393>

⁴ Doctoral student in Intellectual Property and Innovation. Instituto Nacional da Propriedade Industrial (INPI). E-mail: thalita@duquepaes.com.br Doctoral student: <https://orcid.org/0000-0002-5546-7375> Lattes: <https://lattes.cnpq.br/1501220349253023>

⁵ Master's student in Intellectual Property and Innovation. Instituto Nacional da Propriedade Industrial (INPI). E-mail: cristianavf@gmail.com Doctoral student: <https://orcid.org/0009-0000-0538-999X> Lattes: <https://lattes.cnpq.br/1012752946972157>

⁶ Dr. in Science. Universidade Estadual de Campinas. E-mail: winterinpi@gmail.com ORCID: <https://orcid.org/0000-0002-0896-9276> Lattes: <http://lattes.cnpq.br/5404510836890906>

⁷ Dr. in Intellectual Property and Innovation. Instituto Nacional da Propriedade Industrial (INPI). E-mail: evanildo@inpi.gov.br Doctoral student: <https://orcid.org/0000-0002-5546-7375> Lattes: <http://lattes.cnpq.br/0291501734843678>

the National Graduate System support the Health Economic-Industrial Complex (CEIS). Adopting a transversal approach, it examines the role of regulatory frameworks, such as the New Legal Framework for S,T&I, in reducing external dependence and promoting health sovereignty. The results indicate that the resilience of health policies depends on the integration between the MS technological induction and the academic capacity fostered by the MEC.

Keywords: Innovation Financing. Health Sovereignty. National Graduate System.

RESUMO

Este estudo analisa os dispêndios públicos em Ciência e Tecnologia (C&T) e Pesquisa e Desenvolvimento (P&D) no Ministério da Saúde (MS), correlacionando-os à formação de recursos humanos via Ministério da Educação (MEC/CAPES) entre 2014 e 2023. O recorte temporal abrange desde a crise fiscal de 2015 até a recomposição orçamentária de 2023, incluindo o impacto crítico da pandemia de COVID-19. A pesquisa investiga como o investimento estrutural na base científica e a qualificação de pessoal no Sistema Nacional de Pós-Graduação sustentam o Complexo Econômico-Industrial da Saúde (CEIS). Utilizando uma abordagem transversal, examina-se o papel de marcos regulatórios, como o Novo Marco Legal de C,T&I, na redução da dependência externa e na promoção da soberania sanitária. Os resultados indicam que a resiliência das políticas de saúde depende da integração entre a indução tecnológica do MS e a capacidade acadêmica fomentada pelo MEC.

Palavras-chave: Financiamento da Inovação. Soberania Sanitária. Sistema Nacional de Pós-Graduação.

RESUMEN

Este estudio analiza el gasto público en Ciencia y Tecnología (C&T) e Investigación y Desarrollo (I+D) del Ministerio de Salud (MS), correlacionándolo con el desarrollo de recursos humanos a través del Ministerio de Educación (MEC/CAPES) entre 2014 y 2023. El período abarca desde la crisis fiscal de 2015 hasta la recuperación presupuestaria de 2023, incluyendo el impacto crítico de la pandemia de COVID-19. La investigación analiza cómo la inversión estructural en la base científica y la cualificación del personal del Sistema Nacional de Posgrado apoya el Complejo Económico-Industrial de la Salud (CEIS). Mediante un enfoque transversal, examina el papel de los marcos regulatorios, como el Nuevo Marco Legal para C&T e I+D, en la reducción de la dependencia externa y la promoción de la soberanía sanitaria. Los resultados indican que la resiliencia de las políticas de salud depende de la integración entre la inducción tecnológica del MS y la capacidad académica impulsada por el MEC.

Palabras clave: Financiamiento de la Innovación. Soberanía Sanitaria. Sistema Nacional de Posgrado.

1 INTRODUCTION

The national sovereignty of a country, in the twenty-first century, is intrinsically linked to its capacity for technological response in the face of global health crises and to the robustness of its National Innovation System (SNI). In Brazil, this dynamic is supported by a strategic institutional binomial: on the one hand, the Ministry of Health (MoH), which acts as a demand inducer and funder of applied Research and Development (R&D); on the other, the Ministry of Education (MEC), which, through the Coordination for the Improvement of Higher Education Personnel (CAPES) (BRASIL, 2023), provides the human and academic infrastructure necessary for the production of knowledge.

The time frame between 2014 and 2023 is particularly emblematic for analyzing this integration. This decade was crossed by a contradictory institutional duality. If, on the one hand, regulatory frameworks such as the New Legal Framework for S, T&I (Law No. 13,243/2016) sought to reduce bureaucracy in innovation and foster the triple helix, on the other hand, the imposition of Constitutional Amendment No. 95/2016 ("Spending Ceiling") subjected public investments to a scenario of financial asphyxiation, deepening the chronic underfunding of the Unified Health System (SUS) and impacting the sustainability of long-term policies (Souza *et al.*, 2020; FIOCRUZ, 2023).

In this context, health is not seen only as a social service, but as a thriving economic sector, synthesized in the concept of the Health Economic-Industrial Complex (CEIS) (BRASIL, 2023). According to the perspective of Mariana Mazzucato's (2014; 2022) "Entrepreneurial Public Administration", the State must act not only by correcting market failures, but as an inducing agent of strategic "missions". In Brazil, however, the operationalization of this theory faces the challenge of budget fragmentation and a temporal misalignment between the training of masters and doctors and the capacity of absorption of these talents by the market and the public sector according to the Organization for Economic Co-operation and Development (OECD, 2023).

The COVID-19 pandemic in 2020 acted as a catalyst for this system, exposing both the resilience of Brazilian research institutions and their external vulnerability in basic inputs (APIs) and cutting-edge technologies. While the Ministry of Health presented emergency peaks in expenditures to respond to the crisis, the Ministry of Education faced the challenge of maintaining the stability of the National Graduate System (SNPG) in the face of budget cuts and the discontinuation of internationalization programs, such as Science without Borders, which generated direct impacts on the global circulation of knowledge and the phenomenon of "brain drain" (CGEE, 2022).

In view of the above, the present study seeks to analyze the correlation between the expenditures in Science and Technology (S&T) and R&D carried out by the Ministry of Health and the Ministry of Education and the Ministry of Education (MEC/CAPES) in the mentioned period. We investigate the hypothesis that the volatility of the Ministry of Health's investments, in contrast to the relative formative inertia of the Ministry of Education, creates a mismatch that threatens national health sovereignty. The objective is to understand how the fluctuation of these *input* indicators affected the scientific base in the health area and how the alignment, or lack thereof, with current public policies shaped the country's innovation capacity.

2 METHODOLOGY

This study is based on the analysis of official secondary data released by the Ministry of Science, Technology and Innovation (MCTI) (BRASIL, 2025), referring to federal expenditures in Science and Technology (S&T) and Research and Development (R&D) carried out by the Ministries of Health (MS) and Education (MEC) in the period from 2014 to 2023. The collection of indicators is under the scope of the hypothetical-deductive method (Marconi; Lakatos, 2024). The objective was to examine the evolution of these expenditures over time, focusing on the area of Health and the training of human resources.

Marconi and Lakatos (2024) divide this process into rigorous steps that guarantee the validity of the subsequent analysis:

- a. **Planning:** define exactly what to measure (the indicators).
- b. **Instrumentalization:** create the collection forms or matrices.
- c. **Data Collection:** the field phase or secondary data collection.
- d. **Tabulation:** organization of the data so that they can "speak".
- e. **Analysis and Interpretation:** where the data are confronted with the initial theory.

Financial data were extracted from the MCTI's *publication National Indicators of Science, Technology, and Innovation 2025* (BRASIL, 2025), specifically from Tables 1.2.2 (*Federal government expenditures on S&T, by agency, 2000–2023*) and 1.2.3 (*Federal government expenditures on R&D, by agency, 2000–2023*). Based on this information, comparative Figures were prepared for expenditures in S&T and R&D directed to the Ministry of Health and the Ministry of Education.

In addition, indicators related to the training of human resources and scientific capacity in Health Sciences were analyzed, also obtained from the same MCTI report (BRASIL, 2025), in the specific areas of the area. Data from the CNPq Directory of Research Groups (2023) (Table 2.4.2 – *Researchers registered by major area, 2000–2023*), CAPES on graduate scholarships awarded in the country (Table 3.7 – *Scholarships by large area, 2000–2024*), as

well as information on academic background, were used, based on Tables 2.2.1 (*Undergraduate graduates*), 2.3.2 (*Doctoral students*), and 2.3.3 (*Master's degree students*), all referring to the period from 2000 to 2024.

The analysis focused on input indicators, organized into two axes: (i) financial indicators, including federal expenditures on S&T and R&D, disaggregated by ministry and analyzed in annual historical series at current values; and (ii) indicators of scientific capacity and training of human resources, covering the number of undergraduate and graduate students, national and foreign graduate scholarships, and the number of researchers registered in the area of Health Sciences.

The methodological procedures involved descriptive analysis of the time series and interinstitutional comparison between the Ministry of Health and the Ministry of Education, with the organization of the data in Figures to allow the visualization of the patterns of funding and scientific training over the period analyzed.

3 RESULTS AND DISCUSSION

3.1 THE EVALUATION OF THE EVOLUTION OF INPUT INDICATORS IN SCIENCE, TECHNOLOGY AND INNOVATION IN THE AREA OF HEALTH

The analysis of the evolution of *input* indicators in Science, Technology, and Innovation (S&T) and Research and Development (R&D) in the area of Health, in the period from 2014 to 2023, shows distinct patterns of funding and formation of scientific capacities among the main federal actors, notably the Ministry of Health (MS) and the Ministry of Education (MEC). These indicators allow us to understand both the budgetary dynamics and the support of the human resource base and research groups responsible for national scientific production.

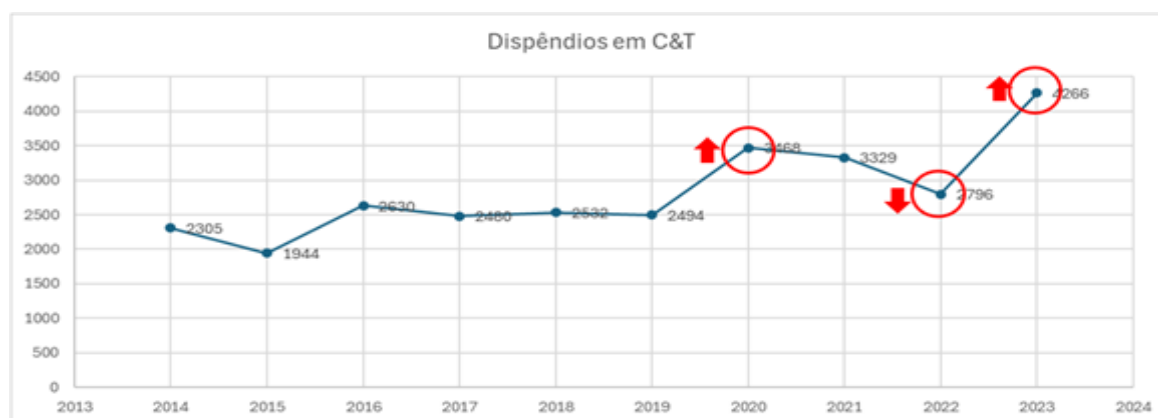
Figures 1 to 4 were generated with data from 10 years (2014-2023) from tables 1.2.2 and 1.2.3 of the *MCTI's National Indicators of Science, Technology and Innovation 2025* (BRASIL, 2025, p. 33 and 35).

Figures 1 and 2 show the amounts of expenditures indicated in the aforementioned tables made to the Ministry of Health. These Figures show significant oscillations in investments to the Ministry of Health, highlighting points of more significant increases or decreases in investments in the analyzed series. In S&T, there was a decrease between 2014 and 2015, followed by a recovery in 2016 and relative stability between 2017 and 2019. In 2020, there is a strong expansion in expenditures, followed by a retreat in 2021 and a further reduction in 2022. In 2023, investments reached the highest level in the time series (R\$ 4.266 million), signaling a significant resumption of financing. The trajectory of R&D spending is

similar, with a decline in 2015, a recovery in 2016, stability until 2018, and growth in 2019. In 2020, there was a new peak, followed by retractions in 2021 and 2022. In 2023, R&D expenditures grew significantly again, reaching the highest level of the decade (R\$3.883 million).

Figure 1

S&T expenditures to the Ministry of Health between 2014 and 2023



Source: BRAZIL (2025).

Figure 2

R&D expenditures to the Ministry of Health between 2014 and 2023

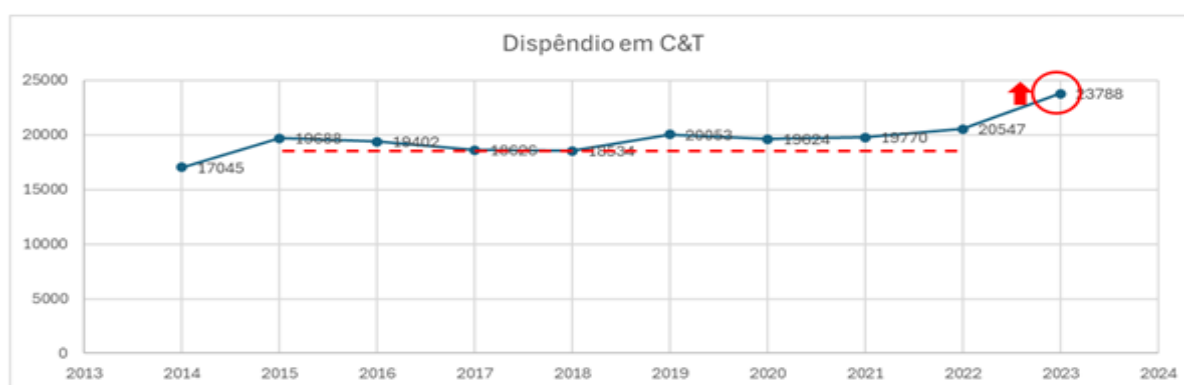


Source: BRAZIL (2025).

Figures 3 and 4 show the amounts of expenditures indicated in the aforementioned tables made to the Ministry of Education. In contrast to the Ministry of Health's outline, the Ministry of Education's expenditures on S&T and R&D show a significantly more stable trajectory over the period analyzed. Between 2015 and 2021, the values remain relatively constant, with small oscillations around a stable average. From 2022 onwards, there is more consistent growth, culminating in 2023 at the highest level in the series in both S&T (R\$21.788 billion) and R&D (R\$21.934 billion).

Figure 3

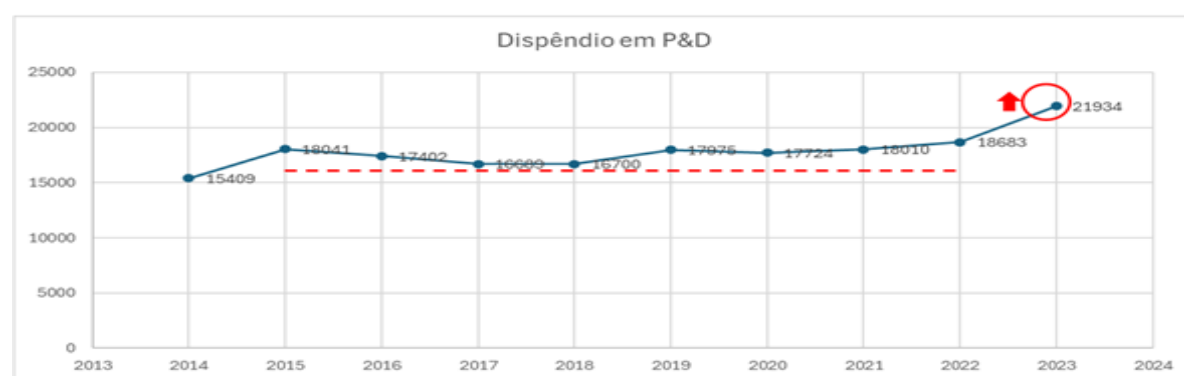
S&T expenditures to the Ministry of Education between 2014 and 2023.



Source: BRAZIL (2025).

Figure 4

R&D expenditures to the Ministry of Education between 2014 and 2023.



Source: BRAZIL (2025).

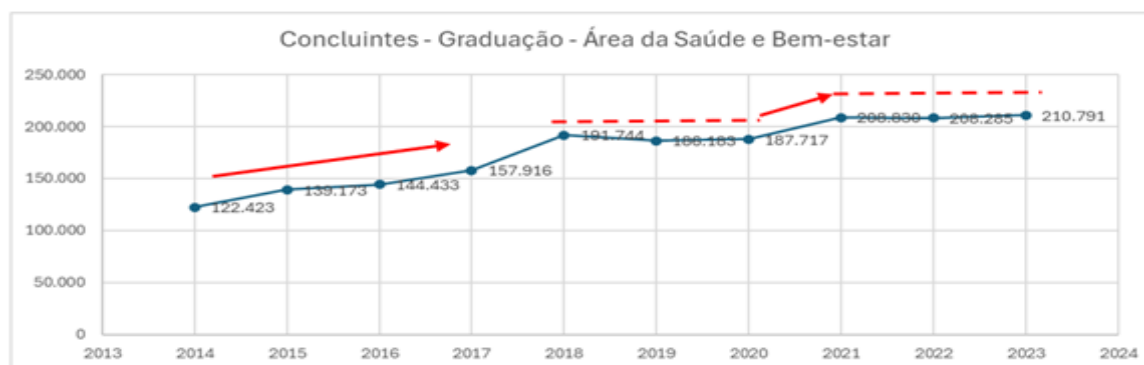
The comparison between the expenditures of the Ministry of Health and the Ministry of Education in S&T (Figures 1 and 3) and R&D (Figures 2 and 4) shows that there is no direct or synchronized link between the two budgets. While the MEC shows regular and predictable behavior, the MS exhibits greater volatility, responding to specific policies and health events. This dissociation suggests that these spheres of federal investment operate according to different logics: a structural one, aimed at maintaining the scientific base (MEC), and a conjunctural one, oriented to the application and response in public health (MH).

Figures 5, 6 and 7 were prepared with 10-year data from tables 2.2.1, 2.3.2 and 2.3.3 of the *MCTI National Indicators of Science, Technology and Innovation 2025* (BRASIL, 2025, p. 70, 76 and 79) and show that the training of human resources in the area of Health and Social Welfare showed gradual, but timid growth throughout the decade, both at the undergraduate and graduate levels. In undergraduate studies, there was a more upward trajectory between 2014 and 2017, followed by a decrease in pace between 2018 and 2020, forming a plateau, with a subsequent resumption in 2021 and a new stabilization until 2023.

A similar pattern is identified in graduate studies, with continuous growth in the number of master's and doctoral degrees until 2019, a sharp drop in 2020, and a gradual recovery in subsequent years. These movements indicate that, despite the expansion of the training base in Health Sciences, growth occurs in a contained way.

Figure 5

Number of graduating undergraduate students in the area of health and well-being between 2014-2023



Source: BRAZIL (2025).

Figure 6

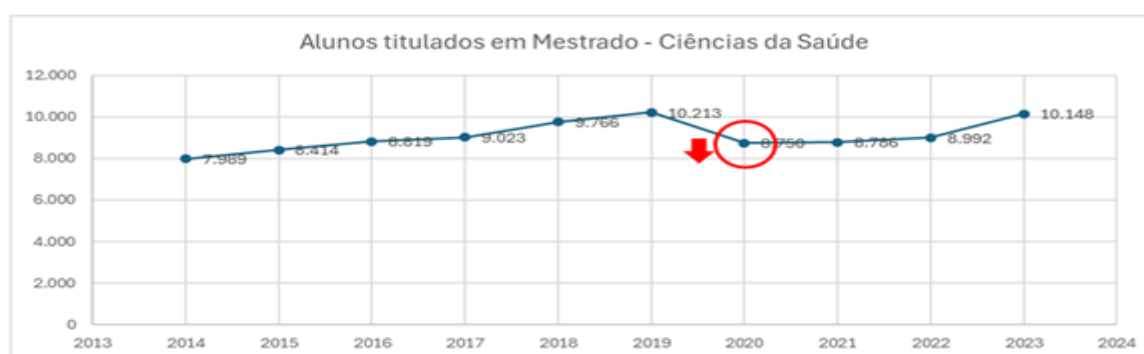
Number of PhD students in the area of health sciences between 2014-2023



Source: BRAZIL (2025).

Figure 7

Number of students with master's degrees in the area of health sciences between 2014-2023

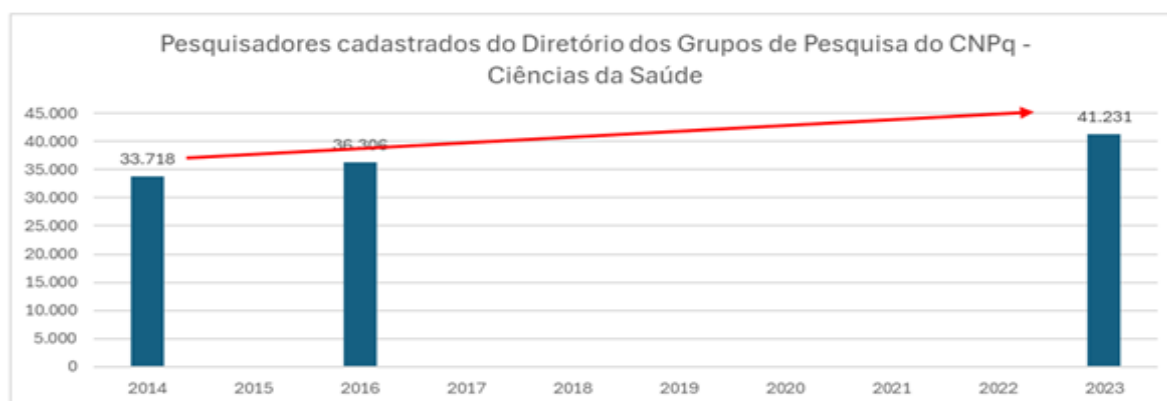


Source: BRAZIL (2025).

Figures 8, 9 and 10 were generated from tables 2.4.2 and 3.7 of the *MCTI National Indicators of Science, Technology and Innovation 2025* (BRASIL, 2025, p. 85 and 104). There is a continuous growth in the number of researchers registered in the CNPq Directory of Research Groups (2023) between 2014 and 2023, with an approximate expansion of 22%, indicating a strengthening of the scientific capacity installed in the country. However, this growth has not been proportionately matched by funding for advanced training. National graduate scholarships remained relatively stable between 2014 and 2018, with a slight retraction in 2019 and only timid growth until 2023. In contrast, graduate scholarships awarded abroad showed a strong retraction throughout the decade, with a sharp drop from 2015 onwards, reflecting the reduction in the internationalization of health research and the limitation of the global insertion of Brazilian researchers.

Figure 8

Number of Researchers Registered with CNPq – Health Sciences area, between 2014-2023



Source: BRAZIL (2025).

Figure 9

Number of CAPES Graduate Scholarships – Health Sciences area, awarded nationally between 2014-2023



Source: BRAZIL (2025).

Figure 10

Number of CAPES Postgraduate Scholarships – Health Sciences area, awarded abroad between 2014-2023



Source: BRAZIL (2025).

3.2 ALIGNMENT WITH GOVERNMENT PUBLIC POLICIES (2014-2023)

The alignment between public expenditures in Science, Technology and Innovation (S, T&I) and Research, Development and Innovation (R&D&I) in the areas of Health and Education with federal public policies from 2014 to 2023 reveals a trajectory marked by institutional advances, fiscal tensions and strategic redefinitions in the role of the State as an inducer of innovation. This alignment can be understood in three interdependent planes: political-normative, budgetary and strategic-programmatic.

Table 1

Federal Policies – Milestones and Alignments

Policy/Framework	Alignment and Impact on S,T&I and R,D&I
<i>National Policy for Science, Technology and Innovation in Health (PNCTIS) – Ministry of Health (MS)</i>	<i>The PNCTIS has consolidated itself as the structuring axis of the health innovation policy, prioritizing the strengthening of research applied to the Unified Health System (SUS), mainly through the Research for the SUS (PPSUS) program. The MoH's expenditures on S&T (see Table 1.2.3 of the MCTI's 2025 S&T Indicators) (BRASIL, 2025) reflect this orientation, with resources channeled to clinical and epidemiological studies and the development of assistive technologies and strategic medicines. The Department of Science and Technology (DECIT/SCTIE) played a central role in the operationalization of these resources, although budget execution was impacted by fiscal limitation and the slowness of transfers.</i>
<i>Legal Framework for Science, Technology and Innovation (Law No. 13,243/2016)</i>	<i>Established to make the management of public research more flexible and to encourage partnerships between universities (MEC), research institutes and the productive sector, the Legal Framework sought to reduce bureaucratic barriers and increase efficiency in the use of R&D resources. In the area of Health, the device expanded the possibilities of interaction between universities and public and private pharmaceutical laboratories, especially in biotechnology projects and vaccine production. In Education, it allowed greater integration between universities and companies, contributing to curricular and technological innovation in strategic areas.</i>
<i>National Graduate Plan (PNPG 2011–2020) – MEC/CAPEs</i>	<i>The PNPG established guidelines for the expansion and qualification of the National Graduate System (SNPG), providing for strong integration with the S&T and Innovation agendas. The increase in the number of masters and doctors in the area of Health and Science Education shows the effect of public investments and the development policies of CAPES and CNPq. The PNPG also strengthened the training of qualified human resources to work in research and innovation networks, an essential element for the consolidation of R&D&I ecosystems. The new PNPG (2021–2030) reinforces this priority, highlighting health as a strategic area for innovation missions.</i>
<i>Constitutional Amendment No. 95/2016 (Spending Ceiling)</i>	<i>It represented a negative inflection point in public financing of S&T and R&D. By limiting the real growth of primary expenditure for 20 years, EC 95 reduced the investment capacity of the Ministries of Health (MS) and Education (MEC). Although the areas have minimal constitutional obligations, the cap imposed severe restrictions on discretionary spending, precisely those that finance grants, laboratories, and scientific infrastructure. This restriction generated structural misalignment between the rhetoric of innovation and budgetary practice, directly affecting the execution of development programs.</i>

Source: authors.

3.3 GOVERNMENT STRATEGIES AND PLANS (2019–2023)

Federal expenditures on S&T and R&D in the area of Health maintained coherence with the most recent government policies and plans, demonstrating that, even under fiscal constraints, there was an attempt to maintain coherence with the State's strategic missions:

- a. Multi-year Plan (PPA 2020–2023): consolidated the guideline for strengthening the Health Economic-Industrial Complex (CEIS) (BRASIL, 2023), encouraging the national production of pharmaceutical inputs, vaccines, and medical equipment. This policy was reflected in the Ministry of Health's expenditures aimed at technological autonomy and innovation in public health, especially during and after the COVID-19 pandemic (BRASIL, 2020).
- b. ST&I Plan for Sustainable Development (BRASIL, 2020): promoted the integration of the areas of health, biotechnology, and social innovation, seeking to combine technological innovation with the reduction of regional inequalities. Public investments in biotechnology and pharmaceuticals have aligned with this guideline, boosting R&D projects at universities and public institutes.
- c. "New Industry Brazil" Strategy (BRASIL, 2024): still in the implementation phase, it anticipates developments from the previous cycle. NIB's "Health Mission" positions the sector as a vector of technological reindustrialization, prioritizing biotechnology, immunobiologicals and innovation in medical devices. Although outside the time frame (until 2023), its formulation derives from the institutional learning of the previous period, reinforcing the continuity of public policies for innovation in health.

3.4 THE DIMENSION OF EDUCATION AND SCIENTIFIC TRAINING

In Education, investments in S&T and R&D were strongly articulated with policies for the formation of human capital and educational innovation:

- a. The MEC, through CAPES, CNPq and Federal Institutes, was responsible for boosting the development of scientific and technological skills at the national level.
- b. The expansion of graduate studies and the creation of interdisciplinary programs aimed at pedagogical and technological innovation have strengthened the country's scientific base and sustained the training of researchers focused on priority areas (Health, Education and Technology).
- c. Programs to foster educational and scientific innovation — such as PIBIC, the Professional Master's Program in Teaching, and the Interinstitutional Research Networks — were aligned with the guidelines of the PNPG and the goals of the National Education Plan (PNE).

3.5 STATES AND MUNICIPALITIES

The federated entities act mainly through:

- a. Research Support Foundations (FAPs): State FAPs, such as those in São Paulo (FAPESP) and Minas Gerais (FAPEMIG), are crucial for R&D funding.
- b. PPSUS: The Research Program for SUS (PPSUS) is a decentralized program (MS/CNPq/FAPs) that aligns research with state and municipal priorities, evidencing the federative coordination effort in S&T in Health.
- c. Investment in Infrastructure (MEC): States and municipalities are responsible for maintaining part of elementary and secondary education. The contribution to S&T and R&D occurs more indirectly, through support for state universities or the use of resources linked to the Fund for the Maintenance and Development of Basic Education and the Valorization of Education Professionals (Fundeb).

3.6 ANALYTICAL SYNTHESIS

Between 2014 and 2023, it is observed that federal expenditures on S&T and R&D in Health and Education were strongly correlated with federal public policies (BRASIL, 2023; FIOCRUZ, 2023), with emphasis on:

- a. The centrality of Health as a vector of national innovation, via PNCTIS, PPSUS and CEIS;
- b. Scientific qualification as a State policy, via PNPG and CAPES;
- c. The tension between inductive innovation guidelines and fiscal restrictions, especially after EC 95/2016;
- d. The strategic reorientation of the role of the State, which, in the light of the Entrepreneurial Public Administration (MAZZUCATO, 2014; 2022), began to assume a more active role in inducing national development and innovation missions.

Thus, the period 2014–2023 configured a decade of institutional consolidation and financial challenges for the Brazilian S&T system, with Health and Education remaining as priority and complementary areas in the effort to transform knowledge into sustainable socioeconomic development.

3.7 HYPOTHESES FOR THE BEHAVIOR OF INDICATORS IN THE HEALTH AREA (MS + MEC)

The Figures indicate that the Ministry of Health's expenditures on Science and Technology and Research and Development do not present a linear or stable trajectory over time, but rather a cyclical behavior, strongly sensitive to conjunctural events. There was a significant increase in investments in 2020, which can be directly associated with the COVID-19 pandemic, a period in which there was an urgent demand for research aimed at the

development of vaccines, treatments, epidemiological studies, and strengthening the scientific capacity of the health system.

In 2023, there is a new peak in investments, which suggests a resumption or even a strategic prioritization of the area, possibly influenced by the lessons learned during the pandemic and the need to strengthen the research infrastructure and the response capacity of the health sector.

On the other hand, the decreases observed in 2015 and in the years 2021 and 2022 may be related to periods of fiscal adjustment or to the reduction of the budget priority allocated to the area, reflecting both changes in government guidelines and the economic context faced by the country at these times.

3.8 HYPOTHESES FOR THE MINISTRY OF EDUCATION'S INDICATORS

In contrast to the behavior observed in the Ministry of Health, the Ministry of Education's expenditures on Science and Technology and Research and Development show a more stable pattern over time. Between 2015 and 2021, investments remained relatively constant, which can be explained by the structural nature of these expenditures, mainly aimed at financing scholarships, maintaining graduate studies, and the functioning of higher education, which require continuous and predictable resources.

As of 2022, there is a growth trend, with emphasis on the values recorded in 2023, which may indicate the adoption of a policy to strengthen the educational and research system as a whole, reinforcing the role of higher education and graduate studies in national scientific production.

3.9 CORRELATION BETWEEN HEALTH AND EDUCATION INDICATORS

The analysis of the indicators reveals that there is no direct correlation between the budgets of the Ministry of Health and the Ministry of Education, since each portfolio has its own financing dynamics and different patterns of behavior over time. Even so, the joint observation of these data allows us to identify some relevant relationships. Although the investments of the Ministry of Education in Science and Technology and in Research and Development remain more consistent, the training of human resources in the area of health, both in undergraduate and graduate courses, showed a gradual expansion over the period analyzed, but with signs of stabilization. This behavior suggests the existence of a plateau, indicating that investments directed to health education were relatively modest and did not keep up with a faster pace of growth.

There is also a contradiction in the promotion of research in the area of Health Sciences. Despite the approximate growth of 22% in the number of researchers between 2014 and 2023, the funding mechanisms, especially graduate scholarships abroad, did not evolve at the same rate. On the contrary, there was a significant retraction in the number of scholarships awarded outside the country, evidencing limitations in the process of internationalization of Brazilian health research. National scholarships, in turn, remained relatively stable over the period, showing only timid growth until 2023, insufficient to compensate for the reduction in international training opportunities.

This scenario is directly related to the closure of the Science without Borders program, which had a significant impact on the promotion of graduate scholarships abroad, especially in the area of Health Sciences. The data show a sharp drop in the number of international scholarships, which went from 4,690 in 2014 to only 686 in 2023. This reduction coincides with the period after the end of the undergraduate program, in April 2017. Although Science Without Borders was later reformulated with a greater focus on graduate studies, this change was not enough to contain the significant decrease in the number of scholarships abroad. Thus, the end of the program is pointed out as one of the main factors responsible for the retraction of the internationalization of research and the limitation of the global insertion of Brazilian science.

As a consequence, the discontinuation of Science without Borders directly contributed to the reduction of the flow of Brazilian researchers abroad, negatively impacting the training of highly qualified human resources and international scientific cooperation, both in the area of health and in other fields of knowledge. In summary, the data indicate that funding in Science and Technology and Research and Development in the area of health tends to be reactive to specific events and specific policies, as occurred during the 2020 pandemic, in contrast to the more structural and continuous nature of investments in education. Despite the numerical growth of the system for training health researchers, funding has not kept pace with this evolution, especially with regard to internationalization, which may represent an obstacle to the development and competitiveness of Brazilian research in this area.

4 FINAL CONSIDERATIONS

The analysis of the period between 2014 and 2023 shows that the Brazilian S, T & I system in the health sector was marked by relevant institutional changes and recurrent fiscal instabilities. This interval ranges from the fiscal crisis of 2015–2016 to the attempts to recompose the budget in 2023, revealing the centrality of the State in responding to health emergencies, especially during the COVID-19 pandemic.

The results show that the MoH's spending on S&T and R&D presents a cyclical and predominantly reactive behavior, sensitive to external shocks, in contrast to the greater stability observed in the MEC's investments aimed at sustaining the scientific base. The investment peaks recorded in 2020, followed by retractions to pre-pandemic levels, show a structural fragility in the funding of applied health research, marked by the dependence on exceptional contributions to the detriment of permanent and predictable mechanisms.

In the axis of human resources training, there was an expansion of the base of researchers until 2020, followed by stagnation associated with budget retraction. Although the number of researchers has grown over the period, the reduction in per capita funding has compromised the continuity of long-term projects and the ability to retain talent. The discontinuity of internationalization policies, reflected in the significant drop in scholarships abroad after 2017, reinforced structural limitations to the international insertion of Brazilian science.

EC No. 95/2016 emerges, in this context, as one of the main factors of systemic restriction to the financing of S, T&I, deepening the misalignment between strategic innovation objectives and the fiscal reality (FIOCRUZ, 2023). Although normative frameworks such as the Legal Framework for S, T & I and the PNCTIS have created instruments favorable to cooperation between academia and the productive sector, their effects have remained conditioned to an environment of chronic underfunding, particularly sensitive within the scope of the SUS and the CEIS (BRASIL, 2023).

5 FUTURE PERSPECTIVES

In light of the findings of this study, the future prospects of S, T & I in health in Brazil depend on overcoming structural inconsistencies identified both in the literature and in institutional practice. One of the main gaps observed lies in the mismatch between the existence of legal frameworks favorable to innovation and the absence of stable financial mechanisms that guarantee its effective operationalization over time.

In this sense, future research can contribute to the development of financing models that articulate budget predictability and institutional flexibility, reducing dependence on emergency cycles associated with health crises. The literature still lacks comparative empirical analyses that assess the impact of different continuous funding arrangements on the sustainability of applied health research (BRASIL, 2023), especially in countries with universal systems similar to the SUS.

Another relevant inconsistency concerns the fragmentation of inter-institutional governance. The results indicate the need to deepen studies on coordination mechanisms

between MS, MCTI, MEC, CAPES, and CNPq (BRASIL, 2023), capable of aligning the training of human resources, scientific research, and technological innovation with the strategic priorities of the health system. Future investigations can explore integrated governance models that minimize overlaps, expand synergies, and optimize the use of public resources.

In addition, the retraction of internationalization policies reveals an important gap in the understanding of the long-term effects of the discontinuity of academic mobility programs on the quality, competitiveness, and global insertion of national science. Future studies may evaluate alternative strategies for international cooperation that reconcile fiscal constraints with the maintenance of strategic scientific networks.

Finally, the adoption of mission-oriented approaches, inspired by the Entrepreneurial Public Administration model, presents itself as a promising field of applied research. Future analyses can examine how this model can be adapted to the Brazilian institutional context, in order to articulate the existing scientific base with innovation guided by concrete challenges of the SUS, contributing to the strengthening of the CEIS (BRASIL, 2023) and to the expansion of technological sovereignty in health.

REFERENCES

- Brasil. Ministério da Ciência, Tecnologia e Inovação. (2025). Indicadores nacionais de ciência, tecnologia e inovação 2025. <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/indicadores>
- Brasil. (2020). Plano plurianual 2020–2023. Ministério da Economia.
- Brasil. (2024). Nova indústria Brasil (NIB). Governo Federal.
- Brasil. Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2023). Dados de bolsas e programas de pós-graduação, área de saúde (2014–2023). <https://www.gov.br/capes/pt-br>
- Conselho Nacional de Desenvolvimento Científico e Tecnológico. (2023). Diretório dos grupos de pesquisa no Brasil: Lattes. <http://lattes.cnpq.br/web/dgp>
- Centro de Gestão e Estudos Estratégicos. (2022). Observatório de ciência, tecnologia e inovação (OCTI). <https://octi.cgee.org.br/indicadores/brasil/outros/amazonia-legal>
- Fundação Oswaldo Cruz. (2023). Relatórios de gestão 2020–2023: Subfinanciamento do SUS e impactos na capacidade de P&D em saúde pública. <https://portal.fiocruz.br>
- Marconi, M. de A., & Lakatos, E. M. (2024). Fundamentos de metodologia científica. Atlas.
- Mazzucato, M. (2014). O estado empreendedor: Desmascarando o mito do setor público vs. setor privado. Portfolio Penguin.

Mazzucato, M. (2022). Mission economy: A moonshot guide to changing capitalism. Penguin.

Organisation for Economic Co-operation and Development. (2023). OECD reviews of innovation policy: Brazil 2023. https://www.oecd.org/en/publications/oecd-reviews-of-innovation-policy_19934211.html

Souza, C., et al. (2020). O subfinanciamento do sistema único de saúde e seus efeitos na saúde pública. *Physis: Revista de Saúde Coletiva*, 30(3), e300309. <https://doi.org/10.1590/S0103-73312020300313>

LANGUAGE, DISCOURSE AND TOTALITARISM: FROM THE REDUCTION OF THE OTHER TO THE DEMOCRATIC PATHS OF DIALOGUE

A CONSTRUÇÃO DA LINGUAGEM E O DISCURSO TOTALITÁRIO: DA REDUÇÃO DO OUTRO ÀS VIAS DEMOCRÁTICAS DO DIÁLOGO

LA CONSTRUCCIÓN DEL LENGUAJE Y EL DISCURSO TOTALITARIO: DE LA REDUCCIÓN DEL OTRO A LAS VÍAS DEMOCRÁTICAS DEL DIÁLOGO



<https://doi.org/10.56238/sevened2026.008-250>

Antonio Coêlho Soares Junior¹, Joaquim Ribeiro de Souza Junior², Isabella Holanda da Silva³

ABSTRACT

This article aims to analyze the relationship between the constitution of language and the central role of discourse in the individual's participation within the social sphere, based on the hypothesis that the predominance of monolithic discourses fosters the emergence of totalitarian regimes. Such regimes systematically seek cultural and social homogenization, transforming all forms of alterity into threats to be eliminated, thereby contributing to the construction of exclusionary logics and potential social and political conflicts. The study adopts a hypothetical-deductive method, grounded in bibliographic research, and draws on the contributions of Michel Foucault and Ludwig Wittgenstein in the field of philosophy of language, particularly regarding the formation and functioning of language. With respect to totalitarianism and the construction of authoritarian discourse, the analysis is supported by the theoretical frameworks of Hannah Arendt and Claude Lefort. Finally, the article emphasizes the importance of the inclusion of the other and the role of dialogue, from a Habermasian perspective, as fundamental elements for the preservation of democratic societies and for resisting the consolidation of totalitarian structures.

Keywords: Dialogue. Discourse. Totalitarianism.

RESUMO

O presente artigo tem por objetivo analisar a relação entre a constituição da linguagem e a centralidade do discurso na participação do indivíduo no âmbito social, partindo da hipótese de que a predominância de discursos monolíticos favorece a emergência de regimes totalitários, os quais buscam, de maneira sistemática, a uniformização cultural e social, convertendo toda forma de alteridade em ameaça a ser eliminada, contribuindo, assim, para a construção de uma lógica de exclusão e potenciais conflitos sociais e políticos. A pesquisa

¹ Dr. in Law. Università degli Studi Roma Tre. E-mail: antonio.coelho@ufma.br
Orcid: <https://orcid.org/0000-0003-3408-9915> Lattes: <http://lattes.cnpq.br/9061637440474333>

² Doctoral student in Law. Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
E-mail: joaquimjunior33@gmail.com Orcid: <https://orcid.org/0000-0003-3488-5508>
Lattes: <https://lattes.cnpq.br/3574109956957619>

³ Graduated in Law. Universidade Federal do Maranhão. E-mail: isa.bella1895@hotmail.com
Lattes: <http://lattes.cnpq.br/1577940080377071>

adota o método hipotético-dedutivo, com base em revisão bibliográfica, mobilizando, no campo da filosofia da linguagem, as contribuições de Michel Foucault e Ludwig Wittgenstein acerca da formação e funcionamento da linguagem. No que concerne à análise do totalitarismo e da constituição do discurso autoritário, recorre-se às reflexões de Hannah Arendt e Claude Lefort. Por fim, o estudo enfatiza a importância da inclusão do outro e do diálogo, a partir da perspectiva habermasiana, como elementos fundamentais para a preservação de sociedades democráticas e para a resistência à consolidação de estruturas totalitárias.

Palavras-chave: Diálogo. Discurso. Totalitarismo.

RESUMEN

El presente artículo tiene por objeto analizar la relación entre la constitución del lenguaje y la centralidad del discurso en la participación del individuo en el ámbito social, partiendo de la hipótesis de que el predominio de discursos monolíticos favorece la emergencia de regímenes totalitarios, los cuales buscan, de manera sistemática, la uniformización cultural y social, convirtiendo toda forma de alteridad en una amenaza que debe ser eliminada, contribuyendo, de este modo, a la construcción de una lógica de exclusión y de potenciales conflictos sociales y políticos. La investigación adopta el método hipotético-deductivo, con base en revisión bibliográfica, movilizándolo, en el campo de la filosofía del lenguaje, las contribuciones de Michel Foucault y Ludwig Wittgenstein acerca de la formación y del funcionamiento del lenguaje. En lo que concierne al análisis del totalitarismo y de la constitución del discurso autoritario, se recurre a las reflexiones de Hannah Arendt y Claude Lefort. Por último, el estudio enfatiza la importancia de la inclusión del otro y del diálogo, desde la perspectiva habermasiana, como elementos fundamentales para la preservación de sociedades democráticas y para la resistencia a la consolidación de estructuras totalitarias.

Palabras clave: Diálogo. Discurso. Totalitarismo.

1 INTRODUCTION

The relationship between language, discourse and social organization constitutes one of the central axes of contemporary reflections on democracy and power. Far from being limited to a neutral instrument of communication, language is configured as a space of symbolic dispute, in which meanings are produced, power relations are structured and the limits of social inclusion and exclusion are defined. In this context, the way in which discourses are constructed and legitimized plays a decisive role in the constitution of social and political practices, and can both favor democratic environments and enable structures of domination.

This study starts from the hypothesis that the predominance of monolithic discourses — characterized by the denial of plurality and the delegitimization of otherness — creates favorable conditions for the emergence of totalitarian dynamics. Such dynamics operate through symbolic uniformity and the reduction of the other to the condition of threat, which compromises the possibility of dialogue and weakens the foundations of democratic coexistence.

To develop this analysis, the article initially mobilizes the contributions of Michel Foucault and Ludwig Wittgenstein, whose reflections allow us to understand language not only as representation, but as a situated social practice, crossed by rules, uses and power relations. Then, we resort to the formulations of Hannah Arendt and Claude Lefort, in order to examine the mechanisms of constitution of totalitarianism and the centrality of discourse in the maintenance of authoritarian regimes.

Finally, from the perspective of Jürgen Habermas, the importance of the inclusion of the other and dialogue as essential normative conditions for the consolidation of democratic societies is discussed. It is argued that openness to the plurality of voices and the recognition of otherness not only strengthen the public space, but also act as forms of resistance to totalizing tendencies present in different historical and social contexts.

From the methodological point of view, the research adopts a theoretical-analytical approach, guided by the hypothetical-deductive method, based on a qualitative literature review. The investigation is structured from a conceptual and comparative reconstruction of the contributions of Michel Foucault, Ludwig Wittgenstein, Hannah Arendt, Claude Lefort and Jürgen Habermas, seeking to identify points of convergence and tension between their perspectives regarding language, discourse and forms of social organization. From this theoretical articulation, a critical analysis of the conditions that favor the emergence of totalitarian discourses is carried out, as well as the normative possibilities of overcoming them within democratic regimes.

2 LANGUAGE AS A REPRESENTATION OF THOUGHT

2.1 THE FORMATION OF LANGUAGE IN MICHEL FOUCAULT

The understanding of language, in Michel Foucault's thought, moves away from perspectives that conceive it as a mere instrument for the representation of reality, assuming it as a historically situated practice that is inseparable from power relations. In this sense, language is not limited to describing the world, but actively participates in its constitution, operating as one of the main means by which knowledge is produced, discourses are organized, and forms of domination are structured.

In his archaeological phase, especially in *the work Words and Things*, Foucault introduces the concept of *episteme* as the historical configuration that defines the conditions of possibility of knowledge in a given period. Language, in this context, is not understood as a neutral system, but as part of a broader order that delimits what can be said, thought, and recognized as true. Thus, knowledge is no longer seen as a simple progressive accumulation and is understood as an effect of historical structures that organize discourses.

Language, in this sense, is intrinsically linked to the world, not only as a means of its representation, but as a constitutive element of the ways in which it is understood and organized. Through language, concepts are constructed, at the same time that the processes of problematization and resignification of reality become possible. Furthermore, it is language that establishes the mediation between the subject and the world, configuring a field of experience in which meanings are produced and ways of understanding reality are structured.

It is important to note, however, that this relationship should not be interpreted from ontological categories alien to Foucaultian thought. Although there is influence from Martin Heidegger at certain moments of his intellectual trajectory, Michel Foucault does not directly adopt concepts such as *Dasein*⁴, privileging, in his analysis, the investigation of the historical and discursive conditions that make possible the emergence of knowledge and forms of subjectivation.

In this context, it is possible to identify two fundamental moments that influence Foucault's understanding of knowledge. The first refers to the period before the seventeenth century, in which knowledge was predominantly organized based on the search for

⁴ *Dasein* is a central concept in Martin Heidegger's philosophy, especially developed in *Being and Time* (1927), which can be translated as "being-there" or "being-in-the-world". The term designates the human being's own mode of existence, characterized by his openness to the world, his ability to understand the being and his insertion in a historical and relational context. Although he exerted an indirect influence on several thinkers of the twentieth century, including Michel Foucault in the early stages of his career, the concept is not adopted in a systematic way in his work, which privileges the analysis of the historical and discursive conditions of knowledge production.

similarities and correspondences between the elements of the world. In this configuration, knowledge was not structured by ruptures or rigorous distinctions, but by relations of analogy, in which discourses tended to reproduce and reiterate what they intended to explain (FOUCAULT, p. 57). Thus, even when there were attempts at interpretation or criticism, these remained strongly linked to the object analyzed, producing variations that, although distinct in appearance, maintained a structural proximity to the original discourse. In this way, language operated as a mechanism of continuous reiteration, in which meanings unfolded indefinitely based on relations of similarity, generating an interpretative chain that did not break with its point of origin, but reproduced it under new forms (FOUCAULT, p. 57).

The second relevant moment for the understanding of Foucaultian thought emerges in the twentieth century, especially from the 1960s onwards, when language began to be problematized not only as a system of representation, but as a constitutive element of discursive practices. In this period, Foucault shifts his analysis to the historical conditions that make knowledge possible, showing that what can be said, thought and recognized as true is conditioned by specific discursive structures.

In the following decade, a deepening of this perspective was observed, with the more explicit incorporation of the relations between knowledge, power and subjectivity. Language, in this context, is no longer conceived only as a means of expression and is understood as a practice that actively participates in the production of truths and in the constitution of the subjects.

It is in this horizon that the notion of *parrhesia* is⁵ inserted, developed by Foucault in his late courses, understood as the practice of true saying, in which the subject assumes an ethical relationship with the truth, expressing himself in a frank and responsible way, even in the face of possible risks. This concept reinforces the ethical and political dimension of discourse, showing that language can operate not only as an instrument of power, but also as a space of resistance and critical constitution of the subject.

In addition to the notion of *parrhesia*, the concept of *episteme*⁶ is also highlighted, through which Foucault establishes an articulation between language, culture and forms of knowledge. It is the historical structure that delimits the conditions of possibility of knowledge at a given time, defining the criteria from which something can be recognized as true. In this sense, *episteme* is not reduced to a specific domain, but encompasses different fields of

⁵ The conception of *parrhesia* occurs as an experience of truth-telling, which becomes relevant in the second part of the twentieth century, proposed by Michel Foucault, as well as by Pierre Hadot, and Martha Nussbaum.

⁶ *Epistémê* deals with a necessary order of knowledge, "a principle of historical ordering of knowledge prior to the ordering of discourse established by the criteria of scientificity (...) the configuration, the disposition that knowledge assumes at a given time and that gives it a positivity" (p. 148-149). MACHADO, R. Science and knowledge: the trajectory of Foucault's archaeology. Rio de Janeiro: Graal, 1981.

knowledge — such as language, economics and biology — evidencing the existence of an underlying order that guides the production of knowledge in each historical period.

In this context, it becomes possible to understand the transition between the classical period and modernity with regard to the organization of knowledge about language. In the classical period, language was fundamentally conceived as a system of representation, structured by the relationship between signs and things, in which the search for an orderly and transparent correspondence between words and the world predominated.

In this horizon, the functioning of language was guided by principles of classification and ordering, in which the analysis of signs — often understood from the articulation between signifier and signified — aimed to guarantee the intelligibility of the real. It should be noted that part of the influences mobilized by Foucault in the analysis of this period refers to the rationalist tradition, especially to Port-Royal's General Grammar, which sought to establish universal foundations for language based on logical and cognitive structures⁷.

Furthermore, when advancing to the analyses developed by Michel Foucault from the 1970s onwards, a deepening of the articulation between knowledge, language and power is observed. In this context, knowledge is no longer understood as a neutral instance, but is conceived as the result of historically situated discursive practices, through which regimes of truth are established and power relations are organized.

Thus, language not only conveys knowledge, but actively participates in its constitution, becoming a central element in the production and legitimation of knowledge. Among the consequences of this perspective, the centrality of discourse as a space of dispute and production of meaning stands out, in which both the reproduction of structures of domination and the opening to critical practices become possible.

In this horizon, dialogue assumes a relevant role as a condition for the circulation of different perspectives and for the problematization of established discourses, configuring itself as a fundamental element for freedom of thought — an aspect that will be taken up and deepened in later sections.

From this perspective, when developing his analyses on the relations between knowledge and power, Michel Foucault shifts the focus from the understanding of knowledge as a merely normative or moral instance, starting to investigate it as a historically situated practice, crossed by power relations. In his late courses, especially in *The Government of Self and Others*, the author returns to ancient philosophy — with emphasis on the Socratic-

⁷ The Grammar of Port-Royal was published in 1660 with the purpose of presenting answers to the dissatisfactions with Renaissance grammar. It initially seeks scientific rigor, based on the foundations of French rationalism proposed by René Descartes

Platonic tradition — in order to examine the ways in which the subject constitutes itself in relation to truth.

In this reading, the emphasis falls on the modes of subjectivation, that is, on the processes by which individuals constitute themselves as subjects based on discursive and ethical practices. Truth, in this context, is not understood as absolute or universal data, but as something that is constructed in the relationship between the subject and the current regimes of truth, opening space for critical forms of positioning in the face of dominant discourses.

It is in this horizon that the notion of *parrhesia is inserted*, understood as the practice of saying truth, in which the subject assumes the commitment to enunciate the truth in a frank way, even in the face of risks. Inspired by the experience of Athenian democracy, Foucault shows that such a practice presupposes the possibility of confrontation between different perspectives, with dissent being a constitutive element of public life.

With the historical development of forms of social organization, however, there is a shift in this practice towards forms of discourse predominantly guided by rhetoric, in which persuasion occupies a central place. In this process, the discourse tends to dissociate itself from the ethical commitment to the truth, prioritizing argumentative efficacy to the detriment of the authenticity of the utterance, which contributes to the weakening of its critical potential.

2.2 NOTES ON LANGUAGE FOR LUDWIG WITTGENSTEIN

Having made the initial considerations about the Foucaultian perspective, we move on to the analysis of the conception of language developed by Ludwig Wittgenstein, especially from his work *Philosophical Investigations* (1953). In this context, the philosopher shifts the focus from an essentialist understanding of language to a pragmatic approach, in which meaning is not determined by a fixed essence, but by the effective use of expressions in concrete contexts of interaction.

Thus, language comes to be understood as a social activity, structured by practices shared within a community. Linguistic functioning, in this sense, is not based on abstract and universal rules, but on forms of use that are consolidated in everyday life, guiding mutual understanding among participants.

It is in this horizon that the notion of "language games" is inserted, through which Wittgenstein shows that to speak a language is to participate in a set of practices regulated by socially established conventions. Such games do not have rigid or completely fixed boundaries, but they present regularities that allow the recognition and intelligibility of the utterances, evidencing the dynamic and contextual character of the language.

In *Philosophical Investigations*, Ludwig Wittgenstein proposes a decisive inflection in the understanding of language by highlighting that the meaning of words is intrinsically linked to their use in specific contexts (WITTGENSTEIN, 1996). In this sense, the attribution of names or denominations is not carried out in an isolated or purely mental way, but presupposes the insertion of the subject in shared practices, in which one already knows how to use certain expressions.

From this perspective, language cannot be understood as an exclusive product of internal or subjective states, since its functioning depends on public criteria of use, constructed within a linguistic community. Meaning, therefore, does not precede use, but emerges from it, being continuously stabilized by social practices that enable mutual understanding among speakers.

In this context, Wittgenstein problematizes the idea of a private language, arguing that language necessarily presupposes the possibility of intersubjective sharing and verification. Speaking a language, therefore, implies participating in forms of life in which the senses are collectively constituted and recognized.

Furthermore, by developing the notion of language games, the author shows that linguistic practices are regulated by conventions that guide the use of expressions, without this implying the existence of rigid or absolutely fixed rules. On the contrary, such rules are subject to variations and may, in certain situations, reveal limits or tensions, as the author himself suggests when he observes that, when we follow previously established rules, we may face unforeseen difficulties in their application (WITTGENSTEIN, 1996, p. 74).

In this way, Wittgensteinian philosophy highlights the dynamic, public, and practical character of language, moving away from both strictly mentalist conceptions and models that presuppose totally closed normative systems.

From the propositions previously examined, it is possible to extract some relevant consequences for the understanding of language in the thought of Ludwig Wittgenstein. In the first place, it is not a matter of denying the possibility of attributing truth or falsity to propositions, but of recognizing that such criteria do not result from a direct and immediate correspondence between language and reality. On the contrary, the validity criteria are linked to the contexts of use and the linguistic practices in which the utterances are employed.

In this way, Wittgenstein's analysis shifts the problem of truth to the realm of practices, showing that the meaning and intelligibility of propositions depend on the rules and ways of life shared by the speakers. Such a perspective does not imply the rejection of empirical knowledge, but questions the idea that it can be based exclusively on isolated sensory data, disconnected from the linguistic and social contexts in which they are interpreted.

In this sense, Wittgenstein's central concern lies in the clarity in the use of language and in the understanding of the rules that guide discursive practices, differing from Michel Foucault's approach, which emphasizes the relationship between discourse, power and the production of knowledge. While Wittgenstein seeks to elucidate the ways in which language operates within forms of life, Foucault investigates the historical and institutional conditions that structure the regimes of truth, without, however, reducing the analysis to mere formal clarity, but highlighting the effects of power implied in the circulation of discourses.

Furthermore, it is possible to identify points of convergence between the perspectives of Ludwig Wittgenstein and Michel Foucault, although situated in different theoretical horizons. In Wittgenstein, the notion of language games shows that meaning emerges from use in shared social practices, being inseparable from the forms of life in which language is inserted. In turn, Foucault, when dealing with the so-called truth games, analyzes the mechanisms by which certain statements come to be recognized as true in specific historical contexts, based on relations between knowledge and power⁸. Although they are not equivalent concepts, both authors converge in rejecting the idea of an absolute and timeless truth, highlighting that the criteria of validity and meaning are conditioned by social, historical, and institutional practices. In this sense, both language games and truth games show the situated character of the production of meaning, although under different approaches: pragmatic, in the case of Wittgenstein, and historical-discursive, in the case of Foucault.

From the convergences previously outlined, as well as the central elements that structure the thought of Ludwig Wittgenstein and Michel Foucault, the theoretical bases for the development of subsequent analyses are established. In this sense, the articulation between language, discourse and social practices allows us to highlight the centrality of discourse in the constitution of social relations, as well as in the definition of the conditions of equality between subjects.

In this way, the valorization of discursive plurality and the recognition of the other as a legitimate interlocutor are fundamental elements for sustaining democratic environments, in which dissent and diversity of perspectives are not only admitted, but constitute an indispensable condition for the critical development of thought.

3 A BRIEF ANALYSIS OF TOTALITARIANISM

When starting a discussion about Totalitarianism, it is necessary to remember that there are several perspectives on this subject, for this reason, it is emphasized that the

⁸ Truth games are determined by the compilation of rules for the production of truth, and the individual who determines what can be declared as truth are free men, who agree among themselves and are immersed in a specific community, and its institutions, as Foucault teaches

guiding concepts of this topic will be based on the thought of the German philosopher Hannah Arendt.

From Hannah Arendt's perspective, totalitarianism has specific characteristics that distinguish it from other forms of political domination. In general, it is a regime marked by the pretension of total control over the lives of individuals, extending to all spheres of existence and operating through the integral submission of the population (ARENDT, 1989, p. 375). In this context, terror is not limited to a punctual instrument of repression, but assumes a structuring function, being systematically used as a mechanism of government and maintenance of the obedience of the masses (ARENDT, 1989, p. 26).

Furthermore, unlike traditional authoritarian regimes, in which power tends to manifest itself predominantly in the public and institutional sphere, totalitarianism advances on the internal dimension of individuals, seeking to shape not only their actions, but also their perceptions and ways of thinking. Such dynamics intensify the experience of fear, not only as a reaction to external threats, but as an internalized element, which guides behaviors and contributes to the reproduction of structures of domination.

Hannah Arendt draws a fundamental distinction between totalitarianism and other forms of political domination, such as tyrannies and dictatorships. Although these can also resort to fear and violence as instruments of control, in totalitarianism terror assumes a qualitatively different function, ceasing to be just a means of repression to become a structuring principle of the regime itself, operating in a continuous and comprehensive way over the totality of social life. In this context, the distinction between internal and external enemy is dissolved, since any individual can potentially be identified as a threat, which contributes to the generalization of insecurity and instability (ARENDT, 1989).

In addition, the author highlights a particularly relevant phenomenon: the internalization and reproduction of authoritarian discourse by the individuals subjected to the regime. Such dynamics are not limited to direct coercion, but involve mechanisms of adhesion, in which subjects begin to reproduce, in a mimetic way, the dominant ideological patterns, whether out of fear, the need to belong, or the search for recognition within the power structure.

Finally, the concept of totalitarianism in Arendt is not reduced to specific historical models, but is configured as a singular form of domination. In this sense, the author shows that, in such regimes, power does not necessarily manifest itself in the most visible instances of the state apparatus, and can operate in a diffuse and opaque manner, so that less apparent organizations concentrate greater capacity for control — a dynamic that expresses the complexity and depth of totalitarian structures (ARENDT, 1989, p. 453).

In Hannah Arendt's thought, it is highlighted that totalitarian domination is not sustained exclusively through direct coercion, but also involves forms of adherence that can take on the appearance of voluntariness. In this context, individuals are led to give up freedoms and rights in the name of a supposed protection offered by the State, which reveals the effectiveness of ideological mechanisms in the production of social conformity.

Such dynamics do not imply a fully free choice, but are inserted in structures that limit the real possibilities of action and political participation, producing a sense of engagement that often conceals the reproduction of dominant interests and discourses. The apparent participation in confronting threats — often constructed or amplified by the regime itself — contributes to the legitimization of practices that restrict plurality and weaken the autonomy of subjects.

In this sense, the consolidation of homogeneous discourses and the delegitimization of divergent perspectives are central elements of totalitarian structures, in which freedom is not simply explicitly denied, but progressively emptied in its practical dimension. As Arendt observes, the most disturbing character of these regimes lies not only in the direct suppression of freedom, but in the conception that it can – and should – be sacrificed in the name of a supposed historical development, whose course is intended to be necessary and inevitable (ARENDT, 1989, p. 51).

In the context of totalitarianism, as analyzed by Hannah Arendt, there is a significant rupture between the production of knowledge and the concrete experience of reality. This phenomenon is manifested in the construction of narratives that present themselves as coherent and self-evident truths, even if they are disconnected from the facts, contributing to the consolidation of closed ideological systems.

In this context, the formation of large masses that are socially and politically disjointed plays a fundamental role. According to Arendt, the viability of totalitarian domination is associated with the existence of populations considered "superfluous", whose elimination or sacrifice does not generate, in structural terms, immediate consequences that compromise the social order (ARENDT, 1989, p. 361).

Adherence to such dynamics does not result from a direct relationship with empirical reality, but from the internalization of ideological constructions that project future scenarios — often improbable — as a justification for maintaining power. In this way, discourses disconnected from concrete experience become socially effective, insofar as they offer totalizing explanations and mobilize collective action, even when based on fragile or distorted premises.

3.1 THE FORMATION OF AUTHORITARIAN DISCOURSE

After the analysis of the concept of totalitarianism developed by Hannah Arendt, we move on to the investigation of Slavoj Žižek's contributions about the constitution of reality within ideological discourses and the subject's submission in totalitarian contexts. To this end, the work *The Most Sublime of Hysterics: Hegel with Lacan is taken as a reference*, in which the author articulates elements of Lacanian psychoanalysis and Hegelian philosophy to understand the dynamics of ideology.

In this theoretical framework, Žižek proposes that the social bond in totalitarian contexts is not sustained only by external impositions, but by the internalization of ghostly structures that guide the desire of the subjects. In other words, ideology does not operate only at the conscious level, but structures the very way individuals perceive reality and relate to it. Thus, the distinction between social norm and subjective desire tends to dissolve, causing adherence to the system not only by coercion, but also by libidinal investment (ŽIŽEK, 1991, p. 157).

From this perspective, totalitarian discourse not only imposes an order, but mobilizes desire by presenting certain ideals as objects of collective identification. Power, in this context, is not limited to external domination, but is realized to the extent that it is recognized and desired by the subjects themselves, which evidences the centrality of the Other as an instance of symbolic validation.

In this way, the violence associated with such regimes is not restricted to the physical dimension, but also manifests itself in the form of symbolic submission, in which individuals come to identify with the very mechanisms that dominate them. Such dynamics compromise the critical capacity of the subject, who ceases to position himself as a reflective agent and starts to reproduce, in a repeated way, the discourses that sustain the power structure.

The central problem shifts, in this context, to the modes of legitimation of discourse, which are no longer anchored in argumentative processes guided by critical reflection and start to privilege rhetorical strategies aimed at obtaining adherence and imposing certain meanings. In this scenario, the success of the discourse does not result from its rational consistency, but from its ability to assert itself as dominant, even in contexts of argumentative fragility.

In this way, subjects aligned with discursive structures of a totalitarian nature tend to operate in the sense of restricting the field of dissent, seeking to eliminate or delegitimize alternative perspectives, in order to preserve the appearance of unity and incontestability. Such dynamics may imply the use of symbolic mechanisms and, in certain contexts, coercive practices, which aim to prevent the emergence of competing discourses.

In this process, the construction of the enemy — or the "Other" — plays a fundamental role. The systematic disqualification of subjects or groups, through their reduction to categories devoid of legitimacy or recognition, contributes to the erosion of empathy and to the naturalization of exclusionary practices. Thus, violence, both symbolic and material, is justified as a necessary response to the neutralization of a previously dehumanized otherness.

3.2 THE WEAKENING OF THE OTHER TO DELEGITIMIZE DISCOURSES

Equality between individuals is a fundamental condition for the existence of dialogue, understood not only as a communicative exchange, but as a practice that presupposes mutual recognition between the interlocutors. From this perspective, the parity dimension does not refer to the individual characteristics of the subjects, but to the attribution of value and legitimacy to their positions in the discursive space. It is in this context that ideology plays a relevant social function, by enabling the articulation of subjects around common references, structuring forms of belonging that constitute social and political practices.

The legitimizing discourse, in turn, is often linked to institutional structures, operating as a mechanism for justifying socially accepted norms, values and practices. Such discourse can manifest itself in different spheres, from everyday interactions to more complex formulations in the political and legal spheres, conferring meaning and validity to certain social orders based on historically situated references.

However, the mere existence of legitimizing discourses is not enough to characterize a democratic environment. Democracy presupposes openness to dissent, to the plurality of perspectives and to the confrontation of ideas, indispensable elements for the construction of a dynamic public space. It is precisely within these conflicts — especially on the ideological level — that it becomes possible to observe the mechanisms of delegitimization of the other, a phenomenon that intensifies in totalitarian contexts.

In these scenarios, the maintenance of domination often relies on the construction of narratives that produce the perception of threat, directing collective attention to external or internal enemies. Such discourses tend to have a more intense impact on vulnerable groups, whose identity is progressively deconstructed through processes of stigmatization and disqualification. By weakening the legitimacy of their voices, their ability to participate in the public space is also limited.

As a consequence, the imposition of a homogeneous discursive order contributes to the fragmentation of social relations and to the internalization of fear, leading individuals to adopt defensive and unreflective postures. In this context, the weakening of alterity

compromises the conditions for the possibility of dialogue, replacing plurality with hierarchical relations marked by the asymmetry between authority and submission. Violence, both symbolic and material, thus emerges as an instrument for maintaining this structure, often legitimized by the previous dehumanization of those who come to be identified as a threat.

4 TOTALITARIAN SYMBOLISM

After analyzing the mechanisms of delegitimization of the other and the consolidation of authoritarian discourses, it becomes relevant to incorporate Claude Lefort's contributions on the symbolic dimension of power and its implications for the understanding of democracy and totalitarianism (LEFORT, 1981). Dialoguing with the political tradition, especially based on readings of Machiavelli, Lefort proposes a reflection on the transformations that mark the passage from absolutist forms of power to the democratic experience. In this context, democracy is understood as a regime marked by a singular symbolic structure, in which power is not incorporated into a fixed figure or instance, but is presented as an empty place (LEFORT, 1981). This means that, unlike absolutist forms – in which power was identified with the body of the sovereign – in democracy there is no subject who can claim its definitive possession. This characteristic implies the permanent opening of the political space to conflict, dispute and plurality of perspectives. Based on this conception, Lefort criticizes the attempts to recompose a fictitious unit of the social body, often associated with discourses that intend to represent the "people" as a homogeneous entity — the so-called Povo-Uno (LEFORT, 1981). In these cases, there is a tendency towards the symbolic reincarnation of power, which moves from the figure of the sovereign to structures such as parties or political leaders that claim to fully represent the collective will, making room for totalitarian dynamics.

It is in this horizon that the notion of disincorporation is inserted, developed by Lefort to describe the process by which power ceases to be anchored in a central figure and becomes the object of dispute within society. Such transformation, associated with the fall of absolutist regimes, breaks with the symbolic unity previously guaranteed by the sovereign and inaugurates an order in which individuals are no longer bound by a unified political identity.

In this scenario, the introduction of mechanisms such as universal suffrage does not imply the formation of a homogeneous collective will, but, on the contrary, reinforces the contingent and provisional character of political representation. Thus, democracy is configured as a regime that does not eliminate conflict, but institutionalizes it, recognizing the impossibility of a fully unified social identity.

From this process, the emergence of a people is configured that can no longer be fully captured or domesticated by an instance of centralized power, coming to exist in a condition marked by indeterminacy. In this context, collective identity ceases to present itself as a fixed unit and begins to be continuously tensioned and reconfigured within the political space, in which dispute, conflict and plurality constitute structuring elements of the democratic experience (LEFORT, 1981, p. 118).

In this context, although the people are now recognized as the holder of power in the symbolic sense, there is a tendency to seek stable references that can reduce the indeterminacy inherent to the democratic experience. Such a movement expresses the difficulty of dealing with the absence of absolute foundations, a central characteristic of democratic societies, in which power is no longer anchored in a fixed instance.

In response to this indeterminacy, attempts to stabilize the social emerge through the valorization of certain institutional and cultural references, which are invested with strong legitimacy. Examples of this can be found in the centrality attributed to institutions such as the family, property and certain forms of cultural organization, often mobilized as elements of cohesion and social order.

Such processes do not imply a direct return to absolutist forms of power, but reveal the recurrent search for foundations that can provide greater predictability and security to social life, thus stressing the constitutive opening of the democratic space.

Furthermore, the symbolic void characteristic of democratic regimes should not be understood as a deficiency, but as a constitutive condition of their own dynamics (LEFORT, 1981). It is precisely this indeterminacy that enables the emergence of divergent perspectives, promoting the plurality of ideas and openness to dissent, fundamental elements for the vitality of public space. In this sense, the centrality does not lie in the elimination of conflict, but in the guarantee of egalitarian conditions of participation, which allow the confrontation of positions anchored in reflective processes.

The risk, however, manifests itself when this indeterminacy ceases to operate on the symbolic level and translates into a practical disengagement of individuals in relation to political life (LEFORT, 1981). In these cases, the weakening of citizen participation and the retraction of interest in public space contribute to the weakening of democratic structures, opening space for the emergence of discourses that promise to restore unity and social stability.

Such discourses are often organized around the construction of a homogeneous collective identity – the so-called Povo-Uno⁹ – which seeks to suppress the constitutive

⁹ Concept used by Claude Lefort to designate the ideological construction of a fictitious unit of the social body.

plurality of society (LEFORT, 1981). In this process, the figure of the other, as a legitimate interlocutor and bearer of different perspectives, is progressively delegitimized, being replaced by a logic of uniformity that reduces diversity to a threat to be contained.

This tendency to construct a fictitious unit of the social body is also observed in contemporary analyses of populism. As Jan-Werner Müller points out, populist discourses operate from the claim to represent the "true people", while excluding those who do not align with this identity construction. Such dynamics reinforce the homogenization of the political space and weaken the legitimacy of dissent, approaching, in certain aspects, the logics of exclusion characteristic of totalitarian regimes (MÜLLER, 2016).

As a consequence, a dynamic is consolidated in which difference is emptied and the reproduction of hegemonic discourses becomes predominant, compromising the conditions for the possibility of dialogue and criticism. In this horizon, totalitarianism can emerge under the guise of defending one's own democratic values, mobilizing discourses of protection and cohesion that, paradoxically, operate in the sense of restricting the plurality and freedom that constitute the basis of democracy (LEFORT, 1981).

5 THE INCLUSION OF THE OTHER IN HABERMAS AND THE EXCLUSIONARY TOTALITARIAN SYSTEM

Starting from Claude Lefort's contributions on the constitutive indeterminacy of democracy and the implications of the standardization of thought, it is possible to move on to the approach developed by Jürgen Habermas, especially with regard to the autonomy of individuals and the emancipatory dimension of communication in modern society. Inserted in the context of the second generation of the Frankfurt School, Habermas proposes a reformulation of the philosophy of language, attributing centrality to the role of dialogue in the constitution of social practices guided by understanding.

In this sense, the author distinguishes different forms of knowledge, among which those guided by technical, practical and emancipatory interests stand out (HABERMAS, 1999). The emancipatory perspective, in particular, is linked to critical reflection on the conditions of domination, and the understanding of these structures is the first step towards overcoming them. Thus, rationality is not conceived as a neutral instance and detached from the social context, but as a process intrinsically related to the interests that guide the production of knowledge.

From this conception, Habermas develops the idea of communicative rationality, according to which mutual understanding between subjects is achieved through the use of language in conditions of argumentation free of coercion. Although the so-called "ideal

speech situation" is not fully realized at the empirical level, it functions as a normative horizon that guides communicative practices aimed at the validity of arguments and reciprocal recognition between the interlocutors.

In this context, the notion of intersubjectivity — later deepened as "inclusion of the other" — assumes a central role, as it shows that the construction of legitimate consensus depends on the participation of free and equal subjects in the communicative process. Democracy, from this perspective, is not reduced to a set of formal procedures, but is based on openness to dialogue, the possibility of questioning and the willingness to consider different perspectives.

In the contemporary context, such issues gain new dimensions with the advent of digital technologies and communication networks. As Manuel Castells analyzes, the network structure of today's societies expands the possibilities of participation and circulation of discourses, but also enhances the dissemination of polarized narratives and the formation of fragmented communicative spaces. In this scenario, the challenges to the construction of a public sphere guided by dialogue become even more complex, requiring the constant reaffirmation of inclusive communicative practices (CASTELLS, 2013).

In convergence with Lefort's analyses, Habermas points out that the exclusion of the other constitutes one of the central elements of totalitarian dynamics. The denial of plurality, the construction of rigid boundaries between groups and the hierarchization of cultures compromise the interdependence between individuals and make the formation of an inclusive public space unfeasible. Thus, the absence of egalitarian conditions of participation in the discourse implies the erosion of democratic bases, since, where there is no mutual recognition among the subjects, there is no effective possibility of democracy.

6 CONCLUSION

As outlined throughout the article, it was not intended to exhaust the contributions of the authors analyzed, but to highlight the centrality of language and discourse in the constitution of social and political relations, as well as their direct implication in the maintenance or weakening of democratic regimes. From the reflections of Michel Foucault and Ludwig Wittgenstein, it was possible to understand language as a situated social practice, in which meanings are produced, knowledge is organized and validity criteria are established that guide the interaction between subjects.

In continuity, the analyses of Hannah Arendt and Claude Lefort allowed us to identify the mechanisms by which totalitarianism is structured, especially through the suppression of plurality, the construction of a fictitious unity of the social body and the delegitimization of the

other as a valid interlocutor. In this context, it was evident that the weakening of the public space and the internalization of homogeneous discourses compromise the conditions for the possibility of critical thinking and democratic participation.

In turn, Jürgen Habermas' perspective offered a normative horizon from which to reaffirm the importance of dialogue, intersubjectivity and the inclusion of the other as foundations of democracy. Communication guided by understanding, although not fully achievable in ideal terms, is an essential parameter for the construction of social practices based on mutual recognition and discursive legitimacy.

Thus, it is argued that the maintenance of democratic environments depends directly on the preservation of discursive plurality, openness to dissent, and the recognition of alterity as a constitutive element of social life. On the other hand, contexts marked by the homogenization of thought, the centralization of power, and the naturalization of exclusionary discourses tend to favor the emergence of authoritarian dynamics.

Thus, the valorization of dialogue and critical reflection is not only presented as a theoretical requirement, but as a practical condition for the strengthening of democracy, insofar as it enables individuals to recognize themselves as active political subjects, capable of participating in the collective construction of the public space.

In the final analysis, the defense of plurality and dialogue is not presented only as a theoretical requirement, but as a normative imperative for the preservation of the conditions of possibility of democracy itself.

REFERENCES

- Arendt, H. (1989). *Origens do totalitarismo*. Companhia das Letras.
- Castells, M. (2013). *Redes de indignação e esperança: Movimentos sociais na era da internet*. Zahar.
- Foucault, M. (2002). *As palavras e as coisas* (S. T. Muchail, Trad.). Martins Fontes.
- Habermas, J. (1999). *Teoría de la acción comunicativa: Racionalidad de la acción y racionalización social* (Vol. 1). Taurus.
- Heidegger, M. (1986). *Ser e tempo* (M. S. C. Schuback, Trad., 8ª ed.). Vozes.
- Lefort, C. (1981). *A invenção democrática: Os limites do totalitarismo*. Brasiliense.
- Machado, R. (1981). *Ciência e saber: A trajetória da arqueologia de Foucault*. Graal.
- Müller, J.-W. (2016). *O que é populismo?* Companhia das Letras.
- Žižek, S. (1991). *O mais sublime dos histéricos*. Zahar.

Wittgenstein, L. (1996). *Investigações filosóficas* (M. Montagnolli, Trad.). Vozes.

THE CHILD AS AUTHOR: CHILDREN'S NARRATIVES AND CREATIVE WRITING IN PUBLIC SCHOOLS

A CRIANÇA AUTORA: NARRATIVAS INFANTIS E ESCRITA CRIATIVA NA ESCOLA PÚBLICA

EL NIÑO COMO AUTOR: NARRATIVAS INFANTILES Y ESCRITURA CREATIVA EN LAS ESCUELAS PÚBLICAS



<https://doi.org/10.56238/sevened2026.008-251>

Andréa King de Abreu Yamaguchi¹, Mariana Moraes Camacho Reis²

ABSTRACT

This article analyzes creative writing practices developed in public school contexts, understanding them as possibilities for the constitution of children as authors of their own experiences. The study adopts a theoretical-analytical approach grounded in the systematization of teaching experiences (Jara, 2006), articulated with pedagogical records and reflections from everyday school life. The theoretical framework draws on Freire's critical pedagogy, Bakhtin's dialogical perspective, Benjamin's reflections on childhood and experience, and Soares' literacy studies. The analysis highlights tensions between normative school practices and proposals that value children's lived experiences, indicating that writing, when connected to these experiences, fosters authorship, expression, and meaning-making. The study concludes that recognizing children as subjects of language requires shifting writing from an instrumental task to a space of creation, interpretation, and social participation.

Keywords: Creative Writing. Childhood. Literacy. Narrative. Public School.

RESUMO

Este artigo analisa práticas de escrita criativa desenvolvidas no contexto da escola pública, compreendendo-as como possibilidades de constituição da criança enquanto autora de suas experiências. O texto assume caráter teórico-analítico, ancorado na sistematização de experiências docentes, conforme perspectiva de Jara (2006), articulada a registros pedagógicos e reflexões produzidas no cotidiano escolar. O referencial teórico dialoga com a pedagogia crítica de Freire, a perspectiva dialógica de Bakhtin, as reflexões de Benjamin sobre infância e experiência e os estudos do letramento de Soares. A análise evidencia tensões entre práticas escolares normativas e propostas que valorizam a experiência infantil, indicando que a escrita, quando vinculada às vivências das crianças, favorece processos de autoria, expressão e produção de sentidos. Conclui-se que reconhecer a criança como

¹ Master's degree in Education. Universidade do Estado do Rio de Janeiro (UERJ).
E-mail: andyamaguchi@gmail.com Orcid: 0000-0002-5297-8794

² Master's degree in Education. Universidade Federal Fluminense (UFF). E-mail: moraesm378@gmail.com
Orcid: 0009-0008-7379-4020

sujeito de linguagem implica deslocar a escrita de um lugar instrumental para um espaço de criação, interpretação e participação social.

Palavras-chave: Escrita Criativa. Infância. Letramento. Narrativa. Escola Pública.

RESUMEN

Este artículo analiza las prácticas de escritura creativa desarrolladas en el contexto de las escuelas públicas, entendiéndolas como posibilidades para la constitución del niño como autor de sus propias experiencias. El texto adopta un carácter teórico-analítico, anclado en la sistematización de las experiencias docentes, según la perspectiva de Jara (2006), articulada con registros pedagógicos y reflexiones producidas en la vida cotidiana de la escuela. El marco teórico dialoga con la pedagogía crítica de Freire, la perspectiva dialógica de Bajtín, las reflexiones de Benjamin sobre la infancia y la experiencia, y los estudios de alfabetización de Soares. El análisis revela tensiones entre las prácticas escolares normativas y las propuestas que valoran la experiencia infantil, indicando que la escritura, cuando se vincula a las experiencias de los niños, favorece los procesos de autoría, expresión y construcción de significado. Concluye que reconocer al niño como sujeto del lenguaje implica trasladar la escritura de un lugar instrumental a un espacio de creación, interpretación y participación social.

Palabras clave: Escritura Creativa. Infancia. Alfabetización. Narrativa. Escuela Pública.

1 INTRODUCTION

Written production in public schools, especially in the classes of the early years of elementary school, has been configured, in pedagogical practice, as a field tensioned between school demands and the concrete experiences of children. From the systematization of teachers' experiences in a public school located in an urban context, it is observed the recurrence of situations in which writing is experienced by students as a normative task, often associated with the fulfillment of formal requirements, such as text extension, structural organization and linguistic correction.

The pedagogical records produced throughout the teaching practice show that, in the face of proposals for textual production, statements such as "how many lines do you need to have?", "does it have to be long?" or "can I write little?", are common, indicating a relationship with written language guided more by external demands than by the construction of meanings. Such manifestations, far from expressing simple disinterest, reveal ways of appropriating language mediated by school practices that do not always dialogue with children's experiences and repertoires.

At the same time, other situations present in the school daily life point to significant displacements when writing is proposed in articulation with students' daily experiences, memories, territories and interests. In these circumstances, greater engagement, expansion of participation and emergence of more authorial narratives are perceived, in which children mobilize elements of their social, cultural and affective life.

The systematized teaching experiences allow us to problematize the understanding of school writing as a homogeneous practice, indicating that its meaning depends, to a large extent, on the conditions of production and the pedagogical mediations that sustain it. From this perspective, resistance to writing can be interpreted not as an individual incapacity or demotivation, but as an effect of decontextualized practices that restrict language to an instrumental use.

In view of this scenario, this article proposes to analyze creative writing practices developed in the daily life of classes in the early years, understanding them as possibilities for the constitution of the child as the author of their own narratives. The study, based on the systematization of experiences and reflections produced in school practice, contributes to the pedagogical debate without intending statistical generalizations. From a theoretical-analytical approach, it seeks to show how proposals that value the children's experience can favor processes of authorship, expression and construction of meanings in the school space.

2 CHILDHOOD, LANGUAGE AND EXPERIENCE: THEORETICAL BASES

From pedagogical experiences recorded with classes of the early years in public schools, normative conceptions of writing are tensioned, valuing its power as a practice of meaning in the children's experience.

In this sense, Freire's (1987) contribution is fundamental in stating that the reading of the world precedes the reading of the word. Such a formulation allows us to understand that the act of writing does not begin in the domain of the code, but in the relationship that the subjects establish with their reality. Pedagogical records show that, when written language distances itself from children's experiences, it tends to be perceived as a mechanical activity; on the other hand, when it approaches their life contexts, its meaning expands.

In dialogue with this understanding, Bakhtin (1997) understands language as an essentially dialogical phenomenon, constituted in the interaction between subjects and crossed by multiple social voices. The practices observed in the school daily life show that children's writing cannot be understood as an isolated production, but as a situated enunciation.

Benjamin's (2002) reflections on childhood contribute by evidencing the inventive and creative character of children. When observing pedagogical practices in which writing is articulated with playfulness and imagination, it is perceived that they mobilize expressive resources that escape traditional school models.

In the field of literacy studies, Soares (1998), in dialogue with Kleiman (1995) and Street (1984), highlights that writing should be understood as a social practice, which implies considering not only its technical dimension, but also its uses, functions and meanings. From this perspective, literacies are multiple and crossed by power and cultural relations.

The pedagogical experiences examined indicate that, when inserted in significant literacy practices, children become more actively engaged, appropriating writing as a form of expression and social participation, as Barton and Hamilton (1998) also point out when discussing everyday literacies.

Articulating these references, it is understood that creative writing can constitute a space of mediation between experience, language and identity.

3 METHODOLOGICAL PATHS

The present study is part of the field of qualitative approaches and is configured as a theoretical-analytical essay, based on the systematization of teaching experiences, as proposed by Jara (2006).

It is based on the understanding that the school daily life constitutes a legitimate space for the production of knowledge, and it is possible, from its critical analysis, to construct interpretations of educational processes.

The analytical corpus is composed of pedagogical records, reflective notes and textual productions developed in creative writing practices, taken as materialities that allow problematizing the relationship of children with written language.

The study is guided by an interpretative perspective of thematic inspiration, seeking to identify recurrences, tensions and meanings produced in the observed practices, in dialogue with the theoretical framework.

4 BETWEEN RESISTANCE AND POSSIBILITY: MEANINGS OF WRITING

The records produced in the school daily life show that the children's relationship with writing is marked by ambivalence, expressed in different situations experienced at school. In more traditional proposals, centered on the reproduction of models or the fulfillment of formal criteria, recurrent manifestations of resistance emerge, often associated with fatigue, difficulty and little identification with the activity.

Such statements, when analyzed in the light of Bakhtin (1997), can be understood as social voices that express not only individual perceptions, but shared experiences within historically constituted school practices. As Possenti (2012) argues, the learning of writing is not effective through decontextualized exercises, but in significant practices of language use, which helps to explain the resistances observed when writing is proposed in a mechanical way and disconnected from experience. In this way, resistance to writing reveals tensions between different conceptions of language: on the one hand, a normative and instrumental perspective; on the other, the possibility of writing as a practice of expression and production of meanings.

On the other hand, different episodes observed indicate that, when writing is proposed based on significant experiences — such as memories, daily experiences or topics of interest to students — there is a shift in the way students relate to the activity. In these circumstances, there is greater involvement, increased dedication time, and greater complexity in productions.

This change can be understood, in the light of Freire (1987), as a result of the approximation between language and experience, to the extent that subjects begin to write from their reading of the world. Thus, writing is no longer perceived as an imposed task and becomes a significant practice.

5 CREATIVE WRITING AND NARRATIVE PRODUCTION

The systematization of pedagogical experiences indicates that creative writing, when incorporated into school practices, can favor processes of authorship and student engagement.

The records analyzed reveal that the textual productions present elements such as repetition, rhythm, rhyme and a strong presence of orality, which evidences a process of appropriation of written language still under construction, but deeply significant. Instead of being interpreted as flaws, such characteristics can be understood, according to Soares (1998), Kleiman (1995) and Tfouni (1995), as a constitutive part of literacy practices.

In this context, creative writing is configured as a practice that expands the possibilities of expression, allowing children to experiment with different ways of saying the world. The thematic diversity present in the productions reinforces the idea that the text gains meaning when linked to experience.

In addition, the incorporation of playful practices in the writing process contributes to displacing the activity from a strictly normative place to a space of creation. In dialogue with Benjamin (2002), it is possible to understand this movement as an expression of the inventive character of childhood.

6 WRITING, IDENTITY AND SOCIAL CRITICISM

The productions examined indicate that children's writing can be constituted as a space for identity construction and critical elaboration of reality. The narratives produced by the children reveal perceptions about everyday life, social relationships and life experiences, indicating that the text operates as a form of interpretation of the world.

In dialogue with Freire (1987), it can be stated that such productions are configured as expressions of the reading of the world carried out by the subjects, showing that writing is not restricted to linguistic codification, but involves processes of signification and positioning.

The monitored practices indicate that, when inserted in pedagogical proposals that value their experiences, children begin to recognize themselves as authors, assuming a more active position in the production of knowledge. This movement contributes to the strengthening of self-esteem, belonging, and participation.

In addition, the presence of themes related to inequalities, daily challenges and social relations points to the critical dimension of children's writing. Although expressed in an initial way, such narratives reveal the children's ability to reflect on the world in which they live, articulating language and experience.

7 FINAL CONSIDERATIONS

The present study showed that creative writing practices, when articulated with children's experiences, can favor significant processes of authorship, expression and production of meanings in the school context.

The pedagogical records allowed us to understand that resistance to writing should not be interpreted as an individual disability, but as an effect of decontextualized practices that limit language to an instrumental use.

On the contrary, when writing approaches the students' experiences, a shift in its meaning is observed, becoming a space for creation, interpretation and social participation.

As a limitation, it is highlighted that the analysis is anchored in experiences situated in the school routine, not having as its objective the generalization of the results, but the problematization of practices and meanings.

Even so, the study contributes to the educational field by reinforcing the importance of pedagogical practices that recognize children as subjects of language, capable of narrating, interpreting and transforming the world in which they live.

REFERENCES

- Bakhtin, M. (1997). *Estética da criação verbal*. Martins Fontes.
- Barton, D., & Hamilton, M. (1998). *Local literacies: Reading and writing in one community*. Routledge.
- Benjamin, W. (2002). *Reflexões sobre o brinquedo, a criança e a educação*. Editora 34.
- Freire, P. (1987). *Pedagogia do oprimido*. Paz e Terra.
- Freire, P. (1996). *Pedagogia da autonomia: Saberes necessários à prática educativa*. Paz e Terra.
- Jara, O. (2006). *Para sistematizar experiências* (2ª ed.). Ministério do Meio Ambiente.
- Kleiman, A. B. (1995). *Os significados do letramento: Uma nova perspectiva sobre a prática social da escrita*. Mercado de Letras.
- Possenti, S. (2012). Sobre o ensino de português na escola. In J. W. Geraldi (Org.), *O texto na sala de aula*. Anglo.
- Soares, M. (1998). *Letramento: Um tema em três gêneros*. Autêntica.
- Street, B. (1984). *Literacy in theory and practice*. Cambridge University Press.
- Tfouni, L. V. (1995). *Letramento e alfabetização*. Cortez.

REVISITING TO UNDERSTAND: EMOTIONS AND IDENTITY CONSTRUCTION PROCESSES OF YOUNG QUILOMBOLA PEOPLE 16 YEARS LATER

REVISITAR PARA COMPREENDER: EMOÇÕES E PROCESSOS DE CONSTRUÇÃO IDENTITÁRIA DE JOVENS QUILOMBOLAS 16 ANOS DEPOIS

REVISITANDO PARA COMPRENDER: EMOCIONES Y PROCESOS DE CONSTRUCCIÓN DE LA IDENTIDAD DE JÓVENES QUILOMBOLAS 16 AÑOS DESPUÉS



<https://doi.org/10.56238/sevened2026.008-252>

Ana Paula Moraes Camacho Estrela¹, Andréa King de Abreu Yamaguchi², Mariana Moraes Camacho Reis³, Tatiana Moraes Camacho de Castro⁴

ABSTRACT

This article revisits a master's thesis defended 16 years ago, aiming to analyze, from the perspective of the sociology of emotions, the affective dimension present in the narratives of subjects from a quilombola community in the southern region of Rio de Janeiro state, Brazil. The original research, qualitative in nature, was based on interviews with young people and local leaders, addressing themes such as family, territory, culture, and community participation. In this study, a reinterpretation of these interviews is proposed, seeking to identify emotions that permeate the narratives, such as shame, pride, belonging, and fear, especially regarding cultural practices such as jongo and the construction of quilombola identity. Methodologically, an interpretative analysis inspired by content analysis (Bardin, 1979) is carried out, articulated with a reflexive perspective on the researcher's position in the knowledge production process. The results show that emotions play a central role in the constitution of social experiences and in the re-signification of cultural practices, being fundamental to understanding identity affirmation processes. The temporal distance allowed for an expansion of the analytical perspective, revealing dimensions that were not addressed in the original research.

Keywords: Emotions. Quilombola Identity. Jongo. Territory. Reinterpretation of Research.

RESUMO

Este artigo revisita uma dissertação de mestrado defendida há 16 anos, com o objetivo de analisar, à luz da sociologia das emoções, a dimensão afetiva presente nas narrativas de

¹ Specialist in Visual Arts and Art Therapy, Specialist in Civil Law and Civil Procedure. FACUMINAS, Ordem dos Advogados do Brasil (OAB-RJ). E-mail: camachoestrela40@gmail.com Orcid: 0009-0008-9236-9433

² Master's degree in Education. Universidade do Estado do Rio de Janeiro (UERJ). E-mail: andyamaguchi@gmail.com Orcid: 0000-0002-5297-8794

³ Master's degree in Education. Universidade Federal Fluminense (UFF). E-mail: moraesm378@gmail.com Orcid: 0009-0008-7379-4020

⁴ Specialist in Teacher Training in Entrepreneurship and Management for High School, Specialist in Art Therapy. Universidade Federal Fluminense, Faculdade FACUMINAS. E-mail: tatiana_moraescamacho@yahoo.com.br Orcid: 0009-0001-7025-8627

sujeitos de uma comunidade quilombola no sul do estado do Rio de Janeiro. A pesquisa original, de caráter qualitativo, foi desenvolvida a partir de entrevistas com jovens e lideranças locais, abordando temas como família, território, cultura e participação comunitária. Neste trabalho, propõe-se uma releitura dessas entrevistas, buscando identificar emoções que atravessam os discursos, tais como vergonha, orgulho, pertencimento e medo, especialmente no que se refere às práticas culturais como o jongo e à construção da identidade quilombola. Metodologicamente, realiza-se uma análise interpretativa inspirada na análise de conteúdo (BARDIN, 1979), articulada a uma perspectiva reflexiva sobre o lugar da pesquisadora no processo de produção de conhecimento. Os resultados evidenciam que as emoções desempenham papel central na constituição das experiências sociais e na ressignificação de práticas culturais, sendo fundamentais para compreender os processos de afirmação identitária. A distância temporal possibilitou uma ampliação do olhar analítico, evidenciando dimensões não tematizadas na pesquisa original.

Palavras-chave: Emoções. Identidade Quilombola. Jongo. Território. Releitura de Pesquisa.

RESUMEN

Este artículo revisita una tesis de maestría defendida hace 16 años, con el objetivo de analizar, desde la perspectiva de la sociología de las emociones, la dimensión afectiva presente en las narrativas de sujetos de una comunidad quilombola en el sur del estado de Río de Janeiro, Brasil. La investigación original, de carácter cualitativo, se basó en entrevistas con jóvenes y líderes locales, abordando temas como familia, territorio, cultura y participación comunitaria. En este trabajo, se propone una reinterpretación de estas entrevistas, buscando identificar las emociones que atraviesan los discursos, tales como vergüenza, orgullo, pertenencia y miedo, especialmente en lo que respecta a prácticas culturales como el jongo y la construcción de la identidad quilombola. Metodológicamente, se realiza un análisis interpretativo inspirado en el análisis de contenido (Bardin, 1979), articulado con una perspectiva reflexiva sobre el lugar de la investigadora en el proceso de producción de conocimiento. Los resultados evidencian que las emociones desempeñan un papel central en la constitución de las experiencias sociales y en la resignificación de las prácticas culturales, siendo fundamentales para comprender los procesos de afirmación identitaria. La distancia temporal permitió una ampliación de la mirada analítica, evidenciando dimensiones que no fueron problematizadas en la investigación original.

Palabras clave: Emociones. Identidad Quilombola. Jongo. Territorio. Reinterpretación de la Investigación.

1 INTRODUCTION

The production of knowledge in qualitative research does not end with its writing: the data remain open to new interpretations, especially when revisited under different theoretical references and altered historical contexts.

This article proposes a rereading of a master's dissertation defended 16 years ago, focused on cultural practices – such as jongo –, family relationships and identity construction in a quilombola community in the south of Rio de Janeiro. At the time, the analysis prioritized sociocultural and educational dimensions, without systematically exploring the affective dimensions in the narratives of young people.

When revisiting the interviews, emotions such as pride, shame, belonging and fear are evidenced, which cross the discourses and structure social experiences. Inserted in the sociology of emotions – which understands them as social constructions that organize practices and relationships (AGUILAR; VILLAGRÁN, 2013) – this study answers: how do these emotions cross the identity of young quilombolas and how are they resignified after 16 years?

The time interval problematizes the role of time in the analytical view, unveiling new readings of social experiences and reinforcing the affective relevance for quilombola education and identity politics.

2 THEORETICAL FRAMEWORK

The sociology of emotions understands that emotions are not only individual experiences, but socially produced and shared phenomena (AGUILAR; VILLAGRÁN, 2013).

By articulating emotions, body and space, Aguilar and Villagrán (2013) highlight that territories are lived in an affective way, being crossed by memories, bonds and sensitive experiences. This perspective is fundamental to understanding the relationship of young people with the quilombola territory.

In the field of aesthetic and sensitive experience, Didi-Huberman (2016) argues that emotions produce displacements and transformations in the ways of seeing and feeling, allowing new interpretations of reality.

Kaplan (2013), when dealing with youth, shows that emotions such as fear, insecurity and belonging are directly related to forms of social insertion. Certeau (1994) contributes by highlighting everyday practices as spaces for the production of meaning, in which subjects reinvent their experiences.

3 METHODOLOGY

This study is characterized as a qualitative research of an interpretative nature, based on the rereading of interviews conducted in the context of a master's dissertation developed 16 years ago. The corpus is composed of semi-structured interviews with young people and leaders of a quilombola community, addressing topics such as family, territory, culture and social participation.

The analysis was guided by the assumptions of content analysis (BARDIN, 1979), focusing on the identification of emotional categories emerging in the narratives, such as shame, pride, belonging and fear. However, more than a thematic reclassification of the data, it is proposed here a displacement of the analytical gaze, by taking emotions as the central axis of interpretation.

In this sense, the research also assumes a reflective character, by recognizing that the data are not neutral, nor are they exhausted in a single reading. The rereading of the interviews, after an interval of 16 years, shows that certain dimensions — especially the affective ones — were already present in the discourses, but were not thematized in the original analysis.

This movement implies recognizing the place of the researcher as a constitutive part of the process of knowledge production. At the time of the initial research, the gaze was guided by other theoretical and analytical concerns, which directed attention to certain aspects to the detriment of others. In the present work, by adopting the perspective of the sociology of emotions, it becomes possible to identify and problematize elements that previously remained implicit.

Such repositioning dialogues with the understanding that knowledge is situated and historically constructed, being crossed by the experiences, formations and displacements of the researcher herself. In this sense, temporal distance is not understood as an obstacle, but as a condition of possibility for the expansion of the analytical view, allowing new interpretations of the data.

In addition, when revisiting the interviews, the researcher also revisits herself, her methodological choices and her ways of listening. This process shows that analysis is not only a technical exercise, but also a movement of implication, in which memory, experience and sensibility are intertwined.

4 ANALYSIS AND DISCUSSION

4.1 SHAME AND PRIDE: EMOTIONS IN THE RESIGNIFICATION OF JONGO

The narratives show a movement of emotional transformation in relation to jongo, which goes from an experience marked by shame to an experience crossed by pride and belonging.

One of the young women interviewed explains this process when she states: "before I was ashamed to dance jongo [...] Now I'm more proud to talk about jongo, to dance jongo." This displacement reveals the socially constructed character of emotions, which are transformed as the subjects resignify their cultural practices (AGUILAR; VILLAGRÁN, 2013). The jongo, in this context, ceases to be just a cultural manifestation to constitute a space for identity affirmation.

Similarly, the report of another interviewee highlights the weight of stigma: "they said that jongo was macumba [...] I didn't question it myself, I thought it wasn't from my stronghold." The negative association reveals how certain emotions — such as fear and rejection — are socially produced, especially in contexts marked by historical prejudices. The subsequent approximation with jongo transforms this perception, evidencing the role of experiences in the reconstruction of the senses (DIDI-HUBERMAN, 2016).

4.2 BELONGING AND AFFECTIONS: THE EMOTIONAL DIMENSION OF THE COMMUNITY

The interviews also highlight the centrality of emotions in the construction of community bonds, in which the notion of family goes beyond blood ties and expands to the collective.

One of the participants describes the community as a space of strong affective connection: "even those who are not related know each other [...] many care about one another". This excerpt shows that belonging is not only a social condition, but also an emotional one, being sustained by relationships of care, recognition and daily coexistence. In this sense, the community is experienced as a space of affection, in which emotions structure social relations (KAPLAN, 2013).

In addition, the way in which young people refer to families reinforces the symbolic and affective dimension of the territory, which is constituted not only as a physical space, but as a lived space (AGUILAR; VILLAGRÁN, 2013).

4.3 EMOTIONS AND ENGAGEMENT: THE CONSTRUCTION OF A COLLECTIVE CONSCIOUSNESS

Another relevant aspect refers to the articulation between emotions and processes of political engagement. The construction of a critical consciousness appears, in the narratives, deeply crossed by emotional experiences.

One of the interviewees says: "I'm not going to keep doing certain things because there are a lot of people who need me out there." The speech evidences a feeling of social responsibility that guides their choices and trajectories. This type of emotion — which articulates belonging, commitment, and identification — contributes to the formation of politically engaged subjects.

At another point, the same interviewee associates his participation with the recognition of his voice: "I had a space to show what I thought [...] People gave me importance." This recognition produces emotional effects that strengthen identity and encourage participation, evidencing that emotions are central elements in the constitution of social practices (CERTEAU, 1994).

5 FINAL CONSIDERATIONS

The rereading of the interviews, carried out in the light of the sociology of emotions, made it possible to show that the affective dimensions are not peripheral aspects of social experiences, but central elements in the construction of the quilombola identity. Emotions such as shame, pride, belonging and fear cross the narratives of the subjects, organizing their relationships with the territory, with cultural practices and with the collectivity.

By analyzing these narratives, it becomes possible to understand that processes such as the resignification of jongo, the construction of community bonds and social engagement do not occur only in the realm of practices or discourses, but also in the field of emotions, which guide perceptions, choices and positions. In this sense, emotions emerge as constitutive dimensions of social life, contributing to the affirmation of identity and to the production of meanings about belonging.

The temporal distance of 16 years between the production of the data and its reinterpretation proved to be fundamental for the broadening of the analytical view. This interval made it possible not only to identify aspects that were not previously thematized, but also to problematize the very limits of the analysis carried out in the past. When revisiting the interviews, it is evident that emotions were already present in the discourses, although in an unnamed or secondary way, revealing that the data are not exhausted in a single reading.

This movement of return to data necessarily implies a repositioning of the researcher, who begins to recognize her own intellectual trajectory as part of the process of knowledge production. Revisiting the research is also revisiting the theoretical choices, the ways of listening and the forms of interpretation that guided the original work. Thus, this article not only analyzes

the emotions of the subjects researched, but also explains the shift of the researcher's own gaze, evidencing the situated, processual and unfinished character of scientific knowledge.

Finally, the study reinforces the importance of revisiting previous research as a strategy for theoretical and methodological deepening, especially when articulated with new analytical frameworks. By highlighting the centrality of emotions in the construction of quilombola identity, the article contributes to the field of sociology of emotions and to studies on education and territory, indicating that understanding the affective dimensions of social experiences is fundamental for the analysis of educational, cultural and political processes in contexts marked by memory, resistance and belonging.

REFERENCES

- Aguilar, M., & Villagrán, P. (Orgs.). (2013). *Cuerpos, espacios y emociones: Aproximaciones desde las ciencias sociales*. Universidad Autónoma Metropolitana.
- Bardin, L. (1979). *Análise de conteúdo*. Edições 70.
- Certeau, M. de. (1994). *A invenção do cotidiano: Artes de fazer* (9ª ed.). Vozes.
- Didi-Huberman, G. (2016). *Que emoção! Que emoção?*. Editora 34.
- Instituto do Patrimônio Histórico e Artístico Nacional (IPHAN). (2005). *Jongo no Sudeste*. IPHAN.
- Kaplan, C. (2013). Os jovens e os seus medos sociais: Da morte e de serem excluídos. *Revista Teias*, 14(32), 252–264.

REALIZAÇÃO:



ACESSE NOSSO CATÁLOGO!



WWW.SEVENPUBLI.COM

CONECTANDO O **PESQUISADOR** E A **CIÊNCIA** EM UM SÓ CLIQUE.